WestFAST

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WestFAST Agencies

Water-Climate Change

Program Inventory

April 2010

Agencies/Members

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WestFAST Agencies
Water-Climate Change Program Inventory
April 2010

Introduction

In support of the Climate Change Impacts elements of the 2008 "*Next Steps*" (Western Governors' Association (WGA)) report (actions 30-40), the Western States Federal Agency Support Team (WestFAST) conducted an inventory of the current water science and water management climate change activities of its member agencies. The purpose of this inventory is to share information on Federal climate change programs that are relevant to western water managers to facilitate closer coordination between Federal agencies and State water scientists and managers.

The "*Next Steps*" report noted that "Cooperation among the states and the federal government continues to be vital" and that "Developing optimal solutions to the challenges laid in the 2006 WGA water report will require an integrated approach and greater partnerships among state, local, and federal agencies."

The Federal climate change programs that relate to water science and adaptive water management are in a relative early stage of development and are evolving at a rapid pace. It is hoped that this WestFAST inventory will help the western States better understand the nature and scope of some of these federal climate change programs and better inform the discussion between the Western States Water Council and the WestFAST agencies on how to proceed in developing a common, integrated approach to adapting water resources management to climate change and variability.

The inventory was conducted from October 2009 – March 2010, and includes information on FY 2009, 2010, and proposed 2011 activities and budget as available.

This summary report starts with a general overview of the full Federal Climate Change Program, the U.S.Global Change Research Program, and its Global Water Cycle component. The report then presents a brief summary of WestFAST agencies' climate-change coordination activities and an overview of the climate change work being conducted by each individual WestFAST agency. Agency contacts and links to appropriate websites are listed for each WestFAST Agency.

This inventory shows that:

- Federal climate change programs that focus on adaptation are typically in an early formative stage, but they are growing and can be expected to develop and evolve in the coming years.

- Many of these programs are currently inwardly focused on agency specific mission requirements.

- There are a number of new interagency coordinating groups being formed to better integrate and direct Federal climate change programs, such as the Climate Change and Water Working Group, and the Council on Environmental Quality (CEQ) Interagency Committee on Climate Change Adaptation – Water Resources Working Group.

- There are emerging opportunities for States to better engage with Federal agencies through formal partnering programs, such as the Department of Interior's Climate Change Centers and Landscape Conservation Cooperatives and EPA's Climate Ready Water Utilities Working Group.

- There are current examples of effective State-Federal climate-water coordination, such as NOAA's National Integrated Drought Information System.

U.S. Federal Climate Change Program

The Federal Government has a substantial and growing Climate Change Program, of which water science and management represents a relatively small part. Federal appropriations for Climate Change Programs has increased in recent years from $7.4 Billion (B) in 2008 to approximately $18.2 B in the President's proposed FY 2011 budget, with an additional $79.5 B in American Recovery and Reinvestment Act (ARRA) funds directed to climate change program expenditures. From FY 2009-2011, the Federal Climate Change Program has been organized around the following major categories:

Category	FY 2009 Million $	FY 2010 Million $	FY 2011 Million $
US Global Change Research Program	$2,023	$2,122	$2,561
Climate Change Technology Program	5,386	5,504	5,690
Energy Tax Provisions	1,870	4,140	3,950
Energy Grants	1,050	3,090	4,460
International Assistance	373	1,080	1,494
Wildlife Adaptation	0	65	87
Total	$10,702	$16,961	$18,242

Source: www.whitehouse.gov/omb/assets/legislative_reports/FY2011_Climate_Change.pdf

United States Global Change Research Program

The U.S. Global Change Research Program www.globalchange.gov/ (formerly known as the Climate Change Science Program (CCSP)) coordinates and integrates Federal research on changes in the global environment and their implications for society. The CCSP 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*." By 2009 (the last year for which the following budget breakout is available) funding for the CCSP had grown to about $2.0 B and was organized around eight major topics:

Topic	Million $
Earth Observation Satellites	$769
Climate Variability	$486
Atmospheric Composition	$166
Global Water Cycle	$138
Carbon Cycle	$122
Human Contribution	$110
Ecosystems	$107
Land Use	$30
Climate Change Research Initiative (various topics)	$150

Source: www.usgcrp.gov/usgcrp/Library/ocp2009/ocp2009-budget-table3.htm

The Global Water Cycle Program

Research associated with this element involves studies of the crucial role the water cycle plays in climate variability and change, and the influence climate has on aspects of the global water cycle on which society and nature depend. Most of this work is directed to fairly high level science that addresses global water processes. In 2009/2010 emphasis was placed on coordinated observations and modeling of selected sites, at the river basin or catchment scale, to improve understanding of terrestrial water cycle processes leading to better closure constraints on water budgets at this scale. Funding for the Global Water Cycle Research was distributed among Federal Agencies in 2009 as follows:

