

Statement
by
Dr. Michael C. MacCracken
Chief Scientist for Climate Change Programs
Climate Institute, Washington DC
before the Subcommittee on Energy and Environment,
House Committee on Science and Technology
United States House of Representatives
for the hearing entitled
“Reorienting the U.S. Global Change Research Program
toward a user-driven research endeavor: H.R. 906”
May 3, 2007

Introduction

Mr. Chairman, Members of the Subcommittee, thank you for the opportunity to participate in today’s hearing on H. R. 906, the Global Change Research and Data Management Act of 2007. I am honored to testify before you today in both my capacity, since 2002, as Chief Scientist for Climate Change Programs at the Climate Institute¹ here in Washington DC and as the executive director of the Office of the U. S. Global Change Research Program (USGCRP) from 1993 to 1997 and of USGCRP’s National Assessment Coordination Office from 1997-2001.² My detail as senior scientist with the Office of the USGCRP as senior scientist for climate change concluded in September 2002.

Prior to my detail from the University of California’s Lawrence Livermore National Laboratory (LLNL) to the Office of the USGCRP in 1993, my research at LLNL beginning in 1968 focused

¹ The **Climate Institute** is a non-partisan, non-governmental 501(c)(3) organization that was established under the leadership of John Topping in 1986 to heighten national and international awareness of climate change and to identify practical ways for dealing with it, both through preparing for and responding to the ongoing and prospective changes in climate and by reducing emissions and slowing the long-term rate of change. These goals are pursued, among other ways, through preparation of papers, presentation of talks, and organization of symposia, conferences, roundtables, and special briefings. These have been carried out not only in the U.S., but also in Canada, Australia, Japan, Europe, and more than two-dozen developing countries. To accomplish this, the Climate Institute taps into its vast network of experts and alliances in the U.S. and internationally. In all of these efforts, the Institute strives to be a source of objective and reliable information, promoting global climate protection through practical and cooperative approaches. The Board of Directors, to which I was recently elected, governs the activities of the Climate Institute. The Board, which is currently led by Mr. William Nitze, is made up of academic, business, environmental and scientific leaders from several nations, and the Institute’s Board of Advisors, which plays a critical advisory role, is also very broadly based. The Climate Institute receives financial support from membership, private and corporate contributions, grants, and contractual services for government agencies, nonprofit organizations, and publication sales. My service with the Climate Institute has been on a volunteer basis.

² The **U. S. Global Change Research Program** (USGCRP) was established by the Global Change Research Act of 1990. Throughout my detail with the USGCRP, it was managed by the interagency Subcommittee on Global Change Research (SGCR), which was made up of research program managers from NSF, NASA, NOAA, DOE, EPA, DOI, USDA, HHS, DOD, and the Smithsonian Institution plus representatives from OSTP, OMB, and, on occasion, other offices of the Executive Office of the President. To facilitate interagency research cooperation, the SGCR established the Office of the USGCRP in 1993, which has continued since 2002 as the Office of the Climate Change Science Program. The National Assessment Coordination Office was created by the SGCR in 1997 and then closed in 2001 at the end of the U.S. National Assessment.

on computer simulation of climate change and air pollution. In addition, from 1974-1987 I served as deputy division leader and from 1987-1993 as division leader of LLNL's Atmospheric and Geophysical Sciences Division. While at LLNL, I gained valuable experience in facilitating interagency cooperation by leading or co-leading cooperative research programs among the DOE national laboratories and across the campuses of the University of California. In none of these cases, including with the Office of the USGCRP and NACO, did I have control of the funding to force cooperation; leadership, in each case, was primarily through the offering of ideas that would attract the various participants to work cooperatively together. A biographical sketch is appended to this statement.

In inviting me to testify, I was asked to address two questions:

1. What lessons did you learn from your experience as Executive Director of the National Assessment Coordination Office of the U. S. Global Change Research Program about the importance of regional, state and local participation of a National Assessment?
2. What are the specific tasks necessary to develop an on-going dynamic National Assessment process and what financial resources are needed to support them?

In addressing these questions, I will also be drawing on my experiences participating in various ways in the assessment activities of the Intergovernmental Panel on Climate Change (IPCC), the Arctic Climate Impact Assessment, the City of Aspen, and related efforts.

Facilitating an Integrated National Research and Assessment Program on Global Change

The Global Change Research Act of 1990 (GCRA90) is relatively unique in its establishment of an interagency research program; when effectively directed, the cooperative efforts led to very positive results and accomplishments. Growing out of interagency activities and planning beginning in about 1988 (with roots reaching back even further), establishment of the USGCRP energized cooperative interagency activities, with each agency bringing their strengths to the collaborative effort, thereby creating an impressive and comprehensive national and international research program. GCRA90's requirement to prepare an integrated research plan and OMB's requirement that the agencies collectively approve the budget increments of any particular agency served to encourage cooperation and maintain budget discipline in the early days of the program.

