



7 | Human Contributions and Responses

Strategic Research Questions

- 9.1 What are the magnitudes, interrelationships, and significance of the primary human drivers of, and their potential impact on, global environmental change?
- 9.2 What are the current and potential future impacts of global environmental variability and change on human welfare, what factors influence the capacity of human societies to respond to change, and how can resilience be increased and vulnerability reduced?
- 9.3 How can the methods and capabilities for societal decisionmaking under conditions of complexity and uncertainty about global environmental variability and change be enhanced?
- 9.4 What are the potential human health effects of global environmental change, and what climate, socioeconomic, and environmental information is needed to assess the cumulative risk to health from these effects?

See Chapter 9 of the *Strategic Plan for the U.S. Climate Change Science Program* for detailed discussion of these research questions.

Human activities play an important part in virtually all natural systems and are forces for change in the environment at local, regional, and even global scales. Social, economic, and cultural systems are changing in a world that is more populated, urban, and interconnected than ever. Such large-scale changes increase the resilience of some groups while increasing the vulnerability of others. A better integrated understanding of the complex interactions between human societies and the Earth system is needed if we are to identify vulnerable systems and pursue options that take advantage of opportunities to enhance resilience.

Research on human contributions and responses includes studies of potential technological, social, economic, and cultural drivers of global change, and how these and other aspects of human systems may affect adaptation and the consequences of change for society. Human drivers of global environmental change include consumption

of energy and natural resources, technological and economic choices, culture, and institutions. The effects of these drivers are seen in population growth and movement, changes in consumption, de- or reforestation, land-use change, and toleration or regulation of pollution.

Global environmental variability and change must be analyzed in the context of other natural and social system stresses—such as land-use and land-cover change, population changes and migrations, and global economic restructuring. There has been significant progress in analyzing and modeling regional vulnerabilities and possibilities for adaptation, including in the context of multiple stresses. Progress has been made in understanding how society adapts to seasonal climate variability and, by extension, how it may adapt to potential longer term climate change.

It is well-established that human health is linked to environmental conditions, and that changes in the natural environment may have subtle, or dramatic, effects on health. Timely knowledge of these effects may support public health systems in devising and implementing strategies to compensate or respond to these effects. Federally supported research has thus far provided information on a broad range of health effects of global change, including the adverse effects of ozone, atmospheric particles and aeroallergens, ultraviolet radiation, vector- and water-borne diseases, and heat-related illnesses.

Decisionmaking is challenged by uncertainties including risks of irreversible and/or nonlinear changes that may be met with insufficient or excessive responses whose consequences may cascade across generations. The difficulties associated with uncertainty have become increasingly salient given the interest of policymakers in addressing global environmental change.

The NRC 2001 report, *Climate Change Science: An Analysis of Some Key Questions*, concluded that: “In order to address the consequences of climate change and better serve the Nation’s decisionmakers, the research enterprise dealing with environmental change and environment-society interactions must be enhanced.”

HIGHLIGHTS OF RECENT RESEARCH

Highlights of recent research supported by CCSP participating agencies follow.

Fire-climate assessment process. National priority issues such as drought, forest fires, energy supply, ecosystem restoration, and human health concerns such as West Nile and Encephalitis are being addressed locally and regionally through place-based,

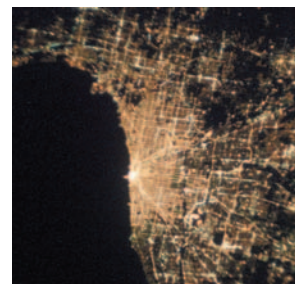
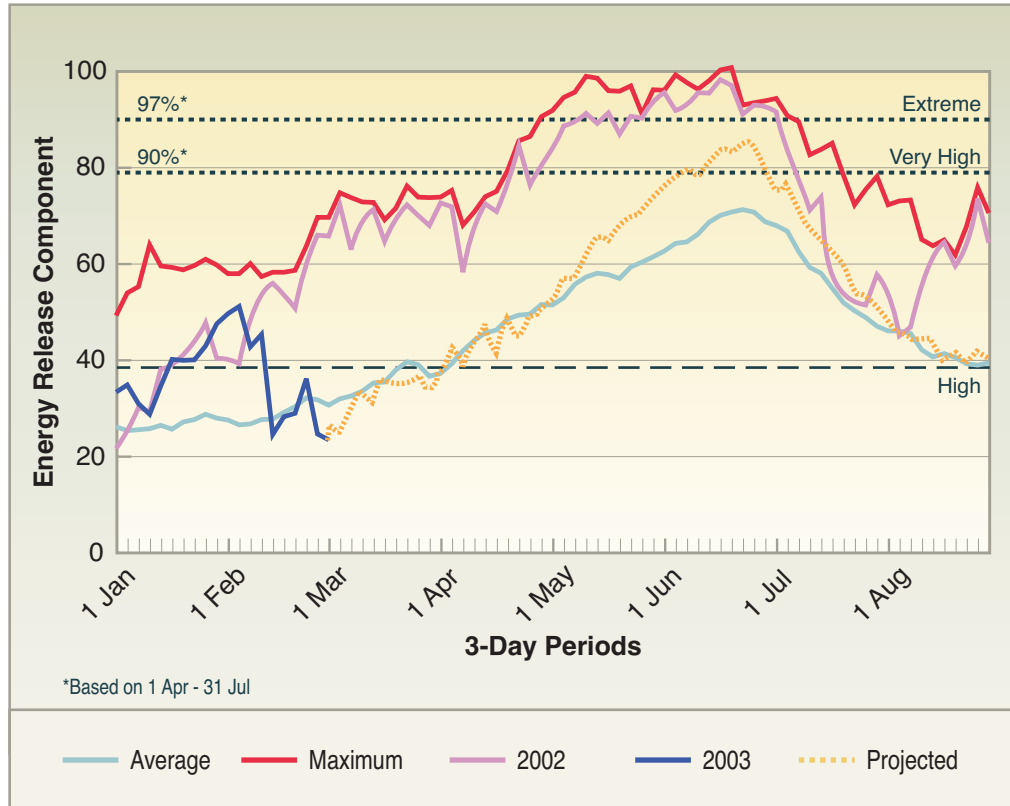


