

**Integrating Climate Science for Decision-Support,
Mitigating Risk and Promoting Resilience
Climate Assessment for the Southwest (CLIMAS) Phase 3**

Annual Report
for
May 1, 2008 – April 30, 2009

Contents

CLIMAS Program Team	2
Main Stakeholders and Partners	2
Areas of Focus	3
Research and Stakeholder Collaboration Highlights	4
Tools, Models, and Products	9
Workshops, Media briefings, Presentations	11
Links with Other NOAA Programs	18
Cross RISA Collaborations	18
Peer Reviewed Publications	19
Non Peer-reviewed Publications	20

CLIMAS Program Team

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Main Stakeholders and Partners

Arizona Agribusiness Council	New Mexico State University
Arizona Cooperative Extension	Pacific Institute
Arizona Department of Water Resources	Pima County
Arizona Drought Monitoring Technical Committee	Pima County Regional Flood Control District
Arizona Electric Power Cooperative	Protección Civil (emergency preparedness planners) (Sonora)
Arizona Farm Bureau Federation	Salt River Project Water Resource Operations
Arizona Irrigation District Managers	San Carlos Apache Environmental Protection Agency
Arizona Local Drought Impact Groups	Sonoran Institute
Arizona Public Service Corporation	Southwest Indian Agricultural Association
Arizona Water Institute	Sustainability of semi-Arid Hydrology and Riparian Areas (SAHRA) NSF Center
Carpe Diem Project Team	The Nature Conservancy
Central Arizona Project	Tohono O'odham Department of Water Resources
Comisión Nacional del Agua (Sonora)	Tucson Botanical Gardens
Cotton Inc.	Tucson Department of Transportation
East Valley Water Forum (Phoenix)	UCAR Cooperative Program for Operational Meteorology, Education and Training (COMET)
Ejido residents north of Hermosillo, Sonora	Universidad de Sonora
El Colegio de Sonora	US Bureau of Reclamation
Environmental Defense	US Institute for Environmental Conflict Resolution
Hopi Tribe Department of Natural Resources	Water managers in Tucson, Hermosillo, Ambos Nogales, Puerto Peñasco
Inter Tribal Council of Arizona	Western Resource Advocates
Kinship Conservation Fellows	
Local communities in US-Mexico Colorado River Delta region	
Lower Colorado River Basin water users	
Mid-Region Council of Governments	
National Park Service Public Use Statistics Office	
National Park Service Social Science Program	
National Weather Service	
National Wildlife Federation	
Navajo Nation Department of Water Resources	

Areas of Focus

During the performance period, CLIMAS team activities fell into four broad categories with numerous focus areas in each category:

1. Capacity Building
 - 1.1. Provide support for climate change adaptation in the Southwest
 - 1.2. Translate climate variability and climate change science for stakeholder needs
 - 1.3. Improve drought impact reporting and monitoring
 - 1.4. Develop hydroclimatology and paleohydrology for decision support
 - 1.5. Build capacity for climate knowledge application in the US-Mexico border region
 - 1.6. Conduct fire-climate science and facilitate translation
 - 1.7. Improve forecast evaluation and apply in operational settings
 - 1.8. Provide social science support for partners on program and tool development
 - 1.9. Improve CLIMAS internal and external interactions through evaluation
2. Understanding decision-maker needs
 - 2.1. Improve the use of climate information in agricultural decision-making
 - 2.2. Understand perceptions of climate variability and change in the US-Mexico border region
 - 2.3. Climate assessment for regional partners
3. Climate Research
 - 3.1. Improve understanding of connections between climate and public health
 - 3.2. Improve understanding of climate dynamics of the Southwest in the global system
 - 3.3. Improve understanding of current drought conditions in the Southwest in the context of past climates
 - 3.4. Improve understanding of North American Monsoon variability
4. Vulnerability
 - 4.1. Assess economic impacts of drought and climate change on agriculture and energy sectors in the Southwest
 - 4.2. Assess economic impacts of climate variability on Southwest park visitation
 - 4.3. Assess impacts of climate variability and change in indigenous communities
 - 4.4. Assess community vulnerability through case studies

Research and Stakeholder Collaboration Highlights

1. Capacity building

1.1 Provide support for climate change adaptation in Southwest

- Developed Scenario Development Framework in collaboration with SAHRA NSF Center. Framework identifies multiple types of scenarios, stages in scenario development and application, and offers approaches for linking integrated models with institutional planning and management processes. Website supports stakeholders in understanding scenario development and application (<http://www.sahra.arizona.edu/scenarios>). This collaboration has provided a foundation for stakeholders to solicit CLIMAS involvement in their projects related to climate change adaptation and scenario planning (Hartmann).
- Engaged the Carpe Diem project, headed by Ex Loco, Inc. This project involves a variety of large and small non-governmental organizations and foundations in developing a sector-wide strategy for developing funding projects to facilitate climate change adaptation within the water management sector in the US West. (Hartmann, Garfin, Ferguson)
- Continued collaboration with National Park Service in assessing climate change adaptation, planning, and strategies. The goal is to develop an approach that can be applied across the National Park System for each park unit to develop climate change adaptation plans (Hartmann).
- CLIMAS co-sponsored, helped organize, and contributed scientific talks to “Adaptation to Climate Change in the Desert Southwest: Impacts and Opportunities” conference in Tucson, January 22-23, 2009. This conference brought together approximately 250 participants from across the region to begin the discussion about climate adaptation in the desert Southwest. (Overpeck, Frisvold, Hartmann, Ferguson)
 - » Immediately following this adaptation conference, CLIMAS convened a small group of high level stakeholders from Arizona to begin assessing next steps for climate adaptation planning in Arizona. This meeting has resulted in a nascent effort to form a stakeholder working group to help support and lead any eventual state adaptation planning (Overpeck, Ferguson, Garfin).
- Served on organizing committee and workshop facilitation team for The Nature Conservancy’s 2008-2010 project, to implement a methodology for developing climate change ecosystem management adaptation plans, with state and federal agency partners, in the Southwest. The first workshop was conducted with managers in New Mexico’s Jemez Mountains region on April 21-22, 2009 (Garfin).
- Working with City of Tucson Climate Committee, which reports to the Mayor and City Council, to spearhead climate change mitigation and adaptation for the city (Overpeck).

1.2 Translate climate variability and climate change science for stakeholder needs

- Produced monthly issues of the *Southwest Climate Outlook* and distributed to approximately 1600 people via email (Guido, Ferguson, Garfin).
- Contributed a chapter on Active Management Areas to the Arizona Department of Water Resources’ Arizona Water Atlas (Garfin, Guido).
- Coauthored National Research Council report on ecological impact of climate change (Overpeck).
- As part of an overall strategy to engage Native Nation stakeholders in the Southwest, gave a series of invited presentations on the science of climate change to tribal groups (Ferguson).
- CLIMAS core office continues to respond to routine stakeholder requests to deliver presentations to a variety of audiences on the current state of knowledge of climate change science (Overpeck, Garfin, Ferguson, Guido).
- Contributing author to U.S. Climate Change Science Program Synthesis and Assessment Product 5.3: Decision-Support Experiments and Evaluations Using Seasonal to Interannual Forecasts and Observational Data: A Focus on Water Resources (Garfin).

