

# National Climate Adaptation Summit

Enrique V. Iglesias Conference Center
Inter-American Development Bank
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Washington, D.C. 20577, USA

25-27 May 2010

Report prepared by the National Climate Adaptation Summit Committee

29 September 2010

UNIVERSITY CORPORATION FOR ATMOSPHERIC RESEARCH

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH | UCAR COMMUNITY PROGRAMS

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13 September 2010

Dr. John P. Holdren
Executive Office of the President
Office of Science and Technology Policy
Washington, D.C. 20502

Dear Dr. Holdren:

Enclosed you will find the report from the National Climate Adaptation Summit held in Washington, D.C. on 25-27 May 2010. The Summit was in response to your May 2010 conversation with the UCAR Board about UCAR working with its member universities and other relevant groups to organize and convene a summit on climate adaptation. This event brought together more than 180 invited users and providers of climate adaptation information to examine the needs, knowledge, and roles required for effective adaptation to climate change.

The report includes seven high priority near-term actions that will help better prepare our nation for a changing climate. I believe the report will be very useful input for planning climate research, services, and policy programs.

Over the past several years, UCAR has been working with our member universities to explore our role in helping to make our nation more resilient to climate change. We have explored how best to train the next generation of environmental leaders and a workforce that can tackle these complex challenges. We have also investigated how to create university-city climate adaptation partnerships that can learn from one another and be useful for the future national climate services.

The Summit was a great forum to broaden these community discussions and the range of impacted stakeholders. I hope you find the report interesting.

Sincerely,

Richard A. Anthes

Richard A. Anthes
UCAR President

Enclosure: National Climate Adaptation Summit Report

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*National Climate Adaptation Summit Speakers*

# Acknowledgements

**We'd like to acknowledge the following contributions to the Summit:**

- The members of the Summit Committee for the overall Summit planning (see box).
- The U.S. Global Change Research Program agencies for the bulk of the financial support for the Summit and the contributions from other sponsors (see Appendix D).
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- Peter Backlund, Sarah Carter, and the USGCRP Coordination Office staff (Emily Cloyd, Tanya Maslak, Sheila O'Brien, David Allen, and Fabien Laurier) for contributions to the report writing.
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# Foreword

*Atmospheric concentrations of greenhouse gases continue to grow rapidly, and there is mounting evidence that the United States and other nations are already experiencing significant impacts from a changing climate, as documented in many reports, assessments, and analysis from the National Academy of Sciences, the U.S. Global Change Research Program (USGCRP), the Intergovernmental Panel on Climate Change (IPCC), and other organizations (see Appendix A).*

*Options for responding fall into two broad categories that are not mutually exclusive. Our nation can adapt to observed and expected changes by making adjustments in behavior and management to limit harm and exploit beneficial opportunities, and we can mitigate the amount of change we experience by reducing greenhouse gas emissions and concentrations. The ever-increasing disruption of our planet's climate argues for a well thought out and comprehensive portfolio of adaptation and mitigation measures. The National Climate Adaptation Summit which resulted in this report was organized to help inform the definition of such measures.*

*It is an opportune time for a comprehensive examination of federal climate change programs, policies, and research activities. Responding to climate change and climate impacts is no longer primarily a federal concern; multiple presentations at the Summit described creative new private sector, state, regional and local programs that address climate challenges, many of which span the boundaries between levels of government and between the public and private sectors. There is an increasing recognition of the necessity of adapting to changing climate conditions in addition to mitigating, or limiting, the degree of change. A variety of new scientific tools and methods holds promise for producing the information needed to design, evaluate, and improve current and newly initiated climate change management efforts (e.g., very high resolution climate models, new observing networks, and integrated research that draws together physical science, ecology, and social science).*

*The current Administration is addressing this new landscape with initiatives for both mitigation and adaptation. During the Summit, senior representatives from Office of Science and Technology Policy and the Council on Environmental Quality described the development of a national climate change adaptation strategy and a new strategic plan for the USGCRP, including a stronger emphasis on more robust and ongoing scientific assessment. The participation of the President's Science and Technology Advisor, the Secretary of Agriculture, the Deputy Secretary of Interior, the Deputy Secretary of Housing and Urban Development, and the Under Secretary of Commerce for Oceans and Atmosphere in the Summit demonstrated the Administration's commitment to developing climate adaptation policy and the increasing engagement of federal agencies with important adaptation responsibilities.*

*Our goal in producing this report was to provide useful information for federal decision makers and other stakeholders as they develop strategies, programs, and policies to address a changing climate.*

The National Climate Adaptation Summit Committee

# Executive Summary

The National Climate Adaptation Summit was in response to a conversation the President's Science and Technology Advisor, Dr. John Holdren, had with the University Corporation for Atmospheric Research (UCAR) Board members and took place in Washington, DC, on May 25-27, 2010. This event brought together more than 180 users and providers of climate adaptation information to examine the needs, knowledge, and roles required for effective adaptation to climate change. The goal of the Summit was to inform federal, state, regional, and local climate adaptation efforts, including the planning of the federal Interagency Climate Change Adaptation Task Force[1] and the U.S. Global Change Research Program[2].

**There was a strong consensus among participants that wise adaptation measures can help minimize the negative impacts of a changing climate on our Nation's communities, businesses, ecosystems, and citizens.** Effective adaptation will require improved coordination within agencies and among agencies, states, regions and the private sector. It also calls for new methods of communication; sharing of best practices; budget increases in a few key areas; research to produce needed missing information; development of new partnerships; and 'learning by doing', or *adaptive* adaptation.