During the 1990s, the collective interagency budget approached \$2B a year, and significant research efforts could be accomplished. For example, international field programs that combined the satellite and other capabilities of NASA, the aircraft and ship capabilities of NOAA, the university research and field experiment capabilities of NSF, and similar contributions from other countries led to much more comprehensive and complete data sets for analysis by scientists in all nations, thus promoting, at lower cost to the US, more complete and faster insight into such phenomena as the El Niño, the ozone hole, oceanic uptake of carbon, and more. Improvement of climate models and transfer of such models to the new generations of massively parallel computers was accelerated by combining the strengths of DOE and its laboratories with the modeling expertise of NSF, NASA, and NOAA—each effort prompting the others to do better. The sharing of data and model results allowed other agencies to draw on the results for studies of ecosystem change, hydrology, agriculture, and more. There were many other examples that,

when the overall effort was adequately funded, significantly advanced scientific understanding in ways that have and can continue to benefit society.

With more and more scientific questions coming up, however, the budget was held to roughly level dollars starting in the mid 1990s as a step to bring the overall budget deficit under control, leaving only the scientific benefits of working together in win-win ways and Executive Office encouragement to drive interagency cooperation. Even though budgets were tight, the agencies recognized the importance of having an assessment activity and jointly sponsored the US National Assessment from 1997-2001.

With the GCRP budget becoming significantly smaller³ (e.g., within EPA and NASA), with the erosive effects of inflation, with the significance of the decrease being somewhat hidden by changing the set of ongoing agency activities included in the USGCRP budget (e.g., within NOAA), and with the CCSP having less knowledgeable and inspirational leadership, much less is seeming to be accomplished. Scientists are spending far too much of their time writing proposals, fewer young scientists are being supported, the observation program is deteriorating, agencies have been very slow to get activities going on important new questions (e.g., research on hurricanes and their relationship to climate change), the US is falling behind the rest of the world and not doing its share in supporting cooperative international research programs, and the overall national assessment activity is far below what it was and should be given the situation being faced by the American public. While there is indeed still much research to be done (enumerated most recently in the *Strategic Plan for the U.S. Climate Change Science Program* completed in 2003), and I certainly support sustaining a strong interagency research program with greater funding, just listing what should be done is not enough.

In addition, the *Strategic Plan* did not even call for a comprehensive decision support program, which is both very disappointing and a real disservice to those who are experiencing climate change now and who will be exposed to much greater change in years to come. The Administration is not even providing sufficient support to investigate the uncertainties that it claims are important, much less the many areas deemed important by the national and international scientific community and the public, just at a time when the pace of climate change and its impacts are accelerating.

The main change that is needed, in my view, is highly qualified leadership, restoration of the very strong research effort that had been going on, and a significant commitment to openly, forthrightly, and expeditiously provide the best possible information to the American public through a comprehensive decision support and assessment activity. Interagency cooperation can be encouraged by ensuring each agency has a strong research program and then, for interagency activities, allocating responsibilities across the agencies, with each taking on a proportional share of the tasks that it can capably undertake and fund. Shared responsibility has the effect of ensuring a real stake in the collective effort by all of the agencies. Although I have been disappointed in OSTP's leadership for the past few years, my recommendation is nonetheless maintain responsibility for the interagency coordination under OSTP and the science adviser, and

³ See their enumeration of the budget at <http://www.climatescience.gov/infosheets/highlight2/default.htm#funding> and <http://www.usgcrp.gov/usgcrp/budgets/funding1989-2008byagency.htm>.

to keep the research on climate change science separate from that on energy technologies to avoid potential biases and to ensure effective management.

Building a Useful and Effective National Assessment Capability

Assessments are too often thought of only as reports, as, for example, the assessment reports of the Intergovernmental Panel on Climate Change (IPCC), the WMO and UNEP reports on Stratospheric Ozone, the Arctic Climate Impact Assessment (ACIA), and the US National Assessment. Indeed, GCRA90 and H. R. 906 both focus on the delivery of a report to Congress.

For the assessment activity to be useful, however, it has been widely recognized for some time that a much grander vision and process is needed, both in terms of the set of stakeholders that are included and in establishing the type and scope of activities that need to be undertaken. While provision of information to Congress to support policy development is certainly important, preparing for and adapting and responding to the impacts of climate change must start locally and regionally—each region is distinct, and each type of impact manifests itself in different ways in different places and for different sectors of the economy. While there are certainly some areas where national policy steps are warranted, there will be many where individuals, public and private sector organizations, local communities, states, and regions will need to respond. USGCRP activities need to serve all of these scales and stakeholders, not dictating what policies to follow, but providing information and capabilities needed by those experiencing the impacts so that they can prepare for and adapt and respond to future conditions.