- With leveraged support from Arizona state funding sources, began the development of the Southwest Climate Change Network web resource. CLIMAS has contributed a substantial amount of synthesized information about climate change science and impacts. This website is being developed as a resource for stakeholders throughout the region who need both up-to-date and reliable information about climate science. In addition to this information brokering function, by utilizing basic social networking technologies, the site will allow stakeholders an avenue for directly accessing a wide variety of experts who contribute to the general climate services enterprise. More information below in the “Tools, Models, and Products” section of this report (Crimmins, Ferguson, Garfin, Guido, Overpeck, Owen).
- Worked with consulting firm (CH2M Hill) to develop proposals on climate change adaptation planning in Southwest cities (Garfin).
- In collaboration with University of Arizona Cooperative Extension, conducted five online videobriefings with stakeholders across Arizona and New Mexico, between April 2008 and February 2009. Briefings addressed recent climate variations, extreme weather and climate impacts, and seasonal climate and streamflow forecasts (Crimmins, Garfin).
 - » Beginning with the July 30, 2008 video briefing, NOAA National Weather Service forecast offices (Las Vegas, Flagstaff, Phoenix, Tucson, Albuquerque, El Paso) have been active partners, presenting analysis of recent conditions, and forecasts. The NOAA Colorado Basin River Forecast Center participated in the February 2009 briefing.
 - » Approximately 25 people attend each videobriefing.
 - » The briefings have generated news articles in the *Albuquerque Journal*, the *Tucson Citizen*, and the *Prescott Courier*.

1.3 Improve drought impact reporting and monitoring

- Continued work with the Arizona Drought Monitoring Technical Committee on outreach to county-based Local Drought Impact Groups in Santa Cruz, Graham, Navajo, Pinal, and Pima Counties, with UA Cooperative Extension. Part of implementing the Arizona Drought Preparedness Plan (Crimmins, Ferguson, Garfin)
- As part of NOAA’s Transition of Research Applications to Climate Services (TRACS) Program and CLIMAS (through PI Garfin) is working with Andrew Ellis (Arizona State University), to strengthen partnerships with key stakeholder groups (e.g., East Valley Water Forum, Society of American Foresters) with regard to their needs for drought monitoring and assessment information. The main goals of this project are:
 - » to implement a new drought assessment index;
 - » transfer it to operational partner;
 - » exchange knowledge with Arizona stakeholders on their assessment needs and use of the index.
- HCN-M for the Southwest. Advised NOAA-NCDC on high priority sites in Arizona for new HCN-M automated weather stations (Garfin).

1.4 Develop hydroclimatology and paleohydrology for decision support

- Constructed a flood hydroclimatology database linking climate, floods, and paleofloods to provide a climatic perspective on the causes and variability of past extreme flood events and their probability of occurrence under different types of atmospheric circulation patterns (Hirschboeck).
- Identified cultural factors that affect risk perception and behavior during flash floods in Tucson, AZ to reduce flood risk and increase resilience to climate-related flooding variability (Hirschboeck, Coles).
- Continued work on expanding the TreeFlow project into the Southwest (specifically the Lower Colorado River basin), which serves to transfer paleodata into useful tools for water resources decision support. The project includes the development of a website that assists water managers in coping with drought, low flow extremes, and high flow extremes by providing them with a long-term perspective of tree-ring streamflow reconstructions. The website also provides workshop and outreach materials (Woodhouse, Hartmann, Hirschboeck).

1.5 Build capacity for climate knowledge application in the US-Mexico border region

- Production and distribution of the quarterly *Border Climate Summary* (BCS) for the US-Mexico border region, with funding from the Inter-Americas Institute for Global Change Research. BCS prototype developed by CLIMAS. Investigators garnered baseline demographic data and feedback on the BCS from stakeholders in Northern Mexico at a workshop in November 2008. Available through the CLIMAS website (Garfin, Wilder).

- Organized the Border Climate Workshop on climate change at the US-Mexico border, on behalf of the Border Governors Conference with funding from the California Department of Water Resources (Garfin).
- Worked with Arizona Water Institute to assist Navajo Nation Department of Water Resources to improve hydroclimatic monitoring and data sharing with federal and state agencies, in Arizona, New Mexico, and Utah (Garfin).

1.6 Conduct fire-climate science and facilitate translation

- Co-organized January 2009 Eastern Seasonal Assessment Workshop, and April 2009 North American Seasonal Assessment Workshop to provide pre-season fire potential forecasts for the United States, Canada, and Mexico. These forecasts are designed to inform national and North American fire management resource allocations (Garfin).

1.7 Improve forecast evaluation and apply in operational settings

- Continued to work with UCAR Cooperative Program for Operational Meteorology, Education and Training (COMET) to develop online training module, designed for hydrologic forecasters at NWS River Forecast Centers and Weather Forecast Offices. Information available at <https://www.meted.ucar.edu> (Hartmann)
 - » Introduction to Verification of Hydrologic Forecasts, Cooperative Program for Operational Meteorology, Education and Training (COMET), University Corporation for Atmospheric Research (UCAR), Boulder, CO, published 30 June 2008. (Note: This tool was developed by COMET personnel. H. Hartmann served as science contributor in development of the online web course, with M. Kelsch, J. DeMagne, K. Werner).
- Continued trainings in using the Forecast Evaluation Tool. (Hartmann)
 - ◊ Wide variety of registered users, including public agencies, private organizations (energy and commodity firms), and individuals

1.8 Provide social science support for partners on program and tool development

- Facilitated UA County Extension's Climate and Natural Resources Working Group two-day strategic planning meeting in April 2008. The purpose was to evaluate the working group's past climate change workshops (all of which CLIMAS has helped organize and contributed to) and incorporate lessons learned into the group's future plans (Owen).
- Coordination of upcoming (May 2009) focus group session for the NWS Colorado Basin River Forecast Center to evaluate the usefulness and usability of the CBRFC's two web-based soil moisture and gridded precipitation tools for Arizona. The goal is to obtain user feedback on the usefulness of the two new tools and ways that they can make the Web interface more usable (Guido, Owen, Ferguson, Garfin, Crimmins).

1.9 Improve CLIMAS internal and external interactions through evaluation (Ferguson, Garfin, Owen)

- Continued evaluation of the CLIMAS project to understand distribution and extent of information flow; perceived salience, credibility, legitimacy of CLIMAS and changes in knowledge, behavior, understanding as a result of interactions with CLIMAS. Conducted 16 individual stakeholder interviews, 2 focus groups, and two surveys: 1) to assess CLIMAS stakeholder interactions; and 2) to assess the *Southwest Climate Outlook* (Ferguson, Garfin, Owen).
 - » Results and lessons learned extended to the RISA program through presentations and panel at the 2009 Climate Prediction Applications Science Workshop.

2. Understanding decision-maker needs

2.1 Improve the use of climate information in agricultural decision-making

- Examined demand for climate (and other) information by agricultural producers, including the sources and types of information producers use and what types of information producers use for which decisions. Investigated how differences in sources and uses of information differ by operation size and between Arizona and New Mexico (Frisvold).

2.2 Understand perceptions of climate variability and change in the US-Mexico border region

- Assessed perceptions of climate variability and change by institutional stakeholders and local communities across the Lower Colorado River and Delta region. Examined the linkage among water conservation, perceptions of drought and climate change, and valuation of riparian wetland areas by local communities (Wilder).
 - » Entered and analyzed data from 830 household surveys
 - » Completion of final report draft
 - » Presented results at 2009 International Human Dimensions Programme in Environmental Change Open Meeting
- Garfin and Wilder began leveraged project, funded by NOAA's Sectoral Applications Research Program (SARP) that targets four urban 'hotspots' for climate change and water supply vulnerability in the US-Mexico border region. One of these hotspots is Hermosillo, Sonora, for which:
 - » 85 surveys with producers and ranchers were developed and conducted
 - » A study of groundwater rights data was completed
 - » Data was analyzed and draft article written for publication
 - » Paper presented at the 2009 Association of American Geographers Annual Meeting in Las Vegas, NV.
 - » A workshop was held called, "Los flujos de información climática en la costa oeste de América del Norte" (Climatic Information Flows on the North American West Coast) in November 2008.