## The Summit identified seven priorities for near-term action:

- **Developing an overarching national strategy to guide federal climate change adaptation programs.** This strategy should establish agency roles, clear goals and metrics, and better mechanisms for coordinating federal and non-federal activities.
- **Improving coordination of federal plans and programs.** Strong management from the executive branch is needed to break down barriers, integrate planning, move funding into the highest priority areas, and maintain priorities across the multitude of involved agencies.
- **Creating a federal climate information portal.** This would provide single-point access to data from all relevant federal agencies and programs and would evolve over time into a more "national" portal with information about relevant non-federal efforts.
- **Creating a clearinghouse of best practices and toolkits for adaptation.** Such an effort could assist regions and sectors with similar adaptation challenges in learning from each other and explore the intersection of adaptation and mitigation.
- **Including support for assessment in USGCRP agency budgets.** This would enable the regular national-scale assessments of climate change impacts that are required by law.
- **Increasing funding for research on vulnerability and impacts, including economic analyses, and pilot projects that join local, state, and regional governments and academic institutions to develop and test adaptation measures and tools.**
- **Initiating a regional series of ongoing climate adaptation forums.** The goal would be to integrate planning, communication, and coordination of activities across various agencies and U.S. regions.

1 http://www.whitehouse.gov/administration/eop/ceq/initiatives/adaptation

2 http://www.globalchange.gov/

# Introduction

The changing climate already poses major challenges for the United States and the globe. Abundant observational evidence demonstrates that atmospheric concentrations of greenhouses gases (such as carbon dioxide and methane) have increased significantly over the last century due to human activities. This has led to increased air and ocean temperatures and altered weather patterns in many regions around the globe (see Figure 1). Most of the United States has experienced rising temperatures and significant changes in the timing, patterns, and amount of precipitation over the last century. The resulting impacts have affected forests, agriculture, water resources, urban areas, and many other economic sectors and sensitive ecosystems. These climate changes and impacts are projected to increase rapidly over the next century unless mitigation actions to dramatically reduce greenhouse gas emissions and stabilize concentrations are successful. Even with mitigation efforts, climate change will continue to unfold for decades due to the long atmospheric lifetime of past greenhouse-gas emissions and the gradual release of excess heat that has built up in the oceans. Climate change adaptation is thus a necessity for our Nation and the world.

In July 2009, the President's Science and Technology Advisor, Dr. John Holdren, had a conversation with the University Corporation for Atmospheric Research[3] Board members about UCAR working with its member universities and other relevant groups to organize and convene a National Climate Adaptation Summit to examine how the United States could best incorporate adaptation into federal planning processes. The Summit took place in Washington, DC on May 25-27, 2010. This report transmits the key findings, conclusions, and near-term priorities derived from the Summit, and offers these as inputs to OSTP and to broader federal efforts in climate adaptation, assessment, research, services, and related planning.

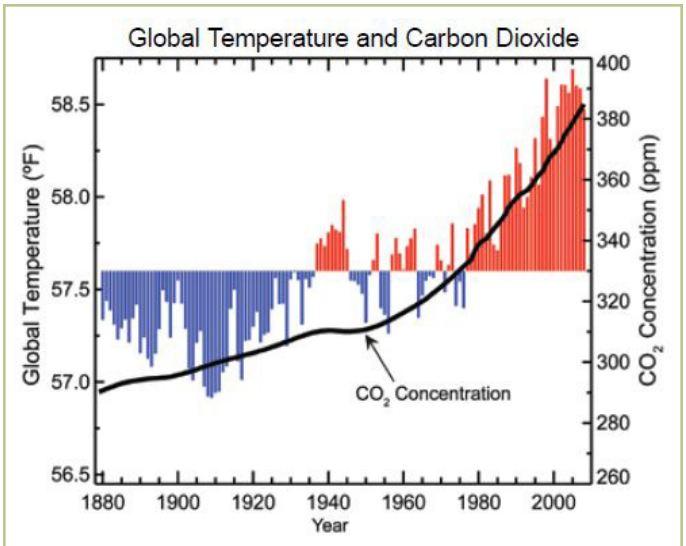



Figure 1: 1880-2009 Global Temperature and Carbon Dioxide Levels. Source: *2009 USGCRP Global Climate Change Impacts in the United States Report.*

The Summit focused primarily on adapting to a changing climate rather than mitigation or reducing green house gas emissions. However, it is very difficult to completely decouple these issues – some adaptation actions, such as improved building insulation, have the potential to reduce emissions, while others, such as increased deployment of air conditioning, could actually lead to emission increases. In addition, many mitigation and adaptation actions could increase demand for water, even as climate change increasingly stresses water supplies in many regions. Thus, the intersection of adaptation and mitigation was necessarily part of the Summit deliberations, an area that has had little exploration to date.

A wide variety of stakeholders took part in the Summit, including participants from the private sector and local, state, and regional governments and organizations who are already deeply engaged in climate adaptation. In many cases, local and state level activities are more advanced than many related federal efforts. In the face of a changing climate, local, state, and regional users and providers of climate-related information are explor-

3 University Corporation for Atmospheric Research is a consortium of over 100 universities that study weather and climate.

ing ways to better plan for their communities' resources and services (e.g., access to reliable and affordable water, food, energy, transportation, and health resources). These planning efforts involve both the public and private sectors, and decision makers are seeking better access to authoritative national information, tools, and approaches.

The Summit was not convened to debate the existence or future magnitude of climate change and its related impacts. Instead, participants were asked to examine the challenge of managing communities, natural resources, and economic sectors, using as context the best available information about current and future climate conditions (see Appendix A). Plenary and breakout sessions addressed three sets of specific questions:


*President Obama's Science and Technology Advisor, Dr. John Holdren*

1. **NEEDS**. What incentives and barriers should be addressed to encourage and facilitate effective climate adaptation and vulnerability assessment (e.g., funding, policy, legal, regulatory, legislative, actuarial, infrastructure, building and other standards and codes, training, cultural, etc.)? Of these, which are significant, which are urgent, and which, if altered, could provide the most substantial leverage?

2. **KNOWLEDGE**. What knowledge (e.g., scientific and technical information, tools, procedures, best practices, advice, etc.) is needed by public and private decision makers (federal, state, local, etc.) to adapt to climate change and assess vulnerability? How do we assure this knowledge is responsive to their needs, actionable, and effectively used?

