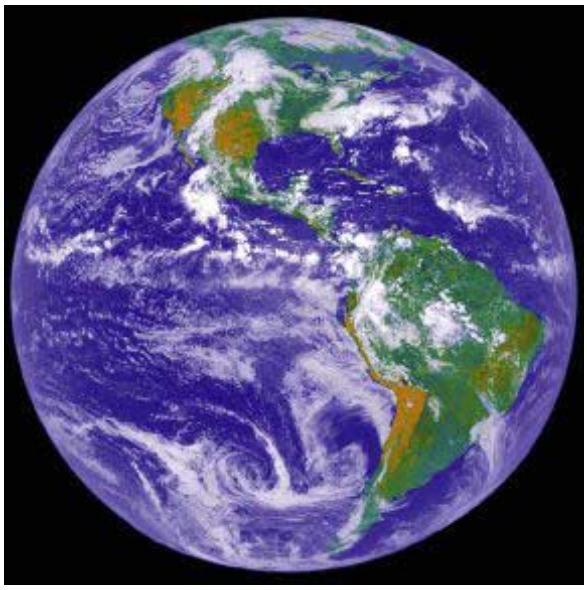
The Development of the U.S. Global Change Research Program: 1987 to 1994



A Policy Case Study Prepared for the 2001
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Preface

The Goal of the Case Study

This case study is written for those with an interest in how scientific research is related to policy development through the institutions of U.S. government. Specifically, the case study focuses on the development of U.S. Global Change Research Program (referred to throughout as the Program), the primary U.S. response to the issue of global climate change, from 1987 to 1994. Thus, the case is designed to provoke discussion and debate among all with an interest in the relation of science and policy.

The case study is motivated by two important concerns. First, in an era of demands for greater accountability of government to the public, the scientific community finds itself relatively unprepared to effectively justify its importance to society. Since World War II, U.S. science policy has taken place under the provisions of the so-called "social contract" espoused in Vannevar Bush's classic report *Science: The Endless Frontier* (Byerly and Pielke 1995). The social contract holds that if government provides the scientific community resources and relative autonomy, then society will realize benefits that exceed the original investment. For many decades this arrangement seemed to work. However, in recent years changes in the environment of science policy presage the rewriting of the social contract in a manner that more closely links the two-way relation of societal needs with scientific research. Public and policy maker support of research depends upon the ability of scientific community to create realistic expectations about what science can and cannot do to address the societal problems often invoked in the justifications used to secure public support (Pielke and Glantz 1995).

Much of our understanding of the connections between science and policy has been shaped by a distinction between "policy for science" and "science for policy" (Brooks 1964). The former refers to issues of resource allocation, peer review, etc. within science, while the latter refers to the production of useful knowledge to contribute to decision making. These frameworks are frequently used in both a practical and an analytical sense to describe the linkage between science and policy. The approach taken in this case study seeks to integrate the two frames of reference, in explicit acknowledgement that the policies government adopts for the conduct of scientific research shapes how the results of that research feed back into policy development -- a process elsewhere we called "policy for science for policy" (Pielke and Betsill, 1997).

A second motivation for this case is concern that important dimensions of the issue of global climate change have been overlooked in what has become a contentious and largely unproductive debate (from the standpoint of policy action) over the scientific aspects of global warming. As a scholar who studies the relation of the atmosphere and society and also as a concerned citizen, I hold an interest in the potential dangerous impacts that human activity might have on the atmosphere and global environment, as well as the impacts that the atmosphere has on society and environment. Thus, I have written this case as a supporter of the overarching mandate of the U.S. Global Change Research Program, as codified in law:

to provide for development and coordination of a comprehensive and integrated United

States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change (P.L. 10-606).

Meeting this mandate is the explicit normative grounding of this book.

If society considers important the problems associated with global environmental change, and particularly those associated with climate, then it is imperative that policies in response be effective. Under the U.S. Constitution, effective policy is not guaranteed by the simple act of passing a law, but through constant attention to implementation of policies with respect to goals and the appropriateness of the goals themselves. When one or more branches of government fails to pay sufficient attention to implementation of policy, it is the law which provides the public or other branches of government the leverage necessary to redirect that attention.

In the case of the U.S. Global Change Research Program, a law was passed which represented compromise among a wide range of opinion about how to respond to the issue of global climate change. This law could have been a starting point for the evolution of innovative, creative, and effective policies to respond to climate change. Yet, this opportunity, at least during the period 1987-1994 discussed in this case, was largely missed for the simple reason that, for the most part, all participants in the global change policy process neglected the Program's overarching mandate. Thus, the Program has evolved based on the perspectives of science administrators, who focused on attaining a predictive understanding of climate. If successful in that endeavor, the result will be Pyrrhic victory of improving science of global change but making little systematic progress on what to do to shape that future.

More broadly, the mandate given the U.S. Global Change Research Program matters for the same reason that the U.S. Constitution matters: It is an agreement between citizens and their government as negotiated by their elected represented officials. The law is the foundation of democratic society. It is the essential means for citizens to hold elected officials accountable and for different parts of government to hold each other accountable to their commitments. If government does not seek in good faith that which it commits to, then the will of the people, as expressed through their representatives means little.

Laws, as the authors of the *Federalist Papers* argued, are not perfect instruments of policy. Rather a law is an approximation of the public interest that must be continuously revisited and refined. Academicians have called this process many things -- incrementalism, boundedly rational, the joining of policy streams, and even a garbage can. Perhaps the simplest description is that the process is one of search and discovery -- a search to discover what we value and how we might achieve those things that we value.

The Approach Taken

The case tells the story of the U.S. Global Change Research Program from 1987-1994 in narrative form. Underlying the narrative is a framework of policy process evaluation that is characterized "by examining how well or poorly the policy process is operating, and by guiding attention to the formal and effective factors responsible for results" (Lasswell 1971). In today's

environment of science policy, decision makers have identified the evaluation of science programs with respect to their contribution to policy goals as an area of critical importance (e.g., GAO 1997). The evaluation of the U.S. Global Change Research Program focuses both on policy process and policy outcomes.

The story of the U.S. Global Change Research Program is a synthesis based on materials found in the public record (notably congressional and administrative documents), published analyses, and as related first-hand to the author in interviews with numerous outside observers, as well as individuals closely involved with the program, from their perspectives on science, administration, and policy. The interviews were conducted over the period 1993-1997, some on record and some off record. I have chosen not to identify by name many interview sources cited in the text out of consideration for their candor and in recognition that the U.S. Global Change Research Program is an ongoing effort with many interviewees having continued involvement in the Program. In the text the interviews are cited simply as ([I]nterview with [A]uthor [year]), e.g., (IA 1994).

In spite of our relatively poor understanding of how science is related to societal goals generally, the position taken here is that our understanding of the policy process is sufficiently well developed to all for improvements in the implementation of particular programs (cf., Ascher 1986, Brunner 1991). That is to say, to improve the performance of individual programs implementers of science programs need not wait for a successor to Vannevar Bush to develop a new science policy paradigm or for public policy scholars to develop a new comprehensive theoretical understanding of the science-policy relationship. Instead, based on what is already known of the policy process, implementers have had at their disposal means to improve program performance. This is clearly the case with the U.S. Global Change Research Program.

Acknowledgements

Many people contributed in large and small ways to the preparation of this case study and the research on which it is based. The case has its origins in research I conducted for my doctoral dissertation at the University of Colorado (Political Science, 1994), and reinterpreted from the perspective of spending the seven subsequent years working as a participant/observer at the National Center for Atmospheric Research conducting policy research in the atmospheric sciences and global change communities. The case study draws in particular on the following publications:

Pielke, Jr., R. A. 2000. Policy history of the U.S. Global Change Research Program: Part I, Administrative development, *Global Environmental Change* **10**: 9-25.

Pielke, Jr., R. A. 2000. Policy history of the U.S. Global Change Research Program: Part II, Legislative process, *Global Environmental Change* **10**:133-144.

Pielke, Jr., R. A., R. Klein, and D. Sarewitz, 2000. Turning the big knob: An evaluation of the use of energy policy to modulate future climate impacts, *Energy and Environment* **11**: 255-276.

Sarewitz, D. and R. A. Pielke, Jr. 2000. Breaking the Global Warming Gridlock, *The Atlantic Monthly*, July.

Sarewitz, D., R. A. Pielke, Jr., and R. Byerly, (editors) 2000. **Prediction: Science, Decision Making and the Future of Nature** (Washington, DC: Island Press).

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Betsill, M. M. and R. A. Pielke, Jr. 1998. Blurring the boundaries: Domestic and international ozone politics and lessons for climate change, *International Environmental Affairs*, **10**:147-172.

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Pielke Jr., R. A. 1995. Usable information for policy: An appraisal of the U.S. Global Change Research Program, *Policy Sciences*, **38**: 39-77.

Pielke Jr., R. A. and M. H. Glantz, 1995. Serving science and society: Lessons from Large-Scale Atmospheric Science Programs, *Bulletin of the American Meteorological Society* **76**:2445-2458.

Byerly, R., Jr. and R. A. Pielke Jr., 1995. The changing ecology of United States science, *Science*, **269**: 1531-1532,
Pielke Jr., R. A. 1994. Scientific information and global change policymaking, *Climatic Change*, **28**:315-319.

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This case study was made possible by the open, trusting, and supportive atmosphere for research at the National Center for Atmospheric Research and its Environmental and Societal Impacts Group. In addition, officials in the U.S. Global Change Research Program, congressional and executive branch staff, interviewed for this book showed the utmost respect for independent policy inquiry, which even when investing what is now rapidly becoming policy history, can at times be uncomfortable, particularly given that the Program continues to find itself in an annual political process. I'd also like to acknowledge the American Meteorological Society for the motivation to prepare this case study and for providing an opportunity to share it with others with an interest in the interconnections of science and policy.

Chapter 1

I. Introduction

On a hot day in June, 1988 NASA scientist James Hansen testified before a U.S. Senate Committee that he was "99%" certain that global warming was underway (Hansen 1988).[1] In the record hot summer of 1988, Hansen's testimony elevated the subject of global warming, and the specter of associated impacts such as more hurricanes, floods, and heat waves, to unprecedented levels of attention from the public, media, and policy makers. In the years that followed Hansen's testimony, the U.S. government committed itself to one of the most ambitious programs of research ever conducted and then signed an international treaty with the goal of limiting global warming. In spite of these commitments, a problem existed because through at least 1994, analyses of the design of these policies suggested that they were bound to fail.

This case study tells the story of the U.S. Global Change Research Program, the centerpiece of the U.S. response to global warming. Important elements of the story include personalities, bureaucracies, Presidents, members of congress, advocacy groups, and experts. At its core, it is a story of how science was enlisted in support of policy development through the institutions of U.S. government. The book argues that the early design of U.S. response to global warming was bound to fail because it has misdefined the role of science in the policy process. The U.S. response is based on the ability of science to force a political consensus on the causes and impacts of global warming. Following Hansen's call to action, a political consensus in support of the U.S. response remained as distant as ever, and attention to the issue of global warming diminished.

The central thesis of this case study is that how policy makers, administrators, and scientists define the role of science in the policy process is critical to success or shortfalls of policies that depend on scientific input. Policy makers established the Program to support policy development, and its administrators subsequently structured the Program to develop predictive knowledge of the earth's climate.[2] However, rather than forcing a political consensus, scientific research has been selectively used (and misused) by opposing camps in the global warming debate largely to support previously held positions. As a result the Program through 1994 achieved notable bureaucratic and scientific successes while falling short of its ultimate goal to support policy development.

The Program is in many respects a tremendous success story. It represents years of hard work, political maneuvering, and scientific progress by individuals and institutions that feel strongly that global warming is an important matter of societal concern. At the same time, the Program through 1994 did not meet its mandate; it has not met the needs of policy makers. As one Congressman asked in 1992,

> How much longer do you think it will take before [the USGCRP is] able to hone [its] conclusions down to some very simple recommendations, on tangible, specific action programs that are rational and sensible and cost effective for us to take . . . justified by what we already know (quoted in Chapter 3)?

As the Program was originally designed, the answer might have been "never": because the Program was structured to develop a predictive understanding of the earth's climate, and not to provide recommendations on "action programs," it did not systematically provided information useful to policy makers. This represented a performance shortfall in program implementation, which persisted because of breakdowns in the policy process.

II. The U.S. Program in International Context

The issue of global warming has motivated a variety of domestic and international responses. Beginning in 1992, more than 150 nations of the world have become engaged in a process of negotiation under the terms of the United Nations Framework Convention on Climate Change. The goal of the Convention process is to prevent human activities from "dangerous interference" in the climate system. The United Nations also played an important role in the creation of the Intergovernmental Panel on Climate Change (IPCC), one of the most ambitious scientific assessment bodies ever created, in order to provide an authoritative summary of science associated with climate change. Representing approximately half of the world's research on climate change, the U.S. Global Change Research Program plays an important role in the domestic policy process as well as in the IPCC and Framework Convention.[3]

III. A Reader's Guide to the Case Study

The case study examines the relationship between climate change science and policy in the United States through an evaluation of the Program from 1987-1994. Implementation of the Program is important because the program is the primary U.S. response to the issue of climate change. More broadly, this evaluation has potential to inform understanding of the role of science in the international climate change negotiations and the relation of science and society more generally.

Background

On 16 November 1990 President George Bush signed the Global Change Research Act of 1990 (P.L. 101-606) that established in law the Committee on Earth and Environmental Sciences (hereafter, the Committee) to oversee the U.S. Global Change Research Program. The Program was initiated by several federal agencies in the late 1980s in response to concerns in the national and international scientific community about climate change, ozone depletion, and other global changes.[4] As a result of such concerns Congress in the late 1980s directed the Program to provide information that it could use in the formulation and execution of policy responses. Subsequent to its legal establishment the Committee oversaw a doubling in the Program's budget. In 1993 the federal government budgeted approximately $2.7 billion dollars for the USGCRP and its contributory programs, representing about 12% of all civilian research funding, and more than the combined budgets of the Superconducting Super Collider and NASA's space station

(AAAS 1992, FCCSET 1992).[5] From 1990 through 1994 the government spent over $6 billion on the Program (Table 1.1).

The story of the Program can be understood from two distinct, but related points of reference. The first point of reference is the story of the Committee on Earth and Environmental Sciences, an interagency body established in law by Congress and the President in 1990 with instructions to develop and implement a Global Change Research Program. The Committee was terminated and replaced in 1994 by the Clinton Administration. The second point of reference is the unfolding story of the Program, which existed before the Committee had responsibility for its implementation and continued following the Committee's termination under different institutional structures. The story of the Committee is the story of the Program from late 1990 to early 1994, a period of about three and a half years. The story of the Program is part of the broader policy process in which the Committee existed. It is possible to draw definitive conclusions about and assess responsibility for the Committee's successes and shortfalls with respect to its legal mandate. However, definitive conclusions about Program's performance and responsibility are not possible as the program continues to evolve and change. The Committee is a fixed target, amenable to policy appraisal; The Program has continued to evolve, and thus allows for only tentative conclusions subject to reinterpretation as events unfold.

Why Evaluate Performance?

Under the Committee, the Program did not meet its legal mandate and a "growing number of critics warn[ed] that the program appears headed toward failure unless fundamental changes are made" (Monastersky 1993, 158). This book argues that the program was given a broad mandate to produce “usable information” for policy makers. The program was structured to “reduce uncertainty” rather than “expand policy alternatives,” and as a consequence the program produced little in the way of usable information. Decision makers noted the policy shortfall in a 1993 congressional oversight hearing in which several witnesses testified that the program was falling short of its legal mandate.[6] One witness argued that in spite of high quality science conducted in the program, "these studies have had only a tenuous connection to the present needs of public and private decision makers" (Rayner in HCSST 1994, 64). Other witnesses argued, "the program's agenda has not focused on addressing policy relevant questions" (Dowlatabadi and Morgan in HCSST 1994, 86).

In the broader context of U.S. science policy, policy makers have struggled with the task of evaluating the performance of federal program and agencies. The evaluation task has been motivated by the passage of the Government Performance and Results Act (GRPA) of 1993 (P.L. 103-62). Congress enacted the GRPA because it felt that

> all too frequently individual agencies have lacked clear missions and goals, and related agencies efforts have not been complementary. Moreover, legislative mandates may be unclear and Congress, the executive branch, and other stakeholders may not agree on the goals an agency and its programs should be trying to achieve, the strategies for achieving those goals, and the ways to measure their success. Thus, many agencies cannot confidently answer the basic questions in defining a mission -- what is our purpose, whom do we serve, and how do we meet our mission? (GAO 1996, 4)

Science programs, in particular, have been identified as difficult to evaluate due to poor understanding of the connections between research efforts and related societal benefits (GAO 1996). This evaluation of the Global Change Program has potential to shed light on the challenging task of evaluating science programs in the context of demand by the public and their representatives for greater accountability and efficiency in federal programs.

Criteria for Evaluation

Under the U.S. Constitution, the program's legal mandate is an appropriate criteria for program evaluation. Alexander Hamilton writes in *Federalist 34* that a law "is a rule which those to whom it is prescribed are bound to observe" (Rossiter 1961, 204). The law is an agreement between the President and Congress, on behalf of U.S. citizens, which expresses national priorities. As such, the law is a working approximation of the public interest. Moreover, the law provides a means for the executive and legislative branches to hold one another accountable in the policy process. In *Federalist 15* Hamilton describes why accountability to public law is necessary:

> It is essential to the idea of law that it be attended with a sanction; or, in other words, a penalty or punishment for disobedience. If there be no penalty annexed to disobedience, the resolution of commands which pretend to be laws will, in fact, amount to nothing more than advice or recommendation (Rossiter 1961, 110).

The Committee's successes and shortfalls, and the health of its broader policy process, therefore should be judged with respect to its compliance and fulfillment of the provisions of its legal mandate. Compare James Madison in *Federalist 37*: "Energy in government is essential to that security against external and internal danger and to that prompt and salutary execution of the laws which enter into the very definition of good government" (Rossiter 1961, 226). In a more general sense, the Committee's performance is a matter of "good government."

Of course, enactment of law is only one part of the process of public decision. Prompt and salutary execution of law depends upon accurate and effective translation of intent into action. James Madison, in *Federalist 37*, observes that

> All new laws, though penned with the greatest technical skill and passed on the fullest and most mature deliberation, are considered more or less obscure and equivocal, until their meaning be liquidated and ascertained by a series of particular discussions and adjucations (Rossiter 1961, 229).

Because laws are inevitably ambiguous, evaluation of the Committee and the Program with respect to its legal mandate must go beyond the sparse legal language and glean from congressional, administration, and agency documents and discussions the intent of the program's enacting legislation. Legislative intent provides guidance to how words in legislation are to be translated into action and to the selection of appropriate criteria to judge the successes or shortfalls of the Committee's performance.

The Committee's performance was important from the standpoint of the public interest. Congress and the president expressed in P.L. 101-606 that the nation needed to address the issue of global change, at the time focused largely on climate change. In the long run, if the Program

fails to achieve the goals set for it in its legislative mandate then the nation faces the possibility of being poorly prepared to address the many problems associated with climate change. More broadly, the program serves as an important test of the ability to integrate science with policy in a manner that contributes to the resolution of an important societal problem.

The Organization of the Case

To paraphrase Machiavelli, one is apt to be misled when considering issues at only a general level. In order to shed light on the interface between science and policy, this book focuses on the particulars of the development and implementation of the Global Change Program. It proceeds from a general description and critique of the broad international context of climate change (Chapter 2) to describe the political, institutional, and administrative history of the Global Change Program (Chapter 3), illustrating how the scientific research agenda was shaped to meet a perceived policy need. It then examines on the legislative history of the Program, focusing on how the political process shaped the justifications used to promote the program (Chapter 4). To assess implementation of the Program from 1990-1994, the book next compares what Congress sought via Program performance (Chapter 5). The assessment finds a performance shortfall, i.e., the program did not fulfill its legislative mandate. Responsibility for the shortfall lies with program administrators, Congress, and executive branch officials (Chapter 6). In conclusion, the book distills lessons of the Program's early years Program implementation as well as science policy more generally (Chapter 7).

Chapter 2

Context:
Climate Change Science and Policy

I. Introduction

Global warming, the popular term for global climate change, refers to the possibility that human activities are resulting in detrimental effects on the world's climate. Table 2.1 lists some of the possible impacts that have been associated with global climate change. Society's concerns about climate go well beyond the issue of global warming and originate in actual or expected climate-related impacts.[7] These impacts could be societal or environmental, and can only sometimes be effectively expressed in monetary terms. Generally, climate policies are focused on capitalizing on the positive aspects of climate impacts (e.g., a good growing season) and the reduction of future negative impacts (e.g., reduction in vulnerability to floods. Some have suggested that society is becoming more "climate-proof" due to advancing technology and thus climate ought not be a major concern (e.g., Ausubel 1991). In some respects this argument is valid, particularly for wealthy societies. Yet, in many respects both rich and poor societies are increasingly vulnerable to climate. Consider recent trends in losses associated with floods, tropical cyclones, blizzards, droughts, as well as the incidence of disease, famine, and other climate impacts.[8]

A fundamental problem exists in that in spite of the considerable resources, intellectual talent, and political capital put into addressing the issue of climate change, the United States, and indeed the world, supports a policy that cannot succeed. This is for two reasons. First, the Framework Convention has a significant probability of failure with respect to its own goals. Second, even assuming that the Framework Convention does in fact meet its goals, many if not most of society's climate-related problems will persist, including those associated with climate change, with their root causes left unaddressed.

A result of the lack of recommendations on tangible, specific action programs that are rational and sensible and cost effective has been that science has been enlisted in an advocacy role in order to support the goal of preventing climate change, primarily through the reduction of emissions of certain gases. Recent years have seen contentious debate over the science of climate change, with the answer to the question "global warming: yes or no?" serving as a proxy for the question "emissions reductions: yes or no?" and in more recent years "Kyoto Protocol: yes or no?" The subtext of ongoing debate is that scientific consensus about climate changes serves as reasons in support of emissions reduction policies and lack of consensus provides reason to delay such action. Thus, science has been placed in an advocacy role in the policy

process, leading to the formation of scientific assessment groups and numerous public relations machines intended to influence public and policy maker framing of the problem of climate change. In short, science has not played a significant role in the invention, evaluation, and implementation of policy alternatives that might me more realistic, practical, or cost effective with respect to the myriad political, social, and technical issues that make up the climate change issue.

This Chapter seeks to set the broad scientific and political context that envelops the Global Change Program and in the process provide more detail on the policy problem, its origins, and its consequences.

II. The Basis of Concern About Climate Change

Global warming refers to the possibility that the Earth's surface temperature will increase due to increases in the amounts of certain gases released through human activity into the atmosphere. Named for the theory that has been used to predict climate change, these gases are called "greenhouse gases," and include carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons. The greenhouse effect was first presented as a scientific hypothesis over 100 years ago. S. A. Arrhenius, a Swedish scientist calculated in 1896 that a doubling of carbon dioxide in the atmosphere would result in global warming of about 4 to 6 degrees Celsius, fairly close to some predictions of the 1990s.[9]

The underlying physics of the greenhouse effect is not complicated. The sun radiates energy to the earth, of which some is reflected by the atmosphere back into space, some is absorbed by the atmosphere, and the rest is absorbed by the Earth's surface. The energy absorbed by the earth's surface radiates away from the earth. Some of this energy escapes into space, and some is absorbed by the atmosphere. It is hypothesized that as the amount of greenhouses gases present in the atmosphere increase, other factors being equal, the amount of outgoing radiation "trapped" by the atmosphere increases, and hence the earth's temperature increases. In other words, more greenhouse gases means more heat. To understand the physics of the greenhouse effect completely would require understanding all elements of the global earth system that affect the radiation balance of the earth.

Scientists, seeking to understand the nature of global warming and possible impacts on societies and environment, have organized numerous programs of research. In addition to satisfying innate human curiosity about how the world works, these research programs have also filled an important role in the process of developing domestic and international responses to climate change.

III. International Policy Responses

The Intergovernmental Panel on Climate Change (IPCC)

In 1988, the United Nations Environment Program and the World Meteorological Organization established one of the largest scientific assessment processes ever undertaken, the Intergovernmental Panel on Climate Change (IPCC). The IPCC was given the charge to report to

the United Nations a summary of the scientific and technical aspects of climate change as input to the international policy process. The IPCC initially organized itself into three working groups on science, impacts, and responses. In 1992, the IPCC moved the response Working Group to reside with impacts and created a new third working group on economics issues. The IPCC produced an assessment in 1990, an update in 1992, a second assessment in 1995, and its third assessment is to be published in 2001. These assessments are widely viewed as tauthoritative summaries of knowledge on climate change; nonetheless there has been a vocal body of critics of the content and procedures of the IPCC.[10]

The Framework Convention on Climate Change (FCCC)

As the IPCC assessments were underway, a number of countries began to mobilize to establish an international process within which policy responses to climate change might be negotiated, agreed upon, and implemented. In 1990, the United Nations established an International Negotiating Committee with a charge to develop a climate convention to be opened for signature at the U.N. Conference on Environment and Development (popularly known as the "Earth Summit") in June 1992 (Reinstein 1993). What emerged from this process is the Framework Convention on Climate Change (Rowbotham 1996, Bodansky 1995, Sebenius 1991).

The Framework Convention focuses on the prevention or limitation of adverse impacts of climate change. The goal of the Framework Convention is

> . . . to achieve. . . stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The exact definition of "dangerous anthropogenic interference" is the subject of much debate; though it generally refers to the impacts of climate on society and environment (e.g., Moss 1995b). Another important aspect of the Convention's objective is that it focuses on stabilization of greenhouse gas concentrations, rather than on emissions. This means that its goal is to stabilize concentrations of greenhouse gases in the atmosphere, which could occur at a range of levels depending on total emissions of greenhouse gases, instead of prescribing specific emissions targets.

As of the end of 2000, the Framework Convention was signed by more than 150 countries. It has been characterized as a "weak" and "ambiguous" document (Robotham 1996). However, the Framework is a work in progress with much of the details having been left to be worked out in subsequent negotiations (Bodansky 1995).

What is Climate Change?

There is not consensus between the IPCC and the Framework Convention on the meaning of the phrase "climate change." On the one hand, the Framework Convention defines climate change as

> . . . a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability over comparable time periods.

On the other hand the IPCC adopts a broader definition of climate change as "any change in climate over time whether due to natural variability or as a result of human activity" (IPCC 1996a, 3). The distinction between the definitions is critical to how the problem of climate is viewed by decision makers: Is climate a problem only to the extent that human activities change it in addition to existing variability? Or is climate a problem, irrespective of the sources of change?

Policy Alternatives: Mitigation and Adaptation

Policy alternatives in response to the issue of climate change have not changed significantly in at least several decades. By 1980 scientists and policy makers had established the two policy alternatives that would frame discussion of climate change in the time since: prevention of climate change by addressing its causes and adapting (or adjusting) to climate change by addressing its impacts.[11] In the early 1980s debate among academics focused on prevent *versus* adapt. By the late 1980s debate had shifted, prevention was the leading alternative and adaptation had largely fallen out of favor (possible reasons for this change are discussion below). The nature of the debate had become "prevention: yes or no?" with a focus on alternative prevention strategies.[12] The change in the debate is evident in a 1990 report by the U.S. Environmental Protection Agency on "Policy Options for Stabilizing Global Climate" in which the focus is exclusively on prevention of climate change (EPA 1990). By the mid-1990s prevention had come to be known as "mitigation" of climate change.

Mitigation. Mitigation refers to efforts to prevent climate change, and thus prevent future climate impacts, through intentional alteration of the climate system. The IPCC states that mitigation

> or "limitation" attempts to deal with the causes of climate change. It achieves this action through actions that prevent or retard the increase of atmospheric greenhouse gas concentrations by limiting current and future emissions from sources of greenhouses gases and enhancing potential sinks (IPCC 1996b, 831).

It is generally accepted that humans might intentionally alter climate through one of two ways. Geoengineering refers to attempts to intentionally change climate by physically interfering with the climate system.[13] For instance, in the 1990s scientists discussed the possibility of seeding oceans with iron in order to alter climate (Broad 1996). Other geoengineering techniques that have been discussed include mirrors in space, increasing oceanic alkalinity, and placing aerosols or reflective balloons into the upper atmosphere (IPCC 1996b, 813-814, cf. NAS 1992) .

A second way that society might intentionally alter climate is through social policy. That is, policy decisions could be made to alter human behavior in order to modulate the concentration of greenhouse gases in the atmosphere. To date, policy makers have not advocated geoengineering, relying instead on efforts to intentionally alter the composition of the atmosphere through social policies. The logic of mitigation is as follows: (1) human activities, particularly the use of fossil fuels, have increased greenhouse gas concentrations in the atmosphere. (2) These greenhouse gases are associated with changes in climate, and (3) these changes in climate will result in negative impacts (e.g., costs) to society. The logic of response is as follows: (i) mitigation activities, i.e., reduction of greenhouse gas emissions and increase of greenhouse gas sinks, will lead to a reduction in the increase of greenhouse gas concentrations (or more

optimistically, a decrease in atmospheric concentrations). (ii) Fewer greenhouse gases will lead to fewer changes in climate, and (iii) thus society and the environment will experience less adverse impacts. Research, discussion, and debate on climate change has focused almost exclusively on (1), (2), and (3). The three working groups of the IPCC roughly map onto these three assertions, focusing on science, impacts, and economics of climate change.

Adaptation. Adaptation refers to efforts to reduce society's vulnerabilities to climate. According to the IPCC (using its broad definition of "climate change"), adaptation

> is concerned with responses to both the adverse and positive effects of climate change. It refers to any adjustment -- whether passive, reactive, or anticipatory -- that can respond to anticipated or actual consequences associated with climate change. It thus implicitly recognizes that future climate changes will occur and must be accommodated in policy (IPCC 1996b, 831).

For instance, in 1992 a U.S. Government task force completed a comprehensive overview of how the United States might modify its susceptibility to flooding (FIFMTF 1992). Actions surveyed included structural (e.g., dam building) and non-structural (e.g., insurance) measures including: regulation, development policies, disaster preparedness, forecasting and warning plans, insurance, tax adjustments, emergency measures and disaster assistance, education, post-flood recovery, floodproofing and elevation, dams and reservoirs, dikes, channel alterations, flow diversions, stormwater management, shoreline protection, and land treatment measures. For any potential climate impact there are a wide range of such structural and non-structural measures that might be incorporated to reduce impacts that fall under the definition of adaptation.