2.3 Climate assessment for regional partners

- Facilitated World Café discussion sessions at a US Fish and Wildlife Service climate change adaptation workshop in August 2008 and producing report for FWS based on these sessions.
 - » Synthesis report in process. The report will provide both CLIMAS and the FWS with an assessment of climate change issues confronting the Service (Guido, Ferguson, Garfin).

3. Climate research

3.1 Improve understanding of connections between climate and public health (Comrie)

- The primary goal of this project is to provide simulations of mosquito populations using dynamic modeling driven principally by climate. The aforementioned DyMSiM is one of only a few dynamic mosquito population models and may be the first for *Culex quinquefasciatus*. Using global circulation model output from the IPCC AR4 to drive DyMSiM, the following results were found across the southern US:
 - » Although there was an observed decrease in mid-summer populations due to increased drying at higher temperatures, increased precipitation often counteracted the effect causing population increases in most places.
 - » In almost all locations fall and spring populations sustained themselves longer due to warming temperatures while summer was generally controlled by precipitation
 - » A couple locations experienced significant decreases in mosquito population under climate change scenarios due to very high mortality from extremely high temperatures.
 - » Although the GCM simulated drying across much of the southwest in spring and fall there were not significant decreases in the mosquito population. In most cases populations increased, due to permanent water sources, which are independent of climate.

3.2 Improve understanding of climate dynamics of the Southwest in the global system (Overpeck)

- Improve understanding of how late-winter and spring precipitation has been changing, and why it has been changing. This work, being conducted by graduate student Stephanie McAfee (with Overpeck colleague Joellen Russell), has so far yielded an important indication that drought severity in the coming decades in the Southwest is likely to intensify.

3.3 Improve understanding of current drought conditions in the Southwest in the context of past climates (Overpeck, Woodhouse)

- Graduate student Cody Routson (with Overpeck and Woodhouse as co-advisors) is conducting tree-ring and lake sediment analysis to understand past drought in the region.

- Graduate student Weiss has spearheaded (with advisor Overpeck and UA colleague Chris Castro) an examination of the current SW drought in the context of the 1950's drought.

3.4 Improve understanding of North American Monsoon variability (Overpeck)

- Overpeck is collaborating with UA colleague Julie Cole on a new paleo-monsoon initiative aimed at creating an understanding of decade to century-scale variability in the North American Monsoon that is so important to stakeholders in the Southwest.

4. Vulnerability

4.1 Assess economic impacts of drought and climate change on agriculture and energy sectors in the Southwest

- Investigated how drought influences the market price of water, using econometric analysis of water transaction and climate data from 1987 to 2008. This project includes the development of supply reliability tools and a preliminary set of guidelines for using these tools to enhance water supply reliability under climate change in the Southwest (Colby, Frisvold).
 - » U.S. Bureau of Reclamation uses this work in their negotiation with irrigation districts on dry year supply reliability arrangements.
- Investigated new methods for predicting and adapting to climate impacts linked to energy load forecasting and climate information. Power contracts tend to be long term and inflexible, but persistent drought and climate change affect the range of costs, and, hence, energy and water management operations and policy. Increased temperatures will increase summer power demand in the Southwest (due to higher energy requirements for indoor cooling, agricultural irrigation and urban outdoor water use), and that multi-decade drought will reduce electricity supply reliability and hydropower generation. Water and power costs are likely to increase, leading to increased financial stress for households and businesses and resource management challenges in the water and energy sectors. This project provides detailed statistical analyses of energy loads, water transaction prices and climate data for targeted case study areas within Arizona and New Mexico (Colby, Frisvold).
 - » Electric power suppliers are considering the new techniques we developed to incorporate climate information into load forecasting.
- Updated and expanded the US Agricultural Resources Model (USARM) in collaboration with Kazim Konyar (CSU – San Bernadino), see Tools section below for more information (Frisvold).

4.2 Assess economic impacts of climate variability on Southwest park visitation

- Examined how climate and water availability affect recreational visits to national and state parks in the Southwest and estimated economic impacts of climate-induced changes in visitation on rural communities (Frisvold).

4.3 Assess impacts of climate variability and change in indigenous communities

- Indigenous Climate Knowledge Network: A cross-RISA (ACCAP, CLIMAS, Pacific RISA) project to conduct tri-region (Arizona, Alaska, and Pacific Islands) videoconferences to: (1) assess information on climate decision needs of tribes and indigenous peoples; (2) begin connecting Native stakeholders across these regions to one another so that they have access to impacts and adaptation strategies being used; (3) garner lessons on use and effectiveness of videoconferencing technology (Ferguson, Garfin, Owen).

4.4 Assess community vulnerability through case studies

- Continued study of the Upper Little Colorado basin, assessing the vulnerability principal livelihoods in the region – farming, ranching, forestry, recreation, and recent urbanization – in light of climate variability and the local institutional framework (Finan).

Tools, Models, and Products

AgroClimate (Garfin, Guido, Hartmann, St. Hilaire)

- Adapting tools from SECC's AgroClimate project to New Mexico. Beta versions currently available.
 - » AgroClimate Tool for New Mexico farmers and ranchers and Cooperative Extension agents
 - ◊ <http://nmclimate.nmsu.edu/ClimateRiskDoc.html>:
 - » Climate Risk tool
 - » Growing Degree Days tool
 - » Chill Accumulation (in development)
 - » Analysis of frost occurrence dates to see if there is a statistical relationship between phases of the ENSO cycle and the first and last agricultural season frost dates
 - » Gathering information and feedback regarding stakeholder needs, preferences, and usability of tool
 - » Garnering lessons on public sector technology transfer
- AgroClimate Urban Drought Tool for New Mexico cities:
 - » Urban landscape water budget calculator for homeowner and water conservation manager use:
 - ◊ <http://nmclimate.nmsu.edu/wb/>
 - » Garner information on stakeholder needs and usability

Arizona Dynamic Drought Index Tool (Garfin, Hartmann)

- Importing CISA's Dynamic Drought Index Tool to Arizona
 - » Gathering stakeholder feedback on features to make tool useful and usable
 - » Garnering lessons on public sector technology transfer.
 - » Project is very near completion. Final tool will be used by a broad range of stakeholders. Our primary test audience: resource managers and Cooperative Extension.

Climate Information Delivery and Decision Support System (CLIDDSS) (Hartmann)

- Limited access prototype currently available. Users include information providers (e.g., Climate Prediction Center, Pacific Region Climate Information Service, DDIT, AgroClimate, TreeFlow, NCDC, River Forecast Centers), information intermediaries (state climatologists, extension specialists and agents, consulting firms), and climate information users.

Dynamic Mosquito Simulation Model (DyMSiM) (Comrie)

- Continued work on the climate driven Dynamic Mosquito Simulation Model (DyMSiM) to assess the effects that climate change and variability may have on two mosquito disease vectors, *Culex quinquefasciatus*, a West Nile virus vector, and *Aedes aegypti*, a vector of dengue fever.
 - » Calculated mosquito populations for Tucson, AZ area and for climate change scenarios across the entire southern US.
 - » Currently evaluating the impact of climate on other critical mosquito species in the region.
- DyMSiM has been calibrated for the *Culex quinquefasciatus* species, a vector for West Nile virus. Results include:
 - » The model is able to simulate mosquito population aggregated to the weekly level in both moist and dry climates.
 - » When modeled mosquitoes are subjected to warmer temperatures there is often a mid-summer dip in the population due to drying of habitats and in extreme cases increased mortality.
 - » Although summer populations are often suppressed, the seasons in which the mosquito population can maintain itself is almost always lengthened.
 - » Using GCM output from the IPCC AR4 to drive DyMSiM, differing trends were found in *Culex quinquefasciatus* population across the southern United States.
- Next steps include making the model public and introducing it to stakeholders and calibrating the model for other mosquito disease vectors.