3. **ROLES.** Who should provide this knowledge and leadership, how should it be delivered, and how should these providers be related to one another? What organizations, structures, and mechanisms might be needed for effectively communicating knowledge to action and vice versa?

The Summit was organized by the National Climate Adaptation Summit Committee comprising both public and private sector climate adaptation practitioners. It brought together invited users and providers of climate adaptation information from diverse climate regions, economic sectors, and levels of government (see Appendix B for a list of participants).

A rich set of keynote presentations and breakout group discussions provided invaluable insights into what is needed for effective national and regional climate adaptation and vulnerability assessment (see Appendix C for the Summit agenda). We hope the Summit output will help better prepare our country for a more sustainable future (see the *Looking Ahead* box). Many of the plenary talks and breakout reports were webcast and can be viewed on the Summit website[4].

*Stakeholder Panel*

4 National Climate Adaptation Summit website: http://www.joss.ucar.edu/events/2010/ncas/index.html

### Looking Ahead: The Value of Climate Adaptation

The keynote speakers and the participants (in small breakout groups) were asked to examine how best to position our Nation to deal effectively with climate adaptation. If successful, one might hope to see the following statement two decades from now:

> *October 2030: Today, the President acknowledged the 20th anniversary of our national climate adaptation strategy and related partnerships. The strategy has allowed our country to effectively plan for a changing climate. It was put in place in 2010 through a broad range of novel partnerships, from local communities to the highest levels of the Federal government, that were designed to effectively exchange useful climate information and tools. The strategy was successful because it ensured that information was easily accessed and used to direct a broad range of activities, such as making effective investments in climate research and monitoring, ensuring that our Nation had consistent policies and standards that reflected effective climate adaptation planning, and implementing a national assessment process to monitor the progress of these activities. Even as we continue to reduce greenhouse gas emissions to limit future climate change, we have minimized the adverse impacts of change on America and other nations around the world and made our communities, businesses, and natural resources much more resilient to a wide range of environmental and societal challenges. The President commended the wisdom and leadership of those people who took these bold steps so many years ago.*

**What is keeping us from making this statement in 2010?** While progress is being made, the key constraints and issues identified by the Summit participants included the lack of: (1) an overall national climate adaptation strategy, (2) clear federal leadership and coordination, (3) access to critical tools and information, and (4) appropriate training for climate adaptation leaders and the broader workforce. Thus, most federal, public, tribal, or private sector groups and organizations find it quite difficult to undertake effective climate adaptation planning or evaluate the risks and vulnerabilities they are facing.

# Key Issues and Challenges

Participants in the Summit were energized by the opportunity to examine how the Nation can best respond to its changing climate. They identified problems with existing efforts and opportunities for improving these efforts. They also acknowledged areas where existing programs and collaborations are working well. This section provides a synthesis of the key issues that emerged from Summit breakout sessions and plenary discussions.

### The Need for a Clear National Strategy for Climate Adaptation.

Currently there is no overall national climate adaptation strategy to guide federal efforts and interactions with other important stakeholders. Relevant federal agency programs are not well coordinated—among themselves; with relevant state, regional and local government efforts; or with private sector activities. In addition, funds to help build effective federal and non-federal partnerships and support climate adaptation planning are inadequate. As mentioned earlier, climate adaptation planning in many cities and regions is far more advanced than current federal efforts, and most climate adaptation decisions will be made locally, not nationally. Thus, while the federal government needs to play a key role in establishing a national strategy, this must be done in cooperation with and for the benefit of state, regional, and local stakeholders.

Regional adaptation forums would contribute to both the development and implementation of a successful strategy. These could improve federal-regional-local partnerships, cooperation, and coordination; enable regular exchanges of information among interested parties; and avoid unnecessary duplication of efforts. They could also help define reasonable goals and milestones for the strategy, including incentives to promote climate resiliency and metrics to measure progress. Finally, such forums would provide a venue for professional groups, local-to-federal officials, and regulators to work together on incorporating climate adaptation approaches into system and infrastructure standards and codes (e.g., for buildings, bridges, power and water systems, emergency management, etc).

A national strategy should also involve a limited number of pilot projects to experiment with different adaptation approaches and methods. Such pilot projects should be monitored and carefully evaluated to facilitate "learning by doing," or *adaptive* adaptation. The adaptation forums described above could help with identifying and designing pilot projects that are responsive to local and regional needs.

Another important element of a strategy is increased focus on practical and usable climate information. Our nation needs a climate research and service enterprise that generates a limited set of authoritative and timely federal climate products, but also recognizes that the private sector and other non-federal organizations are often better suited to tailor this information for local decisions on climate adaptation. Climate information should be driven by user needs, and these needs should help inform and guide federal research and service priorities, but it is also important to note that users do not always fully understand their needs in such complex situations as climate adaptation. An iterative process between users and producers of climate information is therefore critical.

Tools and information developed by this enterprise need to be accessible from an easy-to-use, one-stop national climate information portal. The portal would include a roadmap to federal and non-federal climate adaptation efforts, so users can understand what roles and responsibilities have been defined, whom to contact for a particular issue, what resources are available, and what best practices might be relevant to their situation. This portal would start with federal climate information and evolve over time into a more "national" portal with information about relevant non-federal efforts.

Finally, the success of a strategy for climate adaptation ultimately depends on people with the skills to do this work and on better communication of the impacts of climate change and the risks of inaction, so that both the public and private sectors can respond appropriately. This will require ongoing training and education to ensure a climate-knowledgeable workforce. It will also require improvements in development and delivery of usable, understandable and accurate information, including GIS-based systems and visualization products that graphically show things like the impact of sea level rise and the shifting of regional climate into new regimes. States and regions can benefit significantly from the experiences of others. For example, New York City is likely to have a future climate similar to coastal North Carolina; it can learn from North Carolina now. A national strategy needs to facilitate these interactions.

