2012-13

Climate Assessment for the Southwest

ANNUAL REPORT

CLIMAS

Climate Assessment for the Southwest

MARIA GRIFFIN

Contents

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In mid-February a sinuous jet stream ferried cold Arctic air into the Tucson metropolitan region and many other areas in the Southwest. Temperatures plunged to below freezing for several days, and on February 21—the day this photo was taken—snow blanketed the Santa Catalina Mountains and dusted saguaro cacti on the valley floor.

COVER PHOTO CREDIT: ZACK GUIDO

ARIZONA

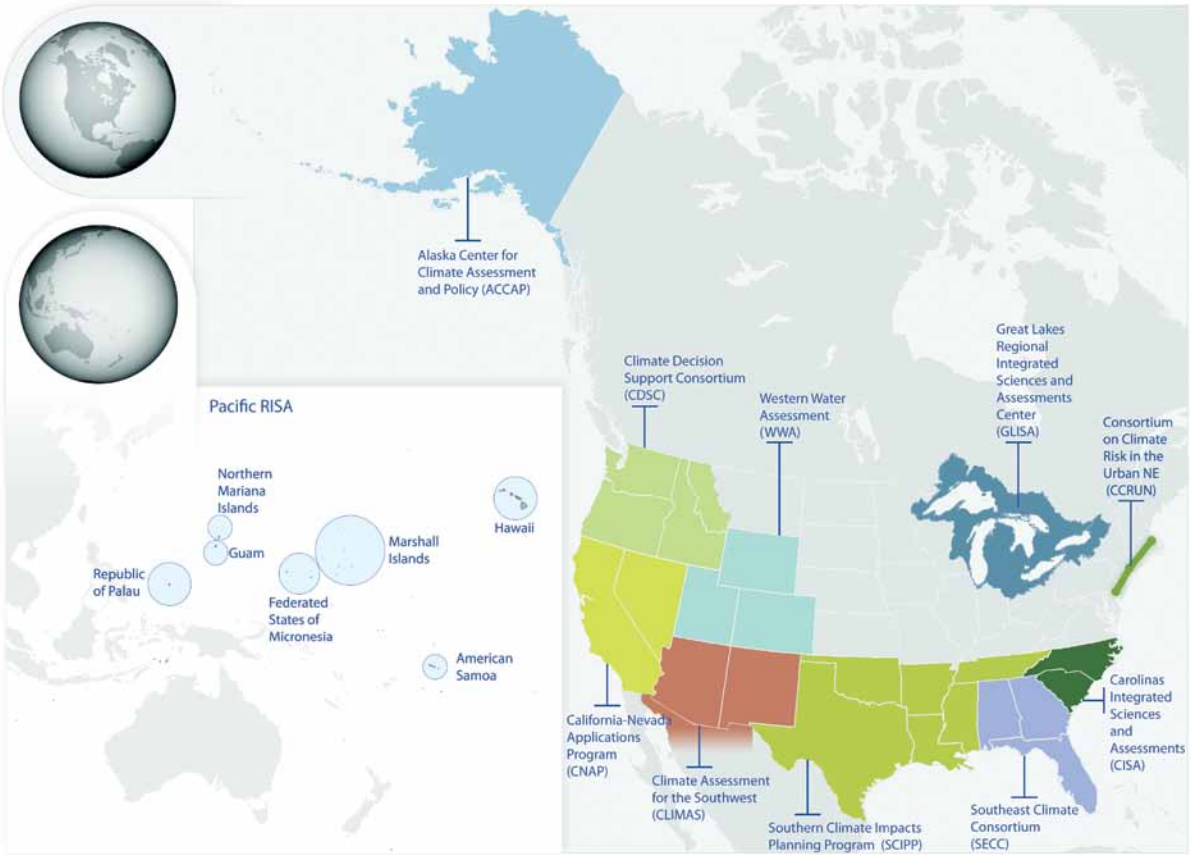
NM STATE UNIVERSITY

Institute of the Environment

RISA

A REGIONAL APPROACH TO CLIMATE SERVICES: REGIONALLY INTEGRATED SCIENCES AND ASSESSMENTS (RISA)

In the mid-1990s, the National Oceanic and Atmospheric Administration (NOAA) created the Regional Integrated Sciences and Assessments (RISA) program to support research that addresses complex climate-sensitive issues of concern to decision makers and planners at a regional level. The number of these regional teams, primarily based at universities, has grown over the last 15 years as the need for climate information in support of decision making has also increased. As of May 2013, 11 RISA teams are funded, covering much of the United States and U.S. territories in the Pacific.



Climate Assessment for the Southwest (CLIMAS)

CLIMAS, established in 1998, is the RISA program in the Southwest. The primary focus of the program is Arizona and New Mexico, although members of the CLIMAS team conduct research around the world. Headquartered at the University of Arizona's Institute of the Environment, CLIMAS also includes a core group of investigators at New Mexico State University as well as affiliated researchers throughout the West. The CLIMAS mission is to improve the region's ability to respond sufficiently and appropriately to climatic events and changes. The program promotes participatory, iterative research involving scientists, decision makers, resource managers, educators, and others who need more and better information about climate and its impacts. CLIMAS investigators conduct research of the nature, causes, and consequences of climate change and variability in the southwestern United States, providing valuable information to decision makers in a variety of fields, including water and fire management, agriculture, ranching, and public health. The program also supports efforts to improve climate forecasting in the region. Since its establishment over a decade ago, CLIMAS has built a large, diverse network of stakeholders and partners who have worked together on a tremendous range of projects. This report highlights some of the work in which CLIMAS was engaged from May 2012 through April 2013.

CLIMAS Team

INVESTIGATORS

Jonathan Overpeck (Lead PI), Bonnie Colby, Andrew Comrie, Michael Crimmins, David DuBois, Daniel Ferguson, George Frisvold, Gregg Garfin, Holly Hartmann, Katherine Hirschboeck, Margaret Wilder, and Connie Woodhouse

STAFF RESEARCHERS

Jaimie Galayda, Zack Guido, Gigi Owen, Ali Kimbrough, and Jessica Swetish

POST DOCTORAL RESEARCHERS

Heidi Brown, Julie Brugger, Angie Jardine, Cory Morin, Kiyomi Morino, Adrian Quijada-Mascareñas, and Jeremy Weiss

GRADUATE STUDENTS

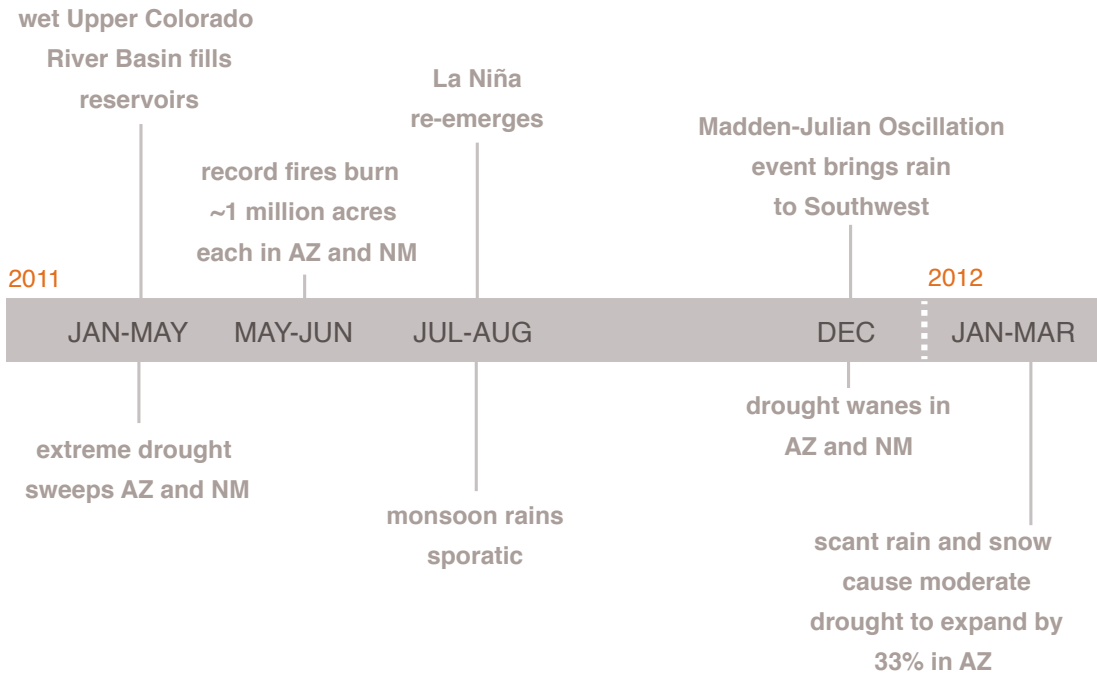
Toby Ault, Mindy Butterworth, Gouro Camara, Jessica Conroy, Holly Faulstich, Brett Fleck, Todd Gaston, Christina Greene, Daniel Griffin, Gan Jin, Sarah Kelly, Saeahm Kim, Ron Klawitter, Tatiana Marquez, Zeyn Mirza, Georgia Pfeiffer, Hunter Richards, Cody Routson, Xuan Vu, and Diana Zamora-Reyes