Forecast Evaluation Tool (FET) (Hartmann)

- FET currently has a wide variety of registered users, including public agencies, private organizations (energy and commodity firms), and individuals.
 - » <http://fet.hwr.arizona.edu/ForecastEvaluationTool>
- CLIMAS is currently working with the NWS Climate Prediction Center to begin the process to integrate the FET into CPC operations.
- CLIMAS core office staff (led by Guido) is now using the FET to generate a series of forecast verification figures for the monthly *Southwest Climate Outlook*.

Southwest Climate Change Network (Overpeck, Ferguson, Guido, Owen, Garfin, Crimmins)

- This website, currently available in a beta form, provides regionally-focused information on climate change science, impacts, and solutions, and in general builds on CLIMAS' 10-year history of stakeholder engagement in the Southwest. The website also supports a regional "knowledge network," offers tailored news and announcements feeds sourced from a variety of organizations, provides a customizable "my page" for registered users, and acts as a platform for gathering information needs from stakeholders and building applications based on the needs identified.
 - » www.southwestclimatechange.org/

Southwest Climate Outlook (SWCO) (Guido, Crimmins, Garfin, Ferguson, Owen)

- Continued refinement of the *Southwest Climate Outlook* monthly climate summary based on both user feedback from CLIMAS's overall evaluation efforts and staff innovations.
 - » Implementing new forecast verification graphics and text, which is being generated from CLIMAS's Forecast Evaluation Tool
 - » Refinement to the length and areas of focus for the monthly feature article.
 - » Exploration of ways to address large data gaps in (mostly tribal) areas throughout the region.
- SWCO is routinely used as a source for climate information in local media.
- SWCO graphics and text are now commonly used in a variety of stakeholder reports and publications.

Southwest TreeFlow Project (Woodhouse, Hartmann, Hirschboeck)

- Updated Arizona tree-ring streamflow reconstructions for decision support
 - » An interactive method has been developed by UA Tree Ring Lab colleague Dave Meko for evaluating the probabilities of past low streamflow in comparison to different periods selected to represent the current drought. Tree-ring based hydroclimatic scenario products designed for use as tools in drought management planning across the West.

US Agricultural Resources Model (Frisvold)

- Updated and expanded the US Agricultural Resources Model (USARM) in collaboration with Kazim Konyar (CSU – San Bernadino). USARM, originally developed by UC-Davis and the USDA, is a multi-region, multi-commodity agricultural sector model that accounts for price changes in national markets that farm-level or watershed-level models ignore. Unlike other agricultural sector models, USARM includes extensive coverage of fruit and vegetable crops.
- The model has been updated to reflect (a) changes in agricultural policies from the 2007 farm bill and (b) recent changes in relative prices of agricultural commodities. The model has been updated to conduct different economic and policy simulations, with the intent to develop simulation studies in collaboration with stakeholders.
- A first application, to demonstrate "proof of concept" is an analysis of agriculture's response to a 25% reduction in water supplies in the Southern Mountain states and Southern California.

Workshops, Media briefings, Presentations

Bonnie Colby

Academic Presentations

- Colby, B., and L. Jones. "Water Transactions and Climate." University of Arizona, Western Regional Science Meetings. Kona, HI. February 2008.
- "Adapting Western Water Policy for Resilience under Climate Change." Natural Resources Law Center Conference. Boulder, CO. June 2008.

Workshop and Stakeholder Presentations

- "Coping with Drought and Climate Change: Evaluating Strategies in US." Australian National Water Summit. Melbourne, Australia. March 2008.
- "Resilient Inter-Jurisdictional Water Management under Climate Change: Innovative Agreements, and Transactions." International Conference on Water Policy and Climate Change. World Bank. Barcelona, Spain. May 2008.
- "Climate Change Adaptation for Resource Managers." Kinship Conservation Fellows Annual Workshop. Bellingham, WA. July 2008.
- "Essential Tribal Economic and Financial Strategies in Water Negotiations and Litigation Given Climate Change." National Conference on Indian Lands and Resources. Tucson, AZ. November 2008.

Andrew Comrie

Academic Presentations:

- Morin, C. and Comrie, A. "A West Nile Virus Vector's Response to Climate Variability using the Dynamic Mosquito Simulation Model (DyMSiM)." Association of American Geographers. Boston, MA. April 15, 2008.
- Morin, C. and Comrie, A. "Modeled Response of the West Nile Virus Vector *Culex quinquefasciatus* to Changing Climate Using the Dynamic Mosquito Simulation Model." Association of American Geographers. Las Vegas, NV. March 26, 2009.
- Comrie, A. and Morin, C. "Dynamic Modeling of Future Mosquito Population Trends Across the Southern United States." Association of American Geographers. Las Vegas, NV. Presented March 26, 2009.

Michael Crimmins

Academic Presentations

- "Developing a state-level drought impact monitoring program: Arizona DroughtWatch." 89th American Meteorological Society Meeting (AMS), Phoenix, AZ. January 11–15, 2009.

Workshop and Stakeholder Presentations

- "Drought Planning and Preparedness: Examples from Arizona." Governor's Conference on Managing Drought & Climate Risk, Denver, CO, October 8-10, 2008.

Daniel Ferguson

Academic Presentations

- "Are we bridging the gap? Evaluating climate assessment and translational science efforts in the US Southwest." American Geophysical Union annual conference. San Francisco, CA. December 15, 2008
 - The session in which this talk was given was co-convened by Connie Woodhouse (WWA, CLIMAS), Dan Ferguson (CLIMAS), Andrea Ray (WWA), and Jennifer Rice (UA graduate student who worked with Woodhouse on WWA project).

Workshop and Stakeholder Presentations

- "Climate Change in the American Southwest: What does the science tell us?" Hopi Agricultural & Food Symposium. Kykotsmovi, AZ. June 10, 2008. (Invited)
- Co-organizer of CCSP Listening Session. Tempe, AZ. January 16, 2009.

- “Climate Change in the American Southwest: What does the science tell us?” Southwest Indian Agricultural Association 21st Annual Conference. Laughlin, AZ. January 20, 2009. (Invited)
- “Climate Change in the Southwest.” Southwest Strategy Tribal Relations Support Team Meeting. Phoenix, AZ. February 23, 2009. (Invited)
- NOAA Climate Prediction Application Science Workshop. Norman, OK. March 24, 2009.
 - Talk and panelist: “Evaluating Climate Assessment and Translational Science Efforts in the U.S. Southwest: Lessons from a CLIMAS Pilot Evaluation Project.”
 - Poster: “Fostering Collaboration and Information Exchange with New Technologies: Drought, Climate Change, Water Impacts, and Indigenous People.”
- “The Broad Contours of Climate Change in Indian Country.” National Weather Service Western Region Climate Change Workshop. Boulder, CO. April 15, 2009. (Invited)
- “Climate Change in the Southwest: Science, Impacts, and Solutions.” Inter Tribal Council of Arizona Tribal Environmental Managers Working Group Meeting. San Carlos, AZ. April 8, 2009. (Invited)

George Frisvold

Academic Presentations

- “Strategic Behavior in Transboundary Water and Environmental Management.” Presentations at:
 - Water: Economics, Policy, Politics and Agricultural Celebration at the International Expo. Zaragoza, Spain. May 12-15, 2008.
 - Economics, Law and Environment (ELE) Workshop. Rogers School of Law, University of Arizona. Tucson, AZ. March 27, 2009.