The environmental community of nongovernmental organizations (NGOs), concerned citizens, some scientists, and a few policy makers has long preferred mitigation policies. In addition, some environmentalists have also viewed the issue of global warming as a vehicle to get at other concerns such as population growth, energy use, and environmental conservation. The Framework Convention implicitly favors mitigation responses because the definition of "climate change" it uses places emphasis on only those climate impacts attributable to human-caused changes in the composition of the atmosphere. An eclectic group of business, industrial, and energy interests, some economists, and many policy makers have opposed, with varying intensities, mitigation policies under the claim that this particular cure for climate change would be worse than the disease. This collection of actors has offered opposition to mitigative action, but little in the way of policy alternatives.

As mentioned above, compared to mitigation, adaptation has not received the same level of attention from either policy makers or researchers. It has been called "an unacceptable, even politically incorrect idea" (as noted by Burton 1994, 14). There are at least four reasons why the climate change community has discouraged consideration of adaptation responses.

The first reason is a perception that discussion of adaptation could make a "speaker or a country sound soft" on mitigation (Burton 1994, 14). In other words, talk of adaptation could lend an impression, rightly or wrongly, that one was against mitigation activities and in a broader sense anti-environmental. As Glantz (1995, 43) notes, 'proponents of preventive strategies wanted attention to focus mainly on prevention as the best way to cope with global warming." A

second reason is the difficulty of incorporating adaptation measures in an international negotiation process (Bodansky 1995). According to Burton (1994, 12), "it was not clear how effectively some of the developing countries would be able to use adaptation as a bargaining tool." Adaptation raises further complications in a negotiation process. For instance, what obligation does a country have to participate in the negotiations if it expects to be able to largely adapt to expected impacts and is not viewed as one of the more significant causes of the problem?

A third reason is that adaptation has been associated with "passive acceptance" or "fatalism" about human effects on the environment. Then-Senator Al Gore espoused this view: "believing that we can adapt to just about anything is ultimately a kind of laziness, an arrogant faith in our ability to react in time to save our skin" (Gore 1992, 241). Burton (1994) finds this weak view of adaptation, i.e., "passive, resigned, accepting," present in the Framework Convention, compared with its strong presentation of mitigation as "active, combative, controlling." A final reason is a perception that future climate impacts must be known with some degree of specificity before it is possible to plan adaptation responses. As a Framework Convention report notes "few studies have been attempted to compare the costs of adaptation strategies with the cost of greenhouse gas mitigation strategies because it is difficult to assess adaptation costs accurately when the regional impacts of climate change are highly uncertain" (FCCC 1996, 16). Climate models do not have the capability to accurately predict climate impacts at regional or local scales (see, e.g., Henderson-Sellers 1996).

There is little wonder that adaptation has been out of favor: Who wants to be viewed, at best, as working prematurely on adaptation studies and, at worst, obstructionist, lazy, arrogant, and anti-environmental?

III. Why the Framework Convention Can Not Succeed

Why do policy makers and scientists believe that mitigation activities can succeed? One important answer to this question is the lessons that have been distilled from the precedent of international policy responses to ozone depletion. The problem of ozone depletion has been compared to global warming because it involved detrimental effects on society associated with the emission of certain gases. The response to ozone depletion has been cited as a model for the response to global warming: the international community negotiated an agreement in 1987 to phase out ozone depleting gases (e.g., Gore 1992).

In spite of the apparent similarities between the two issues, there is reason to believe that the ozone precedent has been *mis*applied to the case of climate change. While a full elaboration of this issue goes well beyond the scope of this Chapter (see Chapter 6 for further discussion), several important differences between the two cases are as follows: The science of ozone depletion was "simpler" (Darmstadter and Edmonds 1989), fewer political and economic actors were involved (Haas 1992), the issue was socially easier to deal with, e.g., ease of finding substitutes (Doninger 1988); and a framework for policy action appeared early on (Pielke and

Betsill 1997). The ozone precedent is a success story. However, its successes may be less relevant to the climate issue than many have suggested.

Beyond the ozone precedent, a close look at the logic of mitigation suggests that achieving success, i.e., "preventing dangerous interference," may be difficult to achieve. The following sections examine the logic of mitigation, first looking at the realities of experience and second conducting several thought experiments. (The following sections (i), (ii), and (iii) follow the discussion of mitigation logic presented in the previous section.)

(I) Will societies be able to institute the mitigation activities needed to reduce increases in greenhouse gases?

Recent experience in seeking to limit the growth of greenhouse gas emissions to the atmosphere provides a sobering lesson in the difficulties of that task. A number of political and technical issues present obstacles to successful implementation of mitigation actives. These obstacles and recent experience provide reason for restrained optimism at best and outright pessimism at worst about the likelihood of mitigation activities actually resulting in emission reductions of the sort currently proposed by the Framework Convention. An even more dismal outlook is warranted for proposed future actions of the Framework Convention that go beyond existing proposals.

The experience of the United States in the 1990s provides a cautionary tale. On Earth Day, 1993 President Bill Clinton announced that

> We must take the lead in addressing the challenge of global warming that could make our planet and its climate less hospitable and more hostile to human life. Today, I reaffirm my personal and announce our nation's commitment to reducing our emissions of greenhouse gases to 1990 levels by the year 2000 (quoted in FCCC 1995).

In October, 1993 the U.S. government released its Climate Change Action Plan (CCAP) detailing the means to be employed to reach the emission goal, which would have required only a 7% cut in emissions from what was expected for 2000 (Paarlberg 1996). Within little more than a year it was apparent that the U.S. would fail to meet President Clinton's goal. In a national communication to the Framework Convention in 1995 the U.S. stated that it would not meet the goal of reducing emissions to 1990 levels by the year 2000 because the economy had grown faster than expected, the price of oil fell sharply, and the Action Plan was not fully funded (FCCC 1995, cf. CAR 1994).[14]

At the core of the Clinton Administration's failure to meet its emission reduction goal was vigorous debate over an energy tax during the President's first term. The tax was proposed primarily as a means to achieve deficit reduction and not in terms of climate policy. A tax was proposed on all energy uses (based on input rather than output), greenhouse gas producing or not, in order to mollify the band of the political spectrum that relied on coal production and use (Muller 1996, Paarlberg 1996). Congress (led at that time by Democrats) quickly rejected the proposal for a number of reasons, including a middle class who had been promised a tax cut during the election and a number of exemptions granted to certain industries and not others (Muller 1996). In its place the President proposed and Congress enacted a modest gasoline tax (4

cents per gallon). The gasoline tax became an issue in the Presidential election of 1996 when Republican candidate Bob Dole promised to rescind the tax if elected. Senator Dole's proposal received much popular support, including that of President Clinton (Mitchell and Rosenbaum 1996). To place in broader global context the Clinton Administration's failure to meet its reductions target, consider that had the emission goal been met experts estimated that total global emissions of greenhouse gases would have negligibly affected (Paarlberg 1996).

In the 1992, nations participating in the Earth Summit met in Rio de Janeiro and agreed to limit global greenhouse emissions by the year 2000 to 1990 levels (however the agreement was not binding and shortfalls would carry no formal sanctions). In 1996, of the countries that had agreed to reduce emissions to 1990 levels, only two, Germany and the United Kingdom were expected to meet the target (White 1996).[15] The shortfall reveals technical obstacles to meeting emissions targets.

> Meeting a target is technically tricky because future emissions and the consequences of policy actions are not perfectly predictable. Modelers and scientists are marked by different, incompatible core assumptions. . . Yet much is at stake depending upon the view adopted because different forecasts and models imply vastly different policy actions, costs, and benefits (Victor and Salt 1994, 8-9).

Perhaps more importantly, the shortfall also reveals that domestic politics often limits what can be achieved:

> no single government agency -- not even the head of a delegation -- speaks for the full interests of the state. Translating broad international objectives into domestic plans that can be implemented requires complicated and time-consuming coordination across ministries and interests (Victor and Salt 1994, 9).

Muller (1996) examined the cases of the European Union and Australia, which, like the U.S., failed to legislate energy tax proposals, finding common obstacles in all three cases: public concerns about relative national competitiveness and job security, and also strong business opposition to such measures. Other experience does not lend optimism to future efforts to overcome the obstacles in the way of limiting or reducing global greenhouse gas emissions (e.g., Bodansky 1995, Changnon 1995, Kauppi 1995, White 1996, Cushman 1996).

Some have suggested that climate impacts will motivate the political impetus necessary to overcome such obstacles. However, Ungar (1994, 454) is less sanguine, documenting a decrease in public and political concern about climate change during a period of extreme climate impacts around the world, "if weather impacts of this magnitude are barely newsworthy, revitalizing global warming as a celebrity social problem may take more extreme events than one would like to countenance."

Steps actually needed to stabilize greenhouse gas concentrations at levels lower than are present in 1997 dwarf those currently proposed. It has been estimated that stabilization of greenhouse gas concentrations in the atmosphere at *current levels* would requires reductions of 60 to 80 percent in greenhouse gas emissions (IPCC 1994). One economist has estimated that reductions of that magnitude might cost $30 trillion (in 1989 US$, over 120 years, Nordhaus 1992). Others have proposed that reductions could be achieved with relatively modest emissions reductions in the near term and more drastic ones in the future (Wigley et al. 1996). Discussion of such steps predictably garnered the attention of a range of economic interests.

A further point of concern in the implementation of the Framework Convention is rapid development in many countries around the world. Because, many developing countries view the industrialized world as the cause of the climate change problem, they suggest that industrialized countries should bear the burden of greenhouse gas reductions while simultaneously providing energy efficient technologies to lesser developed countries to allow continued growth and development (White 1996). These issues complicate negotiations over a protocol. They also only thinly mask a more fundamental issue for many developing countries: the relative benefits of development and increased energy use associated with higher standards of living versus the costs expected from climate change. For many countries, such a calculus may not swing in the favor of the Framework Convention.

(ii) Will a reduction in greenhouse gases mean less changes in climate?

For the purposes of conducting a thought experiment, assume that implementation of the Framework Convention is successful, (that is, countries agree to take binding steps to stabilize concentrations of greenhouse gases in the atmosphere at levels agreed upon to prevent dangerous interference with the atmosphere). Under this success scenario, there are at least two reasons why the problem of climate to society will not have been solved. One involves the inevitability of climate change, based on the IPCC projections, and the second is related to fluctuations in climate independent of human causes.

Under the analysis conducted by the IPCC, concentrations of greenhouse gases in the atmosphere will not for the foreseeable future be reduced to pre-industrial levels. Thus, the IPCC (1996, 188) notes "even with the most ambitious abatement policy, some climate change seems likely to occur."[16] In short, even under a scenario of aggressive mitigation efforts most experts expect climate change. Thus, mitigation efforts alone cannot completely deal with the problems associated with human-induced changes in climate, as projected by the IPCC.

A second scenario is not considered by the IPCC or the Framework Convention and that is the possibility that climate might fluctuate in surprising and unpredictable ways independent of human-induced changes (Kates and Clark 1996). The recent historical record is full of such surprises such as changes in the frequency and intensity of El Niño-Southern Oscillation (ENSO) events and for particular locations variation in periods of drought, precipitation, and extreme events (e.g., Glantz 1996).[17] Over much longer periods of centuries, millennia, and eons the climate record has shown significant variability, all of it essentially prior to the industrial age. Thus, the possibility exists that mitigation activities would succeed yet climate would change.

(iii) Will less change in climate mean fewer adverse impacts?

For purposes of extending the thought experiment, assume that mitigation activities succeed in stabilizing concentrations of greenhouse gases and also that as a result there are fewer changes in climate. Under this scenario, there is significant cause to expect *more* rather less adverse impacts to environment and society, as many actions taken by society are increasing vulnerabilities of people and the environment to climate impacts. Such actions include development of marginal lands (Glantz 1995b), development of land at greater risk to extreme

events (e.g., IRC/IIPLR 1995), dependence upon highly technical, interdependent systems (Quarantelli 1996), increased need around the world for food, clean water, health care (e.g., World Resources 1997), etc.. Most, if not all, of these trends are driven by population growth and technological change. It is certainly possible to imagine a scenario under which the frequency and magnitude of climate events remains constant, yet societal impacts (as measured by economic and other human effects) increase because more people and property have put themselves (or been placed) in harm's way. A number of measures of climate impacts exhibit such a trend (e.g., Swiss Re 1996). In short, the problem of climate change might be successfully dealt with without positively affecting, much less solving, society's climate problems.

IV. Science in the International Policy Process

How is it that the world has adopted a climate policy that at worst either cannot succeed or at best is incomplete with respect to climate-related problems? One primary factor is an idealized view of the science/society relation that holds that science ought to be incorporated into the climate policy process in a linear fashion. From this perspective, science is expected to be in some sense completed, or at least summarized at periodic junctures, and this scientific understanding is supposed to inform the policy process. The linearity of the science-society relation is expressed in the structure of the IPCC which was developed with three workings groups -- science, impacts, and responses -- representing a progression from science to action (e.g., Bolin 1994, see Chapter 3).[18]

The actual history of the development of climate policy fails to square with the idealized view of the science-society relation. Those with concerns about the risks posed by climate change generally agreed on a strategy of mitigation *prior to* much of the scientific assessment and research conducted in support of policy development. This is reflected in the focus on mitigation expressed in the organization of the IPCC Working Groups II and III and well as in the Framework Convention. The amount of time, money, and other resources invested in activities related to mitigation dwarfs those resources that have been focused on adaptation. A result is that virtually all scientific research on climate change has been viewed through the lens of "mitigation: yes or no?"

Consequently, science has been put into an advocacy position: all climate change research is interpreted by the media, policy makers, and the public as either in support of a mitigative strategy or in opposition to a mitigative strategy as expressed in the following statement,

> If scientists were to find a clear signal that the earth has begun a process of greenhouse warming, or substantially reduced the uncertainties about the timing, magnitude, and regional effects of climate change, then these developments could spur the political process forward . . . without greater certainty, many states are likely to remain reluctant to take costly actions to mitigate climate change (Bodansky 1995, 448).

Indeed, a prevailing view of the role science in debate over climate change is to reduce uncertainty in order to forge a political consensus about the need to mitigate climate change. The vast majority of funding for climate change research has focused on reducing uncertainty about the causes and consequences of climate change. Science has not been used to introduce alternatives to mitigation that might serve as "insurance," in the event that mitigation efforts fail or be implemented in the near term as international negotiations proceed.

The cost of foregone opportunities is high: because the Framework Convention cannot solve the climate change problem, even if it succeeds according to its own goals, reducing uncertainty about the causes and consequences will be a Pyrrhic victory as climate impacts will continue to grow around the world. Securing a global agreement to reduce greenhouse gas emissions would be an important accomplishment, yet incomplete from the standpoint of reducing societal and environmental vulnerabilities to climate and climate change. Underlying the incomplete response to climate change has been a focus on reduction of uncertainty to the exclusion of development of a range of policy alternatives to feed policy debate, directly resulting from how science has been linked to the policy process.

Chapter 3

Policy History of the U.S. Global Change Research Program

Background

Through much of the twentieth century only scientists showed much interest in the potential for climate change related to human use of fossil fuels remained a topic of interest only to scientists. In the 1970s climate change came to public attention through concern about global cooling. Some scientists warned of an impending ice age. By the early 1980s concern over cooling diminished and scientists were once again studying climate change in terms of global warming. However, the issue generally remained of narrow scientific concern. During the 1980s something happened -- by 1990 the U.S. government had established a billion dollar, multidecade interagency U.S. Global Change Research Program to address threats of climate change.

The Executive Branch and Climate change in the Early 1980s

The Reagan and Bush administrations' climate change policies were set by the president along with the help of a close circle of advisors, in spite of the creation of various climate change advisory and decision making bodies in the agencies. It is clear that by the end of the 1980s on the issue of climate change the executive branch relied on ad hoc decision making rather than a central policy coordinating body (GAO 1990). Executive branch organization frustrated those members of Congress who wanted to organize the agencies to respond to climate change. These pressures intersected in the formation of a White House Committee on Earth Sciences in the late 1980s.

Climate change joined the White House agenda through an administrative structure that had been developed by the Reagan Administration during the 1980s. Shortly after his inauguration on 20 January 1981 President Ronald Reagan established five Cabinet councils: economic affairs, commerce and trade, human resources, natural resources and environment, and food and agriculture (Brownstein and Kirschtien 1986).[19] These councils were the brainchild of advisor Edwin Meese who believed that policy issues would "bubble up" through the councils to the full Cabinet for Presidential decisions (Brownstein and Kirschtien 1986). In practice, however, policy rarely "bubbled up" through the councils, but rather was controlled by Chief of Staff James Baker III, his deputy Richard Darman, and OMB director David Stockman.[20] According to one anonymous White House official, the Councils were often irrelevant to what was really going on: "There were many instances where the Cabinet councils were sitting around discussing things and Stockman couldn't make the meeting because he was on the Hill negotiating a settlement of the exact same issue they were discussing" (Brownstein and Kirschtien 1986, 1583). In an April 1985 reorganization Chief of Staff Donald Regan replaced

the cabinet councils with a Domestic Policy Council and an Economic Policy Council, both cabinet-level bodies (Brownstein and Kirschtien 1986).

The Economic Policy Council was to advise the President on economic policy and trade issues, while the Domestic Policy Council was to be concerned with domestic issues that did not deal with economics or trade (CCSTG 1991).[21] Under each Council, working groups staffed by sub-cabinet officials were created to deal with specific issues. The primary function of such working groups was to reduce the range of policy alternatives in a particular issue area to a number that could be handled at the cabinet level.

Climate change first appeared on the White House agenda in the Domestic Policy Council working group on the Energy, Natural Resources, and Environment during President Reagan's second term (Nitze 1991, Kennedy 1992a). Climate change became a matter of White House concern because of public attention to Congressional hearings that were called in response to warnings from the scientific community of the consequences of increasing carbon dioxide in the atmosphere.

Background: Congress and the National Climate Program

Legislation calling for a national climate program was introduced in Congress in 1975. Congressional concern "arose over a series of severe climatic anomalies and climate related events that occurred in many parts of the world in the brief interval from 1971 to 1978" (Justus and Morrison 1988, 11). Events included the failed Peruvian anchovy harvests in 1971 and 1973, the 1972-1974 drought in the African Sahel, a severe 1972 winter freeze in the Soviet Union, and in 1974 floods, drought, and early frost in the U.S. Midwest. In 1977 winter in the eastern U.S. was the coldest ever recorded and summer was one of the three hottest in a century (Justus and Morrison 1988).

The Climate Program was established by Public Law 95-367 in September 1978.[22] The law was passed by Congress to "assist the Nation and the world to understand and respond to natural and human-induced climate processes and their implications" (P.L. 95-367, sec. 3). The law called for "assessments of the effect of climate" on various aspects of society, basic and applied research to improve scientific understanding, forecasts and data collection of climate processes, and international and intergovernmental cooperation in climate research. The law also called for "studies on policy options for reducing the impact of man's activity on global climate change. The studies will be made available to Federal Agencies, the Congress, and the public" (sec. 5.d.9). In short, the Climate Program was to generate climate information, conduct climate research, and explore the policy implications of climate. The interagency program was to be coordinated by a National Climate Program Office (NCPO) within NOAA under the Department of Commerce.

The Climate Program delegated to various agencies responsibility for implementation of different aspects of the program. For example, the State Department was responsible for coordination of U.S. participation in international programs, NASA was responsible for remote

sensing, and NSF was to conduct basic research. Table 2.1 shows the various agencies and their responsibilities in the Climate Program. These responsibilities served to strengthen traditional agency efforts in the area of climate change and would later form the core of agency responsibilities in the Global Change Program.

In a 1986 report, the National Academy of Sciences found that the Climate Program had many "significant achievements" and faced a "promising future" (NAS 1986, viii). The report found also that the program could be improved with better communication and integration of research findings with public policy. The report notes "climate and public policy are inextricably intertwined. Coordination of the climate-related activities and interests of the various federal agencies involved is fundamental for program success" (NAS 1986, 1-2). The Report noted also that policy development in response to climate-related problems would be difficult as "management strategies to deal with socioeconomic consequences of climate variation. . . are virtually unknown as yet, except as concepts, and their development will involve participation from several disciplines" (NAS 1986, 2). An implication of the NAS report is that research into the scientific aspects of climate was advancing faster than research into the policy implications of climate science.

By the mid-1980s some members of Congress sought to improve upon the Climate Program. For instance Congressman George Brown (D-CA), who had introduced the Climate Program legislation in the 1970s, observed in a 1987 hearing that

> Our inability to forecast the implications of human-induced climate change stems from our vast ignorance of how in fact we are disturbing our surroundings. The National Climate Program Act of 1978 was a step in the right direction, towards helping us grasp the nature of climate change on planet Earth. However, that program has represented only a first effort in what will be required to address this enormous problem (HCSST 1987, 3).

A number of scientists and other experts testified before Congress to the effect "to have a problem-oriented approach toward the future, we have to integrate more disciplines than those in the traditional atmospheric sciences or climate-related disciplines" (Schneider in HCSST 1987, 5). In other words, the Climate Program was judged to be producing good science, but to be incomplete from the perspective of clarifying policy responses to the threat of climate change.

The Climate Program became subordinated to the larger and more ambitious Global Change Program by the late 1980s for a number of reasons: First, congressional concerns about human impacts on the global environment increased, and the Climate Program was a relatively narrow program. And secondly, the science and agency communities wanted to expand the research agendas of a new area -- global change studies. The legacy of the Climate Program was to help to define agency roles in earth sciences research that would continue throughout the 1980s and into the 1990s.

Background: The Development of Agency Roles and Responsibilities

Agencies participating in the Climate Program developed expertise and responsibility for different aspects of the climate change issue. Of these agencies the National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA),

and National Science Foundation (NSF) became the three major players in climate change science in the 1980s and 1990s (Bloch et al. 1987). The Department of Energy was the most active agency in the climate change area in the late 1970s and early 1980s because of the energy crisis. However, the energy crisis of the 1970s abated and with the election of Ronald Reagan DOE fell out of political favor, e.g., Reagan formally proposed DOE termination.

NOAA, NASA, and NSF entered the 1980s with intense political and budgetary pressures. NOAA was a favorite target of the Reagan Administration, which had proposed eliminating the agency on at least several different occasions. NASA had successfully launched the Space Shuttle in 1981, and hoped to increase a flat budget in order to return to its glory days of the Apollo era. NSF, while a favorite of the Reagan Administration, remembered the challenges of the late 1960s and 1970s to the post-war science consensus, and sought to protect itself from future assaults upon basic research. These conditions were favorable for the rise of a unified global change community across the federal agencies.

National Oceanic and Atmospheric Administration. In 1970 President Richard Nixon created by executive order the National Oceanic and Atmospheric Administration within the Department of Commerce to consolidate the Environmental Sciences Services Administration (ESSA), the Bureau of Commercial Fisheries, and the Lake Survey of the Corps of Engineers (Fleagle 1986).[23] At the same time the Environmental Protection Agency (EPA) was created. NOAA's missions were to serve public safety and welfare and to support commercial development.

From NOAA's first budget in 1971 to 1981, a period typically characterized by observers of science policy as one of bad fortunes for science, NOAA funding rose from $280 million to $840 million. During this period NOAA's budget rose by an average of 11% annually, or 3% greater than the average annual rate of inflation (Fleagle 1986). In 1981 NOAA, like DOE, came under attack by the Reagan Administration. In his first five budget submissions to Congress, Reagan requested an average 14% cut in the NOAA budget. However, as was typical of the period, in every fiscal year Congress appropriated more to NOAA than it had the previous year, but less than had been projected in prior years.[24] Because of these budgetary pressures and uncertainty during the mid-1980s NOAA sought stability and focus that would lower the level of political tension brought on by the Reagan Administration (Fleagle 1986).

National Aeronautics and Space Administration. NASA began the 1970s with the rejection by the Nixon Administration of its vision of a human mission to Mars. With the assembly lines of the Apollo program shut down in the early 1970s the agency decided not to abandon its technological vision of a space shuttle, space station, and mission to Mars. Instead, NASA decided to pursue its vision as a series of logical steps, of which, logic dictated that a space shuttle must be step one. The space shuttle was approved by President Nixon in 1972 and became NASA's primary development program of the 1970s.

During the decade of the 1970s the agency produced a series of science spectaculars beginning with the Pioneer missions to the inner and outer planets. In 1976 the Viking probes

landed on Mars and the decade ended with the Voyager probes at the outer boundaries of the solar system (Edelson 1988). However, despite such science successes NASA budgets continued to fall (in constant dollars) from their 1965 Apollo peak. In the late 1970s when the Shuttle began experiencing technical problems and significant cost overruns, the agency sacrificed many science programs to pay for the Shuttle and preserve its vision of human spaceflight. James Van Allen (1986, 37), a prominent space scientist, later called this "the slaughter of the innocent."

Congress came to the rescue of human spaceflight and appropriated supplemental funds to support the Shuttle program. Therefore, NASA was able to afford many of the science programs cut previously. The Space Shuttle lifted off on its maiden voyage in 1981. For NASA visionaries the main lesson of the 1970s was based upon the Shuttle and Apollo precedents: The goal of colonization of space had to be achieved through a series of logical steps secured at the presidential level (Pielke 1993). These lessons were invoked when James Beggs, administrator, and Hans Mark, associate administrator, President Reagan's appointees to NASA's two highest posts, announced plans to pursue political approval of an orbiting, permanently occupied space station (Mark 1990).

In short, NASA entered the decade of the 1980s with a sense of optimism about its chances to return to the golden age of spaceflight through a new space station proposal. For space scientists, a lesson of the seventies was that no matter how successful their programs were, within the agency they would be secondary to the human spaceflight program. Hence, many space scientists viewed warily the proposed space station.

National Science Foundation. NSF entered the 1980s recovering from challenges to its mandate in the 1960s and 1970s. In the 1970s NSF had an essentially level budget, accounting for inflation. NSF has never had a large budget compared to other science agencies. For example, in 1981 the agency's budget was about $1 billion out of a total of about $34 billion spent by the government on research and development. Thus, when President Reagan expressed strong support for the agency it helped "turn around" concerns stemming from the 1970s (Smith 1990, 122-158). Morin (1992, 71) compares the NSF to a "proud and purposeful mouse foraging in a limited territory among a herd of lumbering federal elephants." To extend the metaphor, in the 1980s NSF began to take steps to ensure that it would not get stepped on by the giants of the federal bureaucracy.

* * *

The 1980s saw the spinning of a complex web of agencies, perspectives, events, developments, and ideologies that set the stage for the emergence of a large-scale program of global change science. The sciences of global change had made remarkable advances due to improved technologies and a long record of decentralized support from the federal government. Thus, the scientific disciplines of global change were ripe for interdisciplinary inquiry (Edelson 1988). During the 1970s many science agencies had seen their proposals for increased funding defeated or deferred due to austere budgets, creating an atmosphere of institutional crisis,

especially in NOAA and NSF.[25] Anthony Calio, a NOAA Administrator in the 1980s observed that "there's a natural climate for us to coexist these days. . . [The budget pressure] forces us to work closer and closer together" (Cowen 1987, 18).

The Selling of Global Change: "A Nonsinister Conspiracy"

The global change movement arose from a group of scientists and administrators from various countries, agencies, and disciplines who sought a coordinated, large scale, and interdisciplinary research program. What seems to be an incoherent hodgepodge of acronyms -- NASA, NOAA, NSF, ICSU, NAS, System Z, EOS, MTPE, NRC, IGBP -- was in reality the institutional affiliations, often overlapping, of a well-defined community interested in creation of a global change program in the United States. The "nonsinister conspiracy" refers to the efforts by members of the global change community to initiate a research program. Global change was first presented as a scientific initiative by NASA in 1982 and by the late 1980s was a large-scale program of research.

NASA first publicly presented its proposal for a global change science program in July 1982 when it sponsored a conference on what it called "global habitability." The concept of "global habitability" originated in a February 1982 meeting between NASA associate administrator Hans Mark and Harvard professors Richard Goody and Michael McElroy (Waldrop 1984). The purpose of the NASA conference, according to its summary report, was to design a space-based scientific program to examine environmental "changes that may affect the habitability of the earth." The report asked "Why should NASA be responsible for this program?," and answered "The short answer is that NASA can do it and no other Federal Agency can" (Goody 1982). One month later, NASA presented its interdisciplinary global habitability concept at the UNISPACE '82 conference, sponsored by the United Nations in Vienna, Austria.

NASA administrator James Beggs and associate administrator Hans Mark used the UNISPACE 82 conference to push a broad new agenda for NASA (Dickson 1982). The new agenda revolved around selling a manned space station program to President Ronald Reagan and Congress in order to help reverse what Beggs and Mark saw as NASA's institutional decline in the 1970s (Mark 1990). Mark recognized the expediency of advancing the agency's agenda on a broad front. According to one scientist involved with the "global habitability" study,

> One of the things that [Mark] was concerned about was a rationale for NASA's earth presence. What is NASA going to do on the earth that is not in competition with NOAA or some other agency? The planets he saw as interesting, but that's not going to keep the agency afloat (Quoted in Kennedy 1992a, 4).

In order to gain support for the space station program from those scientists who were hesitant about supporting any large-scale spaceflight effort based on their previous experience with the Shuttle, the agency offered earth scientists a remote sensing program, called "System Z," to be funded out of the station budget (Taubes 1993). President Reagan's Commerce Secretary Macolm Baldrige explained why System Z was necessary

> The science and applications community bears many scars from the Apollo and space shuttle programs. The perception, no matter what the reality may be, is that the user community's interests were always subordinated to the more glamorous manned activities. To prevent a large outcry

> from that community, the space station program must have a parallel effort, separately budgeted, to support the uses of the station and its companion man-tended platforms (Lowndes 1984, 151).

System Z became the Earth Observing System in 1983 and then part of NASA's Mission to Planet Earth in 1987. It was to become the centerpiece of the U.S. Global Change Research Program in the 1990s.

System Z, referred to as a "gift" by one prominent earth scientist, appealed to many scientists for at least two reasons.[26] First, it offered scientists an opportunity to conduct simultaneous measurements of many environmental variables which, many scientists believed, would help investigators assess the complex interactions of the Earth system (Taubes 1993). Second, some scientists believed that linkage to the space station budget would increase the chances for congressional funding of such an ambitious project. According to NASA scientist Dixon Butler, "the space station gave us optimism for the first time to think of a mission that addresses the comprehensive earth science need" (Taubes 1993, 912). And Burt Edelson, former head of NASA's space science office, recalled

> We sort of cut a deal. In the face of the agency trying to start up the space station program, I could never have come up with a brand new multi-billion dollar program. It was certainly a good deal for the [space station office] because they were gaining the support of a very large and vociferous element of the national scientific community (Stevens 1990).

