

Usable information for policy: An appraisal of the U.S. Global Change Research Program

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Abstract. The U.S. Global Change Research Program (USGCRP) was established in law in 1990 (P.L. 101–606) with a mandate to provide policymakers with ‘usable information.’ The law gave a White House Committee on Earth and Environmental Sciences (CEES) responsibility to implement the program with respect to its policy mandate. In 1994 CEES was replaced, in part, because it failed to provide ‘usable information.’ This article, documenting the development of the program’s policy mandate and CEES implementation of the USGCRP, finds a performance shortfall. The shortfall is attributed to a breakdown in the legislative process, participant perspectives, and the structure of post-World War II science policy. The purpose of the article is to explain the CEES performance shortfall in hope that its successor can improve USGCRP performance with respect to its legal mandate based upon the lessons of experience.

Introduction: Defining the policy problem

On November 16, 1990, President George Bush enacted in law the U.S. Global Change Research Program (USGCRP) when he signed the Global Change Research Act of 1990, Public Law 101–606. The program was initiated administratively in 1987 in response to concerns about climate change, ozone depletion, and other global changes. The law requires the program to provide policy makers with ‘usable information on which to base policy decisions relating to global change’ (P.L. 101–606). From November 1990 until May 1994, the White House Committee on Earth and Environmental Sciences (CEES) oversaw the implementation of the USGCRP. In 1994 the federal government budgeted about \$1.4 billion for the USGCRP.¹ And, through 1994 over \$5.6 billion dollars was spent on the program, representing one of the largest science programs ever conducted (Table 1).² In 1994 the USGCRP consisted of 125 projects, among 31 federal bureaus, within 11 federal agencies (CEES, 1992). This article appraises USGCRP implementation under CEES with respect to P.L. 101–606 and its mandate for ‘usable information.’

A policy problem is ‘a perceived discrepancy between goals and an actual or anticipated state of affairs’ (Lasswell, 1971: p. 56). The USGCRP presents a policy problem because under CEES it did not meet its legal mandate to produce ‘usable information’ and a ‘growing number of critics warn that the program appears headed toward failure unless fundamental changes are made’ (Monastersky, 1993: p. 158).³ In other words, the program may produce information without systematically producing usable information. A

Table 1. USGCRP Funding 1989 to 1995 in millions of current dollars. Each participating agency defines its contributions to the USGCRP as focused or contributing on an annual basis. Focused programs are formally part of the USGCRP; contributing programs are justified for other reasons, but judged relevant to the USGCRP.

Fiscal year	Appropriation (millions of \$)		
	Focused	Contributing	Increase (% of focused)
1989	134	1476	—
1990	659	1412	491
1991	1034	918	45
1992	1110	1186	16
1993	1326	1391	19
1994	1446	unavailable	11
1995 (est.)	1794	unavailable	24
Totals	7452	6383	17.5 (avg. 1992–1995)

Sources: CEES (1989–1993) and CENR (1994b).

number of terms arise throughout this paper: A *policy* is a commitment to a course of action in order to achieve a desired goal (cf. Lasswell and Kaplan, 1950: p. 71). *Policy issues* refers to the context of such commitments; *policy alternatives* refers to a range of actions, one of which might be implemented to achieve the desired goal, itself chosen from a range of possible goals. *Policy science research* seeks to improve decisionmaking through the contextual integration of goals and action alternatives recursively over time (cf. Lasswell, 1971). Too often discussion of global change is muddled by a failure to distinguish between the practice of policy making (i.e., politics, the process of bargaining, negotiation, and compromise) and the science of policy (e.g., the invention and evaluation of action alternatives).

In spite of growing criticism, the USGCRP has yet to be systematically evaluated with respect to its legal mandate (OTA, 1993: p. 139), although the program's scientific content has been evaluated at least several times (e.g., NRC, 1991; OTA, 1993; SCENR 1993). Evaluation of the program with respect to its legal mandate is appropriate under the U.S. Constitution. This article evaluates the USGCRP under CEES based on the premise that policy implementation must follow the 'rule of law' (Currie, 1988: pp. 34–38). That is, Congress, president, and agencies alike are bound by federal law. Without the rule of law Congress, president, and agencies cannot hold one another accountable in the policy process; citizens, moreover, cannot hold government accountable through their elected officials (cf. Moe, 1994).

This article uses a logical framework to evaluate the USGCRP under CEES: It compares program performance with goals set forth in law, and judges formal and effective responsibility for successes and failures (Lasswell,

1971: p. 76). The first section documents the USGCRP legal mandate to provide 'usable information.' The second section documents CEES' efforts to meet its legislative mandate, following the administrative successes of its predecessor, the Committee on Earth Sciences (CES). The distinction between CEES and its predecessor, CES, is important because each had a distinct mandate with different requirements for USGCRP implementation. The last section attributes the CEES performance shortfall to failures in the legislative process, participant perspectives, and the structure of modern science policy. Changes to the program since CEES termination give hope that evaluation of the program's performance with respect to P.L. 101-606 will be received constructively.

USGCRP legislative mandate

USGCRP goal: Usable information

Public Law 101-606 explicitly subordinates USGCRP science objectives to a policy goal. The law's stated purpose 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 (P.L. 101-606).

The law calls for CEES 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' (P.L. 101-606). 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 policy makers attempting to formulate effective strategies for preventing, mitigating, and adapting to the effects of global change' (P.L. 101-606). Thus, the USGCRP was created by Congress to do more than just produce scientific information on global change. It was created to produce information usable in the development of prevention, mitigation, and adaptation policies in response to the many potential threats of global change.

Instrumental objectives: A scientific understanding or policy issue clarification?

One group of participants, among them some USGCRP administrators, policy makers, and scientists, claimed that the development of a scientific understanding of global change was necessary and temporally prior to policy making in the context of global change. These participants failed to reconcile

the program's scientific focus with its policy mandate to provide 'usable information.'

Program administrators considered the USGCRP a science program, not a policy program. For instance, the first USGCRP annual report acknowledged the program's policy goal but did not explain how the goal was to be met through its instrumental science objectives (CES, 1989b). The report explained that the program's instrumental objectives focus on attaining 'an adequate predictive understanding of ... the total Earth system' (CES, 1989b: p.8). The instrumental objectives are to 'document,' 'observe,' and 'predict' Earth system processes. These three objectives comprised the program's 'functional architecture' (CES, 1989b: p.102). The report did not discuss the relationship of the program's instrumental objectives to its mandate to provide usable information.

Consider written testimony presented before the House Science Committee in 1989 by Dr. Robert Corell, a NSF representative to the CES. He argued that scientific research would meet the needs of global change policy making. He stated that 'broad trust in the objectivity of science is essential for the success of policy making efforts, particularly in international negotiations with far-reaching economic implications. Independent and objective science, therefore, serves both science and policy needs' (HCSST, 1989: p.99). Dr. Corell added that global change science would best serve policy through ad hoc communication between high level CES officials and their counterparts in policy making 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: pp. 99-100).

In other words, 'usable information' was that scientific information which CES members communicated to other high level officials in the Executive branch on an ad hoc basis.⁴

Consider also a statement of Dr. Shelby Tilford, a NASA representative to the CES, in the same hearing. He argued that

it is vital for there to be a clear separation of responsibilities between the scientific agencies and the policy makers.... 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: pp. 129-139).

Dr. Tilford argued that science had to be kept separate from considerations of 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. In other words, policy science research within the program could lead to 'politicized' science that would damage the quality of research in the USGCRP. Concerns that science would become 'politicized' are not without grounding. For example, Congress found in 1976 that scientific research in an EPA program had been systematically distorted for political reasons (HIFCC, 1976).

Policy makers supported separating global change science and policy research when they stated that scientific answers were necessary to formulate policies in response to global changes. Such statements imply that science must be completed in some sense before actions could be taken. For instance, Senator Ernest Hollings stated that his purpose in sponsoring the bill that would create the USGCRP was to produce information needed 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: p. 3, emphasis added).