Local planners will want information on likely changes in precipitation amount and flooding rains; farmers and farm cooperatives will want information on changes in season length and temperature, not just for their own farms, but for those of their local and distant competitors; coastal zone managers will want information on likely changes in sea level, storms, estuarine temperatures, and more; water resource managers will want information on likely changes in snowpack and runoff, and the chance of floods and drought; community health planners will want information on changes in location of freezing conditions and the frequency of extreme heat waves; industry will want information on changes in extremes that might affect their businesses and shipping; those preparing environmental impact statements will want information on the degree of change in a particular location; those doing economic analyses will want information across the region, and lots more.

In addition to providing information for stakeholders, the program needs to have an associated outreach and educational activity, helping to inform people about the changes ahead so that they can make decisions that will be robust over time and not lead to wasteful investments. As for other parts of the economy and society, information, even somewhat uncertain information, can be very valuable. In that Congress created the Global Change Research Act as an application-oriented research effort, I believe that the USGCRP has an obligation to make information available as it is produced, and not hold back such information until the changes being studied have occurred or the very high degree of confidence that the scientific community ultimately strives for has been obtained.

Reflections on the US National Assessment Experience (1997-2001)

Over the four-year period, significant progress was made in moving toward creating a broad and comprehensive National Assessment capability. We realized that we needed to create opportunities for real people (referred to collectively as stakeholders) to meet with scientists and specialists to learn about and discuss the information that the research is providing, have the opportunity to ask questions and to contribute their detailed knowledge and expertise, get information in the form and type that they need to make their own analyses, and to make their own judgments about whether the degree of confidence and uncertainty that scientists have in this information will make it useful to them.

Certainly, a top-down effort by USGCRP could set the process in motion by helping to sponsor meetings and by carrying out illustrative analyses of the larger-scale impacts. However, top-down reports tend to lack the detailed, local knowledge of an area and generally inadequately treat the social, economic, and demographic issues that would be expected to make a climate impact report of real relevance to city and regional planners; reports about local issues published by agencies in Washington are just not perceived to have the credibility of reports coming from local experts. Quite clearly, strong bottom-up regional efforts based at local academic institutions are much more credible than national level efforts, especially when analyses are done at local to regional scales by local and regional experts.

A second approach to evaluating impacts is to look nationally, or even internationally where appropriate, at particular economic or resource sectors. For many sectors, national policies exist and commercial entities are very active or interested, making a national perspective most appropriate. As a result, the National Assessment set up a series of sectoral studies. Because many of those in industry consider their ability to adapt and prepare for climatic fluctuations and changes a component of their proprietary business information, it also became clear that, for some types of sectoral studies, the assessment would need to be left to the private sector (and in the field of weather-related issues, there is already a strong private sector capability). Industry participants might well want to receive information, but did not want to have to explain their requests.

So, building on experiences from already ongoing efforts by NOAA to help water resource managers and others in the Pacific Northwest make use of the improving predictability of El Niño and La Niña events, the SGCR decided to create an ongoing, nationally distributed assessment capability, not only to prepare the periodic national-level report, but to also provide ongoing decision support and assessment capabilities to both regional and sectoral stakeholders.

During 1997 and 1998, the USGCRP agencies sponsored 20 primarily university-based teams across the country to organize workshops that would provide an opportunity for the scientific and stakeholder communities to come together.⁴ Guidance was also given to make sure that a broad

⁴ 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.

array of stakeholders were invited, and the OSTP director sent letters to each governor and each member of Congress from the area inviting their participation. Each workshop posed a set of four questions⁵ as a way of seeking to identify the most important impacts likely to affect each particular region.

Based on the issues identified and the capabilities for analyzing and summarizing the likely impacts in these areas, fifteen of the groups were funded to conduct regional assessments,⁶ and of these, all but three completed their studies over the next couple of years and, in addition to significant outreach to regional stakeholders, published reports summarizing likely impacts.⁷

Following a national-level workshop in the fall of 1997 and in response to guidance from the director of the OSTP regarding fulfillment of the GCRA90 requirement for a national assessment, the USGCRP agencies established the National Assessment Synthesis Team (NAST) as a federal advisory committee in early 1998. Working with the agencies, NAST organized sectoral assessment teams covering agriculture, forests, human health, water resources, and coastal area and marine resources. Each of the five sectoral teams was based at a university and co-chaired by a university and government laboratory scientist. While it was recognized that there were additional sectoral topics meriting coverage (and even mentioned specifically in GCRA90), the particular choices were made because it was recognized that other sectoral topics would likely depend on the results from these areas (e.g., assessing impacts on the energy sector would require estimates of changes in water resources). In addition, because the intent was that assessment activities would be ongoing, holding off for a few years seemed prudent, especially because the most important aspects of these issues would be getting covered in the regional assessments.