### The Need for Federal Leadership and Improved Coordination of Federal Programs.

The United States has a bewildering mix of loosely connected climate and climate adaptation research and programs distributed across roughly a dozen federal agencies. The landscape is marked by inconsistent federal policies, subsidies, and regulations that discourage good climate adaptation decision making and risk analysis; the absence of a clear federal planning and budget process to integrate multi-agency climate adaptation efforts or metrics to measure progress; and few federal agencies that mainstream climate adaptation planning into their own agency planning processes. Creation of a national adaptation strategy, as described above, would help address these issues, but additional steps are needed.

Increased Presidential engagement on climate adaptation issues would both elevate the importance of adaptation activities within the government and raise the profile of the adaptation challenge with the nation as a whole. Opportunities include being more vocal on the importance of this topic, the validity of the science, and the need to take reasonable actions. Instructing federal agencies to mainstream “climate adaptation best practices” in their routine operations would also be a very significant step, as would the strengthening of Office of Management and Budget and OSTP oversight and coordination of climate research and service efforts within federal agencies in order to reduce program duplication. Effective and visible incorporation of climate concerns in the ongoing activities of the federal agencies could help galvanize and maintain the development of effective responses in the private sector and states, regions, and localities.

There is also the opportunity to examine and, if necessary, revise policies, regulations, and programs to ensure that they are consistent with climate adaptation needs (e.g., building and rebuilding in hazardous areas, farming subsidies and practices, land management, outdated FEMA maps, environmental impact analysis, the National Environment Protection Act regulations, etc.) is another opportunity. Making effective climate adaptation planning a criterion for awarding and evaluating relevant federally funded projects should also be considered.

The federal government should inventory, learn from, and use proven means of effective federal, local, and regional planning partnerships, including those with a state or federal component (e.g., the Western Governors Association, NOAA Weather Forecast Offices and Regional Integrated Sciences and Assessment groups, U.S. Department of Agriculture and Sea Grant extension offices, etc.) and, especially, partnerships involving early adopters of climate adaptation planning on the local level (e.g., New York City; Chicago; Keene, New Hampshire; and King County, Washington, as well as networks of university-city partnerships). The goal would be to empower new partnerships without impeding existing ones.

## The Need for Tools and Information to Support Climate Adaptation.

Federal investments in physical climate science, observations, and modeling have significantly advanced predictive capability, but a wider variety of scales and types of information is needed for climate adaptation. Currently, much federally-produced data is underutilized because it is difficult to find and use. Many observations are not optimal for climate adaptation because they were developed for other reasons or because their planning was not integrated with other systems (e.g., research vs. operational, space-based vs. ground-based). Significant knowledge gaps threaten the effectiveness of adaptation planning due to lack of funding for key research areas. In addition, the federal government does not produce simple and authoritative federal climate scenarios or risk analysis methods that can be used in either federal or non-federal planning.

To address these issues, the federal government must continue to support critical basic climate science and modeling while augmenting research efforts that are directly relevant to climate adaptation, including investigation of the sensitivities of human and natural systems to climate parameters, cost/benefit analyses of adaptation options, and the development of methods to measure the effectiveness of adaptation actions. Better integration of social, behavioral, demographic, and economic research into climate change scenarios, projections, and decision making is critical for analyzing risk and vulnerability to climate change impacts and for developing and implementing viable options for adaptation. The federal government should also work to improve the dissemination of existing usable climate information in the very near term to address immediate needs, while continuing to improve the local applicability of climate modeling and prediction through downscaling and finer-resolution modeling.

Improvement and better coordination of federal state, regional, and local observation and monitoring programs (space-, aircraft-, and surface-based) should also be a priority. Accurate long-term observations are critical for effective planning, decision making, and evaluation of progress. An observation system for climate adaptation should initially focus on a few key parameters, (e.g., precipitation, stream flow, heat, evaporation, extreme events, sea level change, etc.) and should include partnerships with non-federal groups to enable incorporation of data collected locally (e.g., water quality, demographics, health, etc). The NOAA Climate Reference Network and the new NSF National Ecological Observatory Network can provide strong foundations for such an effort, as could stream gauge and snow measurement networks supported by many states, Department of Interior's U.S. Geological Survey and U.S. Department of Agriculture. The creation and maintenance of standards for data collection and stewardship is another important component in improving observing systems.

## The Need for Climate Training and Education.

The conduct of climate resiliency research and its application to policy and decision making is a very demanding and interdisciplinary enterprise. It is increasingly clear that traditional discipline-based education approaches are not adequate for producing the climate-savvy leaders and workforce required for effective climate adaptation planning. It is also clear that a variety of training programs are needed in the near-term to help public and private sector organizations with building climate considerations into their ongoing operations.

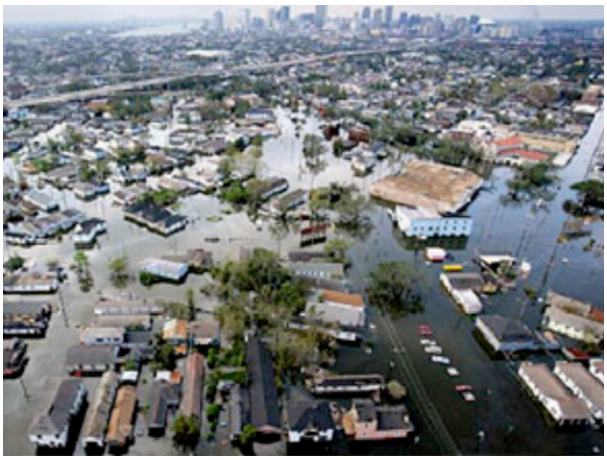
One of the greatest needs in this area is increased federal funding for interdisciplinary education and research programs, including "professional certificate" programs, at the undergraduate and graduate levels. These should address decision making under uncertainty and the evaluation of risk and liabilities associated with climate adaptation. Another opportunity for improvement is targeting

federal funds to support the interaction of universities and research institutes with local, regional and state level climate decision makers. This would help build practical concerns into the development of climate education and research activities in academia. If consistent funding for such efforts were maintained and coupled with increased opportunities for recognition, perhaps through new prizes and awards (already implemented in some states for climate work), it would help increase the respect for, and recognition of, applications-oriented science in the academic world.

