

**Climate Change Activities
of the
Department of Water Resources
during 2009**



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November 2010

DWR Climate Change Program
Annual Report 2009

California Department of Water Resources
November, 2010

Sacramento, CA

Cover photo from the California Academy of Sciences, San
Francisco

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Field studies

Twitchell and Sherman Island Subsidence Reversal Projects

Status: In progress
Contact: Bryan Brock

DWR is currently developing several projects to demonstrate the potential for subsidence reversal and carbon sequestration. Sequestering atmospheric carbon via plant photosynthesis and net retention of carbon within the soil by decomposing plant matter will not only reverse subsidence in the western Delta, but may also help reduce the impacts caused by greenhouse gas emissions. Currently, there are four projects that are in various phases of implementation including:

- DWR/US Geological Survey (USGS) Wetland Research Facility – Twitchell Island
- Permanent Wetland for Waterfowl - Sherman Island
- Farm Scale Rice Demonstration and Research Facility - Twitchell Island

Furthermore, as a carbon market develops in California, the potential for the sale of carbon credits may provide an alternate means of producing income on existing agricultural lands. Through these demonstration projects, DWR will study the costs and benefits of these land use management practices to help define the potential value in a carbon market.

DWR/USGS Wetland Research Facility – Twitchell Island

DWR and the USGS constructed approximately 15 acres of wetlands in 1997 to evaluate land surface elevation changes and carbon accretion due to the accumulation and decay of plant materials. Two ponds were constructed and flooded to depths of 25 and 50 centimeters. Tule and cattail growth was measured as they populated the ponds. Water siphoned from the San Joaquin River keeps the water elevation constant year-round. When plants die at the end of each growing season, they decompose on site and measurements are taken to determine the amount of accumulating organic matter and land surface elevation change.

Ongoing research at this facility has shown that surface elevation changes due to accretion range from 3.2 to 5.6 cm/yr (1.3 - 2.2 in/yr), while surrounding areas used for agricultural purposes lost elevation due to subsidence. The new material bulk density is fairly low (i.e., less than 0.1 g/cm³), but it has a high degree of structural integrity. The test cores required considerable effort to section with a hacksaw, and there was no evidence of compaction during collection of the cores.

This study has shown that decaying organic matter can not only eliminate subsidence, but also reverse subsidence through utilization of appropriate land management practices. Additional studies will be implemented in the near future to investigate carbon sequestration rates on a per acre basis, as well as the potential air and water quality impacts that may occur as a result of the decaying organic matter.

Permanent Wetland for Waterfowl - Sherman Island

The creation of a permanent wetland for waterfowl on Sherman Island—which may also reduce subsidence and sequester carbon—is currently under construction and will be completed by October 1, 2010. The land identified on Sherman Island is a 307-acre parcel currently owned by DWR that is leased to individuals that operate the land as a duck club. The proposed project will enhance and create wetlands on the mid-westerly portion of the island.

Currently the land is a mixture of uplands, seasonal wetlands, and ponds, but it does not remain wet year-round. The proposed project will make necessary improvements to ensure the land can be maintained as a permanent wetland. Key project components include:

- Increasing perimeter levee height to ensure year-round saturation,
- Incorporating interior levees to enable management of water quality and vegetation,
- Building drainage swales and depression areas to allow for waterfowl ponds, and
- Creating loafing islands for secure waterfowl habitat.

As a result of these wetland improvements and based upon carbon sequestration data determined from the DWR/USGS wetland study on Twitchell Island, it is anticipated that this project will also achieve carbon sequestration and subsidence reversal.

Farm-Scale Rice Demonstration and Research Facility

Similar to growing tules, growing rice may be a very effective and sustainable way to reduce subsidence and facilitate carbon sequestration, while maintaining a farm economy. There are several water quality and farming issues that must be evaluated and resolved during this large-scale demonstration. The data analyzed during this five-year project will allow DWR and others to develop recommendations on how this method can be applied to reduce subsidence and sequester carbon. This data will also provide a road map for best management practices that can be used for rice farms throughout the Delta.

DWR will conduct this research on an approximately 300-acre farm-scale demonstration rice field in the Delta. Key research components of this project include:

- Demonstrating the feasibility of growing rice in the Delta;
- Quantifying subsidence and carbon sequestration rates;
- Determining water quality contaminant loading and exports; and
- Creating best management practices to minimize environmental impacts, while maximizing subsidence reduction and carbon sequestration.

Currently all 300 acres are planted in rice and will be harvested in October, 2010.

Planning, modeling, and data collection

Analysis of Climate Change for the California Water Plan Update

Status: Completed
Contact: Rich Jurichich

With input from the Water Plan's technical advisory group, the Statewide Water Analysis Network (SWAN), DWR chose to apply the Water Evaluation and Planning System (WEAP) for Update 2009 as a tool to help quantify future scenarios and alternative water management responses (www.weap21.org). During and after the completion of Update 2005, DWR evaluated several possible approaches to quantify future scenarios for Update 2009, including the Analytica tool used for Update 2005. In 2005, DWR participated in a study with the Stockholm Environment Institute (SEI) funded by the U.S. Environmental Protection Agency to apply the WEAP tool to understand the potential effects of climate change on the Sacramento Valley. DWR chose the WEAP tool for Update 2009 because WEAP:

- has a friendly graphical user interface that supports collaboration,
- requires a shorter learning curve than alternatives,
- was successfully applied by RAND Corp to evaluate climate scenarios for the Inland Empire Utilities Agency, and
- received generally positive feedback from SWAN and other Water Plan stakeholders.

For Update 2009, most of the scenario analysis was performed at the hydrologic region scale. DWR used WEAP to develop a low-resolution regional water demand representation for each of the 10 hydrologic regions in California. For this analysis, indoor urban demand was represented in a manner similar to that used for the CWP 2005 Update. The representation of outdoor urban and agricultural water demand was improved using evapotranspiration (ET) requirements and irrigation patterns, and variable monthly sequences of precipitation and temperature based on 12 available scenarios representing future climate change.

Future water demand is affected by a number of factors like population growth, planting decisions by farmers, size and type of urban landscapes, and water conservation measures. Water Plan Update 2009 quantifies several factors that together provide a description of future water demand for the urban, agricultural, and environmental sectors. Each of these factors is varied between three scenarios to describe some of the uncertainty faced by water managers. For example, no one can predict future population growth with certainty. The three scenarios use three different, but plausible values of future population when determining future urban water demands. As a pilot study, Update 2009 also presents a more detailed analysis of scenarios and water management response packages for the Sacramento River and San Joaquin River hydrologic regions. The pilot study will be developed at a suitable (smaller) spatial scale to capture the major hydrologic flows, represent major demographic and land use trends, and evaluate the effects of water management responses. In general, the model is organized by DWR Planning Areas—there are 11 Planning Areas in the Sacramento River Hydrologic Region and 10 in the San Joaquin River Hydrologic Region.