Thus, many scientists lent support to the space station concept in exchange for the promise of System Z.[27]

There was, predictably, resistance in the scientific community to the trade-off. Some scientists criticized John McElroy, then NOAA assistant administrator for satellite programs, for not being openly against the station. He stated, "some of my science friends have called me a traitor for even being this positive about space station" (Lowndes 1984, 151). James Van Allen expressed why some scientists might consider McElroy a traitor: "The [System Z] polar platforms should not be tied to the station effort in any way - it's political fraud to fund them like that" (Covault 1988, 46). However, in spite of such protests, the promise of System Z was enough to garner a critical mass of scientific support for the space station. When System Z was renamed the Earth Observing System (EOS) in 1983, NASA officials and scientists alike hoped that -- likes its namesake -- EOS represented the dawn of a new era for the space program (Broome 1985).[28]

NASA received a positive response to its space station at UNISPACE '82, however its "global habitability" proposal was not well received (Waldrop 1984, Edelson 1988). One participant at the conference said that the proposal "came across like NASA trying to take over the world."[29] A NASA official later agreed that the proposal was not advanced tactfully, "NASA moved out on global habitability prematurely, without having developed a collegial understanding across the government and internationally to back it."[30] The negative reaction foreshadowed conflicts to come over the structure of global change research. In spite of the negative reaction to the form of NASA's proposal, its content persisted.

In 1983 NASA reintroduced "global habitability" to the scientific community as "Earth System Science" in the form of a committee headed by Francis Bretherton, director of the National Center for Atmospheric Research in Boulder, Colorado (Edelson 1988).[31] The Earth System Science Committee was committed to avoid previous NASA mistakes in the promotion of the global habitability initiative. According to Bretherton

> From the outset, we realized that we had to look at NASA's role in a broader context than just NASA programs. NASA wasn't the only, or even the largest, agency looking at the earth. So we set up a liaison program with people from NSF and NOAA.[32]

NOAA had been developing a program called Climate and Global Change and NSF had a program called Global Geosciences. Each was looking at the new area of global change. Through collaboration stemming from these parallel initiatives the three agencies, NASA, NSF, and NOAA, became the core of federal global change research in the 1980s (Bloch et al. 1987).

During the same period that the Bretherton Committee was being formed by NASA, Herbert Friedman, chair of the National Research Council Commission on Physical Sciences, Mathematics, and Resources, proposed an "international geosphere-biosphere program" to commemorate the twenty-fifth anniversary of the International Geophysical Year (Waldrop 1984, Perry 1991).[33] Perhaps recalling the political reaction to NASA's "global habitability" proposal, John Perry of the National Academy of Sciences later suggested "the genius of Friedman's initiative lay in its inscrutability" (Perry 1991, 40). The proposed geosphere-biosphere program was defined in greater detail at another Woods Hole conference during the summer of 1983 (Perry 1991). At this conference, participants debated whether a geosphere-biosphere program should be explicitly focused on research to advance scientific understanding, or related to policy development. Perry recalls that those favoring research supporting policy development prevailed in the debate and observes that the final report of the workshop failed to document the "spirited" debates over the two alternatives. These debates were a precursor to debate over the role of global change science in public policy making that arose with concerns over global warming later in the decade.[34]

An outcome of the 1983 NAS workshop was the formation of a U.S. Committee for an International Geosphere-Biosphere Program of the National Research Council (NRC 1986). The Committee held several meetings and produced a 1986 report that proposed the scientific basis and orientation of an “international geosphere-biosphere program.” The work of the NRC committee and the Bretherton Committee (1986) laid the foundation for a series of national and international global change efforts in the international science community.[35]

The International Geosphere-Biosphere Program (IGBP) of the International Council of Scientific Unions was proposed in 1986 by an ad hoc planning group to begin in 1992 and last for 10 years (ICSU 1986, Malone 1986).[36] The IGBP proposal was significant because it represented a consensus among scientists of many disciplines around the world on the need for a large-scale and long-term research program focused on global change. The goals and objectives of the ICSU proposal resemble very closely those of the NRC and Bretherton reports. This is understandable because several individuals served more than one committee.[37] Perry observes that "the structure of overlapping memberships in the concurrent development of scientific

concepts and government program has kept this nonsinister conspiracy together very well" (Edelson 1988, 10). The "nonsinister conspiracy" acted to advance the interests of scientists and the agencies. Global change science first arose more from a "push" from the bottom (i.e., scientists and administrators), than from a "pull" from the top (i.e., elected officials) of the decisionmaking structure.

Climate Change Becomes Political

The Senate held several hearings on the topic of global warming and climate change in response to the report of an international scientific conference held in Villach, Austria in the fall of 1985. These were the first hearings on climate change in the Senate since 1979. The House had held hearings on rising levels of atmospheric carbon dioxide under the guidance of Representative Albert Gore in 1981, 1982, and 1984. Senator David Durenberger observed presciently, in his opening statement to the December 1985 hearings on global warming, "grappling with this problem [of climate change] is going to be just about as easy as nailing Jell-O to the wall" (SCEPW 1986a, 1).

More members of Congress became interested in climate change following Senate hearings of June 1986. In these hearings a NASA scientist, Robert Watson, testified "I believe global warming is inevitable. It is only a question of the magnitude and the timing" (SCEPW 1986b, 22). Major papers such as the New York Times picked up the statement and *Washington Post* briefly elevating what had been a relatively obscure scientific topic to national prominence. Administration officials testified before the Senate committee the next day. In general, the officials from EPA, Commerce, NASA, State, and Energy tried to downplay the significance of Watson's comments, which only served to bring them into sharper relief. Following the testimony of the administration officials Senator John Chafee summarized the hearings as follows: "It was the scientists yesterday who sounded the alarm, and it was the politicians, or the government witnesses, who put the damper on it" (SCEPW 1986b, 183-184). Chafee's comments were an accurate characterization of the developing relationship between many in Congress who sought to heed the scientists' alarm and those in the executive branch who tried to dampen it.

Although press attention to climate change in 1986 was characteristically short-lived, the hearings had piqued the interest of a number of policymakers. For example, Senator Patrick Leahy (D-VT) wrote NASA Administrator James Fletcher several weeks after Watson's testimony, expressing his interest that NASA work closely with NOAA and NSF to coordinate research on climate change (Leahy 1986). An effect of Watson's comments was to shore up congressional support for the research proposed by NASA's Earth System Science Committee, presented by NASA before Senator Leahy and the rest of NASA's Senate Appropriating Committee less than two weeks after Watson's testimony.[38]

Creation of the Committee on Earth Sciences

In the months following Watson's testimony a White House Domestic Policy Council working group on climate change was formed, headed by NOAA Administrator Anthony Calio

(Kennedy 1992a). A former Calio aide recalled that "this is not the way Reagan asked the question, but the question [posed to the DPC group] was basically "Is there anything to this climate change issue, and if there is, what am I, as President of the United States, supposed to do about it?"' (IA 1994). Participation in the working group presented Calio with an opportunity to reverse NOAA's fortunes with the Reagan Administration (Kennedy 1992a). The success of NASA's Earth System Science proposals caught the attention of NOAA leadership. According to one participant

> [Earth System Science], to a lot of us, was typical NASA. Damned if they hadn't figured out what was going to be hot, and there it was. And [NOAA's] Mike [Hall] knew that it was time to build a [new] climate program at NOAA, that if we didn't get on board as a visible, high-profile player, NASA and NSF would run off with the program (Kennedy 1992a, 9).

The DPC working group, which existed for less than six months, brought Calio into close contact with White House science advisor William Graham, giving him an opportunity to sell NOAA as a home for climate change research.

The warnings of global warming by the national and international scientific communities had not gone unnoticed by the Office of Management and Budget. OMB was not concerned with climate change *per se*, but that policy responses that might be enacted in response to the scientists' warnings of climate change could negatively affect the economy (Kennedy 1992a). Norm Hartness, an OMB economist, recalled, "The general tenor was 'the sky is falling.' People abroad and in our domestic scene had some crazy ideas about how serious this was and how quickly we should do something about it" (Kennedy 1992a, 11). Jack Fellows, who focused on science budgets for OMB, used the Bretherton Report framework to classify agency funding for global change in order to get a rough approximation of funds going to global change science in the total budget. He discovered that the disparate science programs totaled over $1 billion (Kennedy 1992a). Fellows later recalled his surprise at the large total, "I was floored, actually. But, I talked to some higher ups at OMB and said, 'You know, this could probably be spent in a better fashion than it's currently being spent"' (Kennedy 1992a, 11). Thus, OMB lent its support to better coordinate and better focus the decentralized research.

Consequently, when NOAA's Calio presented a proposal to coordinate global change research to Science Advisor Graham, the political atmosphere in the administration fostered its acceptance.[39] According to Jack Fellows, "All of a sudden, Graham decided that there would be a committee. It just came together" (Kennedy 1992a, 12). Graham proposed that the Federal Coordinating Council on Science, Engineering, and Technology (FCCSET, pronounced "fix-it") mechanism of the Office of Science and Technology Policy coordinate global change research. FCCSET had been largely neglected in favor of other coordinating in the executive branch mechanisms, such as the cabinet-level Domestic Policy Council (Sun 1984, Knezo 1991). It is understandable, then, that there was little, if any, Congressional interest when in March, 1987 Graham formed the Committee on Earth Sciences within the FCCSET structure with NOAA's Calio as chair. The Committee's Charter described its purpose

> to increase the overall effectiveness and productivity of Federal R&D efforts directed toward an understanding of the Earth as a global system. In fulfilling this purpose, the Committee addresses significant national policy matters which cut across agency boundaries (CES 1987).

The mandate emphasized coordination of research and development in the earth sciences over clarification or consideration of policy issues related to global change.

Meanwhile, some members of Congress had been trying to organize the agencies to develop alternative policies to deal with climate change. The Global Climate Protection Act of 1987 (P.L. 100-204) was enacted in December 1987 after numerous congressional hearings during the year (GAO 1990). The Act gave authority for development of climate change policy to the Environmental Protection Agency and the State Department. The Reagan Administration opposed (but signed) the legislation, arguing that the White House Office of Science and Technology Policy was responsible for interagency coordination of science issues and that the law would interfere with existing policy mechanisms (GAO 1990). The Reagan Administration (and later Bush) used such arguments to effectively thwart the intent of the Global Climate Protection Act by retaining control over climate change policy at the highest levels (GAO 1990). As congressional efforts to organize the agencies to help the legislative branch to develop policies in response to climate change were being frustrated by the Reagan Administration, the Committee on Earth Sciences began to organize climate change research in the federal agencies.

Development of the Global Change Research Program

The Committee on Earth Sciences and Budgetary Coordination

In spite of the Committee's stated purpose, participants had different expectations about what role it would play in the policy making process. Within OSTP, Science Advisor Graham saw the Committee as a mechanism that could reinvigorate the FCCSET process, which had played little role in science policy since its creation in 1976. Federal agencies saw the Committee as a lead towards securing increased federal funding for earth sciences, while the OMB viewed it as a source of intelligence on the distribution and amount of federal funding for the earth sciences, which were diffused through many different federal agencies. Some agency representatives to the Committee, including its chair, saw it as the Reagan Administration's central science and policy coordinating body on issues of climate change. These different perspectives clashed at the Committee's first meeting in April 1987.

The first meeting of the Committee on Earth Sciences was a "disaster."[40] At the meeting Calio presented his view that the Committee would coordinate federal global change science and policy responses. A new organizational entity to staff the Committee, such as a secretariat, was required in order to fulfill Calio's vision. One participant recalled that Calio's

> … proposal seemed to build an empire, then figure out something for it to do. The group just didn't see a program large enough to justify that, particularly since the agencies knew they'd have to come up with the money [to support the proposed staff secretariat].[41]

The NSF representative to the committee interpreted Calio's proposal to encroach somewhat on the Foundation's "turf," which traditionally had been to plan and prioritize a large portfolio of research. The OMB representative rendered the argument moot when he declared that the Budget Office would not allow the Committee to develop a program simply to increase earth sciences funding. One participant described the meeting as follows.

> The combination of three things made the meeting very tense and emotional: The antagonism between some of the players, the anger that anything in FCCSET would have anything to do with policy, and then being told [by OMB] that there's no reason to be here anyway because we're not going to give you any money. [In response] Calio basically said, "Okay, it"s over. We tried. It's over" (Kennedy 1992b, 2).

Another participant recalled the meeting in more graphic terms: "It was a feeding frenzy in a shark tank with Calio as the chum" (IA 1994).

Calio resigned from government before the Committee regrouped for a second try. Science Advisor Graham recalled that despite the tone of the first meeting "I didn't have any sense of failure. I didn't have enormous aspirations for the group, particularly, either, but [the first meeting] started the process. People were still talking to each other" (Kennedy 1992b, 2). The people still talking together included the representatives from NASA, NOAA, and NSF who had a continuing interest in organizing a global change effort. The continuing interests of the three agencies following the first meeting are documented in a letter from the directors of the three agencies to the director of OMB (Bloch et al. 1987). According to one participant this letter was instrumental in keeping the Committee together following the lack of progress in its first meeting (IA 1994). It was during this period that NASA, NSF, and NOAA developed parallel global change initiatives: NASA was developing the Earth System Science Program, NSF the Global Geosciences Program, and NOAA had the Climate and Global Change Program. Moreover, for budgetary reasons, OMB was still interested in organizing earth sciences research in the federal agencies.

Graham appointed Dallas Peck, director of the U.S. Geological Survey within the Department of Interior, to replace Calio as the Committee's chair, before it met for a second time in December 1987. This time, the meeting was "smooth as could be."[42] Prior to the meeting Peck had met individually with most agency representatives to the Committee to determine what roles for the Committee each thought acceptable and unacceptable.[43] One attendee recalled that participants had been "greased" ahead of time by Peck so that the second meeting was a "love-in" (IA 1994). At the second meeting the Committee established a staff working group to do the bulk of the its work, and various agencies and the OMB voiced their different views of the role that the Committee would play. Not surprisingly, the views of agency officials were consistent with the missions of their home institutions: OMB stressed the need for data on current and projected earth sciences funding, NOAA emphasized environmental policy planning, and the State Department stated that policy issues and decisions should be the concern of the president's Domestic Policy Council (where it had more influence). Such concerns limited the role of the Committee to coordination of science budgets, constrained by existing agency turf. The Committee delegated to its Staff Working Group the task of proposing how to describe and achieve a federal global change program by the next meeting.

The global change program began as a multi-agency budget summary, or crosscut. A budget crosscut is a funding table organized in two dimensions: by agency and by discipline (or program). Typically, agencies kept budget numbers and projections to themselves because control of such information is a valuable resource in budget negotiations with Congress and the

OMB. OMB participation in the crosscut held the promise of budget increases, and this ensured that each agency's budget figures would be released to the budget office. According to a former executive secretary of the Committee, OMB coerced cooperation by promising funding in return for the budget crosscut:

> [OMB said] the administration is so eager to come out with some kind of statement as to what we're doing nationally in response to global change, we'll get [the statement] released at the same time as the president's budget. Well, you know, such visibility. We have to meet this challenge.[44]

The Committee developed budget crosscuts for FY 1989 and FY 1990.[45]

The Staff Working Group spent much of 1988 developing the first budget crosscut. The task was difficult because many agencies were unsure about how a global change program would be politically received, because under the Reagan Administration the "environment" was not a favored policy issue. Hence, some in the agencies worried about a negative political reaction to a global change program. A participant recalled that

> The agencies were hesitant. They wanted to show that they were players, so they had to show something, but they certainly didn't want to show it all, because that's where you're vulnerable. You're putting your budget on the line, and nobody knows where this is going. This is brand new. So most agencies thought, we can risk a certain level; then we'll still survive if for some reason the dagger comes out after it's out on the table.[46]

In a creative move that would allow agencies to show support for the initiative, yet minimize their budgetary risk, the Committee created two budget categories: The *focused* global change budget consisted of programs explicitly addressing global change. The *contributing* global change budget consisted of programs that were in some way relevant to global change. Each agency was allowed to define what was focused and what was contributing.

Table 2.2 shows the first budget crosscut. Of the crosscut total, about 70% was money for existing programs (OTA 1993a, 18). Thus, when an agency contributed funds to the crosscut process they were risking "base" (i.e., "money in the bank") funding in addition to proposed new funding. About $134 million, 8% of the crosscut total, was classified as focused. The large ratio of contributing to focused budget elements indicates agency concerns about how the program would be received: If the program was politically unsuccessful, then each agency could argue that the bulk of its earth sciences research was for a purpose other than global change and thereby mitigate any long-term political damage. For instance, in the first cross-cut NASA refused to classify its proposed Earth Observing System program budget as focused, although the program was to be the centerpiece of a Global Change Program. The crosscut was released in January 1989 with the President's Fiscal Year 1990 budget in a report entitled *Our Changing Planet: A Strategy for U.S. Global Change Research.*

The Committee was able to conduct its first crosscut in relative obscurity. In the spring of 1988 global warming had yet to fully emerge on the public stage, and in the political arena it was still overshadowed by other environmental concerns such as acid rain and ozone depletion. However, change occurred rapidly following the congressional testimony of James Hansen, a NASA scientist. Hansen testified on a scorching hot June day in 1988 before a Senate Committee that he was "99%" certain that global warming was underway (SCENR 1988). While

Hansen's statement was very similar in substance to Robert Watson's two years earlier, the political and physical context that framed the statement had changed significantly. Congress had slowly become more aware of the global warming issue through hearings, legislation, and dealings with the President over the previous two years. In addition, the summer of 1988 was extremely hot in the United States and the Midwest was experiencing a severe drought. Later that summer Yellowstone experienced its largest forest fires on record, and in September, one of the most powerful hurricanes of the century, Hurricane Gilbert, heavily damaged Cancun and the northeastern coast of Mexico. These anomalous weather events were linked to global warming in the press, and thus certainly added momentum to Hansen's warning. In contrast, Watson's statement of two years before had little staying power.

OMB was the primary beneficiary of the first crosscut because it provided heretofore unavailable comprehensive budget data on the earth sciences community in the federal agencies. However, in order to better make difficult budget choices, OMB needed to prioritize the crosscut data. The agencies had yet to see any benefits because it was still unclear whether the visibility that came along with the report would result in budget cuts or increases. Early in 1989 the Committee had no formal role in the budget process: budgets were determined through each agency's individual negotiations with OMB. For the agencies, the true test of the value of the proposed program would come with the second crosscut for fiscal year 1990.

As the 1990 budget process gathered steam in 1989 OMB asked the Committee to prioritize its crosscut by discipline (or program) in return for a promise of new funding for the earth sciences. A former executive secretary of the Committee recalled how OMB exchanged classification of the program as the first "Presidential Initiative" in return for the list of priorities within the earth sciences, "OMB came back to us and said, 'Well, gee, you guys did a great job. This is fine. Nice work. But we need more' . . . The agencies were saying 'Presidential Initiative. New money. They're serious; we're going to put some extra effort into this.'"[47] As a result, the Committee, in collaboration with the National Academy of Sciences Committee on Global Change, produced what came to be known as the "tombstone" chart, because of the shape of the tables and because the lower priority items on the chart would be the first to be cut or "killed" in tight budgets. Hence each box of priorities is a potential tombstone. The tombstone charthad climate and hydrological systems as the program's top priority and solar influences as the bottom. Science elements are further prioritized within each of the seven science priorities.

The OMB, armed with comprehensive budget data on and a list of priorities in the earth sciences developed through agency collaboration, next gave the Committee an opportunity to participate formally in the budget process. OMB requested that the agencies submit their global change research budget requests directly to the Committee so that it could prepare five alternative program compositions to meet five different levels of funding provided by the Administration. OMB would then use the Committee's recommendations as a template for earth sciences funding. The Staff Working Group decided that it made political sense to leave existing projects alone, so as not to antagonize the agencies, and thus decided to adjust the budget within each of the five alternatives by approving or rejecting proposed new projects. In this manner, the Committee had

taken on the role of a "virtual" budget examiner, and was, in effect, doing some of OMB's work for them.[48] In exchange, a Global Change Research Program was taking shape.

The addition of NASA's Earth Observing System to the focused part of the Global Change Research Program was the most important change from the first to the second budget crosscut. Table 2.3 shows the second crosscut as it was presented in July 1989 and in October 1990. NASA's focused element of the program changed from $21.5 million in July 1989 to $488.6 million in October 1990. Meanwhile, NASA's contributing element of the program decreased from $412.6 million to $24.7 million. The symmetrical changes in budget categories indicate that NASA redefined the EOS program as directly supportive of the goals of the Program. NASA was on board, yet the substance of neither EOS nor the global change program had changed.[49]

Climate Change Policy in the Bush White House. . .

President George Bush came into the White House in 1989 after raising expectations during his campaign for action on climate change, claiming that he would counter the greenhouse effect with the "White House effect." Upon entering office in January, 1989 President Bush initially attempted to deal with the increasingly visible issue of climate change through his own Domestic Policy Council working group on energy, environment, and natural resources. According to William Nitze (1991, 13), that group failed to develop policy alternatives, in part, because of a struggle "between national security and domestic policy elements of the White House staff."

Political missteps by the Bush Administration during 1989 and 1990 helped to keep climate change in the headlines. For example, in May 1989 NASA scientist James Hansen once again made headlines when he accused the OMB of altering testimony that he was to give before the House Science Committee (Shabecoff 1989b, 1989c).[50] Two days later, in an effort to quell criticism, President Bush announced that he would convene an international meeting on global warming in the fall of 1989, which ensured that attention would remain on the issue for at least another six months (Shabecoff 1989d). Other events that served to keep the media and Congress focused on climate change include the Paris Economic Summit of June 1989 and a rift in the Bush Cabinet over climate change that became public prior to the fall conference that, ironically, Bush had called in the wake of Hansen's run-in with OMB (SCFR 1989, Gold 1989). In addition, the Exxon Valdez oil spill in Prince William Sound in March 1989, while unrelated to climate change, helped keep attention on the environment. Such events and missteps seemed to haunt the Bush Administration and served to keep the media and Congress focused on climate change.

To coordinate climate change policy President Bush created, in early 1989, a National Security Council Policy Coordinating Committee on Oceans, Environment and Science chaired by Frederick Bernthal, an assistant secretary of state (Nitze 1991, SCFR 1989). The line of authority ran from Bernthal through the Secretary of State, James Baker, and the National Security Advisor, Brent Skowcroft, to the President. The relatively low position of the Bernthal

Committee limited its ability to shape policy, leaving effective control of climate change policy to administration officials. The Bernthal committee, with putative authority for policy issues related to climate change, had no formal connection to the Committee on Earth Sciences (GAO 1990). Consequently, the science and policy of climate change were poorly linked at this time.

. . . And Congressional Frustrations

For those members of Congress who dealt with climate change, the convoluted organization of the climate change policy making structure in the executive branch was often baffling. A line of questioning pursued by Senator Paul Sarbanes (D-MD) of William Reilly, EPA administrator, and Frederick Bernthal during a hearing before the Committee on Foreign Relations following the Paris Economic Summit, where climate change played an important role, is representative of Congressional frustrations in attempts to understand executive branch organization (SCFR 1989, 29-30).

Sen. Sarbanes:	Is there going to be an environmental action task force to try to implement the [Paris economic] communiqué's provisions on the environment?
Mr. Reilly:	Secretary [James] Baker, Governor [John] Sununu, and I had a conversation with the President on Air Force One. . .in which we were agreed upon the need to give this a very high and urgent priority in the coming weeks. There was no decision to have a task force to address it, however. We have tended to operate on this either through the Domestic Policy Council or through conversations with various of the agencies affected on a specific part of the problem.
Sen Sarbanes:	Who is the responsible person [for international environmental policy] within our Government?
Mr. Reilly:	Well, the President.

Senator Sarbanes had no more luck with Frederick Bernthal, the next witness (SCFR 1989, 45).

Sen. Sarbanes:	Who do you consider the responsible person Government-wide to be for following through on the environmental portion of the summit agenda - other than the President of the United States who I understand is the responsible person for everything?
Mr. Bernthal:	I do not think I can point to a single responsible person.

Senator Sarbanes may not have realized it at the time, but with the advantage of hindsight it is clear that EPA Administrator William Reilly answered his question in his first sentence: Policy development with respect to climate change was controlled by the President and a close circle of advisors, and not through a formal organizational mechanism.[51] According to Nitze (1991, 31), the Bernthal Committee had little impact on policy development and coordination because it had to send its proposals through National Security Advisor Brent Skowcroft, who had "little interest," and Chief of Staff John Sununu and OMB Director Richard Darman, who were opposed to any policies in response to threats of climate change.

Even the committee that funds the White House Office of Policy Development (OPD) showed signs of befuddlement when it came to the development of policy in the Bush Administration. In hearings on the 1991 budget, the Chair of the House Subcommittee on Treasury, Postal Service, and Government Appropriations asked a White House representative "Do you [the OPD] recommend policy? . . .Do you coordinate it?. . .Does debate take place?. . .what I am trying to get this for is a picture of what takes place" (HCA 1990, 99-100). In general Congress had little idea how the Bush administration operated, and in the case of climate change was growing increasingly frustrated.

Bernthal, in addition to being chair of the State Department committee, was also chairman of the policy response working group of the Intergovernmental Panel on Climate Change (IPCC) (Houghton et al. 1990). While the IPCC is an international group, the lines of authority from Bernthal's perspective were identical to those he faced from his position as chair of the coordinating committee within the State Department. Hence, in both national and international contexts the formal climate change policy structure of the executive branch was effectively controlled by a small group of close presidential advisors.[52]

Congressional frustration over the Administration's apparent lack of coordination and inaction on the climate change issue resulted in a request to General Accounting Office to determine what, exactly, the federal government was doing to organize and respond to the threats of climate change. The GAO confirmed in a January 1990 report that the Administration was, in fact, taking very little action on climate change (GAO 1990). In the dry prose of the GAO (1990), "Administration approach cautious pending validation of threat." Interestingly, the GAO itself appears to have had difficulty wading through the Byzantine executive branch structure, as it presented an incomplete overview of the Administration's climate change policy organization. For example, it failed to explicitly consider the policy role of the Bernthal Committee within the State Department. As is typical under the division of labor in Congress, fragmentation created significant obstacles to Congress' ability to compel and coordinate the various agencies involved with global change to assist in the development of policy alternatives. According to one observer, was "like putting Humpty Dumpty together again."[53]

Congressional frustration intensified as the Bush Administration emphasized research over action (Vig 1994, Shabecoff 1990a and b, GAO 1990, Roberts 1989, Gabriel 1989).[54] Interestingly, President Bush initially used the phrase "no regrets" during his campaign as a phrase to justify certain types of policy action in response to climate change, but by early 1990 "no regrets" was used to justify inaction (Shabecoff 1989a). The most complete, yet frustratingly vacuous, presentation of "no regrets" from the Bush Administration's perspective is an article by EPA Administrator William Reilly (1990). As a result of Congressional frustration and inability to compel the Bush Administration to respond to climate change, in the late 1980s Congress looked for new ways to increase pressures on the Administration to coordinate policy development with respect to climate change.

Thanks to the efforts of the Committee on Earth Sciences, Congress had available a complete budgetary picture of global change research and access to a coordinating body which could, in principle, be used to aid Congress in the development of policy responses to climate change. However, the Committee was heretofore used within the executive branch to coordinate the budgets of agencies that conducted global change science, and had little (if any) responsibility for consideration of policy issues. Congress would have to change the Committee's mandate -- to adapt it to its own purposes -- if the Committee was to go beyond coordination of agency budgets. That is exactly what happened with the passage of P.L. 101-606.

Chapter 4

Usable Information for Policy

Introduction

In the late 1980s, as some members of Congress were growing increasingly frustrated about the Bush Administration's seemingly reticent attitude towards consideration of global change policy issues, the establishment of the White House Committee on Earth Sciences provided Congress with a convenient opportunity to attempt to influence the executive branch to serve congressional instead of executive branch goals.

The Global Change Research Act in the Legislative Process: 1989 and 1990

On 25 January 1989 Senator Ernest Hollings (D-SC), and a number of cosponsors, introduced the Senate version of the bill (S.169) that became P. L. 101-606. The text of the bill is consistent with the activities mandated by the charter of the Committee: Science was to be the proposed Program's priority goal. One month later the Senate Commerce Committee held the first congressional hearing on the bill. In that hearing Robert Corell, representing the Committee, characterized the priority goal of the proposed Program: "It will principally address the question: What scientific knowledge is required to predict future change reliably (SCCST 1989, 46)?" The initial bill largely justified the program in terms of scientific research with only indirect references to policy and was consistent with the Committee's desires for the program to emphasize scientific research and to leave consideration of policy issues to others.

Two weeks later, on 8 March 1989 during its fifth meeting, Committee representatives from the Budget office, Agriculture, NSF, NASA, and State agreed that in the future the Committee and any Program should deal with issues of science, and not of policy.[55] A participant recalled that Committee officials interpreted the initial bill as a "simple codification" of the Committee's 1987 charter (IA 1994).

As happens with many pieces of legislation, S.169 began to evolve and change as it worked its way through the legislative process. An important change from the standpoint of the Committee's mandate occurred with the introduction of the House version of the bill (H.R. 2984) on 24 July 1989. The House version called for the proposed Program to provide "usable information" to support policy development. The Hollings' Bill *did not* use the phrase "usable information."[56] Committee officials testified before the House Science Committee three days later, and presented testimony identical to that of the Senate hearing on the proposed Program the previous February. In follow-up questions to the House hearing the a congressman asked Dallas Peck, Committee chair, to clarify the Committee's position "with respect to the proposed legislation" (HCSST 1989, 249). In his reply Dr. Peck made no mention of "usable information on which to base policy decisions," but he did reassert that the advancement of science was the driving factor behind the program.

> It has always been our intention to create an integrated, comprehensive program and not just a collection of ongoing agency programs. All of the programs must be weighed against an evolutionary research priority framework which was developed based on the data, process, and modeling needs required *to improve our ability to predict global change. The credibility of the USGCRP can be evaluated based on the programs' ability to address this goal* (HCSST 1989, 250, emphasis added).

A member of the Science Committee also asked Peck about the role that policy development activities would play in the Committee. The question indicates that at that time the Science Committee did not have a clear perception of the exact role that the proposed Program would play in policy development with respect to global change, in spite of the presence of the term "usable information" in the House bill.