# Conclusions and Priorities

**The United States' response to climate change must include adaptation as well as mitigation**. Adaptation can help minimize the negative impacts of climate change on our Nation's communities, businesses, ecosystems, and citizens. Effective adaptation will require sharing of best practices; new methods of communication; coordination within and between agencies and with states, regions and the private sector; research to produce needed information; and learning by doing, or adaptive adaptation.

**The current suite of federal adaptation activities and plans lacks clear organization and is confusing to potential state, regional, and local partners and other stakeholders.** "Stovepiping" in federal efforts is a major concern, especially with the profusion of new adaptation-relevant efforts across the federal government; between various levels of state, regional, and local government; and across relevant sectors. There is no clear roadmap that identifies specific roles and priorities. **Priorities for near-term action:**



- **Developing an overarching strategy to guide federal climate adaptation programs.** This strategy should specify agency roles, clearly define its goals, and establish mechanisms for coordinating federal and non-federal activities. It should include support for regional and local planning, iterative assessments, creation and distribution of "federally-certified and usable" data products on regional impacts; and evaluation of best practices. Research is needed to develop metrics for measuring adaptation "success."

- **Improving coordination of federal plans and programs**. The Administration should better integrate the planning and development of adaptation programs and budgets among federal agencies. Strong management from the executive branch is needed to break down barriers, integrate planning, and maintain priorities across multiple agency programs. Congressional evaluation and oversight of adaptation programs would be more effective if also done in an integrated fashion (i.e., through multi-agency hearings and testimony). A possible structure for a national climate adaptation strategy and related climate research and services based on the Summit discussions can be found on the Report's back cover.

**The federal government's production and dissemination of materials to raise public awareness of the challenges and opportunities associated with climate change has been sporadic and inconsistent.** There is no easy one-stop access to the information and resources needed to support

planning for and responses to climate change, nor is there sufficient capacity to translate science and technical information into actionable information for decision makers. Addressing these issues will help enable the anticipatory learning and advance planning that are necessary for effective adaptation. **Priorities for near-term action:**

- **Creating a federal climate information portal to provide single-point access to data from all relevant agencies and programs.** This should have a user-friendly interface and technical staff trained in effective stakeholder communication. It should be initiated with federal information, including a roadmap that explains how federal research and management centers, initiatives, and programs fit together. The portal could then be expanded over time into a more "national" portal with information about relevant non-federal efforts.

- **Creating a clearinghouse of adaptation best practices and toolkits.** This capability should be maintained by the federal government and include information about adaptation plans, actions, and results in myriad regions and sectors, both domestically and internationally, as well as analyses that characterize the specific adaptation benefits of actions. Such a database will assist regions and sectors with similar adaptation challenges in learning from each other. This is particularly important as various localities begin to experience impacts that other regions are already addressing. As the clearinghouse is developed, its information should be linked with and easily accessible through the national portal described above.

**Recent budget increases for federal climate adaptation and research activities are encouraging, but important funding needs remain and must be addressed.** Research on the impacts of climate change has never been a large proportion of overall USGCRP funding. Many important questions relevant to adaptation have not been adequately addressed, particularly with regards to climate impacts on society and on ecosystems and ecosystem services. The periodic assessments called for in the Global Change Research Act of 1990 (the authorizing legislation for the USGCRP) have been carried out less frequently than required. **Priorities for near-term action:**

- **Including support for assessment in USGCRP agency budgets** to enable the regular national-scale assessments of climate change impacts that are required by law, and to enable the design and implementation of regional, sectoral, and issue-specific assessments to inform adaptation planning and decisions.

- **Increasing funding for research on vulnerability and impacts, including economic analyses, as well as for pilot projects that join local, state, and regional governments and academic institutions to develop and test adaptation measures and tools.**

**Strong new partnerships are required for effective adaptation, with a particular need for ongoing engagement** among federal, regional, and local government; tribes and non-governmental organizations, such as academia and private industry. The federal government has resources, expertise, information, and tools. Non-federal actors possess trusted, locally relevant knowledge, experience, and expertise that is critical for the planning, management, and implementation of adaptation measures. Collaborations between federal agencies and regional stakeholders will be necessary to identify feasible adaptation options in a variety of places. **Priority for near-term action:**

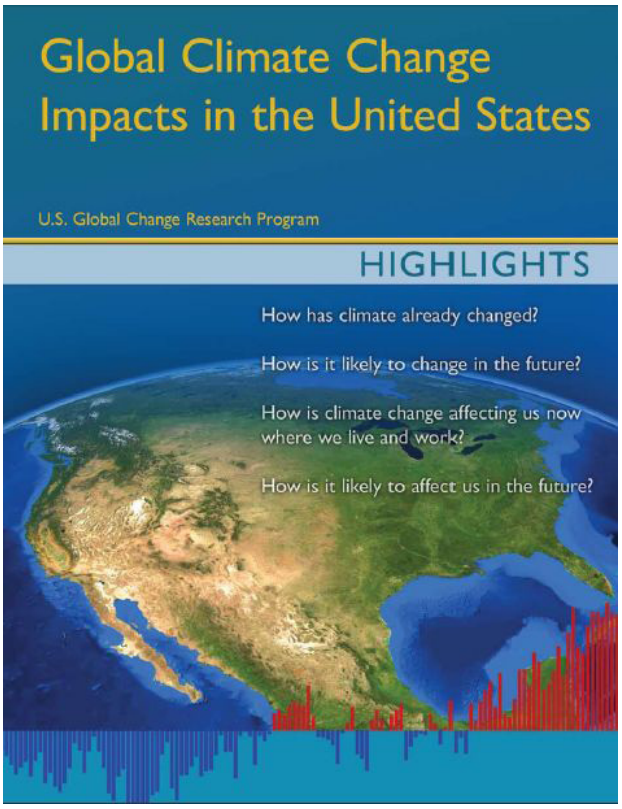
- **Initiating a series of ongoing climate adaptation forums in several regions across the Nation.** These forums should meet regularly (e.g., quarterly) and include regional federal agency offices, academic institutions, and non-governmental organizations, as well as regional, state, and local governments. Sustained and well-organized regional forums could improve the integration of regional planning and could help with communication and coordination of the activities of multiple agencies in various regions.

