AMS Case Study:
Preparing Assessments that Evaluate the Impacts of Climate Change on the United States

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This case study considers the challenge of identifying, researching, summarizing, evaluating, and adapting to the likely consequences of climate change on the United States.[1] As background for ultimate consideration of the question of what steps to take in the future, this note provides a very brief overview of the scientific development of this issue and then a description of two previous periods (1985-1990 and 1995-2000) when this general issue was addressed in a pioneering and insightful way by US decision makers in the Congress and Administration, respectively. By providing a brief synopsis of what occurred during those two periods (and there is no attempt here to be complete), it is hoped that the lessons of what was done and consideration of the effectiveness (or lack thereof) of the efforts can serve to improve the choices to be made over coming months for providing the most useful possible information to decision makers and the public. To prompt your input to developing a plan for future actions that should be taken, some comments about how various steps worked are contained in the footnotes, and the final section of this write-up identifies a number of issues and questions.

Scientific and Institutional Background

In the 1860s, James Tyndall was the first to propose that changing the atmospheric composition could alter the climate. In 1896, Sweden's Svante Arrhenius published an initial calculation indicating that the increasing CO_2 concentration resulting from human activities could eventually increase the global average temperature by a few degrees. Between 1938 and 1949, the UK's George Callendar published his findings indicating that both the atmospheric CO_2 concentration and global average temperature were increasing, drawing the conclusion that these changes were due to human activities. In 1957, Roger Revelle and Hans Seuss identified the mechanisms limiting the uptake of the CO_2 emitted into the atmosphere. This finding laid to rest the contention of many doubters that the oceans, with their vast carbon stores, would simply take up any CO_2 emitted by human activities. They suggested, therefore, that the changes in the atmospheric CO_2 concentration being caused by human activities amounted to a "large-scale geophysical experiment" that would have long-term consequences.

Prompted by their improved understanding of the carbon cycle, Revelle prompted Charles D. Keeling to begin measuring the atmosphere's changing atmospheric composition. With the

[1] Simultaneously, there was growing research attention and public and decision maker interest in a broad range of global environmental issues, including: seasonal-to-interannual variations in the climate (e.g., El Niño events); depletion of stratospheric ozone: deforestation, invasive species, and impacts on biodiversity; etc. To maintain focus, this discussion is limited to the challenge of dealing with climate change, but participants should keep in mind that the actions and approaches undertaken needed to, and still need to, deal with global change, broadly defined.

urging of and funding from Harry Wexler, Keeling began taking regular observations in 1957 at the Mauna Loa Observatory in Hawaii. By the early 1960s, these observations indicated that there was both an annual cycle in the Northern Hemisphere's CO_2 concentration (due to the seasonal greening of the planet) and an underlying increase that indicated that roughly half of the CO_2 emitted by human activities was remaining in the atmosphere. This finding, and associated studies with atmospheric radiation models, formed the basis of an appendix in the 1965 report of the President's Science Advisory Committee that was prepared by a panel chaired by Revelle, and composed of Keeling, Wally Broecker, Harmon Craig, and Joe Smagorinsky. The panel made clear that there was a sound basis for concluding that human activities are responsible for the increasing CO_2 concentration and that the rising CO_2 concentration would inevitably lead to global warming. The panel recommended augmented research efforts and attention to this environmental issue. By the early 1970s, a number of international groups, some of which advised the UN, had come to the same conclusion.

As recommended, research efforts were intensified during the 1970s. NOAA and NASA focused their research on expanding the observational data sets and building and improving climate models that could calculate the changes in climate from specified changes in the CO_2 concentration. Recognition that chlorofluorocarbons (CFCs) appeared capable of depleting the stratospheric ozone layer drew NASA and DOT led to research on stratospheric chemistry and perturbation of the ozone layer. Unusually cold winters in the mid-1970s led NOAA to emphasize research on understanding seasonal variations and fluctuations. With so much going on, Congress created an interagency climate office under the leadership of NOAA, set up so that each agency had distinct responsibilities, with an office in NOAA responsible for keeping track of what each agency was doing. NSF joined NOAA and NASA in funding research and modeling studies and NASA began planning for a major, wide-reaching research effort on understanding Earth system behavior. The new Department of Energy set up a focused program on the potential climatic and environmental consequences of CO_2 emissions, and built up a substantial research effort on the carbon cycle and climate modeling and supported exploratory efforts on potential environmental and societal impacts. In 1979, DOE contracted with the AAAS to organize a major workshop on climate impacts that identified research needs in a number of different areas; this proposed expansion of research to consider likely impacts and the potential for adaptation collapsed when the incoming Reagan Administration's Secretary of Energy (former head of a School of Dentistry) cutback and transferred control of the program within the Department.