For the four Planning Areas covering the southern Cascade and northern and central Sierra Nevada ranges, the Planning Areas are further disaggregated along watershed boundaries and elevation bands to reflect major reservoir operations and elevation-dependent hydrologic processes. For the remaining 17 Planning Areas, located primarily on the floor of the Central Valley, water demands and water supplies are specified at the Planning Area level, and only disaggregated when necessary to properly reflect usage of different supplies or to evaluate scenarios and response packages of greater interest.

Data Collection and Climate Services

Status: Development

Contact: Jon Ericson, Frank Gehrke, Michael Anderson

Data collection and climate services enable DWR to gather, analyze, and distribute important weather and climate information for operational and planning efforts. This project aims to coordinate data collection activities, manage the incoming data, provide the necessary analyses, distribute information, and interact with other groups who also collect data relevant to DWR's goals and activities. Opportunities for improving the hydroclimate monitoring network and incorporating new technologies will be pursued. Methods are being developed to improve and implement quality control and quality assurance assessments of the incoming data streams. DWR will develop partnerships with other agencies and groups to help achieve the goals of the project. The data gathered through this project will be made available through the California Data Exchange Center website.

In 2009, DWR collaborated with the Western Region Climate Center (WRCC) to create additional climate analyses capabilities for California Climate Data. This effort builds off of an initial investment made by the California Energy Commission to establish the California Climate Data Archive at WRCC. In other efforts, DWR has been collaborating with Scripps Institute of Oceanography and NOAA's Earth Systems Research Laboratory to add atmospheric water vapor and soil moisture sensors along with snow level radar instrumentation to the state's climate and weather monitoring networks. This effort is a five-year process that will add 40 atmospheric water vapor sensors, 30 soil moisture sensors, and 10 snow level radar installations across the state.

Incorporating Sea Level Rise into Water Resources Planning Tools

Status: Completed/Ongoing

Contact: Francis Chung, Jamie Anderson, Sanjaya Seneviratne, Maury Roos

According to the Fourth Assessment report of the Intergovernmental Panel on Climate Change (IPCC), sea levels rose gradually over the 20th century, with the rate of rise increasing in the latter half of the century. This increased rate of sea level rise is projected to continue in the 21st century due to thermal expansion of the ocean and melting of glaciers and polar ice caps. This project develops, applies, and adapts analysis methods and tools to incorporate the potential effects of sea level rise into water resources planning. Work completed to date includes:

- Historical sea level data were examined for the California coast, the Delta, and selected additional North American locations.
- Two methods were used to estimate amounts of possible future sea level rise.

- By extrapolating the current rate of sea level rise acceleration into the future, sea levels could be expected to increase by about 0.5 ft by mid-century and by 1.0 ft by the end of the century.
- If it is assumed that increasing air temperatures will increase the rate of sea level rise, sea levels could be expected to increase by 0.6-1.2 ft by mid-century and by 1.4-4.0 ft by the end of the century.
- Computer applications were developed to estimate salinity intrusion into the Delta for one foot and two foot sea level rise scenarios. These applications can be used in computer models of the operations of the State Water Project and Central Valley Project to evaluate potential impacts of sea level rise on system operations.
- Methods were explored for using sea level rise projection information to create relative probabilities that could be used to support decision-making.

Analyses of Regional Observed and Simulated Historical Period Data

Status: Completed/Ongoing

Contact: Messele Ejeta, Tariq Kadir, Jianzhong Wang

Emerging studies suggest that at a regional level, future warming will be strongly modulated by natural climate variations on time scales of decades. This project focuses on the: 1) analyses of observed data to establish baselines with which to estimate the uncertainties in the data obtained from climate change modeling processes, and 2) evaluation of how well observed data has been reproduced through these modeling processes by analyzing simulated historical period data.

The first part of this project involves continuous regional detection and attribution studies using long term records of temperature, snow, precipitation, natural streamflow, and sea level change data. The trends in each type of data and their correlations across these types of data sets were analyzed previously. These datasets were also analyzed in relation to the Pacific Decadal Oscillation (PDO), a long-lived El Niño-like pattern of Pacific climate variability. For California's eight major rivers that are tributary to the Sacramento-San Joaquin Delta, a strong correlation was found between two "cool" to "warm" PDO regime shifts on record and the two lowest natural streamflows on record since the early 20th century. For seven out of these eight major rivers, the two lowest natural flows occurred in 1924 and 1977. For the remaining river, the natural flows in 1924 and 1977 were among the lowest three flows on record. The two "cool" to "warm" PDO regime shifts are noted to have occurred between 1924 and 1925 and 1976 and 1977. It was further observed that the average natural water productions of the eight major rivers vary between the cool and warm PDO phases. These initial observations, which are being studied further, may be used as a feedback to regional climate change modeling processes to help reduce the uncertainties in the results that these processes produce.

The second analysis involves a continuous evaluation of how well the historical period streamflow data obtained from the climate change modeling processes, which have been produced periodically under the coordination of the Climate Action Team (CAT), represent the observed streamflow data. This analysis approach was the basis for using the projected streamflow data to prepare the 2009 report on the impact of climate change on the State Water Project (SWP) and the Central Valley Project (CVP) as well as on the Sacramento-San Joaquin Delta's water quality.

A draft Technical Memorandum report of these analyses, which is titled “Analyses, Methodologies, and Evaluations,” was prepared in January 2009 and is available upon request.

Ongoing activities under this task include:

- Continuous detection and attribution studies through the analysis of regional historical data. Some insights gained from further analysis of long-term historical precipitation data are being reviewed. The review results will be made available when completed.
- Providing feedback from new insights from these analyses to reduce uncertainties in future climate change and impact studies.
- Continuous evaluation of simulated historical period streamflow data as a bridge to the ongoing study of the impact of climate change on streamflows and hence California’s water projects at a projected level of development.

Analysis of the Impact of Climate Change on Streamflows in California

Status: In progress
Contact: Messele Ejeta

For the 2008 biannual report update to Governor Schwarzenegger, researchers generated daily and monthly streamflows for the Climate Action Team (CAT) at 18 locations across California’s Sierra Nevada mountain range. The data, which spans the 1950 – 2099 period, was generated for two greenhouse gas emission scenarios each modeled using six different General Circulation Models (GCMs). Results from these models were downscaled to the local level using two methods: 1) the Bias Correction and Spatial Disaggregation (BCSD) method, and 2) the Constructed Analog (CA) method. The BCSD method was applied to the results of all the six GCMs for each emission scenario whereas the CA method was applied to the results of three GCMs for each emission scenario. Thus, daily and monthly sets of 12 projected streamflow data corresponding to the BCSD method and six projected streamflow data corresponding to the CA method for all the 18 locations have been obtained by the Bay-Delta Office. The daily and monthly sets of streamflow data have been analyzed with respect to flood occurrence and water supply planning, respectively. A summary report of this analysis is included in the Technical Memorandum report “Analysis, Methodologies, and Evaluations” mentioned above under the “Analysis of Regional Observed and Simulated Historical Period Data” activity.

