

CHAPTER 11

**HUMAN CONTRIBUTIONS AND RESPONSES
TO ENVIRONMENTAL CHANGE**

from the

**Strategic Plan
for the
Climate Change Science Program**

By the agencies and staff of the
US Climate Change Science Program

Review draft dated 11 November 2002

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11 November 2002

Dear Colleague,

The Climate Change Science Program will hold the U.S. Climate Change Science Program Planning Workshop for Scientists and Stakeholders at the Marriott Wardman Park Hotel in Washington, D.C., from 3-5 December 2002. The purpose of the Workshop is to provide a comprehensive review of the discussion draft of the Strategic Plan for U.S. climate change and global change research. This Workshop will offer extensive opportunities for the scientific and stakeholder communities to provide comment and input to the Climate Change Science Program Strategic Plan. When finalized by April 2003, the Strategic Plan will provide the principal guidance for U.S. climate change and global change research during the next several years, subject to revisions as appropriate to respond to newly developed information and decision support tools.

We are writing to request your comments on the discussion draft of the Climate Change Science Program Strategic Plan. Comments on all elements of the plan from all communities are essential in order to improve the plan and identify gaps. In your review, we ask you to provide a perspective on the content, implications, and challenges outlined in the plan as well as suggestions for any alternate approaches you wish to have considered, and the types of climate and global change information required by policy makers and resource managers. We also ask that you comment on any inconsistencies within or across chapters, and omissions of important topics. For any shortcomings that you note in the draft, please propose specific remedies. To participate in the review it is not necessary that you review the entire plan.

We ask that comments be submitted by E-mail to <comments@climatescience.gov>. All comments submitted by 13 January 2003 will be posted on the <<http://www.climatescience.gov>> website for public review. While we are unable to promised detailed responses to individual comments, we confirm that all submitted comments will be given consideration during the development of the final version of the Strategic Plan.

Attached to this letter are instructions and format guidelines for submitting review comments. Following the instructions will ensure that your comments are properly processed and given appropriate consideration. If you wish to distribute copies of the plan to colleagues to participate in the review, please provide them with a copy of this letter as well as the attached instructions and format guidelines. We have posted the plan on the workshop website at <<http://www.climatescience.gov>>. PDF files for individual chapters of the plan can be downloaded from this site. If you have any questions, please contact: Sandy MacCracken at 1-202-419-3483 (voice), 1-202-223-3065 (fax), or via the address in the footer below.

We appreciate your contribution of time and expertise to this review, and look forward to your response.

Sincerely,

James R. Mahoney, Ph.D.
Assistant Secretary of Commerce for Oceans and Atmosphere, and
Director, U.S. Climate Change Science Program

Instructions For Submission of Strategic Plan Review Comments

Thank you for participating in the review process. Please follow the instructions for preparing and submitting your review. Using the format guidance described below will facilitate our processing of reviewer comments and assure that your comments are given appropriate consideration. An example of the format is also provided. Comments are due by **13 January, 2003**.

- Select the chapter(s) or sections of chapters which you wish to review. It is not necessary that you review the entire plan. In your comments, please consider the following issues:
 - **Overview:** overview on the content, implications, and challenges outlined in the plan;
 - **Agreement/Disagreement:** areas of agreement and disagreement, as appropriate;
 - **Suggestions :** suggestions for alternative approaches, if appropriate;
 - **Inconsistencies:** inconsistencies within or across chapters;
 - **Omissions :** omissions of important topics;
 - **Remedies:** specific remedies for identified shortcomings of the draft plan;
 - **Stakeholder climate information:** type of climate and global change information required by representative groups;
 - **Other:** other comments not covered above.
- Please do not comment on grammar, spelling, or punctuation. Professional copy editing will correct deficiencies in these areas for the final draft.
- Use the format guidance that follows for organizing your comments.
- Submit your comments by email to <comments@climatescience.gov> by 13 January, 2003.

Format Guidance for Comments

Please provide background information about yourself on the first page of your comments: your name(s), organization(s), area of expertise(s), mailing address(es), telephone and fax numbers, and email address(es).