RESEARCH AFFILIATES

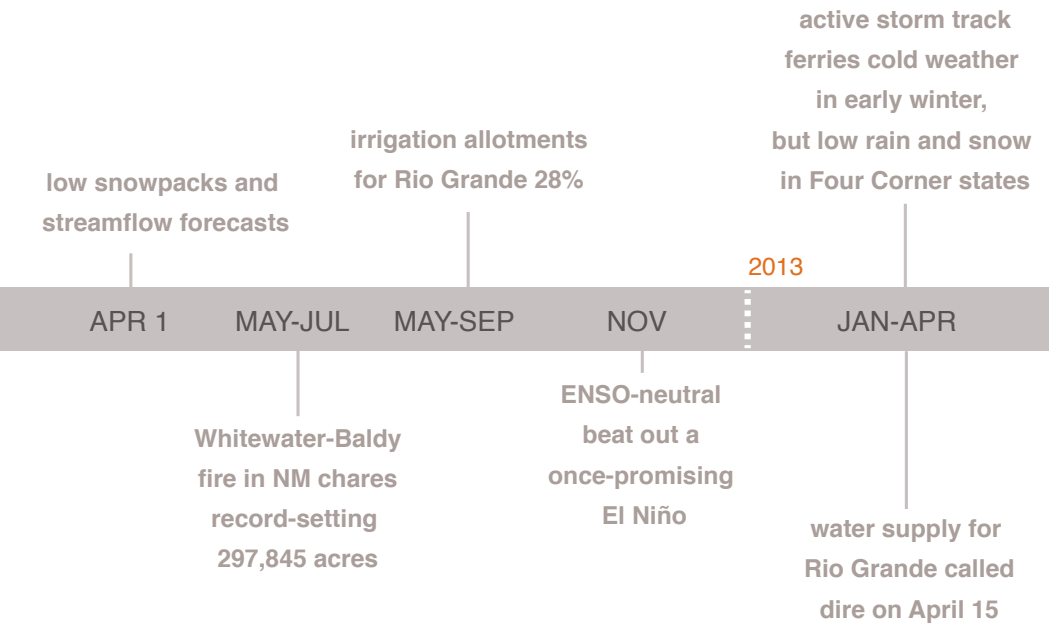
Casey Kahn-Thornbrugh, Diana Liverman, and Alison Meadow

Scant precipitation, record-setting fires, and widespread drought have been commonly used to describe the climate and its related impacts for the Southwest in the past two years. A La Niña event in 2010–11, for example, delivered little winter rain and snow to the Southwest, and record-setting wildfires charred the parched landscape. Staying true to historical statistics, the return of La Niña in 2011–12 again brought dry conditions, laying the foundation for another round of epic fires. The 2012 Whitewater-Baldy fire became New Mexico's largest on record. A wavy jet stream this past winter occasionally ferried winter storms over the region, but drought has remained, particularly in New Mexico, where water stored in major reservoirs is nearly nil.

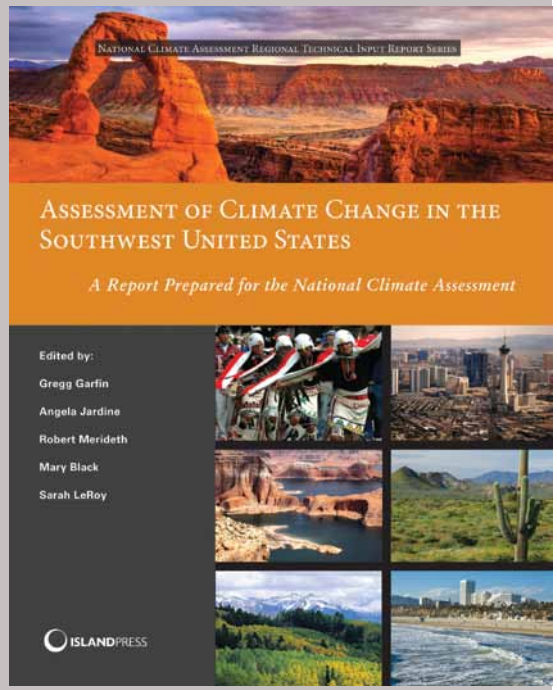
2011-13 Climate Impacts and



Events in the Southwest



Extreme events and dry conditions are a mainstay in the Southwest; research by CLIMAS principal investigators and graduate students recently documented protracted past droughts in the Four Corners region that dwarf those recently experienced. There are also focused efforts to understand the character of extreme events in a warming world, and some of the new efforts by CLIMAS are tailored to address related questions. CLIMAS also continues to help resource managers—from those handling dust in New Mexico's desiccated landscape, to water managers on the parched Rio Grande, to municipal planners in Arizona dealing with enhanced heat stress—better understand and prepare for climate-related challenges and opportunities.



CLIMAS Contributions to the U.S. National Climate Assessment

Assessment of Climate Change in the Southwest United States:
A Report Prepared for the National Climate Assessment

CLIMAS Investigators: Gregg Garfin, Andrew Comrie, Michael Crimmins, Daniel Ferguson, George Frisvold, Holly Hartmann, Jonathan Overpeck, Margaret Wilder, Jaimie Galayda, Angie Jardine, Christina Greene, and Diana Liverman

This 20-chapter assessment provides a snapshot of the current state of climate change information and knowledge related to the region. Stakeholders have been actively engaged in defining the scope of this report and in reviewing the document. The report is intended to be relevant to public policy and resource management. Our findings, judgments, and recommendations are not meant to be prescriptive, but are presented as potential options. The more than 100 authors of this assessment have aimed to summarize complexity by synthesizing knowledge and sorting what is known and widely accepted from what is not known.

REGIONAL SCOPE

The assessment examines what climate and climate change mean for the health and wellbeing of human populations and the environment throughout the southwestern United States, an area of about 700,000 square miles. The region includes Arizona, California, Colorado, Nevada, New Mexico, and Utah, vast stretches of coastline, an international border, and the jurisdictions of 182 federally recognized Native American tribes.

THE ASSESSMENT INVESTIGATES

climate and its effects, on scales ranging from states to watersheds and across ecosystems and regions;

links between climate and resource supply and demand;

effects on sectors such as water, agriculture, energy, and transportation that are critical to the wellbeing of the region's inhabitants;

the region's vulnerabilities to climate changes; and

the responses and preparedness plans that society may choose to make.

RESEARCH FINDINGS

Snowpack and streamflow amounts are projected to decline, decreasing water supply for cities, agriculture, and ecosystems.

Enhanced precipitation specifically associated with atmospheric rivers—a wintertime phenomenon typically yielding extreme precipitation—is projected by most current climate models.

The Southwest produces more than half of the nation's high-value specialty crops, which are irrigation-dependent and particularly vulnerable to extremes of moisture, cold, and heat. Reduced yields from increased temperatures and increasing competition for scarce water supplies will displace jobs in some rural communities.

Many climate change response options simultaneously provide adaptation and mitigation, (co-benefits), reducing the causes of climate change while also increasing the preparedness and resilience of different sectors to climate change. Other response options involve trade-offs between increasing emissions or reducing resilience. More research and monitoring are needed to track and evaluate decision outcomes and to understand the balance and effectiveness of these choices, especially under financial constraints.

Download PDF

View the entire 509-page report:
http://swccar.org/sites/all/themes/files/SW-NCA-color-FINALweb.pdf

Garfin, G., A. Jardine, R. Merideth, M. Black, and S. LeRoy eds. 2013. *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment.* A report by the Southwest Climate Alliance. Washington, DC: Island Press.

Highlights: Research Activities, Collaborations, & Findings

Sectoral Impacts of Drought and Climate Change

CLIMAS Investigators: G. Frisvold and G. Jin

The costs of acreage abandonment (not harvesting planted crop acres) can be substantial. For U.S. cotton alone, costs of abandonment approached $900 million in 2011 when drought conditions affected the crop. Weather variables are important predictors of crop abandonment, with irrigation significantly reducing abandonment risk.

DAVID GOODMAN

Managing Demand, Rethinking Supply:

ADAPTATION, CONSERVATION, AND PLANNING IN THE DROUGHT-PRONE SOUTHWESTERN U.S. AND NORTHWEST MEXICO

CLIMAS Investigators: M. Wilder, G. Garfin, G. Frisvold, J. Brugger, A. Quijada-Mascareñas, S. Kelly, and G. Owen

Ensuring water security for arid regions requires adaptive water management. Governance networks play a key role in identifying adaptive water management strategies. Binational cooperation around the goal of sustaining ecological flows for wetlands in the Colorado River Delta resulted in the recent adoption of a new treaty minute that officially promotes a commitment of water towards this goal.

Climate Change Analysis for the City of Tucson

CLIMAS Investigators: G. Garfin, G. Frisvold, A. Comrie, B. Colby, and J. Weiss

This project synthesized state-of-the-art research related to: (a) Tucson energy-water nexus issues; (b) Tucson's urban heat island; (c) risk related to selected diseases; (d) local food security; and (e) projected impacts and risks related to urban ecosystems and ecosystems surrounding the city of Tucson. Investigators developed definitive climate change projections for Tucson, based primarily on user-specified thresholds that relate to management decision points. Results indicate that maximum temperatures above the user-defined threshold of 100 degrees F will increase by an average of approximately 42 days per year. This is likely to affect public health (heat stress), water, and electricity demand.

Climate and Health

CLIMAS Investigators: A. Comrie, M. Butterworth, C. Morin, and H. Brown

The Dynamic Mosquito Simulation Model (DyMSiM) simulates mosquito vector populations through the input of climate and land cover data. This model can help public health workers identify locations or times of greatest disease transmission risk. Researchers shared a modeled map of West Nile virus mosquito habitat with the Pima County Health Department and with Tucson residents to assess how these products mesh with local perceptions of mosquito ecology across Tucson.

Tribal Drought Information for Monitoring, Assessment, and Planning

CLIMAS Investigators: M. Crimmins, D. Ferguson, C. Woodhouse, A. Meadow, H. Faulstich, and A. Kimbrough

The Hopi Tribe and Navajo Nation have been experiencing widespread and persistent drought conditions for more than a decade. Drought threatens agricultural systems and ecosystems that are critical to supporting the Hopi and Navajo people. CLIMAS researchers carried out a technical review of the Navajo Nation's Drought Contingency Plan for the Navajo Nation Water Management Branch; developed a draft drought impact survey to support long-term drought monitoring and planning, in collaboration with the Hopi Tribe Department of Natural Resources; and conducted an analysis of seasonal patterns of past droughts using a new seasonal tree-ring reconstruction of precipitation in the Four Corners.