Internationally, the first World Climate Conference in 1979 agreed on two thematic areas for international research: seasonal variations in the climate and long-term climate change. To organize international efforts, the World Climate Programme was organized. The World Climate Research Programme, later joined by the International Geosphere-Biosphere Programme and even later by the International Human Dimensions Programme, have since driven the research efforts aimed at improving understanding of how the climate system works and of the coupling of climate to the biosphere and society. Major projects were organized focusing on the atmosphere and oceans, generating very large field activities, and major cooperation began on building a comprehensive satellite observation system.

As a result of the increasing level of scientific activity, new results started to emerge. Updated analyses of changes in global average temperature indicated that the Northern Hemisphere had likely been cooling from the 1940s to early 1970s, leading to a flurry of media attention in the mid 1970s focused on the possibility that the growing atmospheric burden of

particulate matter might induce enough cooling to trigger onset of an ice age (note, however, that there was simultaneously significant consideration of the coming warming influences—by no means was the cooling projection a widespread consensus). Observations from around the world confirmed that the CO_2 concentration was rising, and isotopic studies of ^{14}C proved much of the increase was due to burning of fossil fuels. Satellite observations suggested that there were high rates of tropical deforestation that would also be adding CO_2 to the atmosphere. V. Ramanathan and colleagues pointed out that the rising concentrations of several additional gases, including methane, nitrous oxide, and the CFCs, would also exert warming influences on the climate. Summary reports on the research findings were published by the NRC in 1983 and by the Department of Energy in 1985—the problem was real, although there remained significant uncertainties and problems of credibility of reports coming from single agencies, especially agencies with vested interests in the outcome.

Receiving these reports and others from around the world, the World Meteorological Organization and United Nations Environment Programme convened a meeting of leading scientists and leaders of environmental agencies from nations around the world in Villach, Austria in 1985. The main recommendation of that conference was:

> "Many important economic and social decisions are being made today on long-term projects, major water resource management activities such as irrigation and hydro-power, drought relief, agricultural land use, structural designs and coastal engineering projects, and energy planning, all based on the assumption that past climatic data, without modification, are a reliable guide to the future. This is no longer a good assumption since the increasing concentrations of greenhouse gases are expected to cause a significant warming of the global climate in the next century. It is a matter of urgency to refine estimates of future climate conditions to improve these decisions."

1985-1990: Initial Organization of the US Interagency Response

Faced with the growing recognition of the likelihood of human-induced climate change and that its consequences would significantly impact the environment, coastlines, and societies around the world, decision-makers in the US faced the following issues:

1. How could the US research effort be better organized nationally to advance the state of understanding of climate change?
2. What role should the US play in the international research effort to advance the state of understanding of climate change?
3. What needed to be done to improve understanding of the impacts of climate change?
4. How should evaluation and presentation of the findings be organized to best provide information for decision makers and the public, nationally and internationally?
5. What could be done to start building up the set of options for slowing the pace of climate change?

Actions Taken:

1. Spurred by Congressional hearings on the climate change issue, an interagency team was set up under the White House science adviser to propose a cooperative program on global change research; in 1990, this effort was formalized through enactment of the Global

Change Research Act (GCRA). The GCRA defined global change as encompassing issues well beyond simply climate change,[2] established the Committee on Earth and Environmental Sciences (CEES) that in turn established the Subcommittee on Global Change Research (SGCR), [3] called for a plan for an interagency research and data management program, called for periodic conduct of impact assessments, and, in its only link to mitigation,[4] set up the Global Change Research and Information Office to disseminate information about global change generated by US agencies and research programs.

2. The research plan that was developed identified both strategic and integrating priorities and was organized around a set of key uncertainties in a set of seven prioritized disciplinary areas: climate and hydrologic systems, biogeochemical dynamics, ecological systems and dynamics, Earth system history, human interactions, solid Earth processes, and solar influences.
3. US research managers actively encouraged and promoted participation in major field-oriented research projects of the World Climate Research Programme, and formation of the International Group of Funding Agencies to ensure cooperative international funding of what needed to be done.
4. The US actively encouraged formation of the Intergovernmental Panel on Climate Change and its three Working Groups, with the first IPCC assessment being completed in 1990. The White House Conference on Climate Change was organized, and President Bush (senior) said the greenhouse effect would be solved by the White House effect; he initiated the US Country Studies Program that ultimately helped over 50 nations to prepare national greenhouse gas inventories and initiate impact studies.
5. The NRC organized a major study on the *Policy Implications of Greenhouse Warming*, and was funded to both assist in development of research programs and to carry out analyses of research gaps and program performance.

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[2] The GCRA defined "global change" as "changes in the global environment (including alterations in climate, land productivity, oceans or other water resources, atmospheric chemistry, and ecological systems) that may alter the capacity of the Earth to sustain life."