> Is the CES a good model for coordinating policy research? If so, is there an existing bureaucratic entity, such as the Domestic Policy Council, that could parallel the CES by coordinating policy research and assessments (HCSST 1989, 248)?

In reply, Peck chose not to answer the question directly, but his answer reinforced the separation of science from matters of policy development in the proposed Program. He replied

> I would prefer not to speak for the policy community; they make their own decisions for the best structures to coordinate their activities. However, I should note that international global change science policy is currently being coordinated through the National Security Council's Policy Coordinating Committee for International Oceans, Environment, and Science Affairs [the Bernthal Committee] (HCSST 1989, 252).

Peck indicated, by distinguishing between global change policy development and the Committee's activities, that the proposed Program would emphasize global change science and leave policy matters to others. Peck claimed that the Bernthal Committee in the State Department was coordinating global change policy, although (as document in the previous Chapter) Bush Administration officials had rendered the Bernthal Committee's policy development role effectively moot; it was really just for show.

The Senate passed the S.169 on 6 February 1990 with little debate. However, due to a jurisdictional dispute between the House Science Committee and the House Merchant Marine Committee the House delayed passing its version until 26 October 1990 (Kennedy 1992b). According to Robert Palmer, a House Science Committee staffer who worked on the Global Change Research Act, the jurisdictional dispute involved access to sensitive budget documents.

> A lot of fighting that went on during that legislative process involved getting access to [White House] FCCSET documents. We had a provision in the bill, at one point, that required the administration to share the agency budget documents with us. . . The White House fought that real hard, and the Merchant Marine Committee fought really hard over it. They wanted [the budget

> documents] and this was the thing that held up the bill for a long time, until we found out that Merchant Marine didn't actually have the jurisdiction and didn't really need them. We went forward eventually without [Merchant Marine] (IA 1994).

During the sixteen-month period between the July 1989 House hearing and the final House vote on the bill Congress held only one hearing on the legislation. That hearing is illuminating because it shows the growing frustration in Congress with the Bush Administration's reticence to develop policy with respect to global change.

The Senate Appropriations Subcommittee with jurisdiction over the Office of Science and Technology Policy held the hearing on 8 February 1990. D. Allan Bromley, science advisor to President Bush was the sole witness. Senator Barbara Mikulski (D-MD) explained that the oversight hearing was called because of concerns in the Congress about the Bush administration's apparent lack of attention to the development of global change policies and criticized a recent Bush speech on the topic.

> There is increasing concern that U.S. policy and global climate change is adrift . . . Perhaps most troubling in the President's speech was that is lacked any sense of urgency on the need to develop both a short-term and long-term policy on global warming other than beyond doing more research. This Senator has a great respect for research, and good science should lead to good policy, but good science shouldn't lead to a delay in policy (SCA 1990, 1-2).

Mikulski's opening statement was among the first to link explicitly the proposed research program with global change policy development. Demands for policy development, such as Senator Mikulski's, created pressures for Committee officials to define more explicitly the role of the proposed Program in the policy process.

In the question and answer period, Senator Mikulski pressed Bromley on the relationship of science and policy in the proposed Global Change Program, noting the Bush Administration's apparent bureaucratic shell game of creating powerless committees to be in charge of policy development. She asked "Could you tell me what is the policy structure, in terms of the way you are going to arrive at it, who has been tasked to do it . . .it looks like we were lurching from advisor to advisor. . . who is in charge (SCA 1990, 77-78)?" Bromley responded that, "at the moment," he linked the Committee on Earth Sciences to President Bush's Domestic Policy Council Working Group responsible for global change policy, providing "essential intragovernmental cross-communication" (SCA 1990, 78). The Working Group, he continued, reported to the full Domestic Policy Council under the attorney general, who reported to the president. Senator Mikulski was unhappy with the answer and asked a follow-up question: "Doctor, which individual, if there is one within the administration, has the President tasked to coordinate and develop specific government-wide policy options on global warming (SCA 1990, 80)?" Bromley replied that he was this person.

Sensing the tight spot that they were in, Committee officials found it politically expedient to encourage Congress to link explicitly the proposed Program with the development of policy as climate change became increasing controversial, in spite of the earlier Committee efforts to restrict the program to research only.[57] Representatives of the Committee walked a tightrope between demands for policy action from Congress and the policy reticence of the Bush Administration. They discovered that walking the tightrope meant promising to Congress that the scientific research to be conducted in the Program would be policy relevant, while asserting

to the Bush Administration that the program would be separate from policy development. A participant recalled that

> From the standpoint of the greenhouse issue, you couldn't even contemplate saying "We're serving the people who want to negotiate agreements on greenhouse gas emissions" because you weren't supposed to admit anyone needed to negotiate.

The participant said that Committee officials had to be very careful in the polarized political environment.

> We learned over the years how to finesse words [in program reports and testimony] very carefully to get a little bit of the flavor in to people who knew, the people who were close [to the program] would recognize what we were trying to say, but to the outside reader, they don't mean anything (IA 1994).

The proposed Program became more closely connected to the development global change policy through the efforts of a frustrated Congress seeking to gain an upper hand in its dealings with the Bush Administration over the issue of global warming.[58] Political polarization forced issues of science and policy closer together in the Program as Committee officials sought to maintain a balance between a Congress with interests in policy development and an Administration interested in avoiding policy development..

A result of the inter-branch conflict was that some members of Congress appropriated ambiguous "words that don't mean anything" -- such as "usable information" -- from the global change community and used them to forge a link between research and policy. One participant describes the evolution of the Committee's mandate: At the beginning of the legislative process

> what you had was a simple codification of what CES was doing. There wasn't much in the way of anything broader. What ended up happening was just like what happens in most legislation, [it] became the vehicle to get at a lot of other problems (IA 1994).

In the case of the Global Change Research Act, Congress expanded the Committee's existing mandate to include a provision calling for the Program to "provide usable information on which to base policy decisions relating to global change" (P.L. 101-606). The end result was a different mandate in P.L. 101-606 for the Program and its overseeing Committee than was originally envisioned by the Committee on Earth Sciences.

Legislative and Administrative Intent for P.L. 101-606

President George Bush unceremoniously signed the bill into law on 16 November 1990. The Global Change Research Act of 1990 is quite explicit in its call for research to support policy development with respect to global change. The purpose of the legislation was to

> Provide for development and coordination of a comprehensive and integrated United States Research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change (P.L. 101-606, sec. 101).

The law directs FCCSET to create a Committee on Earth and Environmental Sciences (CEES) "for the purpose of increasing the overall effectiveness and productivity of Federal global change research efforts" (P.L. 101-606, sec. 102). Congress gave the three-year-old Committee on Earth Sciences a new name along with its new mandate.

The law gave the Committee responsibility to develop the Programs ten-year research plan (to be updated every three years), to coordinate federal global change research budgets, to review periodically the Program's performance (with external assistance from, e.g., the National Academy of Sciences), and to cooperate with the State Department when the U.S. participates in international global change conferences, meetings, and programs.[59] The law also gave the

Committee an explicit role in the development of a range of alternative policy responses to global change. It states that the Committee shall consult "with actual and potential users of the results of the program to ensure that such results are useful in developing national and international policy responses to global change" (P.L. 101-606, sec. 102). Finally, the Committee was also directed to communicate annually the results of the program to Congress through a series of reports that cover research priorities, policies, and programs (P.L. 101-606).

The ten-year global change research plan was to be a key element shaping the Program's research direction and its connection to policy development. The plan would establish

> the goals and priorities for Federal global change research which most effectively advance scientific understanding of global change and provide usable information on which to base policy decisions relating to global change (P.L. 101-606, sec. 104).

The legislation defines "usable information" in terms of an "information management" strategy that would, in part,

> combine and interpret data from various sources to produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change (P.L. 101-606, sec. 104).

In other words, "usable information" would help policymakers define and select effective prevention, mitigation, and adaptation action alternatives for consideration in the decision making process. In short, the Program was developed to do more than just produce information on global change: It was created to produce information usable in the development of policies in response to the many potential effects of global change. (Appendix 1 reprints the full text of P.L. 101-606.)

In calling for "usable information" P. L. 101-606 provides insufficient guidance to what "usable information" is and how it would be achieved. In order to resolve these issues it is necessary to consult the historical record to determine legislative and administrative intent for the program. The record indicates that what "usable information" is and through at least 1994 (and arguably to the present) neither Congress nor program administrators resolved how it would be achieved. How scientific information was to be turned into usable information was left ambiguous. Consequently, some in Congress expected the Program to focus on science and exclude considerations of policy, while others expected it to focus science *on* considerations of policy. Program administrators, meanwhile, continued to emphasize the scientific aspects of the Program, but justify the program in terms of its relevance to policy. These different, and sometime conflicting, interpretations of the intent of P.L. 101-606 led to different expectations for program performance and thus set the stage for a performance shortfall.

Legislative Intent: Two Different Interpretations

In spite of formal agreement in law on the goal of usable information, how usable information was to be developed or what the term meant was never defined in the legislative process.[60] As a consequence, participants in the policy process understood differently how usable information was to be achieved, with two significantly different interpretations evident in the public record. One group of participants defined usable information exclusively in terms of global change science. That is, scientific research would be completely separate from consideration of prevention, mitigation, and adaptation research, and the Program would be responsible only for the scientific research. Some were concerned that global change research would be *politically driven*, in the sense that *politics* would drive (and perhaps predetermine)

research findings. Thus, these people wanted to separate global change science from any consideration of policy issues. A second subset of participants defined usable information in terms of the clarification of action alternatives to feed into policy development. The remainder of this section documents and defines each of these two different interpretations of usable information in greater detail.

One Interpretation: Development of a Scientific Understanding

The logic behind calls to separate global change science and policy can perhaps best be illustrated by the metaphor of the assembly line. In an assembly line, one task is completed before the next begins. On the global change assembly line science would be conducted as a first step, and global change policies would then be made as a second step. As science advances, the argument's reasoning goes, new and presumably better policies could then be built upon the growing foundation of scientific research. Under this model, the Program would conduct scientific research and leave consideration of policy issues to others.

Calls to separate global change research from any consideration of policy issues were heard in the congressional hearings that led to program approval, and scientists, politicians, and program administrators espoused such separation.

Several Program administrators argued straightforwardly for the separation of global change science and policy. For example, Francis Bretherton, former chair of NASA's Earth System Science Committee that established the scientific basis for the Program, testified before Congress in 1988 that a global change program required separation from the process of policy development:

> In structuring a national program on Global Change, it is essential that the basic research be loosely coupled to, but conducted separately from, consideration of policy issues . . . [because of] the long time scales required for making significant progress in basic research, the realization that such progress must draw upon a wide spectrum of existing capability spread through the agencies . . . and others which have other responsibilities besides global change, and the imperative to keep the process of scientific discovery free from suspicion that it could be manipulated to justify any particular policy (SCCST 1988, 34).

The substance of Bretherton's remarks was often repeated by global change program officials and by members of Congress as well. Consider written testimony presented before the House Science Committee in 1989 by Robert Corell, the NSF representative to the Committee on Earth Sciences. He argued that a scientific focus in the Program would serve the needs of global change policy:

> Broad trust in the objectivity of science is essential for the success of policymaking efforts, particularly in international negotiations with far-reaching economic implications. Independent and objective science, therefore, serves both science and policy needs (HCSST 1989, 99).

Corell added that global change science would best serve policy through ad hoc communication between high-level Committee officials and their counterparts in policymaking bodies.

> Scientific independence does not imply isolation; for the Nation's interests to be well served by the program, its science-coordinating forum must communicate effectively with policy-formulating forums. The CES can stimulate such exchange, because [its] members . . . are agency directors or assistant directors, whose positions allow and encourage them to communicate effectively with the Office of Management and Budget, the Domestic Policy Council. . .and other appropriate bodies (HCSST 1989, 99-100).

In other words, Committee officials would explain the significance of science produced in the program to other high level officials in the Executive branch on an ad hoc basis.[61]

Consider also the statement of Shelby Tilford, the NASA representative to the Committee, in the same hearing. He testified in greater detail why science and policy must be separate in the Program, arguing that

> it is vital for there to be a clear separation of responsibilities between the scientific agencies and the policymakers. . . Policy directed programs are generally focused on the policy needs of today, with a limited vision of relating longer term scientific issues, and often risk being viewed as intellectually too restrictive to attract the best scientific minds to participate (HCSST 1989, 129-130).

Tilford argued that science had to be kept separate from policy so that scientists would participate in the program, and so that the program could consider long term issues without political pressure for immediate results. As Bretherton had testified, integration of science and policy within the program could lead to "politicized" science that would damage the scientific quality of research in the Program. Concerns that science would become "politicized" have a basis in experience. For example, Congress found in 1976 that scientific research in an EPA program had been tailored to meet predetermined conclusions for political reasons (HIFCC 1976).

Policymakers supported the separation of global change science and policy when they stated that scientific answers would be necessary to formulate policies to respond to global changes. Such statements imply that science must be in some sense completed before policy decisions could be made. For instance, Senator Ernest Hollings (D-SC) stated his purpose in sponsoring S. 169: To produce information necessary to make global change policy.

> It is my attempt to formalize the current interagency research effort, to require sound planning, and to provide good budgetary information and coordination. *My hope is that a long-term coordinated research effort will one day give Congress the information it needs to take corrective action and avert a future disaster*. . . Good answers to the pressing questions we face will not come easily. . .We need a determined and coordinated research effort. . .to get the *facts about the exact causes and consequences* of global environmental change (SCCST 1988, emphasis added).

In Senator Hollings' terms usable information is "facts about the exact causes and consequences" of global change, which is usable because it is what Congress "needs to take corrective action." In floor debate on 27 October 1990 Senator Hollings repeated an analogy first used by Francis Bretherton in hearings. Hollings likened the earth to a car noting "when we have a car problem, we take the car to a repair shop or fix it ourselves using the operator's manual. For the global environment, however, there are no mechanics or manuals." Hollings concluded that the purpose of the Program was therefore "to obtain the knowledge we need to train the mechanics and write the manual before this global machinery is irreversibly damaged" (*Congressional Record* 1990, 17739). Congressional hearings are replete with examples of policymakers expressing the desire for "answers" or "reduced uncertainty" in the context of global change. Many similar examples have been put forth based on the belief that to properly deal with the problems posed by global change science must precede policy.[62]

A number of scientists also supported separating science and policy in the Program. Of the scientists who testified before Congress on the need for a global change program, many restricted their discussion to science issues only. However, a number of scientists were more vocal about the relationship between science and policy. For example, during a 1987 Senate hearing on global change Senator Tim Wirth (D-CO) asked a panel of authoritative global change scientists what type of policy advice each would give the President, if given the chance. One

scientist responded that he could not give any recommendations, because "we do not understand the details well enough to give detailed advice at this time" (SCENR 1988). The scientist's implication was that more research was needed before the clarification of policies in response could begin.[63]

Concerns that consideration of policy issues within the USGCRP implied research would be *politically-driven* led some to conclude that the program had to conduct research independent of policy. "Politically-driven" research is taken to mean research conducted to support a predetermined political position. An example of concerns over policy-driven research is contained in written questions from Senator Gore to FCCSET chairman Bromley following an April, 1991 hearing. Senator Gore asked

> Are there safeguards in the U.S. Global Change Research Program which will ensure that policymakers do not end up telling the scientists not only WHAT questions need to be answered, but also HOW to answer them? (SCCST 1991, 72, emphasis in original)

Bromley responded that traditional scientific evaluation tools such as advisory panels and peer review would "ensure that policy does not interfere with science" (SCCST 1991, 72). When science is "politically-driven" the assembly line presented above is shifted into reverse, with research built upon a foundation of politics, and thus, used expediently.[64]

The call to separate scientific research from consideration of policy issues is, ironically, a point of agreement between opposing perspectives on environmental action. For example, then Senator Al Gore, whose environmental policy preferences are well known, stated in the Senate prior to the Program's approval that

> more research and better research and better targeted research is (sic) absolutely essential if we are going to *eliminate the remaining areas of [global change] uncertainty* and build the broader and stronger *political consensus necessary for the unprecedented actions* required to address this problem (SCCST 1989a).

From Senator Gore's perspective usable information referred to that information which would "force" a political consensus. For instance, a scientific consensus that global warming is underway, with a high degree of certainty, would allow little room for opponents of action. Such a scientific consensus, Gore intimated, would make obvious the need for the "unprecedented actions" needed to deal with global changes.[65]

On the other side of the ideological spectrum similar conclusions about the need for research independent of policy issue clarification were reached from a much different starting point. For instance, President George Bush often expressed the need for more global change research.[66] In a February, 1990 speech before the U.N.-sponsored Intergovernmental Panel on Climate Change (IPCC) President Bush stated that global change policies must be carried out in the context of

> [the] reconciling of environmental protections to the benefits of economic development. . . Wherever possible, we believe that market mechanisms should be applied and that our [global change] policies must be consistent with economic growth and free market principles in all countries (Shabecoff 1990, Weisskopf 1990).

In the following months the Bush administration was frequently accused of using scientific uncertainty to justify political inaction.[67] A political strategy of inaction would emphasize the lack of scientific consensus or certainty, and thus would emphasize the need to conduct research separate from (prior to) policy development.

While Senator Gore and President Bush began from distant points on the ideological spectrum, their political concerns resulted in similar conclusions about the structure of global change research: Before consideration of policy issues could move forward, scientific uncertainty must be resolved, one way or the other, through research. Therefore when Senator Gore advocated a global change program it is likely that he expected it would demonstrate conclusively and convincingly the need to respond comprehensively to global warming. At the same time, when President Bush signed the bill establishing the Program it was consistent with his policy of "no regrets" which also called for certainty in research prior to any policy actions. President Bush likely expected that such certainty would not be immediately forthcoming. In was in this manner that measures of scientists' opinions and estimates of levels of uncertainty became important in the climate change debate. Global change became a matter of narrow debate over "yes" or "no" on whether global warming was actually underway. Alternative definitions of "usable information" to aid in the process of policy development was lost in the clamor of the debate.

In short, to achieve the Program's primary goal of producing usable information a number of participants, including Program administrators, policymakers, and scientists, supported the separation of science from policy. In other words, the program would focus on the development of a scientific understanding of global change and not on issues related to the needs of policy development.

A Second Interpretation: Contribution to the Process of Policy Development

Some participants did, however, question the ability of a program that focused exclusively on global change science to meet the program's goal of providing information usable by decision makers. This group of participants, which included some scientists but mostly policymakers, believed that scientific research would be insufficient to meet the mandated objectives of the Program.

Robert Corell, who had earlier advocated before Congress keeping science and policy separate, contributed to the ambiguity of the Program's mandate by further testifying that integration of science and policy in the context of global change required new ways of thinking. This seems to contradict his statements in which he stated a need to keep global change science and policy separate:

> Historically, we worked in what I call the "serial mode." Science planning occurs within the community and it comes to the federal government some time later and a plan is then put in effect and implemented. Later on you get some results, upon which policy decisions occur. . . We are operating in a "parallel mode" . . . Instead of having research results published and then do policymaking, we see a need to work in parallel (SCCST 1989a: 63-64).

Corell did not define what working in parallel meant in practice for the implementation of the Program, and Congress failed to press him on the issue. Other Program administrators did not explicitly define or discuss the provisions of the legislation calling for usable information.

Some policymakers contributed to the mandate's ambiguity. Unlike their counterparts who sought to complete research prior to the development of policy, many policymakers saw the need to consider global change policy issues before scientific uncertainty was eliminated. One Senator offered an amendment to the legislation that would establish the program to clarify the implications of the call for a ten-year research plan, arguing that

> such a reference improperly suggests that a 10-year program will resolve the uncertainties and provide us with the answers we need to take action . . . Such false promises often become barriers to the adoption of measures designed to address the problem [of global change] in the intervening 10 years (Baucus 1990).[68]

The amendment passed the Senate, but was overturned in the House.

Representative James Scheuer (D-NY) expressed the tone of many hearings on global change when he asked a witness the following question.

> We [in Congress] are in desperate need of policy assistance. What are the ways - what are some of the things that we could do to increase the policy relevance of scientific research on global change (HCSST 1989, 244)?

Rep. Scheuer was more specific in a hearing several years later when he asked

> How much longer do you think it will take before [the USGCRP is] able to hone [its] conclusions down to some very simple recommendations, on tangible, specific action programs that are rational and sensible and cost effective for us to take . . . justified by what we already know (HCSST 1992, 88)?

In general, the questions raised by Mr. Scheuer were unanswered and unaddressed as the proposed program passed through the legislative process. Rep. Scheuer reaffirmed the program's policy mandate when he noted that "in passing the Global Change Research Act of 1990, Congress mandated the development of an integrated U.S. research program designed to produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change" (HCSST 1992, 2).

Several witnesses called before congressional committees did, however, suggest in greater detail implementation of a global change program that would result in contributions to policy development. Two witnesses, in particular, suggested alternative strategies how the Program might provide usable information. Neither defined what usable information in fact was in the context of global change or how policymakers might recognize it once it was produced, but both witnesses did discuss several strategies about how scientific and policy research might be integrated in the program.

"Assessment" was defined before Congress by Christopher Bernabo as "an iterative process of synthesizing and integrating technical information into a form relevant for decisionmaking." In other words, "policy relevant scientific assessments" should be based upon what information policymakers desired, and would also explicitly define levels of technical detail and policy preferences (HCSST 1989). However, these comments were noted only in passing, and at enactment the Program had no planned capability for policy assessment.

William Clark testified at the same hearing that a policy relevant global change program would include, in addition to assessment, research into adaptation and mitigation based upon academic research into public policy (SCCST 1989a). From his perspective, the Program would be focused primarily on policy research rather than scientific research. Clark discussed "policy tools" that could be used to generate usable information, including models, simulations, and games (cf. Brewer 1986). Under Clark's notion of integrative global change science and policy, science would remain an important focus of the program, but not its driving mechanism. While the Program's mandate did call for information on "preventing, mitigating, and adapting to the effects of global change," it had no planned capabilities to address this provision of the law (P.L.

101-606, sec. 104.d.3). Like discussion of assessments in the hearings, discussion of strategies to produce usable information was brief and in passing.

In short, in spite of general consensus on the goal of usable information expressed in P.L. 101-606, policymakers, administrators, and scientists alike paid little attention to how the program's science elements related to its broader societal benefit goal. The lack of consensus on how the Committee was to achieve the goal of information usable by policymakers makes it difficult to answer precisely the question "what was congressional intent for the U. S. Global Change Research Program at enactment?" While it is clear that the program was created to provide "usable information," how usable information was to be produced was left unnecessarily ambiguous. The record documents that various participants had different, and conflicting, interpretations.

Administrative Intent: A Science Program

The Program, as presented in its first program report, *Our Changing Planet: A U.S. Strategy for Global Change Research* published in July 1989 four months before enactment of P.L. 101-606, acknowledges the program's policy goal, but discusses primarily its scientific content (CES 1989b). The report suggests that program officials defined the Program exclusively in terms of global change science (AGU 1990). These reports failed, however, to clarify the ambiguities of the Congressional hearings. Specifically, Program reports did not discuss the relationship between the scientific information described in the reports and "information readily usable by policymakers" called for by P.L. 101-606.

Program officials clearly viewed the program to exist to conduct research on the scientific aspects of global change. A statement of Dallas Peck, Committee on Earth Sciences chair and Director of the USGS, at the 29 August 1989 news conference announcing the Bush Administration's support for the proposed Program illustrates the perception that the Program would keep separate science and policy. Peck stated "Our [the USGCRP] goal is not to make policy recommendations but to develop the scientific understanding so that the policy apparatus can make those decisions" (FNS 1989). At the same news conference, Robert Corell stated the program's mission and relationship to policy as follows.

> [The program's goal] is to gain an understanding in how this magnificent planet ticks, how it works, what are the interactions between the various components, and working at levels that are different from our experience because the dynamics of the science tend to be at the interfaces between our more comfortable biological, chemical, physical understanding of natural processes. And how those interrelate, how they interconnect, is essential to the framework we set here, and that framework, as we begin, over the decade ahead, to more clearly understand how it works, *will naturally feed into policy formulation and decisionmaking* (FNS 1989, emphasis added).

At a later point in the news conference these views were restated:

> I want to make it clear that what we're talking about is the science planning -- the science program that underpins the U.S. and the United States [sic] federal interests in global change. . . This [research plan] is the next step in the evolution to help us in a coordinated fashion address a national response to these issues that will *feed into policy planning and development* within this government (FNS 1989, emphasis added).

These statements reflect the notion that the program would address global change science and not policy issues, but the information produced by the program would automatically feed into the policy process. Program officials consistently emphasized the Program's science objectives over

any mention of its broader policy goal. If program officials ever considered the phrase "usable information" for implementation of the Program, there is no indication of it in the public record.

Yet, while program officials were distancing the proposed program from issues of policy development, program documents discussed a need to more closely connect science and policy. Program documents oriented the Program in the context of what it identified as an emerging relationship between science and policy on global scales (CES 1989b). The report claims that

> Reliable information and predictions regarding global changes are required at many decision levels within society: individuals (e.g., farmers), industries (e.g., energy and chemical producers), and regulators (e.g., governments). . .Many such decisions are immediate, demonstrating that global change and the needed scientific input to prudent policymaking are not abstract concepts to be dealt with at some future time (CES, 1989b).

The report links scientific research questions with contemporary policy issues. For example, it linked scientific questions about global changes with policy issues.

> Scientists ask-
>
> > -Has a "greenhouse" warming already been detected?
> > -What is the uncertainty in the prediction of the magnitude and timing of global warming corresponding to trace-gas increases?
>
> Policymakers ask-
>
> > -Should Congressional actions, particularly those with multiple payoffs, be initiated to reduce the growth rate of "greenhouse" gases in the atmosphere?
> > -What land- and water-management decisions could be made now to make water supply systems more robust in the face of possible precipitation pattern changes (CES 1989b)?

The framing of these questions indicates that program administrators believed that scientists and policymakers each had questions that could be answered by the scientific elements of the Program. In other words, the report argued that the achievement of the science objectives would be sufficient to meet the needs of scientists and policymakers simultaneously. The reports argues that

> The scientists rightly seek a defensible understanding of their problems. The policy makers rightly request useful advice on their problems. The points here are twofold: (1) the always challenging dialogue between science and policy is occurring in a new arena - *global change*, and (2) it is occurring *now* (CES 1989b, emphasis in original).

According to program documents, the goal of the Program was to advance the science of global change in order to support policy responses to global change. This point is made many times in the research plan. For example,

> The underlying premise. . . of the U.S. Global Change Research Program is that wise use of the Earth for human habitation and survival is inextricably linked to an improved understanding of the systems that are undergoing change at varying rates in response to natural and human-influenced processes. A vigorous, well-coordinated Federal research emphasis will be critical to improving predictive understanding and will support the formulation of sound policy decisions. The U.S. Global Change Research Program has been established to provide that vigorous, coordinated effort (CES 1989b).

But was the science to be produced equivalent to the "usable information" promised in its legislative mandate? This question was never formally addressed in program reports, just as it was never discussed in depth during congressional hearings. Instead, reports either assumed or ignored the relationship.

According to the reports, the program was to meet its mandate through achieving three scientific objectives: monitoring, understanding, and predicting global change. The result of the three objective would be a "predictive understanding" of the global earth system on time scales

up to 40 years into the future (CES 1989b). The report clearly states that the program was not intended to consider issues other than science. It states (p. 7) that

> It is not the role of the Program to formulate policies regarding global change, nor does its mandate cover the research required to develop new technologies that might be used to mitigate or adapt to a changing environment.

P.L. 101-606, enacted four months later, *explicitly called for research into mitigation, adaptation, usable information for policy, and environmental technologies*. Committee officials never explained how the Program would meet its new mandate, and instead continued to focus on the program's science elements, in spite the policy provisions in its mandate.

The implications of the program's scientific objectives for program evaluation are clear: "good science" means a successful program. Hence, the evaluation task would be to assess the state of the science using the many accepted science evaluation mechanisms, such as peer review. The first three (of five) evaluation criteria in the original program plan are based upon assessing whether the program is producing good science (CES 1989b).[69] They are:

> *Relevance/Contribution*
> The research addresses the overall goal and the three key scientific objectives of the program.
> *Scientific Merit*
> The proposed work is scientifically sound and of high priority.
> *Readiness*
> The level of planning is high, the capabilities are of high-quality and in place, and the research is likely to produce early advances.[70]

Based upon these criteria the Program would be judged a success if it is judged to be progressing towards the three scientific goals of monitoring, understanding, and predicting. None of the evaluation criteria address whether the scientific information is, in fact, "usable" to policy makers.

Program reports almost exclusively focused on the scientific elements of the program, with little attention given to how the it was to meet its legislative mandate. Therefore, it is not unreasonable to conclude that program administrators simply equated "usable information" promised in P.L. 101-606 with advancing the science of global change. However, from congressional hearings on the proposed program it is clear that some policymakers believed that the program would provide either answers to their scientific questions, or if not answers, information that would help to clarify action alternatives relating to the need to develop policies with respect to global change. With the advantage of hindsight, it is clear that the differences between the program's scientific objectives and the various expectations of participants for program performance led to a mandate that would be difficult to enforce and easy to evade.

Chapter 5

Implementation of the U. S. Global Change Research Program: 1990-1994

Introduction

The previous Chapter argues that some members of Congress saw in the Committee an opportunity to gain an upper hand in their dealings with the Reagan, then Bush, Administrations over the issue of global warming. In blunt terms, Congress hijacked the Committee to serve its own needs. In the process, P.L. 101-606 replaced the Committee's administrative charter from 1987 and the Committee on Earth Sciences became the Committee on Earth and Environmental Sciences. This Chapter compares the Committee's implementation of the Program during 1990-1994 with each of its four primary responsibilities mandated by P.L. 101-606.

Performance of the Committee on Earth and Environmental Sciences Under Public Law 101-606

1. Committee Mandate: Continue Agency and Budget Coordination

P.L. 101-606 calls for the Committee to "improve cooperation among Federal agencies and departments with respect to global change research activities" and to "provide budgetary advice." The law gave the Committee a formal role in the budget process. In effect, it established in law the budgetary crosscut activities developed for FY 1989 and 1990. This provision of the law called for the Committee to continue to provide the crosscut information. It also called for the Committee to produce an annual report. Each of the other provisions of P.L. 101-606 went beyond the Committee's 1987 administrative charter.

Committee Performance: Continued Coordination of Agencies and Budget

Following passage of P.L. 101-606, the Committee continued to produce budget crosscuts and publish them as the series *Our Changing Planet*. This document fulfilled the provision calling for an annual report to Congress. Table 4.1 shows the budget of the Program from 1990 through 1994. The rapid increase in appropriations to the Program is one measure of the Committee's success in coordinating the budgets of the various participating agencies. There was, however, at least one exception to the successful crosscut process.