Assessing Regional Climate Service Needs through Cooperative Extension

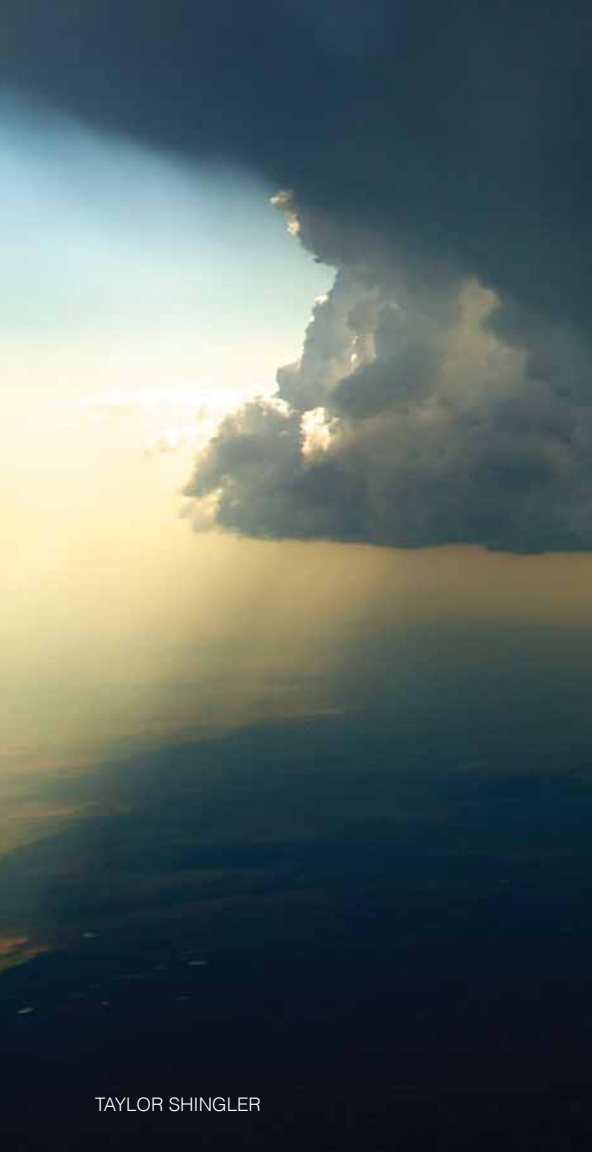
CLIMAS Investigators: M. Crimmins, J. Brugger, and D. DuBois

Rural Arizonans are experiencing a variety of climate changes, including changes in rainfall patterns in time and space; more intense rainfall and localized flooding events; increased temperature extremes; an increase in the frequency of extreme wind events; and an increase in the intensity, duration, and frequency of drought conditions. Their attitudes toward climate change attribution vary. A minority of those who participated in the study accepts it fully because of the climate changes they have experienced. Many, having experienced the extreme variability of climate in Arizona, or being aware of the political sensitivity of the issue of climate change, are hesitant to attribute the changes they are experiencing to human causes.

Dendrochronology in the Tribal Lands of Northeast Arizona

CLIMAS Investigators: C. Woodhouse, D. Ferguson, G. Garfin, M. Crimmins, A. Meadow, and H. Faulstich

The instrumental record does not adequately represent the full range of natural climatic variability possible on the tribal lands. Pre-instrumental drought events have far exceeded anything witnessed by the Four Corners region in the modern era. Many of the historically significant droughts of the past (e.g., the 17th century Puebloan Drought) were not merely winter phenomena, but persisted through the summer season as well. This type of drought (winter deficits followed by a failed monsoon) can have devastating consequences on the tribal lands.



TAYLOR SHINGLER

CLIMAS Projects Started: 2012-13

1 Climate Projections for the Southwest: A Collaboration with NOAA-ESRL

CLIMAS Investigators: J. Overpeck (Lead PI), Z. Guido, G. Owen, D. Ferguson, J. Weiss, and H. Hartmann

Research Collaborators: R. Webb (NOAA-Earth Systems Research Laboratory)

ABSTRACT

CLIMAS is working to identify weather and climate scenarios that would have the most significant impact on the U.S. Southwest. As part of this project, a survey of approximately 250 stakeholders in the Southwest was conducted during the summer of 2012. The information gathered from this survey will help identify the climate extremes that most concern people in the region. This information in turn will inform both CLIMAS investigators over the next several years and our partners in the NOAA-Earth Systems Research Laboratory, Climate Analysis Branch as they work to evaluate the ability of the latest generation of climate models—those from the IPCC AR5/CMIP5 models and regional models derived from these—to simulate and project scenarios of interest to stakeholders across the Southwest.

Other Funding Sources: NOAA-Earth Systems Research Laboratory

2 Climate and Weather Services for Disaster Management: A FEMA, NWS, and CLIMAS Collaboration

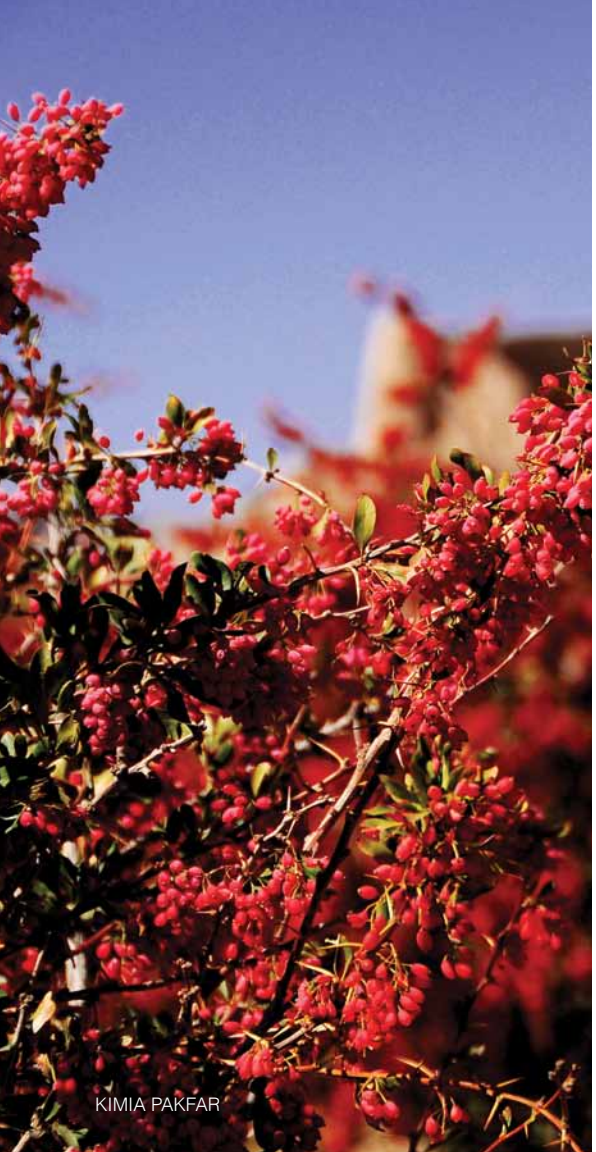
CLIMAS Investigators: M. Crimmins (Lead PI), Z. Guido, and J. McLeod

Research Collaborators: A. Meadow (DOI-Southwest Climate Science Center); Federal Emergency Management Agency; NOAA-National Weather Service Western Region

ABSTRACT

The Federal Emergency Management Agency (FEMA) plays a critical role in helping land, water, and coastal managers prepare for and respond to diverse weather- and climate-driven extreme events. Challenges to accessing, interpreting, and disseminating diverse climate and weather (C&W) information limit FEMA's use of this information, which can impede pre-positioning resources in high-risk areas, delay advanced warnings, and spur misunderstandings. Strategic partnerships that link information to producers and consumers and provide opportunities for co-developing useful C&W information can help agencies like FEMA better fulfill their mandate to safeguard life and property. This climate services case study examines the process of developing strategic partnerships, communication strategies, and relevant C&W information to support FEMA's hazards monitoring efforts in Arizona, Nevada, and California. This study examines the end-to-end process of decision support and will be conducted within a framework advocated by the National Research Council. This includes: (1) assessing FEMA's C&W information needs and gaps; (2) co-producing a decision support tool; and (3) measuring impacts, successes, and limitations of the decision support tool, engagement process, and partnership. The objectives are to better understand how to provide climate services and develop strategies that seamlessly transition from research to operations, while assessing the role of 'boundary organizations' (e.g. RISAs) in developing and mediating partnerships that advance climate services and long-term adaptation efforts.

Other Funding Sources: NOAA-RISA (inter-RISA 2012 funding competition); NOAA/National Weather Service-Western Region; DHS/Federal Emergency Management Agency


KIMIA PAKFAR

3 CLIMAS Project and Program Evaluation

CLIMAS Investigators: D. Ferguson (Lead-PI), G. Owen (Co-PI), B. Colby, A. Comrie, M. Crimmins, D. DuBois, G. Frisvold, G. Garfin, J. Galayda, Z. Guido, H. Hartmann, J. Overpeck, M. Wilder, and C. Woodhouse

Partners: Other Regional Integrated Sciences and Assessment programs and program management

ABSTRACT

CLIMAS, like all the members of the Regional Integrated Sciences and Assessments (RISA) program, has a primary goal of providing relevant climate-related research to support decision making in our region. A fundamental, though frequently overlooked, element of this type of socially engaged research is evaluation of the program and its constituent projects to understand whether we effectively connect climate science with decision makers; learn about the integrative activities that work and why they work; demonstrate successes to funding agencies, stakeholders, and the public; and improve the overall program. Dan Ferguson and Gigi Owen are leading this project and program evaluation effort, but all CLIMAS researchers are involved to first develop and articulate an overarching program theory of CLIMAS, then develop and monitor metrics that allow us to understand how the program and its projects are functioning.