Agency	Million $
NASA	96.1
National Science Foundation	16.4
NOAA	10.0
DOI (USGS)	6.7
USDA (ARS, FS, EXT)	4.6
EPA	3.7

Source: www.usgcrp.gov/usgcrp/Library/ocp2009/ocp2009-budget-table3.htm

The majority of Global Water Cycle funds are directed to NASA to document and enable improved, observationally-based, predictions of water and energy cycle consequences of Earth system variability and change, largely through satellite based remote sensing and data analysis. Five WestFAST agencies formally participate in the United States Global Change Research Program (USGCRP) Global Water Cycle program, and their cumulative budget under the Program was about $120 M in 2009. As shown in the following inventory of WestFAST agency climate change programs, the USGCRP research is just one part of the overall WestFAST agency research effort in water science and management.

WestFAST Interagency Coordination

WestFAST agencies participate in several interagency climate change planning and coordinating work groups. With the expansion of the Federal climate change program in FY 2009 and 2010, a number of new Federal work groups have been formed.

United States Global Change Research Program The USGCRP, as previously described, is comprised of 13 Federal Agencies with important Global Change science and adaptation roles and includes participation by seven WestFAST Agencies (NOAA, DOE, DOI, NASA, USDA, EPA, and DOD) and six non-WestFAST agencies (State, DHHS, NSF, Smithsonian, USAID, and DOT.)

Council on Environmental Quality: Interagency Committee on Climate Change Adaptation – Water Resources Working Group - (USACE CDC, CEA, DOE, DOE/EE, DOI, EPA, NOAA, State, USDA) – September 2009 – present. This work group (one of five CEQ adaptation work groups) focuses on developing recommendations on how the U.S. government can help support and lead adaptation in response to water resources impacts, giving special attention to water quality and scarcity. The work group is considering the impacts of climate change on water resources, the major vulnerabilities and opportunities created by those impacts, and potential actions that the U.S. government could take to adapt to these changing conditions. The work group also looks at the work already being done on this issue by other entities, including lessons learned and the role of the Federal Government. CEQ released an interim progress report on March 16, 2010. The progress report, (available on the CEQ website at: www.whitehouse.gov/ceq/initiatives/adaptation.) outlines the Task Force's progress to date and recommends key components to include in a national strategy on climate change adaptation. The components include: integration of science into adaptation decisions and policy;

communications and capacity building; coordination and collaboration; prioritization; a flexible framework for Agencies; and evaluation. The Task Force will produce a final report in October 2010.

Climate Change and Water Working Group (CCAWWG) CCAWWG is an active, long-term, interagency working group that identifies water operations user requirements to address climate change and develops and applies new technology, science, R&D, and planning tools. CCAWWG is comprised of four WestFAST Agencies (Reclamation, USGS, NOAA, and USACE) that have been working together since 2007. CCAWWG sponsored a Non-Stationarity workshop in January 2010 to investigate ways to model non-stationarity processes for hydrologic frequency analyses, and to initiate mechanisms for a continuing dialog between water managers and scientists on methods to deal with climate uncertainty. CCAWWG also sponsored an Upper Colorado Climate Science Meeting in March 2010 to identify and coordinate climate change science activities in the Upper Colorado River Basin. A draft report is currently in review, entitled *Addressing Climate Change in Long-Term Water Resources Planning and Management: Users Need for Improving Tools and Information*. A second report is in preparation: *Use of Weather and Climate Forecasts in Federal Water Resources Management: Current Capabilities, Required Capabilities, and Gaps*. A workshop is planned for August 2010: Assessment of Methodologies for Producing Climate Change Information to Support Adaptation.

Interagency Climate Change Working Group (USACE, USGS, NOAA, and Reclamation) This was a short-term (2007-2009) working group that was formed to jointly assess the likely impacts of climate change on the management of the nation's water resources and to develop recommendations for an adaptation strategy. The working group produced USGS Circular 1331 *Climate Change and Water Management, a Federal Perspective*.

Department of the Interior Climate Change Partnerships

Climate Science Centers (CSC) – DOI's climate change strategy includes the establishment of eight regional Climate Science Centers, serving the Alaska, Pacific Islands, Northwest, Southwest, Northcentral, Southcentral, Northeast, and Southeast regions. These centers will synthesize existing climate change impact data and management strategies, help resource managers put them into action on the ground, and engage the public through education initiatives. The centers will maximize collaboration with academia, other Federal agencies, and partners and will prioritize their work based on the needs of the land managers. In 2010, centers will be established in three locations: Alaska, the Northwest, and the Southeast. The President's 2011 budget includes an increase of $8.0 million for the U.S. Geological Survey to establish two additional centers, which will be located in the Southwest and Northcentral regions.