To meet the main objective of this activity, which is to provide public access to the methodology and data analysis tools used to determine the impact of climate change on streamflows, preliminary work has been started using Google Earth. A three-step approach is planned to carry out the objective using this tool: 1) geo-reference the streamflow locations in California where data is available; 2) provide static data (such as meta data, references, and web links to completed impact studies; and 3) provide dynamic tools that the users can utilize to perform customized impact studies. The first step of this activity has been completed and work has begun on the second step. This activity will require a server to host the data and provide internet access.

Future plans in this project include:

- Continue the analysis of the impact of climate change on streamflows as more data becomes available and the climate change processes continue to evolve.
- Continue with the efforts to provide public access to the methodology and data analysis tools used to determine the impact of climate change on streamflows.

Sensitivity Analysis of the Upper Feather Basin to Temperature Changes Using PRMS

Status: Completed

Contact: Tariq Kadir

Because snow melt and sublimation is heavily dependent on temperatures, it is important to the operation of Lake Oroville to know how projected future climate conditions can affect both the timing and quantity of inflows. A rainfall-runoff model of the upper Feather Basin was used to examine potential changes in runoff processes impacting flow into Oroville due to changes in ambient air temperature. The approach used was to conduct a sensitivity analysis to determine how increases in air temperature of 1°C, 2°C, 3°C, and 4°C (1.8°F, 3.6°F, 5.4°F, and 7.2°F) in the upper Feather River basin would affect natural flows into Lake Oroville. The Precipitation-Runoff Modeling System (PRMS), a physically based precipitation-runoff model developed by the USGS for DWR in 2004, was used to determine the impacts of increasing daily minimum and maximum temperatures over a 30-year period (water years 1972–2001) on different hydrological components, including streamflow and base flow. The model simulates all the major snowmelt and precipitation-related physical processes, including snowpack accumulation or melting, sublimation, evapotranspiration, surface runoff, subsurface flow, and groundwater flow. Air temperature was the only parameter that changed for each simulation. Spatial and temporal distributions of precipitation and all other model parameters were the same for each simulation. This research focuses on comparing alternative air temperature scenarios with the historical base scenario. Key findings were that the timing of the center of the mass, the April through July runoff as a percent of the annual runoff, and the April snowpack water equivalent are shown to change appreciably with rising temperature.

Climate Change Impacts to State Water Project and Central Valley Project Operations

Status: Completed/Ongoing

Contact: Hongbing Yin, Sushil Arora, Francis Chung

The State Water Project (SWP) and the Central Valley Project (CVP) are the two major interbasin transfer projects for California's water supply system. Investigating climate change impacts to SWP and CVP operations provides a foundation for developing system adaptation plans. DWR has conducted initial studies of climate change impacts to SWP and CVP operations using the CalSim-II model under existing physical, operational and institutional conditions. Impacts were evaluated for projected changes to streamflows, agricultural water demands, and rising sea levels. Twelve climate change projections recommended by the Governor's Climate Action Team were used for the study. Mid-century and end-of-the-century impacts were assessed for

- Annual Delta exports
- Reservoir carryover storage
- Sacramento Valley groundwater pumping

- Power supply
- Delta X2 salinity standard compliance
- Vulnerability of the system to operational interruption

The initial assessment indicates that SWP and CVP would be impacted significantly by projected climate changes. In order to provide a climate change baseline assessment of SWP and CVP impacts and to help regional scale climate change planning studies, the current assessment needs to be further refined in the following aspects: (1) re-evaluate methods of downscaling GCM model outputs and generating projected streamflows; (2) improve the estimation of projected agricultural water demands; and (3) develop the hydrologic inputs under climate change conditions for soon-to-be-released CalSim 3.0 model, which will provide linkages to regional scale climate change studies.

Isolating the Relative Effects of Warming from Climate Change Impacts on California's Water Resources

Status: Completed/Ongoing
Contact: Jianzhong Wang, Hongbing Yin

As described above, impacts of climate change on SWP and CVP operations were evaluated for 12 scenarios using the CalSim-II model. The results from the study were further analyzed to try to isolate the relative effects of inflow seasonal pattern change (caused mainly by the warming trend), annual inflow change (induced predominantly by annual precipitation trend) and sea level rise on water resource management for the SWP and CVP. A three-step perturbation ratio method is proposed to facilitate separation of the impacts of inflow seasonal pattern change and annual inflow change on the water planning. This study provides clues to water resources management strategies on adaptation to climate change. Results from this sensitivity study are being analyzed and will be submitted to a peer-reviewed journal.

Future work includes:

- Estimate climate change impact on water consumptive use and its subsequent impact on water supply in the SWP and CVP
- Improve methods for incorporating climate change into the water planning models such as CalSim-II and CalSim 3.0.

Using Future Climate Projections to Support Water Resources Decision Making in California

Status: Completed
Contact: Francis Chung, Jamie Anderson

Some of the climate change work described above was documented in a report titled "Using Future Climate Projections to Support Water Resources Decision Making in California" submitted to the California Energy Commission. After peer review, the report was released as part of the 2009 Climate Action Team report. The topics covered in the report include:

- Sea level rise
 - projections
 - relative probabilities

- computer software for assessing impacts of sea level rise to Delta salinity
- Evaluation of how well global climate models represented California's climate from 1950-1999
- Methods for using climate change projections to estimate future streamflows
- Impacts of increasing air temperatures on snowpack, runoff, and surface and subsurface flow in the upper Feather River Basin

Impacts of climate change on operations of the State Water Project and Central Valley Project Development of DWR Regional Climate Downscaling System (1): BCSD-2km

Status: Completed
Contact: Jianzhong Wang, Hongbing Yin, Francis Chung

Currently available regional climate projections are too coarse (12-14 km) for some climate change impact studies in California. To date, DWR's climate change impact studies have relied on downscaled climate model projections generated by outside researchers. Therefore, the climate change group in the Bay-Delta Office aims to develop downscaling capabilities in-house, including both statistical and dynamic downscaling methods. Currently, one of statistical downscaling schemes, called Bias Correction Statistical Disaggregation (BCSD), has been used to develop regional climate change projection information at 2km resolution for Northern California. These 2km resolution regional climate projection data are available for dissemination by contacting the study leads.

DFG Climate Change Stakeholder Groups

Status: Ongoing
Contact: Erin Chappell

DWR staff, from the four regional offices, will coordinate with sister agencies and NGO's within the DFG Climate Change Stakeholder working groups to identify how to incorporate climate adaptation for ecosystems into various agency programs/projects. DFG has formed three working groups: Outreach Work Group; Workshops and Research Needs Working Group; and Framework for Implementing Actions across the State Work Group. DWR staff will participate in these work groups to help ensure consistency in incorporating climate adaptation strategies within the Natural Resources Agency.