To provide the technical information needed to underpin the regional, sectoral, and national assessments, the USGCRP agencies also funded initial, but quite limited, activities relating to projection of climate, vegetation cover, economic development, and technology development. In addition, to provide overall coordination and facilitation among the regions, sectors, agencies and NAST, the SGCRA established the National Assessment Coordination Office (NACO). NACO's activities included providing staff support to the NAST, organizing annual meetings of leaders of all the assessment teams, issuing newsletters, maintaining a Web site, and, especially, understanding and communicating the interests and concerns among the groups and with the agencies which, for legal and contractual reasons, were in a number of cases unable to work directly with the groups they were sponsoring.

⁵ 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?

⁶ 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.

⁷ 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 region carried out its outreach activities via other means than publishing a hard-copy report.

While a great deal was accomplished, the most challenging problem was funding. Fulfilling the legal requirement for a report to Congress and supporting such a broad assessment activity was really an unfunded mandate. There was not time, and little likelihood, to move a request for sufficient funding for each agency through the OMB and Congressional budget process, especially to cover activities occurring over a number of years. There was also some question about whether assessment really fits within the definition of research that prevails in some agencies. To bypass the need for coordinated interagency funding approval, the assessment activity was subdivided into about 30 components (e.g., support a regional assessment, support a sectoral assessment, etc.) and each of the 8 active agencies was asked to find the resources to assume responsibility for the several specific tasks most closely related to their mission (e.g., USDA supported the agriculture and forest sectors, etc.). We ended up getting about 25 of the 30 components funded. A key issue for future assessments will be addressing this problem, because the unevenness of the funding that different agencies could and did make available led to unevenness, discontent, bewilderment, and even jealousy across the participating groups.

Despite the complexity and problems associated with the overall effort, a great deal was accomplished. The overall effort, which entailed planning workshops, building of stakeholder interfaces, regional and sectoral analyses and studies, national synthesis, and, for all reports, extensive review, took four years. There was a significant level of coordination achieved, both through exchange of information among teams at workshops and email, and with some direction from the NAST. Most of the reports (and a lot of related publications) were completed and distributed in 1999 and 2000 (regional reports by the regions; sectoral by the sectoral groups; and the national reports through SGCR and OSTP). The reports remain available over the Web at <http://www.usgcrp.gov/usgcrp/nacc/default.htm>, and the national-level reports are also available from Cambridge University Press.

Except for the relatively few regions and sectors where new funding was provided (e.g., in California, where the findings of the regional assessment raised such interest that the state established its own program), these reports remain today the most comprehensive set of information about the likely impacts of climate change on the US. In addition, the National Assessment set of activities served as the primary basis for the summary of impacts that was included in the IPCC's chapter on North America in its Third Assessment Report, in the National Academy of Science's 2001 report prepared in response to a series of questions from President Bush, and in the impacts and adaptation chapter of the *U.S. Climate Action Report-2002*, which, after word-by-word approval by all the key government agencies and the Executive Office of the President, was submitted in late May 2002 as the official U. S. Government communication under the UN Framework Convention on Climate Change that the US ratified in 1992. Quite clearly, the National Assessment process from 1997-2001 served many purposes, from local and regional to national and international.

Rebuilding a National Assessment Capability

As mentioned above, it was envisioned that an integrated regional-sectoral-national assessment activity would continue on well beyond 2001, building on progress spurred by the ongoing research program, interacting continuously with stakeholders, and periodically issuing reports that represented snapshots of understanding at that point. Instead, the Climate Change Science

Program, which came to encompass the USGCRP, chose to focus its resources primarily on further reducing uncertainties relating to the science of climate change rather than building capabilities for evaluating the implications of climate change for people and the environment. There is indeed much research to be done (on climate extremes, on hurricanes, on ecosystem responses, and in other areas listed in the CCSP research strategy⁸), and I certainly support additional funds for addressing the major scientific uncertainties, but much is reasonably well understood, and I believe it is particularly unfortunate for the American public (and also in violation of the GCRA90) to not also be sponsoring a strong national assessment activity. Unfortunately, except for a relatively small number of ongoing activities, the focus of which has in some cases moved away from climate change, most of the regional, sectoral, and national assessment capabilities created for the National Assessment have largely been discontinued. As a result, capabilities will have to be rebuilt if our Nation is going to have available the information needed to effectively and economically prepare for and adapt to the changes that lie ahead. If this is not done, the progress being made through the scientific research will simply not be effectively communicated to and usable by most stakeholders.