In Senator Hollings' terms 'usable information' was 'facts about the exact causes and consequences' of global change, which is usable because it is what Congress 'needs to take corrective action.' Hollings, using the phrases 'long-term' and 'one day,' implied that any policy action lies far in the future, after scientists provide 'answers.' In floor debate over the USGCRP on October 21, 1990, Senator Hollings repeated an analogy first used by Dr. Francis Bretherton in hearings over the proposed USGCRP. Hollings likened the earth to a car, noting that '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 USGCRP 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: p. 17739). Many policy makers expressed a desire for 'answers' or 'reduced uncertainty' in the context of global change.⁵

A second group of participants, mostly policy makers but some scientists, argued that usable information would result from the clarification of action alternatives which could be fed into political debate. In other words, 'usable information' required a synthesis of scientific *and* policy science research. In

general, this group claimed that scientific research and policy science research had to be conducted simultaneously in order for the USGCRP to produce 'usable information.'⁶ For example, many policy makers saw the need to formulate global change policies before scientific uncertainty was eliminated. One Senator offered an amendment to the proposed USGCRP legislation to clarify the implications of a reference to the 10-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).

Representative James Scheuer 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: p. 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 type of questions raised by Representative Scheuer went unanswered and unaddressed throughout the hearings leading to the legislation establishing the USGCRP.

Several witnesses called before congressional committees did, however, suggest in greater detail implementation of a global change program that would result in clarification of action alternatives. 'Assessment' was defined before Congress by Christopher Bernabo as 'an iterative process of synthesizing and integrating technical information into a form relevant for decision-making' (HCSST, 1989). In other words, 'policy relevant scientific assessments' should be based upon what information policy makers 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 USGCRP had no planned capability for policy assessment.

William Clark testified at the same hearing that a policy relevant USGCRP would include, in addition to assessment, research into adaptation and mitigation based upon academic research into public policy (SCCST, 1989a). Extrapolating from his perspective, the USGCRP would be focused primarily on policy science 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. The USGCRP mandate did call for information on 'preventing, mitigating, and adapting to the effects of global change,' however the program had no planned capabilities to address this provision of the law (P.L. 101-606).⁷ Like discussion of assessments in the hearings, discussion of integrative strategies to produce usable information was brief and in passing.

In short, in spite of P.L. 101-606 different participants held different expectations for USGCRP performance. Some, most notably program administrators and a few in Congress, expected the USGCRP to advance global change science while others, including some members of Congress and a few scientists, expected the program to clarify action alternatives for decisionmaking. 'Usable information' – what it was, how it would be developed, for whom, and when – was largely neglected in the legislative development of P.L. 101-606. One is left to conclude that most participants either ignored the program's legal mandate or expected that a scientific understanding of global change would be equivalent to 'usable information.' In either case, as implementation of the USGCRP began under CEES following the enactment of P.L. 101-606, it is clear that the legislative process had provided the program with a mandate that would be difficult to enforce and easy to evade.

USGCRP performance

The USGCRP was conceived in 1987 by the Committee on Earth Sciences (CES) to fulfill the administrative mandate expressed in its charter.⁸ CES was established to coordinate the various agencies conducting global change research; policy issues were a secondary consideration. P.L. 101-606 subordinated USGCRP science objectives to a policy goal. Congress and the President fundamentally changed the CES mandate in 1990, but its implementation of the USGCRP did not change accordingly.

USGCRP under the Committee on Earth Sciences

CES was established in the spring of 1987 by William Graham, President Reagan's science advisor, and was chaired by NOAA administrator Dr. Anthony Calio. The CES Charter described its purpose in these terms:

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).

In spite of its stated purpose, participants had different expectations about what role CES would play in the policy making process.⁹ Within the White House Office of Science and Technology Policy (OSTP), Science Advisor Graham saw CES as a mechanism to reinvigorate the Federal Coordinating Council for Science, Engineering, and Technology (FCCSET) process within the executive branch, which had played little role in the science policy process since its creation in 1976. Federal agencies saw CES as a means of securing increased federal funding for Earth sciences, while the OMB viewed CES as a source of intelligence on federal funding for the Earth sciences, which were scattered through many agencies.¹⁰ Some within CES, including its chair, saw the committee as the administration's central science and policy coordinating body on issues of global change. These different perspectives clashed at the committee's first meeting in April 1987.

By all accounts, the first meeting of CES was a 'disaster' (Kennedy, 1992a: p. 12). At the meeting Chairman Calio presented his conception of a CES that would coordinate federal global change science and policy. 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 Calio's proposal]' (Kennedy, 1992a: p. 12). The NSF representative to the committee interpreted Calio's CES proposal as encroaching on NSF turf, which was to plan and prioritize basic science funding. The OMB representative rendered the argument moot when he declared that OMB would not allow CES to develop a program simply to increase Earth sciences funding. Another 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, 1992a: p. 13).

Calio resigned from government before CES 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: p. 2). The people still talking together included the representatives from NASA, NOAA, and NSF, each with a continuing interest in organizing a global change effort. Moreover, OMB was still interested in organizing Earth sciences research in the federal agencies for budgetary reasons.

Graham appointed Dr. Dallas Peck, director of the U.S. Geological Survey (USGS) within the Department of Interior, as the second CES chair. CES met

for the second time in December 1987, and this time the meeting was 'smooth as could be' (Kennedy, 1992b: p. 3). At the second meeting CES members established a staff working group to do the bulk of the CES work, and representatives of various agencies and the OMB voiced their different views of the CES role. Not surprisingly, the views of agency officials were consistent with the mission of their home institutions: OMB stressed the need for data on current and projected Earth sciences funding; NOAA wanted CES to emphasize environmental policy planning; and the State Department, traditionally responsible for international treaties and agreements, stated that policy issues and decisions should be the concern of the White House Cabinet-level Domestic Policy Council and not CES. Such concerns limited the role of CES to coordination of earth sciences, constrained by existing agency turf. CES 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 such information is a valuable resource in budget negotiations with Congress and the OMB. However, OMB participation in the crosscut held the promise of budget increases; this ensured that each agency's budget figures would be released to the budget office. According to a former CES executive secretary, OMB coerced agency 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 (Kennedy, 1992b: p. 6).

CES developed budget crosscuts for fiscal years 1989 and 1990.¹¹

The CES staff working group spent much of 1988 developing the first crosscut (Table 2). The task was difficult because many agencies were unsure about how a global change program would be received politically. The former CES executive secretary 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 (Kennedy, 1992b: p. 6).

Table 2. Fiscal Year 1989 USGCRP Budget Crosscut by agency

Agency*	USGCRP FY 1989 budget (\$ in millions)			
	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

* DOC (Department of Commerce), DOD (Department of Defense), DOE (Department of Energy), DOI (Department of Interior), EPA (Environmental Protection Agency), NASA (National Aeronautics and Space Administration), NSF (National Science Foundation), USDA (Department of Agriculture).

To allow agencies to show support for the initiative, yet minimize risk, CES created two budget categories. The *focused* global change budget consisted of programs explicitly addressing global change and 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 (CES, 1989b).

The first 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* (CES, 1989a).¹² About \$ 134 million, 8 percent 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 bombed politically, 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 crosscut NASA refused to classify its proposed Earth Observing System (EOS) budget as focused.

OMB was the primary beneficiary of the first crosscut. The budget document provided heretofore unavailable comprehensive budget data on the Earth sciences community in the federal agencies. However, in order to make difficult budget choices, OMB still needed to prioritize the crosscut data. Nonetheless, the first crosscut was useful to OMB because the budget agency had never had such information on Earth sciences research in the federal government. The agencies had yet to see any tangible benefits from the program because it was still unclear whether the visibility that came along with the report would result in budget cuts or increases. Hence, early in 1989 CES 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 cross-cut prepared for fiscal year 1991.

As the second crosscut process began in 1989, OMB asked CES to prioritize the crosscut by discipline (or program) in return for a promise of new Earth sciences funding. A participant recalled how OMB agreed to classify the program as the first 'Presidential Initiative' in return for the priority list: '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' (Kennedy, 1992b: pp. 7-8). In collaboration with the National Academy of Sciences Committee on Global Change CES prioritized the program's science elements in what came to be known as the 'tombstone' chart, 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 with the names of 'dead' programs. The tombstone chart has climate and hydrological systems as the program's top priority and solar influences at the bottom (Figure 1) (CES, 1989b).

