

**Social Sciences Integration to Support USGCRP Strategic Plan  
Implementation**

A White Paper of the USGCRP Social Sciences Task Force

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## **Social Sciences Task Force Participants and White Paper Authors**

Co-Chair: Kathy Jacobs (OSTP/NCA)

Co-Chair: Bill Hohenstein (USDA)

Convening Lead Author: Chris Weaver (EPA/USGCRP)

Cathy Allen (EPA)

Nancy Beller-Simms (NOAA)

Tom Fish (DOI)

Anne Grambsch (EPA)

Pat Hipple (USDA)

Melissa Kenney (NOAA/USGCRP; University of Maryland)

Linda Langner (USDA)

Libby Larson (AAAS/NASA)

Ji Sun Lee (DHS)

Liz Marshall (USDA)

Dave McGinnis (NSF; now at Montana State University)

Sian Mooney (NSF)

Leah Nichols (NSF)

Claudia Nierenberg (NOAA)

Marcy Rockman (DOI)

Art Rypinski (DOT)

Emily Seyller (USGCRP)

Rob Winthrop (DOI)

## Executive Summary

In 2012, the U.S. Global Change Research Program (USGCRP) released its most recent decadal Strategic Plan (*A National Global Change Research Plan: 2012-2021*). The new Plan puts forward a vision of discovery-driven research in continuous dialogue with critical, societally facing priorities, such as informing decisions, sustaining the assessment processes that support decision-making and the development of robust research agendas, and helping communicate with, educate, and engage diverse publics. As explicitly recognized in the Plan, these goals are not achievable without more significant contributions from across the breadth of the disciplines often referred to collectively as the social sciences. This need arises because it is people, and their communities, institutions, and governments, which are at the center of the three main aspects of our global change problem:

- Humans are *drivers* of global change
- Humans are *affected* by global change
- Humans have the capacity to *respond* to the risks posed by global change

In other words, understanding the fundamental human dimensions of global change, linking the Program's basic and applied components, aligning research with national needs, and moving knowledge into action all require increased integration of the social sciences into USGCRP. However, the lack of social sciences capacity in USGCRP agencies (or at least the portions of those agencies that have traditionally been involved directly in USGCRP), means that the Program will need to work to build this capacity internally, as well as establish and sustain partnerships outside its historical core of participation, to deliver on the expanded scope of activities put forward in its new Strategic Plan.

In recognition of this need (and challenge), the Subcommittee for Global Change Research (SGCR) directed the formation of an *ad hoc* Social Sciences Task Force, with membership drawn from the USGCRP agencies, to identify options, and provide recommendations, for accelerating this integration. This white paper is the major deliverable of the Task Force, and it attempts to conceptualize a set of organizing principles for thinking through the challenge of better leveraging social sciences research, expertise, and practices in the activities of the Program.

The conceptual framework employed here emphasizes the need to link fundamental scientific research with decision-making about responding to global change, through deliberate efforts to create and manage an effective boundary space between them. This space, and the integration of scientific knowledge and translational activities that take place within it, provides a number of logical insertion points for greater contributions from the social sciences. This framework thus helps define the topic areas within which the Task Force chose to provide recommendations: i.e., areas that require, and provide opportunities for, near-term progress. The Task Force placed a high priority on leveraging existing activities and capacity to make the challenges of integration tractable in the near term while looking toward the longer-term transformation of the Program.

### **I. Recommendations: Supporting Decision-Making About Responding to Global Change**

#### **Scaling Up Decision Support Innovation**

- Develop a framework for vulnerability assessment
- Experiment with alternative decision-making frameworks
- Experiment with public participation methods
- Establish flexible guidance for incorporating local and indigenous knowledge into decision-making

#### **Institutional Arrangements, Knowledge Networks, and Capacity Building**

- Create a forum for participatory decision support exercises
- Develop and encourage the evolution of global change knowledge networks

- Support regional coordination efforts for information development, delivery, and decision support
- Support evaluation of USGCRP programmatic performance and effectiveness
- Strategically integrate social sciences capabilities across interagency working groups

## II. Recommendations: Science Integration and Boundary Activities

### Indicators

- Identify, refine, or develop societal indicators in support of a proposed National Climate Assessment Indicator System
- Develop leading indicators of societal impacts and vulnerabilities related to global change
- Support indicator information system design and evaluation

### Scenarios

- Develop national-scale scenarios that include both socioeconomic and biophysical information
- Support participatory scenario planning
- Use these scenario capabilities to carry out pilot scenario planning exercises

### Valuation

- Develop guidance on key methodological issues in global change valuation
- Synthesize existing valuation studies
- Support the introduction of valuation information into the 4th National Climate Assessment

## III. Recommendations: Research and Data

### Priority Topics for New Fundamental Research

- Vulnerability and Adaptive Capacity
  - *Stimulate coordinated interdisciplinary research on the human dimensions of extreme events*
  - *Establish long-term, place-based studies of adaptive capacity and adaptation efforts*
- Integrated Human-Natural Systems Research and Modeling
  - *Support efforts to accelerate progress in integrated human-natural systems modeling*
  - *Enhance coordination of human-natural systems research and modeling efforts*
- Improved Decision-Making Frameworks, Processes, and Information Products
  - *Support research for implementation and evaluation of alternative decision frameworks*
  - *Support comparative studies of decision processes across different decision contexts*
  - *Support research into developing, sustaining, and using knowledge networks*
  - *Support new social sciences research around key elements of indicator development*
  - *Support new social sciences research around key elements of scenario development*
  - *Improve valuation of global change impacts, responses, and costs of inaction*
- Evaluation Research
  - *Support evaluation of processes and institutional arrangements for the use of scientific information in global change response planning*
  - *Support evaluation of programmatic performance*

### Data Policies and Standards

- Identify existing federal social sciences data useful in a global change context and create partnerships to expand accessibility
- Improve integration of social sciences data into emerging information systems designed for planning and preparedness
- Design and implement a set of social sciences data management policies to inspire improved data integration with biophysical and other data
- Incorporate social sciences measurement capabilities into Earth observations portfolio assessments

The recommendations put forward in this white paper, and discussed in detail in the main body of the document, reflect the dual role of the social sciences in a USGCRP context. **Namely, that social sciences research and expertise is both an important part of the integrated knowledge base about the causes and consequences of global change and can help identify principles that help make this knowledge “work” better for society.** Thus, the social sciences speak not solely to new research investments, but also to operationalizing existing research, expertise, and practices to make possible the linkage of science and societal actions.

Finally, this Task Force recommends a two-part organizational structure to assist in the implementation of the above recommendations, beginning with a series of near-term steps described in detail in Section 5. This consists both of a small, centralized USGCRP Social Sciences Coordinating Committee, as well as enhanced participation by social scientists on a number of strategically chosen USGCRP working groups. The Coordinating Committee is needed to promote cross-working group collaboration in making progress toward the recommendations in this white paper, provide a center of gravity for engaging with groups outside USGCRP with capacity to assist in improved social sciences integration within the Program, and serve as a point of contact for achieving convergence across the many common elements of the concurrent discussions about evolution of USGCRP’s organizational and business model and approaches for sustaining an ongoing assessment process that is fully integrated with USGCRP’s core functions.

## 1. Introduction

**Motivation and Opportunity: Why, and why now?** Writing in *Nature* in 2012,<sup>1</sup> Ryan Meyer assessed the new USGCRP Strategic Plan<sup>2</sup> in light of the challenges faced by governments around the world in implementing national research programs that foster both the development, and use, of new knowledge in areas of pressing societal need. He praised USGCRP for organizing its new plan not solely around advancing science, but also informing decisions, carrying out national and international assessments as a continuous and sustained process, and helping communicate with, educate, and engage diverse publics as core functions of the Program<sup>3</sup> worthy of substantial strategic focus (Figure 1). He commended the nuanced understanding evident in the Plan of the way that fundamental global change research should interact with these societally-facing functions, and how these elements should be woven together to realize the desired public values outcomes of the Program, as a model for other science-policy organizations to emulate. The National Academies, in their own review of the Plan, concurred with this view, and urged USGCRP to implement institutional and organizational changes to help bring about this transformation.<sup>4</sup>

### **Vision Statement: What are the purposes of this white paper?**

- Stimulate the efficient integration of the social sciences within USGCRP to help fully achieve the goals of its new Strategic Plan
- Suggest ways to improve the ability of USGCRP agencies directly – and through the relationships that agencies have with states, communities, and individuals – to support decisions about managing risks from global change
- Propose new strategic investments in social sciences research
- Recommend concrete, near-term actions from which to build, leveraging existing capabilities

Central to this vision for USGCRP is the concept of “fundamental, use-inspired research”<sup>5</sup> - i.e., in the global change context, research that contributes both to improved scientific understanding and more effective decision-making in the areas of most pressing national need. As expressed in the Strategic Plan:

*“To serve society in meeting present and future challenges, this research program will be built on two principles. The first is to improve fundamental scientific understanding of the integrated natural and human components of the Earth system. The second principle is to focus on the essential science needs for reducing ecological and societal vulnerability to global change by increasing resilience and helping the Nation manage risk through well-informed responses. This Strategic Plan defines a research program for USGCRP that acknowledges the complexity of global change as both a scientific and societal challenge. To meet this challenge, the research program embraces multiple forms of integration across the components of the Earth system (including people), across observations and modeling, across space and*

<sup>1</sup> Meyer, R., 2012: Finding the true value of U.S. climate science. *Nature*, **482**, 133, doi:10.1038/482133a.

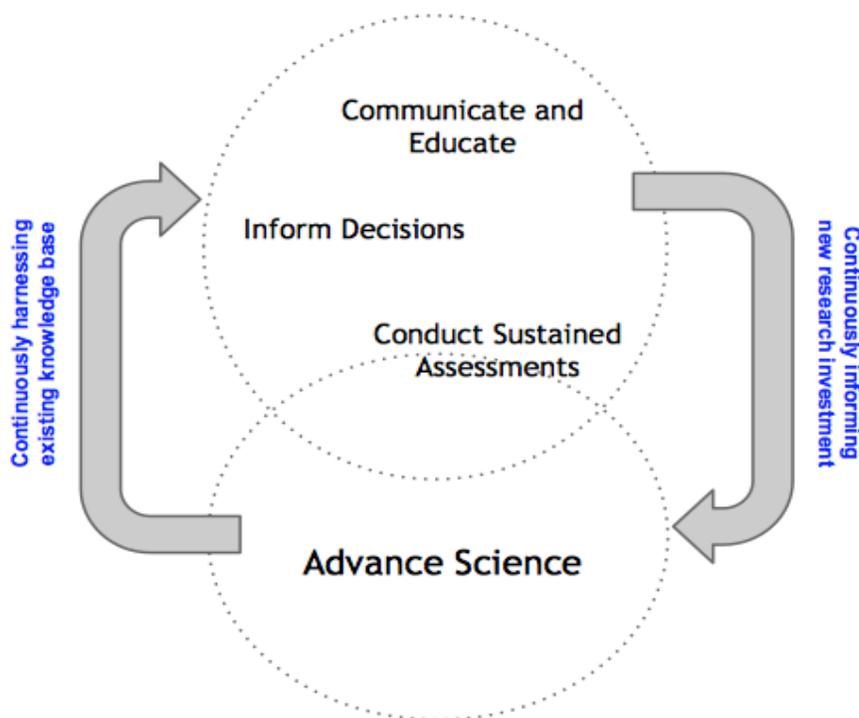
<sup>2</sup> Both “the Strategic Plan” and “the Plan” refer to the *National Global Change Research Plan: 2012-2021* (<http://library.globalchange.gov/u-s-global-change-research-program-strategic-plan-2012-2021>)

<sup>3</sup> “USGCRP” and “the Program” will be used interchangeably.