4 Climate in Context (RISA Book)

CLIMAS Investigators: G. Garfin (Lead PI), D. Ferguson, M. Crimmins, and G. Owen

Research Partners: A. Parris (NOAA-Climate Program Office); K. Dow (Univ. of South Carolina); R. Nelson (Univ. of Tasmania); R. Meyer (California Ocean Science Trust)

ABSTRACT

Climate in Context is an edited volume describing the development and implementation of the NOAA-RISA program, an innovative program to research and develop experimental region-based climate services. The book covers scholarly contributions on use-inspired research in five key areas: understanding the context of working with stakeholders and decision makers, understanding risk-based climate applications, supporting the development of knowledge networks, innovating regional climate services, and advancing science policy. The

book editors are Adam Parris, Gregg Garfin, and an editorial working group of applied climate and science policy experts. The book will be published by Wiley & Sons; the expected date of publication is fall 2014.

Other Funding Sources: NOAA-Climate Program Office

5 Building Climate Science into Land and Water Conservation Planning and Decision Making in the American Southwest

CLIMAS Investigators: G. Garfin

Research Collaborators: W. Travis (Western Water Assessment) and J. Barsugli (Western Water Assessment)

ABSTRACT

This project will connect the climate expertise of two RISA programs—the Western Water Assessment (WWA) and CLIMAS—with regional conservation planners and decision makers through collaboration with The Nature Conservancy's (TNC) Southwest Climate Change Initiative (SWCCI) to improve climate adaptation planning and implementation by land managers in the American Southwest. Key challenges include bringing climate knowledge to bear on the many habitat and species conservation efforts underway in the region and moving conservation projects beyond vulnerability assessments to adaptation planning and implementation. This project is intended to advance four goals: 1) expand translational science capacity in the region to support adaptation; 2) improve regional climate-sensitive conservation decision making; 3) disseminate climate knowledge through conservation networks in the region; and 4) develop both a comprehensive evaluation of the project and a training curriculum for future personnel intending to engage in this type of work. The project aims to prototype and develop a model for expanding the translational climate science capacity needed to move ecosystem management beyond vulnerability assessments and into on-the-ground decision making for adaptation to climate variability and change.

Other Funding Sources: NOAA-Climate Program Office


GARRY FORGER

6 Making the Connection between Science and Decision Making: A Graduate Seminar

CLIMAS Investigators: C. Woodhouse and D. Ferguson

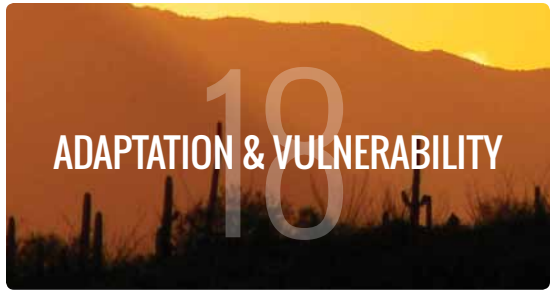
ABSTRACT

Scientific knowledge can be critical for dealing with complex, socially relevant environmental issues. Much science is ultimately not used to inform decision making surrounding these issues, however, because there is often a mismatch between the types and format of information available and what is useful for these potential consumers. Related to this confounding incongruity is a frequent fundamental lack of two-way communication between scientists and decision makers. This seminar, aimed at graduate students from any relevant discipline, explores concepts at the intersection between environmental science and decision making, including scientific information supply and demand, boundary organizations, co-production of knowledge, and knowledge networks, as well as recognition of the political context for decision making. It also includes practical aspects of two-way communication to explore the ways in which exchanges take place between scientists and decision makers, who can include resource management professionals, planners, policy makers, NGOs, and the general public.

Other Funding Sources: Univ. of Arizona-School of Geography and Development

Areas of Focus

CLIMAS projects are organized into seven major areas of focus. The CLIMAS team works across a wide variety of integrated research themes, with any given project touching on at least two (and often many more) of these themes. For the purpose of this report, projects are highlighted within seven of these areas of focus:



SOLMAZ OSMAN

Adaptation & Vulnerability

Adaptation Strategies for Water and Energy Sectors in the Southwest

CLIMAS Investigators: B. Colby (Lead PI), G. Frisvold, H. Hartmann, C. Woodhouse, B. Fleck, and R. Klawitter

Research Collaborators: E. Schuster, A. Kerna (Univ. of Arizona-Agricultural and Resource Economics); Sonoran Institute; Western Water Assessment; U.S. Bureau of Reclamation; U.S. Department of Agriculture

Partners: Arizona Department of Water Resources; Central Arizona Project; Salt River Project; The Nature Conservancy, Western Regional Office; Western Resource Advocates; Environmental Defense; ProNatura; Western Governors Association; Western States Water Council

ABSTRACT

This project examines potential climate change and variability adaptation strategies in water and environmental energy sectors in the Southwest. Researchers are investigating how climate influences the market price of water and are developing a menu of supply reliability tools and guidelines for using these tools to enhance water supply reliability, particularly for environmental needs. This research investigates new methods for predicting and adapting to climate impacts in the water and electricity urban supply sectors and for providing water for critical habitat needs.

DELIVERABLES: PUBLICATIONS

(1) Colby, B. and R. Bark. 2012. Chapter 41: Inter-sectoral water trading as a climate change adaptation strategy. In *Water Resources Planning and Management.* Q. Grafton and K. Hussey (eds). Cambridge, UK: Cambridge University Press. This book chapter examines incentive-based innovations worldwide to adapt to climate change effects on regional water supplies.

(2) Schuster, E. 2012. Farm Resilience to Water Supply Variability: An Econometric Analysis of Risk

Management Strategies in the Mexicali Valley, Mexico. Thesis, Department of Agricultural and Resource Economics, University of Arizona. Examines farmer responses to decreasing water supply reliability in the Mexicali Valley, Sonora, Mexico, and considers what can be learned for climate change adaptation.

(3) Kerna, A. 2012. Environmental Flows: A CVM Study and Water Market Activity Analysis. Thesis, Department of Agricultural and Resource Economics, University of Arizona. Measures and analyzes environmental water values and water transactions as tools in climate change adaptation.

(4) Preparation of two guidebooks: *Prioritizing Water Acquisitions to Achieve Environmental Objectives* (Jones, L. & B. Colby 2013) and *Measurement, Monitoring and Enforcement of Irrigation Forbearance Agreements* (Jones, L. & B. Colby 2012).

Other Funding Sources: NOAA-Sectoral Applications Research Program; Univ. of Arizona-Office of Arid Lands Studies; U.S. Bureau of Reclamation; Walton Family Foundation; Sonoran Institute

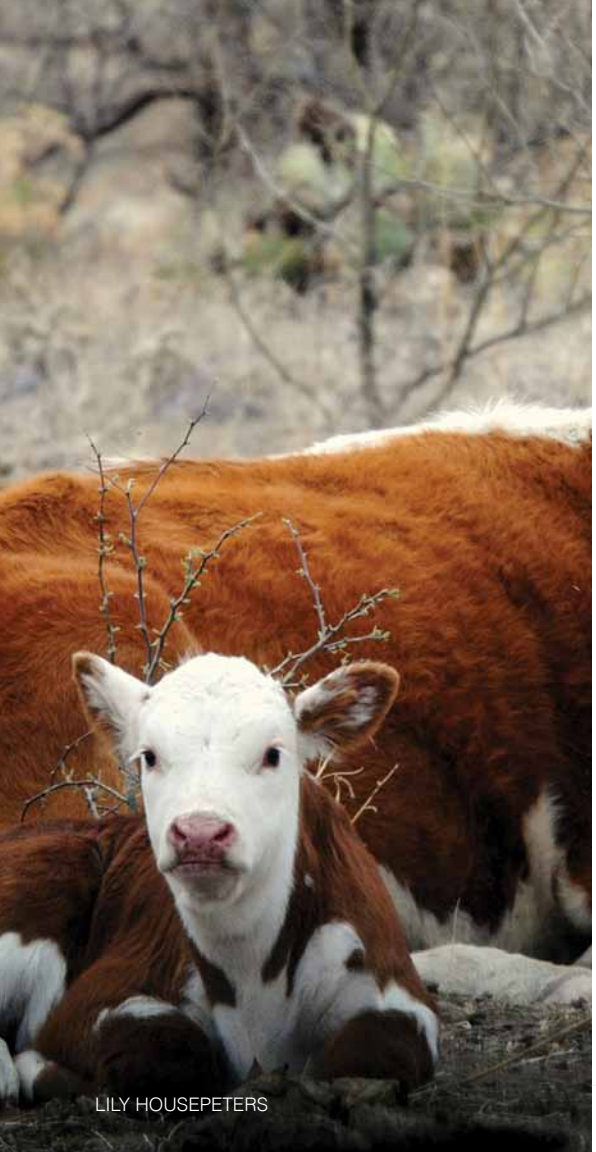
Assessing Regional Climate Service Needs through Cooperative Extension

CLIMAS Investigators: M. Crimmins (Lead PI), J. Brugger, and D. DuBois,

Partners: University of Arizona Cooperative Extension

ABSTRACT

Cooperative Extension (CE) has more than 100 years of experience in delivering science-based decision support to clientele from multiple sectors. The CE structure enables a high level of connectedness and awareness of local issues and provides opportunities to assess local and multi-sector climate service needs. We are working through CE offices to capture snapshots of local climate science and service needs across rural areas of Arizona and New Mexico. Since CE agents in these states work closely with both private land owners/producers (e.g., ranchers and farmers) and state/federal natural resource managers, we are able to assess both the needs and interconnections between private and public resource managers, consistent with the concept of assessing climate change impacts and responses at multiple scales.