OMB, armed with comprehensive budget data on Earth sciences and a priority list of projects developed through agency collaboration, next gave CES an opportunity to participate formally in the budget process. OMB requested that the agencies submit their global change research budget requests directly to CES so that CES could prepare five alternative program compositions to meet five different levels of funding. OMB would then use the CES recommendations as a template for Earth sciences funding. The CES staff working group decided that it made political sense to leave existing projects alone, so as not to antagonize the agencies, and adjusted budgets within each of the five alternatives by approving or rejecting proposed projects. CES had taken on the role of a 'virtual' budget examiner.¹³ Meanwhile, OMB had secured the addition of NASA's EOS to the USGCRP, a significant change from the first to the second CES budget crosscut (Ascher, 1993).

In summary, after a difficult beginning CES performed well with respect to its administrative mandate. It developed the USGCRP as a means to achieve the goal of budgetary coordination set forth in its charter. The Earth sciences community, the agencies, and the OMB each benefitted from the establishment of the USGCRP. OMB was able to gain greater budgetary control over the Earth science community, including NASA and its EOS program. The various federal agencies expected the creation of a large-scale program to address their various institutional concerns, and the Earth sciences community saw the establishment of a comprehensive Earth science program that had been under development for over a decade. In short, CES was a success.

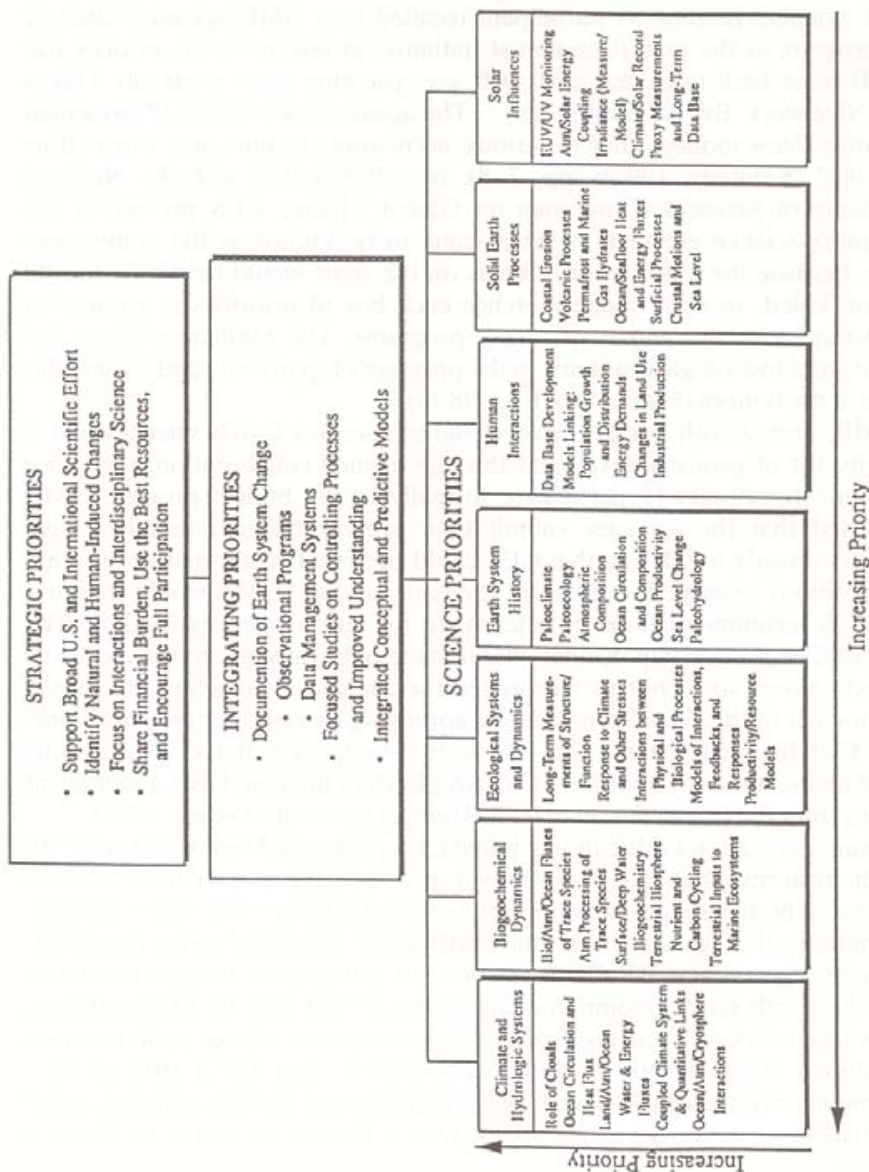


Fig. 1. The 'Tombstone' Chart.

The USGCRP under the Committee on Earth and Environmental Sciences

CEES has been characterized as using a strategy of 'non-decisionmaking' in order to achieve its goals (Lambright, 1993). However, CEES did initiate several initiatives to fulfill its legal mandate, but for various reasons each has failed to provide the 'usable information' called for in P.L. 101-606. For instance:

- In 1991, CEES created an ad hoc task group to discuss implementation of a Global Change Research Information Office (GCRIO). 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: p. 60). The Office now seeks to serve all end-users of the USGCRP (CEES, 1993).¹⁴ In this capacity, the GCRIO could be a key provider of information readily usable by policy makers. However, because it has yet to be fully implemented its capacity to address the USGCRP mandate remains limited.
- In 1992, CEES created the Research Program on the Economics of Global Change. The economics program was initiated '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: p. 15). However, the economics program has explicitly excluded policy science research, 'the short-term evaluation of specific policy proposals' (p. 3), from its purview. The program claims that it has excluded policy science research to preserve its 'credibility' and to adhere to 'scientific standards of review' (p. 3). It appears that the economics program confused policy science research with advocacy of a particular political agenda. Rather than develop one 'best' policy, the economics program could consider a wide range of action alternatives and thus maintain its credibility and scientific standards by having policy makers, and not the USGCRP, decide among them. By excluding policy research, the Economics Research Program has handicapped its ability to address the information needs of decisionmakers who depend upon 'the short-term evaluation of specific policy proposals' (Brunner, 1993).
- In 1993, the USGCRP added assessments to the program's functional architecture (CEES, 1993: pp. 6-7). According to CEES, assessments are explicitly added to the program to assist policy making: '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). Currently, however, the nature of assess-

ments in the USGCRP and how they will provide readily usable information for policy makers is unclear.¹⁵ The program needs to define what it means by 'assessment' for decisionmakers to determine if the information produced will be in fact 'usable.' In November 1993, an OTA official claimed that 'assessment is a word that has really come to mean all things to all people' (HCSST, 1994: p. 44).

The best opportunity for the USGCRP to meet its mandate ended in 1992 with the termination of the CEES working group on Mitigation and Adaptation Research Strategies (MARS), an effort worth reviewing in detail. MARS was established in January 1990, prior to the enactment of P.L. 101-606, based on a directive from Science Advisor D. Allan Bromley to CES chair Dallas Peck. MARS was to develop strategies in response to the threat of global change and membership was open to representatives of any agency.¹⁶ The working group saw its role as addressing the global change issue 'comprehensively' (1991a: pp. 12-13). In the words of the MARS working group (1991a: p. 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 mitigation and adaptation responses.

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

MARS participants considered the working group to be separate from the USGCRP. Participants considered the MARS working group and the USGCRP to be two parts of a 'U.S. Global Change Program' that would have scientific research and policy research as its two components.

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 needs 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: p. 8, emphasis added).

The MARS conception of the USGCRP is clearly at odds with the goal of the USGCRP stated in P.L. 101-606. The legislation dictated that the USGCRP was responsible for providing 'information readily usable by policy makers 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 assigned to the USGCRP the tasks that MARS had earlier been established to perform.

During 1990 MARS focused on creating its own budget crosscut to explain the various agency roles and plans in mitigation and adaptation research (MARS, 1991: pp. 29–31).¹⁷ MARS found that participating USGCRP agencies contained projects on mitigation and adaptation research totalling about \$ 9.5 million. However, OTA (1993: p. 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, the USGCRP’s instrumental objectives were 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: p. 133).