Under P.L. 101-606 once agencies signed off on their contribution to the Program during budget negotiations with Office of Management and Budget, that money became "fenced off." Therefore, once an agency committed funds to the Program it was not allowed to "change its mind" as OMB would not allow the agency to reprogram the funds for other purposes elsewhere

in its budget (Kennedy 1992b). All participating agencies had agreed to this arrangement as ground rules of the FCCSET crosscut process. Once an agency completed budget negotiations on its contribution to the Global Change Program with the Committee, it then lost control over those funds to the Committee. With respect to budgets for global change research, this agreement formally gave Committee officials equal power to cabinet secretaries in the global change budget process (Kennedy 1991b).

In late 1990 and early 1991 the Committee's role in the budget process collided with Manual Lujan Jr., Secretary of Interior, as it began to put together its FY 1992 crosscut under the leadership of Committee chairman Dallas Peck, who was also director of the USGS within Interior, under Lujan. At first, the crosscut procedure progressed as it had the two previous years: Each participating agency committed funds to the Program which were then fenced off from the rest of their agency budget. It was at this point in the budget process that Secretary Lujan decided that he wanted to reallocate Interior's contribution to the Program to fund other programs within Interior (Kennedy 1991b).

According to one Committee member, Lujan "figured out that this whole [FCCSET] process was wiring around the traditional budget process and the traditional authority of department political types" (Kennedy 1991b, 13). To support their position, Committee officials pointed to the agreements signed by Lujan earlier in the budget process. However, this did little to reduce tensions. A House Science Committee staffer recalled that

> The agencies submitted their Global Change [Program] budgets. Interior went forward, so presumably they were sort of locked in -- this is their request. Apparently, after that had been done, the Secretary [Lujan], for whatever reason, had sudden need for a bunch of money for Indian Health Programs and he started looking around in the budget for where he could find a hundred million bucks. It turns out that Interior submitted a fairly substantial bump in the Global Change Program that included some things like retrieving some of the archives, archiving them, and putting them into more useful forms. Some very important national priorities had been determined through this whole process (IA 1994).

The staffer recalled that Lujan sought to reallocate the global change funds in the Interior budget, which he felt was under his control: "Lujan essentially said 'I'm not playing this game, I need this money for my Indian Health Programs,' and he removed it." When Peck sought to reverse the reallocation, a conflict arose because as Chairman of the Committee on Earth and Environmental Sciences, Peck was technically Lujan's equal in global change budget negotiations, but at the same time Peck, as director of the USGS, was Lujan's subordinate. In the end, the OMB came down on Peck's side (Kennedy 1991b).

In the year following, still smarting from the previous year Lujan made it clear that "No bureaus of the department [of Interior] may transmit any fiscal year 1993 budget figure to FCCSET committees prior to my final decisions," which Lujan said would come in September (Hamilton 1991). Under the rules of the FCCSET cross-cut process agencies were required to submit their budget requests for programs participating in the process by 15 July. The conflict between the Committee and Interior highlighted a weakness in the FCCSET cross-cut process: "The minute somebody said 'I don't want to play' all they had to do was pick up and walk out of the room" (IA 1994).

Because of the conflict, the "fencing off" provision of the crosscut process was relaxed. However, the conflict did have a lasting effect: It indicated to Committee officials that the interagency crosscut process was very precarious: A cabinet official unwilling to participate could, in principle, bring the whole structure down. Consequently, Committee officials found support in P.L. 101-606 that established the Committee and its budgetary role by statute. A Committee official said "we feel, in some respects, as though we would not be around today if not for that piece of legislation" (Kennedy 1991b, 14).

The conflict between the Committee and Interior was over the coordination of agency budgets. It is important to note that coordination of budgets and agencies is not the same as coordination or integration of research. The former is largely designed to satisfy those participating with the program, e.g., agencies, OMB. The latter type of coordination is largely for purposes of those outside of the program, i.e., including scientists, Congress, the public, and other decision makers. The provision of P.L. 101-606 that discusses budgetary coordination refers to coordination of the first kind. Coordination and integration of research are addressed in another provision of P.L. 101-606.

2. Committee Mandate: Develop a National Global Change Research Plan

P.L. 101-606 gave the Committee responsibility to "serve as the forum for developing the [Global Change Research] Plan and for overseeing its implementation." In Section 103 the law defines the Global Change Research Plan in greater detail. It calls for the Plan to

> … establish, for the 10-year period beginning in the year the Plan is submitted, the goals and priorities for Federal global change research which most effectively advance scientific understanding of global change and provide usable information on which to base policy decisions relating to global change.

The law called for the first plan to be submitted to Congress "within one year of enactment" and a revised plan to be submitted "at least every three years thereafter."

Committee Performance: Ten-Year Plan Never Developed

The Committee did not develop or release a Global Change Research Plan. Representative James Scheuer of the House Subcommittee on the Environment (of the House Science Committee) expressed concern about the Plan in a 10 May 1991 letter to President Bush's Science Advisor and FCCSET Chair D. Allan Bromley. Scheuer asked that Bromley "Please verify that the Plan will be submitted in a timely fashion and will respond to the requirements" of P.L. 101-606 (Bromley 1991a). Bromley responded that the Committee had been producing an annual report, the budget crosscuts, which provided "detailed information on the USGCRP" (Bromley 1991a).

Scheuer was not satisfied with Bromley's response. He and Representative Howard Wolpe, Chairman of the House Investigations and Oversight Committee (of the House Science Committee), wrote again to Bromley on 19 August 1991

> Section 103(b) [of P.L. 101-606] provides for development of a 10-year National Global Change Research Plan, to be delivered to the Congress by November 16, 1991. Do you intend to develop the ten-year plan,

> with the contents described in section 103(b), or not? When will it be provided to the Congress (Scheuer and Wolpe 1991)?

Bromley responded that it was the Committee's intention "to produce a document to satisfy the planning requirement described in section 103(b)" (Bromley 1991b). He stated further "this document (which will include research milestones), the FY 1991 Research Plan, *Our Changing Planet*, and subsequent updates will comprise the Administration's submission to satisfy this requirement" (Bromley 1991b). Yet, the Committee never produced a ten-year Global Change Research Plan. Congress did not follow up on the oversight efforts by Chairmen Scheuer and Wolpe in 1991 with respect to the ten-year plan.

3. Committee Mandate: Provide for Periodic Peer-Review

P.L. 101-606 called for the Committee to "work with academic, State, industry, and other groups conducting global change research, to provide for periodic public and peer-review of the program." The legislation specifically calls for the Committee to have the National Research Council "evaluate the scientific content of the [ten-year] plan" and to recommend "priorities for future global change research."

Committee Performance: No Formal Evaluation

The Committee did not fulfill the call for periodic public and peer-review of the program. In 1993 the Office of Technology Assessment found that "there has been no formal evaluation of the overall scope, goals, and priorities of USGCRP and of whether its activities are addressing the need of policymakers" (OTA 1993, 139). Through the end of the Committee's tenure no formal evaluation of the program had been initiated (IA 1994). Furthermore, because the Committee did not produce a ten-year report the National Research Council was unable to assess the plan. Prior to enactment of the law, the Committee did arrange for the National Research Council to convene a panel to assess the Program's FY 1991 plan. However, the independence of this report may have been compromised.

Science Advisor Bromley requested the report in January 1990, ten months prior to enactment of P.L. 101-606. The report was to review the FY 1991 *Our Changing Planet* and the NASA Earth Observing System (EOS) program. The Academy's report was produced, however, the process had several irregularities. Contrary to standard National Academy procedures, Committee officials had obtained a draft copy of the report prior to its completion (IA 1994). Committee officials were concerned that the report's executive summary contained errors, and that these would adversely affect the NASA EOS part of the global change budget (IA 1994). Committee and Academy officials met and the Committee officials suggested where the writing of the executive summary might be made more accurate. As a result, "changes were made" (IA 1994). The release of the report, which was already being printed, was delayed one week. One NAS official said that in the years since or before he had seen nothing like the events surrounding the global change report (IA 1994).

The events behind the report are significant for several reasons. First, that the highly respected National Academy changed its report in response to complaints from agencies that were examined by the review at least presents the appearance that the peer-review process was

compromised. It would be unrealistic to assume that, in general, agencies have no influence over Academy reports: There are many indirect avenues of influence, for example, through the composition and lobbying of Academy review panels (Boffey 1975). However, the Academy compromised their credibility by sitting down with Committee officials and going over the report and allowing changes prior to publication. Second, Committee interference with the Academy process gives further weight to the argument that the Committee did not ensure that the Program would be externally peer-reviewed. As it was, the content of the report was somewhat critical of the Program. To the extent that Committee officials acted to "soften" the report's findings indicate that they were concerned more with protecting the Program's budget over recognition of shortfalls in the prospects for successful program implementation identified by the Review panel.

4. Committee Mandate: Provide "Usable Information"

P.L. 101-606 calls for the Committee to "consult with actual and potential users of the results of the program to ensure that such results are useful in developing national and international policy responses to global change." One source of usable information was to be the ten-year plan which was to establish the "goals and priorities for Federal global change research which most effectively advance scientific understanding of global change and provide usable information on which to base policy decisions relating to global change." The plan was also to define and explain how the federal government was to "combine and interpret data from various sources to produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, or adapting to global change." The program was also to produce every four years a scientific assessment that

1. integrates, evaluates, and interprets the findings of the program and discusses the scientific uncertainties associated with such findings;
2. analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and
3. analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years.

As the previous Chapter documents, some in Congress wanted the Program to do more than simply produce scientific information: They wanted it to produce information usable in the decision making process.

Committee Performance: Did Not Define or Systematically Produce "Usable Information" and Failed to Identify Users

The Committee did not establish a process to provide usable information or to define how the scientific and technical information the Program would generate would be usable, and to whom it would be useful.[71] Committee officials were aware of the provision calling for usable information and publicly claimed that it was their intention to fulfill this objective. During a 1992 hearing a USGCRP official was aware of the pitfalls of "waiting too long in order to produce products that are readily usable to policymakers, whether it is in the executive branch or in the Congress" (HCSST 1992, 79). One Congressman pressed the official on what he meant by "products." The official responded

> Principally information that can be translated into an instrument that's useful in policymaking . . . I have been educated in the need to translate our research activities, our scientific results, into products that [policymakers] can understand and use (HCSST 1992, 80).

Another Committee official at the same hearing stated that "the U.S. Global Change Research Program was conceived to provide the scientific understanding of global change, and was developed to be policy-relevant and hence to support the timely needs of the United States and other nations to address the scientific uncertainties related to changes in the Earth's environment" (HCSST 1992, 18). Yet, a statement by the first official later in the same hearing illustrates the expectation of some program officials that the program would focus exclusively on science, in spite of the provisions of P.L. 101-606 which called for research on prevention, mitigation, and adaptation policy responses to global change. He stated that "whether [USGCRP] research can translate into actions to deal with the climate change problem . . . is not really the business of the [CEES]. That is where our job ends and, thank God, in some sense, other people's job starts" (HCSST 1992, 93). Members of Congress failed to address the apparent conflict between the purposes stated in law for the Committee and its implementation strategy.

The Committee did not address explicitly the provisions of P.L. 101-606 calling for "usable information." Its implementation of the Program largely was restricted to the activities that fell under the 1987 administrative charter of the Committee on Earth Sciences. However, during its tenure the Committee did initiate several new efforts that had potential to address the call for "usable information." But each of these efforts fell far short of systematically defining or establishing a process to produce "usable information." Among Committee initiatives was the establishment of a working group on Mitigation and Adaptation Research Strategies, a Research Program on the Economics of Global Change, and a Global Change Research Information Office. In 1993, the Committee added an assessment function to the program's functional architecture. Each is discussed below.

1991: Global Change Research Information Office

In 1991 the Committee created an ad hoc task group to discuss implementation of a Global Change Research Information Office (GCRIO).[72] The GCRIO was originally intended to provide scientific "information useful in preventing, mitigating, or adapting to the effects of global change" to foreign governments and other foreign entities (CEES 1993, 60). In 1993 the Office defined its mission more broadly: to serve all end-users of the USGCRP (CEES 1993).[73] In this capacity, the GCRIO could be a key provider of information readily usable by policymakers. However because it was not fully implemented, its potential to address the call for "usable information" remained unfulfilled.[74]

1992: Research Program on the Economics of Global Change

The Committee also created the Research Program on the Economics of Global Change. The economics program was initiated in 1992 "to enhance the ability of the Federal Government to evaluate the likely magnitude of the economic effects of global change on society and to evaluate the cost of options designed to address global change . . . driven by the needs of policy makers" (CEES 1992b). However, the economics program explicitly *excluded* policy research from its purview. By excluding policy research from its purview the Economics Research

Program handicapped its ability to address the information needs of decision makers. Further, in the words of one critic the Economics Research Program was an "afterthought" (HCSST 1993, 61).

1993: Assessments

In 1993 CEES added assessments to the program's functional architecture (CEES 1993, 6-7). According to the Committee, assessments were explicitly added to the program to assist policymaking.

> Building on the new assessment component, the goal of this program expansion is to enable the U.S. Government to conduct end-to-end (integrated) assessments of global change issues upon which sound policies can be identified, adopted, implemented, and maintained at regional, national, and international levels (CEES 1993).

Through the President's FY 1995 budget CEES was unclear on the nature of assessments in the Program. Therefore, how assessments would provide readily usable information for policymakers remained to be defined.[75]

The Legacy of the Mitigation and Adaptation Research Strategies Working Group

The best opportunity for the Committee to meet its mandate ended in 1992 with the termination of its working group on Mitigation and Adaptation Research Strategies (MARS).[76] MARS had been established prior to the enactment of P.L. 101-606 in January 1990 based on a directive from Science Advisor D. Allan Bromley to Committee chair Dallas Peck. MARS was to develop strategies in response to the potential of global changes.[77] A report of the Working Group stated that

> The fundamental objective of MARS is to coordinate the establishment of the scientific, technological, and economic basis for efficient, cost-effective global change response technologies and practices to sustain environmental well-being (MARS 1991a, 9).

MARS had a number of operational objectives to reach its fundamental goal (1991, 9-10). Among these were

> 1. The development, demonstration, and enhancement of the technologies, and practices to limit future growth in emissions of greenhouse gases …
> 2. The determination of the sensitivity of human and other natural systems to global change …
> 3. The development, demonstration, and enhancement of the technologies and practices and [sic] management strategies to adapt to global changes …

The working group saw its role as addressing the global change issue "comprehensively" (1991a, 12-13). In the words of the Working Group (1991a, 13):

> The result of a comprehensive approach is a more coherent understanding of the factors contributing to potential global climate change and their impacts, and more efficient design of any policies to address those factors, including both limitation and adaptation response.

Thus, the MARS working group saw itself as the policy relevant component of a broader global change program.

The MARS report indicates that participants viewed the working group to be separate from the Global Change Research Program. The report indicates that the MARS working group and the Global Change Research Program were considered to be two parts of a "U.S. Global Change Program" that would have research and policy as its two component parts.

> One objective of the CEES was to establish the U.S. Global Change Program. This Program has two distinct foci: the Global Change Research Program addressing basic research need and the MARS Program addressing technological research and development. A very close relationship exists between the GCRP and MARS. *The GCRP provides the science underpinning for MARS. . .research related to mitigation and/or adaptation will be coordinated on an interagency basis through MARS* (MARS 1991a, 8, emphasis added).

The MARS conception of a Global Change Program is clearly at odds with the structure of the U. S. Global Change Research Program stated in P.L. 101-606. The legislation dictated that the Program was responsible for providing "information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change" (Sec.104.d.3). Thus, P.L. 101-606 mandated that the activities that MARS would have overseen -- the production of usable information in terms of prevention, adaptation, and mitigation of the impacts of global change -- be within the Program.

During 1990 MARS focused on creating its own budget crosscut explaining the various agency roles and plans in mitigation and adaptation research (MARS 1991, 29-31).[78] MARS found, using a classificatory system similar to that used in the FCCSET crosscuts, that participating agencies contained projects on mitigation and adaptation research totaling about $9.5 million. However, OTA (1993, 133) has found that "these projects are not included in the USGCRP because they do not conform to the USGCRP mission of 'observe, understand, and predict.'" In other words, those implementing the Program described its scientific objectives to be a barrier to the inclusion of mitigation and adaptation programs.

By the end of 1991 the mission of MARS had changed. Its primary purpose was to "coordinate Federal assessment, research, and development efforts to address the potential mitigation and adaptation steps to offset effects of global change" (MARS 1991b). It was no longer to "coordinate the establishment" of a "comprehensive" mitigation and adaptation program (MARS 1991a), but rather to coordinate "current and planned" research in the federal agencies that "address the focused mitigation and adaptation areas" (MARS 1991b). The distinction is important; MARS had evolved from a proactive working group to one that "served primarily to identify existing agency programs" (OTA 1993, 133).

According to OTA (1993, 133), "by 1992, MARS, as a formal entity, ceased to exist." MARS demise has been attributed to

> internal and external failings, including an ill-defined mandate, absence of support from the [Bush] Administration, lack of support from the basic science components of the USGCRP, lack of financial resources, inability to define a vision for itself, and lack of leadership (Rayner 1993, 11).

It is clear, however, that MARS was destined to fail with respect to P.L. 101-606 before it was terminated in 1992. Once it evolved from a working group that would oversee mitigation and adaptation research to one that would simply record such research, MARS lost its ability to contribute what it had identified in 1990 to be missing in the program, namely research on mitigation and adaptation to global change. However, P.L. 101-606 still contained language calling for such research.[79]

The experience of MARS is significant for two reasons. First, it identified limitations of the Program to provide information usable by policymakers because the Program was primarily, in MARS' words, a "basic research" program (MARS 1991a, 8). Thus, MARS served indirectly as one of the first evaluations of the ability of Committee to meet its legislative mandate. The findings of the MARS cannot be discounted as those of a rogue operation. Several members of the full Committee and the its staff working group were also members of the MARS working group. Second, it is unclear whether Congress ever recognized the significance of the activities of MARS group for fulfillment the Program's mandate. D. Allan Bromley makes the only the only reference to MARS found in congressional hearings, as follows (SCCST 1991, 20):

> Dr. Bromley: . . .We have within the FCCSET program, Mr. Chairman, a subcommittee known as MARS, the Mitigation and Adaptation Research Strategies Subcommittee, focusing specifically-
>
> Mr. Gore: OK. Dr. Bromley, I am afraid that we are going to get to a vote on the floor. . .

MARS appears to have largely escaped congressional consideration or oversight.

Congress also seems to have overlooked that P.L. 101-606 gave the Committee responsibility to oversee mitigation and adaptation research. In a 1992 hearing a Committee official was asked if the Program

> pays sufficient attention to the potential impacts of climate change on human society, and the impacts on society of climate change; that is, the economic issues, the sociological issues, the international issues, the institutional issues (HCSST 1992, 89).

To which the official replied "we do not, in the USGCRP, support what's called mitigation and adaptation research. . . This program is focusing on some of the fundamental scientific issues" (HCSST 1992, 89). Members present at the hearing did not appear to note that the answer was in direct conflict with provisions of P.L. 101-606. The absence of research on mitigation and adaptation strategies in response to potential global change was not missed until Program performance became an issue in 1993 (OTA 1993).

In summary, when Congress and the President changed the Committee's mandate by passing and signing into law P.L. 101-606, the Committee (1990-1994) did not successfully adapt the Program from a science program to one that provided "usable information." This cannot, however, be attributed to a lack of new initiatives. The Committee attempted to implement a Global Change Research Information Office, an Economics and Global Change Research Initiative, a Mitigation and Adaptation Research Strategies working group, and began efforts to establish policy assessments as part of the program's functional architecture. MARS was consistent with the P.L. 101-606 provision calling for research on prevention, mitigation, and adaptation to global change. Yet, MARS was terminated, in large part, because it was not consistent with the *scientific* objectives that the Committee had established for the Program. Under the Committee each of these four initiatives fell short of meeting the provisions of P.L. 101-606 that call for "usable information."

Summary and Conclusion

P.L. 101-606 changed and broadened the mandate of the overseeing Committee of the Global Change Program. Yet, following passage of the law, implementation of the Program

continued much as it had prior to its passage. In other words, Congress and the President fundamentally changed the Committee's mandate. Therefore, one would expect to find changes to Program implementation following enactment to comply with new provisions in public law. However, close examination of the Committee's implementation of the Program shows few actual changes. The Committee continued to emphasize coordination of budgets and agencies over the definition and production of "usable information," as mandated by P.L. 101-606.

The Committee performed well if the provisions of its administrative charter under which it operated from 1987-1990 are taken as the evaluation criteria. When the Committee was initiated administratively it was to essentially fulfill the role of an OMB budget examiner. That is, the committee was to gather intelligence on earth sciences research in the federal budget and make recommendations on future spending priorities within the earth sciences. The Committee's intelligence and recommendations coalesced into a proposed research program on global change. With the information the Committee provided, OMB could better integrate the earth science recommendations with the broader budget. Participating agencies successfully developed and synthesized budget requests across bureaucratic boundaries. For this reason the Committee was often hailed as a model of interagency cooperation.

Yet, when the Committee's mandate was changed, it did not respond as effectively to the provisions of P.L. 101-606 that went beyond the Committee's 1987 administrative charter. During its tenure, the Committee did not produce a ten-year plan. It did not ensure external peer-review of the program. And it did not address how, in what forms, or for whom it would systematically produce "usable information." These conclusions are not hard to reach: In most instances the Committee clearly and unambiguously fell short of meeting the provisions of its legal mandate.

Chapter 5

Responsibility for the CEES Performance Shortfall

Introduction

Implementation of the U.S. Global Change Research Program by the Committee on Earth and Environmental Sciences fell short of meeting most provisions of P.L. 101-606. This shortfall contributed to the replacement of the Committee in 1994 with the Committee on the Environment and Natural Resources (CENR). The CENR was created as part of a massive reorganization of federal science policy in the executive branch that included termination of the FCCSET process. One of the CENR's stated goals was to improve implementation of the Program with respect to P.L. 101-606. As implementation of the Program and as U.S. science

policy continues to change, it is important to know why the Committee did not meet its mandate, in hope that lessons might be distilled and applied.

Assessing responsibility for program successes and shortfalls is always a difficult task (cf. Ingram and Mann 1980). There is rarely a single, smoking gun of responsibility, but rather a confluence of factors when considered alone would be insufficient to explain performance, but when taken together, form a coherent explanation. This Chapter asks and answers two questions: (1) What factors account for the performance shortfall? and (2) Consequently, what conditions are necessary for the Program to meet its mandate? The answers are presented through nine interrelated areas of responsibility. They are:

- Breakdown in the legislative process;
- Lack of oversight;
- Obstacles to outside review;
- Lack of alternatives;
- Understandings of the relationship of science and policy;
- The Ozone precedent;
- All participants neglected the law as a basis for implementation;
- Administrative pluralism; and
- Congressional fragmentation.

This Chapter concludes that the House and Senate committees with legislative jurisdiction over the Program, i.e., the House Science Committee and Senate Commerce Committee, share formal responsibility with Program officials and President Bush for the performance shortfall.

Breakdown in the Legislative Process

In spite of the change in the Program's mandate in 1990 implementation of the Program continued to follow the provisions of the 1987 Committee charter, rather than its legislative mandate expressed in P.L. 101-606. Why did the Committee not adapt the Program to its legislative mandate? Because the legislative process gave the Committee a mandate that was difficult to enforce and easy to evade.

The process which culminated in Public Law 101-606 broke down because it resulted in a mandate that the Program provide "usable information" to decision makers but did not define what such information is, how would be generated and delivered, or identify the program's "users." The legislative process (i.e., legislation, hearings, reports, etc.) did not resolve these issues. Participants agreed in principle that the science to be conducted by the Program was justified in terms of its policy relevance. However, when participants descended from generalities to specifics, consensus broke down on how the program's policy goal was to be achieved. Congressional hearings, program reports, and public statements by Program administrators indicate that "usable information" was defined differently by different participants: At approval some in Congress expected the program to clarify policy alternatives in response to global change issues; program administrators expected that the program would advance global change science. The two sets of expectations are not necessarily completely inconsistent. Yet, the phrase "usable information" in P.L. 101-606 remained unnecessarily

ambiguous, thus expectations for program performance of program officials and policymakers could easily diverge. To paraphrase James Madison and Alexander Hamilton, government has a responsibility to ensure that words in law are promptly and effectively translated into action. And, discovering the meaning of those words is a critical first step.

Congress and executive branch officials share formal responsibility for allowing the Program's mandate to remain unnecessarily ambiguous. Ambiguity meant that some expected the Program to emphasize only science, while others expected the program to clarify policy alternatives in the context of global changes. On the one hand, it is clear from statements of Program officials that they saw the program to be a basic research program decoupled from policy development. Congress, on the other hand, was uncertain in January 1989, when the Program's enacting legislation was first introduced, about what role the proposed Program would play in issues of global change. But, as some in Congress became increasingly frustrated in their dealings with the newly elected Bush Administration as the bills worked their way through the House and Senate over 22 months, they began to view the Committee to be the key link between science and policy development by the time President Bush finally signed the law in November 1990.

The legislative dynamics of the Program lead to a number of questions, including: Why did the Committee expressly favor matters of science over policy within the Program, but increasingly justify the program in terms of its policy relevance? Why did Congress allow the mandate to remain ambiguous? Why did the Executive Office of the President (EOP) or its Office of Science and Technology Policy (OSTP) not intervene? To answer such questions it is necessary to understand oversight of the Program.

Lack of Oversight

Congress failed to enforce P.L. 101-606 through 1993. An agency participant viewed congressional oversight as unnecessary and recalled that

> There is a lot of trust between the staffers on the Hill and the scientists and program managers in an agency. [Oversight hearings] tend to be love-fests or they don't tend to hold the hearings at all. I think there is, or has been anyway, a lot of trust in the core people, the [Robert] Corells, [Shelby] Tilfords, [Michael] Halls. Those people are respected by folks on the Hill. There is a sense they are doing their best to make the program work, and so they don't feel the need to call them up and yell at them. In some cases, when they have thought about it, they usually pick up the phone and say, will it help or hurt if we have a hearing? There still remains a tremendous amount of trust in the core management of the program. That sort of indicates to the Congress, to the staff in particular, they don't have to worry about it (IA 1994).

A former staff director of the House Science Committee's Investigations and Oversight Committee admitted that through 1993 Congress had not conducted effective oversight of implementation of the Program. However, he disagreed with the agency official about the reason for and significance of the lack of oversight. He argued that the lack of oversight was a primary reason for the performance shortfall:

> After the law was enacted what happened was that we did an atrocious job of oversight, and all the things that were called for in the law we never really pushed the Bush Administration to produce. . . that is why you write those laws in the first place, so you can come back and hammer them. As is

> to often the case - a little mea culpa here - we didn't do our job. So, we have no one to blame [for the performance shortfall] but ourselves (IA 1994).

The agency official admitted that the unnecessarily ambiguous mandate hampered meeting Congressional expectations and noted that

> What we haven't had on either side is an articulation using the Act of how we are actually meeting the intent of Congress. I think in part because it is ambiguous in the Act what usable information is. . . I think that is one of the reasons using the law as the measuring matrix [of program success] is hard because you can't know what you are measuring (IA 1994).

Effective Congressional oversight with respect to the provisions of P.L. 101-606 would have noticed the ambiguous mandate as an obstacle to program evaluation and taken steps to clarify it.

One observer of the Program came to a similar conclusion about the significance of the lack of oversight for the breakdown in the legislative process.

> A significant factor contributing to the current lack of policy-relevant climate assessment efforts is the paucity of effective Congressional oversight. Although many hearings have examined the state of the science and debated policy, too few have focused on ensuring the already mandated programs were being implemented and managed to produce the types of scientific outputs most useful for decision makers.
>
> As major policy-clients of the science, the Congress must exercise more consistent and productive interaction with the research and assessment programs it creates. The problem is not the lack of appropriate legislation, both the National Climate Program Act of 1978 and the Global Change Research Act of 1990 have articulated clear mandates for relevancy. However, without sustained oversight and greater involvement by the Congressional-client, implementation of those programs has been allowed to stray from their intended missions as scientists proceeded without adequate guidance and feedback from users (Bernabo 1993, 10).

The lack of Congressional oversight of implementation of the Program allowed those responsible for implementation to evade, disregard, or simply remain unaware of the provisions of P.L. 101-606 calling for "usable information."

One top Program official, noted that the Program's performance "has more to do with the philosophy of the people who are running the program than it has to do with exactly what words are in the law. . . If people don't want to live up to it, they are going to find a way to do the bare minimum" (IA 1994). If elected officials and U.S. citizens value this particular program's performance with respect to the goals established in law, it is the elected officials who have responsibility to assure that the program its meeting its mandate. For this reason, lack of congressional oversight was a key factor in the performance shortfall, and the claim that oversight is unnecessary is rejected.

There are three explanations for the lack of congressional oversight. First, effective Congressional oversight of the Program was hampered by general unfamiliarity with the unique program outside the small circle of members with an interest in the global change issue. For instance, as late as 1991 over two years after legislation had been first introduced and a year after it had become law, many members of Congress were unaware of the size or scope of NASA's contribution to the Program, which included the multi-billion dollar Earth Observing System (EOS). Representative Howard Wolpe (D-MI), a member of the House Science Committee, stated that he was largely unaware of EOS, "I was surprised it was almost the magnitude of the

space station. I had some vague recollection that it was there, but I don't think many of us paid attention to it (Rubin 1991, 1185)." If a member of the House Science Committee was unaware of EOS, and thus probably its parent, the Global Change Program, then it makes sense that members of Congress with interests outside science policy issues would have even less knowledge of the program.[80] Representative Robert Walker (R-PA), ranking Republican on the House Science Committee, stated that he did not "think there is any cognizance of the size and scope or this program in Congress or the long-term nature of it" (Rubin 1991, 1185).[81]

Second, lack of awareness is understandable as Congress is limited in its ability to consider any one issue in depth because of the number of issues that it must deal with on a continual basis. Congress is inundated with information, but "cannot be expected to interpret complex information which is not easily presented in an almost binary fashion" (Byerly 1989, 12). In other words, Congress needs "a message, not data." The Program was designed to provide reams and reams of data, but not necessarily a message. For instance, the Earth Observing System will generate enough information annually to fill 4 million 100-megabyte computer hard drives, so much that "no system in use to date has come close to handling this amount of data" (OTA 1993b, 103). However, even after 400 trillion bytes of global change data are reduced to thousands of journal articles, Congress will still lack a message. Under the Committee, the Program was to produce much data on global changes, but lacked a means of using the data to define or address policy problems posed by global change.