Figure 24:

Southwest area GACC fire risk outlook for 2003. Southwest Area Energy Release Component (ERC) curve for 2003 with observed (January-February) and projected most likely scenario (March-August) of fire potential. ERC values are normally expected to peak between late May and early July, which correlates with the peak potential for large fire activity. The 2003 analysis correctly projected the timing of the very high fire danger period (mid-to-late June) encompassing the Aspen fire in Arizona's Coronado National Forest. The analysis also correctly projected that 2003 fire danger would be less severe for the southwestern United States than the 2002 fire danger. Through collaborative efforts of scientists and fire managers, pre-season forecasts can support improved management strategy and response and reduce the likelihood of future fires turning into major infernos.
 Credit: Gregg M. Garfin, CLIMAS/Institute for the Study of Planet Earth, University of Arizona.



stakeholder-driven climate research. Drawing on integrated research from the social, physical, and biological sciences, teams across the United States are developing decision support resources to expand decisionmakers' options in dealing with climate change and variability. One such example is the fire-climate assessment process (see Figure 24), which allows fire and fuels specialists in each of the National Interagency Fire Center's eleven Geographic Area Coordination Centers (GACCs) to work with NOAA climate scientists to develop GACC-level assessments of pre-season fire risk at seasonal and shorter time scales.

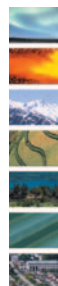
Comparing measures for measuring costs in cost-benefit analyses. In assessing potential climate change policies, as with any new economic or regulatory policies, there is a need to compare the costs and benefits of the new policies to existing policies and other alternatives to determine which policy is most cost-effective. Not all cost measures, however, arrive at the same ranking. An analysis of differences among a variety of measures showed that policies could rank differently depending on the choice of measure, and proposed a method for calculating costs that is theoretically superior to other measures.

Integrated assessment modeling of changes in terrestrial carbon stocks.

The representation of the response of plant and soil carbon stocks to historical changes in land cover, land-use management, atmospheric CO₂ concentration, and climate has been analyzed and improved in integrated assessment models. This improvement helps understanding of how short- and long-term natural carbon fluxes, carbon sequestration, and human emissions contribute to the net global carbon emission trajectories. The results of this work will be available for the development of emission scenarios, both for the CCSP and for the IPCC.

Potential consequences of global climate change for the U.S. forest and agricultural sectors.

Large-scale analyses are underway that examine the potential consequences of global climate change for the U.S. forest and agricultural sectors. A recently completed national assessment of several different climate scenarios and ecological responses concluded that, under several scenarios of global climatic change, economic welfare in the forest and agricultural sectors would be increased. Part of this improvement would be expected to result from an overall increase in U.S. forest productivity that boosts long-term timber inventory and allows more timber harvests. The projected impacts of global climate change on the two sectors vary over the 100-year projection period, with potential risks to producers' income. The forest sector was found to have adjustment mechanisms that mitigate climate change impacts, including interregional migration of production, substitution in consumption, and altered stand management. A more recent study of U.S. agriculture showed that, by the year 2060, the benefits of climate change to American croplands could be less than



CCRI PRIORITY - DECISIONMAKING UNDER UNCERTAINTY

The Climate Change Research Initiative will leverage existing U.S. Global Change Research Program efforts to provide structured information to inform national, regional, and local discussions about possible global change causes, impacts, and mitigation and adaptation strategies.