According to the OTA (1993: p. 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 in HCSST, 1993).

It is clear, however, that MARS had little chance of to fulfill the USGCRP mandate 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 as missing in the USGCRP, namely research on mitigation and adaptation to global change. However, P.L. 101–606 still contained language calling for such research.

The experience of MARS is significant for two reasons. First, because the USGCRP was, in the words of MARS, primarily a ‘basic research’ program the working group concluded that the program was limited in its capacity to develop mitigation and adaptation action alternatives. The findings of MARS are significant because several members of the full CEES and the CEES staff working group were also members of the MARS working group (MARS, 1991a). MARS served, indirectly, as one of the first evaluations of the ability of the USGCRP to perform successfully with respect to its legal mandate. Second, it is unclear whether Congress ever recognized the significance of the MARS group for fulfilling the USGCRP mandate. MARS appears to have

escaped congressional consideration or oversight, and was, in effect, legislated out of existence by P.L. 101-606. The absence of research on mitigation and adaptation strategies in response to potential global change was not missed until the program's performance became an issue in 1993 (OTA, 1993).

To summarize, the USGCRP under CEES failed to meet the provisions of P.L. 101-606 that went beyond the CES charter. When CES became CEES in 1990, more changed than simply its name: From 1987-1990, CES was supposed to coordinate federal agencies conducting global change science; from 1990-1994, CEES was supposed to produce global change information usable by policy makers. In the process, coordination of the various agencies went from an end to a means. Both committees have performed well with respect to the CES administrative mandate; however, CEES failed to meet its legislative mandate to provide usable information for policy makers. Therefore, under CEES the USGCRP existed much as it did prior to passage of P.L. 101-606. The program continued, *de facto*, to emphasize the development of a scientific understanding of global change over the clarification of policy alternatives.

Responsibility for USGCRP performance

There are three interrelated reasons why CEES failed to adapt the USGCRP to its legislative mandate and responsibility for the policy failure is shared equally among USGCRP administrators, Congress, and the Bush Administration. First, the legislative process broke down in the case of P.L. 101-606: The program's mandate was easily avoided and difficult to enforce. Second, participants in the USGCRP policy process, including scientists, administrators, and policy makers, expected that the mandate would be unenforced, and hence failed to use the law as a guide for implementation. And third, the structure of post-war science policy helped to create an atmosphere in which participants expected that enforcement of the mandate would be unnecessary. The next three sections consider in turn the legislative process, participant perspectives, and the structure of U.S. science policy.

USGCRP in the Legislative Process

P.L. 101-606 is flawed because it clearly mandates 'usable information' but neither the legislation nor the legislative process clarified what such information is or how it is to be achieved. Congress, the President, and the agencies agreed that 'the goal of the Program is to provide a sound scientific basis for developing national and international policy on global change issues' (CES, 1989a: p.3). However, when participants descended from generalities to specifics, consensus broke down on how the program's policy goal was to be

achieved, and under CEES the issue was never resolved. Congressional hearings, program reports, and public statements by USGCRP administrators indicate that 'usable information' was instrumentally defined differently by different participants: At enactment some in Congress expected the program to clarify action alternatives with respect to global change which could be fed into the process of decisionmaking; program administrators expected that the program would advance global change science. The two sets of expectations are not necessarily completely disjunct. However, the meaning of 'usable information' in the USGCRP mandate is ambiguous, and as a consequence the expectations for program performance of program officials and some policy makers have diverged.

Of course, enactment of law is only one part of a broader process of decision. Prompt and salutary execution of laws 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 adjudications (Rossiter, 1961: p. 229).

Because laws are inevitably ambiguous, evaluation of CEES implementation of USGCRP 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 in implementation. The legislative process broke down in the case of CEES: P.L. 101-606 was not used as a guide to USGCRP implementation. Hence, legislative intent was not faithfully translated into action.

Who was responsible for the breakdown in the legislative process? Congress and the Executive branch share formal responsibility for failing to oversee the program's implementation with respect to P.L. 101-606. USGCRP officials restricted their interpretation of the bills that became P.L. 101-606 to the activities of the CES. It is clear from statements of CES officials that they intended the proposed program to be a science program first, with its policy utility as a secondary consideration. Congress, on the other hand, had a mixed perception in January 1989 of what role the proposed USGCRP would play in issues of global change when the USGCRP's enacting legislation was first introduced. But Congress became increasingly frustrated in its dealings with the newly elected Bush Administration as the global change bills worked their way through the House and Senate over 22 months. Bush claimed to be the 'environmental president' but consistently emphasized research over action in the context of global change, frustrating those members of Congress interested in responding to potential environmental prob-

lems.¹⁸ These frustrations resulted in Congressional demands for the USGCRP to be the key link between science and policy by the time the bill was passed in November 1990. The remainder of this section explains in greater detail these legislative dynamics that led to the flawed USGCRP decision.

On January 25, 1989, Senator Ernest Hollings, and a number of other senators, introduced the Senate version of the bill (S. 169) that became P.L. 101-606. As introduced, the Hollings Bill *did not* use the term 'usable information.'¹⁹ The text of the bill is consistent with the activities of CES: science was the proposed USGCRP's priority goal. One month later the Senate Commerce Committee held the first congressional hearing on the bill. In that hearing Dr. Robert Corell, representing CES, characterized the priority goal of the USGCRP as follows: 'It will principally address the question: "What scientific knowledge is required to predict future change reliably"' (SCCST, 1989: p. 46)? Thus, the initial bill, which justified the USGCRP as a science program with indirect references to policy, was consistent with CES desires for the program to emphasize science over policy, much as the 1987 CES charter did.

Discussion by CES members two weeks later, during its fifth meeting on March 8, 1989, supports the interpretation that they viewed the USGCRP as a science program first, with policy as a secondary consideration. CES representatives from OMB, USDA, NSF, NASA, and State each stated that in the future the Committee, and hence the USGCRP, should deal with science, and not policy (CES, 1989c). CES, before Congress and as a group, clearly wanted to restrict the scope of the program to science and avoid considerations of policy.

The term 'usable information' was introduced with the House version of the bill (H.R. 2984) on July 24, 1989. CES officials testified before the House Science Committee three days later, and presented testimony identical to that presented at the February Senate hearing. In follow-up questions to the House hearing, the Science Committee asked Dr. Dallas Peck, CES chair, to clarify the CES position 'with respect to the proposed legislation' (HCSST, 1989: p. 249). In his reply Dr. Peck made no mention of 'usable information,' however he did reassert that 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 modelling 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: p. 250, emphasis added).

The Science Committee also asked Dr. Peck about the role of policy in CES, indicating that at that time the Science Committee did not have a clear conception of the policy role of the proposed CEES in spite of the presence of the term 'usable information' in the House bill. The Committee asked, 'Is the CES a good model for coordinating policy research? Is so, is there an existing bureaucratic entity, such as the Domestic Policy Council [in the Executive Office of the President], that could parallel the CES by coordinating policy research and assessments' (HCSST, 1989: p.248)? In reply, Dr. Peck stated that 'I would prefer not to speak for the policy community; they make their own decisions for the best structures to coordinate their activities' (HCSST, 1989: p. 252). By distinguishing between global change policy and the USGCRP, Dr. Peck indicated that the program would emphasize global change science and leave policy matters, including policy science research, to others.

The Senate passed the Hollings Bill on February 6, 1990. However, the House delayed passing its version until October 26, 1990, due to a jurisdictional dispute between the House Science Committee and the House Merchant Marine Committee (Kennedy, 1992b). During the 16 month period between the July 1989 House hearing on the proposed USGCRP and the final House vote on H.R. 2984, Congress held only one hearing on the proposed USGCRP. That hearing is illuminating because it shows the growing frustration in Congress with the Bush Administration's global change policies.

The Senate Appropriations Subcommittee, with jurisdiction over OSTP and FCCSET, held the hearing on February 8, 1990. D. Allan Bromley, science advisor to President Bush, was the sole witness. Senator Barbara Mikulski explained that the oversight hearing was called because of concerns in the Congress about the Bush administration's apparent lack 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 it 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: pp. 1-2).