- Overview comments on the chapter should follow your background information and should be numbered.
- Comments that are specific to particular pages, paragraphs or lines of the chapter should follow your overview comments and should identify the page and line numbers to which they apply.
- Comments that refer to a table or figure should identify the table or figure number. In the case of tables, please also identify the row and column to which the comment refers.
- Order your comments sequentially by page and line number.
- At the end of each comment, please insert your name and affiliation.

Format Example for Comments

I. Background Information

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II. Overview Comments on Chapter 5: Atmospheric Composition

First Overview Comment: (Comment)

Reviewer's name, affiliation: John Doe, University College

Second Overview Comment: (Comment)

Reviewer's name, affiliation: John Doe, University College

III. Specific Comments on Chapter 5: Atmospheric Composition

Page 57, Line 5: (Comment)

John Doe, University College

Page 58, Line 32 - Page 59, Line 5: (Comment)

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Table 1-4, Row 3, Column 6: (Comment)

John Doe, University College

Please send comments by email to <comments@climatescience.gov>

Foreword

In February 2002 President George W. Bush announced the formation of a new management structure, the Climate Change Science Program (CCSP), to coordinate and direct the US research efforts in the areas of climate and global change. These research efforts include the US Global Change Research Program (USGCRP) authorized by the Global Change Research Act of 1990, and the Climate Change Research Initiative (CCRI) launched by the President in June 2001 to reduce significant uncertainties in climate science, improve global climate observing systems, and develop resources to support policymaking and resource management.

The President's Climate Change Research Initiative was launched to provide a distinct focus to the 13-year old Global Change Research Program. The CCRI focus is defined by a group of uncertainties about the global climate system that have been identified by policymakers and analyzed by the National Research Council in a 2001 report requested by the Administration.

The Climate Change Science Program aims to balance the near-term (2- to 4-year) focus of the CCRI with the breadth of the USGCRP, pursuing accelerated development of answers to the scientific aspects of key climate policy issues while continuing to seek advances in the knowledge of the physical, biological and chemical processes that influence the Earth system.

This *discussion draft* strategic plan has been prepared by the thirteen federal agencies participating in the CCSP, with input from a large number of scientific steering groups and coordination by the CCSP staff under the leadership of Dr. Richard H. Moss, to provide a vehicle to facilitate comments and suggestions by the scientific and stakeholder communities interested in climate and global change issues.

We welcome comments on this draft plan by all interested persons. Comments may be provided during the US Climate Change Science Program Planning Workshop for Scientists and Stakeholders being held in Washington, DC on December 3 – 5, 2002, and during a subsequent public comment period extending to January 13, 2003. Information about the Workshop and the written comment opportunities is available on the web site www.climatescience.gov. A specially formed committee of the National Research Council is also reviewing this draft plan, and will provide its analysis of the plan, the workshop and the written comments received after the workshop. A final version of the strategic plan, setting a path for the next few years of research under the CCSP, will be published by April 2003. We appreciate your assistance with this important process.

James R. Mahoney, Ph.D.
Assistant Secretary of Commerce for Oceans and Atmosphere, and
Director, Climate Change Science Program

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Acronyms

Authors and Contributors

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CHAPTER 11

HUMAN CONTRIBUTIONS AND RESPONSES TO ENVIRONMENTAL CHANGE

This chapter's contents...

Question 1: What are the magnitudes, interrelationships, and significance of the primary human drivers of change in atmospheric composition and the climate system, changes in land use and land cover, and other changes in the global environment?

Question 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?

Question 3: How can the methods and capabilities for societal decisionmaking under conditions of complexity and uncertainty about global environmental variability and change be enhanced?

Question 4: What are the potential human health effects of global environmental change, and what tools and climate and environmental information are needed to assess and address the cumulative risk to health from these effects?

Key Linkages

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Human activities play an important part in virtually all “natural” systems and are changing the environment at local, regional, and even global scales. Social, economic, and cultural systems also are changing in a world that is more populated, urban, and interconnected, increasing the resilience of some groups while increasing the vulnerability of others. A more integrated understanding of the complex interactions of human societies and the Earth system is essential to identify vulnerable systems and pursue options to take advantage of opportunities and enhance resilience.