As part of the CCRI, NSF will provide continuing support for a set of competitively selected interdisciplinary centers focusing on decisionmaking under uncertainty associated with climate change and variability. These centers, which will be established in FY 2004 following a special competition, will conduct fundamental research on decisionmaking associated with climate change and variability. The centers are expected to advance basic understanding about decision processes dealing with issues such as inter-temporal choice, risk perception, hazards and disaster reduction, opportunities, tradeoffs, equity, framing, and probabilistic reasoning associated with uncertainty.

The centers will develop tools that people, organizations, and governments can use to better understand the risks and uncertainties associated with climate variability and change and the options they have to address them. In order to do this, they will develop and disseminate tangible products for researchers, decisionmakers, and other relevant stakeholders and make them readily accessible through a range of different media.

The centers will build on and complement work that has been and continues to be supported by NSF programs, such as the Decision, Risk, and Management Science Program, and by programs at other agencies.

Highlights of Recent Research and FY 2004-2005 Plans

previous work had indicated. A team of scientists found that finer scale simulations tend to reduce projected benefits and increase projected losses for a wide range of crops across most parts of the nation.

Youth and the future of the environment. The Center for the Integrated Study of the Human Dimensions of Global Change (CIS-HDGC) brings together more than 50 scientists and engineers. An important line of inquiry at CIS-HDGC has focused on the implications of environmental policy decisions across multiple generations. Current research into adolescent psychology suggests that young people in their mid-teens tend to harbor deep concerns about some aspects of their world, including the future of the environment. CIS-HDGC scientists are in the advanced stages of a project that has elicited young people's view of the natural world and their desires for it, in policy-relevant terms. Analyses reveal that, asked to explain changes or propose solutions, most teens do not think primarily in terms of institutions, such as governments or corporations. Instead, they consider responsibility to be widely diffused, using terms like "everybody," "just people," and "all of us." The most commonly proposed mitigation strategy was best classified as "increased public awareness." The results of this study are expected to offer guidance for parents, educators, and policymakers who are concerned with both the cognitive and the emotional bases for environmental values.

Health effects of exposure to ultraviolet radiation. Many measurements have demonstrated a relationship between stratospheric ozone depletion and increased levels of ultraviolet (UV) radiation at the surface. The internationally standardized UV Index scale presented to the public is defined in terms of the "skin-reddening" or "sunburning" UV irradiance.

- *Risk factors for malignant melanoma.* Sunlight exposure is known to be directly associated with risk for skin cancer. Although many of the risk factors for malignant melanoma—the deadliest form of skin cancer—are known, they are not well understood. Recent findings by National Cancer Institute researchers are providing new insights into the genetic and environmental factors that increase the risk for the disease. For example, a hospital-based case-control study published in 2003 is the first large epidemiological investigation to show that reduced DNA repair capability present in some individuals and not in others may play a role in causing sunlight-induced melanoma. This study may help explain why only a relatively small proportion of individuals exposed to sunlight develop the disease.
- *UV exposure and prevalence of cataract.* Epidemiological investigations have reported a higher prevalence of cataract in regions of the world that have unusually high levels of UV exposure. The National Eye Institute is supporting research that will examine various wavelengths of UV-A and UV-B to determine which are the most damaging to the lens and result in the formation of cataracts in human and animal tissue cultures.



HIGHLIGHTS OF FY 2004 AND FY 2005 PLANS

The CCSP will continue to support fundamental research and assessments of the effects of human activities on the global environment and the potential societal consequences of global change. Key research plans for FY 2004 and FY 2005 follow.

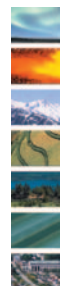
Research centers for decisionmaking under uncertainty. During FY 2004, the process of establishing a set of centers focusing on decisionmaking under uncertainty (DMUU) associated with climate variability and change will be completed. The DMUU centers will function for 5 years (into 2008) and will conduct fundamental research on decisionmaking associated with climate change and variability. Center-supported research will be well-grounded in relevant theoretical frameworks based in the social, behavioral, and economic sciences as well as other appropriate science and engineering disciplines. Center research programs will advance basic understanding about decision processes dealing with issues such as inter-temporal choice, risk perception, hazards, disaster reduction, tradeoffs, equity, framing, and probabilistic reasoning associated with risky phenomena. The centers will develop tools that people, organizations, and governments can use to better understand the risks associated with climate variability and change and the options they have to address those risks. They also will develop and disseminate tangible products for researchers, decisionmakers, and other relevant stakeholders.

These activities will address a CCRI priority and Question 9.3 of the CCSP Strategic Plan.