Mikulski's opening statement was among the first explicitly questioning the nature of the linkage of the proposed USGCRP with global change policy making. Demands for policy development such as Senator Mikulski's created pressures for CES officials to define explicitly the role of the USGCRP in the policy process.²⁰

In the question and answer period, Senator Mikulski pressed Dr. Bromley on the relationship of science and policy in the USGCRP, noting the Bush Administration's apparent bureaucratic shell game. 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. ... [I]t looks like we were lurching from advisor to advisor. ... [W]ho is in charge?' (SCA, 1990: pp. 77–78). Dr. Bromley responded that, 'at the moment,' he linked the CES to President Bush's Domestic Policy Council (DPC) working group responsible for global change policy, providing 'essential intragovernmental cross-communication' (SCA, 1990: p. 78). The DPC working group, he continued, reported to the full DPC 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 governmentwide policy options on global warming?' (SCA, 1990: p. 80). Dr. Bromley replied that he was this person.

CES officials found it politically expedient to encourage Congress to link the USGCRP with policy as climate change became increasing political, in spite of earlier CES efforts to restrict the program to research only.²¹ Representatives of CES walked a tightrope between demands for policy action from Congress and the policy reticence of the Bush Administration. CES officials discovered that walking the tightrope meant promising policy relevance to Congress in terms of scientific research, in other words, 'usable information.' Thus, the USGCRP became explicitly linked to 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.²²

Congress failed, however, to press CES officials, including Dr. Bromley to define how science would be developed into the 'usable information' promised in the USGCRP's legislative mandate. One reason that Congress failed to define 'usable information' was its lack of attention to the USGCRP in the legislative process. Following the February 1990 Senate Appropriations hearing, there were no USGCRP oversight hearings until October 1991, meaning that Congress had held only one dedicated USGCRP oversight hearing in a period of over two years. During the two years Congressional intent for the proposed USGCRP changed dramatically: First proposed as a research program, the USGCRP became a key link between global change research and policy by the time of initial approval. 'Usable information' became equated by some in Congress with clarification of policy alternatives for dealing with global change.

The legislative dynamics of the USGCRP raise a number of questions: Why did the CES favor science over policy, but justify the program in terms of its policy relevance? Why did Congress allow P.L. 101–606 ('usable information') to remain ambiguous? Why did the Executive Branch Office of Science and Technology Policy (OSTP) not intervene? To answer such questions, it is necessary to understand the perspectives of participants in the major institutions of the global change policy process.

Perspectives

It is not surprising that USGCRP administrators proposed the USGCRP to advance their scientific and institutional interests. One USGCRP participant described the growth of global change science in the federal agencies as the work of a 'nonsinister conspiracy' of scientists and administrators.²³ The actions of the members of this 'nonsinister conspiracy' are best understood in terms of 'policy entrepreneurship' (Lambright, 1994; Kingdon, 1984). Policy entrepreneurs, like everyone else, act in ways which advance their interests as they perceive those interests to be (Lasswell, 1971). Policy entrepreneurs within NASA, NSF, and NOAA developed the USGCRP as an interagency science program to contribute to the International Geosphere-Biosphere Program, an international global change science program (Perry, 1991; NRC, 1990). And, each agency supported creation of the USGCRP in response to perceived budgetary pressures of the early and mid-1980s (cf. Edelson, 1988).

Congress failed to define how the USGCRP's instrumental objectives would result in 'usable information' and then failed to enforce the program's mandate. There are three explanations for congressional failures.

First, effective congressional oversight of the USGCRP was hampered by general unfamiliarity with the unique program outside the small circle of members with an interest in the global change issue. Many members of Congress were unaware of the size or scope of NASA's contribution to the USGCRP as late as 1991, over two years after USGCRP legislation had been first introduced. Representative Howard Wolpe, a member of the House Science Committee, stated that he was largely unaware of NASA's Earth Observing System (EOS), the single largest project within the USGCRP: '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: p. 1185). If a member of the House Science Committee was unaware of EOS, and thus likely also unaware its parent program, the USGCRP, then it is likely that members of congressional committees outside the science policy area would have even less knowledge of the program.²⁴ On congressional awareness of EOS Representative Robert Walker (ranking Republican on the House Science Committee) stated that he did not 'think there is any cognizance of the size and scope of this program in Congress or the long-term nature of it' (Rubin, 1991: p. 1185).²⁵

Second, lack of awareness is understandable because Congress is limited in its ability to consider any one issue in depth given the number of issues that it must deal with on a continual basis. In the context of the problems of global change, Congress often has too much information, instead of not enough. Congress is inundated with information on global change, but 'cannot be expected to interpret complex information which is not easily presented in an almost binary fashion' (Byerly, 1989: p. 12). In other words, Congress needs 'a message, not data' (Byerly, 1989: p. 12). That Congress asks for information it

cannot use is understandable: Decision theorists have learned 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 policy makers, for the most part, do not want to make difficult decisions about global change: Thus, they seek information in hopes that science will provide 'the answer' (Clark and Majone, 1985).²⁶

Finally, on any particular issue Congress often confuses directing money towards research with problem-solving. Congress has traditionally focused its efforts on 'priority setting' on the input side of the science-policy relationship (OTA, 1991), although program performance, or the output side, has been of increasing concern in recent years (HCSST, 1992b). The logic of congressional science policy at the time of USGCRP approval was that the higher the priority, the bigger the input, and the greater chance that the problem will be solved. Representative Don Ritter 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: p. 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: p. 10).

In short, members of Congress are burdened by an unending supply of information, which they nevertheless seek in hopes of obviating difficult decisions. Congressional attention is focused only briefly, if at all, on any one issue. Emphasis on the input-side of the science-policy relationship created disincentives for Congress to oversee the USGCRP rigorously once it had been approved. For these reasons, Congress failed to adequately define and enforce the USGCRP mandate.

OSTP, another key institutional participant in the formation of the USGCRP, also failed to ensure that P.L. 101-606 was adequately defined. The president's science advisor, who also is director of OSTP and was chair of FCCSET, is a key interface among 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 science advisor is pulled at least three different ways. First, within the White House the science advisor is responsible for the president's political needs. Second, as director of the Office of Science and Technology Policy, the Science Advisor is responsible for offering 'think-tank' type advice to Congress and the President (Prager, 1988). Finally, the Science Advisor is viewed by the science and technology community, including the federal agencies, as the chief defender of their interests. These different roles create an environment

in which the science advisor is less concerned about matters of public policy, such as whether the mandate expressed in P.L. 101-606 is well-defined, and more concerned about satisfying other congressional, presidential, and agency demands.

Other high-level officials in the executive branch also failed to address the flaws of P.L. 101-606. The Bush Administration's lack of a clear policy on global change contributed to CEES failure to meet its goal set forth in P.L. 101-606 (cf. GAO, 1990).²⁷ 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: p. 85). It is unclear if, or to what extent, the Bush Administration explicitly acted to thwart the provisions of P.L. 101-606. It is clear, however, that the Bush Administration's informal science policy advisory system – led on the climate issue by Chief of Staff John Sununu (Vig, 1994) – discouraged congressional attempts to oversee global change policy and thus did little to ensure CEES compliance with P.L. 101-606. 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 while control over global policy never left the White House inner circle.

USGCRP administrators, members of Congress, and executive branch officials – these groups each considered a piece of the global change puzzle: administrators were concerned with science and their institutions, Congress with legislating, and the executive branch officials with politics. However, no one considered how administration, science, and politics would be integrated and translated into usable information for policy. CEES failed because *everyone* in the USGCRP process failed to consider the law as the basis for program implementation.

Structure

The structure of U.S. science policy underlies the USGCRP 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.²⁸ 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 which can be tapped and applied to national needs. Third, in order that the fountain of knowledge flow freely, science must proceed unfettered. Based on the three assumptions, 'science is a proper concern of government' (Bush, 1960: p. 11). The social contract suggests that the relationship between science and society should become continuous and stable because science would inevitably show social benefits (Bush, 1960). In other words, the social contract would validate itself over time.