<sup>4</sup> [http://www.nap.edu/catalog.php?record\\_id=13330](http://www.nap.edu/catalog.php?record_id=13330)

<sup>5</sup> Stokes, D.E., 1997: *Pasteur's Quadrant – Basic Science and Technological Innovation*. Brookings Institution Press.

time, across scientific disciplines, across domestic and international partnerships, and across the capabilities of science and the needs of stakeholders.”



**Figure 1:** The four Goals of the National Global Change Research Plan: 2012-2021. The fundamental scientific research foundation of USGCRP is in continuous dialogue with the decision support, outreach and engagement, and assessment arms of the Program. This dialogue works to operationalize the evolving scientific knowledge base to meet pressing national needs for responding to global change, as well as helps to guide strategic new investments in research.

The global change challenge is one of enormous human significance. Systematic identification and characterization of the most urgent vulnerabilities and the greatest risks faced, so as to help prepare and build societal resilience effectively and sustainably, is a national and international grand challenge. This is brought home by the charge put forward in the President’s June, 2013 Climate Action Plan to deliver the science needed to support national preparedness in the face of global climate change.<sup>6</sup>

*“As we act to curb the greenhouse gas pollution that is driving climate change, we must also prepare for the impacts that are too late to avoid. Across America, states, cities, and communities are taking steps to protect themselves by updating building codes, adjusting the way they manage natural resources, investing in more resilient infrastructure, and planning for rapid recovery from damages that nonetheless occur. The federal government has an important role to play in supporting community-based preparedness and resilience efforts, establishing policies that promote preparedness, protecting critical infrastructure and public resources, supporting science and research germane to preparedness and*

<sup>6</sup> <http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf>

*resilience, and ensuring that federal operations and facilities continue to protect and serve citizens in a changing climate.”*

As explicitly recognized in the USGCRP Strategic Plan, however, these aspirations for more direct societal relevance of the scientific knowledge base, aided by strategic investments in the “new” areas of the Program, are not achievable without significant contributions from across the breadth of the disciplines that are often referred to collectively (variously in different contexts) as the social sciences, social, behavioral, and economic sciences, or human sciences.

To support its mission and vision, USGCRP must integrate, in a strategic, targeted, and efficient way, contributions from experts such as economists, geographers, demographers, decision scientists, sociologists, anthropologists, communications experts, and cognitive and behavioral scientists. The Program needs this expertise to align research with national needs in helping to understand the fundamental human dimensions of global change, in linking the Program’s basic and applied components, and in moving knowledge into action.<sup>7</sup>

**Note on Language:** The term “social sciences” will be used as shorthand in this white paper, acknowledging that this term does not adequately identify many of the disciplines relevant to a number of the topics and recommendations discussed below. Where needed for clarity in different parts of the text, more specifically appropriate terminology will be used.

Why is this so? It is because people, and their communities, institutions, and governments, are at the center of the three main aspects of our global change problem:

**Humans are *drivers* of global change:** Better integration of social sciences expertise is needed to account for human actions in the integrated Earth system to understand, describe, and model the causes of global change, as well as to consider a broader range of possible futures (and potential surprises) across both biophysical and socioeconomic dimensions

**Humans are *affected by* global change:** Better integration of social sciences expertise is needed to understand the consequences of global change for human communities and systems, including impacts at the national, regional, and local scales and on key socioeconomic sectors

**Humans have *the capacity to respond* to the risks posed by global change:** For example, social sciences expertise and practices are needed to support the current preparedness and resilience imperative, where there is a high demand for broader stakeholder participation and

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<sup>7</sup> See also Science and Technology Priorities for the FY 2015 Budget: “*R&D for informed policy-making and management: Agencies, especially those with primary missions other than R&D, should give priority to R&D that strengthens the scientific basis for decision-making in their mission areas, including but not limited to health, safety, and environmental impacts. This includes efforts to enhance the accessibility and usefulness of data and tools for decision support, as well as research in the social and behavioral sciences to support evidence-based policy and effective policy implementation.*” <http://www.whitehouse.gov/sites/default/files/omb/memoranda/2013/m-13-16.pdf>

information exchange in scientific processes and to support decision-making in operational and policy settings, such as climate change adaptation planning by federal agencies

*To help meet these needs, USGCRP has the opportunity and the mandate, under its new Strategic Plan and the President’s Climate Action Plan, to: support new research in the social sciences; reach more deeply into its participating agencies to access and benefit from existing social scientific expertise; establish partnerships with agencies that have not traditionally been involved in USGCRP but have extensive social sciences capacity; and leverage emerging new interagency bodies, communities of practice, knowledge networks, and other formal and informal institutional arrangements aimed at getting science into practice.*

## 2. Background

**Social Sciences in the USGCRP Context:** The “social sciences” are comprised of many different disciplines, each with their own theories, frames, and methods, and therefore each brings a different perspective to understanding global change. Taken together, these disciplines can provide a nuanced understanding of the human dimensions of global change. Many of these disciplines contain common theoretical framings – such as human perception and behavior; social institutions, societies, and governance; and risk framing and decision making – that are useful in the context of a number of the imperatives articulated in the Strategic Plan. The social sciences can be solutions-oriented and context-specific, which is helpful in supporting real-world decisions. They are often distinguished from the natural sciences by the approaches taken and/or the questions asked. In addition to helping quantify the human drivers and impacts of global change, social scientists ask the questions that arise from looking at global change from an initially social or human perspective, including explanations for the behaviors and interactions of individuals, communities, markets, nations, and all types of institutions.

The new USGCRP Strategic Plan highlights a wide range of social science topics as being important to supporting the Program’s mission and vision and achieving its short- and long-term goals. The words in the Plan reflect the *conceptual* integration that has been taking place within USGCRP over the recent past. The purpose of this white paper is to provide guidance on concrete steps that will bring the Program closer to the implementation of this integration *in practice* to achieve its desired outcomes.

### Historical Context

The call for a more comprehensive integration of social sciences research to support the breadth of USGCRP activities has not, of course, occurred in a vacuum. On the contrary, it builds from a rich tradition within USGCRP of significant accomplishment in many areas central to the major topics discussed in this white paper. For example, the Human Contributions and Responses (HCR) and Land-Use and Land-Cover Change (LULCC) Interagency Working Groups (IWGs) coordinated substantial efforts over the past decade in a number of areas, including (among many others):

- The establishment of the National Science Foundation (NSF) Decision Making Under Uncertainty

(DMUU) research centers

- Explorations of the utility of seasonal and interannual forecast products to support planning decisions related to crop planting, wildfire management, forestry, water resources, and public health
- Research to understand the natural and anthropogenic drivers of large-scale land-use and land-cover change, and the resulting regional and global climate impacts

In addition, a variety of multi-agency expert reports, referred to as Synthesis and Assessment Products (SAPs), were created under the auspices of the Program, including for decision support- and human dimensions-related areas such as “Goal 5: Explore the uses and identify the limits of evolving knowledge to manage risks and opportunities related to climate variability and change.”<sup>8</sup>

And finally, the United States is the world leader in Integrated Assessment Models (IAMs), as a result of continued investment by the Department of Energy (DOE) as part of the overall USGCRP portfolio. These models explicitly link socioeconomic drivers of global change with climate system processes, thereby allowing research and policy makers to explore issues such as greenhouse gas mitigation options, changes in terrestrial carbon stores, and the development of emissions scenarios that underpin Global Climate Model (GCM) studies of potential future climate change, among many other areas. Continued development and investment in this area should remain a high priority for USGCRP under its new decadal Strategic Plan.

The recommendations put forward in this white paper embody the critical dual role of the social sciences in the USGCRP context: namely, that **social sciences research and expertise is both an important part of the integrated knowledge base about the causes and consequences of global change and can identify a set of principles that help make this knowledge “work” better for society; i.e., makes possible the linkage of science and societal actions.**

Improved integration also presents important challenges for USGCRP. The different norms in natural and social sciences disciplines introduce significant transaction costs into collaboration. For example, social sciences frequently start with observations of human behavior, which may not be reducible to a set of equations consistent with physical climate systems studies. Similarly, Earth system models cannot easily operate across the full range of scales necessary to comprehensively link human systems and decision-making to biophysical processes.

Historically, USGCRP has framed the science of global change mostly in terms of the physical sciences. As such, despite investments in environmentally focused social science in a few agencies, in general the federal programs that participate in USGCRP have not made it a high priority to build internal capacity to advance and draw upon the existing social sciences knowledge base. There is also work (and investment) needed to foster greater emphasis on global change problems within the “core” social sciences disciplines.

These factors mean that, unlike for most of the areas of knowledge it has focused on over the last 20+ years, USGCRP member agencies will need to establish, invest in, and sustain partnerships and build communities of research and practice beyond its historical core of agency participants to deliver on the expanded scope of activities put forward in its new

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<sup>8</sup> <http://www.climate-science.gov/infosheets/factsheet5/default.htm>

Strategic Plan over the next decade. Making progress on all of the above will also require a new commitment to joint problem formulation between biophysical and social scientists.

**This Task Force:** In recognition of the needs and challenges articulated above, the Subcommittee for Global Change Research (SGCR) directed the formation of an ad hoc Social Sciences Task Force, with membership drawn from the USGCRP agencies, to identify options, and provide recommendations, for improving the integration of needed social sciences contributions into the USGCRP portfolio (see Appendix A for the Task Force charge from the SGCR). This integration will certainly be aided by new research investments in the social sciences, but it also will depend on the efficient application of targeted social scientific expertise to assist in developing and refining the processes and institutional arrangements needed to achieve the new engagement, assessment, and decision support elements of the USGCRP portfolio.

The Task Force was also asked to engage with the National Research Council (NRC). In their review of the USGCRP Strategic Plan, the NRC identified in particular the need to identify initial steps the Program would take with respect to the social sciences to achieve the proposed broadening of its scope, to develop critical capacity that is now lacking, and to link the production of knowledge to its use. To establish an ongoing dialogue around these issues, the Task Force and the NRC therefore co-hosted a one-day workshop in July 2012 to explore issues related to better integrating the social sciences within the evolving Program and provide inputs to the development of this white paper. In addition, the Task Force discussed its findings with, and received feedback from, the NRC Board on Environmental Change and Society (BECS) during a one-day workshop in March 2013. As will be discussed later in the white paper, the Task Force recommends that this interaction between USGCRP and BECS continue beyond the lifetime of the Task Force.

This white paper (along with a number of spin-off activities sparked by the Task Force discussions; see Section 5) is the major deliverable of the Task Force. **It contains high-level recommendations on strategies for efficient integration that builds from existing efforts and focuses on an initial set of activities that are expected to lead to concrete deliverables consistent with the near-term priorities of the Program.** The subsequent sections outline the conceptual framework for social sciences integration into USGCRP that emerged from the Task Force's deliberations; the recommendations themselves, organized according to this framework and grouped by major topic area; and advice on near-term implementation steps.