LILY HOUSEPETERS

FINDINGS

Rural Arizonans are aware of a variety of climate changes, including changes in rainfall patterns both in time and space; more intense rainfall and localized flooding events; increased temperature extremes; an increase in the frequency of extreme wind events; and an increase in the intensity, duration, and frequency of drought conditions. Their attitudes toward climate change attribution vary. A minority of those who participated in the study accepts it fully because of the climate changes they have experienced. Many, having experienced the extreme variability of climate in Arizona, or being aware of the political sensitivity of the issue of climate change and the policy recommendations associated with it, are hesitant to attribute the changes they are experiencing to human causes.

DELIVERABLES: PUBLICATION

Brugger, J. and M. Crimmins. 2012. Weather, Climate, and Rural Arizona: Insights and Assessment Strategies. Technical Input to the U.S. National Climate Assessment.

Other Funding Sources: U.S. Global Climate Research Program-National Climate Assessment

Adaptation to Climate Variability and Change: Markets, Policy, Technology, and Information

CLIMAS Investigators: G. Frisvold (Lead PI), B. Colby, and T. Gaston

Partners: U.S. Bureau of Reclamation; Central Arizona Project; Greater Yuma Economic Development Council

ABSTRACT

This project examines mechanisms for adapting to climate variability and change that include: (1) the use of water markets by agriculture and urban water utilities; (2) the use of weather and climate information by agricultural producers; (3) the adoption of improved irrigation technologies; (4) agricultural and other policy responses; and (5) the role of crop insurance and disaster payments in risk mitigation.

FINDINGS

Although university and extension specialists are the source of information used most by irrigators for water management decisions, there is no single information source used by more than half of irrigators. There is no “one-stop shopping” for water management information.

Farm-household income diversification affects demand for weather data in complex ways. Diversification within agricultural production increases demand, while diversification out of agricultural production decreases demand.

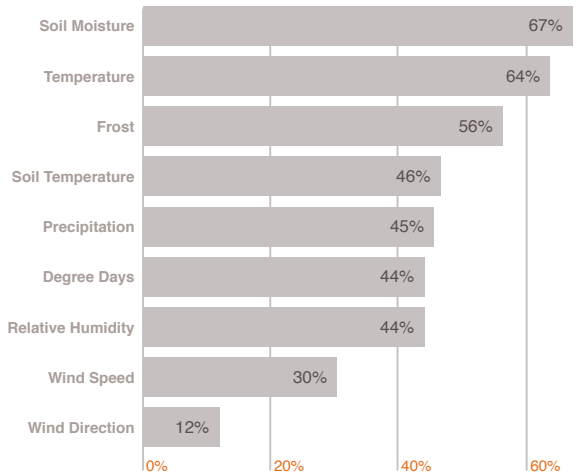
DELIVERABLES: PUBLICATIONS

(1) Frisvold, G. and A. Murugesan. 2013. Use of weather information for agricultural decision making. *Weather, Climate & Society* 5:55–69. Economic diversification affected the intensity of weather data; use was greater among producers with diversified agricultural production, but lower among producers with greater reliance on off-farm income.

(2) Frisvold, G. and S. Deva. 2012. Farm size, irrigation practices, and conservation program participation in the US Southwest. *Irrigation and Drainage* 61:569–582. Statistical analysis of Arizona and New Mexico irrigators found larger operations used more types of information for water management, especially private, tailored information. Larger operations were more likely to use directly provided data than smaller operators, who relied more on information provided by intermediaries. Adoption of scientific irrigation scheduling was low for all groups, but especially so for small-scale irrigators.

(3) Dhanireddy, P. and G. Frisvold. 2012. Disaster Assistance and Crop Insurance Participation in the US. Selected Paper, Agricultural & Applied Economics Association’s Annual Meeting. August 2012, Seattle, WA. The study estimated how much the probability of receiving disaster payments among more than 13,000 farms across 27 U.S. states was increased by drier or wetter-than-normal hydrologic conditions and warmer-than-normal temperatures. http://ageconsearch.umn.edu/bitstream/124720/2/DisasterAssistance%20and%20CropInsuranceParticipation.pdf

Other Funding Sources: USDA-National Agricultural Statistics Administration; NOAA-Regional Climate Centers



Importance ratings for different types of weather data for agricultural production and marketing decisions.

Climate Change Analysis for the City of Tucson

CLIMAS Investigators: G. Garfin (Lead PI), G. Frisvold, A. Comrie, B. Colby, and J. Weiss

Research Collaborators: T. Kong, D. Garcia (Univ. of Arizona-School of Natural Resources and the Environment); C. Carrillo (Univ. of Arizona-Department of Atmospheric Sciences); Cascadia Consulting Group, Inc.

Partners: L. Ethen, J. Brown (City of Tucson-Office of Conservation and Sustainable Development); City of Tucson Climate Change Committee

ABSTRACT

In this project, investigators are assisting the City of Tucson and its contractors in a vulnerability assessment for the community regarding anticipated climate change impacts. We will conduct studies and deliver best estimates on projections of future climate and hydrology of the Tucson basin and projections of future climate and hydrology of Colorado River surface water supplies that are part of Tucson Water's water resources portfolio. We synthesize state-of-the-art research related to: (a) Tucson energy-water nexus issues; (b) Tucson's urban heat island; (c) risk related to selected diseases; (d) local food security; and (e) projected impacts and risks related to urban ecosystems and ecosystems surrounding the city.

FINDINGS

Maximum temperatures above the user-defined threshold of 100 degrees F will increase by an average of ~42 days per year; this is likely to affect public health (heat stress), water, and electricity demand.

Extreme high precipitation (precipitation > 0.5 in/day and precipitation >1.0 in/day), which is a concern of floodplain managers, increased slightly but not outside the average of the historic range. Precipitation with a return period of 100 years is projected to occur twice as frequently; this result has a wide spread in model projections.

DELIVERABLES: MAPS

Climate and society risk maps for City of Tucson. Maps overlay neighborhood-level socioeconomic status with extreme temperature and flood risks. These maps will aid the city's climate change committee in developing and prioritizing adaptation strategies.

Other Funding Sources: City of Tucson

Hydrologic Extremes and Water Management in a Warmer World - California Perspectives

CLIMAS Investigators: Z. Guido (Lead PI), D. Ferguson, K. Hirschboeck, and J. Overpeck

Research Collaborators: California Department of Water Resources; California Nevada Applications Program; Western Water Assessment; Arizona State Univ.-Global Institute of Sustainability; Univ. of Washington; NOAA-Earth Systems Research Laboratory; DOI-Southwest Climate Science Center

Partners: U.S. Geological Survey-Scripps; Western Regional Climate Center

ABSTRACT

Two workshops were convened to identify applied science activities that could facilitate climate change adaptation to extreme events/severe weather and for flood management, and to develop a road map for implementing those activities. California has been a leader in climate change adaptation, and California state agencies involved in the water sector are making progress on adaptation related to water supply management and sea level rise. However, planning for flood management-related adaptation is complicated by hydrologic non-stationarity induced by climate change, a concept that challenges traditional standards of practice in hydrologic analysis and engineering design that have been in place for decades. Prior workshops involving state and federal water agencies and the research community have revealed a variety of issues associated with climate change non-stationarity. The workshops seek to develop strategies that advance research and practice that support adaptation by state and local resource management agencies.

DELIVERABLES: WORKSHOP

Hydrologic Extremes in a Warming World: California Perspectives part 2; October 29–30, 2012, Scripps, La Jolla, CA. The California Department of Water Resources (CDWR) wanted scientists and water managers to co-identify practical and important research projects related to extreme events. CLIMAS organized this workshop.

Other Funding Sources: DOI-Southwest Climate Science Center; California Department of Water Resources

FEMA

SOHA NAMNABAT

Effective Approaches for Using Scenarios to Support Adaptation

CLIMAS Investigators: H. Hartmann (Lead PI) and K. Morino

Research Collaborators: The Nature Conservancy; U.S. Bureau of Land Management; White Mountains Land Trust

Partners: Cienegas Watershed Partnership; U.S. Bureau of Reclamation

ABSTRACT

We are extending and refining participatory scenario planning methods to be transferred and scaled to support many users across wide regions. We are using scenarios of climate and other forces in exercises for strategic planning, research integration, and capacity building for decision makers and science translators. Working in collaboration with stakeholders, we generate experiential outcomes (e.g., scenario planning capacity, scenario thinking, development and evaluation of portfolios of adaptation options) and process artifacts (e.g., scenario narratives) that can serve as a foundation for adaptation planning and integrated assessment research. This effort provides methods and case study examples to support more relevant, legitimate, credible, and creative scenario planning within a risk management framework for addressing climate change.

FINDINGS

Scenario planning embraces uncertainty, enabling organizations to approach climate change with a sense of empowerment rather than a sense of reacting to crises.

DELIVERABLES: THREE WORKSHOPS

(1) Scenario Planning Workshop. June 2012, Tucson, AZ. This workshop explored options for a scenario planning project focused on the region encompassing the Las Cienegas National Conservation Area.

(2) Team Leader Training on Scenario Planning. February 2013, Tucson, AZ. This workshop provided training for resource team leaders about the scenario planning process. It also helped us refine scenario planning workshop exercises for land managers.

(3) Fast Track Workshop on Floodplain Adaptation Portfolio Development. February 2013, Tucson, AZ. This workshop prototyped workshop exercises and approaches for using scenarios to evaluate adaptation options and develop adaptation project portfolios.