Landscape Conservation Cooperatives (LCCs) – The network of Landscape Conservation Cooperatives will engage other Federal agencies, local and State partners, and the public in crafting practical, landscape-level strategies for managing climate change impacts in coordination with the eight regional CSCs. The LCCs focus is on impacts such as wildlife migration patterns, wildfire risk, drought, or invasive species that typically extend beyond the borders of any single national wildlife refuge, BLM unit, or national park, but not encompassing an area as large as an entire region.

All of Interior's land management agencies will be investing in the development of an integrated network of LCCs, with FWS taking the lead in standing up nine LCCs in 2010 including an LCC that will be formed from the Lower Mississippi Joint Venture. The Bureau of Reclamation, BLM and the BIA will initiate the formation of additional LCCs in 2011.

Climate Ready Water Utilities Working Group - The U.S. Environmental Protection Agency's (EPA) National Water Program Strategy: Response to Climate Change (2008) identified the need

to provide drinking water and wastewater utilities with easy-to-use resources to assess the risk associated with climate change and to identify potential adaptation strategies. The National

Drinking Water Advisory Council (NDWAC), established under the Safe Drinking Water Act, as amended (42 U.S.C. 300f et seq.), provides practical and independent advice, consultation and recommendations to the Agency on the activities, functions and policies related to the implementation of the Safe Drinking Water Act. On May 28, 2009, the NDWAC voted on and approved the formation of the Climate Ready Water Utilities (CRWU) Working Group. The Working Group will have five face-to-face meetings over the course of 2009-2010 in addition to conference calls and/or video conferencing on an as needed basis. After the Working Group completes its charge, it will make recommendations to the full NDWAC. The full NDWAC will, in turn, make appropriate recommendations to the EPA. WestFAST agencies participating in the CRWU Working Group include EPA, NOAA, Reclamation, and USACE in addition to numerous State, regional, tribal, and local utility representatives. client-ross.com/crwuwg/

EPA's State-Tribal Climate Change Council (STC3) - - The U.S. Environmental Protection Agency's (EPA) National Water Program Strategy: Response to Climate Change provides an overview of the likely effects of climate change on water resources and the nation's clean water and safe drinking water programs. The Strategy, and subsequent updates, identify key actions that the EPA Office of Water and EPA Regions' water programs are taking to adapt to climate change and to mitigate emissions of greenhouse gases. The STC3 brings together a geographically diverse and representative set of State, Tribal, and Federal government water managers and co-regulators in a dialogue to share information about the effects of climate change on clean water and safe drinking water programs, and to inform potential response strategies.

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Agency: U.S. Army Corps of Engineers (USACE)

Program Title(s): Sea-Level Change in Civil Works Projects, Impacts and Responses to Sea-Level Change, Adaptation to Climate Change Program, Climate Change and Water Management Project Development Team (PDT)

Program Type: Policy, Science, Management, and Operations

Program Description: In recent years the USACE has led interagency work groups to develop guidance on approaches for addressing sea-level change. This work resulted in reports such as *Incorporating Sea-Level Change in Civil Works Programs* EC 1165-2-211 and *Sea-Level Change Impacts and Responses to Civil Works Programs*, an Engineer Technical Letter in production. In the realm of water resources management, in 2008, the USACE developed a Climate Change and Water Management planning team to review the extent of flexibility the USACE has in reservoir regulation and develop a strategic plan for how USACE water managers can better adapt to climate change. The USACE is also working to develop guidance for its planners to use multiple scenarios rather than a most likely future condition to better deal with the uncertainties of future conditions introduced by climate change and variability. Starting in FY 2010 the USACE developed the Responses to Climate Change (RCC) Program to develop and implement practical, nationally-consistent, and cost-effective approaches and policies to reduce potential vulnerabilities to the Nation's water infrastructure resulting from climate change and variability. Under RCC, USACE is conducting a paired basin study with Reclamation on climate impacts to sedimentation at USACE and Reclamation reservoirs in selected river basins. Reclamation reservoir selections are (a) Bighorn Lake in MT and WY and (b) Elephant Butte Reservoir in NM. USACE reservoir selections are (a) Garrison Reservoir in ND and (b) Cochiti Reservoir in NM. In FY 2011, USACE has proposed a program included in the President's Budget called Global Change Sustainability (GCS) Program. This program will address the effects of global changes on USACE programs, projects and systems. The GCS will develop and test new methods that provide resilience in the face of global change and update guidance to reflect new knowledge. Other activities include updating drought contingency plans, integrating climate change mitigation and adaptation, and performing a comprehensive evaluation of projects with respect to sea-level change. In the area of water science, the USACE has supported the production of downscaled projections from general circulation models (GCMs) for regional and local applications through an American Recovery and Reinvestment Act (ARRA) project at Climate Central, Inc. The USACE also has been active in collaborative interagency activities through CCAWG and the Interagency Climate Change Working Group.