### **3. Conceptual Framework**

The Task Force began with the challenging job of narrowing the scope of its work from the possible universe of ways the social sciences might be integrated within a global change research program. A number of principles guided this scoping exercise, beginning with the need for tangible early successes in addition to a longer-term strategy. The Task Force therefore spent time considering which of USGCRP's current activities provide straightforward

opportunities to integrate more social sciences expertise, and where the Program could reap substantial near-term benefits from this improved integration, while achieving efficiencies.

In particular, the Task Force placed a high priority on leveraging existing efforts for which there is already momentum. These include, for example, activities associated with the Interagency Climate Change Adaptation Task Force (ICCATF),<sup>9</sup> the National Climate Assessment (NCA), and existing IWG activities. The Task Force also recognized the need to search for new capacity via partnerships beyond USGCRP to support longer-term transformation of the Program, a topic that has broader currency within current USGCRP implementation planning, as will be discussed in more detail in Sections 4 and 5. And it recognized the need to propose strategic investments in social sciences research that resonate with USGCRP agency missions and can be implemented in the near term. The following can thus be considered the “implementation principles” underlying the recommendations discussed in this white paper:

### **Implementation Principles**

- Prioritizing activities where there is existing momentum, or that provide straightforward targets of opportunity for improved integration of the social sciences
- Leveraging existing groups and structures within and outside USGCRP
- Emphasis on capacity building through “learning by doing”
- A combination of small, exploratory steps for “early wins,” along with a few “big bets”

In these multiple contexts, the conceptual model described in Figure 2 diagrams the major topic areas, and the relationships between them, within which the Task Force thought it would be most useful to provide recommendations. The Task Force identified these categories as requiring, and providing the opportunity for, near-term progress in the improved integration of social sciences research, expertise, and practice. It chose this conceptualization to be consistent with historical investments within USGCRP and emerging infrastructure around federal climate-related decision-making (particularly in adaptation). As such, it is intended to make the challenge of social sciences integration more tractable in the near and longer term.

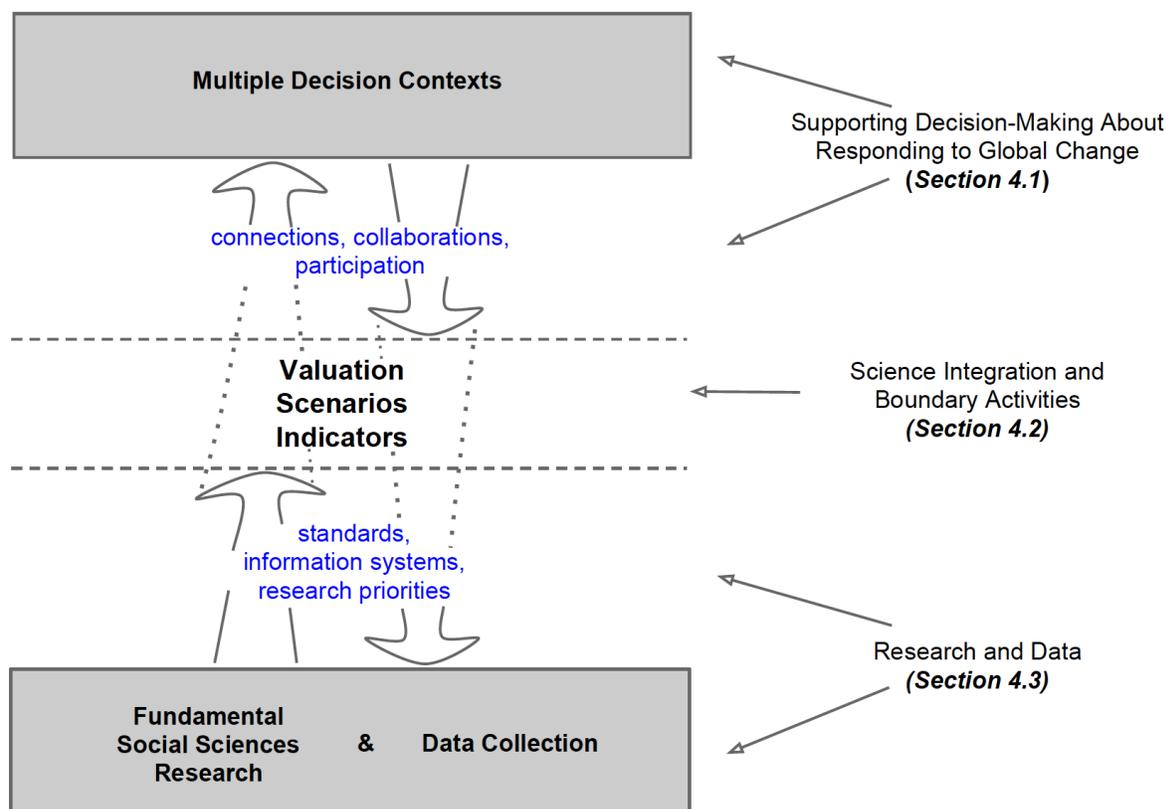
First and foremost, Figure 2 emphasizes the importance of decision context in driving priorities for research and action. Much has been written on the elements of effective, science-based decision support for climate-related problems.<sup>10</sup> The existing federally funded examples of use-inspired science, while modest in comparison to other global change investments, are in high demand. The goal is the production of knowledge that is “credible,” “salient,” and “legitimate;” and to meet this goal, widespread agreement exists on the need for collaboration and dialogue among scientists, managers, and decision makers. Therefore, social sciences knowledge and expertise is immediately essential to support the development of effective (and inherently iterative) processes to identify partners and build and sustain interactive dialogues involving

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<sup>9</sup> Now emerging as the “Council on Climate Preparedness and Resilience” under the new mandate of Executive Order 13653 (<http://www.whitehouse.gov/the-press-office/2013/11/01/executive-order-preparing-united-states-impacts-climate-change>).

<sup>10</sup> For example, see National Research Council, 2009: *Informing Decisions in a Changing Climate*. The National Academies Press, Washington, DC.

producers and users of scientific information – to jointly define questions and develop a deep understanding of decision processes about global change responses.<sup>11</sup>



**Figure 2:** Diagram showing the conceptual framework for understanding the boundary management, science integration, and translational activities that connect the fundamental USGCRP scientific knowledge base and the need to support decision-making about responding to global change. This framework identifies the major topic areas, along with bridging activities such as participatory decision-making processes, connection of knowledge networks, common data standards, and information system development, within which the Task Force thought it would be most useful to provide recommendations about the integration of the social sciences.

Therefore, Figure 2, which emphasizes that creating actionable science benefits tremendously from linking research with decision-making via multi-way dialogue and co-production of new knowledge, **represents a social process**. Social sciences expertise is thus needed to help create, and be taken up into, emerging institutional arrangements, knowledge networks, and other forms of capacity building for supporting national preparedness efforts.

The Task Force concluded that the thoughtful and deliberate management of the boundary space<sup>12</sup> – between the long-term development of the fundamental scientific knowledge base

<sup>11</sup> For example, see Moss, R.H., et al., 2013: Hell and high water: Practice-relevant adaptation science. *Science*, **342**, 696-698.

and the process of decision-making and the needs of decision-makers – is an important part of this process. This boundary space includes the scientific integration and translational activities that take place within it, such as:

- characterizing and assessing vulnerability
- scenario development and use in planning
- developing common standards for interoperability of biophysical and social data
- tracking change in impacts and vulnerabilities over time for decision-relevant indicators
- valuation of biophysical and societal impacts of global change
- creating participatory stakeholder processes to support science-based decision-making

These boundary spanning activities can not only profitably be informed by social science expertise, but can also create a number of logical insertion points for specific linkages between the social sciences and the Program’s research and assessment activities in the physical and biological sciences.

Several points about this framework warrant additional emphasis. First, this conceptual framework for the Science Integration and Boundary Activities intended to bridge gaps between science and action, as listed above, align remarkably consistently with those proposed in the National Climate Assessment and Development Advisory Committee (NCADAC) Special Report, “Preparing the Nation for Change: Building a Sustained National Climate Assessment Process.”<sup>13</sup> Though independently developed, they are nearly identical to the recommendations under Critical Element 2 (“Enhance and organize the scientific foundations for managing the risks and opportunities of climate change”) in the Special Report. Thus, there exists a substantial convergence between the strategic priorities of both Federal social scientists and the scientific community regarding what is most needed to move global change science into support for decision-making.

Second, critical research needs underlie boundary-spanning activities such as indicators, scenarios, and valuation. Their positioning in the boundary space does not mean they are disconnected from the research activities of USGCRP – quite the opposite. This space should be viewed as a locus for the integration of the diverse scientific capabilities of the Program as much as a place where science is translated into action. The latter absolutely depends on the former. More concretely, as will be highlighted in more detail below, robust research programs are needed to support the framework presented in Figure 2. This includes, but is not limited to, new fundamental research into the role of humans in the changing Earth system, and improvement of our ability to capture this understanding in the next generation of modeling tools, as per our framing above of humans as drivers of global change.

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<sup>12</sup> By “boundary space” we refer broadly to the collection of collaborative activities, information networks, and supporting institutional arrangements that link the development of fundamental scientific understanding about the causes and consequences of global change with the contextualization and use of (subsets of) that knowledge to support policy- and decision-making about responding to those changes.

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[http://downloads.globalchange.gov/nca/NCADAC/NCADAC\\_Sustained\\_Assessment\\_Special\\_Report\\_Sept2013.pdf](http://downloads.globalchange.gov/nca/NCADAC/NCADAC_Sustained_Assessment_Special_Report_Sept2013.pdf)

Third, these social sciences efforts must be fully integrated within USGCRP – not just as an add-on to existing activities. Global change encompasses both the biophysical and human realms and must be understood from the broadest possible perspective. To develop and sustain enthusiasm for these types of activities within the social-scientific community, the social sciences must be treated as equal partners not afterthoughts. We urgently need joint problem formulation between biophysical and social scientists to encompass the true dimensions of the challenge (and solutions) and advance the science meaningfully.

The conceptual framework described here thus provides a USGCRP-specific and internally consistent set of organizing principles for thinking through the challenge of better integrating social sciences research, expertise, and practices. The collection of recommendations in Section 4 below are organized according to the major categories and activities mapped in Figure 2 (as indicated by the section headings on the right-hand side of the diagram). Each of the recommendation subsections below attempts to address the importance of the given topic in the context of an evolving USGCRP and what needs to be done in terms of specific near-term and longer-term recommendations. The structure of the recommendations is intended to emphasize connections between the driving imperative – the need to support decision-making – with boundary spanning activities and objects and specific areas of new fundamental social sciences research.

## **4. Recommendations**

This section lays out the recommendations themselves, and how and why they fit into the overall enterprise in the context of the conceptual model presented above. Section 5 will provide information about plausible first steps in the implementation of these recommendations.

### **4.1 Supporting Decision-Making About Responding to Global Change**

As emphasized above, a properly identified and well-defined decision context is the starting point for effective decision support. This requires attention to both (1) the key elements of any given decision context and (2) building an effective process to link all relevant stakeholders with the information needed to support more effective decision-making within a given context.