That Congress asks for information it cannot use is understandable: Decision theorists have observed that organizations systematically gather more information than they use, yet continually ask for more (Feldman and March 1981). Why? In Congress the main reason is that policymakers, for the most part, neither want to make difficult decisions about global change nor do they wish to be surprised by unanticipated problems. They seek information in hopes that science will provide "the answer" to the various problems of global change.

Finally, on any given issue Congress typically equates the allocation of resources with problem solving. In other words, Congress has traditionally focused its efforts on "priority setting" on the input side of the science-policy relationship. The logic of congressional science policy at the time of Program approval was that the higher the priority, the bigger the input, and the greater chance that the problem will be solved. Representative Don Ritter (R-PA) says that Congress sees big science programs as a panacea.

> We [in Congress] seem to be mesmerized by the big. As a nation we're constantly looking for the home run ball. Mission to Planet Earth, the space station Freedom: These titles are meant to inspire great ideas. It's part of our obsession with the all-encompassing (Rubin 1991, 1190).

However, as one study has observed "when inputs are but loosely attached to outputs, great battles over how much goes into a program can be won and lost without much affecting the problem-solving in the outside world" (Clark and Majone 1985, 10).

In short, members of Congress are burdened by an unending supply of information that they nevertheless seek in hopes of avoiding difficult decisions. Congressional attention is thus focused only briefly, if at all, on any one issue. Emphasis on the input-side of the science-policy

relationship meant that there were few incentives for Congress to rigorously oversee the Program once it had been approved.

The Executive Office of the President, another key institutional participant in the Program's implementation, also did not ensure that P.L. 101-606 was adequately defined. The president's science advisor, who was also director of Office of Science and Technology Policy (OSTP) and Chair of FCCSET, is a key interface between Congress, the executive, and the agencies. However, the science advisor's ability to respond to demands from any one institution is handicapped by the cross-pressures of the position. The different roles the science advisor must play create an environment in which the science advisor is less concerned about matters of public policy, such as P.L. 101-606, and more concerned about satisfying congressional, presidential, and agency demands.

One role the science advisor plays is presidential advisor. As a presidential advisor the science advisor has an opportunity to be among the closed circle of individuals who offer the president policy advice. Yet, this also subjects the science advisor to internal White House politics. Recall that D. Allan Bromley told Senator Barbara Mikulski in 1990 that he was the link between global change science and policy in the Bush White House to allay Congressional concerns about global change policy. Yet, with hindsight it is clear that in the Bush White House the role of "science advisor" was effectively played by different individuals at different times, including Chief of Staff John Sununu in the context of global change policy (Vig 1994). Thus, during the Bush Administration, "politics" complicated the science advisor's role in overseeing Program implementation.

A second role the science advisor must play is director of OSTP, who is responsible for making recommendations of science funding among federal agencies. This creates a situation where the advisor and OSTP "will inevitably be seen as an interest group with an agenda of their own and priorities of their own."[82] For the broader science and technology community, having a representative of science in the White House is important because "a lot of money gets moved around in the Administration . . . and . . . it can be influenced."[83] The editor of *Science* magazine characterized in 1988 his expectations of the science advisor's roles, one that was "to defend the merits of scientific projects in comparison with other parts of the budget" (Koshland 1988). Traditionally, the science advisor played the role of science representative in the White House, often resulting in charges of conflicts of interest.

In short, for reasons of politics and process the White House OSTP failed to conduct oversight of the Program's implementation with respect to P.L. 101-606.

Other high-level officials in the executive branch also did not address the Program's performance shortfall. The Bush Administration's lack of a coherent policy on global change contributed to the shortfall (cf. GAO, 1990).[84] Bush signed P.L. 101-606, thereby committing his administration to develop "usable information" for policy, but at the same time was "holding the line" on environmental initiatives (Vig, 1994: 85). It is unclear if or to what extent the Bush

Administration explicitly acted to thwart the provisions of P.L. 101-606. However, at the same time it is clear that the Bush Administration -- led on the climate issue by Chief of Staff John Sununu -- did little to ensure compliance with the provisions the law related to policy development.

Although a few members of Congress were growing increasingly frustrated by the Bush Administration's informal science policy advisory system on the issue of global change, Administration officials were largely able to discourage Congressional attempts to oversee global change policy. The Administration accomplished this feat through a bureaucratic shell game in which putative authority for global change policy was vested in various councils and committees, however at the same time, control over global policy never left the White House inner circle.

According to a number of Program officials interviewed, the Bush administration's policy reticence towards global change is sufficient to explain the performance shortfall. Although the Bush administration's policy reticence contributed to the shortfall, it is not the whole story. The Bush administration's policy reticence would have been difficult to sustain if Congress had enforced through oversight the Program's policy mandate. In addition, with effective evaluation of the Program the performance shortfall would likely have been noticed and difficult to justify. The actions of the Bush administration were part of a broader breakdown in the policy process. Hence, this single factor explanation of the performance shortfall is rejected.

Obstacles to Outside Review

Another factor that contributed to the performance shortfall were obstacles to effective outside review of the Program's implementation. The National Academy of Sciences, which had formal responsibility to independently assess the Program, failed to do so for several reasons. First, as documented earlier, the NAS allowed Program officials who disputed a report's findings prior to publication to compromise the NAS assessment of the Program's 1991 plans. Second, the Committee never produced a ten-year plan for the Program, so there was no plan for NAS evaluators to evaluate.

Independent reviews were hampered for a number of reasons. First, there was no audience for independent reviews: neither Congress nor the Bush Administration was paying attention to Program performance with respect to its legal mandate. Hence, in spite of the publication of several accurate critiques (see below) of the Program early in its tenure, for several years apparently no one in a position of influence noticed or was concerned. Second, of those people with detailed knowledge of the Program in its early years, virtually all were associated with it in one form or another. It was only in 1993 years that independent analysts began to focus on implementation of the Program.

Lack of Alternatives

Related to the obstacles to outside review, the policy process failed to introduce alternative strategies of program implementation. According to one participant there was little demand or need for alternatives to the Committee's implementation strategy after the passage of

P.L. 101-606. "In the early years, and to some extent until very recently, there hasn't been a sense that the agencies who are USGCRP actually need to do anything beyond science" (IA 1994). Without a sense that there was in fact a performance shortfall, there was not demand for alternative strategies of program implementation to that put forward by the Committee.

Understandings of the Relationship of Science and Policy

Post-war U.S. science policy underlies the Program's mandate. In the post-World War II era, U.S. science policy has been conducted under a de facto "social contract" between science and the rest of society (Byerly and Pielke 1995). The social contract is based on three assumptions. First, scientific progress is essential to promoting the national welfare. Second, science provides a reservoir of knowledge that can be tapped and applied to national needs. Third, in order that the fountain of knowledge flows freely, science must proceed unfettered. Based on the three assumptions, "science is a proper concern of government." The social contract suggests that the relationship between science and society would become continuous and stable because science would inevitably show benefits (Bush 1960). In other words, the social contract would validate itself over time.

The Program is an example of the social contact: The program was designed to provide a fountain of global change knowledge that policymakers could tap in the process of policy formulation. Under the social contract the Program's mandate would not need to be enforced so long as the program was producing "good science." With this understanding, it makes sense then that Congress largely abdicated oversight responsibilities to the scientific community, who are best qualified to assess the science within the program.

The ideology of U.S. science policy, therefore, created an atmosphere that diminished policymaker attention to the provisions of the Program's legal mandate. Because policymakers and program officials failed to reach consensus on expectations for program performance, the Program was implemented largely as a research program by scientists for the sake of increasing scientific understanding of global change. When policymakers finally demanded "usable information," the Program responded with "good science." But "good science" was judged not equivalent to "usable information." Following recognition that science being produced by the Program would be insufficient for policy needs, implementation of the Program began to change. Up to that point, underlying the Committee's implementation of the Program was tacit belief that somehow policymaker demands and administrative interests would intersect and the Program would thus, in the end, meet its mandate.

Some argued that from 1990 to 1994 the Program did perform successfully with respect to P.L. 101-606 with logic as follows.[85] The Program produced good science, and good science *is* usable information necessary *and* sufficient for the formulation of policies in response to global change. Robert Watson, a NASA official, stated this view during a 1992 hearing:

> I believe that the U.S. Global Change Program and some of the international programs of ICSU are, indeed, focused on trying to provide information required for policymakers. What do I mean? We need to understand the magnitude of climate change, one of the most important factors, largely dominated by our understanding of greenhouse gases (HCSST 1992, 176).

In May 1994 Watson testified in recognition of the Program's performance shortfall and admitted that "the Administration recognized the scope of the existing program was too narrow to provide effective comprehensive assessments of global change; thus the needs of the policymakers was [sic] not being met." Watson's changing interpretation is representative of a broader recognition that the scientific focus of the Program under the Committee was not sufficient for the needs of policy development.

There are at least two reasons why scientific information is not equivalent to "usable information" asked for by policymakers in the context of global change. First, the science to be produced by the Program is insufficient for the needs of rational policy making. The Program emphasized the development of a predictive understanding of global change. But, "a predictive model of the integrated Earth system is not sufficient for rational decisions on global warming" because

> Clarifying the future consequences of alternatives is only one element of a rational policy process, which also involves the invention, evaluation, and selection of action alternatives. In addition, a rational policy process provides rules for reconciling substantive differences over the realism or worth of alternatives through politics - and politics are unavoidable so long as different groups resolve uncertainties and ambiguities into different positions on the issue (Brunner 1991, 297).

In addition, politics is necessary to resolve value differences between competing groups and interests (Schattschneider 1976). To be sure, the Program, as it was structured under the Committee, would have contributed some information relevant to the needs of decision makers, however it would not have provided insight to many questions important to policy formulation, perhaps most importantly, What actions, if any, can and should now be taken?

Lack of insight to important questions of global change was identified in perhaps the most authoritative evaluation of the Program. The Office of Technology Assessment in 1993 found the program to be lacking in three areas in particular: ecosystem-scale research, ecological, human, and economic adaptation research, and in the "evaluation of all focused and contributing research results and their implications for public policy" (p. 111), despite finding the program to be "scientifically well-grounded" (1991, 110). For these reasons the Program had potential to succeed with respect to its scientific objectives, but fail with respect to its legislative mandate. This situation is possible because good science is not equal to good policy. Policy decisions require more than that which science can provide. As Etzioni (1968, 170) eloquently observes: "Decision-making, however, requires synthesized knowledge and an interdisciplinary perspective. Thus, science per se provides only limited help for the decision-maker who must find connections among the facts of numerous disciplines, each incomplete in itself." Therefore, it is likely that any attempts to modify the Program to perform better with respect to its legal mandate will fail if the modifications neglect issues beyond science, such as politics and value considerations, or fail to integrate diverse information produced by the Program in a fashion that is usable with respect to policy goals.

Second, even if policymakers had instant access to all new scientific information, policy decisions would be neither obvious nor easy to arrive at. Often, the argument that good science inevitably leads to good policy is cloaked in demands for better communication between

scientists and policymakers or the public. Such arguments are a variation of the linear model of the relationship between science and society and are implicit in the social contract. The logic of such arguments is as follows: Science collects facts about the natural world. Policymakers use such facts to make decisions about the allocation of resources in society. Therefore, policy is best made when policymakers have valid and reliable information at the frontiers of knowledge at their disposal. Scientific information need not be certain, the argument goes, as long as the level of uncertainty is known. When "good science" exists, attention is then focused on the "link" between science and policy. This logic is often implicit in calls for better scientific "communication," "education," or "outreach." This is not to say that global change policymaking could not be improved by better communication between scientists and policymakers or scientists and the public. Rather, poor communication is not a factor that limited the Program's performance.

A simple thought experiment illustrates the logic of this argument. Imagine that Congress were to be composed of 535 global change scientists, instead of its current members. Each scientist has a doctoral degree in a relevant scientific field such as climatology or biogeochemistry, and thus has the ability to understand in great detail the sciences of global change. In this imaginary Congress there would be no need for communication between scientists and policymakers because the scientists would be the policymakers. What would debate on policy responses to global change look like in this Congress?[86] It would probably look a lot like the very public and rancorous debate over "global warming" between global change scientists of the last several years: often misleading, sometimes personal, unresolved, with a subtext of value differences -- much like debate in the real Congress!

Public debates involving scientists on the topic of global change provide a glimpse of what might be observed in floor debate of the imaginary Congress. The following exchange on the Public Broadcasting System's *MacNeil/Leher Newshour* on 17 April 1990 between two scientists, Dr. Michael Oppenheimer, Environmental Defense Fund, and Dr. Richard Lindzen, Massachusetts Institute of Technology and moderated by Robin MacNeil, suggests what the debate might sound like.[87]

Mr. MacNeil:	Why not do what the President [Bush] said, study [global change] more?
Dr. Oppenheimer:	There are a lot of reasons. First of all no reputable scientist thinks the uncertainties will be vastly reduced in the next 20 years. . .

Dr. Lindzen took Dr. Oppenheimer's response as a personal affront.

Mr. MacNeil:	Let me ask Dr. Lindzen that. What's your answer to the same question?
Dr. Lindzen:	First, I'm glad to know that I'm not a reputable scientist. . .We'll never know anything perfectly, but to say that we will not significantly know more I think is a rather questionable thing for Dr. Oppenheimer to say because I don't think he's involved in research on the subject.
Dr. Oppenheimer:	Neither are you, Dick.

Dr. Lindzen: That's not true. I have 40 papers in the area of climate research.

Dr. Oppenheimer: Where is your last computer model?

Dr. Lindzen: Computer models are not the only way to do research.

Dr. Oppenheimer: You're not at the cutting edge.

Dr. Lindzen: You don't know.

Dr. Oppenheimer: I know as well as you do. I publish papers in this area too.

Mr. MacNeil: Gentlemen. . .

Scientific communication was not a factor limiting the ability of the Program to provide usable information because policymaking is a process of bargaining, negotiation, and compromise in pursuit of societal goals for which scientists and the scientific method provide little assistance. Rather, science provides empirical evidence and verifiable hypotheses, and generally does not consider the significance or usability of evidence and hypotheses for policy decisions or goals. Under the Committee, the Program neglected the needs of policymakers involved in a political process: It did not provide assistance to policymakers with the clarification of policy action alternatives that could be fed into political debate. For example, the 1993 OTA evaluation identified a number of issues in the form of questions neglected by the program:

> What are the implications [of climate changes] for forestry, agriculture, and natural areas? What mitigation strategies would slow climate the most? How much would they cost? To whom? How might society respond to changes in climate and global ecosystems? What technologies should be developed? (P. 118)

These questions cannot be answered solely with scientific information on the predicting, monitoring, or understanding of the global earth system. Better communication would not have addressed the fact that the Program was not fundamentally structured to answer the questions.

The Ozone Precedent

The case of ozone depletion has had a significant influence on how people think about global change. That influence has not always been positive for implementation of the Global Change Program.

The issue of ozone depletion appears to share many characteristics in common with the global warming: For example, ozone depletion was first called to the attention of policymakers by the national and international scientific communities and, like the threat of global warming, has been attributed to the effects of releasing anthropogenically-produced gases into the atmosphere. In addition, the scientific basis of ozone depletion research was highly uncertain during key periods of the national and international policymaking process. These similar characteristics have led many participants and observers to conclude that the national and international response to global climate change should be based upon the ozone precedent. For example, the executive director of the U.N. Environmental Program claimed in 1990 that "the

mechanisms we design for the [Montreal] Protocol will - very likely - become the blueprint for the institutional apparatus designed to control greenhouse gases and adaptation to climate change (Benedick 1991, 7)." A number of Global Change Research Program officials adopted this lesson. Consider the testimony of Shelby Tilford, NASA representative to the Committee, who testified before Congress in 1990 that

> Many lessons learned from the ozone issue apply directly to global change. Space-based data on global change problems and sustained research are essential to reaching mature scientific understanding. That understanding is needed for an international scientific consensus to form on the timing and magnitude of future effects and, therefore, on predictability, which constitutes the foundation of prudent, acceptable policy (Tilford 1990, 24).

Such conclusions, however, are flawed in important respects, and to the extent that they have formed a basis for the Global Change Research Program have likely guided implementation of the Program in the wrong direction. Demands for the resolution of scientific uncertainty or for the demonstration of a scientific consensus in the Program often show influence of conclusions drawn from the ozone depletion precedent.

Background

As a result of the international and national pressures to regulate chlorofluorocarbons (CFCs) that had been growing since the early 1970s, in 1985 an international treaty, the Vienna Convention, was adopted. The Vienna Convention was superseded two years later. Backed by a scientific consensus several years of international efforts, in September 1987 47 nations agreed in Montreal, Canada to freeze CFC production at 1986 levels, and also to cut CFC production in half by the end of the next decade (OTA 1991). The Montreal Protocol was ratified in January 1989 and was called "the most significant international environmental agreement in history."[88]

Comparison

The primary lesson drawn from the process that led to the Montreal Protocol by many participants and observers was that scientific information was the key element in the resolution of the ozone depletion issue. For example, according to Ambassador Richard Benedick, chief U.S. negotiator of the Montreal Protocol, science was the most important factor in resolution of the ozone issue. He argued that

> First and foremost was the *role of science* in the ozone negotiations. . . The best scientists and the most advanced technological resources had to be brought together in a cooperative effort to build an international scientific consensus. Close collaboration between scientists and government officials was also crucial. Scientists were drawn out of their laboratories and into the negotiating process, and they had to assume an unaccustomed and occasionally uncomfortable shared responsibility for the policy implications of their findings. For their part, political and economic decision makers need to understand the scientists, to fund the necessary research, and to be prepared to undertake internationally coordinated action based on realistic and responsible assessments of risk (Benedick 1991, 5).[89]

Many participants in the development of the Global Change Program invoked this particular conclusion to justify research in global change. Often overlooked in such retrospectives is the limits of science in policymaking. Benedick (1991, 5) also cautions that "scientific theories and discoveries alone, however, were not sufficient to influence policy" in the ozone depletion issue.

The primary flaw in most invocations of the ozone experience used to justify the Program is that they pay close attention to the role of science in the development of the Montreal Protocol, but they ignore cautions of the limitations of science for environmental policymaking. For example, Tilford testified in 1989 that

> The key lesson of the chloroflourocarbon (CFC) - ozone issue is that it is vital for there to be a clear separation of responsibilities between the scientific agencies and the policymakers. . . If the atmospheric research programs of NASA, NOAA, and NSF had not had a long term commitment to a broad [ozone] research program. . . it is highly unlikely that we would have been able to detect or understand the cause of the Antarctic ozone hole for years to come. This is an important lesson for the U.S. Global Change Program, which encompasses a larger suite of global change issues and involves a larger number of federal agencies ((HCSST 1989, 129-130).

In other words, Tilford argued that the separation of responsibilities between agencies and policymakers with respect to ozone depletion research implied that a Global Change Program a-lso required separation from the policymaking arena and a long-term commitment in order to succeed.

Tilford's (and others') argument do not acknowledge that effective policy responses in pursuit of policy goals requires a range of action alternatives introduced into the policy process. From these alternatives policymakers can engage in the political process of bargaining, negotiation, and compromise. Value considerations need to be made explicit as components of action alternatives. A consequence of the demands for separation was that the Program was designed to produce much information but failed to create a process in which information would be used to generate or clarify action alternatives to feed policy development.

With hindsight it is clear that because of significant differences in the contexts of the ozone and global change cases, the ozone depletion issue is a poor guide for the implementation of the Program for at least four reasons.

First, to compare the Global Change Program and its explicit policy mandate to over 20 years of decentralized ozone depletion research is to compare apples and oranges. Ozone depletion research was never part of an interagency program with a policy mandate to produce "usable information." It was the product of a number of scientists working in various agencies for different reasons. For example, early ozone research was conducted by the Department of Transportation to assess the potential impacts of the proposed Supersonic Transport; NASA conducted its own research to assess the space shuttle's effects on the atmosphere, etc.. The Global Change Program is a comprehensive national science program that promises to deliver "usable information" to policymakers.

The structural difference is important: The Global Change Program is required by law to provide "usable information," ozone research had no such overarching mandate. Ozone depletion research was generally focused on resolving *specific* research questions for applied purposes (e.g., regulation). As Benedick observes, the signing of the Montreal Protocol was made possible by good science, but not certain. Robert Watson observed in 1988 testimony that the U.S. scientific contribution to the international negotiations resulting in the Vienna Convention and the Montreal Protocol had "no formalized interagency mechanism to promote

the exchange of scientific information between the scientific community and the policymakers in Washington, DC" (SCCST 1988, 90).[90] P. L. 101-606 set a higher standard of performance than ozone depletion research ever had to meet.

Second, the science of ozone depletion has been much more tractable than the science of global change. Or in other words, had ozone depletion research been conducted under a legislative promise of "usable information," that program would have had a much greater chance to meet that mandate than does the Global Change Program because the scientific questions of ozone depletion were amenable to resolution on short time scales. The science of global climate change, on the other hand, will not be resolved any time soon.[91]

Third, the scientific tractability of the ozone issue complemented the relatively simple political and economic structure of the CFC industry. CFCs do not occur naturally. In the 1980s only one company (Du Pont) produced all CFCs used in Europe, North America, and Japan, which facilitated regulation (Haas 1991). In addition, regulation was predicated on the technological development of economically viable substitutes (Doniger 1988). Haas (1991, 233) characterizes succinctly the unique simplicity of the ozone depletion issue. He argues that

> The control of CFCs may be virtually a *sui generis* in the annals of global environmental change. Change in the global physical system was managed without corresponding changes in the social dynamics which gave rise to physical changes. To some extent this issue did not involve any hard choices. A technical fix proved feasible. . .The pollutant, politically and economically, was not costly, and opposition was not wide spread in society due to the few personal adjustments which it would be necessary to make. Moreover, industry was not heavily reliant on the production of CFCs: for example, CFCs accounted for 2% of Du Pont's revenues in 1987, and a slightly higher percentage of profits. Industrial users were mollified with the promise of substitutes.

The ozone issue is an example where scientific information and technological innovation helped to settle a contentious policy debate. The contribution of science and technology was facilitated by the streamlined political and economic context of CFC production.

Although ozone depletion and global change research and operate in significantly different contexts, one aspect of the ozone experience bears directly upon implementation of the Program. The Clean Air Act Amendments of 1977 (P.L. 95-95) gave regulatory authority of CFCs to the Environmental Protection Agency. With the exception of the Food and Drug Administration, national policy with respect to ozone depletion was stalled until the Natural Resources Defense Council filed a lawsuit to coerce EPA to regulate CFCs as require by law. Similarly, the Committee on Earth and Environmental Sciences largely ignored the policy aspects of global change until the House Science Committee and others invoked P.L. 101-606 and its call for "usable information" for policymakers. Once the law was invoked, the Program began to change. An important lesson from the ozone experience, and corroborated in the case of the Committee, is that the law is instrumental in securing criteria for evaluating and coercing government performance. Few will argue that the law need not be obeyed.

All Participants Neglected the Law as a Basis for Implementation

There is little indication in the public record that through 1993 Program officials, congressional staff and Members, and administration officials explicitly considered the

provisions of P.L. 101-606 related to policy development. Instead, the public record reveals a research program that primarily met the needs of the agencies and the science community. A former agency official, recalled that Committee members always kept the program's legal mandate in mind even if they could not address it in the program or in public:

> Many of us in the early days used to talk about the [USGCRP] goals and objectives. Frankly, we would often as not, not address what we believed to be the ultimate goal, which is to change the way you make environmental decisions. To make environmental decisions proactively, anticipating change, rather than reacting to change. That is what a lot of us called the religious side of U.S. Global Change, because you didn't talk about it very much, because often you would get into a political battle. You couldn't say that in documents under the Reagan and Bush Administrations because it never would have been cleared. (IA 1994).

As documented above, Congress and the executive branch both failed to use the law to conduct oversight of Program. Yet, no matter how well intentioned participants are the public interest cannot be effectively translated into policy actions without accountability to law.

Operating in a difficult political environment, it is not surprising that Committee Officials proposed the program to advance their scientific and institutional interests. One participant described the growth of global change science in the federal agencies as the work of a 'nonsinister conspiracy' of agency officials.[92] The actions of the members of the "nonsinister conspiracy" are best understood in terms of "policy entrepreneurship" (Lambright 1994). Policy entrepreneurs, like everyone else, act in ways which advance their interests as they perceive those interests to be (Kingdon, 1984). Policy entrepreneurs within NASA, NSF, and NOAA developed the Program as an interagency science effort to contribute to the International Geosphere-Biosphere Program. In addition, each agency supported creation of the Program as a way to counter actual and perceived budgetary pressures of the early and mid-1980s.

Program administrators, members of Congress, and executive branch officials each considered a piece of the global change puzzle: administrators were concerned with science, institutions, and political sustainability, Congress passed legislation but failed to follow it through implementation, and top executive branch officials sought to evade the policy provisions of P.L. 101-606. No one considered how administration, science, and politics would be integrated and translated into usable information for policy as was called for in law.

The performance shortfall occurred -- then persisted -- because *everyone* in the Global Change Program policy process neglected the law as the basis for program implementation. The law was invoked in 1993 by a number of independent evaluators to assert a performance shortfall. This led to Congressional hearings that focused attention on program performance and thus may have begun a process of correcting the shortfall. It took only one part of the community to take the law seriously in order for the rest of the community to quickly follow suit. It was when all participants ignored the law that the performance shortfall went unnoticed.

Administrative Pluralism

Administrative pluralism implies that agencies sacrifice the integrative nature of the program to their particular institutional missions (Lambright and Changnon 1989). A concept distinct from administrative pluralism is "imbalance" of funding among agencies or disciplines.

For example, when DOD joined the USGCRP in 1990, Robert Corell alluded to "imbalance" when he claimed that "Without DOD the U.S. Global Change Research Program has been an enormous jigsaw puzzle. Now the picture will be complete" (Morgan 1990). Imbalance of the research effort clearly affected Program performance as the program clearly neglected research on mitigation, adaptation, and prevention, as called for in P.L. 101-606. In addition, some areas of scientific research (e.g., space-based) were favored over others. However, the record shows that while the agencies have not always worked together smoothly, agency infighting was not a primary factor that affected performance with respect to the law.

From the outset there was concern that the agencies could not work together. For instance, the National Research Council (NRC) warned in its 1990 evaluation of the Program that administrative pluralism could hurt the program's performance. The NRC stated that many of the scientists consulted for its evaluation were concerned about the effects of agency interests.

> [T]he USGCRP - defined as it is by the CEES through agency initiatives - might appropriate the more critical elements of the program to create intramural endeavors, or to fund existing initiatives in the name of USGCRP. If in-house, agency research endeavors were allowed to dominate, the program would almost certainly lose the active support and involvement of those academic scientists who have provided the ideas on which the program is based and whose contributions have traditionally defined the cutting edge of research (NRC 1990, 17).

The NRC characterized administrative pluralism in terms of a proper mix between agency and interagency research (1990, 16). Concerns about administrative pluralism have also surfaced in oversight hearings. For example, Representative Rick Boucher (D-VA) expressed concerns in a 1991 oversight hearing that agency infighting would hurt the program's performance.

> The problem as suggested . . .is that the priorities of the Global Change research Program are not, in fact, being carried out, that the agencies are simply pursuing old agendas that are divergent from if not in conflict with the goals of global change research (HCSST 1991, 79).

In other words, agencies place their missions ahead of the shared objectives of the Program.

The example of administrative pluralism most often cited is that between NASA and the rest of the agencies. NASA has been the beneficiary of most Program funding since program inception. Most of NASA's funding is budgeted for the Earth Observing System (EOS) within the Mission to Planet Earth (MTPE). EOS became part of the focused Program budget because OMB wanted greater control over the Program and Committee members wanted to ensure NASA participation. According to one Committee member

> If we had scratched EOS NASA wouldn't have come to the table. So we bought it. We bought it and gave it the 'Good Housekeeping Seal of Approval' as part of the U.S. Global Change Research Program, and we're paying the consequences of doing that (quoted in Kennedy 1992a, 10).

Another Committee member explained what paying the consequences meant.

> If you look at the global change budget, you see this great thunking piece in EOS, which makes it hard to have a coordinated program. Every time EOS sneezes and needs more money, somebody else gets pneumonia and dies. I think without EOS, it would be a much more balanced program of equals (quoted in Kennedy 1992a, 10).[93]

However, OMB saw a number of benefits in including EOS in the Program. For example, OMB used the FCCSET structure to compel NASA to subject EOS to independent review in 1991 (Kennedy 1992a, OTA 1993b).

Imbalance as agency infighting, however, did not affect adversely program performance under the Committee. The success of the Committee in producing annual budget crosscuts is evidence for assertions that Program performance with respect to the law did not suffer due to agency infighting. Due largely to successful coordination of agency budgets, the Committee was recognized by observers inside and outside the global change community as a model of interagency cooperation (Lambright 1993).[94] In addition, President Bush's science advisor D. Allan Bromley reworked the FCCSET structure in 1992 to establish subcommittees on biotechnology, high-performance computing, and other areas based on the Committee model (Goodwin 1993). It is likely that, for many years, rapidly rising budgets largely precluded significant agency infighting over the budget. Of course, the Program was imbalanced in that it neglected research related to mitigation, adaptation, and prevention aspects of global change that could have contributed to the production of usable information. This was the essence of the performance shortfall.

Recommendations to correct administrative pluralism focus on fragmentation within the program. The Office of Technology Assessment argued that an appropriate balance among the resources provided to the agencies in the Program is difficult to achieve "because the USGCRP does not have a program budget" (1993, 132). A program budget refers to a comprehensive, top-down approach to budgeting, as compared to a structure where each agency retains significant control over its contribution to the program. A program budget would likely require that Congress reorganize itself such that the Program could be reviewed much like an agency.

Congressional Fragmentation

A common explanation for the performance shortfall is the fragmented nature of Congress. The 1993 OTA evaluation of the Program argued that congressional fragmentation hinders program performance noting that

> The USGCRP budget falls within the jurisdiction of several congressional authorization and appropriations committees and subcommittees. With all of these committee reviewing components of the USGCRP budget, it is much more difficult for Congress to consider the USGCRP budget as a whole than it is for the executive branch to do so (OTA 1993, 121-122).