[3] Involving the research managers for the broad set of areas encompassed by *global* change from all of the agencies and offices in cooperative action has proven a significant challenge, Difficulties have arisen because: (1) the agency and department managers whose purview encompasses all aspects of global change are typically so high in an organization that they are both very busy and often unable to deal adequately with specifics; and (2) because the broad scope means that each of the subject areas gets so little attention that meetings are not always directly relevant to a manager's key focus areas, especially when budgets are level or declining, as has been the case since the mid-1990s.

[4] The GCRA separated oversight of research focused on the science of global change and its impacts from research on mitigation (i.e., ways to alternative energy technologies and other means to reduce the effects of human activities on the environment). This was done in order to allow each effort to proceed without being potentially biased by the other. While independence has seemed intellectually reasonable, those focused on building the basis for action and addressing the issue in a timely manner have tended to favor close coupling and coordination. These two perspectives are still contending—with charges the science is being politicized while simultaneously some in Congress are proposing legislation to amend the GCRA in ways that would coordinate research and policy even more tightly that the Administration did when it set up the Cabinet-level Committee on Climate Change Science and Technology Integration that oversees the Climate Change Science Program and the Climate Change Technology Initiative that are active today.

1995-2000: Beginning to Evaluate the Impacts of Climate Change on the US

The IPCC's 1990 assessment report provided a comprehensive summarization of climate change science, impacts, and options for mitigation. While there were convincing indications that a problematic situation was emerging, the assessment also identified many shortcomings and limitations in understanding, prompting plans for significant and long-term enhancement of national research programs. A number of global environmental events, however, made clear that the need for greater understanding was quite urgent. Growing recognition of the nature and impacts of El Niño and La Niña events, drought in the Sahel and Great Plains, the 1991 eruption of Mt. Pinatubo, the appearance of the Antarctic Ozone Hole, ongoing increases in the global average temperature, and more, contributed to growing international concern about the global environment and prompted calls for the IPCC assessment activities to be intensified, looking at additional aspects and at changes in more detail.[5]

In response to the findings of the IPCC assessment, and prompted by the apparent increase in volatility of the global climate, the UN convened the Global Earth Summit in Rio de Janeiro in 1992. A number of agreements were negotiated, including the UN Framework Convention on Climate Change (UNFCCC), which, in Article 2, said:

> "The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

The UNFCCC, which was rapidly approved by most of the world's nations,[6] transformed what had been a scientific problem into an international scientific and political issue, especially because it called for controls on emissions. While national efforts to limit emissions out to the year 2000 were to be voluntary, negotiations were organized for further measures that would likely be mandatory. The UNFCCC then called for additional IPCC assessments that would contain more useful and specific information. In that the IPCC does not itself conduct research, this created pressures for the major national and international research programs to be accelerated so that a richer base of information would be available for IPCC evaluation.

Organizationally, the CEES served mainly as a high-level, and not very active, oversight body, with responsibility for the USGCRP vested in the SGCR, under the chairmanship of Dr. Robert Corell (Assistant Director of NSF for Geosciences). Interagency working groups were formed, although how to organize and fund interagency activities remained problematic. In response to the plan's outline of an interagency research program (with up to 12 agencies participating), funds for climate change science and satellite observation increased substantially through the early 1990s. Research on the consequences and impacts of climate change, however, received only a few percent of the research budget. Both scientific and political reasons have been suggested to explain this. On the scientific side, evaluating impacts generally required use

[5] An important side effect was an increase in the demands on the time and agendas of researchers.

[6] US ratification occurred without controversy in October 1992.

of local to regional scale projections that had relatively low confidence; the diversity of locations and types of impacts made it difficult to formulate a coherent program; and the research community in this field was less well-organized and often focused on other issues. On the policy side, those not wanting to deal with the climate change issue felt that studying impacts would acknowledge climate change was indeed a problem, whereas those wanting to immediately address the issue believed study of impacts would distract attention from efforts to limit emissions (i.e., mitigation).

Nonetheless, some impacts research and assessment did get started. The 1989 EPA assessment of likely impacts in five representative regions around the US identified a number of critical issues, including sea level rise, water resources in the western US, and more.[7] This effort did not progress into a full-scale national assessment, in part because its top-down structure generally failed to connect with regional stakeholders and so it generated relatively little bottom-up pressure for more information.

The Congressional Office of Technology Assessment (OTA) undertook analyzes from about 1990 to 1993 regarding climate change and the likely consequences across the US and recommended policies for dealing with the projected impacts. OTA organized expert panels that covered a number of natural resource areas, [8] and for each area, scientific understanding was reviewed and specific policy actions by Congress and government departments were recommended. However, at that time, the state of science was considered relatively uncertain, significant changes in climate were not yet evident, and the changes in policies would have affected a number of long-held interests. As a result, this report, like the EPA initial assessment, generated little response.