The need for research on human contributions and responses—sometimes referred to as the “human dimensions” of global change—motivates research questions throughout this plan. Human dimensions research 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. Much of this research is “cross-cutting”—integral to explorations of causes and impacts of changes in atmospheric composition, climate, the water cycle, the carbon cycle, ecosystems, land use and land cover, and other

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1 global changes. Research on human contributions and responses also is an area of study in its
2 own right. Common forcing scenarios must be developed that integrate information from
3 different research elements. The interacting impacts of multiple environmental stressors on
4 human activities must be examined. New hypotheses, methods, and models must be developed
5 and tested.

6
7 A series of national and international reports has identified a broad research agenda addressing
8 human contributions and responses (including adaptation) to global change. The National
9 Research Council (NRC) has issued several reports that identify key research issues, most
10 recently including *Global Environmental Change: Research Pathways for the Next Decade*
11 (NRC, 1999a), which includes a chapter on "Human Dimensions of Global Environmental
12 Change," and *Under the Weather: Climate, Ecosystems and Infectious Disease* (NRC,
13 2001c). The NRC report *Climate Change Science: An Analysis of Some Key Questions*
14 (NRC, 2001a) concluded that, "In order to address the consequences of climate change and
15 better serve the Nation's decisionmakers, the research enterprise dealing with environmental
16 change and environment-society interactions must be enhanced." This enterprise should include
17 (among other elements), "support of interdisciplinary research that couples physical, chemical,
18 biological, and human systems." This chapter draws from these reports and from priority areas
19 identified by the research community through federal research programs.

20
21 Two overarching questions for research on the human contributions and responses to global
22 change are:

- 23 • **How do humans and human societies drive changes in the global environment?**
- 24 • **How do humans respond to global environmental change?**

25
26 These questions are addressed through research focused on the following areas:

- 27 • Human forcing of the climate system, changes in land use and land cover, and other
28 global environmental changes;
- 29 • Impacts of global change on societies and societal vulnerability, resilience, and adaptive
30 capacity in responding to the impacts;
- 31 • Decisionmaking under conditions of complexity and uncertainty; and
- 32 • The potential effects of global change on human health.

33
34 In all of these areas of research, there is a particularly strong need for the integration of social,
35 economic, and health data with environmental data. This will require data from physical,
36 biological, social, and health disciplines on compatible temporal and spatial scales, to support
37 the integration of the data for research and to support decisionmaking.

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Question 1: What are the magnitudes, interrelationships, and significance of the primary human drivers of change in atmospheric composition and the climate system, changes in land use and land cover, and other changes in the global environment?

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STATE OF KNOWLEDGE

The influence of human drivers of global environmental change may be greater, yet be modeled with more uncertainty, than the influence of some factors studied in the natural sciences. For example, as difficult as it might be to predict the response of tropical forests to increasing levels of carbon dioxide (CO₂), it is probably more difficult, yet might be more important, to project the rates and patterns of global deforestation and the potential effectiveness of policies to control it.

The subject of potential human drivers is very broad. Research has been conducted for many years in many fields and for many reasons. However, the level of understanding achieved to date is quite uneven. Researchers who need to model human actions in order to project future conditions and consequences often find the foundation for quantitative models lacking.

ILLUSTRATIVE RESEARCH QUESTIONS

What are the key processes and trends associated with population growth and demographic change, technological change, and trade and global economic activity, and how can improved understanding of these issues be used to improve scenarios and projections of global change?

Population growth and demographic change

- What are the relationships among demographic changes, migration, and other related variables such as economic productivity, energy use, and ecosystem services?
- How do people use information and form perceptions about potential changes in health status to make decisions about migration, compared to information and perceptions about other factors, such as economic status?

Technological change

- What induces technological innovation and adoption of new technologies?
- What affects the transfer of technology from country to country?
- What can be predicted about the future of energy technologies, carbon sequestration options, and agricultural productivity?
- How do food production decisions (including land use, technology choice, and exposure to chemicals) affect environmental change?

Trade and global economic activity

- What influences the movement of goods and services domestically and from one country to another, and how do operational and technological changes affect economic productivity and energy use?

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- 1 • How are environmental risks to health affected by structural economic changes, such as
2 shifts from rural to urban lifestyles, changing modes of transportation, and openness to
3 international trade?
- 4 • How is growth in economic productivity and increasing energy use related to emissions
5 of contaminants and changes in land and water use?