Funding Summary: USACE funding for climate change activities was about $1 M in FY 2009. With implementation of the Responses to Climate Change Program, funding increased in FY 2010 to about $3M. FY 2011-2020 funds for RCC and GCS are projected to range between about $10M to $15 M.

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Websites: Sea Level Change- 140.194.76.129/publications/eng-circulars/ec1165-2-211/
Army USACE Climate Change website -www.iwr.usace.army.mil/climatechange/index.cfm

Collaboration:
CCAWWG
Council on Environmental Quality Interagency Climate Change Adaptation Working Groups

Partnership Opportunities:

1. Agencies participating in the development of the sea-level guidance: USACE, NOAA, USGS, Reclamation, Navy, FHWA, FEMA, EPA, HR Wallingford (UK), U. Southhampton (UK).
2. The GCS will conduct Sustainable Rivers Program demonstration projects, prioritized in partnership with The Nature Conservancy (TNC) and other stakeholders, and including USACE-TNC collaboration on the refinement of evaluation methods and environmental values/benefits based on ecological services and ecosystem needs.
3. Additional guidance related to climate change will include appropriate science and operating partners and stakeholders.

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Agency: Bureau of Land Management (BLM)

Program Title: Soil Water and Air Program, Planning Program

Program Type: Policy, Science, Resource Assessment

Program Description: BLM is addressing climate change from a variety of perspectives, including policy, science, and resource assessment. Funding appropriated under the Soil Water and Air (SWA) Program budget item is being used to fund a variety of resource assessments to determine the vulnerability of resources under BLM's control to climate change. These activities include assessing resource condition in different ecoregions and improving data resources and management. BLM is also working to refine policy on addressing climate change for planning and NEPA purposes. A final manual with climate change policy has been produced by the Planning and SWA Program. In addition, BLM is working with a variety of partners (including the Mountain Studies Institute and the University of Colorado) to downscale GCM models to the San Juan area of Colorado to better understand projected climate change impacts in southwestern Colorado. BLM also will participate in DOI Landscape Conservation Cooperatives, which are aimed at developing climate change adaptation strategies for natural resources by all DOI agencies. BLM is also implementing a wide range of conservation and restoration actions on the ground aimed at increasing resilience and decreasing resource vulnerability to climate change impacts.

Funding Summary: BLM is currently (2010) investing $15 M in developing and implementing climate change adaptation strategies. The BLM 2011 budget request for its Climate Change Adaptation strategy is $17.5 million.

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Collaboration: Mountain Studies Institute and the University of Colorado

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Agency: Bureau of Reclamation (Reclamation)

Program Title: Basin Study Program, Science and Technology Program, Regional Initiatives (NEPA, ESA, planning, and operations)

Program Type: Water Planning, Research and Development

Program Description: Reclamation's climate change program is driven by the need to plan and operate water storage and distribution facilities in the West. Through its Science and Technology Program, Reclamation develops new tools and information that will assist water managers to plan and manage water resources projects in a changing climate environment. One of the Program's recent products is the Literature Synthesis on Climate Change Implications on Reclamation's Water Resources," published in February of 2010 and available on the web at the URL shown below. This report aims to support longer-term planning processes by providing Reclamation region-specific literature syntheses on what already has been studied regarding climate change implications for Reclamation operations and activities in the 17 Western States. Through the Basin Study Program, Reclamation partners with States, Tribes, and irrigation districts on a 50/50 cost share basis to conduct comprehensive water supply and demand studies that evaluate the impacts of climate change on water resources within a basin or sub-basin, and identify potential adaptation strategies. The first Basin Studies were started in 2009 and includes the Yakima, Colorado, and St. Mary and Milk River basins. Through its regional planning and operations, Reclamation is increasingly incorporating a broader range of climate information into project-specific studies. Such studies are often exploratory, given the limited current understanding of how climate change might affect local streams, ground-water, aquatic species, water demand, and reservoir storage.