Social sciences expertise has at least two unique roles or contributions in this regard:

1. In characterizing the often critical social aspects of a given decision context and the various interests involved;
2. In informing the development of structures, networks, and iterative processes to identify and transmit information in multiple directions (e.g., between knowledge producers, decision-makers, and other key stakeholders).

Regarding point #1, the social sciences have well developed bodies of research and meta-analysis pertaining to decision-making at the individual, group, community, and institutional levels, as well as the need for, and approaches toward, integration of stakeholder knowledge.

However, this understanding has not yet informed much practice within federally supported efforts to address global change and its impacts, creating opportunities for significantly scaling up the practical impact of this knowledge base. Agencies undertaking adaptation could benefit from experimenting with the implementation of decision-making methods and supporting protocols in several areas for which a mature and useful body of research already exists. These efforts should also include rigorous evaluation of processes and outcomes to support scaling up of successful efforts.

Regarding point #2, there is a small but growing collection of federal interagency groups, as well as formal and informal knowledge networks and communities of practices, working hard to create the capacity to incorporate information about climate and global change into planning efforts. Social sciences expertise could be instrumental in informing the structures and processes within and across these efforts to achieve more efficient and effective movement of science into action and improved decision outcomes. USGCRP has the opportunity to provide a “center of gravity” in this context, playing a constructive, agency-neutral role through its convening powers and direct connection to the science investments and knowledge base. In addition, USGCRP will be able to leverage this role in conjunction with the release of the 3rd NCA in spring 2014, where NCA products and findings will provide opportunities for enhanced decision support, as well as test cases for evaluating the uptake of this information into different decision processes and the link to outcomes.

It is important to acknowledge here that the Task Force made a deliberate decision to place the primary emphasis in this white paper on decision support related to preparedness, resilience, and adaptation, rather than for mitigation. Among the reasons is the current, strong federal focus on adaptation planning and building national resilience, compared to a less well-developed and agency-spanning national mitigation policy. Nevertheless, as far as the specific topic areas discussed below, a number of the priority research questions have relevance for both adaptation and mitigation (e.g., understanding social and behavioral drivers and improving the connection between human and natural system in models); in addition, indicators, scenarios, and valuation implicitly relate to both. With respect to valuation specifically, the Task Force chose to omit much discussion of the social cost of carbon, which has been treated extensively elsewhere, to focus on the relatively much less studied topic of understanding the costs of regional and sectoral impacts and the benefits of adaptation actions (and costs of inaction). In the view of the Task Force, an important follow-on activity will be to undertake additional analysis and deliberation, perhaps leading to additional recommendations, of the role of the social sciences in supporting the more systematic development of a mitigation science portfolio within USGCRP.

## **A. Scaling Up Decision Support Innovation**

### ***Develop a framework for vulnerability assessment:***

- Support the development and adoption of a systematic and flexible framework (or set of interrelated frameworks) for science-based global change vulnerability assessment in support of decision-making in key sectors

- Design this framework to fully acknowledge the following: (1) understanding and accounting for all important elements of the decision context; (2) attention to the key social frames during problem formulation; and (3) strategies for ensuring engagement and participation of key stakeholders in an iterative dialogue throughout the assessment process

***Experiment with alternative decision-making frameworks:***

- Implement, document, and assess a full range of decision-making approaches that are grounded in decision science theory and that may offer advantages for supporting global change-related decision-making (e.g., with respect to handling of deep uncertainty, highly distributed impacts, and the incorporation of key social and socioeconomic aspects of the decision context)
- Leverage opportunities for incorporating new USGCRP scientific findings and products, in particular those from the 3rd NCA, into these alternative decision-making frameworks in a variety of federal, regional, and sectoral contexts

***Experiment with public participation methods:***

- Implement, document, and assess a full range of well-studied public participation methods and protocols to support effective, science-based global change-related decisions that can enjoy broad-based legitimacy among key stakeholders
- Explore the potential of innovative methods (e.g., web-based, interactive tools) to facilitate greater participation and engagement and support effective decision-making

***Establish flexible guidance for incorporating local and indigenous knowledge into decision-making:***

- Highlight successful case studies from which best practices can be derived (and updated) for using local and indigenous knowledge in global change decision-making contexts, as well as stimulate future work in this area

**B. Institutional Arrangements, Knowledge Networks, and Capacity Building**

***Create a forum for participatory decision support exercises:***

- Support the development of a forum for participatory decision support exercises for the federal agencies that draw on and help communicate many of the activities mentioned in this paper, including scenarios, indicators, and valuation
- Encompass in this forum agencies that extend beyond USGCRP, including (1) agencies with missions that are likely to be impacted by global change and (2) agencies that have significant social sciences capabilities and shared interests in improving management of future risks
- Support these efforts with common, USGCRP-developed information products and tools (e.g., associated with the 3rd NCA), as well as with any (evolving) outcomes of the “Climate Data Initiative” and “Climate Resilience Toolkit” from the President’s Climate Action Plan, as developed by the White House and the agencies

- Structure these efforts to be iterative, such that learning occurs over time to improve uptake of relevant scientific information and overall decision outcomes

***Develop and encourage the evolution of global change knowledge networks:***

- Support the development of new knowledge networks<sup>14</sup>, and leverage existing networks, with capacity and expertise both in social sciences and with ensuring the accessibility of science in practical settings, as a means of disseminating information more effectively, and promoting social learning in peer-to-peer settings, around developing science-based responses to global change
- Develop and empower bridging organizations and individuals, as well as use the resulting knowledge networks as test-beds for studying the flow of information between users and producers of knowledge
- Establish dedicated capacity in the agencies to oversee and improve the level of networking (within individual agencies, across multiple agencies, and across the Federal government and outside entities) around sharing best practices in responding to global change

***Support regional coordination efforts for information development, delivery, and decision support:***

- Continue to facilitate regional cooperation among its member agencies, building on the effort initiated via the ICCATF (and to be taken up under the new Council on Climate Preparedness and Resilience)
- Build on existing efforts to promote the integration of local information with global change research and help ensure that contextualized knowledge base is accessible for adaptation planning and implementation actions on the ground

***Support evaluation of programmatic performance and effectiveness:***

- Use social sciences expertise to evaluate the effectiveness of USGCRP efforts and institutional structures designed to promote research cooperation and integration, to move science into action, and to communicate and engage diverse publics
- In particular, use social sciences expertise to evaluate the impact of the 3rd NCA, along with other regional and sectoral efforts, in catalyzing uptake of information and products into decision processes, influence on public attitudes, and value in supporting improved decision outcomes

***Strategically integrate social sciences capabilities across interagency working groups:***

- Design and employ organizational strategies to strategically integrate the social sciences capabilities of its member agencies across certain of its working groups and interagency efforts, as most needed, rather than walling off this knowledge base within a single, separate “human dimensions” group or component
- Provide organizational space within USGCRP for a strong and sustained multi-agency focus on advancing social sciences in the context of global change

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<sup>14</sup> For example, see Bidwell, D., T. Dietz, and D. Scavia, 2013: Fostering knowledge networks for climate adaptation. *Nature Climate Change*, **3**, 610-611.

- Leverage expertise from outside the realm of the USGCRP participating agencies rather than trying to develop “in-house” capacity in all areas

#### **4.2 Science Integration and Boundary Activities**

Vulnerability to global change impacts, as well as the ability to respond, is highly dependent on where people live and their demographic profile. Economic systems, institutions and governance, and available technologies and social networks are also critically important determinants of vulnerability. Robust planning in the face of global change is not possible without attention to these critical societal and socioeconomic factors.

Nevertheless, one of the most important conceptual and practical challenges for supporting global change-related decision-making is a lack of understanding about which specific variables need to be monitored and what metrics of risk are most useful to decision-makers – both in terms of indicators (to assess status, rates, and trends in decision-critical quantities) and scenarios (to envision future states). For example, global change-related decisions should be informed by indicators that track changing conditions, vulnerability, and adaptive capacity at a variety of scales, in much the same way that economic decisions are based upon a broad and carefully developed set of indicators (e.g., Consumer Price Index, Gross Domestic Product).

Moreover, a critical challenge is the lack of a centralized national capability to integrate socioeconomic information into indicators systems and scenarios we have already developed (or are developing) for physical and biological systems. Equally important is the lack of guidance on, and support for, participatory planning processes that make effective use of indicator and scenario information in decision-making, at the federal level on down.<sup>15</sup> And finally, there is a need to ensure a robust linkage between the needs for, and implementation of, indicators and scenarios efforts, and the fundamental research agendas needed to support these efforts.

Also affecting the ability to respond is the insufficient depth, accuracy, and level of detail of the monetized damages associated with global change impacts, especially at local scales. This is in part because the concept of value is often not easily defined or agreed upon. It is also related to the challenges of collecting data needed for valuation in a rigorous and consistent fashion across diverse categories of impacts. In addition, there is a unique set of challenges to valuation in the context of long-term global change, such as the potential for non-marginal impacts, unanticipated consequences, and the intergenerational aspects of valuing benefits of actions. As a result, global change-related benefit-cost decision-making at various levels of government (and in the private sector) is extremely limited and subject to a high level of uncertainty. Finally, as important to decision-making is assessment of the costs of inaction in the face of global change. In this context, improved monitoring and documentation of the societal impacts of the

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<sup>15</sup> We are using an expansive definition of the term “scenario” in this white paper, potentially encompassing both qualitative and quantitative elements, and acknowledging the need to carefully consider the design and implementation of effective, participatory processes within which scenario “objects” are embedded (and thereby ultimately have value for decision support purposes).

extremes, abrupt changes, and potential low-probability but high-consequence events that tend to dominate damages is an important need.