## End of Report


*Dr. Rosina Bierbaum Summarizes the Summit Discussions*

# Appendix A. References


- Global Climate Change Impacts in the United States (2009, USGCRP – see below) http://www.globalchange.gov/publications/reports/scientific-assessments/us-impacts
- Synthesis and Assessment Product 4.3: The effects of climate change on agriculture, land resources, water resources, and biodiversity in the United States (2008, USGCRP). http://www.climatescience.gov/Library/sap/sap4-3/final-report/default.htm
- Synthesis and Assessment Product 4.4: Preliminary review of adaptation options for climate-sensitive ecosystems and resources (2008, USGCRP). http://www.climatescience.gov/Library/sap/sap4-4/final-report/
- Climate Change 2007 (Intergovernmental Panel on Climate Change, Fourth Assessment Report http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html
- Restructuring Federal Climate Research to Meet the Challenges of Climate Change and Informing Decisions in a Changing Climate (2008, NRC) http://books.nap.edu/catalog.php?record_id=12595
- Actions to Make Our Nation Resilient to Severe Weather and Climate Change (2008, UCAR) http://www.ucar.edu/td/
- Coping with Climate Change: National Summit Proceedings (2008, University of Michigan) http://islandpress.org/bookstore/detailsd66a.html?prod_id=1851
- America's Climate Choices (2010) http://americasclimatechoices.org/

# Appendix B. List of Participants

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**Field, Christopher**, Dept. Global Ecology, Carnegie Institution

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**Franco, Guido**, California Energy Commission

**Frankel-Reed, Jennifer**, U.S. Agency for International Development

**Freed, Adam**, NYC Mayor's Office of Long-Term Planning & Sustainability

**Freed, Randall**, ICF International

**Frumhoff, Peter**, Union of Concerned Scientists

**Furlow, John**, USAID

**Gade, Mary**, Gade Environmental Group, LLC

**Gasper, John**, Argonne National Laboratory

**Glick, Daniela**, Office of Governor Bill Richardson

**Goodman, Sherri**, CNA

**Goshi, Brandon**, Metropolitan Water District of Southern California

**Grambsch, Anne**, U.S. EPA

**Grimm, Nancy**, Arizona State University

**Griner, Debora**, Miami-Dade County

**Grunwaldt, Alfred**, Inter-American Development Bank

**Gulledge, Jay,** Pew Center on Global Climate Change

**Hamilton, George**, Institute for Sustainable Communities (ISC)

**Hatfield, Jerry**, U.S. Department of Agriculture-Agricultural Research Service

**Hausker, Karl**, ICF International

**Hayden, Mary**, National Center for Atmospheric Research

**Hayes, David**, Department of Interior

**Henry, Michael**, University Corporation for Atmospheric Research

**Hill, Alice**, Department of Homeland Security

**Hirsch, Leonard**, Smithsonian

**Hohenstein, William**, USDA Climate Change Program Office

**Holdren, John**, Director of the Office of Science and Technology

**Holmes, Richard**, Southern Nevada Water Authority

**Hurrell, James**, National Center for Atmospheric Research

**Inman, Pamela**, Western Governors Association

**Iseman, Thomas**, Western Governors' Association

**Jacobs, Kathy**, Office of Science and Technology Policy

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**Kaye, Jack**, NASA Headquarters

**Kharitonov, Nikolay**, Russian Embassy

**Kheshgi, Haroon**, ExxonMobil Research and Engineering Company

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**Kostyack, John**, National Wildlife Federation

**Kraucunas, Ian**, National Research Council

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**Learner, Howard**, Environmental Law & Policy Center

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**Leurig, Sharlene**, Ceres

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**Luber, George**, Center for Disease Control

**Ludena, Carlos**, Inter-American Development Bank

**Luers, Amy**, Google

**Macauley, Molly**, Resources for the Future

**MacCracken, Michael**, Climate Institute

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**Manous, Joe**, Office of Assistant Secretary of Army for Civil Works

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**Miles, Edward**, University of Washington, School of Marine Affairs

**Moreno, Alberto, Luis**, President Inter-American Development Bank

**Moseley, Robert**, The Nature Conservancy and Chicago Wilderness

**Moser, Susanne**, Susanne Moser Research & Consulting

**Moss, Richard**, Joint Global Change Research Institute

**Mote, Philip**, Oregon Climate Change Research Institute

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**Nordgren, John**, The Kresge Foundation

**Nutter, Frank**, Reinsurance Association of America

**Oakley, Janet**, American Association of State Highway and Transportation Officials

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**Palmisano, Anna**, U.S. Department of Energy

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**Penn, Kimberly**, White House Council on Environmental Quality

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**Peterson, Jeff,** Council on Environmental Quality

**Petes, Laura**, National Oceanographic and Atmospheric Administration Climate Program Office

**Piltz, Rick**, Climate Science Watch

**Pulwarty, Roger**, National Oceanographic and Atmospheric Administration

**Quay, Ray**, Water Services City of Phoenix

**Reeder, Spencer**, State of Washington, Department of Ecology

**Revkin, Andrew**, Pace University/ New York Times

**Richardson, Bill**, Governor of New Mexico

**Rose, Chris**, White House Council on Environmental Quality

**Rosenblum, Cheryl**, CNA

**Rosenzweig, Cynthia**, NASA Goddard Inst. of Space

**Rossi, Steve**, City of Phoenix

**Sanio, Michael**, American Society of Civil Engineers

**Scheraga, Joel**, U.S. Environmental Protection Agency

**Schimek, Gary**, Seattle Public Utilities

**Schultz, Peter**, ICF International

**Seidel, Stephen**, Pew Center on Global Climate Change

**Shea, Eileen**, National Oceanographic and Atmospheric Administration National Climate Data Center

**Silverman, Seth**, Council on Environmental Quality

**Sims, Ron**, Department of Housing and Urban Development

**Slimak, Michael**, U.S. Environmental Protection Agency

**Smith, Joel,** Stratus Consulting Inc.

**Staudt, Amanda**, National Wildlife Federation

**Stickel, Lorna**, Portland Water Bureau

**Sundt, Nick**, World Wildlife Fund

**Taft, Alexander**, National Grid

**Takle, Eugene**, Iowa State University

**Titley, David**, US Navy

**Tollerson, Ernest**, Metropolitan Transportation Authority, NYS

**Trivedi, Dilip**, Moffatt & Nichol

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**Udall, Brad**, CU-NOAA Western Water Assessment