The USGCRP is an example of the social contract. Because the program separated science from policy, the program was designed to provide a reser-

voir of global change knowledge which policy makers could tap in the process of policy formulation. Under the logic of the social contract, it would be unnecessary to enforce the USGCRP mandate so long as the program was producing 'good science.' It is logical then for Congress to largely abdicate oversight of the USGCRP to the scientific community, which is better qualified to assess the quality of science within the program.

The structure of modern U.S. science policy, therefore, created an atmosphere that diminished policy maker attention to the promises of the USGCRP. Because policy makers and program officials failed to reach consensus on expectations for program performance, the USGCRP has been largely unaccountable. When policy makers demand 'usable information,' the USGCRP responds with 'good science.' But when 'good science' is judged not equivalent to 'usable information,' there are no means to bridge the gap. Moreover, policy maker demands of the program have been free to change with prevailing political winds, while program administrators have at the same time, been largely free to follow agency and scientific interests. In this situation there is a tacit belief that somehow policy maker demands and administrative interests will intersect and the USGCRP will, in the end, meet its mandate.

Alternative explanations

Congressional fragmentation

A common explanation for the CEES performance shortfall is that the USGCRP has suffered because of the fragmented nature of Congress. The 1993 OTA evaluation of the USGCRP argued that congressional fragmentation hinders program performance:

The USGCRP budget falls within the jurisdiction of several congressional authorization and appropriations committees and subcommittees. With all of these committees 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: pp. 121–122).

The report suggests that Congress consider 'an ad hoc appropriations subcommittee' to review the entire USGCRP budget and concludes that 'large, interagency programs such as the USGCRP will require innovative methods of funding if they are to succeed' (OTA, 1993: p. 122). Such concerns are not new. For instance, in 1990, prior to USGCRP approval, 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?' (Smith and

Justus, 1990: p. 32). Congressional fragmentation did affect CEES but was not a factor limiting its performance with respect to P.L. 101-606 for the following reasons.²⁹

Congress is fragmented. Perhaps no program illustrates congressional fragmentation as well as the USGCRP. Agencies in the program are overseen by 14 House and Senate authorizing committees and seven appropriations subcommittees in each chamber (OTA, 1993a: p. 124). However, congressional reorganization is unnecessary to improve oversight of the USGCRP. Virtually any government 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 many different issues, and not to optimize any particular one. Congress does not need an ad hoc appropriations committee to oversee the USGCRP because Congress already has a clear line of authority over the program: CEES was responsible for program performance, and the House Science and the Senate Commerce Committees had CEES oversight jurisdiction. CEES also fell under the jurisdiction of the House and Senate VA/HUD Appropriations Subcommittee. These four committees have had authority to oversee the USGCRP 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 policy makers.³⁰ The resumption of Congressional oversight in 1993 and 1994 is evidence that congressional reorganization is unnecessary to improve USGCRP performance.

Can Congress do a better job of overseeing the USGCRP? Certainly. Has its organization limited its ability to oversee the program? No. Oversight hearings begun by the House Science Committee in 1993 have directed attention to USGCRP performance. In response to renewed Congressional oversight, USGCRP officials have sought to improve the program's performance with respect to P.L. 101-606, indicating that program failures are due more to lack of attention to the program's performance with respect to its mandate rather than an inability to oversee the program due to its interagency structure.

Administrative pluralism

Some analysts claim that the USGCRP suffers from 'administrative pluralism' or, in other words, agency interests detract from the collaborative effort, and hence program performance.³¹ Administrative pluralism implies that the various participating agencies pursue their own agendas, and thus sacrifice the integrative nature of the program.³² Administrative pluralism is also called 'imbalance' of funding among agencies. The National Research Council (NRC) warned in its 1990 evaluation of the USGCRP that 'imbalance' among agencies could hurt the program's performance. Concerns about administrative pluralism have surfaced also in USGCRP oversight hear-

ings. For example, Representative Rick Boucher (D-VA) expressed concerns in a 1991 USGCRP oversight hearing that agency interests were hurting the program's performance when he stated that 'the problem ... 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: p. 79). In other words, he was worried about agencies putting their missions ahead of the shared objectives of the USGCRP.³³ The record shows that neither administrative pluralism nor imbalance among agencies is responsible for the CEES performance shortfall. Imbalance between scientific research and policy science research, however, was the essence of the performance shortfall.

The example of imbalance most often cited is that between NASA and the rest of the agencies. NASA has been the beneficiary of most USGCRP funding since program inception. Most of NASA's USGCRP funding is budgeted for the Earth Observing System (EOS), a large-scale satellite program within NASA's Mission to Planet Earth (MTPE) program (Lambright, 1994). EOS was not part of the focused USGCRP until 1991. It joined the USGCRP because OMB wanted greater control over the program and CEES members wanted to ensure NASA participation in the USGCRP. According to one CEES 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: p. 10).

Another CEES member explained what paying the consequences meant:

If you look at the global change budget, you see this great thinking 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: p. 10).³⁴

However, OMB saw benefits in including NASA's MTPE in the USGCRP. For example, OMB used the CEES structure to compel NASA to subject EOS to independent review in 1991 (Kennedy, 1992a; OTA, 1993b). Many participants remain concerned about the relationship of NASA to the rest of the USGCRP.

Of course, the USGCRP was imbalanced in that it neglected research related to mitigation, adaptation, and prevention aspects of global change. This was the crux of the performance shortfall. Administrative pluralism or imbalance among agency budgets, however, did not affect adversely USGCRP performance under CEES. The success of CEES (and its pre-

decessor CES) in producing the USGCRP budget crosscuts is evidence in support of assertions that USGCRP performance did not suffer because of agency infighting. Due largely to successful coordination of agency budgets, CES and later CEES have been recognized by observers inside and outside the global change community as a model for interagency cooperation (Lambright, 1993).³⁴ 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 CEES model (Goodwin, 1993).

Recommendations to correct administrative pluralism and imbalance generally return to the issue of fragmentation. For instance, OTA argues that balancing NASA's part of the USGCRP with other agencies is difficult 'because the USGCRP does not have a program budget' (1993: p.132). A program budget refers to a comprehensive, top-down approach to USGCRP budgeting, as opposed to the current program structure where each agency retains significant control over its contribution to the program. A program budget would require that Congress organize itself such that the USGCRP could be reviewed as a single program, which was dismissed above as unnecessary to improve USGCRP performance with respect to its legal mandate.

Good science = usable information

A third alternative explanation of program performance argues that the program is performing as well as can be expected because good science is usable information, reaffirming the logic of the 'social contract.' However, this argument is flawed in at least two respects.

First, the science to be produced by the USGCRP is insufficient for the needs of rational policy. Scientific information is relevant to policy when it helps in clarifying goals, describing trends with respect to those goals, accounting for observed trends, projecting a realistic range of scenarios, or leading to the development of action alternatives (Lasswell, 1971). The USGCRP emphasizes the development of a predictive understanding of global change, which will likely contribute some useful information to policy, but as Brunner (1991: p.297) argues, 'a predictive model of the integrated Earth system is not sufficient for rational decisions on global warming.' He continues, arguing that science provides only part of the logical requirements of policy making:

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.

To be sure, the USGCRP, as implemented by CEES, would have contributed some useful information to decision makers. However, it would have contributed insufficient information for the needs of rational policy making, and the useful information that it would have produced would not have been provided in any systematic manner. The program lacked the continuous integration of knowledge to produce action alternatives.