RESEARCH NEEDS

8 Key needs have been identified, including:

- 9 • Development of integrated assessment models with the ability to analyze the effects of
10 measures directed at the reduction of urban air pollution and greenhouse gas emissions;
- 11 • Development of integrated assessment models that introduce new energy and carbon
12 sequestration technologies;
- 13 • Comprehensive studies of greenhouse-relevant emissions and potential climate change
14 that include carbon aerosols in an integrated assessment model and the appropriate
15 specification of emissions, costs of control, and chemical and radiative characteristics of
16 those aerosols;
- 17 • The development of the capability to study the economic and trade effects of control
18 measures that differ in complex ways, both within and among countries, including broad
19 policy approaches (e.g., emissions targets, technology subsidies, voluntary national
20 goals) and means of implementation (e.g., voluntary programs, taxes, cap and trade
21 systems, and quantity constraints).
- 22 • Assessment of the full costs and benefits (including productivity impacts) of
23 environmental policy and technology choices that affect human health at the individual or
24 household level; and
- 25 • Analysis of how social, cultural, and economic factors affect the discounting of future
26 health and environmental costs and benefits.

PRODUCTS AND PAYOFFS

29 Users of the results of this research will have an improved understanding of the variables
30 affected by human actions. For example, the preparation of scenarios will be strengthened by
31 an improved understanding of the interdependence among economic growth, population growth,
32 energy consumption in different sectors (e.g., electricity, transportation), pollutant emissions, and
33 migration. Research will provide a basis for improving the development and evaluation of those
34 scenarios.

Question 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?

37

1 **STATE OF KNOWLEDGE**

2 Research has shown that the extent to which global environmental change can affect societies
3 depends as much on the social systems that lead to vulnerability as on the biophysical systems
4 that cause environmental change. This is the case, for example, in understanding how climate
5 variability in the past has affected societies. According to the NRC *Pathways* report (NRC,
6 1999), “a major conceptual advance occurred in moving from impact assessments based on
7 climate model scenarios to analyses based on an understanding of vulnerability. For example,
8 rapid increases in water demand have increased drought vulnerability, and the spread of urban
9 settlements into coastal and flood-prone regions has increased vulnerability to sea level rise and
10 severe storms.” Moreover, the capacity of society to prepare for climate impacts will be
11 influenced in part by the capacity of individuals and institutions to respond to improved scientific
12 information.

13
14 **ILLUSTRATIVE RESEARCH QUESTIONS**

- 15 • How may methods be refined to accurately assess the combined impacts of climate
16 change, changes in water quality and availability, land use change, sea level rise, and
17 ecosystem change?
- 18 • How does vulnerability in human systems to global environmental change develop and
19 how can it be reduced?
- 20 • What are the determinants of and processes associated with the capacity for
21 adaptation?
- 22 • How can society use improved information about the climate system and its potential
23 impacts to adapt more effectively to possible future changes?

24
25 **RESEARCH NEEDS**

26 Associated research needs include empirical studies, field campaigns, and model-based
27 simulation studies of the influence of social and economic factors on vulnerability and adaptive
28 capacity in households, organizations, and communities; analyses of the consequences of rapid
29 climate changes in the past and the ability of hazard and resource management institutions to
30 respond to surprising shifts in climate and to seasonal forecasts; and studies analyzing the factors
31 that affect adaptive capacity in the context of multiple social and natural system stresses (climate
32 change, land use change, population change and movements, sea level rise, and changes in
33 political institutions).

34
35 **PRODUCTS AND PAYOFFS**

36 Research on these questions can be expected to improve analytical methods and models of how
37 climate variability and change, land use change, population change, sea level rise, and other
38 global environmental changes affect decisionmaking in public health, water management,
39 agriculture, transportation infrastructure, urban areas, coastal areas, and other climate-sensitive
40 sectors. Improved communication and dissemination of accurate climate information, including
41 characterization of uncertainty, is being developed that attempts to meet the needs of
42 decisionmakers in these sectors.

43

Question 3: How can the methods and capabilities for societal decisionmaking under conditions of complexity and uncertainty about global environmental variability and change be enhanced?

1

2 **STATE OF KNOWLEDGE**

3 Research suggests that the potential social and economic impacts of global climatic variability
4 and change may be very large. Much less research has been devoted to examining how
5 individuals, organizations, and governments can make better decisions to reduce risks and take
6 advantage of opportunities related to global climatic variability and change.