Funding Summary: In recent years, Reclamation spent in excess of $ 5 M in the development and application of climate change methodologies into its planning and operation of water resources projects. The Reclamation 2011 budget request for Climate Change Adaptation is $7 million.

Contact: Avra Morgan, Basin Study Program Coordinator, Lakewood CO, aomorgan@usbr.gov, 303-445-2906, and Curt Brown, Research Director, Lakewood CO, cabrown@do.usbr.gov, 303-445-2098

Websites: Basin Studies: www.usbr.gov/WaterSMART/basin.html
Science and Technology Program: www.usbr.gov/research/science-and-tech/
Climate Change Literature Synthesis: www.usbr.gov/research/docs/climatechangelitsynthesis.pdf

Collaboration: Reclamation is an active member of the Federal Climate Change and Water Working Group (CCAWWG)

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Agency: U. S. Department of Energy (DOE)

Program Title: Climate Change

Program Type: Policy, Operations, and Management

Program Description: The Office of Policy and International Affairs (PI) serves as the focal point within the U.S. Department of Energy (DOE) for the development, coordination, and implementation of DOE-related aspects of climate change technical programs, policies, and initiatives. The Office of Climate Change Policy and Technology, located within PI, provides supporting policy, planning, technical and analytical services to carry out this function. To the extent delegated by the Secretary, the Office provides similar services to other Federal agencies and to Cabinet and sub-Cabinet-level interagency policy committees that work on climate change-related policy, science, technology, and greenhouse gas (GHG) mitigation programs.

Several DOE programs conduct climate related activities:

- The Office of Energy Efficiency and Renewable Energy (EERE) works to strengthen the United States' energy security, environmental quality, and economic vitality through research, development, and demonstrations, and a variety of public-private partnerships. EERE's goal is supported by enhancing energy efficiency and productivity; bringing clean, reliable and affordable energy technologies to the marketplace. EERE is organized across ten programs, each dedicated to reducing the impacts of climate change.
- The Office of Fossil Energy (FE) is pursuing multiple major strategies to reduce carbon emissions that contribute to global climate change concerns, including making fossil energy systems more efficient, and capturing and storing greenhouse gases. To retain coal and other fossil fuels as viable energy sources in a carbon-constrained world, carbon capture and storage (CCS) technologies are expected to play a pivotal role. On a global scale, CCS technologies have the potential to reduce overall climate change mitigation costs and increase flexibility in reducing greenhouse gas emissions. FE is implementing several large-scale CCS programs to establish the early generation technology base to move CCS from concept to reality.
- The Office of Electricity Delivery and Energy Reliability (OE) leads efforts to develop a Smart Grid and modernize the country's transmission and distribution system. An updated electrical system will reduce greenhouse gas emissions and help the electricity sector implement carbon management strategies by improving the energy efficiency of the electrical system infrastructure and reducing power delivery losses, while enabling greater integration of renewable energy and other clean power systems.

- As a low carbon energy source, nuclear energy has significantly reduced U.S. and global emissions of carbon dioxide, the chief greenhouse gas, and other pollutants by substituting for fossil fuels in electricity production. The current fleet of 104 U.S. reactors avoids the emissions of almost 700 million metric tons of CO2 a year when compared to fossil plants, while generating about 20% of the nation's electricity. The Office of Nuclear Energy (NE) is working to extend the useful lifetimes of these plants in order to continue these benefits and is working to enable the construction of new nuclear plants in order to extend climate change and other benefits.
- Through DOE's Climate Change Sciences Program, the Office of Science (SC), Office of Biological and Environmental Research (BER) approaches the problems associated with climate change through research and modeling efforts to:(1) improve the understanding of factors affecting the Earth's radiant-energy balance; (2) predict accurately any global and regional climate change induced by increasing atmospheric concentrations of

aerosols and greenhouse gases; (3) quantify sources and sinks of energy-related greenhouse gases, especially carbon dioxide; and (4) improve the scientific basis for assessing both the potential consequences of climatic changes. These activities are performed in support of the United States Global Change Research Program (USGCRP). Additionally, BER and Basic Energy Sciences (BES) work with the DOE Applied Programs to provide the needed basic research supporting research on the climate change mitigation technologies. Fusion Energy Sciences (FES) performs the research for the U.S. Fusion Programs.

- In 2007, the Advanced Research Projects Agency – Energy (ARPA-E) was created within DOE by the America COMPETES Act. To get the program started in 2009, $400M was allocated to ARPA-E from the America Recovery and Reinvestment Act (ARRA). A primary focus is on creative "out-of-the-box" transformational energy research that industry by itself cannot or will not support due to its high risk but where success would provide dramatic benefits for the nation. ARPA-E creates a new tool to bridge the gap between basic energy research and development/industrial innovation.