In perhaps the most authoritative evaluation of the USGCRP, the OTA (1993: p. 111) found the program to be lacking in three particular areas: 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.' The OTA reached this conclusion despite finding the program 'scientifically well-grounded' (1991: p. 110). For these reasons, under CEES the USGCRP had the potential to succeed with respect to its scientific objectives, but fail with respect to its legislative mandate to provide usable information for policy makers. This was possible because good science does not equal usable information. As Brunner (1991) suggests, policy decisions usually require more than what science can provide (cf. March, 1982). Etzioni (1968: p. 170) stated the case in general: 'Decision-making ... 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.' It is likely that future attempts to modify the USGCRP to meet its mandate, including the implementation of integrated assessments, will also fail to provide usable information if they do not address the policy requirements of global change decisionmaking overlooked by the USGCRP and identified by the OTA and others.³⁶

Second, even if policy makers had instant access to all new scientific information, policy decisions would be neither obvious nor easy to reach. Often, the argument that good science equals usable information is cloaked in demands for better communication between scientists and policy makers or the public. The logic of such arguments goes as follows:³⁷ 'Science collects facts about the natural world. Policy makers use such facts to make decisions about the allocation of values in society. Therefore, policy is best made when policy makers have at their disposal valid and reliable information at the frontiers of knowledge.' Scientific information need not be certain, the argument adds, as long as the level of uncertainty is known. The implication of this line of reasoning is that good policy occurs when science is independent of, but fed into, the decisionmaking process. When 'good science' exists, attention is then focused on improving 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 policy making could not be improved

by better communication between scientists and policy makers or scientists and the public. Rather, scientific communication is not a limiting factor in the ability of the USGCRP to provide usable information because policy making is a process of bargaining, negotiation, and compromise in pursuit of policy goals for which scientists and the scientific method provide little assistance. The USGCRP under CEES failed to provide usable information for policy makers because it has neglected to address the needs of policy makers involved in a political process: The program did not provide assistance to policy makers in the form of action alternatives which could be fed into political debate. The OTA (1993: p. 118) identified the shortfall in the form of questions neglected by the program:

What are the implications [of climate change] 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?

These questions cannot be answered by the scientific information on predicting, monitoring, or understanding the global Earth system that the USGCRP under CEES was designed to provide. Better communication would not have addressed the fact that the program was not structured to provide usable information in terms of action alternatives.

Politics

A final explanation for the CEES failure is that the Bush Administration's reticence towards policy making with respect to global change is sufficient to explain the USGCRP performance shortfall. Although the Bush administration's policy reticence contributed to the CEES failure, 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 policy mandate of P.L. 101-606. In addition, with effective evaluation of the USGCRP with respect to its legal mandate, 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, the single factor explanation of the CEES performance shortfall fails.

Other appraisals: Good science but not policy relevant

Most other evaluations of the USGCRP are consistent with the findings presented here. In addition, while evaluation of the science elements within the USGCRP goes well beyond this evaluation, most evaluations of the program's

scientific performance agree that the USGCRP is largely succeeding in its goal of producing 'good science.'³⁸ Early appraisals suggested that the program would face difficulties delivering on its mandate. For example, in an early report the National Research Council (1990) assessed the USGCRP program plan and found that the program would be unlikely to deliver on its policy goal without additional direction. Other early assessments of the USGCRP plan came to similar conclusions.

For example, in 1991 Rubin et al. warned that the USGCRP could wind up producing much scientific information, but not much of use to policy makers. In May 1993, a House Science Committee hearing was called to evaluate the program with respect to its legislative mandate. Witnesses agreed that the USGCRP appeared to be producing good science while failing to be policy relevant. The hearing was also significant because it was the first time during congressional oversight hearings that the program's legislative mandate was explicitly used as a benchmark of program performance. Most recently, in 1993 the OTA published a critique of the USGCRP, entitled *Preparing for an Uncertain Climate*. Like other evaluations, the OTA found the USGCRP to be producing good science, but likely to fail to provide policy makers with the information needed to respond to the potential threats of global change (OTA, 1991: p. 111).

USGCRP after CEES

On May 17, 1994, John Gibbons, science advisor to President Clinton, signed the charter to the Committee on Environment and Natural Resources (CENR), replacing the CEES. The CENR is one of nine committees under the National Science and Technology Council (NSTC) which was established by President Clinton in November 1993 to replace FCCSET.³⁹ The establishment of the NSTC fulfilled a recommendation of Vice President Gore's report on 'reinventing government.' Gibbons, in the CENR charter, claims that the CENR creation 'is in the public interest in connection with the performance duties imposed on the Executive Branch by law' (CENR, 1994). Will the creation of the CENR lead to USGCRP success with respect to P.L. 101-606 or are changes simply cosmetic?

There is reason for optimism. In testimony before the Senate Committee on Energy and Natural Resources on March 30, 1993, Science Advisor Gibbons stated that the USGCRP needed improvement. He identified two areas where the program had flaws.

First, there are big gaps in the research program that need to be filled. We need to expand research on the effects and impacts of global change, including research on human health, settlements, and societal responses. ... We need to know more about potential mitigation and adaptation strategies to help us face inevitable changes, and we need a sharper focus on development of technologies to implement those strategies.

Second – but no less important – we have to better integrate research with policy making. Research has to be directed toward answering current and anticipated policy questions; and policy has to respond to new research results. ... We intend to give the Federal Government an integrated process for developing and reviewing meaningful options to address global environmental change issues (SCENR, 1993: p. 12).

The CENR was established to provide the 'integrated process' that Gibbons referred to. Based on Gibbons' testimony, it appears that the Executive Branch has identified flaws in USGCRP and is set upon correcting them. For instance, in 1994 the NRC called for 'research on the decision-making process,' noting that 'scientific research is of little practical value if it does not address the issues that matter to decision makers and reach them in a useful form' (NRC, 1994: pp. 15–20). And the NSF has developed a program for policy science research with respect to global change.

Yet, there is reason for caution as well. In its 1995 fiscal year research plan for the USGCRP, the CENR identified a need 'to strengthen the science/policy linkage,' but failed to address explicitly how this would be accomplished (CENR, 1994: p. 6). The report admits that 'in order to be of more assistance to governments, USGCRP results need to be better communicated in a way that contributes directly to the formulation of domestic policy and to the development of international protocols and conventions' (CENR, 1994: p. 80). The report claims that the program will achieve better communication through the development of 'integrated assessment capabilities' and 'decision tools and analytic approaches,' but discusses these terms in only a general way (CENR, 1994: pp. 82–84). The program has yet to define how these additions to the program will produce 'usable information.' Therefore, it is unclear whether recent changes to the program will produce 'usable information' for policy makers as required by P.L. 101–606.

Recent changes in the USGCRP give hope that the program will be judged successful with respect to P.L. 101–606. For this to occur, program officials need to define explicitly how the information it produces is 'usable' and by whom. Congress needs to continue to reassert oversight of the program with respect to the law. Finally, Executive branch officials must exercise administrative oversight of the program with respect to the provisions of public law. An opportunity for oversight will be presented when the USGCRP releases a 10-year research plan, as required by P.L. 101–606 (CENR, 1994: p. 4). This document could go a long way towards resolving what 'usable information' is and how the program will produce it. Congress must ensure that the document is specific enough to allow for solid judgements of success and failure with respect to the program's legal mandate.

Summary and conclusion: A need for accountability

The USGCRP under the CEES failed to perform as promised for the following reasons. First, Congress and the Executive Branch failed to enforce P.L. 101-606, which required the USGCRP to provide policy makers with 'usable information.' Second, as a result, participants in the USGCRP have pursued 'usable information' as defined within particular institutional or disciplinary contexts. For example, USGCRP administrators have defined 'usable information' in terms of science, while some policy makers have defined 'usable information' in terms of the clarification of alternatives for action. Third, these different sets of expectations were not recognized because of the paucity of congressional and administration oversight of the program. Oversight which did occur has failed to address the issue of program performance with respect to P.L. 101-606. Recent actions by the Clinton Administration and renewed congressional oversight activity give hope that these flaws are being corrected.

There is a complex tapestry of explanations for USGCRP performance, of which several important threads involve the roles of participants in the legislative process and their perspectives. Congress, the Executive, and the agencies share responsibility for the program's policy failures. The structure of contemporary science policy also underlies the failure of the USGCRP. The USGCRP was initiated under an implicit assumption that the mere existence of a global change research program was what mattered most in the resolution of problems presented by global change. Political, agency, and scientific contexts of the USGCRP contributed to the tacit acceptance of this logic. Therefore, little attention was paid by policy makers prior to legal enactment to exactly what the proposed program was to achieve, and consequently, little attention was paid to the program's performance following enactment.

The USGCRP is a vivid example of the limitations of science in the resolution of social problems. The program has been widely judged by scientists as expanding the frontiers of knowledge, but at the same time policy makers have found its contributions to decisionmaking wanting.