National Research Council (NRC) Sea Level Rise Study

Status: Ongoing
Contact: John Andrew, Jeanine Jones

In response to Executive Order S-13-08, the Department identified funding partners and prepared a scope of work for a roughly \$500,000 contract with NRC to address planning for future sea level rise, including estimation of a range of likely amounts of sea level rise in 2030, 2050, and 2100. Contracts were initiated with other California State Agency funding partners (Caltrans, SWRCB, CEC, and OPC) that would provide their shares of the cost to DWR for inclusion in DWR's master contract with NRC. Three federal agencies (USACE, NOAA, and USGS) made contributions directly to NRC in support of the study, and the states of Oregon and Washington provided draft contracts

to DWR for their portion of the funding. The study is expected to commence by the end of 2010 and conclude in early 2012.

Climate Change Technical Advisory Group

Status: Ongoing

Contact: John Andrew/ Elissa Lynn/ Megan Fidell

In 2008, DWR convened a highly qualified team of climate experts to provide technical advice to DWR on incorporating climate change into decision-making about California's water resources. This team, known as the Climate Change Technical Advisory Group (CCTAG), is focusing on the challenges presented in applying state-of-the-art climate change science, better analytical tools for modeling and planning for climate change impacts, and developing adaptation strategies for climate change adaptation for California's water sector. The CCTAG met in 2009 to help define the scope of climate change in the Central Valley Flood Protection Plan (CVFPP), the California Water Plan Update 2009, and Resource Agency's Climate Adaptation Strategy.

Operations

Coordinated Reservoir Operations

Status: Development
Contact: Boone Lek

DWR will develop and implement a Forecast-Coordinated Operations (F-CO) program for the major reservoirs in the Central Valley to improve downstream flood protection without impacting the water supply of the upstream reservoirs. The F-CO program will allow operators to make controlled releases ahead of flood events allowing for more water supply storage during the flood control season (October through April). Increasing operational flexibility and flood control space is critical if the expected climate change impacts of higher snowlines, decreased snowpack, and earlier snowmelt are realized. This may include updates to applicable water control manuals (or at least flood control curves) issued by the U.S. Army Corps of Engineers.

The F-CO program is considered one of the most cost-effective measures to improve flood control and is currently being implemented on the Yuba-Feather system. The F-CO will help minimize the risk of exceeding river channel capacity and increase the warning times to communities along the major California rivers and downstream of flood control reservoirs through enhanced communication between local, state and federal agencies; improved data gathering and exchange; and utilization of the most recent advancements in weather and river forecasting.

Evaluation of Benefits of Reoperation of Water Supply Systems

Status: Development
Contact: Sean Sou, Michael Mierzwa

California's water system is made up of state, federal, and local agencies, each having infrastructure in place to provide water supply and flood control benefits. The current operation of these independent systems is based on physical and legal constraints. Changes in the climate, legal framework, and social values associated with water use may require modifications to existing operations and management procedures, new facilities, and new laws. System reoperation refers to changes made to existing operations and management procedures.

DWR has begun to develop a scoping document for the system reoperation studies to define the scope of study to evaluate the potential to achieve the objectives of SBX2 1. The studies will define the scope of system reoperation and serve as a guide for other local and federal agencies to evaluate the potential benefits associated with reoperation of their own programs. Appropriate climate change scenarios will be incorporated in the system reoperation studies to evaluate the potential to achieve the following objectives:

- a) Integrate flood protection and water supply systems to increase water supply reliability and flood protection, improve water quality, and provide for ecosystem protection and restoration.
- b) Re-operate existing reservoirs, flood facilities, and other water facilities in conjunction with groundwater storage to improve water supply reliability, flood control, and ecosystem protection, and to reduce groundwater overdraft.
- c) Promote more effective groundwater management and protection and greater integration of groundwater and surface water resource uses.

d) Improve existing water conveyance systems to increase water supply reliability, improve water quality, expand flood protection, and protect and restore ecosystems.

Approximately \$10 million has been allocated for system reoperation studies. It is estimated that a comprehensive evaluation of system reoperation for California's water system would cost about \$30 million. Therefore, the scope of system reoperation studies focus on feasibility evaluations that can be done with \$10 million in funding. The deliverables include a feasibility report for proposed initial strategies to reoperate existing water system to achieve the SBX2 1 objectives. The studies are anticipated to be completed in July 2013.

Evaluation of Benefits of Meadow Restoration on Sierra Nevada Water Supply

Status: Development
Contact: Harry Spanglet

In a natural, un-degraded condition, mountain meadow communities have deep soils, dense vegetation, and a naturally-developed drainage pattern where water flows across the flat meadow surface and infiltrates the soil; shallow meandering channels then carry water to downstream drainages. Meadows typically remain fully saturated for most of each year and store substantial quantities of groundwater in their soils, acting as natural reservoirs of water at high elevations. Streams that drain the Sierra Nevada typically run high during early summer when snow pack is melting, but typically contain very low flows by late summer and fall. Slow release of water stored in meadow sediments to downstream drainages provides base flow to streams long after surface runoff has stopped for the season; in addition, the water storage capacity of meadows can buffer the rate of water runoff during snowmelt and reduce peak flows that cause flooding downstream. The net result is a reduction in extremes of runoff, increasing the low flow and reducing peak flows.

Degraded meadows that have been exposed to poor land-use practices, such as overgrazing of livestock, off-highway vehicle traffic, and draining, typically exhibit "gully erosion", in which shallow channels are deeply eroded and all water entering the meadow drains rapidly into stream channels rather than across meadow surfaces, eliminating the beneficial hydrologic effects of meadow communities. Meadow restoration is the practice of reversing the effects of gully erosion by filling gullies and re-establishing a quasi-natural hydrologic regime by redirecting surface flows across meadows, allowing water to infiltrate the sediment, raise groundwater levels, and potentially restore the beneficial hydrologic functions of meadows.

DWR will fund the US Department of Agriculture Forest Service to investigate the hydrologic effects of meadow restoration and how restored meadows can contribute to improved system operation as well as ecosystem functioning.

Energy and Greenhouse Gas Emissions

Water-Energy Subgroup of the Governor's Climate Action Team ("WETCAT")

Status: Ongoing

Contact: Mark Cowin/John Andrew

DWR co-chairs the Water-Energy Subgroup, better known as the WETCAT, of the Governor's Climate Action Team. In addition to DWR, the principal agencies in the subgroup are State Water Resources Control Board, California Energy Commission, and the California Public Utilities Commission. In 2008, the WETCAT developed and proposed five measures to the California Air Resources Board for inclusion in the AB 32 Scoping Plan.

- Water conservation
- Water recycling
- Energy intensity of water systems
- Urban runoff and stormwater reuse
- Renewable energy production

In 2009, the WETCAT began implementation of the all five measures, in particular, the Governor's "20x2020" initiative to reduce per capita water use by 20% by 2020.