Other Funding Sources: The Nature Conservancy; White Mountains Land Trust; Cienegas Watershed Partnership; U.S. Bureau of Land Management

Managing Demand, Rethinking Supply: Adaptation, Conservation, and Planning in the Drought-prone Southwestern U.S. and Northwest Mexico

CLIMAS Investigators: M. Wilder (Lead PI), G. Garfin, G. Frisvold, J. Brugger, A. Quijada-Mascareñas, S. Kelly, and G. Owen

Research Collaborators: P. Romero Lankao (National Center for Atmospheric Research); M. Ibarra, M. Montero (Servicio Meteorológico Nacional; Comisión Nacional del Agua (CONAGUA)); M. Carmen Lemos (Univ. of Michigan); C. Neri (Univ. Nacional Autonoma de México); N. Pineda Pablos (El Colegio de Sonora); L. Farfan (Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE)); L. Brito (Centro de Investigaciones Biológicas del Noroeste (CIBNOR)

Partners: ProNatura; World Wildlife Fund; Sonoran Institute; Tucson Water; Agua de Hermosillo; U.S. Geological Survey; Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias

ABSTRACT

Adaptation in water management is a greatly revered yet poorly understood goal and concept. Arnell (2010) found that case studies of how adaptation is actually being delivered, and barriers to effective delivery (e.g., information, capacity, institutions), are critical missing components of existing adaptation research. We address this gap both theoretically and methodologically in four study sites in the Arizona-Sonora region of the U.S-Mexico border: Tucson, AZ; Yuma, AZ, and the Colorado River Delta; the Upper Gulf of California (from Puerto Peñasco, Sonora, north); and Hermosillo, Sonora. The key research questions guiding this project are what is the role of networks in governance and the implications for using climate knowledge; what are the most effective climate services to support efforts to adapt; and how can decision support tools build institutional adaptive capacity.

MARIA GRIFFITH

NASA/GSFC/METI/JAPAN SPACE SYSTEMS, U.S./JAPAN ASTER SCIENCE TEAM

FINDINGS

The Arizona-Sonora portion of the U.S.-Mexico border is an arid, hotspot region for climate change with a high degree of socioeconomic vulnerability. In Arizona, vulnerabilities include strong institutional capacity combined with relatively weak integration of climate science, and continued reliance on sole-source supply (e.g., Colorado River water), driving a regional focus on desalination of seawater as a regional water solution.

Ensuring water security for arid regions requires adaptive water management. Binational cooperation around the goal of sustaining ecological flows for wetlands in the Colorado River Delta resulted in the recent adoption of a new treaty minute that officially promotes commitment to this goal.

DELIVERABLES: PUBLICATIONS

(1) Scott, C., F. Meza, R. Varady, J. McEvoy, M. Wilder, L. Farfán, G.M. Garfin, and N. Piñeda Pablos. 2013. Water Security and Adaptive Management in the Arid Americas. *Annals of the Association of American Geographers* 103(2):280-289. The article examines adaptive water management strategies in arid regions of the Americas, including the U.S.-Mexico border, in the context of demographic transition and climate change.

(2) Varady, R., C. Scott, M. Wilder, B. Morehouse, N. Piñeda Pablos, and G. Garfin. 2013. Transboundary adaptive management to reduce climate-change vulnerability in the western U.S.-Mexico border region. *Environmental Science & Policy* 26:102-112. http://dx.doi.org/10.1016/j.envsci.2012.07.006 This paper addresses how organizations and stakeholders can build adaptive capacity and foster adaptive management in a complex international transboundary region to better confront the impacts of global change.

(3) McEvoy, J. and M. Wilder. 2012. Discourse and Desalination: Potential Impacts of Proposed Climate Change Adaptation Interventions in the Arizona-Sonora Border Region. *Global Environmental Change* 22(2): 353-363. http://dx.doi.org/10.1016/j.gloenvcha.2011.11.001 This article focuses on a proposed Arizona-Sonora binational desalination project, using insights from risk and hazards literature to analyze how, why, and to what effect desalination is emerging as a preferred climate change adaptation response.

(4) Garfin, G., P. Romero Lankao, and R. Varady. 2013. Editorial: Rethinking integrated assessments and management projects in the Americas. *Environmental Science & Policy* 26:1-5. http://www.sciencedirect.com/science/article/pii/S1462901111002000

Other Funding Sources: NOAA-Regional Climate Services Directors; NOAA-Sectoral Applications Research Program

Climate

Seasonality Matters: Changing Temperature Distributions Across the Southwest

CLIMAS Investigators: Z. Guido (Lead PI) and J. Swetish

ABSTRACT

Recent gridded global temperature analyses have shown that temperature distributions are, on average, shifting in mean and variance. They also have shown that the frequency of extreme temperatures is occurring at much greater percentages than in the past and at frequencies greater than their statistical properties would suggest. We follow a similar methodology as Hansen et al. (2012)—one of the recent global temperature analyses—to assess how seasonal minimum, maximum, and average temperature distributions have changed in the instrumental record across Arizona, New Mexico, Utah, and Colorado. We focus on quantifying changes in distributions and extreme temperatures in 20-year periods between 1931 and 2010 for each Historical Climate Network station in the four states, and compare these results to global analyses. This local, station-based analysis provides insights about seasonal changing temperatures at scales more appropriate to local decision makers.

FINDINGS

Temperature distribution variances have not significantly changed; however, the mean of the distributions have significantly shifted for the 1991–2010 period in comparison to the previous 1971–1990 period. This is most pronounced for minimum temperatures.

The May–June period has experienced the most pronounced temperature distribution shifts (more than winter or monsoon seasons).

KYLE COLAVITA

OWEN KELLY

Hydroclimatology and Paleohydrology for Decision Support

CLIMAS Investigators: K. Hirschboeck (Lead PI), G. Garfin, D. Zamora-Reyes, and S. Kim

Research Collaborators: N. Paretti (U.S. Geological Survey-Arizona Science Center); California Nevada Applications Program

Partners: Arizona Department of Water Resources; Multi-Agency Task Force of the AZ Flood Warning System; California Department of Water Resources; Arizona State Univ.-Decision Center for a Desert City; City of Chandler; Arizona Climate and Water Resource Alliance

ABSTRACT

This project is exploring innovative ways to address risk and resilience related to hydroclimatic extremes in both the upper and lower tails of streamflow probability distributions. The goal is to transfer the knowledge and record length that climate information and paleodata provide into useful tools for hydrologic decision making involving risk and resilience related to both floods and drought. Specific objectives include: (1) transfer of information from tree-ring reconstructions about past extreme streamflow episodes to water managers for integration into operations; (2) ongoing construction of a flood hydroclimatology database for linking climate, floods, and paleofloods; (3) interaction with stakeholders to develop innovative ways to use the flood database information in (2); and (4) exploration of issues surrounding flood risk and human behavior to improve flood hazard management and flood warning practice.

FINDINGS

We have identified a distinct regionality of climate-sensitive flood behavior in Arizona that can be used to improve flood frequency estimates in different watersheds and have also identified temporal variations in the heterogeneity of flood-causing weather and climate mechanisms (e.g., atmospheric rivers, summer convective versus winter storms) that can be used in scenario planning to address future flood hazards due to climate change.

Other Funding Sources: U.S. Geological Survey-Arizona Science Center

Patterns and Causes of Southwest Drought Variability

CLIMAS Investigators: J. Overpeck (Lead PI), J. Conroy, C. Routson, T. Ault, and J. Weiss

Research Collaborators: B. Udall (Western Water Assessment); Julie Cole (Univ. of Arizona-Department of Geosciences); and D. Meko (Univ. of Arizona-Laboratory of Tree-Ring Research)

Partners: Intergovernmental Panel on Climate Change; U.S. Bureau of Reclamation; U.S. Department of Defense; Tucson Water; federal and state judges

ABSTRACT

This project investigates the observations of current and past drought, as well as the causes and impacts of these droughts, including the role of ENSO versus Atlantic sea surface temperatures in modulating drought, the exact nature of medieval megadroughts in the Four Corners, the ecological impacts of drought, the evaluation of how well climate models simulate drought, and strategies for overcoming climate model deficiencies in assessing future drought.

FINDINGS

State-of-the-art climate models underestimate the risk of megadrought in the Southwest.

DELIVERABLES: PUBLICATION

Ault T., J. Cole, J. Overpeck, G. Pederson, S. St. George, B. Otto-Bliesner, C. Woodhouse, and C. Deser. 2013. The continuum of drought variability in western North America: Insights from instrumental, paleoclimate and global climate model data. *Journal of Climate*. (In press).

Other Funding Sources: NOAA-C2D2; National Science Foundation; National Center for Atmospheric Research

MURPHY WOODHOUSE

Communicating Science

Planning for Local Government Climate Challenges: Connecting Research and Practice

CLIMAS Investigators: D. Ferguson (Lead PI), Z. Guido, and J. Galayda

Research Collaborators: J. Buizer (Univ. of Arizona-Institute of the Environment); N. Chetri, A. Reichman (Arizona State Univ.-Global Institute for Sustainability); M. Roy (Arizona State Univ.-Office of the President); and R. Quay (Arizona State Univ.-Decision Center for a Desert City)

Partners: urban planners; water managers; urban sustainability office staff and leadership; city managers and their staff

ABSTRACT

As the Southwest U.S. moves into a 21st century climate that is likely to be increasingly different than anything we have experienced in the modern era, elected officials, city managers, urban sustainability offices, planners, and resource managers will all face decisions that could be informed by ongoing research about climate, impacts from changes, and the most promising practices for adapting to climate change. In an effort to both inform these important stakeholders and learn from them, CLIMAS has teamed up with colleagues from Arizona State University to create a collaborative environment among municipal leaders (e.g., city managers, planners, and resource managers) and experts in climate-related research to stimulate and support climate adaptation and resiliency efforts across the state.

DELIVERABLES: WORKSHOP

Planning for Local Government Climate Challenges: Connecting Research and Practice. October 2012. The workshop was part of a larger project whose main objective is to work with municipal leaders to co-produce useful materials that facilitate and support local climate adaptation efforts. The workshop brought together a small group of municipal leaders from across Arizona and a small group of international experts from physical

and social science fields to exchange useful and state-of-the-art knowledge about climate variability, climate change, adaptation, and the unique challenges facing municipal leaders in Arizona.