## **A. Indicators**

### ***Identify, refine, or develop societal indicators in support of a proposed NCA Indicator System:***

- Coordinate the identification, modification, or development of a suite of societal and socioeconomic indicators to be systematically tracked over time as part of agency efforts and a proposed NCA Indicator System, including indicators of key dimensions of regional and sectoral changes, impacts, vulnerabilities, and adaptation and mitigation responses
- Include both economic and non-economic indicators in this Indicator System
- Integrate these societal indicators with biophysical indicators already being used or under development, to support better assessment of impacts and preparedness and to transfer learning about vulnerabilities and response strategies across sectors/regions

### ***Develop leading indicators of societal impacts and vulnerabilities related to global change:***

- Coordinate USGCRP indicators and scenarios efforts to develop leading indicators (extrapolated trends or early warning indicators) that build upon indicators currently under development
- Develop leading threshold indicators, e.g., warning signs associated with threshold-crossing and large step changes in human systems

### ***Support indicator information system design and evaluation:***

- Use social sciences expertise to inform information system design and evaluation to ensure that information is decision relevant, customizable for scales and timeframes that are useful for a suite of decisions, and accessible to a range of audiences
- Using social science analysis techniques, study how such systems are being used and whether they are adequately supporting specific decision contexts

## **B. Scenarios**

### ***Develop national-scale scenarios that include both socioeconomic and biophysical information:***

- Lead the development of integrated, national-scale scenarios that incorporate both biophysical and socioeconomic dimensions of global change, using lessons learned and best practices from other national and international scenarios efforts, such as the Intergovernmental Panel on Climate Change (IPCC), the UK Climate Impacts Programme (UKCIP), the 3rd NCA, and other communities (e.g., the hazards community)
- Use these scenarios to support both agency decision-making needs and the 4th NCA, as well as contribute to approaches and methodologies for international assessments

- Engage agencies (e.g., Census, Bureau of Economic Analysis, portions of the land management agencies) that have not traditionally participated in the USGCRP, but would bring valuable expertise to the socioeconomic aspects of scenario development, such as population growth, migration, land-use change, and regional economics
- Develop tools and guidance to facilitate construction of socioeconomic scenarios at fine scales that maintain consistency with larger scale analyses and can support more detailed regional, local, and sector-specific exercises

***Support participatory scenario planning:***

- Develop guidance and supporting capabilities for carrying out tailored, participatory, scenario planning in support of decision-making in a changing environment, as a complement to a suite of national-scale scenarios products and tools
- Use the most up-to-date findings about the characteristics of effective participatory processes, risk communication, and the incorporation of scientific information in decision-making and coordinate with broader efforts to develop participatory decision-making processes, as described in Section 4.1

***Use these scenario capabilities to carry out pilot scenario planning exercises:***

- Organize the use of the national-scale scenarios and participatory scenario planning capabilities described above around a small number of pilot exercises<sup>16</sup> for critical regions or sectors expected to be highly vulnerable to global change impacts
- Consider scenarios of possible preparedness and resilience options as well as impacts scenarios and explore the adaptive capacity of the study systems in the face of different kinds of extremes events and “surprises”
- Use the pilots to study how the various scenario products are being used, their effectiveness for risk communication, and whether they are adequately supporting the given decision contexts

**C. Valuation**

***Develop guidance on key methodological issues in global change valuation:***

- Coordinate the development of a practical roadmap for producing consistent, transparent and comparable results from valuation studies
- Include: (1) establishing protocols for data collection to support valuation; (2) a typology of impacts and impact categories; (3) identification of sectors and impacts most ready for quantitative valuation; (4) guidelines and priorities for treatment of difficult, recurring cross-cutting issues (e.g., uncertainty, discounting, intersectoral and intergenerational interactions, ecosystem services valuation, aggregation); and (5) the evaluation of benefits transfer protocols; and non-economic valuation methodologies
- Evaluate and synthesize the best practice guidelines developed by several agencies to develop a starting point for global change valuation

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<sup>16</sup> For example, see the discussion of “stress testing” in Stern, P.C., K.L. Ebi, R. Leichenko, R.S. Olson, J.D. Steinbruner, and R. Lempert, 2013: Managing risk with climate vulnerability science. *Nature Climate Change*, **3**, 1-3.

***Synthesize existing valuation studies:***

- Coordinate identification and gathering of information from existing valuation studies, across a range of global change impacts, regions, and sectors, to aggregate into national-scale estimates of climate impacts for key socioeconomic sectors and in areas of particular interest for agency decisions

***Support the introduction of valuation information into the 4th NCA:***

- Building from the data gathering and aggregation efforts and the methodological guidance described above, develop estimates of impacts, and costs of inaction, for at least a subset of the sectors, sectoral cross-cuts, and regions expected to be included in the 4th NCA
- Use the chapters of the 3rd NCA report for an initial screening-level feasibility analysis as much as practicable

**4.3 Research and Data**

The impacts of global change - as well as pathways to effective responses - are conditioned to a large extent by where people live, how fast populations grow, move, and change, the exposure of built and natural assets to changing conditions, and how well decision-making frameworks and policy mechanisms can facilitate decisions that promote resilience. The need for fundamental research into the determinants of vulnerability and resilience, and the decision contexts and processes that support actions in the face of these drivers, also threads through the entire conceptual framework articulated above.

The concept of vulnerability refers to the degree to which a system (e.g. city, ecosystem) is susceptible to, and unable to cope with, both existing variability and the adverse impacts of global change. Along with its subconcepts of exposure, sensitivity, and adaptive capacity, vulnerability provides a major thread linking science, society, and decision-making about responses to global change. It helps focus scientific research around key societal concerns and provides a framework for identifying the sectors, regions, resources, and populations that are most at risk from the impacts of global change. It also aligns strongly with foundational concepts of environmental management, such as risk assessment and benefit-cost analysis, thereby providing a bridge between scientists and the managers who will be on the front lines of actions to promote adaptation and mitigation. Understanding of the key elements of susceptibility and coping is underpinned by basic social sciences research across multiple scales – individuals, households, communities, businesses, institutions, governments – in addressing factors such as social capital, social support systems, and distributional effects across populations.

A fundamental challenge for understanding risks and vulnerabilities, creating and implementing useful decision support objects such as indicators and scenarios, and designing effective coping strategies, remains the need to better integrate across parallel research efforts in the biophysical and social sciences communities. The nature of problems related to global change risks and responses is such that we cannot afford to simply have social sciences as an add-on to research agendas driven only from the biophysical side (or vice versa); co-framing of

research questions from the social sciences and biophysical sciences perspectives is not at all the norm today in global change research, but it is essential. Initial opportunities to engage social sciences communities so as to accomplish such co-framing will likely be most available around existing research trajectories in these communities. There is significant potential for learning from, and leveraging, existing biophysical-human dimensions partnerships that have been developed under the international “sustainability science” rubric.

Another challenge is the lack of coordinated, large-scale data to support the ongoing development of theory and models, including studying the underlying “why” behind the behaviors and interactions of individual, communities, and institutions. Even when they do exist, such data are not always in easily accessible formats or repositories, and/or they are not easily combined with biophysical data to explore key global change problems. Attention to these data issues helps provide the foundation for robust work in indicators, scenarios, and valuation. Community data efforts associated with “core” social sciences disciplines, as well as from other scientific and applications communities (e.g., natural hazards, urban ecology), may provide useful models to emulate. In particular, the impacts, response, and recovery efforts associated with extreme events (e.g., Hurricane Sandy, recent drought and wildfires) are important settings for data collection and improved understanding about crisis, reducing vulnerability to future events, and adaptive capacity of communities and institutions.

In addition, the development of coupled human-natural systems models across organizational, spatial and temporal scales is especially important. To develop fully the science of coupled human-natural systems, modeling capabilities should consist of nested hierarchies of models of local systems within regional systems, and in turn within the global system. Impacts, dynamics, and emergent properties at each scale can influence model behavior at all other scales. Policy- and decision-making that can potentially be supported through modeling efforts occurs at all of these scales. Specifically, it will be critical to support efforts to accelerate progress in small-scale Impacts, Adaptation, and Vulnerability (IAV) modeling, the development of next-generation Integrated Assessment Models (IAMs) that consider the complex interactions of human and natural systems at larger spatial scales, and the next generation of Earth System Models (ESMs) that increasingly couple physical and biological system components to sophisticated representations of societal processes.

Finally, as noted above in Section 4.1, the social sciences have well developed bodies of research and meta-analysis pertaining to decision-making at the individual, group, community, and institutional levels, including on methods for integrating stakeholder knowledge. Therefore, significant near-term progress is possible via experimentation with decision-making methods and supporting protocols drawn from existing research insights for applications such as leveraging information and products from the 3rd NCA, as well as created through current mission agency efforts, to support national preparedness planning. These decision-making experiments themselves should become objects of study for new social sciences research. In addition, how to measure “success” is itself a research question: social sciences expertise should be used to evaluate the effectiveness of USGCRP efforts and institutional structures

designed to promote research cooperation and integration, to move science into action, and to communicate and engage diverse publics.

The two sets of recommendations below speak to the above issues and challenges. As these pertain to fundamental social, behavioral, and economic sciences research and data, they underpin progress in other components of the conceptual framework described above. They are aimed at making research progress in key areas required for improved vulnerability assessment, decision support, valuation, and the development of indicators and scenarios systems. While this section articulates some initial focus areas and initial questions, it is anticipated that growth into an integrated global change social sciences research program will be a long-term, evolutionary process that will require sustained attention from USGCRP and its partners.

Appendix B provides an extended discussion of a number of the motivating social sciences questions and knowledge gaps that helped inform the priorities articulated here.

## **A. Priority Topics for New Fundamental Research**

### Vulnerability and Adaptive Capacity

#### **Stimulate coordinated interdisciplinary research on the human dimensions of extreme events:**

- Coordinate research and widespread data collection to support both new fundamental understanding and decision-making that enhances social, ecological, and economic resilience to extreme events
- Leverage the new knowledge thereby acquired to support the development of improved suites of indicators of vulnerability, and improved scenarios of future risks, in the face of changing extremes

#### **Establish long-term, place-based studies of adaptive capacity and adaptation efforts:**

- Support research to improve understanding of the underlying social and behavioral factors that lead to adaptive capacity and resilience
- Fund long-term observations of individual, community, and regional responses to system perturbations over time and provide insight into these underlying social and behavioral factors

### Improved Decision-Making Frameworks, Processes, and Information Products

#### **Support research for implementation and evaluation of alternative decision frameworks:**

- Support research to accelerate progress on the role of risk perception and communication in decision-making
- Develop and test improved decision-making frameworks for managing the potentially irreducible uncertainty associated with long-term climate and global change

- Support research into the impacts of complex decision-making environments (e.g., including multiple scales, stakeholders, or jurisdictional relationships) on decision processes, as well as methodologies for improving decision-making within such environments

**Support comparative studies of decision processes across different decision contexts:**

- Understand which key attributes of effective decision processes may be consistent across contexts and scales
- Support comparative analysis across multiple decision contexts, including sectors, spatial scales, time horizons, and risk tolerances to establish these consistent elements of effective, scientific information-based decision support
- Examine approaches to uncertainty, participatory processes, incorporation of local and stakeholder knowledge, and the design and use of boundary objects such as scenarios

**Support research into developing, sustaining, and using knowledge networks:**

- Support new research to explore how such knowledge networks form, are structured and maintained, and mediate information flows
- Use the new insights from this research to support the process of creating relationships that lead to the formation of effective knowledge networks, promoting social learning within such networks (e.g., socialization and dissemination of rules of thumb and best practices in a peer-to-peer setting), and identifying and leveraging “bridgers” that increase the connection density within the network

**Support new social sciences research around key elements of indicator development:**

- Support research to develop methods and approaches for indicators of societal changes, impacts, vulnerability (including adaptive capacity), and adaptation and mitigation responses
- Explore methods and approaches for developing indicators of early warning signs of threshold crossing in human systems
- Develop these indicators across multiple space and time scales and multiple decision contexts

**Support new social sciences research around key elements of scenario development:**

- Explore methods and approaches for developing scenarios of possible preparedness and resilience options, adaptive capacity, and adaptation and mitigation actions, including accounting for governance issues and institutional capacity for, and barriers to, action
- Explore methods and approaches for developing scenarios that incorporate future extreme events, cascading impacts, and the possibility of future “surprises”
- Apply these methods and approaches across multiple space and time scales and multiple decision contexts

**Improve valuation of global change impacts, responses, and costs of inaction:**

- Support research to improve the ability to understand and analyze, and reduce uncertainties associated with, climate impacts valuation through data collection, improvements in measurement, theory building, and theory validation
- Support the development of new methodologies for transferring valuation information and generalizing climate impact value information, particularly at the national scale
- Support new research in methods and approaches for non-economic valuation
- Support new research in ecosystem services and natural capital valuation