Funding Summary: The Department of Energy FY-2010 climate change related program budget is $4.4 billion.

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Websites: www.energy.gov

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Agency: Environmental Protection Agency (EPA)

Program Title: Office of Water, National Program Strategy: Response to Climate Change

Program Type: Policy, Operations, and Management

Program Description: Much of EPA's approach to climate change is encompassed in the Office of Water's "National Water Program Strategy: Response to Climate Change" that describes 40 specific actions that EPA intends to take to adapt program implementation in light of climate change. The EPA strategy focuses on areas such as: Water-Related Energy Conservation through improved energy efficiency of water and waste-water utilities; Water Conservation through implementation of the Water Sense Program, water conveyance and leak detection remedies, industrial water conservation and reuse, and Federal water conservation guidance; Promote Water Quality/Climate- Friendly Agricultural Practices by identifying and promoting agricultural management practices that have both water quality and greenhouse gas reducing benefits; Promote Carbon Sequestration by developing geologic sequestration regulations and pilot marketing of nonpoint source biological sequestration; reevaluation of Drinking Water, Water Quality, and Effluent Standards in light of potential increases in water temperature and increasing contaminant levels. This comprehensive strategy also addresses developing a Watershed Approach to climate change adaptation; assessing the influence of climate change on NDPES Permits, Water Infrastructure, and Wetlands Management; and revising EPA approach to Water and Climate Research, Public Education and Outreach, and Water Program Management. The full Strategy with specific goals and action items can be found on the EPA website at the URL noted below.

Contact: Karen Metchis, metchis@epa.gov, 202-564-0734

Websites: EPA National Water Program Strategy - www.epa.gov/water/climatechange/strategy.html

Collaboration: Climate Ready Water Utilities Working Group

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Agency: Fish and Wildlife Service (USFWS)

Program Title: Strategic Plan for Climate Change

Program Type: Science and Management

Program Description: The USFWS is in the process of developing a Climate Change Strategic Plan that will establish a basic framework within which the USFWS will work as a part of the larger conservation community to help ensure the sustainability of fish, wildlife, and habitats in the face of accelerating climate change. This strategic plan, which closed to public comment on November 30, 2009, develops the basic principles and strategy for the USFWS's approach to address climate change through Adaptation, Mitigation, and Engagement. The Strategic Plan has an associated Five-Year Action Plan that describes specific actions to be taken by the USFWS starting in 2010. Specific proposed actions that may be of interest to the water-resources community include: developing Landscape Conservation Cooperatives, conducting species and habitat vulnerability assessments, take conservation action for climate-vulnerable species, promote habitat connectivity and integrity, and identify and fill priority freshwater needs. The USFWS further proposes to develop a National Biological Inventory and Monitoring (I&M) Partnership, promote physical science and remote-sensing monitoring programs, and develop biological carbon sequestration expertise. Further information on the FWS Strategic and Action Plans can be found on the USFWS website at the URL below.

In addition to these planning efforts, the USFWS is working with other Federal Agencies to advance climate change science, conduct habitat restoration efforts to mitigate climate change impacts at the National Wildlife Refuge System, improve habitat of fish species vulnerable to climate change within the framework of the National Fish Habitat Action Plan, provide grants to state to update their State Comprehensive Wildlife Conservation Plans (CWCPs) to address the need for fish and wildlife to adapt to climate change and take steps to address the effects of climate change through on-the-ground projects and through the Partners for Fish and Wildlife program to expand the Service's assistance to private landowners to conserve habitat on private lands in response to climate change.

Funding Summary: The FY 2010 FWS budget for climate change activities described above is approximately $80 M.

Contact: David Diamond, David_Diamond@fws.gov, 703-358-2443

Websites: FWS Climate Change: www.fws.gov/home/climatechange/
Strategic Plan: www.fws.gov/home/climatechange/pdf/CCDraftStratPlan92209.pdf
Action Plan: www.fws.gov/home/climatechange/pdf/CCDraftActionPlan92209.pdf
Collaboration: USGS, National Park Service, NASA, State Departments of Fish and Game, NGOs

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Agency: Forest Service (FS)