Those appointed by the Clinton-Gore Administration started to bring some top-level attention to the issue of impacts. For the first time, the OSTP director appointed an associate director for the environment (Dr. Robert Watson), and he built up the interagency environmental infrastructure, establishing the Committee on the Environment and Natural Resources (CENR) to replace CEES. The CENR assumed oversight of the SGCR and also established a number of other interagency subcommittees dealing with key environmental issues. The SGCR became more active, including establishing an Office of the USGCRP, with Dr. Michael MacCracken as the first executive director. The Office was staffed by assignees from the various participating agencies—each representing the chair of an SGCR-led Working Group (e.g., on Observations, Data Management, Modeling, Field Programs, Education, Assessment, etc.). Although there was increasing internal interest in starting to deal with national-level impacts and assessment, most of the assessment attention focused on support for the international assessments on ozone and on climate change (with the US having major responsibilities for supporting both activities)

In Congress, the strengths and weaknesses of the interagency effort to fulfill the GCRA became the basis for oversight hearings. Increasingly, questions focused on what climate change would mean to the citizens of the US and efforts being made to fulfill Section 106 and its call for periodic scientific assessments:

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[7] A 1979 workshop organized by the AAAS with support from DOE had earlier identified a wide range of potential impacts and research needs. While quite comprehensive, support for initiating a program to do this was squashed by the Administration that came to power in 1981. It took into the mid-to late 1980s for EPA to build its research program up enough to start to undertake impacts assessments.

[8] Panels were organized covering coasts, water, agriculture, wetlands, preserves (federally protected natural areas), and forests.

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

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

At the international level, with Bob Watson serving as the co-chair for IPCC Working Group II on impacts and adaptation, and the activities of other nations ramping up, the failure of the US to be building an impacts program was becoming more and more of a problem. In response to the UNFCCC requirement for quadrennial reports, the US prepared Climate Action Reports in 1993 and 1997. Although not their key focus, a chapter on likely impacts of climate change on the US was required in each of them. Going through this effort made clear that, despite the EPA and OTA efforts, little was known about what the key impacts on the U.S. would be and what adaptation was needed.

When the IPCC's Second Assessment Report, published in 1996, concluded that "the balance of evidence suggests that there is a discernible human influence on global climate," it became clear that the question of climate impacts could no longer be ignored—the Administration and the SGCR had to act.

Actions Taken:

1. To get the process started and provide the auspices and push needed to get the interagency process moving, the new OSTP Assistant Director for Environment, Dr. Jerry Melillo, worked with Vice-President Gore to organize a cabinet level meeting in late January 1997 on the issue of climate change. This meeting led to a call for the convening of a number of regional workshops to better understand potential impacts.
2. The SGCR agreed to initiate an assessment process, calling for a plan from its Assessment Working Group and setting up an interagency coordination effort to promote coordinated action. They also set up the National Assessment Coordination Office (NACO) under the leadership of Dr. Michael MacCracken with a small staff.
3. The SGCR agreed, after considerable discussion, that for credibility, the assessment activities needed to be as independent as possible from the agencies, meaning that the activities should not be led by the headquarters or laboratory staff of the various agencies.
4. As a step in building toward a national assessment, eight regional workshops were organized in 1997 and twelve in 1998 to identify key issues, each hosted by a university acting under the sponsorship of one of the USGCRP agencies.[9] For each workshop,

[9] Workshops were held covering the following areas: New England and Upstate New York, Metropolitan East Coast, Mid-Atlantic, Central and Southern Appalachians, Southeast, South Atlantic Coast and Caribbean, Great Lakes, Eastern Midwest, Northern Great Plains, Central Great Plains, Southern Great Plains, Rocky Mountains/Great Basin, Southwest-Rio Grande Basin, Southwest-Colorado River Basin, California, Pacific Northwest, Alaska, Pacific Islands, and Native Peoples/Native Homelands.

attendees were drawn from both the scientific and stakeholder communities and four key questions were considered[10] and used as a basis for structuring a follow-on regional assessment activity.