Integrated Resource Plan for the State Water Project

Status: Development

Contact: Veronica Hicks

To assist in reducing the State Water Project's reliance on fossil-fired power generation, with its associated adverse impacts, DWR worked towards development of an Integrated Resource Plan (IRP) for procuring power that will increase the use of renewable energy as part of the SWP's power portfolio, and thereby reduce greenhouse gas emissions in California. This plan will be consistent with State policy and the goals established by the Governor's Executive Order S-03-05 (which established greenhouse gas emission reduction goals for California).

While developing the SWP IRP, numerous operational and regulatory constraints shape the following objectives DWR is committed to meeting:

- Reliable water deliveries;
- Affordable water deliveries;
- Protection of the natural environment;
- Responsibilities under regulatory authorities; and
- State and federal environmental policy goals.

As an example of the challenges DWR faces in balancing the needs and requirements of the SWP IRP, in December 2007, U.S. District Court Judge Oliver Wanger imposed court order restrictions on water deliveries from the Delta to protect the threatened delta smelt. The order has significantly decreased water deliveries to homes, farms, cities and industry by both the SWP and the federal Central Valley Project, and has fundamentally affected SWP operations. The full impact of the reduction of the SWP's available energy

resources, pumploads, and therefore greenhouse gas emissions, will in turn affect the SWP's IRP. To date, DWR's strategies for reducing emissions include:

- To develop and maintain a transparent and accurate record of the SWP's energy profiles and baselines, DWR filed its 2007 carbon dioxide emissions (CO₂) to the California Climate Action Registry (CCAR) in June 2008, and will continue reporting its emissions annually. In addition to the indirect emissions associated with the SWP power purchase portfolio, DWR reports direct and indirect emissions for the Department's leased facilities, vehicular fleet, and mobile and stationary facilities equipment.
- The SWP's current energy efficiency improvements programs include the refurbishment and replacement of DWR's hydroelectric generators and pumps at key SWP plant facilities. These programs result in almost one thousand gigawatt hours in cumulative energy savings by 2011. If additional proposed energy efficiency improvements are implemented through 2020, cumulative emissions avoided will reach one million metric tons of CO₂.
- Since July 1983, DWR has received up to 235 Megawatts of energy from Reid Gardner (RG) Powerplant, a coal-fired facility near Las Vegas, Nevada. This long-term agreement for energy from RG Unit No. 4 expires in July 2013, at which point, the SWP's CO₂ emissions levels will drop to over 30 percent from its 1990 levels. To replace this energy with cleaner, more efficient resources, DWR is investigating cleaner technologies such as natural gas combustion turbines, wind energy, small hydroelectric generation, as well as additional energy efficiency projects, and contracts for renewable energy resources.
- During high energy demand periods over the summer months of 2007 and 2008, the SWP was the largest provider for California's Demand Response Program (DRP). Curtailment of loads under the DRP results in avoidance of dispatch of the least efficient thermal generators during peak hours. In 2007, an estimated three thousand tons of CO₂ emissions were avoided as a result of the DRP, and in 2008, an estimated nine hundred tons of CO₂.

2008 Emissions Reports to the California Climate Action Registry and the California Air Resources Board

Status: Ongoing/Implementation

Contact : Holly Cronin/Veronica Hicks/John Engstrom

DWR reported its estimated total direct and indirect CO₂ emissions to CCAR for the second consecutive year. The emissions are the result of the State Water Project (SWP) power purchase transactions, energy consumed at DWR-occupied buildings (excluding buildings leased from the Department of General Services), and fuel used by DWR's on- and off-road vehicles and field equipment. DWR's CCAR GHG Emission Report was audited and approved by an independent third party certifier. Ninety-nine percent of DWR's emissions in 2008 were the result of SWP power purchases. In June 2009, DWR reported the energy generated and consumed by the SWP in 2008, and also the estimated sulfur hexafluoride associated with the SWP's transmission yard electrical equipment, to the California Air Resources Board (ARB).

Business practices and technical expertise

Cement

Status: Development
Contact: Rick Ramirez/Gordon Enas

Emissions of greenhouse gases (GHG) from cement production arise primarily from chemical processing (calcination) and fossil fuel combustion. While the cement industry has achieved significant GHG emission reductions since 1990, opportunities for further reductions still exist, particularly with expanded research into cement processing and concrete blending technologies. DWR will first identify its current contribution to cement-related GHG emissions and then develop a policy to use cement with a lower carbon content, if technically feasible, in DWR construction, maintenance, and replacement activities. A technical forum will be established within DWR to provide technical advice and support on cement-related topics for DWR employees and interested public agencies.

Addressing Climate Change in Departmental CEQA Documents

Status: Completed/On going
Contact info: Katy Spanos/Andrew Schwarz/John Andrew

In June, the director formally established the CEQA Climate Change Committee to review all climate change analyses in DWR environmental documents and exemption considerations prior to publication. Since 2008, the CEQA Climate Change Committee has reviewed and commented on dozens of departmental environmental documents. Through these reviews the committee has developed environmental analysis methodologies and reference materials for use by department staff and consultants. These methodologies and materials are used to help DWR comply with environmental documentation required to implement laws, regulations, and other operational mandates pertaining to climate change. These guidance documents also provide a consistent approach to conducting project specific environmental analyses for CEQA compliance documents, biological assessments, permit applications, and other environmental needs. Because of the evolutionary nature of climate change analysis, these documents will be updated periodically to include the most current legal rulings and expert thinking on the subject. In 2009, the CEQA Climate Change Committee released the following documents to help guide completion of climate change analysis for CEQA projects:

- “Addressing Climate Change in CEQA Documents-Process and Decision Making Outline and Flow Chart”
- “Guidance for Quantifying Greenhouse Gas Emissions and Determining the Significance of their Contribution to Global Climate Change for CEQA Purposes”
- Model CEQA Climate Change Discussion and Impact Analysis Section For EIRs
- Model CEQA Climate Change Discussion for Negative Declarations and Mitigated Negative Declarations

For 2010, the CEQA Climate Change Committee will be initiating discussions and forming a work group and steering committee to develop a programmatic approach to addressing climate change. This programmatic approach may be a department wide Climate Action Plan or several smaller plans that address the activities of each division of the Department. A programmatic approach for addressing climate change in CEQA documents has been encouraged by the California Attorney General's Office as well as new CEQA Guideline Amendments recently adopted by the Natural Resources Agency. The Climate Action Plan or Plans will help to document Departmental compliance with AB32; set greenhouse gas reduction targets and reduction strategies; streamline environmental review; demonstrate DWR's commitment to environmental stewardship, sustainability, and climate change mitigation and adaptation.