If the USGCRP is to overcome its performance shortfall, scientists and policy makers alike need to reconsider the role of research in the policy process. Policy is too often equated with 'politics' and all of the baggage that comes with that term. Effective and efficient policy making requires that a range of action alternatives be available for policy maker consideration. To produce 'usable information,' the USGCRP needs to be designed to produce a wide range of policy action alternatives from which policy makers can choose to answer one question: What, if anything, can and should be done? The USGCRP must not be designed to advocate any particular policy or to put agencies in the position of advocating any particular policy. This is what 'politicizes' science programs. The program can, however, avoid becoming 'politicized' by developing a wide range of action alternatives to feed into political debate. Policy makers, with a wide range of alternatives to choose

from, can engage in the political activities of bargaining, negotiation, and compromise that are necessary to achieve common interests under the U.S. Constitution.

The case of the USGCRP illustrates the vital role of accountability in the policy process. Accountability here would have required the following two conditions: First, Congress and the USGCRP administrators would have agreed on instrumental objectives for the program. That is, there would have been a convergence of expectations for program performance. In the USGCRP legislative process these might have been either the development of a scientific understanding of global change or the development of action alternatives (or some a balance between these). Second, under the provisions of P.L. 101-606, these performance objectives would have guided congressional oversight of the program. If a mismatch between the law and program implementation had been detected, then either the program could have been adjusted to better meet the law, or the law could have been modified to reflect actual program performance. Either route is acceptable under the U.S. Constitution. Congress has clear lines of authority over the USGCRP; the failure of Congress was in not using that authority. Under CEES these two conditions did not occur, and the program was thus not held accountable to performance promises.

CEES, by failing to meet the provisions of P.L. 101-606, was unaccountable to Congress. At the same time, however, members of Congress have failed to faithfully carry out their responsibilities. For accountability to occur in practice requires leadership in Congress, in the White House, and in the agencies. The USGCRP is a clear case where leadership with respect to public law 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 in response perform as mandated. The gap between the words in P.L. 101-606 and the action in its implementation is an example of the 'performance deficit' (Gore, 1992: p. 2) that has undermined public faith in government (cf. Brunner, 1994).

In broader context, the USGCRP experience should serve as an indication that the post-war social contract between science and the rest of society is not valid in all contexts. Problems of modern society, of which global change is one, are difficult to solve. Despite our wishes, such problems cannot be solved by science alone – they must be addressed through the integration of scientific information with conflicting values in various contexts. To put the burden of social problem solving upon the shoulders of science alone will, in the long run, hurt both science and society.

Finally, the case of the USGCRP should be taken as a caution to those who are working to 'reinvent government.' A lesson of the USGCRP is that program performance is often as much a function of securing promises which are enforceable, as it is of measuring program output. In addition, program performance means little if it violates the principles of accountability set forth in the U.S. Constitution.

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Notes

1. When agency programs which contribute to the USGCRP are added, the total in 1993 was \$ 2.7 billion, more than the superconducting supercollider and NASA's space station combined (AAAS, 1992; FCCSET, 1992). Funding for the supercollider and NASA's space station totaled about \$ 2.6 billion in 1993 (Marshall and Hamilton, 1992).
2. The total is \$ 12.7 billion if the program's contributing elements are included.
3. According to the Office of Technology Assessment (OTA) '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 decision makers to respond to global change' (OTA, 1993: p. 111).
4. The answer of Dr. Robert Watson, of NASA, to written questions submitted by Senator Hollings in SCCST (1988: pp. 90-94) follow a similar line of reasoning.
5. Not all calls for answers or reduced uncertainty support this interpretation. Some policy makers called for more research in order to maintain the status quo with respect to global change policy or to demonstrate some other predetermined conclusion. Such calls for research were often labelled 'policy-driven.' See, for example, the discussion between Senator Al Gore and D. Allen Bromley in SCCST (1991).
6. Dr. Corell may have contributed to the ambiguity of the USGCRP mandate by testifying before Congress that integration of science and policy in the context of global change required new ways of thinking, seeming to contradict earlier statements: "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 policy making, we see a need to work in parallel" (SCCST, 1989a: p. 63-64).
7. An exception is the Mitigation and Adaptation Research Strategies subcommittee which is discussed at length below.
8. The USGCRP was implemented by a subcommittee of CES/CEES. To simplify the discussion, references to CES/CEES refer to the subcommittee responsible for USGCRP, unless otherwise noted.
9. The primary sources for the material in this section are Kennedy (1992a and b), Lambright (1993), Perry (1991), and minutes of CES/CEES meetings. Kennedy (1992a and b) were prepared as part of Harvard University's Kennedy School of Government Case Program.
10. The term 'Earth sciences' refers to research on all aspects of the planet's systems, and is referred to as 'Earth system science' in the global change community.

11. CEES continues to produce budget crosscuts. They are published annually as the *Our Changing Planet Series* (CEES, 1989–1993; CENR, 1994b).
12. A more detailed version of the report was released in July 1989 (CES, 1989b).
13. 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 CES was created, in effect, to fulfill the role of a budget examiner. CES was thus doing some of OMB's work for them.
14. 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 Dr. Robert Corell in HCSST (1992: 18–44).
15. For example, Bernabo in HCSST (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 improves on the current predictive focus of the USGCRP. Cf. Brunner (1991) and OTA (1993).
16. Bromley discussed the creation of the MARS working group at a CES meeting on 21 December 1989, according to CES (1990). Members of MARS were, predictably, representatives of agencies who also participated in development of the USGCRP.
17. OTA (1993: 134–135) reproduces the MARS cross cut.
18. On Bush Administration emphasis of research over policy see, for example, Roberts (1989).
19. 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: p. 18, emphasis added). SCCST (1989: pp. 14–28) reprints the entire text of the bill.
20. On congressional wrangling with the Bush Administration see, for example, SCFR (1989), HCA (1990), GAO (1990), and Vig (1994).
21. 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. Dr. Bromley used the proposed Intergovernmental Panel on Climate Change (IPCC) as an example of an 'interface between science and policy,' a phrase that came to characterize the USGCRP following enactment (SCA, 1990b: pp. 233–234).
22. The 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: p. 110) argues that 'the primary questions of policy makers 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; however, the OTA neglects to observe that congressional demands of the USGCRP changed during 1989 and 1990, primarily due to conflicts with the Bush Administration.
23. John Perry quoted in Edelson (1988: p. 10).
24. And also in the Senate where fewer members means that each is required to cover a greater number of issues.
25. Smith and Justus (1991: pp. 6–8) document 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.
26. Feldman and March (1981) argue also that decisionmakers seek more information than they can use to avoid being surprised by the unknown.
27. 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.

28. The social contract is based upon a 1945 report entitled *Science: The Endless Frontier* and is chronicled in Kevles (1977) and England (1980). See also Brunner and Ascher (1992), Smith (1990), and Atkinson and Blanpied (1985).
29. This is not to say that congressional fragmentation is not of broader concern, only that it does not account for the CEES performance shortfall.
30. President Clinton's recent reorganization of the FCCSET structure should not affect oversight of the USGCRP because it remains in the same congressional jurisdiction.
31. Lambright and Changnon (1989) use the concept 'administrative pluralism' to explain the failures of planned weather modification programs.
32. It is important to distinguish between imbalance among agencies and imbalance among disciplines. The program has clearly favored scientific research over policy research and some areas of scientific research (e.g., space-based) over others. This section refers to agency imbalance.
33. Imbalance is cited in many contexts; however, the example of imbalance most often cited in that between NASA and the rest of the agencies (e.g., NRC, 1990; OTA, 1993). NASA has been the beneficiary of most USGCRP funding since program inception with most funding budgeted for the Earth Observing System (EOS) within the Mission to Planet Earth program.
34. See also Rubin (1991).
35. 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: p. 44).
36. See particularly Brunner (1991, 1993).
37. This is a variation of the linear model of the relationship between science and society which for many years has been dismissed as misleading and inaccurate (e.g., Wise, 1985).
38. In general, evaluations of the program have been incomplete and based on anecdotal evidence. The author has identified through 1993 over 25 evaluations or partial evaluations of the USGCRP relevant to its mandate of providing 'usable information.'
39. The NSTC was established by Executive Order 12881, November 23, 1994.

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