The report suggests that Congress consider "an ad hoc appropriations subcommittee" to review the entire Program budget and concludes that "large, interagency programs such as the USGCRP will require innovative methods of funding if they are to succeed" (OTA 1993, 122 and 150). Such concerns are not new.[95] In 1990, prior to enactment of P.L. 101-606, the Congressional Research Service asked rhetorically "would it be advisable to establish a special [congressional] committee on global change, or to reorganize the subcommittees responsible for its many different elements into one (CRS 1990, 32)?"

Congressional fragmentation did affect Program performance but was not a factor limiting performance with respect to law for the following reasons.[96] Congress is fragmented; Perhaps no program illustrates congressional fragmentation as well. Agencies in the program are overseen by 14 House and Senate Authorizing Committees and 7 Appropriations Subcommittees in each chamber (OTA 1993a, 124). The institution of Congress has evolved with a Committee structure that decentralizes authority and responsibility. Virtually any policy

program could claim that it would perform better if Congress were restructured to meet the needs of that particular program. Of course, Congress was designed to make policy across different areas, and not to optimize any particular one. Congress does not need an ad hoc appropriations committee to oversee the Program because Congress already has a clear line of authority over the program: The Committee was responsible for program performance under the law and the House Science and the Senate Commerce Committees had oversight jurisdiction over the Committee. The Committee also fell under the jurisdiction of the House and Senate VA/HUD Appropriations Subcommittees. These four Committees had authority to oversee the Program implementation since its inception, but it was only in 1993 that they began to exert oversight authority with respect to the program's priority goal of providing "usable information" to policymakers. The resumption of Congressional oversight and corresponding changes in Program implementation is evidence that Congressional reorganization is unnecessary to improve program performance.

Can Congress do a better job of overseeing the Program? Certainly. Has its organization limited its ability to oversee the program? No. Oversight hearings by the House Science Committee in 1993 have directed attention to Program performance. In response to renewed congressional oversight, Program officials stated a desire to improve performance with respect to the provisions of P.L. 101-606, indicating that program shortfalls are due more to an absence of oversight rather that an inability to oversee the program due to its interagency structure.

Why Change Occurred

The Committee was terminated in the spring of 1994 under President Clinton's comprehensive reorganization of science policy mechanisms in the executive branch. Within this reorganization, changes in the implementation strategy of the Program occurred for three interrelated reasons. First, Congress reasserted oversight responsibility of the Program in 1993. Second, the reemergence of oversight was due in large part to the development of independent evaluators of the program that called attention to the performance shortfall. Third, and finally, the election of President Clinton brought into the White House an Administration with stated goals of environmental activism that served to focus attention on the Program's performance. For these reasons the performance shortfall was noticed and steps taken to correct it. The following sections explore these factors in greater detail.

The Persistence of an Independent Evaluation Community

The reemergence of Congressional oversight of program with respect to the law was almost certainly tied to the development of an independent evaluation community. Some early critiques of the Program did question its chances for success, yet they were largely ignored or discounted by Congress. Most evaluations of program performance have focused on the research objectives of the Program, finding it to be producing "good science."[97] Early appraisals that did consider the policy mandate suggested that the Committee would face difficulties in implementation. For example, an industry-led assessment argued that

> Along with the fact finding, research and modeling, someone [in the USGCRP] needs to coordinate efforts that are necessary to correct the problems that are identified. This will require a global effort. This understanding-implementation gap must be closed or the current, largely

> academic GCRP exercise will lag government policy and have little productive impact on industry (GEOSAT 1990).

In addition, the 1990 report of the National Research Council assessed the program plan during program inception. Even though Committee officials influenced the report's conclusions prior to its publication, NRC found that the Committee would be unlikely to deliver on its goals without additional direction.

> The program promises to deliver (1) timely information to Congress, the Executive branch, and others; (2) periodic assessments of scientific understanding in critical areas of global change; and (3) seasonal, interannual, and ultimately interdecadal projections of selected climate impacts. The mechanisms that will be needed to achieve these goals, involving assimilation of results including those of modeling and processes of responsible review and consensus, are not specified in plans for the USGCRP, but they will soon need to be (NRC 1990).

The NRC defined usable information to be "timely information," and called into question the program's ability to produce such information in an assembly line fashion, with scientific research preceding policy issue clarification (NRC 1990).

In an article published in 1991 several critics warned that the Program might wind up producing much scientific information, but not much of use to policymakers (Rubin et al. 1991). And Pittock (1990, 26) observed in a review of Committee reports that "the U.S. plan is motivated less by scientific curiosity than by a desire to better inform policy decisions relating to the human impact and response to global change. Thus, it is from this standpoint that the appropriateness of the plan should be judged." Pittock was one of the few early evaluators to correctly identify the program's legislative mandate as the ultimate standard against which to performance. However, such early warnings of pending performance difficulties did not immediately result in continued Congressional oversight. Congressional oversight resumed due to the persistent efforts of an independent evaluation community who found a performance shortfall during program implementation.

The Resumption of Congressional Oversight

In the spring of 1993, after almost two years of no oversight of Program implementation, Congressional oversight resumed. As the previous Chapter documented, active Congressional oversight essentially stopped in mid-1991 following the efforts of Representatives Scheuer and Wolpe to ensure compliance with P.L. 101-606. Before the oversight hiatus three committees, House Science, Senate Environment, and Senate Commerce, asked OTA to examine the relationship of federal research and policy needs in the area of global change (OTA 1993a, 111). As a result, OTA structured an evaluation of many aspects of global change research. Committee implementation of the program was only one aspect of the broader assessment of global change issues (OTA 1993a). The examination of Committee performance was based on a workshop held 25 and 26 February 1993 (OTA 1993c). The workshop, entitled "EOS and USGCRP: Are We Asking and Answering the Right Questions?," was attended by a diverse group of critics and supporters, including several Program officials.

Among other questions the workshop asked, "How well is USGCRP addressing the needs of policymakers" (OTA 1993c, 41)? The report of the workshop noted that "as currently structured, USGCRP will not be able to provide decision makers and natural resource managers

with the information they will need to respond to global change" (OTA 1993c, 6).[98] In other words, in the opinion of the workshop participants, under the Committee the Program would not provide "usable information." A subsequent OTA report published in 1993 and titled *Preparing for an Uncertain Climate*, found the Program to be producing good science, but likely to fail to provide policymakers with the information needed to respond to the potential threats of global change.

One result of the OTA workshop was a May 1993 House Science Committee hearing on Program performance with respect to the program's legal mandate (HCSST 1993a). The May hearing was the first oversight hearing of the Program with respect to its policy mandate since early 1991. At the hearing several critics of the program testified about the program's performance shortfall. It is worth noting that some of the testimony presented before the House Science Committee hearing contained the same criticisms presented almost four years earlier. One witness at the May hearing testified that

> many components of the USGCRP are high-quality projects that may substantially advance the state of the art in various scientific fields. It is equally clear that these studies have had only a tenuous connection to the present needs of public and private decision makers (HCSST 1993b).

Other witnesses agreed and testified that the Program appeared to be producing good science, but was failing to produce usable information. The hearing received wide attention within the scientific community and was covered as a feature article in *Science News*, a popular science weekly (Monastersky 1993). The article was titled "The $15 Billion Question: Can the U.S. Global Change Research Program Deliver on its Promises?"

Meanwhile in the Senate, President Clinton's newly appointed Science Advisor, John Gibbons, had testified that the Program needed "broadening" in order to address "policy issues" (SCCST 1993, 17). He noted that

> The more inclusive and broader scoped research program will be more fully integrated with the policy process within the U.S. government. . To broaden and make more formal the linkages with the policy process, plans are now underway to more fully integrate global change research with the policy process within the executive branch of the Federal government and to enable the USGCRP to be more fully responsive to congressional guidance and interests. This will lead to a comprehensive global change effort rather than a program focused only on the research aspects of global change issues (SCCST 1993, 17-18).

Gibbons testimony was significant because it turned what would have been a typical hearing focused only on science into an Administration statement of the policy shortfalls of Program implementation (the hearing was titled "Science Surrounding the Issue of Global Climate Change"). Gibbons' statement reflected the change in Executive Branch policy with respect to Program implementation following the election of President Clinton.[99]

The Election of President Clinton

A final reason for the changes in Program implementation is the election of President Bill Clinton. The testimony of Gibbons before the Senate Commerce Committee reflected the changed attitude towards Program implementation under the Clinton Administration. The election of President Bill Clinton and Vice-President Al Gore renewed administration oversight of the program. Environmental issues were been a long-time focus of Vice President Al Gore

and President Clinton has committed his administration to define and implement policies in response to global change.[100] President Clinton also reorganized the White House science policy structure in order to "establish clear national goals for federal science and technology investments and to ensure that science, space, and technology policies and programs are developed and implemented to effectively contribute to those national goals" (Clinton 1993). The Program was to be one of the key elements of Clinton's new science policy organization.

Under the Clinton Administration there was less ambiguity over the Program's mandate. While the law remained the same, few officials claimed that the program exists to advance science independent of consideration of policy issues and alternatives. Although it took over five years, by 1994 participants were in almost universal agreement that to successfully meet its mandate the program had to contribute to policy development. Therefore, there was an emerging consensus that the Committee's implementation of the Program was "too narrowly focused" (Watson 1994).

Chapter 7

Science and Decision Making

In the case of the Committee on Earth and Environmental Sciences through 1994 that process of search and discovery for usable information was derailed because *all* participants ignored the law as the basis for Program implementation. As a consequence the program drifted, it was pushed and pulled in a number of directions, and did not systematically search for and discover information usable by policymakers. If the law had been used as the basis for implementation, then there could have been two possible outcomes. One is that Program administrators and elected officials might have realized that P.L. 101-606 was flawed in some substantial way and could have taken efforts to change the law to adjust the course program in line with the interests of the American people. The second possibility is that the program would have created a process to define "usable information," what it is, who it is for, how it is produced, and when – such as was attempted in the MARS program. And through this process fundamentally new insights may have been gained about how to deal with global changes. By not using the law as the basis for program implementation, program performance was compromised. For several years the performance shortfall went largely unnoticed. This was a symptom of breakdown in the policy process. Specifically, no one was paying attention to program performance with respect to goals.

How The Performance Shortfall Might Have Been Corrected

In order to permanently correct the performance shortfall public law must be respected. Congress is responsible for oversight of the program with respect to the law. Even if program or Administration officials disagree with the law, it is their responsibility to fulfill its provisions or

work to change it. Of course, in practice when agencies and/or administrations disagree with congressional mandates, they often act slowly, or use other political strategies, to thwart implementation (Bardach 1978). This underscores the importance of oversight. If program performance is important then oversight with respect to the law is the appropriate sanction to coerce effective and efficient implementation. When agencies and/or administrations agree with congressional mandates, oversight fulfills the need to ensure that programs perform commensurate with expectations.

Although Program officials have admitted that the Committee's implementation of the Program was too narrowly focused on science and have taken important steps to shape its implementation, the USGCRP continues to struggle to explicitly link the scientific and technical information produced by the Program to the provisions of the law calling for "usable information." The program needs effective outside evaluation of its performance with respect to its mandate if performance flaws are to be detected. The case of the Global Change Program points to the need for policy process evaluation, in addition to evaluation of program performance. In general, program performance will be difficult to correct if the fundamental policy process underlying the program is flawed (Bardach 1978).

There is a complex tapestry of explanations for the performance shortfall, of which important seams are the role of government institutions and their interaction with the perspectives of program participants. Officials in Congress, the Executive branch, and the agencies share formal responsibility for the shortfall. Underlying the performance shortfall is the structure of contemporary science policy: the Program was initiated under an implicit assumption that the mere existence of a global change program was sufficient for the resolution of policy problems presented by global change. The political and administrative context of the Program contributed to this logic. Therefore, policymakers paid little attention prior to approval to exactly what the proposed program was to achieve, and similarly, little attention was paid to the program's performance following approval.

The case of the Committee illustrates the vital role of accountability to law in a healthy policy process. In this case, accountability would have meant the following conditions would have been met: First, Congress and Program administrators would have agreed on what "usable information" was and how it was to be achieved. In other words, there would have been a convergence of expectations for program performance. Second, these expectations would have been used to guide Congressional oversight of the program. Congress has in place clear lines of authority over the Program, its simply did not using that authority. Because these two conditions were not met, the program under the Committee was not held accountable.

In not meeting the provisions of P.L. 101-606 through 1994, Program implementation under the Committee was unaccountable to Congress. At the same time, however, members of Congress neglected their oversight responsibilities. Accountability to law in practice requires leadership in Congress, the White House, and the agencies. The Committee's implementation of the Program is a clear case where leadership was avoided throughout the political system. If difficult problems such as those presented by global climate change are to be solved, then leaders must step forward to ensure that programs enacted in response to those problems meet the requirements of public law. Logically, there are two points of intervention in the USGCRP

policy process. One is to modify the program's legal mandate to reflect the realities of program performance. The other is to shape performance to better approximate expectations of usable information.

Change the Law

In 1994, one way to have improved program performance would have be to modify the Program's mandate to reflect actual program performance. A range of observers has judged the Program to be, though not perfect, in general scientifically sound and in some instances leading to fundamental breakthroughs in knowledge of the integrated earth system. In light of such judgments, P.L. 101-606 could have been amended to replace the provisions calling for "usable information" with substitute provisions calling for the "development of scientific understanding" and "interagency coordination." In this manner, expectations of performance could have been scaled to the Program's demonstrated strengths.

Changing the law in such a manner, however, would have reflected a shift in the primary purpose of the Program. As the program was then structured, the development of a scientific understanding and interagency coordination are means to an end -- ultimately -- usable information for decision making purposes. Hence, it is uncertain whether policymakers would have supported a large and expensive research effort under different goals. In other words, policymakers might have been less likely to support the Program without its mandate for information to support policy development. Thus, if it is assumed that policymakers do, in fact, want usable information, then the only alternative to improve performance was to change implementation of the Program.

Change the Program: What Might "Usable Information" Look Like in the USGCRP?

Sustainability of the Program is more likely if its overseers judged it to be a success. Thus, to be judged a success the Program needed to provide policymakers with "usable information." However, through 1994 it emphasized certain types of information over others (e.g., scientific predictions over research into adaptation, mitigation, and prevention), providing an incomplete and unbalanced contribution to the decision making process (OTA 1993). The Program does not require that global change be highly visible to be sustainable. It does, however, need to convince policymakers that its continuance is worthwhile when compared with the myriad alternative choices on the Congressional policy smorgasbord. In other words, expectations of performance must be corroborated by experience in a timely fashion. Sustaining the Program would not guarantee that problems associated with global change will be properly defined or satisfactorily resolved. However, without global change research many problems of global change risk going unaddressed.

It is of utmost importance to note that the Program ought not be in the business of developing "the policy." Instead, to fulfill its mandate the program needs to focus on developing a process to generate a wide range of policy *alternatives* for different levels and timescales of decision from which decision makers can debate and select. In this manner the Program can largely avoid becoming embroiled in political debate that would accompany any single "policy" that it might develop (e.g., Kyoto Protocol: yes or no?). With a sufficient array of alternative courses of action policymakers can then decide the proper mix of mitigation, adaptation, and prevention responses to global change.

Untouched Middle Ground on Global Warming

The Program's policy shortfall helps to explain why there has been little progress on developing policy in response to the actual and expected impacts of a changing climate. A close look at the debate over global warming shows that it has evolved little since 1988 from the narrow scientific question of "global warming: yes or no?" The subtext of this debate has been the policy question as to whether nations around the world should join together in limiting or reducing emissions of greenhouse gases. This question has been addressed under the provisions of the Framework Convention on Climate Change negotiated at the U.N. Conference on Environment and Development in Rio De Janeiro, Brazil in 1992. The Program through 1994, by focusing simply on developing a predictive understanding of global change and neglecting the need to develop usable information more broadly, reinforced the focus on global warming as an issue of simply "yes or no."

The development of a global protocol on greenhouse gas emissions is largely a political question that will be determined based on contemporary scientific knowledge *and* the numerous other factors that form the context of that decision. Scientific predictions about the future state of the global climate are an important input to that decision. Whether or not such a comprehensive global policy will be put into effect and whether it can succeed are open questions. It is known with certainty that whether or not such a policy is put into effect, towns, cities, nations, regions, and the world will forever continue to feel the impacts of climate variability and underlying changes to that variability. A greenhouse gas protocol is *not* a comprehensive solution to the problems associated with global change around the world. Solutions to many problems associated with climate will arise out of that largely untouched middle ground between the global warming "yes or no" debate that can be accessed through the production of "usable information."

The production of usable information about changes in the global climate (as well as other aspects of global change) is important no matter what one's views are on global warming. Because the Global Change Program did not establish a process to meet its congressional mandate, less progress has been made towards identifying and defining climate problems and developing responses that would have been otherwise possible. The policy shortfall has limited systematic inquiry to that middle ground.

Beyond Good Science: Accountability in Science Programs Focused on Societal Goals

The implementation of the Program by the Committee on Earth and Environmental Sciences provides a clear lesson that good science is not necessarily equivalent to information usable by policymakers. Under the Committee the Program was widely judged to be a good science program, but at the same time, policymakers questioned the program's policy utility. Research alone will not "solve" problems presented by global changes, it can however help policymakers assess the value of alternative goals and courses of action. Scientific research can improve our understanding of the past and the future, as well as the relationship between the two, as conditioned by policy choices. Science can also broaden the range of response strategies available to policymakers.

The research conducted by the Program will likely draw attention to problems and potential problems that were previously unknown. Such is the nature of the scientific enterprise. As President Kennedy once said of science, "with each door that we unlock we see perhaps ten doors that we never knew existed" (Lapp 1965, 218). In the context of global change one scientist observed that "the scope of this [climate change puzzle] is expanding willy-nilly. I'm afraid we're not going to resolve this quickly" (Kerr 1994). Good science often leads to demand for more research. Scientists therefore need to be careful when they discuss global change science with policymakers: The Program was often justified in terms of its abilities to resolve scientific uncertainty. It was more likely that the program would instead uncover more uncertainty than it resolves. If expectations of increased certainty are not met, then global change science could experience a loss of credibility. At the same time, the rest of society could suffer from the loss of time and resources that could have been better used to address global change in ways that improve decision making.

Policymakers need to be careful not to abdicate their responsibilities to grapple with conflicting and uncertain information in the process of making decisions. The process of decision making involves the resolution of conflicting values. Science cannot resolve value differences, only politics can. Debate over global change is laden with many implicit conflicting values. Information generated through science represents the beginning of debate, not its closure. In other words, science provides information for use in the unavoidable process of bargaining, negotiation, and compromise necessary to resolve any political issue. Such information is most useful when it is clearly associated with goals and alternative courses of action from which policymakers can choose.

The CEES (1990-1994) performance shortfall forces us to consider limits of science in the resolution of social problems such as those presented by global change. Fortunately, the performance shortfall has been recognized. However, it goes beyond the scope of this case study to assess if this recognition has resulted in improved Program performance or more generally applied in other areas where science is expected to contribute to the resolution of policy problems. The performance shortfall suggests that the social contract between science and the rest of society forged in the years following World War II may be flawed in its fundamental assumptions.

The Importance of Leadership

A broader significance of the performance shortfall is that social problems will not get solved efficiently or effectively without the leadership of individuals. The policy history of global change is replete with examples of policymakers who speak strongly about the need to make decisions in the face of potential global changes, and then follow with little or no action. For example, it is clear that President Bush clearly preferred a course of scientific research to the development of policy alternatives. Yet he signed P.L. 101-606 which committed his administration to the development of "usable information" on "adaptation, mitigation, and prevention" of global change for "policymakers," and then failed to ensure its implementation. Bush also often called himself the "environmental president" (Vig 1994). The gap between words and deeds was a symptom of poor leadership. President Clinton showed a similar tendency in the context of global change to let promises of performance outstrip the intensity of their implementation. In the words of one observer "although Clinton's [global change] goals are

grandiose, the policy tools that his staff is employing are painfully modest" (Kriz 1993, 2028). Policy problems such as global change are difficult to address in any situation; Poor leadership makes such problems intractable.

Congress shares blame for poor leadership. After a strong push by several members for the broad-reaching P.L. 101-606, these same members acted as if their responsibilities had largely ended following enactment of the legislation. Congressional leadership in the global change issue would have gone beyond simply pointing the nation in the direction that Congress and the President decided to go and would have taken steps to ensure that we were making progress towards that destination.

Agency officials showed poor leadership as well. The Committee's implementation of the Program displayed a disturbing disregard for the provisions of P.L. 101-606. It would be one thing if agency officials interpreted a law in ways different than Congress intended. However, it is quite another to completely neglect or ignore all provisions of a law, especially those which are clear and unambiguous (e.g., the delivery of a ten-year plan). Based on implementation of the Program from 1990-1994, it is difficult not to reach the conclusion that program officials largely acted (wittingly or unwittingly) to serve narrow scientific and institutional interests over common interests expressed by Congress and the President in P.L. 101-606.

The case of the Global Change Program shows a breakdown in leadership at all levels of government. Without leaders, government cannot perform well with respect to stated goals. Leadership is not a quantifiable characteristic, yet its absence clearly shows up in government performance. Leadership is a fundamentally human quality that does not appear in the organizational structure of government -- Instead, leadership is evident in the relationship of words and actions.

The Importance of Government Oversight

A lack of oversight can result in unnoticed performance deficits and inability to coerce compliance. The resumption of congressional oversight of the Program in 1993 resulted in attention to the program's performance deficit and steps to close the gap between promised and actual program performance.

Leadership and accountability are interrelated through oversight. Oversight is the process of holding programs and officials accountable to their commitments. Oversight of the performance of government programs is often neglected because it results in few political benefits as it usually occurs unnoticed, outside the spotlight of public attention. Oversight can involve political costs, for example, when an issue does become political and politicians are forced to make difficult decisions. To overcome these disincentives to oversight requires leadership. Oversight is traditionally the responsibility of Congress, however the administration is also responsible for oversight of program implementation with respect to the provisions of public law.

Improvement of government performance in the area of science policy (and more broadly) will not occur if programs and officials are not held to their formal commitments. Congress, presidents, and agencies can use oversight of performance to hold one another

accountable in the policy process. Without oversight performance deficits may go unnoticed and responsibility for such deficits may be easily evaded. This is not to say that the government needs an array of dedicated overseers to account for program performance. Rather, the changes in program implementation by CENR following the resumption of oversight suggests that when Congress and the President follow their Constitutional responsibilities, policy shortfalls can be recognized and steps taken to correct them.

Conclusion: Promises, Performance, and Process

The lack of accountability, leadership, and oversight indicates a breakdown in the policy process. A breakdown in the policy process is different than a performance deficit: A performance deficit is a difference between goals and progress towards those goals. A policy process breakdown is a loss of government capacity to formulate and execute policy. A performance deficit may indicate a breakdown in a program's broader policy process. A broad lesson for government performance more generally is that if we are to recognize breakdowns in the policy process then is important to understand what a healthy policy process is and when it has broken down.

In the introduction to this case study, the story of Program implementation was framed from two perspectives, that of the Committee and that of the Program. Considering each in turn, we find one provides lessons and the other hope.

The story of the Committee on Earth and Environmental Sciences through 1994 provides a number of lessons about the connections of scientific research and societal needs. One is that scientific research, by itself, cannot always contribute positively to the policy process. Societal benefits are not always the inevitable consequence of research funding. Second, if scientific research is supported to provide insight into societal problems, then the societal problem must lay the foundation for the course of research, and we must not simply rely on the generation of new scientific knowledge to solve our problems. A societal problem is consciously defined by members of society and is defined as a difference between where we would like to be and where we think we are. Because groups in society define problems differently, it is important that a research program with stated societal benefit goals support a range of alternative approaches to both defining and solving the problem. In this manner a number of alternative courses of action can feed into the process of policy development.

The ongoing story of the U.S. Global Change Research Program is one of hope -- hope that the performance shortfall under the Committee has been recognized and lessons learned. If so, then the Program has virtually unlimited potential to contribute to improved responses to problems associated with global change and as well ensure its own long-term sustainability. In an era of rapid technological change, difficult policy problems, and competition over finite budgets it is increasingly important to understand how federal science policy relates to the achievement of national goals. Ever since the founding of the nation science and government have had a relationship based on the mutual expectation of gain. Government was a means for science to advance knowledge, and science was a means for government to achieve goals. As we move into the twenty-first century, it is time to reappraise the core assumptions of the government-science relationship that have guided many policy decisions for almost half a century. It is in the interests of policymakers, scientists, and the society that encompasses them

both to create healthy processes of science policymaking that serve the goals of science and the goals of the nation.

Table 2.1. National Climate Program Agency Responsibilities (Justus and Morrison 1988, 32).

Energy:	Lead agency for the study of carbon dioxide and climate
State:	Coordination and policy setting for U.S. participation in international programs.
EPA:	Assessing impacts of climate change on environmental quality and developing a coordinated national policy on global climate change.
NASA:	Developing remote sensing techniques to study the Earth as an integrated system; lead agency for coordination of the ozone program.
NOAA:	Lead agency for coordination of the NCP; monitoring, archiving, and dissemination of atmospheric and ocean data; lead agency for climate prediction.
NSF:	Support of basic research in all aspects of NCP; lead agency for coordinating the Arctic Research and Policy Act of 1984; conduct of U.S. Antarctic Program.
USDA:	Evaluation of the role of climate change and variability on agriculture (food and fiber) systems.
USGS:	Lead agency for study of the interaction between climate and hydrology and for study of paleoclimates.

Table 2.2. Fiscal Year 1989 USGCRP Budget Crosscut by agency.

USGCRP FY 1989 BUDGET ($ in millions)

Agency	Focused	Contributing	Total	Focused/Total
DOC	9.0	442.1	451.1	0.02
DOD	0.0	45.7	45.7	0.00
DOE	20.2	46.5	66.7	0.30
DOI	5.3	210.9	216.2	0.02
EPA	27.4	70.0	97.4	0.28
NASA	14.5	399.2	413.7	0.04
NSF	39.2	112.4	151.6	0.26
USDA	18.3	149.4	167.7	0.11
TOTALS	**133.9**	**1476.2**	**1610.9**	**0.08**

Table 2.3. Fiscal Year 1990 USGCRP Budget Crosscut by agency.

USGCRP FY 1990 BUDGET ($ in millions)

Agency	**Focused**		**Contributing**		**Total**	
	(7/89)	(10/90)	(7/89)	(10/90)	(7/89)	(10/90)
DOC	20.0	18.0	382.8	265.7	402.8	283.7
DOD	0.0	0.0	32.3	31.2	32.3	31.2
DOE	27.2	50.0	46.5	39.3	73.7	89.3
DOI	11.3	13.3	204.5	225.1	215.8	238.4
EPA	35.3	13.2	58.9	83.3	94.2	96.5
NASA	21.5	488.6	412.6	24.7	434.1	509.3
NSF	53.5	55.0	120.0	124.2	173.5	179.2
USDA	22.7	21.2	154.2	25.4	176.9	46.6
TOTALS	**191.5**	**659.3**	**1412**	**818.9**	**1603**	**1478.2**

Table 4.1. USGCRP Funding under CEES, 1990 to 1994, in millions of current dollars. Source: CEES (1989-1993).

	Congressional Appropropriation (millions of $)		
FISCAL YEAR	Focused	Contributing	Increase (% of Focused)
1990	659	1412	491
1991	1034	918	45
1992	1110	1186	16
1993	1326	1391	19
1994	1763	unavailable	33

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Appendix 1
Text of Public Law 101-606

U.S. Global Change Research Program Act of 1990
Public Law 101-606(11/16/90) 104 Stat. 3096-3104

An *ACT* To require the establishment of a United States *GLOBAL CHANGE* Research Program aimed at understanding and responding to *GLOBAL CHANGE*, including the cumulative effects of human activities and natural processes on the environment, to promote discussions toward international protocols in *GLOBAL CHANGE* research, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This *ACT* may be cited as the "*GLOBAL CHANGE* Research *ACT* of 1990".

SEC. 2. DEFINITIONS.

As used in this *ACT*, the term--

"Committee" means the Committee on Earth and Environmental Sciences established under section 102;

"Council" means the Federal Coordinating Council on Science, Engineering, and Technology;

"*GLOBAL CHANGE*" means *CHANGES* in the *GLOBAL* environment (including alterations in climate, land productivity, oceans or other water resources, atmospheric chemistry, and ecological systems) that may alter the capacity of the Earth to sustain life;

"*GLOBAL CHANGE* research" means study, monitoring, assessment, prediction, and information management activities to describe and understand--

A. the interactive physical, chemical, and biological processes that regulate the total Earth system;

B. the unique environment that the Earth provides for life;
C. *CHANGES* that are occurring in the Earth system; and
D. the manner in which such system, environment, and *CHANGES* are influenced by human actions;

"Plan" means the National *GLOBAL CHANGE* Research Plan developed under section 104, or any revision thereof; and

"Program" means the United States *GLOBAL CHANGE* Research Program established under section 103.

TITLE I--UNITED STATES *GLOBAL CHANGE* RESEARCH PROGRAM

SEC. 101. FINDINGS AND PURPOSE.

(a) FINDINGS.--The Congress makes the following findings:

Industrial, agricultural, and other human activities, coupled with an expanding world population, are contributing to processes of *GLOBAL CHANGE* that may significantly alter the Earth habitat within a few human generations.

Such human-induced *CHANGES*, in conjunction with natural fluctuations, may lead to significant global warming and thus alter world climate patterns and increase *GLOBAL* sea levels. Over the next century, these consequences could adversely affect world agricultural and marine production, coastal habitability, biological diversity, human health, and *GLOBAL* economic and social well-being.

The release of chlorofluorocarbons and other stratospheric ozone-depleting substances is rapidly reducing the ability of the atmosphere to screen out harmful ultraviolet radiation, which could adversely affect human health and ecological systems. Development of effective policies to abate, mitigate, and cope with *GLOBAL CHANGE* will rely on greatly improved scientific understanding of *GLOBAL* environmental processes and on our ability to distinguish human-induced from natural *GLOBAL* *CHANGE*.

New developments in interdisciplinary Earth sciences, *GLOBAL* observing systems, and computing technology make possible significant advances in the scientific understanding and prediction of these *GLOBAL CHANGES* and their effects.

Although significant Federal *GLOBAL CHANGE* research efforts are underway, an effective Federal research program will require efficient interagency coordination, and coordination with the research activities of State, private, and international entities.

(b) PURPOSE.--The purpose of this title is to provide for development and coordination of a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of *GLOBAL CHANGE*.

SEC. 102. COMMITTEE ON EARTH AND ENVIRONMENTAL SCIENCES.