### Integrated Human-Natural Systems Research and Modeling

#### **Support efforts to accelerate progress in integrated human-natural systems modeling:**

- Expand support for dynamically linking biophysical systems models with the underlying demographic, social, and behavioral drivers of population change and migration, land-use change, energy use, natural resources depletion, technology change, the evolution of engineered systems, and hazard responses in Impacts, Adaptation, and Vulnerability (IAV) modeling
- Expand support for the development of next-generation Integrated Assessment Models (IAMs) that consider the complex interactions of human and natural systems and the influence of mitigation and adaptation options and coupled feedbacks
- Expand support for the next generation of Earth System Models (ESMs) that increasingly couple physical and biological system components to sophisticated representations of societal processes and are capable of exploring detailed human drivers of global change and the consequences of dynamic feedbacks between human and natural systems processes
- Support the use of agent-based modeling approaches to explore human-natural systems interactions

#### **Enhance coordination of human-natural systems research and modeling efforts**

- Share methods, models, and best practices across agencies (and the Federally funded scientific community) wherever possible to reduce duplicative effort, facilitate model integration, and cross-pollinate innovation in research and modeling

### Evaluation Research

#### **Support evaluation of processes and institutional arrangements for the use of scientific information in global change response planning:**

- Support new survey, focus group, and in-depth case study research to understand the utility (for various scales and decision contexts) of boundary-spanning projects (e.g., indicators, scenarios) developed under USGCRP auspices
- Include in these efforts the use of social sciences expertise to evaluate the impact of the 3rd NCA in areas such as uptake of information and products into decision processes, influence on public attitudes, and the value in supporting improved decision outcomes

#### **Support evaluation of programmatic performance:**

- Support new research in “public values mapping” for evaluating USGCRP progress toward meeting stated goals for public benefits arising from research, science integration, assessment, decision support, and engagement efforts

## **B. Data Policies and Standards**

### **Identify existing federal social sciences data useful in a global change context and create partnerships to expand accessibility:**

- Coordinate the identification and (digital) aggregation of social sciences datasets across the federal government, including federally funded extramural efforts, relevant to global change research and responses
- This effort should begin with baseline demographic and economic data, data on human assets and the built environment, and data collected surrounding recent extreme events and in support of disaster recovery efforts (e.g., related to Hurricane Sandy, recent droughts, etc.)

### **Improve integration of social sciences data into emerging information systems designed for planning and preparedness:**

- Coordinate, in partnership with stakeholder agencies, the integration of social sciences data into digital information systems to serve the analysis and visualization needs of both researchers and decision-makers, including research to identify the most important types of data to target
- These efforts should be informed by best practices in information system design derived from successful existing programs; this could be carried out under the auspices of the overall USGCRP Global Change Information System (GCIS) effort

### **Design and implement a set of social sciences data management policies to inspire improved data integration:**

- Coordinate the establishment of a set of data and metadata policies and standards to ensure that data collected by federally sponsored investigators can be made widely available, incorporated into community data initiatives to support multiple uses, and are interoperable with physical/biological Earth systems data (e.g., via geocoding and the development of standardized semantics and ontologies to aid in data discovery and understanding)
- These efforts should be informed by best practices in data management derived from the experiences of USGCRP agencies and related efforts (e.g., the GCIS effort)

### **Incorporate social sciences measurement capabilities into Earth observations portfolio assessments:**

- Pay close attention to cataloguing and prioritizing critical social sciences observing systems, capabilities, data streams, and repositories, and traceability to societal needs related to global change vulnerability and resilience, in portfolio assessments such as those performed under the new U.S. Civil Earth Observations Assessment process

## 5. Immediate Next Steps in Implementation

Since the Task Force began its discussions for the development of this white paper, and ultimately formulated the above sets of recommendations, a number of relatively straightforward immediate next steps began crystallizing. Most of these involve synergies with ongoing (and newly created) USGCRP activities. The Task Force suggests that the following priority actions would help USGCRP logically and effectively build toward a fuller realization of the longer-term recommendations in this white paper.

These suggested next steps align with the same basic categories as the recommendations themselves: i.e., they refer to activities that are variously research-focused and/or oriented toward moving science into action. For each category, we have also attempted to identify the existing USGCRP groups that might logically play a leading role in pursuing these activities (this identification of groups is also not intended to be exhaustive or exclusive).

Before proceeding, it is worth discussing some organizational considerations. ***One clear implementation-level recommendation from this Task Force is to foster an organizational framework for ongoing social sciences integration within the structure of USGCRP.*** Specifically, there is a need for an organizational structure that can:

- Simultaneously connect with, participate in, and provide oversight for a set of distributed activities across USGCRP involving integration of the social sciences: both as articulated in the recommendations above and the near-term actions discussed below;
- Provide an implementing capability for important, near-term, integrative tasks such as creating aggregated web-based resources (on globalchange.gov) for social sciences-related programs, capabilities, and knowledge across the Federal government;
- Provide a center of gravity for continuing the recent engagement with research efforts and communities of practice external to USGCRP<sup>17</sup> that are a source of fruitful partnerships, capacity, opportunities for collaboration, etc.; and similarly to identify new groups, expertise, and capacity within the Federal government, but currently outside USGCRP, that should be brought into USGCRP activities;
- Provide ongoing engagement with the extramural social sciences research community, beginning with sustaining and building upon the recent partnership with the NRC Board on Environmental Change and Society (BECS), to help identify research gaps and to help move resulting research agendas into the scientific community.

These requirements suggest to this Task Force the need for a two-part organizational structure, consisting of a small, centralized ***USGCRP Social Sciences Coordinating Committee***, to promote cross-working group collaboration and progress toward the recommendations in this white paper; as well as an ***enhanced participation by social scientists on a number of strategically chosen USGCRP working groups***, that would in turn report out to this Coordinating Committee. The Coordinating Committee is envisioned as a small team of agency

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<sup>17</sup> Examples include the Social Sciences Round Table and the Interagency Land Management Adaptation Group (ILMAG), the social sciences working group of the National Ocean Policy, and others.

social science and global change experts that could operate largely “virtually.” They would be tasked with providing input and guidance to existing USGCRP working groups to ensure that social sciences are better reflected in their work: for example, meeting with the working group leads to discuss and provide input on how these groups could respond to the substantive recommendations contained within the White Paper; helping identify synergies across multiple working groups; and, importantly as per above, suggesting additional members with particular social sciences expertise that could join these working groups and assist in implementing these recommendations. The Coordinating Committee would report back to the Principals on overall progress toward these recommendations across the working groups.

At the same time, between the initiation of this Task Force and the present, USGCRP has continued to deliberately take steps to advance its own larger institutional evolution to more fully realize the vision of its 2012 Strategic Plan. Two major pieces of this planning and implementation process are the Office of Science and Technology Policy (OSTP)- and National Security Council (NSC)-chaired USGCRP Operations Task Force, and the Fast Track Action Committee on building a sustained assessment process within USGCRP (created in response to the Sustained Assessment Special Report from the NCADAC to the U.S. government). We have already noted the strong alignment of the recommendations of this Social Sciences Task Force and those of the Sustained Assessment Special Report. Similarly, the Operations Task Force, which includes representation from OSTP, CEQ, the Office of Management and Budget (OMB), USGCRP science agencies, USGCRP mission agencies, and mission agencies outside USGCRP (e.g., the Department of Homeland Security, the U.S. Army Corps of Engineers) that are interested in a closer partnership, is currently deliberating on questions that relate closely to the issues we discuss in this white paper, such as updated the “business model” for USGCRP in the context of the new, more expansive mandate under the new Strategic Plan. Our Social Sciences Task Force can assist the Operations Task Force by providing guidance on the need for engaging groups and agencies beyond USGCRP that are strong in the social sciences, and in turn, the Operations Task Force outcomes may lead to improved mechanisms for such partnerships and for enhanced capacity building in areas like the social sciences.

In the above context, a Social Sciences Coordinating Committee will therefore also be valuable in promoting convergence across the many common elements of social sciences integration, the evolution of USGCRP’s organizational and business model, and decisions about how to sustain an ongoing assessment process that is fully integrated with USGCRP’s core functions and of service to Nation in its efforts to respond to global change.

### **Supporting Decision-Making About Responding to Global Change**

Key Groups: Adaptation Science Interagency Working Group (ASIWG), Climate Change and Human Health Group (CCHHG), Interagency National Climate Assessment group (INCA)

There exist a set of logical first steps for the USGCRP working groups most closely involved as part of their primary missions with moving global change science into action, including the ASIWG, the CCHHG, and INCA, particularly as their activities relate to adaptation planning,

preparedness, national resilience, including implementation of the President's Climate Action Plan under Executive Order 13653.

For example, the release of the 3rd NCA in early 2014 will create a unique opportunity to carry out a number of high-value activities, including:

- Supporting agency adaptation planning using information products derived from the 3rd NCA
- Exploring and experimenting with the use of different kinds of participatory processes, with Federal agency users, for incorporating this information into their planning
- Evaluating the utility of these products and processes

A few key sources of guidance exist for prioritizing the decision contexts most ready for these kinds of scientific information product-drive decision support exercises. These include the ASIWG analysis of the 2013 agency adaptation plans<sup>18</sup> and the key decision contexts identified as the initial targets for the climate data component of the President's Climate Action Plan: i.e., coastal vulnerability to sea level rise, climate change and human health, transportation and supply chain risks, food production vulnerability, energy supply vulnerability, and ecosystem vulnerability.

Some of this work is already underway, for example using NCA sea level rise scenarios to support resilience planning in post-Sandy recovery,<sup>19</sup> and should be built upon and expanded. The Sandy example in particular provides a critical opportunity for improving our understanding of the use of scenarios to manage the risks of an uncertain future, information product discovery, access, and usability, and the pathways and networks that connect users to the tools and information. Overall, it would be extremely valuable to enlist social sciences expertise into these initial activities aimed at developing typologies of users and decisions so as to better match these with information products and collaborative processes of decision support.

Another major opportunity relates to bringing together the existing, extramurally funded social sciences knowledge base around mission agency needs for improved climate-related decision support. One suggestion would be to develop a series of workshops that would bring together social sciences investigators with regulatory and resource management agency participants working to develop adaptation strategies and incorporate climate information into their planning. The participants would work together to operationalize the knowledge and practices from the social sciences research community around particular decision contexts and decision support needs of greatest interests to the agencies involved – i.e., conduct somewhat of a matchmaking exercise to gain advice about the social process aspects of the given decision support needs and the value that social sciences expertise could bring to these processes. Pieces of this are already happening in coastal vulnerability (post-Sandy), drought-related, and land management settings within the Federal agencies, among others, and these would provide productive targets of opportunity for focusing initial efforts.

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<sup>18</sup> See <http://globalchange.gov/resources/federal-agency-adaptation-planning-resources>.

<sup>19</sup> See <http://globalchange.gov/what-we-do/assessment/coastal-resilience-resources>.