Program Title: U.S. Forest Service Research Stations

Program Type: Data, Science, and Management

Program Description: Much of the FS's Climate Change Program that relates to water resources is carried out through its 5 Research Stations, three of which are located in the Western States – the Rocky Mountain, Pacific Southwest, and Pacific Northwest Research Stations. The Rocky Mountain Research Station has a well defined 2009 Climate Change Research Strategy (see the URL below) that describes its research agenda in 5 specific water resources areas, including: Effects of climate change on water dynamics, water resources effects on human and ecological systems, adaptation options for water resources management under climate change, trade offs between carbon sequestration and water supply, and effects on aquatic species including threatened - endangered - sensitive fish. The Southern Research Station also has a continuing national study that entails modeling water supply and demand under a changing climate, population growth, and land use change. This study is working to quantify water availability and demand in each of 2,100 basins across the lower 48 states by using hydrologic modeling and water resources inventories. The study, which started in 2005 has resulted in a journal article in the Journal of American Water Resources Association (44(6) 1441-1457) entitled *Impacts of Multiple Stresses on Water Demand and Supply across the Southeastern United States* by Sun, G., S.G. McNulty, J.A. Moore Myers, and E. C. Cohen. 2008. The Forest Service also collaborates with the National Academy of Sciences, USGS, and others in the Long-Term Ecological Research Network that comprises 26 individual sites with consistent, long-term hydrologic and ecological data upon which the effects of climate can be assessed.

Contact: Long Term Ecological Research - Don Henshaw, dhenshaw@fs.fed.us
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Websites: Long Term Ecological Research: www.lternet.edu/
Rocky Mountain Research Station 2009 Climate Change Research Strategy:
www.fs.fed.us/rmrs/docs/climate-change/climate-change-research-strategy.pdf
US Forest Service Climate Change Resource Center www.fs.fed.us/ccrc/

Collaboration: National Science Foundation, Oregon State, USGS, and others

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Agency: National Aeronautics and Space Administration (NASA)

Program Title: NASA Climate Variability & Change

Program Type: Science and Data

Program Description: NASA's role in characterizing, understanding and predicting climate variability and change is centered around providing the global scale observational data sets on the higher-inertia components of the climate system (lands, oceans and ice), their forcings (e.g., precipitation and radiation), and the interactions with the entire Earth system. Understanding these interactions goes beyond observations, but includes developing and maintaining a modeling capability that allows for the effective use, interpretation, and application of the data. The ultimate objective is to enable predictions of change in climate on time scales ranging from seasonal to multi-decadal. As NASA pioneers new satellite measurements to enable this capability, it will work with agency partners to transition demonstrated observational capabilities to operational capabilities run by other agencies. Through modeling studies NASA can estimate and project the future state of the climate system. However, NASA doesn't have the full understanding of the processes that contribute to the climate variability and change. The future work will be to eliminate model uncertainties through better understanding of the processes. NASA data and analyses will ultimately enable more accurate climate prediction, characterization of uncertainties, and the development of scenarios that are more likely to reflect the realities of the future. Within Earth Sciences, NASA also has an Applied Sciences Program (ASP) with the primary goal to infuse NASA products and information into current and future operational decision support systems operated by end users. The Climate Program is one of eight elements within the ASP program.

Funding Summary: NASA had a $1.7B FY 2009 budget in Earth Sciences. In this budget NASA spent $104.3 M for Water Cycle research and $88.0M for Climate Variability and $47.8 M for Applied Sciences. Under the Applied Sciences Program NASA works to convert their research and technology for societal benefit including adaptation to climate change from impacts to water resources. The FY 2011 Presidential budget request for Earth Sciences is $1.8 B.

Contact: Jack Kaye, jack.kaye@nasa.gov, 202-358-2559

Websites: NASA and Climate Change, climate.nasa.gov
NASA Applied Sciences Program, science.nasa.gov/earth-science/applied-sciences/
NASA GSFC Climate, http://climate.gsfc.nasa.gov/
NASA Cryospheric Science Program, ice.nasa.gov/
NASA Goddard Institute Space Studies (GISS), www.giss.nasa.gov/research/modeling

Collaboration: Numerous collaborations including those with other U.S. agencies, international organizations, and the academic community.

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Agency: National Oceanic and Atmospheric Administration (NOAA)

Program Title: NOAA Climate Program Office

Program Type: Science and Data

Program Description: The NOAA Climate Change Program is a wide ranging research and climate services program that operates through 3 major technical divisions. The Climate Change Observation and the Research Program Divisions manage global scale observation systems and conduct climate process research. The Climate Assessment and Services Division conducts applied science that is relevant to water resources. In partnership with selected universities, the Regional Integrated Sciences and Assessments Program (RISA) operates 7 geographically based research teams, 5 of which cover Western States in which regionally important climate change issues, including water resources, are addressed. Of particular note is the Western Water Assessment being conducted in association with the University of Colorado at Boulder and designed to provide information about natural climate variability and human-caused climate change, usually in the form of climate forecasts and regional vulnerability assessments designed to assist water-resources decision makers. NOAA also conducts the Sector Application Research Program to catalyze interdisciplinary research on the effects of and potential responses to climate variability and change, which includes a water resources sector. Finally, NOAA operates the National Integrated Drought Information System (NIDIS) as an interagency approach for the development and coordination of drought risk information to support proactive decision making. Website links to each of these major NOAA program and to the new NOAA Climate Services Portal are shown below.