5. SGCR's Assessment Working Group initiated development of a plan for organizing and conducting a national assessment. A planning workshop was held at the Aspen Global Change Institute during the summer of 1997 to consider how to structure the assessment, and then a national conference was held in November 1997 to seek comments on the proposed multi-component approach involving regional and sectoral activities as well as a national synthesis.
6. In response to a formal request from the Director of the OSTP for a national assessment, the SGCR established the National Assessment Synthesis Team (NAST) in early 1998 as a NSF-chartered federal advisory committee (operating under FACA rules requiring open meetings, notification in advance of meetings, etc.). Prospective members were nominated by the agencies and then chosen by OSTP and the SGCR leadership. Unusual for an advisory committee, the members agreed not merely to advise, but to actually prepare and write the report. Membership was mainly from the expert community, and co-chairs were selected from the academic, government, and NGO communities.
7. In the spring of 1998, NAST developed an integrated plan for drawing together the multi-component assessment, including the subjects to be covered by sectoral report teams that they were active in helping to form along with the sponsoring agencies. The original plan called for a high-level document of about 75-100 pages for the Congress, with the detailed documentation left to the regional and sectoral reports. The plan was for the NAST report to be completed by January 2000 in order to avoid extending into the election-year cycle.
8. At the request of OSTP, a special Blue Ribbon review panel (co-chaired by Dr. Peter Raven and Dr. Mario Molina) was created by the President's Council of Advisers on Science and Technology (PCAST) to review NAST's plans, performance, and written products. Perhaps the most important step they took was to insist that the NAST's report not merely be an overview document, but also be supported by a foundation report containing chapters written as scientific papers (so with full references, etc.); this decision extended the timeline, with the public review of the report to occur in mid-2000 and the completion in the fall of 2000—right in the election cycle.
9. There not being time to seek separate funding through the normal budget cycle (and there being no real way to provide money to each agency in any other way), the agencies agreed to each take on a few of the roughly two-dozen components of the overall effort (e.g., regional assessments based in academic institutions, sectoral assessment teams co-led by academic and government laboratory scientists, climate scenario development, etc.) while also committing to cover their proportional share of the costs of the national synthesis effort and of NACO.

[10] 1. What are the long-term environmental and resource problems now faced in the region? 2. How would climate change amplify or moderate them or introduce new stresses? 3. What further information is needed to address these questions? 4. What win-win strategies might help to address the problems being faced? By posing the questions in this manner, it was hoped that, while the focus was going to be on the more tangible notion of climate change, other global change types of issues might arise in the discussion.

These efforts, taken mainly in 1997 and 1998, provided the foundation for the conduct of the US National Assessment over the period from 1998-2000 (some regional activities carried on for a time thereafter).

The bulk of the assessment activities took place from late 1998 to 2000. At the national level, the NAST provided guidance for the general approach to the assessment, established liaison efforts to each of the regional and sectoral teams, and held a number of public meetings to plan their work and invite public input. Drawing on the results from the regional and sectoral teams, and with the help of some additional authors and NACO staff support, NAST prepared both overview and foundation documents summarizing regional and sectoral impacts across the country, drawing forth ten key findings of national significance. Both of their reports went through a four-stage scientific and public review, and both were accepted by the SGCR, conveyed to the President and thence to the Congress, published by Cambridge University Press, and made widely available over the Web. The NAST completed its activities at the end of October 2000, as indicated above, about 9 months later than originally scheduled. Having the public review and release of the report during the election cycle led to generally partisan assertions that the report was politically motivated and influence, and the NAST report's final release and submission to Congress on November 11, 2000 ended up over-shadowed by the election stalemate.

The five sectoral teams (agriculture, forests, human health, water resources, and coastal areas and marine resources) worked rapidly and actively from mid-1998 into 2000. Each team was co-chaired by a university and a government laboratory scientist, and administratively based at a university to enhance independence and credibility. NACO provided a sectoral liaison to help coordinate among the various sector-team activities and to provide information as well about relevant regional activities. Each team established an advisory mechanism to serve as a link to the stakeholder community. The NAST appointed one of its members to work closely with each of the five teams to ensure that the results and conclusions of the sectoral teams were accurately and appropriately represented in the national-level reports. Each of the sector teams arranged for external peer review of their report, in two cases going so far as to publish the chapters of their reports in peer-reviewed journals (the health and forest reports were published in the scientific literature; the agriculture report was published by Cambridge University Press; the coastal and water reports were published by the sponsoring agencies).

University-based teams from fifteen of the twenty regions where workshops were held were funded to carry-forward with regional assessments. For various reasons, three of the original workshop teams did not get proposals in and for two teams that did get proposals in, agency funding could not be identified.[11] Regions varied greatly in size and character, from as small as the metropolitan New York area to as large as the southeastern US and from being defined by political boundaries to encompassing a large watershed—the most common characteristic seemed to be that they could get their assessment team together for a one-day meeting. NACO provided a regional coordinator to help coordinate among regions and to communicate as well with sector teams and the NAST. The NAST also had one of its members serve as a liaison with each of the regional teams, although in presenting its results at the national level, it chose to

[11] The five areas for which proposals and funding did not come together were: Central and Southern Appalachians, Eastern Midwest, South Atlantic Coast and Caribbean, Southern Great Plains, and Southwest-Rio Grande, although some additional joint study did go on for the last two areas. The Native People/Native Homelands workshop led to a proposal covering only the Southwest.

combine some of the smaller regions into mega-regions—the pros and cons of doing this have not been evaluated.