**Valencia, Sandra**, Inter-American Development Bank

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**Vilsack, Tom**, Secretary of U.S. Department of Agriculture

**Walsh, Margaret**, U.S. Department of Agriculture Climate Change Program Office

**Wassmann, Robert**, Noblis

**Weiss, Betty**, Institute for Sustainable Communities

**Werner, Carol,** Environmental and Energy Study Institute

**Westman, David**, Con Edison

**Whitmire, Melanie**, UCAR Joint Office of Science Support

**Wilbanks, Thomas**, Oak Ridge National Laboratory

**Witte, Joseph**, WJLA TV Station

**Wuebbles, Don**, University of Illinois

**Yates, David**, National Center for Atmospheric Research

**Yohe, Gary**, Wesleyan University

# Appendix C. Summit Agenda

## Tuesday 25 May 2010

**7:30** **Registration and Continental Breakfast**

**8:30** **Forum Introduction: Welcome participants and outline the Forum goals and structure.**
*Jack Fellows, Vice President, University Corporation for Atmospheric Research*

**9:00** **Federal Climate Adaptation Planning: Description of Federal climate adaptation and assessment planning and how the Summit will contribute to these activities.**
*The Honorable Shere Abbott, Associate Director for Environment, Office of Science and Technology Policy, Executive Office of the President*

**9:40** **Current Understanding of Climate Change and Adaptation: Review of what we know and don't know about climate change and climate adaptation and how the Summit breakouts will work.**
*Rosina Bierbaum, Member, President's Council of Advisors on Science and Technology and Dean, School of Natural Resources and Environment, University of Michigan*
*Tom Karl, Director, National Climatic Data Center, National Oceanic and Atmospheric Administration*
*Tom Wilbanks, Senior Researcher, Oak Ridge National Laboratory*

**10:15** **Break**

**10:45** **Climate Adaptation Stakeholders Panel: Panel participants discuss how their organizations have been dealing with climate adaptation issues and provide their perspectives on the Summit's three questions.**
*Maria Blair, Deputy Associate Director for Climate Change Adaptation, Council on Environmental Quality, Executive Office of the President (moderator)*
*David Behar, Climate Program Director, San Francisco Public Utilities Commission*
*Adam Freed, Senior Policy Advisor on Climate Change Adaptation, NYC Mayor's Office of Long-Term Planning and Sustainability*
*Joyce Coffee, City of Chicago Office of the Environment*
*Anne Choate, Vice President, ICF International*
*Elizabeth Jines, City of Los Angeles*

**12:00** **Adjourn for Luncheon: Move to the IDB Café**

**12:30** **Luncheon Speaker:**
*The Honorable David Hayes, Deputy Secretary, U.S. Department of the Interior*

**1:20** **Luncheon Concludes: Participants head to breakout group locations**

**1:45** **Breakouts Meet on Question 1**

**4:00** **Break**

**4:30** **Question 1 Breakout Reports: Each Breakout will provide a 5 minute report**

**5:45** **Brief Summary: Review what we learned during the day, look toward tomorrow, and adjourn to reception**

**6:15** **Reception: IDB Terrace; addresses by**
*Randall Freed, ICF International Senior Vice President, and Jane Lubchenco, Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator*

## Wednesday May 26 2010

**8:00** **Continental Breakfast**

**8:30** **Welcome and Logistics:**
*Maria Blair, Deputy Associate Director for Climate Change Adaptation, Council on Environmental Quality, Executive Office of the President*

**8:45** **Welcome**
*Luis Alberto Moreno, President of the Inter-American Development Bank*

**9:00** **State Keynote:**
*The Honorable Bill Richardson, Governor of New Mexico*

**9:30** **Local Keynote:**
*The Honorable Ron Sims, Deputy Secretary, U.S. Department of Housing and Urban Development, and former King County, Washington Executive*

**10:00** **Break**

**10:15** **Breakouts Meet on Question 2**

**12:15** **Adjourn for Luncheon: Move to the IDB Café.**

**12:30** **Luncheon Speaker:**
*The Honorable Thomas J. Vilsack, Secretary, U.S. Department of Agriculture*

**1:45** **Luncheon Concludes: Move to Enrique Iglesias Convention Center Auditorium**

**2:00** **Question 2 Breakout Reports: Each Breakout will provide a 5 minute report**

**3:15** **Break**

**3:45** **Breakouts meet on Question 3**

**5:45** **Breakouts conclude: Return to Enrique Iglesias Convention Center Auditorium**

**6:00** **Brief Summary: Review what we learned during the day, look toward tomorrow, and adjourn**

**6:15** **Optional/Informal Briefing: America's Climate Choices Reports on Limiting Emissions, Climate Science and Adapting to the Impacts of Climate Change**

## Thursday 27 May 2010

**8:00** **Continental Breakfast**

**8:30** **Welcome and Logistics:**
*Rosina Bierbaum, Member, President's Council of Advisors on Science and Technology, and Dean, School of Natural Resources and Environment, University of Michigan*

**9:00** **International Keynote:**
*Juan Pablo Bonilla, Chief, Sustainable Energy and Climate Change Unit, Inter-American Development Bank*