To rebuild and expand the national assessment capability so that it is providing information across the country of the kind and quality that California is putting together to address key climate impacts on its citizens, infrastructure, and economy, several steps need to be taken:

1. **Call for a national assessment capability:** It needs to be made explicit in H.R. 906 that the assessment process is more than preparation of a national-level report to Congress. Indeed, it needs to be stated that what is needed is a widely distributed national assessment capability that can benefit private and public sector organizations, local and state governments, and the public at large. As explained below, this effort needs to have regional, sectoral, and national components.
2. **Ensure a broad scope:** GCRA90 and H.R. 906 both properly call for assessments of *global* change, not just *climate* change; that is, in addition to dealing with long-term climate change, the stated intent is to deal with issues that include, for example, the individual and coupled impacts of changes in stratospheric ozone, large-scale changes in atmospheric chemistry, ocean acidification, deforestation and desertification, shifts in species ranges and loss of biodiversity, changes in population and demand for water and other ecosystem services, natural influences such as major volcanic eruptions, and more. For the first National Assessment, we used the threat of “climate change” as a means to initiate consideration of broader concerns over global change and sustainability. This was accomplished by having the first discussion question inquire about other large-scale, long-term issues, influences, and trends (e.g., the overdrawn of underground aquifers in some regions). The second question then inquired about how climate change might exacerbate or ameliorate the consequences of the various factors leading change, or how it might introduce new stresses or opportunities. The assessment activity needs to avoid considering climate change in the absence of how society and the environment are otherwise changing; they will only be useful to real people if done in the context of all

⁸ It is not, of course, enough to list the scientific question in the plan. What has to be done is to have an effective research program to address the key questions, and this is not happening across the various elements, especially in aspects critical to identifying and evaluating the impacts of climate change.

types of changes that are going on. Fully addressing global change and sustainability will likely to require even broader interagency cooperation and budget coordination than at present.

- 3. Allow coupled consideration of mitigation and adaptation:** GCRA90 separated mitigation from adaptation, yet it became clear during the National Assessment that they are coupled in certain ways. Changes in water resources will affect the potential for generation of biomass; changes in climate may well affect wind power resources and demand for energy; changes in land cover for energy generation will affect surface albedo, dust loading, and even air pollution; changes in location of icing could affect transmission lines; etc. Certainly, the technology research programs are best kept separate, but choices regarding particularly renewable energy technologies and their implications need to be considered jointly with issues of impacts and adaptation.
- 4. Provide separate funding:** Whether at NSF where research is defined as something new or at USDA where land-grant funds are allocated for other purposes and seemingly can't be diverted, borrowing and begging from the research budgets of various agencies did not work well, having to struggle to overcome long-standing agency and recipient relationships. At the same time, putting all of the additional funds in one agency would tend to reduce overall credibility, as was the perception when EPA alone was funding early assessment activities in the late 1980s. For credibility, multiple agencies, each with their particular interests and capabilities, need to share the responsibilities and ownership of the assessment activities.
- 5. Provide for national baseline information:** Regional, sectoral, and national assessments will all require developing a set of scenarios of projected changes in climate, ecosystems, demographics, technology, economics, and energy technologies. A problem with the first National Assessment was that these activities were inadequately supported and got started too late to really get the information to assessment teams when it was needed. Each of these efforts can be started up quickly, perhaps most effectively under the oversight of national panels set up under the auspices of a relevant professional society or foundation. Major data sets that are generated can likely best be maintained and made available through, for example, national or agency laboratories or centers. There is also a need for research funding to develop the capability for generating much more useful projections and scenarios, and to find the means to allow for consideration of societal evolution, alternative policies, etc. This will require a coupling of the assessment and research planning efforts. The assessment component of this effort is likely to require several million dollars per year, especially to support the running of regional models and the involvement of the social science community.
- 6. Generalize the time horizon:** GCRA90 called for looking 25 and 100 years ahead. This was too limiting. Many stakeholders want to have projections for only 10 years in the future, even though scientists would say, and the stakeholders understand, that natural variability and events such as volcanic eruptions could cause fluctuations larger than the expected changes over these short time scales. The reason even limited confidence estimates can be important is that businesses are not dependent on conditions being

exactly at the expected mean value; for reasons of competitive edge and to avoid government regulation if failure happens too often, resource-related businesses are typically able to flexibly adapt to conditions that span 90% or more of the possible range of monthly to seasonal climatic variations (e.g., have enough capacity and reserves to be able to ensure enough natural gas or heating oil for all but the very coldest years, after which they might need to resort to significant price increases or extra transport of fuel, or to pleas to the public for conservation, or, in the direst situations, not meeting the demand). In that many businesses already have developed an adaptive capability to deal with a reasonable range of extremes, a projected trend in the mean can be used to plan how best to plan for changes in the likelihood of extreme events (e.g., to ensure sufficient electric power during heat waves). For other groups, for example those planning buildings or developing new paving materials, information out to 50 years is more important. The assessment activity therefore needs to recognize that different groups are likely to need widely divergent information, from changes in the mean to changes in the extremes.