Reflecting each agencies particular situations, traditions, funding, and interests, support levels of the various regions ranged from relatively low, so adequate to cover little more than preparing a report based on results of existing studies, to comparatively high, so sufficient to allow multi-institutional teams to be formed that could even conduct specific regional analyses (e.g., model simulations). Each of the regions worked to involve stakeholders, often through an advisory structure, in order to better tailor their report to the needs and questions of those in the region, and each team arranged for expert and regional peer review of their draft reports. Twelve of the regions published assessment reports; for two of the other teams, draft reports were prepared, but funds were insufficient for publication (their level of activity did, however, otherwise generate a great deal of excitement and activity in their findings); and one region chose to present results directly to stakeholders.[12] A key lesson was that it takes a lot of time to build the contacts and confidence of stakeholders, and that being able to keep in sustained contact is most helpful so that questions can be addressed on a continuing basis as the need for information arises. Unfortunately, only a few of the regional efforts continued to be funded after their reports were issued, so that turning the report-generating effort into an on-going activity was generally not successful and the stakeholder networks in a number of regions generally withered.

Additional outreach and coordination efforts were organized by NACO, including a Web site, a quarterly newsletter, preparation of summary materials for use by museums and educators, annual meetings of the regional, sectoral, and national team leaders, and suggestions and support for similar structure and covers for the various reports.

Audiences for these reports varied greatly. Congress was the official audience for the national-level report. Its members had been invited by the director of OSTP to participate in the regional and other assessment activities as one way of trying to reach out to Congress as a stakeholder group. While this happened to some extent (one regional workshop was attended by seven members of the House), polarization about the science, prompted at least in part by Al Gore being the presumptive Democratic candidate in 2000 and being closely tied to the climate change issue, led to a number of sharp exchanges of letters regarding the assessment activity between House Republicans and OSTP, and incoming Republican Administration in 2001 did not seem to give much credence to the effort.

Copies of the national report were also provided to every state governor, to resource managers and scientific leaders in the government's resource management agencies (e.g., the National Park Service), and to major libraries; publication of the NAST's reports by Cambridge University Press also helped to extend the report's availability. Sectoral reports were provided to those interested in the specific area, and were generally well received. Regional reports were issued by the regional teams, and again were generally well received and well covered in the press; indeed, a few states have stepped in to initiate their own impact assessment programs in response to the findings of the regional teams. All of the reports are also available over the Web.

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[12] While much was accomplished in the three regions that did not ultimately publish assessment reports, a shortfall in funds did prevent the publication of the draft reports for the California and Native Peoples-Southwest regions. The Northern Great Plains regional study carried out its outreach activities via outreach rather than publishing a hard-copy report.

One other reaction to the reports was two lawsuits. The first, filed in October 2000, alleged technical violations of the Federal Advisory Committee Act and a few other points[13] and seemed really to want to smear the effort and thereby discredit the findings regarding potential impacts. This lawsuit was eventually withdrawn in exchange for a letter from Dr. Rosina Bierbaum, then acting director of OSTP, stating what seemed like the obvious, namely that reports of advisory committees do not, in and of themselves, represent government policy. Indeed, so as not to risk political interference with the findings of the NAST, the national level report had never been placed before the agencies for formal approval—all that had been asked was that the agencies approve that the planned process had been followed. What was later explicitly approved by the government agencies was a summary of the most definitive aspects of the report that was included as a chapter in the 2002 submission of the US Climate Action Report to the UNFCCC.[14]

A second lawsuit was filed in 2003 (based on the Administration's failure to act in response to letters sent in in 2002). This lawsuit alleged a violation of the Federal Data Quality Act (FDQA), asserting that the reviews had been inadequate and that, because the two climate scenarios used in the analyses done for the National Assessment differed from one another, one was obviously wrong, and the FDQA provides that agencies should not post or distribute flawed (i.e., incorrect) data. The lawsuit sought to have the National Assessment report withdrawn, a step that was actually not possible given its commercial publication and would have been an unprecedented censorship of a government sponsored report. That lawsuit was later dismissed with prejudice and with no requirement by the court for any action to be taken. However, the Administration did, in apparent agreement with the plaintiff, direct that the CCSP Web site display a disclaimer saying that the National Assessment report had not gone through the review procedures mandated by the FDQA. A letter from assessment authors pointing out that the review procedures that were followed were stricter than required by the FDQA and that, in any case, those guidelines were not in effect at the time of the assessment, neither received a response nor led to a change in the disclaimer on the CCSP Web site. Again, the intent of the lawsuit and posted disclaimer seemed clearly to suppress information on the impacts of climate change.

More important, the Climate Change Science Program that was initiated in 2002 to encompass the USGCRP and additional activities failed to continue most of the impact assessment activities, and, indeed, in the research strategy that was developed references to the National Assessment and those types of activities were essentially scrubbed out of the final version of the Strategic Plan, despite the review comments by the National Academy of Sciences panel that the National Assessment's findings should be utilized in planning the future set of activities of the CCSP.