Workshop and Stakeholder Presentations

- Served on the planning committee and moderated a panel session for the “Adaptation to Climate Change in the Desert Southwest: Impacts and Opportunities,” a conference co-hosted by CLIMAS at the University of Arizona, January 22-23, 2009.
- With collaborators from Arizona State University and from Arizona Agribusiness Council, convened five listening sessions on the future of water and agriculture in Yuma, Coolidge, Buckeye, Scottsdale and Tucson (for the Southwest Indian Agricultural Association). The listening sessions were an opportunity to share information with stakeholders about future demographic, economic and climate projections for the state and to solicit from them information they would like included in ongoing scenario analyses.
- Invited speaker and participant at “Dynamic Deserts: Resource Uncertainty in Arid Environments” – a 3-day international, multi-disciplinary conference and workshop. Dynamic Deserts is designed to encourage review and advancement of our understanding of desert systems through interdisciplinary communication and working groups.
- Invited presentations on recent sharp rise in commodity prices for:
 - Arizona Cotton Growers annual meeting, Gilbert, AZ
 - Great Decisions lecture/discussion series, Tucson, AZ

Media:

- Interviewed for *Arizona Daily Star* article “What’s your water footprint?” June 22, 2008, by Sarah Garrecht Gassen; Article also carried in:
 - *Chinquapin: Newsletter of the Southern Appalachian Botanical Society*. Volume 16, No. 2. Summer 2008
 - EnviroSpeak: An Action Network for Environmental Change blog
- Interviewed for segment of *Arizona Illustrated* that aired on PBS on June 23, 2008 concerning weather and other factors leading to sharp increase in 2008 food and agricultural commodity prices.

Gregg Garfin

Academic Presentations

- American Meteorological Society, 17th Conference on Applied Climatology, August 13, 2008:

- Invited Panel Session Moderator: “Where Does Applied Climatology Need To Go in the 21st Century?”
- “Climate Change Projections for Southwest Vegetation Change” (with J. Eischeid, K. Cole, K. Ironside, M. Crimmins, N. Cobb)
- Invited Panelist: “Research and Adaptation Needs for the U.S. and Canada”
- “Approaches to Local Drought in Arizona.” Drought in a Changing Climate: Sharing Management Approaches. Canberra, ACT, Australia. November 22, 2008.
- American Geophysical Union, December 2008:
 - Talk: “Translational Environmental Research: Improving the Usefulness and Usability of Research Results.”
 - Poster: Garfin, G., J. Eischeid, M. Lenart, K. Cole, K. Ironside, N. Cobb. “Downscaled Climate Change Projections for the Southern Colorado Plateau: Variability and Implications for Vegetation Changes.”
- American Meteorological Society, Phoenix, AZ January 2009:
 - “Information Flows and Policy: Climate, Cyclones, and Adaptive Water-Resources Management at the US-Mexico Border.”
 - “The Socio-Economic benefits of National Hydro-Meteorological Services: Making a Business Case for Support.” Invited talk for the NOAA-NWS International Session on Drought and Climate Services in Arizona.
- “Adaptation To Climate Change: Addressing Challenges In The U.S.-Mexico Border Region.” Advancing the Science of Limnology and Oceanography (ASLO). Nice, France. January 28, 2009.
- Poster: “Institutions and Societal Impacts of Climate in the Arizona-Sonora Portion of the U.S.-Mexico Border Region.” IARU International Scientific Congress on Climate Change. March 13, 2009.

Workshop and Stakeholder Presentations

- Hosted U.S.-Mexico Border Climate Change Workshop in support of the Border Governors Conference April 1-2, 2008 Tucson, Arizona. This workshop was sponsored by the California Department of Water Resources.
 - Publication that resulted from this meeting: J. Jones. 2008. Water and Border Area Climate Change: An Introduction. State of California, Department of Water Resources. Special Report for the XXVI Border Governors Conference.
- AgroClimate New Mexico Agricultural Stakeholders workshops, March 2008 and June 2008.
- “Climate Change in the Desert Southwest.” AWPCA (Arizona Water & Pollution Control Agency). May 1, 2008. (Invited)
- “The State of Drought: Local, State, and Regional.” Tucson Water Citizens Water Advisory Committee. June 4, 2008.
- “Southwest Drought Monitoring.” NOAA Climate Diagnostics and Prediction Workshop. October 22, 2008. (Invited)
- “Growth and Climate Change: Colorado River Basin.” CLE International Water Law Institute on Growth & Water Supply. Phoenix, AZ. October 30-31, 2008.
- “Los Flujos de Información Climática e Hidráulica en la Costa Oeste de América del Norte” (Mexican Water Stakeholders). Hermosillo, Sonora, Mexico. November 7, 2008.
- Co-organizer of CCSP Listening Session. Tempe, AZ. January 16, 2009.
- Eastern Seasonal Assessment Workshop, January 2009. Served as co-organizer, and contributed to developing the agenda, and recruiting participants from Mexico. The workshop produced two reports, available through the National Interagency Coordination Center website.
- Co-Convended CHANGE (Climate and Hydrology Academic Network for Governance and the Environment) workshop: “Climate-Related Water Constraints and their Implications for Relations across North American Boundaries.” Mexico City, Mexico. March 5-6, 2009.
- NOAA Climate Prediction Application Science Workshop. Norman, OK. March 2009.
 - Talk: “A Multi-Scale Hydroclimatic Index for Monitoring Drought in the Semiarid West”
 - Poster: “Reducing Drought Vulnerability Through An Urban Landscape Decision Tool”
 - Poster: “Improving Information Flows to Enhance Drought and Climate Change Resilience in Northern Mexico”

Zack Guido

Workshop and Stakeholder Presentations

- “Climate Change in the Southwest: The Science and the Impacts.” Earth Summit. Sierra Vista, AZ. October 11, 2008.
- “Climate and Climate Change in the Southwest: What does the science tell us?” San Carlos Youth Camp. San Carlos, AZ. July 17, 2008.
- “Migrating with Climate: Understanding the Science and Impacts of Climate Change.” RV Convention. Tucson, AZ. October 23, 2008.
- Southwest Climate Change Network and the *Southwest Climate Outlook* booth at the Southeast Arizona Agricultural Day. Wilcox, AZ. February 4, 2009.

Holly Hartmann

Academic Presentations

- Organized session “Climate and Long-term Planning of Water Resources.” Seventh Users Forum: Weather and Climate Impacts on Water Resources in the Urban Environment, Annual Meeting of the American Meteorological Society. Phoenix, AZ. January 11-15 2009.

Trainings

- Advanced Hydrologic Sciences Course. NWS Cooperative Program for Operational Meteorology, Education, and Training (COMET) Program. Boulder, CO. July 29-August 7, 2008.
 - “Topics in hydrologic forecast verification”
 - “Hydrologic forecast verification”
- Operational Climate Services Residential Training Courses. National Weather Service. Kansas City, MO. August 26-28, 2008.
 - “Understanding CPC seasonal outlooks”
 - “Understanding the quality of CPC products”
- Second River Forecast Center Verification Workshop. National Weather Service/NOAA. Salt Lake City, UT. November 18-20, 2008.
 - “Seasonal forecast verification”
 - “Topics in ensemble verification”
- “Interpretation of CPC 3-Month Outlooks.” Climate Training for NWS Warning Coordination Meteorologists and Surface Coordination Hydrologists. National Weather Service/NOAA. Internet Webinar. December 11, 2008.