7. **Insist on stakeholder involvement and an applications-oriented effort:** It really needs to be made clear that the national assessment activity is an applications-oriented, mission-directed part of the overall USGCRP. Too often, assessments are being done by pulling researchers away from their research. That can be fine for a short time and for scientific review papers, but that is not how this part of the program should be conducted. The assessment effort needs to be designed to maintain an ongoing interface with stakeholders, and to develop the tools and information that stakeholders need, taking account of the special knowledge and situations that are being analyzed. As such, the activity needs to have a philosophy and operating approach that is akin to NOAA's existing regional climate centers. While new information and insights will and can be generated by the assessment process, this effort needs to be informed by research, but driven by stakeholders.

8. **Insist on and support a network of regional decision-support centers:** A wide range of impacts that matter happen where people live. As one approach to estimating impacts, it is essential to have a place-based focus in the assessment process; those who best know and can relate to a region are those who live and do their work there. The National Assessment struggled a lot with the question of what a region is, and ended up with ones of varying size and rationale.⁹ The most important considerations ended up being that the regions included people facing similar problems and that the participants in the region were able to get together for one-day information, coordination, and outreach meetings (getting stakeholders to devote more than one day is very difficult, given the long-term nature of the benefit they can expect). For the first National Assessment activity, keeping in mind that the US is responsible for islands in the Caribbean and Pacific, it seemed that 20 regions was about the right number.

⁹ We considered trying to subdivide the U.S. by watershed, by agency defined administrative region, by political boundary, and more. In the end, recalling the book *The Nine Nations of North America* that focuses on the common interests and values of those in particular areas, and even considering whether the boundaries of major football conferences might help define this, we ended up using no single criterion and allowed fuzzy boundaries for regions.

For the National Assessment, the USGCRP agencies were generally only able to provide enough funding to get a team established that drew members from one university. A number of the regions were able to reach out and build broader teams by attracting separately supported participants from land and sea grant programs, from government laboratories, and simply because of the uniqueness of this first effort; on-going efforts, however, are going to require more substantial support for each center (likely of order \$1-2M per year per region—and if regional modeling is involved, substantially more).

Ideally, I believe that regional centers (or virtual centers or cooperative regional programs) are needed that draw on capabilities from multiple universities, laboratories, stakeholder organizations, and other expertise in a region, thereby creating a regionalized science, assessment, and decision-support capability. Such centers (or capabilities) need to be able to do more than just review existing scientific literature. They need to be able to carry out and analyze the large-scale changes that characterize and drive global and national change, and then apply this large-scale information in local and regional analyses using the available and calibrated local and regional models.

For the assessment and decision-support aspect of the effort, the Regional Integrated Sciences Assessment (RISA) teams that have been established by NOAA in a few regions provide an example of what will be needed (and about which Dr. Phil Mote will testify).¹⁰ The scope of capabilities, however, will need to be strengthened so that these regional centers can address issues of changes not only of climate, but also for ecosystems, water resources, health, agriculture, demographics, economic development, transportation, and more. To achieve both breadth and flexibility as the set of issues change, it may be best to establish a virtual regional center rather than a specific center at a fixed location (California seems to have been able to do this), or to base administrative coordination efforts at a government laboratory or major center within the region, with expertise distributed across a set of universities.

Getting such activities up and going across the country will take at least a few years, but really does need to occur so that all regions can have the types of information now available for those few regions that are supported. Required funding for roughly 20 regional activities likely needs to be roughly \$20M per year.

- 9. Call for and support sectoral assessments:** While many of the impacts are regionally distinctive, our nation is interconnected in many ways. The National Assessment sponsored five sectoral assessments, but recognized that many more were needed and hoped that they would be initiated as part of ongoing activities. There have been a few efforts to do this, with, for example, EPA continuing to sponsor assessments of the significance of climate change for human health and air and water quality, and DOT for issues relating to climate and transportation infrastructure and operation. But the CCSP's efforts have so far been quite limited, forcing the initiation of other modest and generally underfunded efforts (e.g., GAO, at Congressional request, on Public Lands; a few environmental groups for various regions; and a number of groups on defense and national security implications); fully supported studies are needed.

¹⁰ The four regional centers sponsored by DOE's National Institute for Climatic Change Research (NICCR) provide an example of how regional research can be focused and coordinated across several universities in a given region, although their core set of activities is not as focused as for the RISA centers.

Establishing on-going panels that are expected to regularly update their analyses and assessments would likely work best, with a sustained capability maintained in order to be responsive to new questions, inquiries, and research results. The overall objective would be to help those in each sector have the information they need to cost effectively prepare for and adapt to ongoing and prospective climatic and environmental change.

In addition to the areas for which initial assessments were done, areas that are particularly worthy of study include 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.

To lead such efforts, partnerships between independent professional or research organizations and government research entities would likely be most effective, and might be a means that would allow these teams to deal with proprietary information and to develop recommendations on policies that could help ease impacts and promote adaptation in the sector analyzed. Funding for a set of such activities should likely start at a level of about \$5-10M.