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[13] Other points were that: (a) in the review process, a site to download the report was published in the *Federal Register* rather than the text and figures of the full report; and (b) the set of topics covered by the report did not include all covered in the call for the assessment in GCRA90 and included some coverage of topics not mentioned in GCRA90 that pertained to policy rather than science (such as resource management). These objections had been raised in the public review of the report and dismissed, along with a rather bizarre objection that the assessment was supposed to focus on global change and therefore should not be presenting regional change.

[14] And, in the course of preparation of this chapter, one NAST finding, about which NOAA and USGS scientists disagreed with each other regarding, was deleted. It concerned whether more intense precipitation would or would not (and was or was not) leading to more frequent flooding.

2005-2010: Time to Take the Next Step

As reported in the IPCC's Fourth Assessment Report and in many scientific papers, the global average surface temperature has continued to increase and the most recent decade is clearly the warmest in the instrumental record and quite possibly in at least several millennia. In addition, mountain glaciers are melting, oceans are warming, sea level is rising, precipitation is tending to occur in heavier events, and a large fraction of the observed changes in the ranges and phenology of plants and animals are consistent with a response to warming. IPCC's Working Group I *Summary for Policymakers* concludes that "Most of the observed increase in globally averaged temperature since the mid-20th century is *very likely* due to the observed increase in anthropogenic greenhouse gas concentrations" [emphasis in original]. IPCC's Working Group II Summary for Policymakers concludes that "Many natural systems, on all continents and in some oceans, are being affected by regional climate changes, particularly temperature increases [very high confidence]" and that "At the global scale the anthropogenic component of warming over the last three decades has had a discernible influence on many physical and biological systems [high confidence]."

Research in other nations is also directing attention to the likely impacts of changes in climate and how best to adapt to them. Large-scale regional studies, such as the Arctic Climate Impact Assessment, are finding significant impacts and providing information that can be used by the public and decision makers at all levels to plan how best to adapt and respond to the changes in climate that are occurring.

Meanwhile, in the US, relatively little is happening to bring together information on impacts. The agencies are sponsoring a few regional activities, but their focus has tended to be on near-term variability rather than long-term change. Some entities, from as large as California to as small as the city of Aspen, Colorado, are doing their own studies, which is to be commended, but does leave much of the country at an information disadvantage. The Government Accountability Office has found that the existing set of CCSP's assessment products is not meeting the requirements of the GCRA. Congress is pushing for action (one proposed bill calls for a new national assessment to be done within a year after passage) and a lawsuit brought by a number of environmental groups (and joined in by several members of Congress) is also actively seeking compliance with the requirement for period assessments (and also seeking that compliance occur within a year).

But how should all this be done. The CCSP funded preparation of a recent report by the National Research Council that lays out a number of requirements for an ideal assessment (e.g., urging a focus on saliency, credibility, and legitimacy). The report, however, offers little practical advice about how to proceed in the real world of multiple agencies overseen by multiple Congressional committees. Very little review has been done of the strengths and weaknesses of the 1997-2000 assessment process, with its regional, sectoral, and national crosscuts. While the Administration has not yet made a decision on how to proceed, some exploring of options is underway.

BUT, what should be recommended? The questions posed below are intended to stimulate discussion about (and ultimately your group's development and plan for) the design of future national assessment activities. Clearly, it is important that they be credible, useful, and timely for those who would benefit from becoming engaged in planning, developing, conducting, analyzing, communicating, and ultimately making use of the assessment process and the products and information that are developed. But, how can this best be done?

Discussion Questions

1. **Audience:** Who is the audience—who should it be? Congress, because they request the assessment? The agencies because they fund it? Who needs and can use the information—industry, states, communities, NGOs, the public? Other countries because they have interests coupled to ours? Who are the stakeholders for this effort? Is there a role for proponents and doubters—is the question of whether there is climate change, etc. up for grabs? How are ranges of views to be dealt with?

2. **Communicating the Information:** Can this be done with a report every four years? How can one get information when one needs it? What degree of technical sophistication should be assumed? How does one deal with questions arising from stakeholders—do they just send them in? What if it takes a bit of work to answer a question? How does one deal with communicating uncertainties and degrees of confidence—whose perspectives and standards should apply? How are ranges of views to be dealt with? How intense an outreach program is needed? How should one tie into educational programs and curricula development? Who is involved in the communication effort? How is the communication effort supported?

3. **Scope:** Is it most effective to deal with single aspects of the issues of global changes such as climate change, stratospheric ozone, etc. in separate assessment activities, or to consider "global change" in a unified way as called for in the Global Change Research Act? What should the coupling be to other types of changes going on—and how should that be handled? Should the focus be mainly on impacts and adaptation, or also include the change itself (so the science of climate change) and options for dealing with the issue (so mitigation)? How should regional, national, and international assessments be related and coordinated, in topic and time? Should national assessments reconsider what international assessments conclude about climate change, about impacts, about options for addressing the issue, or are international assessments just an integration of information assembled regionally and nationally? Who gets to design the assessment—who decides, who provides input?