Other Funding Sources: NOAA-Sectoral Applications Research Program

Transborder Climate Communication

CLIMAS Investigators: G. Garfin (Lead PI), M. Wilder, and A. Quijada-Mascareñas

Research Collaborators: M. Ibarra, M. Montero (Comisión Nacional del Agua (CONAGUA) and Servicio Meterológico Nacional); L. Farfan (Centro de Investigación Científica y de Educación Superior de Ensenada (CICESE)); and L. Brito (Centro de Investigaciones Biológicas del Noroeste (CIBNOR))

Partners: World Wildlife Fund; ProNatura; CONAGUA; NOAA; U.S. Geological Survey; Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias; CIBNOR; Arizona State Univ.; Colegio de la Frontera Norte

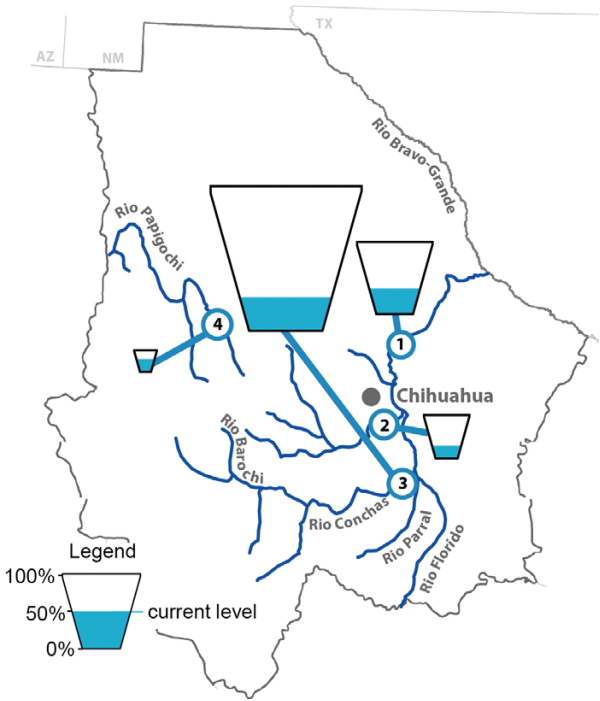
ABSTRACT

Transborder Climate reports on research and forecasts related to climate and its impacts in the transboundary United States-Mexico border region. Transborder Climate also provides brief reports and points to useful information for resource management and policy, with a special emphasis on information relevant to adaptation to climate variations and trends. It is produced quarterly in English and Spanish. The webinar series features talks and dialogue on the latest climate research (including seasonal forecasts, climate, water and environmental impacts, and climate change) and collaborative initiatives aimed at the exchange of knowledge between scientists, natural resource managers, water managers, and other decision makers in the U.S.-Mexico border region. Each webinar featured speakers from the U.S. and Mexico.

DELIVERABLES: COMMUNICATION & OUTREACH

(1) Transborder Climate newsletter. Quarterly news on climate and environment research and outreach activities in the U.S.-Mexico border region. The deliverable gives federal agencies such as NOAA and CONAGUA a resource for tangible evidence of cross-border collaboration on climate services. http://www.climas.arizona.edu/outlooks/tbc

(2) Transborder webinar series. Webinars on climate, water and environment research, climate services,



Size of cups is representational of reservoir size, but not to scale.


March 27, 2013

Southwest Climate Outlook

Vol. 12 Issue 3

In this issue...

Feature Article p. 3

Temperatures in Yuma plunged below freezing for several days in a row in mid-January. This blast of Arctic air, along with others that periodically occur, posed challenges to a variety of growers, from those running citrus orchards to farmers cultivating cotton, broccoli, or leafy greens for Yuma's booming winter lettuce industry.

Precipitation p. 7

Four winter storms passed through Arizona during the past 30 days, and two of these also clipped northern New Mexico. Precipitation from those storms was very localized and most of both states have experienced less than 70 percent of precipitation between February 19 and March 20.

Snowpack p. 13

Precipitation in the last month has been below average in many parts of the higher elevations in Arizona, New Mexico, Colorado, and Utah. Temperatures also have been above average in these states. The combination of the two has caused water contained in snowpacks to be below average throughout the Southwest.

Despite below-average precipitation in many parts of the Southwest, the deserts are beginning to spring into color. Photo: Pacifica Sommers

Would you like to have your photograph featured on the cover of the Southwest Climate Outlook? For consideration send a photo representing Southwest climate and a detailed caption to: zguido@email.arizona.edu

CLIMAS

ARIZONA COOPERATIVE EXTENSION

ARIZONA

NM STATE UNIVERSITY

The information in this issue is available on the Web: http://climas.arizona.edu/outlooks/swco

and knowledge exchange initiatives. Eight webinars were convened during the reporting period. Participants from the U.S. and Mexico attended each webinar. The webinars facilitated the exchange of applied climate information between researchers, knowledge brokers, and stakeholders. http://www.climas.arizona.edu/outlooks/tbc/webinars-current

(3) Map – Reservoir map was made for the state of Chihuahua, providing highlights about drought and climate impacts in Mexico to the NOAA Quarterly Climate Impacts and Outlook for the Southern Plains Region. http://www.srh.noaa.gov/media/srh/news/SouthernPlains_Quarterly_Climate_Impacts_Outlook_Dec2012.pdf

Other Funding Sources: NOAA-Regional Climate Services Directors; NOAA-Sectoral Applications Research Program

The Southwest Climate Outlook

CLIMAS Investigators: Z. Guido (Lead PI), G. Garfin, M. Crimmins, G. Owen, and J. Swetish

Research Collaborators: Arizona Cooperative Extension; Office of the State Climatologist for Arizona; Univ. of Arizona-Institute of the Environment

ABSTRACT

The Southwest Climate Outlook summarizes climate and weather information from disparate sources in nonscientific language, providing more than 1,700 people with timely climate-related information. Since SWCO's inception in 2002, stemming from the END InSight project, the publication has evolved into a tool for two-way communication with stakeholders and a platform for responding to needs throughout the region.

DELIVERABLES: COMMUNICATION AND OUTREACH

(1) Eleven issues of the Southwest Climate Outlook, a monthly e-publication that synthesizes and interprets recent climate and weather conditions in the Southwest, including forecasts based on data and products issued by disparate, credible sources.
http://www.climas.arizona.edu/outlooks/swco

(2) Three podcasts were recorded and made available through the CLIMAS website. Themes built off of the data and forecasts in the monthly Southwest Climate Outlook.

La Niña Drought Tracker; Monsoon Tracker

CLIMAS Investigators: Z. Guido (Lead PI), G. Garfin, M. Crimmins, and J. Swetish

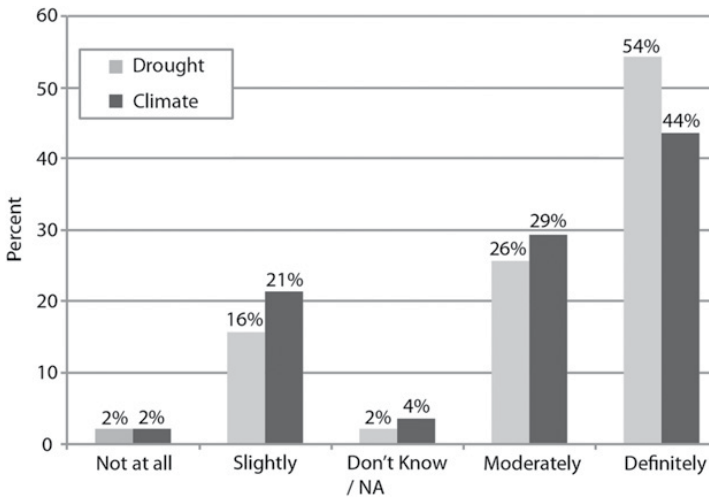
ABSTRACT

One of the strongest La Niña events in the last 60 years became entrenched in August 2010 and persisted for two consecutive winters, signaling that the Southwest U.S. was likely going to experience below-average precipitation during the winters. These events provided a good opportunity to develop a regional climate service that informed the U.S. Southwest of the evolving drought conditions and the underlying climate connections. The La Niña Drought Tracker was a two-page document that was published each month between December 2010 and April 2011, when the Southwest most heavily felt the La Niña impacts. The central goals of the Tracker were to inform the region of current and projected drought conditions, advance climate literacy, and fulfill a niche not provided by other climate service providers in the region, namely the climate connection to the evolving drought conditions. The Tracker was disseminated to more than 1,700 subscribers to the CLIMAS listserv and was routinely viewed by more than 300 resource managers and decision makers each month, as well as numerous media sources. Initial feedback identified the product as a boundary object used by researchers and resource managers and as a source of information managers called on to inform decisions. The success of the Tracker led to the development of the Monsoon Tracker.

DELIVERABLES: PUBLICATION

Guido, Z., D. Hill, M. Crimmins, and D. Ferguson. 2013. Informing Decisions with a Climate Synthesis Product: Implications for Regional Climate Services. *Weather, Climate, and Society* 5(1):83-92. Routine interpretation and synthesis of existing climate information can help enhance access to and understanding and use of climate information in decision making, fulfilling the main goals for the provision of climate services.

Other Funding Sources: NOAA-Climate Prediction Center; USDA-Natural Resources Conservation Service; National Integrated Drought Information System



The percentage of respondents whose understanding of drought and climate changed by reading the Tracker, out of 140 total responses.

MARIELLE SMITH

Forecast Evaluation and Application Research

CLIMAS Investigators: H. Hartmann

Research Collaborators: NOAA-National Weather Service Climate Services Division; NOAA-Climate Prediction Center

Partners: NOAA-NWS Weather Forecast offices; NOAA-NWS River Forecast Centers

ABSTRACT

Early in the CLIMAS project, dialogue with stakeholders clearly identified significant barriers precluding more extensive and effective use of hydroclimatic forecasts, including lack of relevant and quantifiable forecast skill, misinterpretation of forecast products, and inability to place forecasts in historical context. Qualitative aspects of forecasts can be as important as any quantitative attribute in affecting how users interpret, apply, and ultimately judge probabilistic forecasts. Significant work is needed to develop specific forecast product formats that can be interpreted easily, correctly, and reliably without the need for special training. This project applies techniques for qualitatively and quantitatively assessing forecast performance, with the intention of helping stakeholders appropriately align forecast use with measures of forecast skill.