7

8 **ILLUSTRATIVE RESEARCH QUESTIONS**

9 How can methods or approaches be improved:

- 10 • For representing, propagating, analyzing, describing, and communicating uncertainties?
- 11 • For understanding the economic costs and opportunities (societal, organizational, and
12 individual) from global climatic variability and change?
- 13 • For representing how individuals, organizations, and societies make choices regarding
14 threats whose consequences are long-term and uncertain?
- 15 • For evaluating and comparing the effectiveness of different approaches to modeling
16 decisionmaking?
- 17 • For understanding the role of private, governmental, and social decisionmaking affecting
18 health and environmental outcomes?

19

20 **RESEARCH NEEDS**

21 Associated research needs include research to determine what information is required by
22 individuals, organizations, and governments to make better decisions regarding global
23 environmental variability and change; what individuals, organizations, and governments know
24 (and do not know), including uncertainties, about the state of scientific knowledge regarding
25 global environmental change; and what decision resources would be most useful for different
26 decisionmakers in different positions.

27

28 **PRODUCTS AND PAYOFFS**

29 Research on these questions will enable the development of assessments of the kind of
30 knowledge and information needed by different decisionmakers and stakeholders in order to
31 enhance decisionmaking associated with climate change, and will produce decision support
32 resources.

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Question 4: What are the potential human health effects of global environmental change, and what tools and climate and environmental information are needed to assess and address the cumulative risk to health from these effects?

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1 **STATE OF KNOWLEDGE**

2 It is well established that human health is inextricably linked to the environment, and that changes
3 in the natural environment may have a subtle, or even dramatic, effect on health. Over the past
4 decade, several research and agenda-setting exercises have called for continued and expanded
5 research and development of research methods in this area. Given the complex interactions
6 among physical, biological, and human systems, this research must be highly interdisciplinary,
7 well integrated, and span the breadth from fundamental research to operations. An
8 interdisciplinary research program to examine the linkages across these sectors is being initiated
9 in 2003. Focusing on global and developing country impacts, it will begin to improve
10 understanding of how human health is affected by simultaneous environmental and economic
11 shifts.

12
13 Federally supported research has thus far provided information on a broad range of health
14 effects of global change, including the adverse effects of ozone, atmospheric particulates,
15 ultraviolet (UV) radiation, and heat-related illnesses. Research continues to improve
16 understanding of the impact of climate variability on certain infectious diseases, and researchers
17 are developing tools and information products for anticipating and managing these impacts that
18 capitalize on the enormous protections afforded by wealth and the public health infrastructure.
19 However, many questions remain unanswered.

20
21 **ILLUSTRATIVE RESEARCH QUESTIONS**

- 22 • What are the impacts of changes in water quantity and quality, temperature,
23 ecosystems, land use, and climate on infectious disease, and can the capacity for
24 prevention, early detection, and effective response be improved?
- 25 • What are the impacts of atmospheric and climatic changes on the health effects
26 associated with ambient air quality and UV radiation?
- 27 • What are the health effects and effective response strategies associated with
28 temperature extremes and with extreme weather events?
- 29 • What are the best methods for assessing climate-related health impacts and for
30 developing useful tools and information products to enhance public health?
- 31 • What effects will new technologies for global change mitigation and adaptation have on
32 human health?

33
34 **RESEARCH NEEDS**

35 Research needs include:

- 36 • Work on improved understanding of the health effects of UV radiation, including
37 exposure across regions and populations, risk awareness, and early detection;
- 38 • Initiation of a temporally and spatially compatible long-term field study, empirical
39 analysis, and integrated modeling effort of the physical, biological and social factors
40 affecting the impact of climate on public health issues of national importance;
- 41 • The effect of temperature on air quality, particularly in urban heat islands, and the
42 potential public health consequences;

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- 1 • Research on the climate, environment, and atmospheric interactions related to asthma,
2 allergic disorders, and other acute and chronic respiratory disorders and deaths;
- 3 • Research on preventing and reducing the adverse health impacts of extreme weather
4 events;
- 5 • Research on prevention and control of infectious diseases that might increase in
6 incidence as a result of climate change;
- 7 • Research on the control and treatment of vector- and water-borne diseases; and
- 8 • Research on the health effects of production and use of alternative fuels and new energy
9 technologies.