Sustainable Business Operations Initiatives

Status: Development; In progress; Completed

Contact: John Engstrom

DWR will identify, measure, and implement sustainable business operations practices to reduce GHG, and educate employees in these practices. The sustainable business operations practices to make DWR "greener" will include reducing energy and resource consumption, while lowering greenhouse gas emissions and creating healthier working environments for DWR employees. The development of these enhanced business practices will include:

- DWR will integrate a document management system into its business operations. This type of system will reduce paper quantity and create an electronic system for tracking of approvals and electronic retention of documents to save time and resources;
- DWR will continue to promote the Environmentally Preferable Purchasing (EPP) Procurement program to utilize procurement methods that provide options for purchasing "green" products;
- DWR will increase its efforts to reduce, reuse, recycle, and rethink in all areas of DWR's daily business activities. DWR will look at continuing to increase its waste reporting metrics under SB 1016 by using annual waste disposal as a factor when evaluating program implementation.
- DWR will promote and implement energy and water efficiency and conservation in all capital and renovation projects as well as operations and maintenance activities within budgetary constraints and programmatic requirements;
- DWR will promote ways to reduce employee business travel for meetings by use of technology like teleconference centers or web casting. In addition, training webinars and other online training opportunities will be investigated to reduce training commute for employees.

Actual targets for reductions will be identified in policies created as part of the implementation of DWR's new Sustainability Policy, which received approval from Director Snow on April, 22, 2009. The policy embodies the goals and directions the Department will take to be a leader within State government and the California water community. The changes implemented through this policy will not only make DWR better stewards of the

environment, but also should yield cost savings to the State taxpayers through reduced operating cost and provide healthier work environments for staff and the visitors.

Other actions in progress or in planning to promote a more sustainable business include:

- DWR will continue to educate through outreach activities like the annual Green Week event, quarterly Green Print articles, Pod Cast, and AquaNet announcements.
- DWR will promote the first annual California State Green Fair, will be held on Tuesday, April 20, 2010 at the California State Capitol. DWR's goal is to educate and encourage people to use green practices at both work and home.
- DWR will continue to work on a proposed Payroll Deduction Transit Pass Program. This proposed program came from a suggestion made to the Green Team. The proposal recommends that monthly transit passes be sold through a pre-tax payroll deduction program, which benefits for both employees and the Department.

Accomplishments include:

- Environmentally Preferable Purchasing (EPP) Practices- The Purchasing Services Office held purchasing workshops to update the department buyers about the EPP program and why it is in the best interest for the Department to utilize this opportunity. The purchases are reportable in many cases under the mandated goals outlined in the Public Contract Code (PCC) ([12153-12320](#)) for buying recycled-content products (RCPs). The goal of this effort is to increase purchases of RCP's.
- Enterprise Content Management System (ECM) - A feasibility study concluded that there is an acute need for a document and records management system at DWR. On June 2, 2008, DWR Governance Board approved the project and funding. The first phase, procurement and implementation, of the ECM infrastructure is underway. This ECM system will reduce paper retention, thus reduce office space necessary for files. Long term savings for reduction of office space, heating, cooling, and labor efficiency will be gained once this system is completed.
- Green Week- Green Week is celebrated during Earth Week, which was the week of April 22, 2009. The week highlighted information on the 4R's (Reduce, Reuse, Recycle and Re-Buy), Environmentally Preferred Purchasing (EPP), Earth Day, Arbor Day, and DWR's role in promoting like principles with respect to our mission. In addition, DWR also held three public showings of the documentary "A Climate of Change: Water Adaptation Strategies" in the Resources Building Auditorium on Earth Day, April 22. The documentary, developed in partnership between the Water Education Foundation and the California Department of Water Resources, is an overview of what scientists anticipate in the future related to sea level rise and precipitation/runoff changes and explores the efforts that are underway to plan and adapt to climate change.
- Green Print and Podcasts- Staff has promoted sustainability through quarterly "Green Print" articles posted on AquaNet. The articles discuss sustainable opportunities that staff can utilize both at work and at home. In addition, a Podcast was produced on efforts DWR is taking to green it business operations.

- Greening DWR Intranet Web Site- The web page was released in December 2007. Over the last two years, the site has been updated to include new information on sustainable practices. The web site also hosts the home for the Green Print articles past and present. The web page has a suggestion box that has provided input and comments from the readers, which have been the catalyst for recommendations for making our business operations greener. For instance, the Payroll Deduction Transit Pass Program is one of the suggestions currently under review.
- Green Award for Reduction of Waste Disposal- A DWR sustainability award was created to promote waste reduction and recycling within our Department. The recipient of this Diversion Award disposed the least amount of waste from 18 primary categories and 6 hazardous waste material categories. The first award was presented in 2008.
- Leadership in Energy and Environmental Design (LEED) Buildings- The State Water Project Southern Field Headquarters is planned to be the first LEED Gold building developed by the Department. Currently, the project is in design and is scheduled to be completed in 2010. The department is also working with DGS to have the leased facility in West Sacramento LEED Certified.

Climate Change Matrix Team

Status: Ongoing
Contact: John Andrew

DWR's Climate Change Matrix Team includes representatives from every division and major program in the Department. The team of approximately 40 staff (membership is on the last page of this report) meets at least quarterly to communicate and coordinate on climate change projects; meetings regularly feature an external speaker on climate change.

Grantmaking and technical assistance

Integrated Regional Water Management Grant Program

Status: Development
Contact info: Tracie Billington

DWR is preparing the draft versions of the IRWM grant program guidelines and proposal solicitation packages for implementation and planning grants. The guidelines include the IRWM plan standard for climate change; the standard addresses both adaptation to the effects of climate change and consideration of greenhouse gas emissions when selecting project alternatives. Climate change is also discussed as part of the Description of Region and Project Evaluation plan standards. Adaptation to climate change and reduction of greenhouse gas emissions are also program preferences. Thus, proposals meeting these preferences will earn additional points in the application scoring process. DWR anticipates release of the Draft Guidelines and PSPs in early February 2010.

Integrated Regional Water Management Grantees CEQA Documents

Status: Development
Contact info: John Andrew

DWR staff, located in the four regional offices, will coordinate with the Financial Assistance Branch to review IRWM grantee CEQA documents and evaluate their consideration of climate change. These reviews may commence in mid-2010.

Provide Expert Assistance for Integrated Regional Water Management Plans

Status: Development
Contact info: John Andrew

DWR staff, located in the four regional offices, will provide technical assistance to IRWM planning groups and local water agencies to incorporate climate change into their planning efforts beginning in summer 2010. Staff experts will assist with the additional analysis required by the revised IRWM Act to consider climate change adaptation, including coordination with Bay-Delta Office to obtain, develop, and provide downscaled climate and runoff data to the planning groups and local water agencies.

Provide Expert Assistance for DWR CEQA Documents

Status: Development
Contact info: Andrew Schwarz/John Andrew

DWR staff, located in the four regional offices, will also provide technical assistance to Program Managers to incorporate climate change into their CEQA documents for DWR projects. This work will include identifying needed work and providing advice regarding sources of data and analysis.