Contact: Roger Pulwarty Director NIDIS, roger.pulwarty@noaa.gov 303-497-4425

Websites: NOAA Climate Program Office - www.climate.noaa.gov/cpo_pa/
RISAs - www.climate.noaa.gov/cpo_pa/risa/, SARP- Water Resources - www.climate.noaa.gov/index.jsp?pg=./cpo_pa/cpo_pa_index.jsp&pa=sarp&sub=water.jsp#2009
NIDIS - www.drought.gov
NOAA Climate Service Portal www.climate.gov/#climateWatch

Collaboration: Numerous collaborations with the Academic Community.

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Agency: Natural Resources Conservation Service (NRCS)

Program Title: Data and Science

Program Type: Data and Management

Program Description: The NRCS National Water and Climate Center (NWCC) in Portland OR provides water resources data and information that is needed to assess the impacts of climate change on water resources. NWCC operates the cooperative Snow Survey and Water-Supply Forecasting Program, which includes 1200 manually-measured snow courses and over 750 automated SNOwpack TELemetry (SNOTEL) sites and provides seasonal streamflow forecasts for over 750 points in the West. NWCC also operates the Soil Climate Analysis Network (SCAN), which includes 150 stations in 39 states that measure soil moisture, soil temperature and climate data. Data from these networks are available on the Internet at the NWCC URL shown below. NRCS also is actively working to reduce greenhouse gasses and sequester carbon through agricultural conservation practices.

Contact: Carolyn Olson, National Leader Climate Change, Carolyn.Olson@wdc.usda.gov, 202-720-1821
Michael Strobel, Director National Water and Climate Center, michael.strobel@por.usda.gov, 503-414-3055

Websites: NWCC - www.wcc.nrcs.usda.gov
NRCS Climate Change Program - soils.usda.gov/survey/global_climate_change.html

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Agency: U.S. Geological Survey (USGS)

Program Title: National Research Program (Hydroclimatology Group), Cooperative Water Program, Global Change Program, Fisheries Program, Ecosystems Program, National Climate Change and Wildlife Science Centers

Program Type: Data and Science

Program Description: USGS national streamgaging, groundwater, and water-quality data networks serve as a foundation for assessment of the hydrologic effects of climate change by a wide range of government and academic sector researchers. USGS also conducts a wide range of Climate Change research through a number of its science programs. Much of the USGS research that has focused on the hydrologic aspects of climate change has been carried out through the USGS Water Discipline's National Research Program. Over the past 20 years, this research has focused on assessments of annual streamflow trends in the western mountains, long-term trends in glacier motion and mass, paleoclimatology of the west, the effects of the Pacific Ocean on climate and water resources, and computer modeling of the long-term effects of climate change on precipitation and runoff. Additional research that includes some element of the influence of climate change on water resources and aquatic communities is conducted by several other USGS Science Programs. Studies range from assessments of groundwater recharge, snow melt and streamflow, paleohydrology, carbon fluxes, water-quality processes, and climate change impacts on aquatic resources ranging from coral reefs to salmon, brook trout, manatees, etc. Additional information on USGS programs can be found through the websites noted below.

Funding Summary: The USGS annually spends about $67.5 M on Global Change Science and has a budget request of $77.9 M for 2011. Of that, approximately $10 M comprises water related climate change research and investigations. For 2010, the USGS has received an additional $15 M to support the National Climate Change and Wildlife Science Center. Those funds in part will be spent on studies of aquatic resources.

Contact: Earl Greene, eagreene@usgs.gov, 703-648-5048

Websites: Water Resources Programs - water.usgs.gov
USGS Global Change Program - www.usgs.gov/global_change
USGS Ecosystems Climate Change Science - biology.usgs.gov/ecosystems/global_change/index.html,
USGS Geology Climate Change Science - geochange.er.usgs.gov/

Collaboration: Climate Change and Water Working Group (CCAWWG) (Reclamation, USGS, USACE, NOAA), United States Global Change Research Program (www.globalchange.gov/) and with State, local, and Tribal governments through the Cooperative Water Program