10. National vulnerability assessment: The National Assessment Synthesis Team (NAST) was established to provide high-level direction for and integration across the distributed assessment activities. NAST's responsibility included carrying out the national synthesis by considering the larger picture, encouraging learning and interaction across the separate activities, and looking for gaps and weaknesses. Having NAST organized as a federal advisory committee¹¹ created credibility and allowed for openness in its activities, including in its review process.¹² Insisting that such an independent structure be used in the future is important for many reasons, especially credibility; it is fine to ask for an Administration evaluation of the resulting report, but the vulnerability assessment should not be a formal Administration or interagency document.

It is unclear whether an entity similar to NAST could be sustained on a continuing basis using mainly volunteer members who actually are also responsible for writing the report; quite likely some support will be needed for member support, for special studies, and for support staff. Finding a way to have NAST's members be both widely representative of stakeholders (including representing the interests of the agencies and Congress) while also having the needed distribution and depth of expertise will be a challenge. Funding required is likely \$2M per year, including support for national level meetings.

¹¹ Although NAST operated legally under the auspices of NSF, its functioning, oversight, and interactions were handled on an interagency basis, giving it broader independence and credibility. The independence also allowed each agency to separately consider NAST's findings and integrate them into their various roles and priorities. Based on experiences of trying to get all agencies to approve every word of official government reports, it is important that this not be required.

¹² Having a Federal Register review in addition to an extensive expert review served, in my view, a very useful role. However, an open review can also create difficulties because open release of a draft report tends to draw more media attention than release of the final findings.

11. Overall Facilitation and Coordination: The SGCR established the National Assessment Coordination Office (NACO) to ensure effective coordination across all of the various parts of the effort; this involved both a service and a subtle independent voice supporting the overall vision for what is wanted. Some sort of similar function will be needed for future assessments, including especially promoting coordination, cooperation, and exchange of information across the regions, sectors, agencies, and national assessment team. For reasons of credibility and acceptance, it will be important to find a way to make sure this is done on an interagency basis.

12. Timing: GCRA90 and H.R. 906 both provide for an assessment every four years. While periodic reports can be useful, they can also be very disruptive to an ongoing assessment process if every part of the process must focus on meeting the same timelines. For this reason, rather than setting tight timelines and a common, coordinated schedule for all parts of the process as is done for IPCC assessments,¹³ NAST understood that, while there was a need for the various regional and sectoral teams to conduct some common analyses for national integration, each region and each sector also needed some flexibility in undertaking their own studies for their own audiences. Thus, the national synthesis effort was set up as, essentially, a “snapshot” at a particular time and focused on a particular aspect of global change, initially climate change. We envisioned there being future snapshots to catch up with other aspects of the issue.

For the future, I would think it useful to continue to ask for periodic national-level reports—indeed, that the needed report called for in the GCRA90 has not been provided is very unfortunate. While there should not be an expectation that each report will cover every aspect of global change, coordination across successive reports should be done to ensure that Congress really does periodically have an up-to-date synthesis of the key national issues. To accomplish this, what would be most useful, I would think, would be to receive, over time, a series of reports from different perspectives and taking different crosscuts of the issue—one time focused on climate change, another time on ecosystem services and vitality, another time on water resources and drought, etc., and then, in addition, having an integrated executive synthesis. Neither scientific understanding nor climate normally changes fast enough to justify generating a full set of reports in each region and sector on the same material every four years; however, an up-to-date synthesis should always be available.

13. Policy and technology evaluation for adaptation: Unlike GCRA90, H. R. 906 calls in section 107(5) for the vulnerability assessment to analyze “the adoption rates of policies and technologies available to reduce the vulnerability of society to global change ...” This looks to me to be a useful new component of a national-level assessment. Such analyses should also be useful as a foundation for covering this subject in the quadrennial submission of the US Climate Action Report. The National Assessment was not very successful at getting at the issue of adaptation to various impacts; having a special effort, at a reasonable funding level, would likely be very helpful.

¹³ In addition to requiring very tight coordination and essentially the superceding of all other activities and stakeholder interactions, scheduling all reports to finish simultaneously also has the unfortunate side effect of leading to peaks of attention on the issue every several years rather than promoting ongoing attention to the need to build adaptive capacity.

14. Communication, education and outreach program: While the National Assessment planned a communication, education, and outreach component, there were inadequate funds to do very much. A key problem was that the agencies involved just did not feel they were empowered to use funds designated for research for these purposes, especially when the research funding was very tight and there were many issues that needed to be addressed. In some way, the legislation needs to call for such activities and find ways to make sure that funding can be provided, even if through the agency education allocations, etc. Funding should be at \$1-2M per year.