Federal Grant Programs

Status: Ongoing
Contact Info: Jeanine Jones

Jeanine Jones served on NOAA's national review panel for 2009 applications submitted to the Sectoral Applications Research Program (SARP) of NOAA's Climate Programs Office. Three DWR applications for 2010 SARP grants were prepared and submitted to NOAA in coordination with research institution co-sponsors. In response to NASA's receipt of federal stimulus funds for water-related basic research, the Department worked with the Jet Propulsion Laboratory and the Ames Research Center to jointly identify and develop research projects that could have utility for the Department.

Climate and Remote Sensing Training for DWR Staff

Status: Completed
Contact Info: Jeanine Jones

Working with the Climate Services Division of the National Weather Service headquarters, a pilot climate training class for water agencies was developed and provided to DWR staff in Sacramento, and was also made available via webcasting.

Provide Expert Assistance for Water Use Efficiency

Status: Development
Contact info: Manucher Alemi

The Water Use and Efficiency (WU&E) Branch will respond to inquiries about how to use water efficiently at all levels, from statewide usage to options specific to the State Water Project. WU&E have requested resources needed to carry out its water-energy relation activities. When resources are made available, anticipated in January 2011, staff will begin the activities. Staff experts will answer questions or provide data and information. DWR is also requiring grant applicants to analyze the energy impacts of their water conservation projects.

WU&E will work with other organizations within DWR and with other State agencies (ex. California Energy Commission, Air Resources Board, California Public Utilities Commission) to gather and disseminate information about methods to use water efficiently and to reduce greenhouse gas emissions. Staff will also provide analysis and produce studies to determine the most cost-effective programs, projects, or practices that can be implemented to meet the greenhouse gas emission standards mandated by Assembly Bill 32 (AB 32).

National and International Scientific and External Coordination Committees

Status: Ongoing
Contact: Jeanine Jones/Maury Roos

During 2009, Jeanine Jones served on NOAA's Climate Working Group, a subcommittee of NOAA's Science Advisory Board, and on USEPA's State and Tribal Council, a newly created federal climate change advisory committee. She also represented the Western States Water Council (WSWC) on a technical advisory

committee to the federal Climate Change and Western Water Group (a coalition of USBR, USACE, NOAA, and USGS). She served on the Western Governors' Association Climate Adaptation Workgroup, and chaired the WSWC Climate Change Subcommittee.

Maury Roos consulted on Technical Paper VI, *Climate Change and Water*, of the Intergovernmental Panel on Climate Change.

Public Outreach

Status: Ongoing

Contact: Elissa Lynn/Jeanine Jones /Michael Anderson/John Andrew

DWR is actively engaged in outreach efforts with multiple partners on the water resources impacts of climate change, focusing on public awareness, interagency coordination, and adaptation strategies. DWR also maintains a climate change website which provides the opportunity for the general public to e-mail climate change inquires to DWR staff.

Climate Change Video

Released on Earth Day (April 22, 2009), this 22-minute mini-documentary was co-produced and hosted by Elissa Lynn, and co-produced by the Water Education Foundation (see separate attachment for details). Public and media showings and web-release occurred in conjunction with DWR Green Week activities. Video is posted at: <http://www.water.ca.gov/climatechange/>

This mini-documentary has been utilized by numerous local and State partners as climate change adaptation outreach, including:

March 12, 2009: Water Education Foundation Executive Briefing Preview.

June 9, 2009: Climate Action Team public meeting.

June 22, 2009: League of Women Voters' Climate Change Forum.

It also appeared on a 'Focus Earth' episode on California climate change on the Planet Earth network (a subsidiary of Discovery Network), hosted by ABC News' Bob Woodruff. This show aired the second week of January, 2010.

Presentations

DWR made approximately 50 presentations on climate change, including several keynote addresses, including at interstate and international venues (a list is provided as an appendix to this report).

Exhibits

DWR displayed a climate change exhibit at both the fall conference of the Association of California Water Agencies (ACWA) and the annual conference of the Colorado River Water Users Association.

Workshops

- The second annual Winter Outlook Workshop was held in November, 2009 in San Diego, bringing together western U.S. climate experts to provide the first long-range outlooks for California's upcoming rain season.
- November 2009 climate adaptation symposium was held in San Diego in partnership with the Western States Water Council.

Reports

- In December 2009, the Natural Resources Agency released the California Climate Adaptation Strategy (CAS), a first-of-its-kind multi-sector strategy to help guide California's efforts in adapting to climate change impacts. Modeled on DWR's climate change water adaptation white paper, the CAS summarizes the best known science on climate change impacts in seven sectors and provides recommendations on how to manage against those threats.
- In May 2009, DWR released [*Using Future Climate Projections to Support Water Resources Decision Making in California*](#) which evaluates how climate change could affect the reliability of California's water projects. The Department produced the report as part of the biennial Climate Action Team report for 2009.

State Climatologist's Office

Status: Ongoing
Contact: Michael Anderson

The California Office of the State Climatologist (OSC) is housed in the California Department of Water Resources (DWR) Division of Flood Management. Interacting with other divisions within DWR which makes up the state climate office (SCO) and the California Climate Data Archive (CalClim) at the Western Regional Climate Center (WRCC), the OSC provides a growing range of climate services for California. Activities of the OSC in 2009 include supporting NOAA's efforts to produce an update to its rainfall frequency product for California which should be complete sometime in late 2010 or early 2011. California's Bulletin 195, a compilation of depth-duration-frequency curves, continues to be updated with the help of retired State Climatologist Jim Goodridge. Both of these products will be used in an effort to produce hydrologic information for floodplain mapping and other hydrologic and hydraulic studies associated with California's FloodSAFE program.

Collaboration with NOAA and Scripps Institute of Oceanography continues on the development of an extreme precipitation monitoring network that will include GPS-Met stations to monitor atmospheric water vapor, soil moisture sensors, and vertically pointing radar to detect freezing level in the atmosphere. The project, born out of NOAA's Hydrometeorological Testbed work in the American River watershed, is a five-year effort to lay out the initial components to a statewide monitoring network to improve precipitation forecasts and increase lead time for flood mitigation actions. Two snow-level-radar installations have been completed: one at Shasta Dam and one at Colfax in the American River watershed. Two more are scheduled for this year including one in the Merced River watershed and one in the Kings River watershed. On the soil moisture monitoring front, a soil moisture workshop is being organized to bring together the different agencies and research personnel who are monitoring soil moisture in California. The workshop will review the methods and equipment used, identify locations of activities, and explore opportunities to leverage efforts to obtain a statewide network. Another development this past year for this collaboration is the expansion of the effort to include four partial atmospheric river observatories along the coast of California. This effort will expand the investment in the network from \$7.5 million to \$10.5 million.