(a) ESTABLISHMENT.--The President, through the Council, shall establish a Committee on Earth and Environmental Sciences. The Committee shall carry out Council functions under section 401 of the National Science and Technology Policy, Organization, and Priorities *ACT* of 1976 (42 U.S.C. 6651) relating to *GLOBAL CHANGE* research, for the purpose of increasing the overall effectiveness and productivity of Federal *GLOBAL CHANGE* research efforts.

(b) MEMBERSHIP.--The Committee shall consist of at least one representative from--

the National Science Foundation;
the National Aeronautics and Space Administration;
the National Oceanic and Atmospheric Administration of the Department of Commerce;
the Environmental Protection Agency;
the Department of Energy;
the Department of State;
the Department of Defense;
the Department of the Interior;
the Department of Agriculture;
the Department of Transportation;
the Office of Management and Budget;
the Office of Science and Technology Policy;
the Council on Environmental Quality;
the National Institute of Environmental Health Sciences of the National Institutes of Health; and such other agencies and departments of the United States as the President or the Chairman of the Council considers appropriate.

Such representatives shall be high ranking officials of their agency or department, wherever possible the head of the portion of that agency or department that is most relevant to the purpose of the title described in section 101(b).

(c) CHAIRPERSON.--The Chairman of the Council, in consultation with the Committee, biennially shall select one of the Committee members to serve as Chairperson. The Chairperson shall be knowledgeable and experienced with regard to the administration of scientific research programs, and shall be a representative of an agency that contributes substantially, in terms of scientific research capability and budget, to the Program.

(d) SUPPORT PERSONNEL.--An Executive Secretary shall be appointed by the Chairperson of the Committee, with the approval of the Committee. The Executive Secretary shall be a permanent employee of one of the agencies or departments represented on the Committee, and shall remain in the employ of such agency or department. The Chairman of the Council shall have the authority to make personnel decisions regarding any employees detailed to the Council for purposes of working on business of the Committee pursuant to section 401 of the National Science and Technology Policy, Organization, and Priorities *ACT* of 1976 (42 U.S.C. 6651).
(e) FUNCTIONS RELATIVE TO *GLOBAL CHANGE*.--The Council, through the

Committee, shall be responsible for planning and coordinating the Program. In carrying out this responsibility, the Committee shall--

serve as the forum for developing the Plan and for overseeing its implementation;

improve cooperation among Federal agencies and departments with respect to *GLOBAL CHANGE* research activities;

provide budgetary advice as specified in section 105;
work with academic, State, industry, and other groups conducting *GLOBAL CHANGE* research, to provide for periodic public and peer review of the Program;

cooperate with the Secretary of State in--

(A) providing representation at international meetings and conferences on *GLOBAL CHANGE* research in which the United States participates; and

(B) coordinating the Federal activities of the United States with programs of other nations and with international *GLOBAL CHANGE* research activities such as the International Geosphere-Biosphere Program;

consult with actual and potential users of the results of the Program to ensure that such results are useful in developing national and international policy responses to *GLOBAL CHANGE*; and
report at least annually to the President and the Congress, through the Chairman of the Council, on Federal *GLOBAL CHANGE* research priorities, policies, and programs.

SEC. 103. UNITED STATES *GLOBAL CHANGE* RESEARCH PROGRAM.

The President shall establish an interagency United States *GLOBAL* *CHANGE* Research Program to improve understanding of *GLOBAL* *CHANGE*. The Program shall be implemented by the Plan developed under section 104.

SEC. 104. NATIONAL *GLOBAL CHANGE* RESEARCH PLAN.
(a) IN GENERAL.--The Chairman of the Council, through the Committee, shall develop a National *GLOBAL CHANGE* Research Plan for implementation of the Program. The Plan shall contain recommendations for national *GLOBAL CHANGE* research. The Chairman of the Council shall submit the Plan to the Congress within one year after the date of enactment of this title, and a revised Plan shall be submitted at least once every three years thereafter.
(b) CONTENTS OF THE PLAN.--The Plan shall--

establish, for the 10-year period beginning in the year the Plan is submitted, the goals and priorities for Federal *GLOBAL* *CHANGE* research which most effectively advance

scientific understanding of *GLOBAL CHANGE* and provide usable information on which to base policy decisions relating to *GLOBAL CHANGE*; describe specific activities, including research activities, data collection and data analysis requirements, predictive modeling, participation in international research efforts, and information management, required to achieve such goals and priorities; identify and address, as appropriate, relevant programs and activities of the Federal agencies and departments represented on the Committee that contribute to the Program; set forth the role of each Federal agency and department in implementing the Plan; consider and utilize, as appropriate, reports and studies conducted by Federal agencies and departments, the National Research Council, or other entities; make recommendations for the coordination of the *GLOBAL* *CHANGE* research activities of the United States with such activities of other nations and international organizations, including--
(A) a description of the extent and nature of necessary international cooperation;

(B) the development by the Committee, in consultation when appropriate with the National Space Council, of proposals for cooperation on major capital projects;

(C) bilateral and multilateral proposals for improving worldwide access to scientific data and information; and

(D) methods for improving participation in international *GLOBAL CHANGE* research by developing nations; and

estimate, to the extent practicable, Federal funding for *GLOBAL CHANGE* research activities to be conducted under the Plan.

(c) RESEARCH ELEMENTS.--The Plan shall provide for, but not be limited to, the following research elements:

GLOBAL measurements, establishing worldwide observations necessary to understand the physical, chemical, and biological processes responsible for *CHANGES* in the Earth system on all relevant spatial and time scales.

Documentation of *GLOBAL CHANGE*, including the development of mechanisms for recording *CHANGES* that will actually occur in the Earth system over the coming decades.

Studies of earlier *CHANGES* in the Earth system, using evidence from the geological and fossil record.

Predictions, using quantitative models of the Earth system to identify and simulate *GLOBAL* environmental processes and trends, and the regional implications of such processes and trends.
Focused research initiatives to understand the nature of and interaction among physical, chemical, biological, and social processes related to *GLOBAL CHANGE*.

(d) INFORMATION MANAGEMENT.--The Plan shall provide recommendations for

collaboration within the Federal Government and among nations to--

establish, develop, and maintain information bases, including necessary management systems which will promote consistent, efficient, and compatible transfer and use of data;

create *GLOBALLY* accessible formats for data collected by various international sources; and

combine and interpret data from various sources to produce information readily usable by policymakers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of *GLOBAL CHANGE*.

(e) NATIONAL RESEARCH COUNCIL EVALUATION.--The Chairman of the Council shall enter into an agreement with the National Research Council under which the National Research Council shall--

evaluate the scientific content of the Plan; and

provide information and advice obtained from United States and international sources, and recommended priorities for future *GLOBAL CHANGE* research.

(f) PUBLIC PARTICIPATION.--In developing the Plan, the Committee shall consult with academic, State, industry, and environmental groups and representatives. Not later than 90 days before the Chairman of the Council submits the Plan, or any revision thereof, to the Congress, a summary of the proposed Plan shall be published in the Federal Register for a public comment period of not less than 60 days.

SEC. 105. BUDGET COORDINATION.

(a) COMMITTEE GUIDANCE.--The Committee shall each year provide general guidance to each Federal agency or department participating in the Program with respect to the preparation of requests for appropriations for activities related to the Program.

(b) SUBMISSION OF REPORTS WITH AGENCY APPROPRIATIONS REQUESTS.--

Working in conjunction with the Committee, each Federal agency or department involved in *GLOBAL CHANGE* research shall include with its annual request for appropriations submitted to the President under section 1108 of title 31, United States Code, a report which--
(A) identifies each element of the proposed *GLOBAL CHANGE* research activities of the agency or department;
(B) specifies whether each element (i) contributes directly to the Program or (ii) contributes indirectly but in important ways to the Program; and
(C) states the portion of its request for appropriations allocated to each element of the Program.

Each agency or department that submits a report under paragraph (1) shall submit such report simultaneously to the Committee.

(c) CONSIDERATION IN PRESIDENT'S BUDGET.--
The President shall, in a timely fashion, provide the Committee with an opportunity to review and comment on the budget estimate of each agency and department involved in *GLOBAL CHANGE* research in the context of the Plan.

The President shall identify in each annual budget submitted to the Congress under section 1105 of title 31, United States Code, those items in each agency's or department's annual budget which are elements of the Program.

SEC. 106. SCIENTIFIC ASSESSMENT.

On a periodic basis (not less frequently than every 4 years), the Council, through the Committee, shall prepare and submit to the President and the Congress an assessment which--

integrates, evaluates, and interprets the findings of the Program and discusses the scientific uncertainties associated with such findings;

analyzes the effects of *GLOBAL CHANGE* on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and

analyzes current trends in *GLOBAL CHANGE*, both human- induced and natural, and projects major trends for the subsequent 25 to 100 years.

SEC. 107. ANNUAL REPORT.

(a) GENERAL.--Each year at the time of submission to the Congress of the President's budget, the Chairman of the Council shall submit to the Congress a report on the activities conducted by the Committee pursuant to this title, including--

a summary of the achievements of the Program during the period covered by the report and of priorities for future *GLOBAL* *CHANGE* research;
an analysis of the progress made toward achieving the goals of the Plan;
expenditures required by each agency or department for carrying out its portion of the Program, including--
(A) the amounts spent during the fiscal year most recently ended;
(B) the amounts expected to be spent during the current fiscal year; and
(C) the amounts requested for the fiscal year for which the budget is being submitted.

(b) RECOMMENDATIONS.--The report required by subsection (b) shall include recommendations by the President concerning--

CHANGES in agency or department roles needed to improve implementation of the Plan; and

additional legislation which may be required to achieve the purposes of this title.

SEC. 108. RELATION TO OTHER AUTHORITIES.

(a) NATIONAL CLIMATE PROGRAM RESEARCH ACTIVITIES.-- The President, the Chairman of the Council, and the Secretary of Commerce shall ensure that relevant research activities of the National Climate Program, established by the National Climate Program *ACT* (15 U.S.C. 2901 et seq.), are considered in developing national *GLOBAL* *CHANGE* research efforts.

(b) AVAILABILITY OF RESEARCH FINDINGS.--The President, the Chairman of the Council, and the heads of the agencies and departments represented on the Committee, shall ensure that the research findings of the Committee, and of Federal agencies and departments, are available to--

the Environmental Protection Agency for use in the formulation of a coordinated national policy on *GLOBAL* climate *CHANGE* pursuant to section 1103 of the *GLOBAL* Climate Protection *ACT* of 1987 (15 U.S.C. 2901 note); and

all Federal agencies and departments for use in the formulation of coordinated national policies for responding to human-induced and natural processes of *GLOBAL CHANGE* pursuant to other statutory responsibilities and obligations.

(c) EFFECT ON FEDERAL RESPONSE ACTIONS.--Nothing in this title shall be construed, interpreted, or applied to preclude or delay the planning or implementation of any Federal action designed, in whole or in part, to address the threats of stratospheric ozone depletion or *GLOBAL* climate *CHANGE*.

ENDNOTES

1. Hansen testified to three main points: (1) that 1988 was the warmest year on record (of the past 100 years), (2) there was a high degree of confidence that warming was caused by human activities, and (3) that computer models indicated that the greenhouse effect was already large enough to result in extreme events like summer heat waves.

2. Throughout this book the terms Aglobal warming,@ Aglobal change,@ and Aclimate change@ appear in various institution names, etc..

3. According to a 1993 report of the International Group of Funding Agencies Working Group on Resource Assessment, US$2.2 billion was spent on global change research by 20 or so agencies around the world (Helmut Kuehr 1997, personal communication). In 1992 the USGCRP was appropriated $1.1 billion. While global change is in principle much broader than the topic of climate change, a significant fraction of the funding was in fact devoted to climate change. See also Reinstein (1993).

4. However, the focus of the program has been on climate change (OTA 1993).

5. Funding for the super collider and NASA's space station totaled about $2.6 billion in FY 1993 (Marshall and Hamilton, 1992).

6. The performance shortfall during 1990-1994, as documented in the latter sections of the case study, is generally not controversial.

7. The phrase Aclimate-related impacts@ is used to explicitly acknowledge that climate is one factor of many in the relation of society and its broader environment. Throughout the remainder of the book, the less cumbersome terms Aclimate impacts,@ Aclimate policies,@ etc. are used in recognition of the broader context.

9. History of the issue Kellogg, Ausubel, Revelle, etc.

10. IPCC critics Boehmer-Christiansen, Chapter 8 controversy, Lahsen

11. The origins of the prevent versus adapt policy debate are unclear. The two alternatives were clearly established in an April 1980 Senate Hearing on ACarbon Dioxide Buildup in the Atmosphere@ (SCENR 1980). On the origins of the debate and discussion of the two alternative see Glantz (1979), DOE (1980) particularly the chapter therein by Meyer-Abich (1980), Kellogg and Schware (1981), Kellogg (1987), Glantz and Ausubel (1988), Schneider (1989), and NAS (1992). In 1963 the Conservation Foundation held a AConference on the Rising Carbon Dioxide Content of the Atmosphere.@ According to Kellogg (1987), the first recognition by the U.S. government that climate change could be linked to human activities was a 1965 report of the President=s Science Advisory Committee (PSAC 1965).

12. The presentation of a policy alternative in terms of Ayes or no?@ is well understood, see, e.g., Chapter 14 in Lippmann (1965).

13. Volume 33 of *Climatic Change* contains a series of articles on geoengineering

14. Another FCCC report notes that Aregardless of whether the CCAP is successful in meeting the year 2000 target, and despite the fact that the CCAP will affect net greenhouse gas emissions well beyond that date, emissions are expected to be at least 10 percent above 2000 levels in 2010" (FCCC 1996, 14).

15. Only the 24 so-called Annex I (developed) countries agreed to emission limits. Under the FCCC, developed and

developing countries follow different rules.

16. On this, Kauppi (1995) concludes that Aclimate will change, there will be dangerous effects, and the [Framework] Convention objective will be unattainable.@

17. Some have suggested that recent changes in ENSO frequency might be attributable to climate change (see, e.g., Trenberth and Hoar 1996).

18. On linearity see also Jager and O=Riordian 1996 and Moss 1995a/b, Schneider 1989

19. In 1987 Reagan added additional Cabinet councils on legal affairs and government management (Brownstein and Kirschtien 1986).

20. Brownstein and Kirschtien (1986) point also to Baker=s White House Legislative Strategy Group as a key player in creating policy.

21. The members of the DPC were the President (Chair), Vice President, Secretaries of Treasury (Chair, pro tem), State, Agriculture, Commerce, Labor, Transportation, OMB Director, U.S. Trade Representative, Council of Economic Advisors Chair, President=s Chief of Staff, and OSTP director. The members of the DPC were the President (Chair), Vice President, Attorney General (Chair, pro tem), Secretaries of Education, Interior, Health and Human Services, HUD, Energy, OMB Director, OSTP director, and EPA Administrator (CCSTG 1991).

22.Public Law 95-367 was amended by P. L. 97-375 (December 1982) and P.L. 99-272 (April 1986).

23. In 1965 the Weather Bureau, the Coast and Geodetic Survey, and the Central Radio Propagation Laboratory were combined to form the Environmental Sciences Services Administration (ESSA) (Fleagle 1986). The ESSA was a response to growing policymaker concern about environmental problems.

24. Schick (1990) characterizes the Reagan years as a period when Congress could honestly claim to be "cutting back and [actually] spending more." Congress could at the same time cut from projected spending, and increase agencies over the baseline of the previous year. NOAA is an example of these dynamics.

25. The apparent paradox of support and austere budgets disappears when it is recognized that federal science agencies continued to receive a significant federal funding in the 1970s, hence the "long record of support"; however such funding was often less than the agencies expected or desired, hence "austere budgets."

26. Thomas Donohue, former chair of the NRC Space Science Board, quoted in Taubes (1993, 912).

27. The degree to which some scientists accepted the space station in exchange for EOS is evident in a 1988 statement by a NASA project scientist for EOS. He linked, quite illogically, NASA's "Mission to Planet Earth" with human spaceflight to Mars. "[Mission to Planet Earth] can be a stepping-stone to a joint manned Mars project. If we are going to form an international Mars mission we must start on common ground, and Mission to Earth (sic) provides that common ground" (Jerry Stoffen quoted in Covault 1988, 16).

28. Eos is also the name of the Greek goddess of the dawn.

29. As quoted in Edelson (1988, 7). A similar recounting is found in Kennedy (1992).

30. Dixon Butler quoted in Edelson (1988, 7).

31. According to Edelson (1988), the initiative to form the Earth System Science Committee began with Shelby

Tilford, director of NASA's Earth Science and Applications division.

32. Bretherton quoted in Edelson (1988, 7).

33. The International Geophysical Year (IGY) was a scientific effort sponsored by the International Council of Scientific Unions in 1957 (Fleagle 1992, McDougall 1986). Several notable accomplishments of the IGY were the discovery of the Van Allen radiation belts around the Earth, efforts to launch the first western satellite, and the initiation of efforts to monitor the concentrations of carbon dioxide in the Earth's atmosphere.

34. The debate at the Woods Hole workshop is documented also in Kennedy (1992).

35. NRC (1990) documents many of these efforts, including those of the National Academy of Engineering, Social Science Research Council, International Federation of Institutes for Advanced Study, United Nations University, United Nations Educational, Scientific, and Cultural Organization, European Science Foundation, and the International Institute for Applied Systems Analysis.

36. Another important international scientific effort that contributed to climate change was the World Climate Research Program,

37. For example, Dr. John Eddy, chair of the NRC U.S. Committee for an IGBP, was also a member the ICSU Ad Hoc Planning Group on Global Change, and was the National Center for Atmospheric Research=s liaison to the Bretherton Committee. Other influential players have similar concurrent relationships. Compare participants listed in NRC (1986), NASA (1986), and ICSU (1986).

38. Evidence for such support is found in Leahy's (1986) letter to Fletcher when Leahy linked Watson=s testimony with the Earth System Science Committee and his desire to see NASA pursue and "aggressive research program to ensure that our decision makers have the information that they need to develop timely policies to protect the planet." Because Watson's written comments differed significantly from his spoken comments, the long lead time between scheduling of hearings. and the lack of communication between Congressional committees it is unlikely that Watson=s comments were intended to influence the appropriations hearings two weeks following. However, NASA did benefit from the series of events beginning with Watson=s testimony.

39. According to Kennedy (1992a) several science administrators, including Robert Corell of NSF and Shelby Tilford of NASA, had been engaged in discussions with Fellows at OMB and OSTP staff about the coordination of global change science. Hence, Calio's proposal represented a convergence of opinion. In other words, the "nonsinister conspiracy" had gone political.

40. Quoted in Kennedy (1992a, 12). The events of the first meeting were related to the author in interviews with several participants. The most comprehensive published recounting of the first CES meeting is found in Kennedy (1992a and b). Other evidence in the public record is found, for example, in references to a "rocky start," Perry quoted in Edelson (1988, 11), and Corell (1991) dates the Committee's beginning to its second meeting. The CEES secretariat informed the author that the minutes of the first meeting are "unavailable;" all other meeting minutes are available.

41. Anonymous participant at first CES meeting quoted in Kennedy (1992a, 12).

42. Ray Watts, of the USGS, quoted in Kennedy (1992b, 3).

43. The material on the second meeting is drawn from interviews by the author with participants, CES (1988) meeting minutes, and Kennedy (1992b).

44. Paul Dresler quoted in Kennedy (1992b, 6).

45. CEES and CENR have continued to produced budget crosscuts. They are published annually as the *Our Changing Planet Series* (CEES 1989-1993, CENR 1994-1996).

46. Dresler in Kennedy (1992b, 6).

47. Dresler in Kennedy (1992b, 7-8).

48. A budget examiner works for OMB and is responsible for accounting for federal spending within a particular part of the budget, called a budget function. The examiner is responsible for compiling agency requests and needs. Thus, from OMB's perspective the CES was created, in effect, to fulfill the role of a budget examiner.

49. It is unclear whether the increase in the NASA total is related in any way. In addition, the contributing element of the Commerce Department and the focused USDA element changed significantly between the two versions of the second cross-cut. It is unclear why these changes occurred.

50. Response of climate change scientists to Hansen is found in Kerr (1989).

51. See also the exchange between Senator John Kerry (D-MA) and Fredrick Bernthal in SCCST (1989, 61-63).

52. See also Gabriel (1990) and Roberts (1989).

53. Irwin Goodwin, of *Physics Today*, in an interview with Bush Science Advisor D. Allan Bromley quoted in (Anon., 1993, 54).

54. See also the discussion between Michael Boskin, chairman of the president's Council of Economic Advisors and Representative James H. Scheuer (D-NY) in JEC (1990).

55. CES (1989) minutes of meeting five, 8 March 1989.

56. The bill did state that CEES would be responsible for "development of an information base, the assembly of the information essential for effective decisionmaking to respond to the consequences of global change" (SCCST 1989, 18). SCCST (1989, 14-28) reprints the entire text of the bill.

57. The developing relationship between USGCRP science and global change policy was defined further in follow-up questions to OSTP budget justification hearings in May 1990. Bromley used the proposed Intergovernmental Panel on Climate Change as an example of an "interface between science and policy," a phrase that came to characterize the USGCRP following its approval (SCA 1990b, 233-234).

58. An OTA (1993) evaluation of the USGCRP ignores interbranch conflict as an explanation for why Congress explicitly linked the USGCRP to policy development. Instead, the OTA (1993, 110) argues that "the primary questions of policymakers have changed since 1989 in the wake of the world climate treaty and the publication of several key reports" including the IPCC reports. This may be true, but, OTA neglects to observe that Congressional demands of the USGCRP changed during 1989 and 1990, primarily due to conflicts with the Bush Administration. See GAO (1990).

59. Title II of the law gives the State Department responsibility for overseeing any international global change negotiations.

60. There was minimal floor debate in either chamber on the proposed program. This indicates that the bills were

uncontroversial. P.L. 101-606 was considered by the Senate on 6 February and 27 October 1990 and by the House 26 October 1990.

61. The answers of Dr. Robert Watson, of NASA, to written questions submitted by Senator Hollings in SCCST (1988, 90-94) follow a similar line of reasoning.

62. Not all calls for answers or reduced uncertainty support such an "assembly line" model. Some policymakers probably called for more research simply to maintain the status quo with respect to global change policy. This interpretation is considered below under the label of policy-driven science.

63. It is worth noting that this statement was made by Dr. James Hansen who, less than a year later, would state in congressional testimony that he was “99%” certain that global warming was underway.

64. Of course, the phrase "policy driven" is used appropriately to describe research that is conducted to serve policy. The two definitions are almost opposites, and are used frequently enough to merit careful attention when used.

65. By “unprecedented actions” Senator Gore was referring to banning chloroflourocarbons, halting deforestation, and reducing carbon dioxide emissions (SCCST 1989).

66. See, for example, Roberts (1990).

67. See, for example, Wirth (1990), Scheuer (1990), and Shabecoff (1990).

68. Other similar concerns about the need to act under uncertainty can be found in SCCST (1987), SCENR (1987), SCCST (1988), SCCST (1989), and HCSST (1989). See especially questions submitted for the record. In these questions, policymakers often expressed concern about the link between science and policy.

69. Of the remaining two, one refers to national and international partnerships, and the other to adequate funding.

70. See also the response of Dr. Robert Corell to written questions submitted by Senator Larry Pressler (R-SD) (SCCST 1987).

71. CEES also did not produce a scientific assessment. To fulfill its legal mandate the USGCRP would have had to produce an assessment by November 1994. During the Committee's tenure, the Program was not currently structured to produce such a report (IA 1994), thus it is unlikely to meet this deadline. Program officials stated that international assessments, such as those produced by the IPCC, would meet this requirement (Bromley 1991).

72. An undated memo from the GCRIO office titled "Global Change Research Information Office" cites that the task force produced in October 1991 a document called *Recommendations for Creation of Global Change Research Information Office*.

73. See the provisions for providing global change information in Title II of P.L. 101-606, "International Cooperation in Global Change Research". See also the testimony of Robert Corell in HCSST (1992, 18-44).

74. In addition, beginning in 1993 CEES staked the USGCRP's policy relevance on the peg of assessments (CENR 1994). Thus, the GCRIO had a subsidiary role in providing usable information. In 1992 the CEES decided to house the GCRIO in the Consortium for International Earth Science Information Network (CIESIN), which was funded as an earmark out of the NASA budget. CIESIN has an interesting political history, see, for example, Kamen (1993).

75. For example, Bernabo (1993) distinguishes between integrated and end-to-end assessments, while CEES (1993) does not. In addition, Dowlatabadi and Morgan (1993) suggest that "integrated assessments should try to capture the

most salient features, in reduced-form or metamodels . . . the holy grail of a particular discipline." It is not clear how this concept of assessment relates to usable information.

76. The story MARS is related in greatest detail in OTA (1993) pp. 132-139. See also however Monastersky (1993) and the testimony of Steve Rayner in HCSST (1993).

77. Bromley discussed the creation of the MARS working group at a CES meeting on 21 December 1989, according to meeting minutes.

78. OTA (1993, 134-135) reproduces the MARS crosscut.

79. A number of the MARS functions were incorporated in the CEES Subcommittee on Environmental Technology (SET) (OTA 1993). While the SET had little time to operate, its broad mandate and low level of fiscal support limited it progress towards contributing to providing readily usable and timely information for policy decisions on global change.

80. And also in the Senate where fewer members means that each is required to cover a greater number of issues.

81. CRS (1991, 6-8) documents confusion over the relationship between NASA's Mission to Planet Earth and the USGCRP. Such confusion is the result of unfamiliarity with the program as USGCRP documents are clear in relating NASA's program to the broader effort.

82. Quote is of John Holmfeld, a senior staff member of the House Science Committee in the 1980s, in Crawford (1988).

83. AAAS executive officer Alvin W. Trivelpiece speaking at a 1988 AAAS Colloquium on R&D referring to science prospects in the context of tight budgets in Crawford (1988).

84. See Reilly (1990) for a statement of the Bush Administration's "no regrets" global change policy and Gabriel (1989) on environmental policy in the Bush Administration more generally.

85. Following admission of a shortfall by Committee officials and changes to the Program's implementation this argument has largely disappeared. See for example the testimony of Clinton science advisor John Gibbons in SCCST (1993).

86. Whether or not the group of scientists in the imaginary Congress could reach a majority on the likelihood or magnitude of global change is a different issue than deciding what to do.

87. While the following exchange is meant to be suggestive, more systematic approaches to the value judgments of scientists and other experts arrive at similar conclusions, see for example Martin (1979). In the context of climate change see Nordhaus (1994) and Lave and Dowlatabadi (1993).

88. EPA administrator Lee Thomas quoted in Benedick (1991, 1).

89. Benedick (1991) also argues that the success of international ozone depletion negotiations is also attributed to the presence of an informed public, U.N. leadership, U.S. leadership, private organization participation, decentralized fact-finding processes, and the resilience of the Montreal Protocol. Doniger (1988) argues that the development of safe, cost-effective substitutes for CFCs was another factor contributing to the international ozone agreement. See also Haas (1991).

90. See also the discussion between Representative James Scheuer, Robert Watson, and Daniel Albritton (1987), pp. 250-259, on the ozone precedent.

91. On the tractability of scientific questions of ozone see the written statement of Dr. Robert Watson in SCEPW (1986, 52-58), of climate change see Mahlman (1992).

92. Some analysts argue that another environmental issue of the 1980s, ozone depletion, was the product of a similar "conspiracy." For example, Haas (1991, 227) argues that ozone depletion "politics in the USA was driven by the ecological epistemic community." Haas (1991, 226) defines an epistemic community much more broadly than Perry's nonsinister conspiracy: "An epistemic community is a knowledge-based transnational network of specialists whose members share common views about the causes of a problem and the policies which should be adopted to manage it."

93. See also Rubin (1991).

94. See Perry (1992) for a representative view of the global change community. Members of Congress and witnesses testified at most hearings on the proposed P.L. 101-606 of the CES organizational prowess. Consider, for example, a statement of Representative George Brown (D-CA) in 1989: "The CES has shown tremendous potential as a central coordinating committee, and it has made significant accomplishments in the last year" (HCSST 1989, 44).

95. See Bye et al. (1989/1990) for a proposal that suggests how congressional reorganization could improve science policy more generally.

96. This is not to say that Congressional fragmentation is not of broader concern, only that it does not account for the CEES performance shortfall.

97. The following is believed to be a comprehensive list of CEES/USGCRP assessments through 1993: AGU (1989), HCSST (1989), Dolan (1990), GEOSAT (1990), Keenan and Rich (1990), NRC (1990), Pittock (1990), SCA (1990), Bjerklie (1991), Brunner (1991), Kerr (1991), HCSST (1991), Rubin et al, (1991), Fleagle (1992), Webster (1992), SCSST (1991), HCSST, (1992a), NRC (1992), Ascher (1993), Brunner (1993), HCSST (1993), SCENR (1993), Monastersky (1993), and OTA (1993a and b). MARS (1991a), although not intended as a USGCRP evaluation, is also a valuable critique of the program. Bernabo (1992), although not an explicit critique of CEES/USGCRP, was an influential critique of the relationship of global change science and policy. An example of a critique of the scientific priorities of the program is Lean and Rind (1994), who argue that solar variability should be given a higher priority within the Program.

98. OTA (1993a) repeated much the same language: "although the results of the program, as currently structured, will provide valuable information for predicting climate change, they will not necessarily contribute to the information needed by public and private decisionmakers to respond to global change (1993b, 111)."

99. In addition, a number of groups had published reports in 1992 and 1993 that were critical of federal environmental policy in general. These reports, dates of publication, and their sponsors were: *Safeguarding the Future: Credible Science, Credible Decisions*, Environmental Protection Agency, 1992; *Environmental Research and Development: Strengthening the Federal Infrastructure*, Carnegie Commission on Science, Technology and Goverment, December 1992; *A Proposal for a National Institute for the Environment: Need, Rationale, and Structure*, Committee for the National Institute for the Environment, 1993; *Choosing a Sustainable Future* , National Commission on the Environment, 1993; *Research to Protect, Restore and Manage the Environment*, National Research Council, 1993; and *A Biological Survey for the Nation*, National Research Council, 1993.

100. See, for example, Clinton and Gore's *Climate Change Action Plan* (1993). Clinton committed himself to addressing global change in an Earth Day speech on 21 April 1993. Not all agree that Clinton's global change

policies are significantly different from those of the Bush Administration. Some have asserted that Clinton's approach to global warming is actually much like the approach taken by President Bush, see Kriz (1993).