**9:30** **Climate Adaptation Communication Keynote:**
*Andy Revkin, New York Times*

**10:00** **Looking Ahead:**
*The Honorable John P. Holdren, Assistant to the President for Science and Technology and Director, Office of Science and Technology Policy, Executive Office of the President*

**10:30** **Question 3 Breakout Reports: Each Breakout provides a 5 minute report**

**11:45** **Wrap-up: Summit leaders Jack Fellows and Rosina Bierbaum summarize key issues, what we learned, next steps, and thank the participants**

**12:30** **Adjourn the Summit**

# Appendix D. Summit Sponsors

ICF International (NASDAQ:ICFI) partners with government and commercial clients to deliver professional services and technology solutions in the energy and climate change; environment and infrastructure; health, human services, and social programs; and homeland security and defense markets. In the climate impacts and adaptation arena, ICF is assisting its clients through scientific, economic, technical, and policy analyses, and the development and implementation of risk management strategies. The firm combines passion for its work with industry expertise and innovative analytics to produce compelling results throughout the entire program life cycle, from research and analysis through implementation and improvement. Since 1969, ICF has been serving government at all levels, major corporations, and multilateral institutions. More than 3,500 employees serve these clients worldwide. http://www.icfi.com/

The Inter-American Development Bank (IDB) was established in 1959 to support the process of economic and social development in Latin America and the Caribbean, and is the main source of multilateral financing to the region with a total capital of more than $170 billion. Current lending priorities include initiatives on Sustainable Energy and Climate Change, Water and Sanitation and Education. The IDB Group, comprising IDB, the Inter-American Investment Corporation (IIC) and the Multilateral Investment Fund (MIF), provides solutions to development challenges by partnering with governments, companies, and civil society organizations, thus reaching its clients ranging from central governments to city authorities and businesses. http://www.iadb.org/

NCAR conducts wide-ranging, collaborative research in chemistry, climate, weather, the Sun and its effects on the Earth, and the interactions of human society with the environment. NCAR also provides a broad array of tools and technologies to the scientific community, including state-of-the-art instrumentation, research aircraft, supercomputing, and technical support to advance the study of Earth's atmosphere. http://ncar.ucar.edu/home

Noblis, a nonprofit science, technology and strategy organization, helps clients solve complex scientific, systems, process, and infrastructure problems in the areas of environmental sustainability, national security, transportation, healthcare, and enterprise transformation. Noblis' Center for Sustainability applies expertise in systems engineering, analytics, and modeling and simulation in the areas of sustainability planning, climate change adaptation, and environmental stewardship. Noblis' work is helping transition our nation into a new era of energy independence and increased resilience in a carbon constrained world. http://www.noblis.org

The U.S. Global Change Research Program (USGCRP) coordinates and integrates federal research on changes in the global environment and their implications for society. The USGCRP began as a presidential initiative in 1989 and was mandated by Congress in the Global Change Research Act of 1990 (P.L. 101-606), which called for "a comprehensive and integrated United States research program which will assist the Nation and the world to understand, assess, predict, and respond to human-induced and natural processes of global change." The USGCRP is steered by the Subcommittee on Global Change Research, composed of thirteen participating departments and agencies, under the Committee on Environment and Natural Resources, overseen by the Executive Office of the President, and facilitated by an Integration and Coordination Office, which is administered by UCAR. http://www.globalchange.gov/

UCAR is a nonprofit consortium of 75 universities dedicated to understanding the atmosphere and the complex processes that make up the Earth system, from the ocean floor to the Sun's core. UCAR manages NCAR on behalf of the National Science Foundation and the university community. It also provides real-time weather data; digital library services; training for forecasters, hydrologists, and other professionals; field research support; and other services through the UCAR Community Programs. http://www2.ucar.edu/

## A Suggested National Structure for a Climate Adaptation Strategy and Related Climate Research and Services

It is clear that a comprehensive national approach to climate adaptation is needed, and that this should include an adaptation strategy and a suite of climate services—both of which are under development by the current Administration—as well as an ongoing program of research and assessment that now exists in the form of the U.S. Global Change Research Program (USGCRP) but that needs to evolve in response to developing societal needs. These efforts need to be coordinated and mutually supportive. For example, the National Climate Assessment(s) conducted by the USGCRP should be designed to help

- determine which critical data sets are needed from the anticipated National Climate Service,
- set research priorities for the USGCRP, and
- judge overall progress toward national adaptation strategy goals.

Below is an outline of these proposed elements and how they might fit within three overarching components.

**NATIONAL ADAPTATION STRATEGY**

- Leadership, vision, and sustained commitment at the highest levels of Government
- A clear explanation of the state of climate science and the risks of not preparing now to cope with climate change
- A framework for adaptation research, planning, and management in federal agencies
- Mechanisms to coordinate federal and non-federal adaptation activities
- Funding for adaptation and facilitating development of a national adaptation program with regional and sectoral components
- Shared responsibility and collaboration among stakeholders at all levels

**NATIONAL CLIMATE SERVICE(S)**

- Provision of authoritative climate predictions, projections, and information on impacts
- A single, unified National Climate Information Portal for access to credible data and information as part of a distributed network of partners
- Shared responsibility and collaboration among stakeholders at all levels
- National “operational” monitoring system for climate change and climate change impacts
- A system for drawing on the findings of user-developed vulnerability assessments to inform federal research and priorities
- Coordinating and integrating the Federal agencies efforts relevant to climate services and ensuring they reflect stakeholder needs (e.g., states, regions, and economic sectors)

**U.S. GLOBAL CHANGE RESEARCH PROGRAM**

- Planning and coordination of federal climate-related physical, ecological and human dimensions research, experimental observation, modeling, and national and regional assessment to reflect user needs
- Support for the goals of the National Climate Service and National Climate Adaptation Strategy
- A strong, ongoing National Assessment Process that incorporates
- a sustained process for engagement, analysis, interpretation, and monitoring
- the evaluation of science, information needs, adaptation options and progress
- shared responsibility and collaboration among stakeholders at all levels