## Science Integration and Boundary Activities

Key Groups: Indicators System technical teams, Group on Scenarios and Interpretive Science, INCA, ASIWG, CCHHG

As noted above, most of the recommendations from Section 2 of the Sustained Assessment Special Report, relating to vulnerability assessment, scenarios, indicators, valuation, and the treatment of scientific uncertainty in decision-making contexts, align extremely well with the recommendations in this white paper. Since the inception of the Social Sciences Task Force, a number of USGCRP activities and associated groups have developed and matured that relate to indicators, scenarios, and valuation in particular. The initial efforts of these groups provide a number of good opportunities for improved social sciences integration and advancement of the recommendations in this white paper. These include (but are not limited to):

### Indicators:

- Collaborate with and support the current NCA Indicators System technical teams in defining, identifying data sources for, and systematically generating societal indicators
- Include a range of societal indicators in the launch of a proposed NCA Indicator System on the GCIS (anticipated 2015)
- Support decision science research to evaluate the utility of information provided by the Indicators System and its components to a range of audiences

### Scenarios:

- Hold a series of workshops aimed at entraining Federal agency partners and scientific community participants to develop population, migration, land-use and land-cover change, and regional economics scenarios that can be interoperable with physical climate system scenarios already in use in the IPCC and the NCA
- Deploy these new scenario products, along with guidance and tools for further tailoring and contextualizing this information, to support work toward the 4th NCA and agency needs for scenario information

### Valuation:

- Develop a web-based collection of resource materials (e.g., an inventory of existing government guidance documents) on valuation methodologies and data sources (ultimately to be linked to the GCIS information architecture); this could also include updated versions of the background white papers from the 2011 NCA valuation workshop
- Carry out an evaluation of the 3rd NCA report in terms of its potential for valuation – i.e., examine the chapters in the report and evaluate whether valuation would be possible; for example, if we have pricing information for the biophysical impacts represented (and/or models that can get us to prices), and we have physical changes that can be valued, then one could conclude that valuation is possible; if not, one would conclude that additional research is needed before valuation could be attempted

- Use the above as the basis for an expert workshop (c. 2015), to be convened by USGCRP, to identify opportunities for the highest priority application research that could be funded by the agencies
- Develop a preliminary roadmap for leveraging the above efforts toward increasing the strategic inclusion of valuation information useful in a risk management context in the 4th NCA, as well as for developing synergies with complementary activities in the NCA and across the broader USGCRP

## Research and Data

Key Groups: Process Research Clusters and Coordinating Committee, Interagency Group on Integrated Modeling (IGIM), Observations Interagency Working Group, GCIS working group

Finally, there are a number of clear paths forward on the more traditional research components within USGCRP as well. For example, the Process Research “Coordinating Committee and Cluster” structure under Advance Science has already developed, within its framework, space for new Clusters around human dimensions and social sciences topics. Once initiated, these Clusters would work, for example, to coordinate multi-agency funding of new research around the data and fundamental research recommendations in Section 4.3, and they might begin by considering all of the Task Force recommendations in these areas and collectively decide which are most feasible given current agency interests. Including these priorities into existing RFPs or Dear Colleague letters to advance the proposed research priorities could be a near-term way to bridge toward more integrated, multi-agency funding opportunities. Similarly, holding joint PI meetings/progress review meetings across multiple agencies could also support such bridging.

A productive side project within this Process Research space that might provide an additional and useful organizing principle is to attempt an updating of the “Social Process Diagram,” perhaps as integrated within a new “Bretherton Diagram” that significantly expands the view of the social sciences within these kinds of physical sciences framings of the overall problem of global change.<sup>20</sup>

In addition, the mission of the IGIM explicitly recognizes the importance of advancing human dimensions modeling, including improving representation of societal factors in ESM, IAM, and IAV models. Strengthening of these interagency discussions and new interagency collaborations in these areas would significantly benefit overall USGCRP efforts.

Finally, there is an opportunity for a significant amount of near-term progress on identifying Federal agency social sciences datasets and observing networks, and the collection, aggregation, metadata mapping, and ultimate incorporation into the broader GCIS efforts. In particular, large holdings, for example at Census and SEDAC, should be mined as soon as

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<sup>20</sup> See Mooney, H.A., A. Duraiappah, and A. Larigauderie, 2013: Evolution of natural and social science interactions in global change research programs. *PNAS*, **110**, 3665-3672 and <http://www.ciesin.org/documents/SocialProcessDiagram-SocialProcessDiagram.pdf>.

possible. In addition, USGCRP should encourage participation of social sciences programs and outside agencies in the just-initiated GCIS data sources survey.

# **Appendix A**

## **Original Charge to the USGCRP Social Sciences Task Force**

### **I. Motivation**

As articulated in the new USGCRP Strategic Plan, many of the critical questions related to understanding and responding to global change cannot be adequately addressed without substantial contributions from across a broad spectrum of the social sciences. To support its mission and vision, the Program must integrate the contributions of economists, geographers, anthropologists, cognitive scientists, behavioral scientists, sociologists, political scientists, urban planners, public health researchers, and other experts with research activities in the physical, chemical, and biological sciences. This will be a difficult challenge, but the new Strategic Plan now provides a critical opportunity to enhance the engagement of the global change science community with many of these disciplines.

### **II. Task Force Purpose, Goals, and Strategy**

The purpose of the Task Force will be to explore options, and provide recommendations, for improving the integration of needed social sciences contributions into the USGCRP portfolio so as to ultimately achieve the expanded scope of the Strategic Plan.

Charge questions:

- Of the potentially relevant social sciences topics, which are the most urgent and timely for USGCRP, and why?
- What expertise is needed to address these topics?
- What communities and partners could engage with USGCRP in these areas? (Mapping of existing capabilities and gaps, both within and outside USGCRP agencies)
- How can the other Program elements best leverage the social sciences capacity being created under the National Climate Assessment?
- What are options for effective ways to entrain needed expertise into the Program advisory structure and IWGs, and infuse social sciences viewpoints into Program priorities?

The outcome of the Task Force will be a white paper with a set of recommendations to USGCRP about implementation steps to achieve the desired integration across Program activities and interagency processes. In addition to a longer-term perspective, one focus of these recommendations should also be on near-term opportunities for the Program to successfully integrate social sciences in areas that build from the FY13 (and FY14) priorities and the outcomes from the Principals Road Mapping effort.

Strong engagement with the NRC committee to advise USGCRP will be critical. The Task Force should target its initial engagement toward a discussion meeting of this committee (tentatively scheduled for May 2012) on this topic.

### **III. Task Force Logistics**

The Task Force should have a duration of about one year, and it should have a manageable number (~10) of members with broad (but not necessarily exhaustive) representation of USGCRP agencies and social sciences disciplinary expertise. A chair (or co-chairs) will need to be identified, as well as a champion from the SGC leadership (Principals and Vice Chairs).

The major outcome of the Task Force will be a white paper with recommendations on strategies for integrating social, behavioral, and economic sciences into the Program's activities, with a focus, in part, on an initial set of activities that will likely lead to a few concrete deliverables consistent with the near-term priorities of the Program.

The white paper should also provide a preliminary mapping of capabilities and critical partners from across the federal government, and strategies for engaging these partners in USGCRP activities, as well as recommendations for leveraging the NCA capacity. Finally, the white paper should include a plan for infusing Task Force expertise into the IWGs after the Task Force comes to an end.

One major consideration will be to limit the scope of the inquiry. One bounding element should be to focus on the primary social, behavioral, and economic sciences areas articulated in the Strategic Plan. These fall roughly into the following categories:

- Human drivers of global change
- Determinants of vulnerability and resilience to global change impacts
- Research on decision support, including understanding the decision context, structures for co-production, decision frameworks, methods and tools

The Appendix provides a more detailed breakdown of the sub-topics considered in the Strategic Plan.

#### **Appendix: Breadth of Social Sciences Topics in the Advance Science Goal of the SP**

##### *Human drivers of global change*

- Population dynamics
- Economic development
- Land-use change
- Natural resource and energy consumption
- Development and adoption of new technologies
- Impacts of mitigation and adaptation activities and hazard responses

##### *Determinants of vulnerability to natural variability and long-term global change*

- Exposure, sensitivity, adaptive capacity, resilience

- In coupled human-environment systems that concentrate people, infrastructure, economic assets, and ecosystem services (e.g., urban areas, coastal settlements, agricultural systems)
- As relating to natural resources and socioeconomic sectors (e.g., water, energy, farming, transportation, fisheries, forestry, health, military operations and infrastructure)
- Vulnerabilities due to cross-sectoral interactions
- Vulnerabilities due to regional-global interactions
- Differential vulnerability across space and time
- Integration of outside scientific research and information with local knowledge
- Transfer of knowledge relevant to responses across sectors and regions
- Governance issues and institutional vulnerability

#### *Decision Support Methods and Tools*

- Cognitive basis for decision making
- Institutional, social network, political, economic, and cultural context
- Decision frameworks (e.g., prediction-based, robust, precautionary)
- Effective collaborative structures for co-production
- Risk perception and communication
- Boundary object development and use (e.g., scenarios)
- Economic valuation
- Metrics and indicators to support monitoring, learning, and adaptive risk management
- Innovation and knowledge transfer
- Evaluation of the effectiveness of the two-way knowledge transfer in USGCRP decision support and assessment processes
- Clearinghouses
- Communities of practice
- Virtual fora for co-production and information exchange (e.g., websites, collaborative workspaces, speakers bureaus, comparative databases of response options)

#### *Observations (and observation-related issues)*

- Continuous, sustained, research-quality measurements about human population, economic productivity and consumption, health and disease patterns, insurance coverage, hazards exposure, public perceptions and preferences, etc.
- Detailed, place-based data about human behavior, attitudes, relationships, and institutions
- Integration across existing (e.g., U.S. Census) and new (e.g., social media)
- Timely integration and synthesis
- Interoperability (e.g., creating common, geocoded geographic frameworks)
- Addressing mismatches in characteristic spatial and temporal scales of physical, biological, and sociological observational networks
- Integrating observations collected from non-traditional platforms (e.g., social networking sites, smart phones) and “citizen science” research programs

#### *Modeling (and modeling-related issues)*

- Inclusion of socioeconomic drivers of global change in Earth system models
- Information requirements for model outputs to support decision making
- Prioritization of research investments (e.g., spatial and temporal resolution vs. uncertainty characterization vs. model complexity)
- Integrated Assessment Models
- Uptake of prediction information into decision making
- Implications of other decision frameworks (e.g., robust) for simulation design and model outputs

*Information Technology, Management, and Sharing*

- Information-intensive decision support (i.e., where decisions about responding to global change harness the best and most useful information about the many interrelated factors that influence these decisions)
- Interoperability of human systems data with physical/biological systems data
- Providing integrated scientific knowledge in meaningful forms to global change stakeholders
- Distributed tools for categorizing, synthesizing, analyzing, and visualizing integrated data sets that are easy to use and widely accessible
- Integrated databases of stakeholder needs and the details of their adaptation and mitigation projects, efforts, experiences, and best practices for supporting decision making
- Integrated databases of information about diverse audiences and their perspectives on and understanding of global change
- Potential for advances in information technology to transform public engagement with science and harness public participation in research

## **Appendix B**

### **Expanded Discussion of Fundamental Research Needs**

**Leah Nichols (National Science Foundation)**

**Robert Winthrop (U.S. Dept. of Interior/Bureau of Land Management)**

#### **I. KNOWLEDGE, PERCEPTION, AND DECISION MAKING**

The social sciences have well developed literatures on decision making at the individual, group, community, and institutional levels. However, much of this knowledge has not yet been operationalized and widely incorporated into the practice of decision making by federal agencies. USGCRP agencies could benefit from the institutionalization of new practice drawn from these literatures and should experiment with implementing new decision-making methods and protocols. In particular, agencies should prioritize the evaluation of alternative decision frameworks, assessment of public participation methods, analysis of methods for including local knowledge and concepts of public risk perception in decision-making processes, and the exploration of non-economic valuation of ecosystem services. To continue advancing these sciences, agencies should partner with social scientists to help design and critically review any experiments with new decision-making methods.