Workshop and Stakeholder Presentations

- “Using scenarios to plan for climate uncertainty.” Workshop on Climate and Disease. Center for Discrete Mathematics and Theoretical Computer Science and Center for Dynamic Data Analysis, Rutgers University. Piscataway, NJ. April 7-8, 2008.
- “Climate change impacts on hydrological processes.” Climate Change Training Workshop. The Nature Conservancy. Portland, OR. April 16-18, 2008.
- “Using scenarios to plan for hydroclimatic variability and change.” Environmental Sciences Seminar Series. Iowa State University. Ames, IA. April 21, 2008.
- “The Forecast Evaluation Tool: What role can librarians have in the dissemination of web tools?” Conference on Tradition in Transition: Information Fueling the Future of Agbiosciences. US Agricultural Information Network. Wooster, OH. April 27-30, 2008.
- “Translating the science for policymakers and managers.” Getting Ready - Climate Change Impacts on Water in the Southwest. Carpe Diem Convening. Albuquerque, NM. May 29, 2008.
- “Using scenarios to plan for climate change adaptation.” Climate Change in the Northeast: Preparing for the Future. US Department of the Interior. Amherst, MA. June 3-5, 2008.

- “Decision support tools: What is being done? What role can the Enterprise play?” Summer Community Meeting. American Meteorological Society. Boulder, CO. August 11-13, 2008.
- “Water resources and the climate change adaptation challenge.” Funder Briefing. Consultative Group on Biological Diversity. San Francisco, CA. October 21-23, 2008.
- “Synthesis of year 1: Sensitivity results.” Reconciling Colorado River Flow Projections Stakeholder Meeting. RISA Program. Las Vegas, NV. November 14, 2008.
- “CLIDDSS: A decision support tool for climate services.” Informal Seminar. East-West Center and NOAA Integrated Data and Environmental Applications (IDEA) Center. Honolulu, HI, December 9-11, 2008.
- “Climate change and water in the Southwest.” Adaptation to Climate Change in the Desert Southwest: Impacts and Opportunities. (CLIMAS co-sponsored conference) University of Arizona. Tucson, AZ. January 22-23, 2009.
- Organized session “Fostering Collaboration in Decision Support Tool Development.” Climate Prediction Application Science Workshop. Norman, OK. March 24-27, 2009.
- “Collaborative development of decision support tools for climate applications.” With co-author E. Lay. Climate Prediction Applications Science Workshop. University of Oklahoma. Norman, OK. March 24-27, 2009.
- Lay, E. and H.C. Hartmann. “Using web services to integrate climate applications.” Climate Prediction Applications Science Workshop. University of Oklahoma, Norman, OK. March 24-27, 2009.

Katie Hirschboeck

Academic Presentations

- “Implications of a non-stationary future: The importance of sensitivity to time and place.” Presentation as part of an invited panel entitled “Exploring future research gaps: Water resources, Climate Change, and World Regions.” Association of American Geographers Annual Meeting. Boston, MA. April 15, 2008.
- “Taking the “Voodoo” out of Science¹: Improving Stakeholder-Science Communications.” Cross-RISA session at the Association of American Geographers Annual Meeting. Boston, MA. April 16, 2008 (co-organized with Connie Woodhouse)
¹Voodoo science: the term used by water managers at a paleohydrology workshop to describe the process of reconstructing streamflow from tree rings
- Coles, A. “Managing Flash Floods: Risk Perception from a Cultural Perspective.” Annual Meeting of the Association of American Geographers. Boston, MA. April 17, 2008.

Workshop and Stakeholder Presentations

- Co-presenter (with Mike & Theresa Crimmins) of an 8-week learning module on climate change to a Tucson faith-based group (adaptation of program developed by JustFaith titled: “God’s Creation Cries for Justice. Climate Change: Impact and Response”)

Ellen Lay

Trainings

- “Collaborative Software Development Processes.” University of Florida, Tallahassee, FL. July 31-August 1, 2008. Two-day intensive hands-on training.
- “Collaborative Software Development Processes and Preparing for Transfer of the Forecast Evaluation Tool.” National Weather Service Climate Prediction Center. Silver Spring, MD. November 19-21, 2008. Three-day intensive hands-on training.
- “What are web services?” Informal Seminar. East-West Center and NOAA Integrated Data and Environmental Applications (IDEA) Center. Honolulu, HI. December 9-11, 2008.

Jonathan Overpeck

The following represents highlights from PI Overpeck's presentations and media coverage over the past year rather than a comprehensive list

Academic Presentations

- American Geophysical Union, San Francisco, CA, December 15-19, 2008:
 - “The Regional Integrated Sciences and Assessments (RISA) Program, Climate Services, and Meeting the National Climate Change Adaptation Challenge” (with B. Udall, E. Miles, K. Dow, C. Anderson, D. Cayan, M. Dettinger, H. Hartmann, J. Jones, P. Mote, A. Ray, M. Shafer, D. White).
 - “The Changing Character of Phenology, Drought, and the Seasons in the Southwestern U.S.A.” Poster with J. Weiss and J. Betancourt.
- “Developing a National Climate Service,” AZ Joint Panel Discussion Participant. American Meteorological Society Meeting, Phoenix, AZ, January 11-15, 2009.
- “Climate Change, Life, and the Need To Expect the Unexpected.” American Association for the Advancement of Science, Chicago, IL, February 12-16, 2009.

Workshop and Stakeholder Presentations

- “Adapting to Climate Change in the West.” A New Vision for Edge Development in the West, The Urban Land Institute, September 2008.
- Keynote Speaker. WaterSmart Innovations Conference and Exposition, Las Vegas, NV, October 8-10, 2008.
- “Overview of southwestern climate impacts.” Adaptation to Climate Change in the Desert Southwest: Impacts and Opportunities, University of Arizona, Tucson, AZ, January 2009

Media

- Organized news conference about climate change and adaptation at Fall meeting of American Geophysical Union. San Francisco, CA. December 15, 2008.
- Interview with KVBC News, Las Vegas, Channel 3. Climatologist: Southwest a loser in climate change, October 9, 2008.
- Interview with KUAT, Tucson. Impacts of global warming. January 21, 2009.
- Interviewed for: Pellegrino, E. 2008. “UA professor helps lead climate-change push.” Arizona Daily Star, Tucson AZ. Published December 15.
- Interviewed for: Davis, T. 2009. “Expert: AZ in climate-change bull’s-eye.” Arizona Daily Star. Tucson, AZ. Published February 18.

Gigi Owen

Workshop and Stakeholder Presentations

- “Improving stakeholder access to climate information: Results from the *Southwest Climate Outlook* evaluation.” Climate Prediction Applications Science Workshop. Norman, OK. March 24, 2009.
- “Social Network Analysis and Evaluation of the Significant Fire Potential Outlook.” National Seasonal Assessment Workshop. Boulder, CO. April 14, 2009.

Rolston St. Hilaire

- NOAA Climate Prediction Application Science Workshop. Norman, OK. March 2009
 - Poster: “Reducing Drought Vulnerability Through An Urban Landscape Decision Tool”
- Oral presentation on urban landscape decision tool at the Long Term Ecological Workshop on the Social-Ecological dynamics of Residential Landscapes.

Margaret Wilder

Academic Presentations

- “Transboundary Water: Problems and Challenges.” Mexican Migration Scholarship Meeting. Consortium of North American Higher Education (CONAHEC). University of Arizona, Tucson, AZ. April 9, 2008.