15. Policy assessment: Section 108 of H. R. 906 calls for a policy assessment that documents current policies across the country for both adaptation and mitigation, analyzes the effectiveness of these policies, and identifies and evaluates the need for additional policies. I would suggest that the adaptation component of this assessment not related to the emission or uptake of greenhouse gases be made part of the national vulnerability assessment so as to make the remaining effort more focused and manageable. With respect to the mitigation assessment, to ensure credibility, it will be important to have this assessment done by an independent panel organized under the auspices of a university, foundation, or research or policy center. Required funding is likely a few million per year.

What Can Be Done in a Year?

The fact that we have gone seven years without a full assessment would certainly seem a good reason to ask that the next assessment be completed in a year. However, insisting on such a rapid timetable could well lead to such an inadequate result that it would impair progress in getting to the comprehensive national capability that we need. Much, however, can be done in a year:

- A coordinated, interagency effort to prepare, review, and publish a plan for a comprehensive national assessment;
- In that historical and scenario-based information will be required on climate, land cover, demographics, technology, and economics, steps should be required to initiate such efforts;
- The existing set of regionally based activities should be expanded;
- Key agencies should be encouraged to initiate sectoral assessment activities on a number of new topics; and
- Agency budgets should be augmented to provide for their participation in a greatly expanded assessment activity.

In my view, establishing the national capability over the next 1-2 years and then pushing for the next national-level synthesis within three years would be possible while assuring that useful information would be starting to get to stakeholders relatively quickly.

In addition, the Administration should be called upon to complete the seriously overdue Climate Action Report, with the process including an adequate time for expert and public review of the draft and Congressional evaluation of the result.

Biographical Note

Michael MacCracken has been Chief Scientist for Climate Change Programs with the Climate Institute in Washington DC since 2002; he was also elected to its Board of Directors in 2006. Both of these positions are held on a volunteer basis.

Dr. MacCracken received his B.S. in Engineering degree from Princeton University in 1964 and his Ph.D. degree in Applied Science from the University of California Davis/Livermore in 1968. His dissertation used a 2-D climate model to evaluate the plausibility of several hypotheses of the causes of ice ages. Following his graduate work, he joined the Physics Department of the University of California's Lawrence Livermore National Laboratory (LLNL) as an atmospheric physicist. His research in the ensuing 25 years included numerical modeling of various causes of climate change (including study of the potential climatic effects of greenhouse gases, volcanic aerosols, land-cover change, and nuclear war) and of factors affecting air quality (including photochemical pollution in the San Francisco Bay Area and sulfate air pollution in the northeastern United States). At LLNL, he also served as deputy division leader for atmospheric and geophysical sciences from 1974-1987 and then division leader from 1987-1993.

From 1993-2002, Dr. MacCracken was on assignment as senior global change scientist to the interagency Office of the U.S. Global Change Research Program (USGCRP) in Washington D.C., also serving as its first executive director from 1993-1997. From 1997-2001, he served as executive director of the USGCRP's National Assessment Coordination Office, which facilitated and coordinated the efforts of 20 regional assessment teams, 5 sectoral teams, and the National Assessment Synthesis Team (which was constituted as a federal advisory committee) that prepared the national climate impact assessment report that was forwarded to the President and on to Congress in late 2000. During this period with the Office of the USGCRP, Dr. MacCracken also was a co-author/contributing author for various chapters in the IPCC assessment reports and helped coordinate the official U.S. Government reviews of the second and third assessment reports of the Intergovernmental Panel on Climate Change.

When Dr. MacCracken's assignment with the Office of the USGCRP concluded on September 30, 2002, he simultaneously retired from LLNL. In addition to his activities with the Climate Institute, he served on the integration team for the Arctic Climate Impact Assessment from 2002-2004. Dr. MacCracken is also near completing a 4-year term (2003-2007) as president of the International Association of Meteorology and Atmospheric Sciences (IAMAS), members of which are the national academies of science or their equivalent in about 50 nations. As president of IAMAS, Dr. MacCracken also serves on the executive committees of International Union of Geodesy and Geophysics (IUGG) and of the Scientific Committee for Oceanic Research (SCOR). From 2004 to 2005, he served on a panel of the Scientific Committee on Problems in the Environment that prepared a report on what is known about the likelihood and consequences of an asteroid or comet impact, and from 2004-2007 on a scientific expert group convened by Sigma Xi and the UN Foundation at the request of the UN's Commission on Sustainable Development to suggest the best measures for mitigating and adapting to global climate change (report available at <http://www.confrontingclimatechange.org>).

Dr. MacCracken is a fellow of the American Association for the Advancement of Science (AAAS) and a member of the American Meteorological Society, the Oceanography Society, and the American Geophysical Union, among other organizations. His affidavit relating global climate change and impacts on particular regions was recently cited favorably by Justice Stevens in his opinion in the recent decision in *Massachusetts et al. versus EPA*.