##### **Evaluating alternative decision frameworks**

The decision sciences have a long history and well established literature on the many frameworks that individuals, institutions, and societies use when making decisions. Decision making incorporates complex sets of value judgments, including economic costs, political necessities, cultural norms, moral/ethical choices, and personal preferences. Uncertainty and risk perception also complicate these processes. Yet policy-makers have been slow to put into common practice insights gained from the decision sciences. Most efforts to date have been experimental and ad hoc.

*Recommendations:* The USGCRP agencies need (1) to experiment with and assess the implementation of new decision-making processes that are grounded in decision science theory; and (2) to develop and use tools that incorporate multiple decision-making frameworks. Through careful analyses of pilot programs and assessment of existing decision-making protocols, the USGCRP agencies can advance both the science and implementation of new decision-making protocols. The evaluation and assessment of these experiments should consider both policy outcomes and the processes used to achieve them.

In addition, more fundamental research is needed to:

- Better understand the role of communication and the public perception of risk in decision-making;
- Explore how intergovernmental or multi-jurisdictional relationships affect decision-making processes;

- Effectively incorporate the spatial distribution of social benefits and costs from policy decisions, at multiple scales;
- Develop consistent, non-monetary metrics for expressing the degree of predicted disruption to social and natural systems, at multiple scales; and
- For contexts involving high uncertainty or high decision stakes, clarify where risk assessment in contrast to other decision frameworks is most suitable.

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**Assessing participatory decision-making processes**

Broadening stakeholder participation in the policy-making process around issues of global change and environmental sustainability can improve the quality and legitimacy of these processes. Deliberative approaches to public participation move beyond traditional public engagement mechanisms to involve stakeholders in identifying possible solutions and evaluating the likely effects of alternative actions. Although many USGCRP agencies already incorporate or are experimenting with a variety of public engagement methods, such activities could be greatly expanded throughout the agencies.

*Recommendations:* Extensive research and meta-analyses on participatory decision making already exist. The USGCRP agencies should build on this foundation by continuing to experiment with a full range of public participation methods. Regular assessment of the processes and outcomes of these experiments is also essential. Agencies should include social scientists both in the design and assessment of such experiments. Critical evaluation of participatory decision making will help agencies scale up successful efforts while advancing social science theory. Important research questions to pursue include:

- How are policy and social outcomes affected when stakeholders are engaged analytically and deliberatively in the decision-making process?
- How do different organizational structures and means of incorporating technical information affect the outcomes of these processes?
- What are the best ways of organizing these processes so that all sources of information and knowledge (including local or traditional knowledge) are included and appropriately considered?
- How do social, legal, environmental, and technical contexts influence outcomes? How do best practices vary in different decision contexts?

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### **Incorporating local knowledge into decision-making**

The social sciences have developed an extensive literature on the importance of incorporating local knowledge and traditional ecological knowledge into policy-making processes. For example, incorporating local knowledge into vulnerability assessments has numerous benefits: providing an alternative to top-down technical management styles that have not consistently succeeded,[1] identifying a greater range of adaptation options to allow more flexibility in planning and implementation,[2] and enhancing social learning, which has been identified as a critical component in improving community resiliency to hazards.[3] In some cases, indigenous communities have already devised solutions or adaptation schemes for particular hazards. If policymakers disregard this knowledge, they disregard potential solutions.[4] The theory and methods of cultural anthropology provide a particularly strong framework for documenting and applying local and traditional knowledge to the policy challenges of global change.

*Recommendations:* While there has been much academic study of the value of incorporating local knowledge into vulnerability assessments and adaptation strategies, there is little crossover into the policy realm. For many policymakers, incorporating local and indigenous ecological knowledge into their decision-making frameworks is an unfamiliar goal. The USGCRP agencies should convene experts in this field to develop a set of best practices and recommend procedures for operationalizing the documentation and use of local knowledge in decision-making contexts. Providing successful case studies may also encourage policymakers to act.[5]

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Posey, Darrell, ed., *Cultural and Spiritual Values of Biodiversity*, London: Intermediate Technology Press / U.N. Environmental Program, 1999.

### **Perception and cognition of uncertainties and risk**

Many policy decisions concerning global change are informed by environmental and economic measures of risk. Yet the cognitive and decision sciences have demonstrated that risk perception is a complex phenomenon shaped by numerous social and psychological factors. An understanding of how various actors perceive and respond to risks is critical in crafting effective policies concerning global change. The cognitive and decision sciences are well qualified to assist agencies with appropriate framing of risk and uncertainty.

*Recommendations:* USGCRP agencies should partner with social scientists (1) to assess where current understandings of risk and risk perception are insufficiently represented in decision-making processes and (2) to create guidelines and best practices to incorporate this knowledge into agency practice.

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### **Ecosystem services**

The research framework of ecosystem services is intended to assess and value the *human* benefits provided by ecosystem structure and function. The past decade has seen important advances in the research and institutional innovation required for the effective application of ecosystem services to decision making. These steps include better modeling of the impacts of land and resource decisions on ecological processes, in a spatially explicit framework; improved economic methods for valuing ecosystem services; and useful experience with payment for ecosystem services.[6] Two challenges in particular need to be addressed before information on ecosystem services can be used routinely and defensibly to inform decisions across a comprehensive range of land and resource activities.

First, in many contexts economic methods for characterizing environmental value are inappropriate. This is particularly true where the values in question transcend individual welfare maximization, such as the contribution of subsistence hunting to social reciprocity, community integrity, and the preservation of a distinctive way of life.[7] A number of studies have acknowledged the relevance of qualitative methods to characterize sociocultural dimensions of ecosystem services. [8] [9] Nonetheless, the theoretical foundation for such an analysis of values, as an alternative to the neoclassical assumptions of environmental economics, has not been developed.

*Recommendation:* USGCRP agencies should advance research that develops the theoretical underpinnings for non-economic valuation of ecosystem services.

Second, government agencies and other organizations wishing to use ecosystem services information in decision-making lack both consistent standards (including metrics, methods, and tools) and readily accessible data sets to facilitate such analysis. The National Ecosystem Services Partnership is addressing the first deficit through a series of collaborative activities between researchers and federal land management staff from multiple agencies.[10] Regarding data, a recent analysis of ecosystem services valuation tools noted that "A system of data sharing for spatial data, ecological studies needed to parameterize the ecosystem service models, and economic studies needed to conduct valuation would immensely aid ecosystem service valuation efforts." [11]

*Recommendation:* A data infrastructure to facilitate the use of ecosystem services information would support several GCRP strategies, and should be considered as a priority for applied research in the GCRP agencies.

## **II. MODELING COUPLED HUMAN AND NATURAL SYSTEMS**

In the context of global change, the human and natural sciences are deeply interdependent, yet the science of modeling coupled human and natural systems is still relatively young and needs significant development. Advancing the science of coupled human-natural systems and developing coupled systems models relevant to decision making should be a priority.

### **Integrated modeling at multiple scales**

The development of coupled human-natural systems models across organizational, spatial and temporal scales is especially important. To develop fully the science of coupled human-natural systems, models should consist of nested hierarchies of local systems within regional systems within the global system. Impacts, dynamics, and emergent properties at each scale can influence models at all other scales. Policy decisions are also made at all scales. Integrated models of watersheds can help regional water planners make decisions, while integrated global climate models can inform policy design at the federal and global levels.

*Recommendations:* USGCRP agencies should make the development of integrated human-natural systems models a high priority. Existing physical system modeling efforts in the agencies should be expanded to include human components, incorporating multiple disciplinary perspectives within the social sciences whenever feasible. Vulnerability assessments are a particularly appropriate focus for innovative approaches to modeling coupled human-natural systems, because of the complex interactions across stressors, economic sectors, and social practices. Whenever possible, USGCRP agencies should collaboratively share methods, models, and best practices in order to reduce duplicative effort and facilitate the integration of the models when appropriate. Since this field is rapidly evolving, every effort should also be made to connect or partner with researchers exploring the fundamental science underlying these models.

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### **Modeling adaptive capacity**

The adaptive capacity of a community is defined as the ability of a system (such as a socio-ecological system) to respond to and accommodate long-term change and/or sudden disturbances. Systems that can easily adjust to changing conditions or perturbations with minimal suffering have high adaptive capacity. When adaptive capacity is limited, the risk of partial or complete system collapse is high. Maintaining the well-being of their constituents' social, economic, and ecological systems is a high priority for most policymakers. However, since the science of coupled human-natural systems is underdeveloped, our understanding of what promotes adaptive capacity is limited.

*Recommendations:* The USGCRP should establish long-term, place-based studies of the adaptive capacity of communities, sectors, and regions. These types of studies will allow us to

observe community response to system perturbations over time and provide insight into the social, economic, cultural, and institutional factors underlying adaptive capacity.

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**Population dynamics, vulnerability, and adaptive capacity**

The effects of changing human populations on the vulnerability and adaptive capacity of communities is relatively understudied and poorly understood. Much of the research conducted to date on the demographics of vulnerability has focused on aggregate populations and impacts. However, understanding the links between population change, vulnerability, and adaptive capacity will require much finer-grained analyses of population structure and its dynamics. Without sufficient understanding of how people and communities respond to environmental change, adaptive strategies will be ineffective and some may actually increase or accelerate negative social and environmental change.

*Recommendations:* The USGCRP agencies must build our knowledge base in this area by accelerating research on:

- How social and demographic factors (e.g. population growth, socio-economic distributions, education levels, cultural composition) and their dynamics affect the adaptive capacity of communities and regions;
- How culture, social organization, and governmental structure influence adaptive capacity;
- The motivations, patterns, and consequences of human migration. What drives relocation? Where are people going? What are the effects of population growth through migration on the adaptive capacity of communities absorbing the immigrants?

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[2] <http://www.recoveryplatform.org/assets/publication/9%20sept/hurricanes/responding%20to%20coastal%20disasters.pdf>

[3] [https://groups.nceas.ucsb.edu/sustainability-science/weekly-sessions/session-102013-11.01.2010-emergent-properties-of-coupled-human-environment-systems/supplemental-readings-from-cambridge-students/Adger\\_2000\\_Social\\_ecological\\_resilience.pdf](https://groups.nceas.ucsb.edu/sustainability-science/weekly-sessions/session-102013-11.01.2010-emergent-properties-of-coupled-human-environment-systems/supplemental-readings-from-cambridge-students/Adger_2000_Social_ecological_resilience.pdf)

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