- “New Geographies of Environmental Governance: Communities, Conservation and Climate Change in the Colorado Delta and Border Region.” Spaces and Society Lecture Series. University of Redlands, Redlands, CA. May 15, 2008.
- “How Does the Public Fit In? Climate Change, Adaptation and Social Stakeholders in the Southwest US and Northwest Mexico.” University of Redlands, Redlands, CA. May 16, 2008.
- “Promises Under Construction: The Evolving Water Governance Paradigm and the Case of Northern Mexico.” Rosenberg International Forum for Water Policy. Zaragoza, Spain. June 23-28, 2008. (Invited)
- “Political and Economic Apertures: The Shifting State-Society Relationship and National Water Policy Transition in Mexico.” International Water Transitions workshop. University of Amsterdam, Amsterdam, The Netherlands. July 3-4, 2008. (Invited)
- R. Díaz. “Progress Update: Peri-Urban Ejidos and Urban Growth.” Hermosillo Research Group Meeting. Tucson, AZ. Sept 26, 2008.
- “Water, Cities, and Peri-Urban Vulnerabilities in Northwest Mexico.” Annual Meeting of the Association of American Geographers (AAG). Las Vegas, NV. March 23, 2009.

Workshop and Stakeholder Presentations

- Overview of CLIMAS/IAI/NOAA-SARP Water Supply, Climate Change, and Socioeconomic Vulnerability in Arizona-Sonora Region of the U.S.-Mexico Borderlands. Universidad de Sonora, Hermosillo, Sonora. November 7, 2008.

Media

- *Arizona Daily Star*, October 23, 2008. “UA Water Study to Evaluate ‘Hot Sports’ on Border.” Features interviews with M. Wilder.

Connie Woodhouse

Academic Presentations

- “Colorado River Streamflow Reconstructed from Tree Rings: 1200 Years of Hydrological Variability.” University of Arizona College of Law, Environmental Breakfast Club seminar, Tucson, AZ, May 9, 2008.
- “Tree-Ring Based Reconstructions of Annual Runoff in the Colorado River basin.” CUAHSI Biennial Colloquium, Boulder, CO, July 14-16, 2008.
- “Evidence of Climate Variability and Change from Tree-Ring Records.” Geological Society of America Annual Meeting, Houston, TX, October 5-9, 2008.
- “Paleohydrology from Tree Rings and Applications to Water Resource Management.” Climate Change Institute and Environmental & Water Resources Engineering Seminar, University of Maine, Oct. 20, 2008.
- “Paleohydrology Workshops for Water Resource Managers Using an Iterative Evaluation Process” (with J. Lukas). Fall Meeting, American Geophysical Union, San Francisco, CA, December 15-19, 2008.
- “Evaluating the Effectiveness of Science for Decision-Making: Water Managers and Tree-Ring Data in the Western United States” (with J. Rice and J. Lukas). Fall Meeting, American Geophysical Union, San Francisco, CA, December 15-19, 2008.
- “TER Challenges and Rewards: Paleohydrology and Applications to Water Resource Management.” Making the Connection: A Translational Environmental Research Symposium, Tucson, AZ, February 9, 2009.

Workshop and Stakeholder Presentations

- “Using Tree Rings to Reconstruct Streamflow: An Example for the San Juan River.” MTNCLIM 2008 Conference Town Hall Meeting, Silverton, CO, June 9, 2008.
- “Reconstructions of Past Streamflow from Tree Rings: Placing the Gage Record in a Long-Term Context.” Far West Texas Climate Change Conference, El Paso, TX, June 17, 2008.
- “Past Climate and Hydrologic Conditions from Tree Rings.” Utah Associated Municipal Power Systems (UAMPS) 2008 Member Conference, Lehi, Utah, August 19-20, 2008.
- “Urban Water Management Plans and Reconstructed Hydrology.” Western States Water Council/Western Governors’ Association. Climate Change Adaptation Policy Workshop, Irvine CA, Sept. 24-26, 2008.
- “Placing Recent Droughts in a Long-Term Context with Tree-Ring Reconstructions of Precipitation.” Southern California Workshop on Water Conditions and Drought Preparedness, Ontario CA, Oct. 28, 2008.

- “Colorado River Streamflow from Tree Rings: Lessons from the Past, Applications to the Future?” Adjusting to Less Water: Climate Change and the Colorado River, Glen Canyon Institute, Salt Lake City, UT, Dec. 4, 2008.
- “Paleodrought on the Rio Grande.” Borders Governors Conference Water Work Table, Binational Drought Science Conference, San Diego, CA, March 26-27, 2009.

Links with Other NOAA Programs

- Earth Systems Research Laboratory
- National Climatic Data Center
- NWS Climate Prediction Center
- NWS Climate Services Division/ Office of Weather, Water, and Climate Services
- NWS Colorado Basin River Forecast Center
- NWS Office of Hydrologic Development
- NWS Weather Forecast Offices (Albuquerque, El Paso, Flagstaff, Las Vegas, Phoenix, Tucson)
- NWS Western Region Headquarters
- Pacific Region Integrated Data Enterprise (PRIDE) and Integrated Data and Environmental Applications (IDEA) Center
- CLIMAS currently collaborates with all the RISAs: ACCAP, CISA, CIG, CAP, SECC, WWA, SCIPP, Pacific RISA
- Sectoral Applications Research Program
- Southern Regional Climate Center
- Western Regional Climate Center

Cross RISA Collaborations

Coping with Drought Cross RISA Projects

- Reconciling projections of future Colorado River stream flow (with CAP, WWA, CIG, Dept. Interior Bureau of Reclamation, NOAA National Weather Service, Geophysical Fluid Dynamics Laboratory, and Dept. Agriculture Natural Resources Conservation Service)
- Reducing New Mexico’s agricultural drought vulnerability through stakeholder assessment and climate decision support. AgroClimate Tool implementation in New Mexico, for both agriculturalists and urban residents, 2007-2008 (with SECC).
- Index and Impact Tools to Improve Drought Monitoring and Preparedness (2007-2008) and Enhancing and Evaluating the Dynamic Drought Index Tool, 2008-2010 (with CISA).
- Tree-Ring Reconstructions of Hydroclimatic Variability in the Rio Grande Basin (2007-2008) and TreeFlow: A Drought Planning Resource for Water Management in the Western U.S., 2008-2010 (with WWA).
- Indigenous Climate Knowledge Network. (with ACCAP and Pacific RISA)

Other Cross RISA Collaborations

- Collaborated with all other RISAs on developing cross-RISA vision for climate services.
- Collaboration on National Seasonal Assessment Workshops (with CAP and WWA).
- Collaboration on California Department of Water Resources decision support (with CAP and WWA).
- Regular information sharing with SCIPP on development of their core office and related coordination activities.
- Facilitating communication between SCIPP and the Southwest Region of the US Fish and Wildlife Service. FWS would like SCIPP to assist with workshop planning similar to work CLIMAS did with FWS in 2008.

- Working with WWA to publish a chapter from *Colorado Climate Change: A Synthesis to Support Water Resource Management and Adaptation* on the Southwest Climate Change Network website. The chapter, “A Primer on Climate Models, Emissions Scenarios, and Downscaling,” was written by WWA team members and provides a concise explanation of the topic for CLIMAS (as well as WWA) stakeholders.