10
11 A parallel need exists to develop additional appropriate tools and methods for assessing and
12 adapting to potential health outcomes; and for evaluating the impact of research, the
13 effectiveness of Earth science information and products, the methods for communicating that
14 information, and the systematic identification of knowledge gaps and feedback to the research
15 communities.

16 17 **PRODUCTS AND PAYOFFS**

18 Products from this area include operational tools, research to support innovative institutional
19 arrangements and processes, and fundamental research results that may be used by
20 decisionmakers. Expected products include:

- 21 • Tools for preventing and managing the public health threat of infectious diseases,
22 especially those that are vector-borne.
- 23 • Assessments of the health effects of combined exposures to climatic and other
24 environmental factors (e.g., air pollution).
- 25 • Multiagency joint award for competitive multiyear grants to support research on climate
26 variability and health.
- 27 • Next phase of health sector assessments to understand the consequences of global
28 change for human health in the United States, especially for at-risk demographic and
29 geographic subpopulations.

30 31 **Key Linkages**

32 The study of human contributions and responses to global change has ties to all of the Climate
33 Change Science Program (CCSP) research elements, and in many cases needs to be an integral
34 component of collaborative research within these elements. For example, research to identify
35 options for increasing the resilience of national water systems to climate variability and to long-
36 term socioeconomic and climate trends is linked to Water Cycle research (Chapter 7).
37 Similarly, an evaluation of local- and regional-scale factors that condition impacts of land use
38 and land cover change on economic welfare and human health is equal parts Land Use/Land
39 Cover Change research (Chapter 8) and Human Contributions and Responses research.
40 Research on human disease vectors is linked to the study of Ecosystems (Chapter 10).

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1 Comparable examples can be cited for Atmospheric Composition (Chapter 5), Climate
2 Variability and Change (Chapter 6), and the Carbon Cycle (Chapter 9).

3
4 Questions from other research elements that are related to Question 1 above include:

- 5 • What natural processes and human activities control carbon emissions and uptake
6 around the world? (from Carbon Cycle)
- 7 • How do social, political, and economic forces influence human decisions regarding land
8 use and resource management, and how might changes in these forces affect the carbon
9 cycle? (from Carbon Cycle)
- 10 • What are the environmental, institutional, policy, technological, demographic, and
11 economic drivers of land use change? (from Land Use/Land Cover Change)

12 Questions from other research elements that are related to Question 2 above include:

- 13 • What are the multiple stresses that climate change, ozone layer depletion, and regional
14 air quality exert on humans and ecosystems? (from Atmospheric Composition)
- 15 • What are the current patterns of water consumption and how are they likely to change
16 as a result of potential changes in temperature, land cover and land use, demographics,
17 and water policies? (from Water Cycle)
- 18 • How will the combined effects of land use and climate change affect agriculture, aquatic
19 ecosystems, rangeland, and forest extent and productivity, and what are the implications
20 for land management and economics? (from Land Use/Land Cover Change)
- 21 • What is the impact of future changes in land use and land cover on water supply and
22 quality, considering climate-induced changes in the patterns and characteristics of water
23 resources? (from Land Use/Land Cover Change and Water Cycle)
- 24 • What are the most likely vulnerabilities and opportunities arising from climate variability
25 and potential future climate changes, and what climate indicators would be of the most
26 benefit in assessing climate vulnerability and resilience in sectors such as agriculture,
27 water, and other environmental resources, and for assessing other potential societal
28 impacts (positive and negative), including human health? (from Climate Variability and
29 Change)

30
31 Questions from other research elements that are related to Question 3 above include:

- 32 • What are the implications of water cycle research for managing conflicting demands on
33 transboundary waters? (from Water Cycle)

34
35 Research on Human Contributions and Responses to Environmental Change is linked to the
36 International Human Dimensions Programme and to a variety of other international efforts,
37 including the International Research Institute for Climate Prediction (see Chapter 14).

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1 **References:**

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4 National Academy Press).

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7 Academy Press).

8 NRC, 2001c. Committee on Climate, Ecosystems, Infectious Diseases, and Human Health,
9 Board on Atmospheric Sciences and Climate, National Research Council, [*Under the Weather:*](#)
10 [*Climate, Ecosystems, and Infectious Disease*](#) (Washington, DC: National Academy Press).

11

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