California is now in year two of the Community Collaborative Rain, Hail, and Snow Network ("CoCoRaHS"). Over 650 volunteers have signed up with NWS Weather Forecast Offices taking the lead as regional coordinators with help from some DWR personnel. Observers are located in 51 of California's 58 counties. Approximately 9000 reports are submitted per month from California's CoCoRaHS volunteers.

Drought response activities continued with a third dry year in the books. The OSC participated in the DWR drought team providing data and material for decision support and outreach activities. Interactions with the U.S. Drought Monitor continued with increased coordination between the OSC and the NWS California-Nevada River Forecast Center, the Sacramento Weather Forecast Office and the WRCC. New graphical products were developed by the California-Nevada River Forecast Center and are available at: <http://www.cnrfc.noaa.gov/climate.php>. These products look at California's Sacramento Basin 8-Station Index, its San Joaquin 5-Station Index, and storage at a selected number of California's reservoirs. The current state of these indices and reservoirs are related to Drought Monitor classes based on the frequency of the observed state.

Significant improvement in California's water conditions occurred this past year with the exception of California's State Water Project. The Feather River watershed which is the headwaters for the project did not benefit from the winter storms as much as the nearby headwaters to Shasta Reservoir. As a result, drought activities will likely continue.

Data service for California climate data improved this past year with the help of a collaborative project between DWR and Western Region Climate Center. The effort looks to identify quality control routines to run through data coming in from the California Data Exchange Center and develop tools to help analyze the data. Histogram and wind rose graphics are some examples of these new tools. The tools are housed in the California Climate Data Archive. Data serving continues via the web, phone and email.

The annual WERA-102 Committee meeting, a meeting of western State Climatologists, the Western Region Climate Center, and federal resource agency partners was hosted by the OSC and the Monterey Weather Forecast Office in 2009. Discussion focused on the development of the next five-year authorization for the committee. Work for that authorization was completed in early May.

The State Climatologist has also been involved in the Department's Climate Change Matrix team and FloodSafe's Central Valley Hydrology Study and Central Valley Flood Protection Plan. The Central Valley Hydrology Study is developing new design hydrology data to help the Department's floodplain mapping and flood project studies activities. This effort will include a climate change component in which the State Climatologist will be taking a lead role. The Central Valley Flood Protection Plan (CVFPP) is a five-year plan that describes the flood protection project activities that need to be implemented for the Central Valley. This past year the CVFPP convened a climate change working group to advise what climate change activities should be included in the CVFPP. Membership in this committee included the State Climatologist, Kelly Redmond from Western Region Climate Center, Robin Webb from NOAA's Earth System Research Laboratory, Stu Townsley from the Corps of Engineers, and David Raff from the Bureau of Reclamation, among others. A second technical committee has emerged from this effort that will look at quantitative methods of incorporating climate change into the CVFPP that will coordinate with the efforts of the Central Valley Hydrology Study.

Coordination potential of the OSC was improved this past year with the signing of a five-year agreement between the Department of Water Resources and the University of California Office of the President. This agreement allows the OSC to engage the research community of the University of California for climate services via a task order process. Six task orders are currently in the approval process for a range of studies.

Presentations and Posters

Jamie Anderson

CWEMF annual meeting, February, Asilomar

Michael Anderson

California Water and Environment Modeling Forum, February

Keynote speech at the CalGIS conference, September

Two keynote talks at Department of Commerce workshops on climate, water, and energy, September

California Cooperative Snow Surveys Annual Meeting, November

John Andrew

Butte Water Commission, January 6, Paradise

American Water Works Association, January 26, Portland, OR

Interfaith Earth Stewardship Conference, January 29, Auburn

American Groundwater Trust, February 6, Ontario

California Environmental Dialogue, March 5, Sacramento

Utah Water Users Association, March 10, St. George, UT (keynote)

GEOSYM, April 28, on-line

“Ice, Snow, and Water,” May 5, UC San Diego

EnVisionengineering Symposium, June 13, San Diego

League of Women Voters, June 22, Sacramento

Western Association of Fish and Wildlife Agencies, July 14, Newport Beach

ASCE/EWRI/FMA Sustainability Summer Symposium, July 23, Sacramento

California Climate Adaptation Strategy Public Meeting, August 13, Sacramento

California Water Plan Update Advisory Committee, August 13, Sacramento

California Climate Change Conference, September 9, Sacramento (moderator)

Public Health Working Group, September 14, Sacramento

Fifth Annual CEQA Conference, September 22, San Francisco

Public Meeting on California Water Challenges, September 30, Washington, DC

Center for Collaborative Policy Professional Development Seminar, October 5, Sacramento

Parish Forum on Global Climate Change, October 11, Sacramento

San Diego IRWMP Regional Advisory Committee, October 14, San Diego

American Water Works Association, November 16, Seattle, WA

Western States Water Council, November 17, San Diego

California Urban Water Conservation Council, December 10, San Jose

Francis Chung

American Geophysical Union, December, San Francisco

Messele Z. Ejeta et al.

CWEMF Annual Meeting, February, Asilomar (presentation)

Jeanine Jones

American Meteorological Society, January, Phoenix
Border Governors' Conference Water Worktable Binational Drought Conference, March, San Diego
NOAA/NWS pilot climate training class for DWR staff, June, Sacramento
NASA/Water Education Foundation Workshop, September, Pasadena
NOAA/WSWC NIDIS workshop, October, Lincoln Nebraska
NOAA Climate Diagnostics and Prediction Workshop, October, Monterey
WSWC Water Info Mgmt/Climate Change Adaptation Workshop, November, San Diego
DWR Winter Outlook Workshop, November, San Diego
ACWA, December, San Diego
NOAA Sea Level Rise & Inundation Workshop, December, Virginia

Elissa Lynn

Society of American Military Engineers, 2009 California Water Conference, October, Sacramento

Roy Peterson

Linking Climate Change Impacts on Evapotranspiration (ET) and Agricultural Production to Water Resources Decision Making, January
Climate Change Influences on Biological Components of ET, DWR

Maury Roos

Climate Change and Water, February, Butte Basin Water Users, Richvale
Scripps Conference on "Ice, Snow, and Water: Impacts on California and Himalayan Asia." "Reduced Snowpack: Four Impacts on California's Water Supply." May
Lecture for DWR Hydrology Basics Training Class, May, DWR
Climate Change, Sea Level and the Delta, Presentation to Water Education Foundation Bay Delta Tour, June, Sacramento
Climate Change, Sea Level and the Delta, Presentation to Dutch Delegation, June, Sacramento
California Water Resources and Climate Change, December, New Delhi, India

Andrew Schwarz

DWR Three Day CEQA training class, February, West Sacramento

Articles

Maury Roos, "Sea Level Rise; An Increasing Risk to California Water Projects", American Water Resources Association Impacts Journal. Vol. 11, No. 1, January 2009.

Climate Change Matrix Team

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