Peer Reviewed Publications

- Bark, R., D. Osgood, B. Colby, G. Katz, and J. Stromberg. 2008. Habitat preservation and restoration: Do homebuyers have preference for quality habitat? *Ecological Economics* 68(5): 1465-75.
- Chessin, L., and G. Garfin. 2008. A closer look at listening: Interdisciplinarity and the varieties of languages employed in the conveyance of problem and solution. *Art, Design and Communication in Higher Education* 7(1): 5-18.
- Colby, B. 2009. Water management in urbanizing, arid regions: Innovative voluntary transactions as a response to competing water claims. In *Policy and Strategic Behaviour in Water Resource Management*, ed. A. Dinar and J. Albiac, 47-66. London: Earthscan Publications Ltd.
- Ellis, A., G. Goodrich, and G. Garfin. 2009. A hydroclimatic index for examining patterns of drought in the Colorado River Basin. *International Journal of Climatology*. Published online: Feb 25 2009. DOI: 10.1002/joc.1882.
- Frisvold, G. 2009. Strategic Behavior in Transboundary Water and Environmental Management. In *Policy and Strategic Behaviour in Water Resource Management*, ed. A. Dinar and J. Albiac. London: Earthscan Publications Ltd.
- Frisvold, G., and K. Emerick. 2008. Rural-urban water transfers with applications to the U.S. Mexico border region. In *Game Theory and Policy Making in Natural Resources and the Environment*, ed. A. Dinar, J. Albiac, and J. Sanchez-Soriano, 155-80. New York: Routledge Press.
- Garfin, G., C. Enquist. 2008. Mitigating Climate Change in the American Southwest. *Eos Trans. AGU*, 89(1): 3. doi:10.1029/2008EO010004.
- Garfin, G., K. Jacobs, and J. Buizer, 2008. Beyond brainstorming: Exploring climate change adaptation strategies. *Eos Trans. AGU*, 89(25): 227. doi:10.1029/2008EO250007.
- Hartmann, H. 2008. Decision support for water resources management. In *Uses and Limitations of Observations, Data, Forecasts, and Other Projections in Decision Support for Selected Sectors and Regions. A Report by the US Climate Change Science Program and the Subcommittee on Global Change Research*, ed. M. Macauley, 45-55. Washington, DC: NASA Applied Science Program.
- Hirschboeck, K. 2009. Flood flows of the San Pedro River. In *Ecology and Conservation of the San Pedro River*, ed. J. Stromberg and B. Tellman. Tucson: University of Arizona Press.
- Liu, Y., M. Mahmoud, H. Hartmann, S. Stewart, T. Wagener, D. Semmens, R. Stewart, H. Gupta, D. Dominguez, D. Hulse, R. Letcher, B. Rashleigh, C. Smith, R. Street, J. Ticehurst, M. Twery, H. van Delden, and D. White. 2008. Formal scenario development for environmental impact assessment studies. In *Developments in Integrated Environmental Assessment*, Volume 3, ed. A. Jakeman, A. Voinov, A. Rizzolli, and S. Chen, 145-62. Amsterdam: Elsevier.
- McAfee, S., and J. Russell. 2008. Northern Annular Mode impact on spring climate in the western United States. *Geophysical Research Letters* 35(17). doi:10.1029/2008GL034828.
- Miller, J., H. Safford, M. Crimmins, and A. Thode. 2008. Quantitative evidence for increasing forest fire severity in the Sierra Nevada and Southern Cascade Mountains, California and Nevada, USA. *Ecosystems* 12(1): 16-32. doi: 10.1007/s10021-008-9201-9.
- National Research Council. 2008. *Ecological Impacts of Climate Change*. Washington, D.C.: National Academy Press. [J. Overpeck co-author].
- Neff, J., A. Ballantyne, G. Farmer, N. Mahowald, J. Conroy, C. Landry, J. Overpeck, T. Painter, C. Lawrence, and R. Reynolds. 2008. Increasing eolian dust deposition in the western United States linked to human activity. *Nature Geosciences* 1(3): 189-95.
- Pullen, J., and B. Colby. 2008. Influence of climate variability on the market price of water in the Gila-San Francisco Basin. *Journal of Agricultural and Resource Economics* 33(3): 473-87.

- West, C., and M. Vásquez-León. 2008. Misreading the Arizona landscape: Reframing analyses of environmental degradation in Southeastern Arizona. *Human Organization* 67(4): 373-83.
- Wilder, M. 2008. Equity and water in Mexico's changing institutional landscape. In *Water and Equity: Apportioning Water among Places and Values*, ed. R. Perry, H. Ingram, and J. Whiteley. Cambridge: Massachusetts Institute of Technology Press.
- Wise, E. 2009. Climate-based sensitivity of air quality to climate change scenarios for the southwestern United States. *International Journal of Climatology* 29: 87-97.

Non Peer-reviewed Publications

- Artiola, J., M. Crimmins, and M. Yoklic. 2008. Doing our part to help conserve Arizona's water resources and reduce global warming by saving energy at home. Arizona Cooperative Extension, AZ1485. <http://ag.arizona.edu/climate/pubs/pubs.htm>
- Colby, B., and R. Bark. 2008. Task 4 Final Report: Economic overview and summary analysis. *Economic Considerations in Using Colorado River System Conservation to Replace Bypass Flow, Lower Colorado Region*. Report to US Bureau of Reclamation under Cooperative Agreement.
- Colby, B., and R. Bark. 2008. Task 5 Final Report: Summary report and supporting documentation. *Economic Considerations in Using Colorado River System Conservation to Replace Bypass Flow, Lower Colorado Region*. Report to US Bureau of Reclamation under Cooperative Agreement.
- Coles, A. 2008. Managing flash floods: Risk perception from a cultural perspective. Master's thesis, University of Arizona.
- Feldman, D., K. Jacobs, G. Garfin, A. Georgakakos, B. Morehouse, P. Restrepo, R. Webb, B. Yarnal, D. Basketfield, H. Hartmann, J. Kochendorfer, C. Rosenzweig, M. Sale, B. Udall, and C. Woodhouse. 2008. Making decision-support information useful, useable, and responsive to decision-maker needs. In *Decision Support Experiments and Evaluations using Seasonal-to-Interannual Forecasts and Observational Data: A Focus on Water Resources, Report by the US Climate Change Science Program and the Subcommittee on Global Change Research*, ed. N. Beller-Simms, H. Ingram, D. Feldman, N. Mantua, K. Jacobs, and A. Waple, 101-40. Asheville, NC: National Climatic Data Center.
- Garfin, G. 2008. Climate change and Arizona water. *The AWPCA (Arizona Water and Pollution Control Association) Newsletter* 25(2): 1, 36-7.
- Garfin, G., D. Ellis, N. Selover, D. Anderson, A. Teclé, P. Heinrich, and M. Crimmins. 2008. *Assessment of the Navajo Nation hydroclimate network*. Final report to Navajo Nation Department of Water Resources and the Arizona Water Institute. <http://www.azwaterinstitute.org/media/AWI721garfin.pdf>.
- Garfin, G., K. Jacobs, and J. Buizer, 2008. Climate Change Adaptation Lessons from the Land of Dry Heat. Proceedings of the Third Interagency Conference on Research in the Watersheds, September 8-11, in Estes Park, CO.
- Hammond, D., and E. Lay. 2008. Tutorial: How to connect products to CLIDDSS. Arid Lands Information Center, Office of Arid Lands Studies, University of Arizona.
- Hirschboeck, K., and D. Meko. 2008. *The current drought in context: A tree-ring based evaluation of water supply variability for the Salt-Verde River Basin*. Final Project Report. <http://fp.arizona.edu/kkh/srp2.htm>.
- Jones, J. 2008. *Water and border area climate change: An introduction*. Special Report for the XXVI Border Governors Conference. State of California, Department of Water Resources. <http://www.water.ca.gov/news/newsreleases/2008/081508bgcreport.pdf>.
- Morin, C. 2008. A climate driven dynamic mosquito population model with applications to climate change scenarios. Master's Thesis, University of Arizona.
- Patton, W., G. Frisvold, S. Reynolds, and A. Barnhart. 2009. Arizona solar energy and economics outlook. Final Report Prepared for Arizona Solar Energy and Economics Summit, January 9, in Phoenix, AZ.
- Tanimoto, P. 2008. Forecasting the impact of climate change for electric power management in the Southwest. Master's Thesis, University Of Arizona.
- Wilder, M., and R. Diaz. 2008. *Assessing Public Values Towards Wetlands Conservation in a Binational Context: The Lower Colorado River and Delta*. Draft Final Report.