4. **Assessment Components:** So, how do we get to where we want to be? To what extent is this a top-down versus bottom-up task—or is there some sideways perspective? Is what is needed a small addition to the overall research effort, a large addition, or something separate? Is assessment really a subset of research or a separate activity with separate experts carrying it through? How might the overall task be divided into component parts? Once subdivided, how would the overall effort be governed or coordinated, if at all? Are some standard analyses needed to allow comparison or can each part go its own way? How should the components of the effort be funded, and can this be achieved given the funding options that are available (and the constraints on them)? How can the credibility of the process and results be affected by the choices that are made?

5. **Temporal Focus:** What time scale(s) should be the focus of attention? Are the times of 25 and 100 years called for in the GCRA the right choices? Should consideration range from

seasonal and interannual variability to longer-term fluctuations and change, or can and should time scales be split?

6. **Sources of information and projections:** Where will information on baselines and projections come from, how will it be developed? How will information on the climate be developed, what model results will be used, will there be several scenarios? Will central and/or distributed analysis of the climate results be done? Will analyses look at changes in average climate, at changes in variability, at changes in weather patterns? How might a National Climate Service fit in? Will there be a national or regional estimate of changes in vegetation, invasives, biodiversity, etc.? How will account be taken of changes in technology, in demographics and society, in economic development, etc.? How will account be taken of trends and effects of policies regarding energy generation and emissions?

7. **Spatial Detail:** How will the regional pattern of changes and impacts be treated? Will regional analyses be done? How will regions be defined? Who will do the regional studies and analyses? What questions will be looked at and how will this be decided? Who are the regional stakeholders and how are they involved—for their benefit and for the benefit of the study? Will activities be done by one lead organization in a region or area or by multiple ones, and how would they be coordinated? If peer-review is used to select among teams to ensure quality, how are regional teams organized and selected and how is a wider set of participants ultimately brought into the process so all in a region can be involved? Will the focus be on what happens to the people, the economy, society, and/or other aspects of impacts? In addition to impacts, how can response (adaptation and mitigation) be integrated into the effort? To what extent can policy actions be suggested? Where will funding come from (including funding that allows consideration and advocacy on policy, if that is appropriate)? Will the assessment be a review of the literature or will teams be able to actively undertake research? What level of funding is needed? To what extent are participants supported, if at all—are they volunteers or fully funded? How will regional activities be coordinated with other elements, if at all? Will results be presented in periodic reports, through workshops, etc?

8. **Sectoral Detail:** Are there some topical areas (natural or economic sectors) that it would be useful to look at across regions[15]? Who are the sectoral stakeholders and how are they involved—for their benefit and for the benefit of the study? Are economic costs and benefits the right metric for analyses; what others are there, if any? To get estimates of economic impacts, is it actually necessary to look international as well as national and regional scales? What areas might these be? How might these areas be studied? How does one integrate together impact, adaptation and mitigation aspects? How does one consider the implications of changes internationally on the US, and vice-versa? To what degree can policy actions be suggested? Will the assessment just review the literature or will teams be

[15] Some of the suggestions, in addition to the original choice of five, have included: extreme events (e.g., hurricanes), energy, transportation, infrastructure, business and commerce, trade and international economics, recreation and tourism, wildlife and migrating species, drylands and deserts, public parks and natural lands, national security, international interconnections including environmental refugees, urban areas, rural communities, and more. How might such sectoral activities be done separately or coupled together?

able to actively undertake research? Who will do this, and what, if any, is the role of agencies and agency laboratories (e.g., USFS doing the forest assessment)? Where will funding come from (including funding that allows consideration and advocacy on policy, if that is appropriate)? What level of funding is needed; to what extent are participants supported, if at all? How will regional and sectoral activities be coordinated, if at all? How will national and sectoral activities be coordinated? Will results be presented in periodic reports, through workshops, etc? How is credibility and effectiveness assured?

9. **National Synthesis:** Will there be a national integration? Will national integration be the key driver of the process? How will national integration be done, and who will do this? Will those who do the synthesis oversee the national effort—should they? What will be the relationship to regional and sectoral activities? How will independence and credibility be assured? Who is responsible for designing of the process and scope of questions—and who gets to have input? How should the panel members be chosen—expertise, interest, whom they represent, etc.?

10. **What Legislation or other Action is Needed to Make all this Happen?** What sort of legislation is needed or would be helpful? Do assessment/applications activities need to be budgeted separately from research activities—what should and should not be the coupling? Which agencies are best suited to participate (or not)? How rigid should the requirements be and what flexibility should be allowed and encouraged?