Household composition and projections of energy demand. Projections of energy demand and associated greenhouse gas emissions will be improved by analyzing demographic variables. The research will use three case studies—the United States, China, and Indonesia—and focus on one subset of this problem (i.e., household composition) using survey data to estimate relationships with energy use. The objective is to improve projections of energy demand in integrated assessment models by taking into account variations in energy use across household types. Research results are expected at the end of FY 2004 with adoption by integrated assessment models in FY 2005.

These activities will address Question 9.1 of the CCSP Strategic Plan.

Societal use of seasonal forecasts. Researchers will identify lessons learned and tools developed in the area of how society prepares for and adjusts to seasonal and year-to-year climate variability. The focus will be on learning from experiences with and studies of societal use of seasonal forecasts, for the purpose of developing insights into potential longer term adaptation strategies in the face of climate variability and change. A workshop attended by a cross-section of researchers to discuss lessons



Highlights of Recent Research and FY 2004-2005 Plans

learned was convened in early FY 2004, and a report from the workshop is expected by late FY 2004.

These activities will address Question 9.2 of the CCSP Strategic Plan.

Enhancement of regional adaptive capacity. Development of research partnerships with stakeholders will continue to enhance regional adaptive capacity to climate change and variability in a variety of climate-sensitive sectors. Scoping meetings are planned for new regions of the United States where integrated climate research is expected to have the greatest capacity to meet the needs of decisionmakers. Two regional scoping meetings per year will take place in FY 2004 and FY 2005, with workshop reports following the meetings.

These activities will address Question 9.2 of the CCSP Strategic Plan.

State and local plans for sea-level rise. During FY 2004-2005, coastal elevation maps will be produced depicting areas vulnerable to sea-level rise. Planning maps will be created that synthesize current State and local baseline plans for sea-level rise along the U.S. Atlantic Coast. This work will improve understanding of the sensitivity and adaptability of coastal ecosystems and human systems and provide resources to support coastal zone environmental and infrastructure-related decisionmaking. The maps will synthesize current State and local coastal policies along the U.S. Atlantic and Gulf Coast, and divide coastal dry land into four categories: 1) conservation lands where current policies would allow the natural inland migration of wetlands and beaches; and lands where shore protection (and hence wetland elimination) is 2) almost certain, 3) likely, and 4) possible but-unlikely. Conservation officials will be able to use the maps to determine whether current policies ensure sufficient wetland migration, and identify areas where additional wetland migration is feasible. Local governments can focus infrastructure in areas where shores are certain to be protected. Ecologists assessing potential environmental consequences of climate change will have a better idea whether tidal habitat will shift inland or be replaced with seawalls.

These activities will address Question 9.2

(third of the milestones, products, and payoffs) of the CCSP Strategic Plan.

Assessment of global change consequences. Assessment activities will continue to advance understanding of relative risks in the context of multiple stressors, at multiple scales and multiple levels of biological and institutional organization. Assessments are conducted through public-private partnerships that actively engage researchers from the academic community, decisionmakers, resource managers, and other affected stakeholders in the assessment process. Assessment activities are ongoing with interim reports expected in FY 2004.

These activities will address Question 9.2 of the CCSP Strategic Plan.



Climate variability and human health. NOAA and NSF will continue to jointly award research grants to teams of investigators analyzing the connections between climate variability and human health. This research aims to provide the scientific foundation for improved public health early-warning systems for diseases such as dengue fever and malaria, and other climate-sensitive public health issues.

These activities will address Question 9.4 of the CCSP Strategic Plan.

Health effects of exposure to UV radiation.

- *Risk factors for malignant melanoma.* Melanoma is considered an epidemic cancer because its incidence and mortality are increasing rapidly. In the United States, the incidence has more than doubled and deaths have increased about 44% since 1973. Future research should help to further refine measures of exposure to solar radiation and clarify the relationship between sunlight exposure and melanoma risk. Researchers also hope to elucidate genetic and other susceptibility factors and their progression to melanoma and to identify appropriate interventions. To further this agenda, researchers are conducting a large international population-based study, covering a wide range of latitudes, that will determine the relative risk for developing melanoma due to various germline and gene mutations, polymorphisms, and variations that influence disease development in conjunction with UV radiation exposure. Results are expected to be published in 2004-2005.
- *UV exposure and photosensitivity.* Researchers have studied the photochemistry and photobiology of 7-dehydrocholesterol (7-DHC), which accumulates in the plasma and tissues of patients with Smith-Lemli-Opitz syndrome (SLOS), a severe developmental disorder associated with multiple congenital and morphogenic anomalies, and enhanced photosensitivity to UV-A radiation. Findings showing that photosensitivity in SLOS patients may result from UV-A irradiation of skin containing high levels of 7-DHC will be submitted for publication in 2004.

These activities will address Question 9.4 of the CCSP Strategic Plan.