DELIVERABLES: WORKSHOP

Short Course on Interpretation and Use of Climate Monitoring and Prediction Information: 1) Climate forecast interpretation, and 2) Evaluating and using seasonal outlooks. American Meteorological Society, January 2013, Austin, TX. These class lectures helped develop best practices among climate services intermediaries and practitioners.

National Climate Services Design, Support, and Evaluation

CLIMAS Investigators: H. Hartmann

Research Collaborators: American Meteorological Society Committee on Climate Services; Carpe Diem West; National Academy of Sciences-National Research Council Committee on the Assessment of the National Weather Service Modernization Program

ABSTRACT

Recently, the design and implementation of national climate services has become a topic of significant focus within NOAA, the American Meteorological Society, and other organizations. The substantial increase in the national discussion about national climate services increasingly involves CLIMAS investigators in areas ranging from understanding stakeholder needs for climate services to effectively transitioning research to operations. The emphasis is on scaling up from local and regional experience to products and principles that can be implemented at a national level and for stakeholders not involved in any research projects, and defining principles and processes for ensuring appropriate participation by the public, private, and academic sectors in providing services to a variety of applications sectors.

DELIVERABLES

National Research Council. 2012. *Weather Services for the Nation: Becoming Second to None*. Committee on the Assessment of the National Weather Service's Modernization Program. National Academy Press. Washington, D.C. (Hartmann is one of 16 co-authors).

ROSS MORGAN

American Indian Alaska Native Climate Change Working Group

CLIMAS Investigators: C. Kahn-Thornbrugh (Lead PI), J. Overpeck, D. Ferguson, and A. Meadow

Research Collaborators: D. Wildcat, S. Baker (Haskell Indian Nations Univ.); American Indian Alaska Native Climate Change Working Group

ABSTRACT

The purpose of this project was to provide support for the American Indian Alaska Native Climate Change Working Group (AI AN CCWG) and Tohono O'odham Community College for the coordination and implementation of the 2012 AI AN CCWG spring meeting. The meeting was hosted by Tohono O'odham Community College on the Tohono O'odham Nation in southern Arizona. The AI AN CCWG is a Tribal College University-centered network of tribal colleges and universities, tribal and intertribal organizations, federal agencies, scientific research organizations, and NGOs that address the impacts of climate change on humankind, but especially on indigenous peoples.

DELIVERABLES: WORKSHOP

The American Indian Alaska Native Climate Change Working Group meeting had more than 80 attendees representing 13 tribal colleges and universities, three intertribal organizations, four federal agencies, three scientific research organizations, six NGOs, and two Tohono O'odham tribal departments. Key topics presented and discussed at the meeting included climate change in the Southwest, federal and NGO collaboration opportunities with tribal colleges and communities, climate change and geosciences education, sustainability and renewable energy, student environmental research at tribal colleges, tribal vulnerability and adaptation to climate change, and the current state of climate change adaptation from the perspectives of Native nations. Seven tribal college students presented (oral or poster) their research projects at this meeting.

Other Funding Sources: U.S. Geological Survey; Kiksapa Consulting LLC.; NASA Tribal College & University Program

Understanding and Communicating Climate Change in the Southwest

CLIMAS Investigators: J. Overpeck (Lead PI), D. Ferguson, G. Garfin, Z. Guido, and G. Owen

Research Collaborators: Univ. of Arizona-Institute of the Environment; Western Water Assessment; California Nevada Applications Program; NOAA-Earth Systems Research Laboratory; University Corporation for Atmospheric Research; National Judicial Law College; Univ. of Arizona-College of Law

ABSTRACT

The goals of this project are: (1) to lead efforts to communicate about climate variability and change to decision makers and policy makers in the Southwest, and (2) to make climate knowledge useful for stakeholder understanding and decision making.

DELIVERABLES: COMMUNICATION AND OUTREACH

(1) Blog entries on Southwest Climate Change Network (SWCCN) on issues related to Southwest climate and climate issues. Communication on Twitter; Overpeck has about 1,000 followers.

(2) Video – Owen, G. and Z. Guido. 2012. Coping with Drought on the Rio Grande. This video explores the impacts of the current drought on water management and agriculture in New Mexico's Lower Rio Grande Valley. http://www.climas.arizona.edu/node/2582

Other Funding Sources: Arizona Department of Environmental Quality; Univ. of Arizona-Institute of the Environment

DAN GRIFFIN

Decision Support Tools

Tool Development and Training

CLIMAS Investigators: H. Hartmann

Research Collaborators: D. Hammond, D. Martinez (Univ. of Arizona-School of Natural Resources and the Environment); NOAA-National Weather Service Climate Services Division; NOAA-Climate Prediction Center; Carpe Diem West

Partners: NOAA-NWS Weather Forecast offices; NOAA-NWS River Forecast Centers

ABSTRACT

In some cases, barriers to the use of climate information can be met with innovative tools that offer users the ability to perform customized analyses. This project works to develop such tools, with a commitment to ongoing user engagement and adaptation of the tools. In addition, tools that have proved successful in regional applications may be usefully extended to new regions.

DELIVERABLES

(1) Online software application – Dynamic Probability of Exceedance Tool. 2012–2013. Tucson, AZ, and Silver Spring, MD: Arid Lands Information Center, University of Arizona and NWS Climate Prediction Center

(2) Web portal – Carpe Diem West Academy. 2011–2013. Sausalito, CA, and Tucson, AZ: Carpe Diem West and Arid Lands Information Center, University of Arizona. http://carpediemwestacademy.org

(3) Webinar series: Watershed Valuation: A Closer Look (February 2013); Robust Decision Making (November 2012); Vulnerability Assessment: Take Two (September 2012); and Watershed Valuation: Australia to the American West (June 2012). These webinar workshops provided professional development training and shared experience of innovative practices related to topics identified as high interest by water resources practitioners. More than 400 people participated across the four workshops.

Other Funding Sources: Carpe Diem West; NWS-Climate Test Bed

TreeFlow: A Drought Planning Resource for Water Management in the Western U.S.

CLIMAS Investigators: C. Woodhouse (Lead PI), K. Hirschboeck, H. Hartmann, D. Griffin, and K. Morino

Research Collaborators: J. Lukas (Western Water Assessment) and J. Littell (Salt River Project)

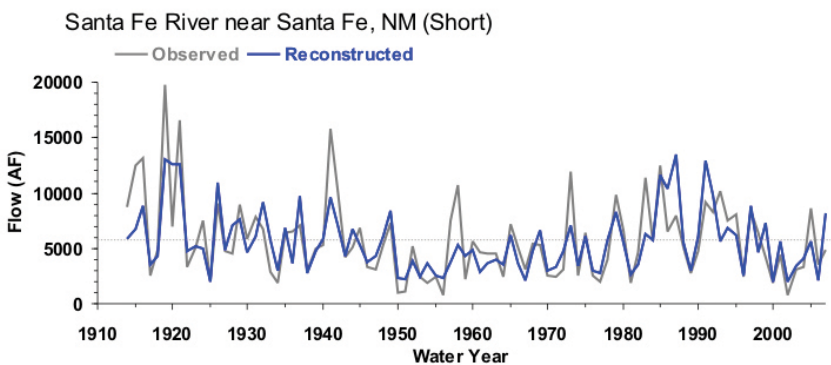
ABSTRACT

Paleohydrologic information collected from tree rings has become a valuable tool for drought planning and water resources management. The goal of this project is to expand that usefulness to a broader range of water providers and resource managers. The website includes pages for accessing, evaluating, and downloading reconstructions of streamflow for a number of western river basins, examples of applications to water resource management, and information about past workshops for water resource managers, including instructional PowerPoint presentations.

DELIVERABLES: WEB TOOL

TreeFlow is a Web-based resource for water resource managers. It was developed in collaboration with water resource managers to make data and information on reconstructions of streamflow accessible, understandable, and useful for placing the record of gauged hydrology in a long-term context. The paleotool component of TreeFlow, under development since 2008, was completed this year. http://treeflow.info/toolbox.html

Other Funding Sources: National Integrated Drought Information System (NIDIS)



Observed (black) and reconstructed (blue) Santa Fe River annual flow, 1914-2007. The observed mean is illustrated by the dashed line.


ZACK GUIDO

Drought

Tribal Drought Information for Monitoring, Assessment, and Planning (Tribal DrI-MAP)

CLIMAS Investigators: M. Crimmins (Lead PI), D. Ferguson, C. Woodhouse, H. Faulstich, and A. Kimbrough

Research Collaborators: A. Meadow (Southwest Climate Science Center); K. Cozzetto, J. Nania, S. Duren (Western Water Assessment); S. Marsh, W. van Leeuwen, B. Orr (Arizona Remote Sensing Center); NOAA/National Weather Service-Colorado Basin River Forecast Center

Partners: Hopi Department of Natural Resources; Navajo Nation Department of Water Resources

ABSTRACT

The Hopi Tribe and Navajo Nation have been experiencing widespread and persistent drought conditions for more than a decade. Drought has impacted vegetation and local water resources in ways that threaten agricultural systems and ecosystems that are critical to supporting the Hopi and Navajo people. Limited hydroclimatological and ecological monitoring across the region has made it difficult to assess current drought impacts and anticipate future impacts. By working with Navajo and Hopi resource managers to develop better drought monitoring tools and tactics, we will help these two communities reduce their vulnerability to drought, cope with unavoidable drought impacts, and plan for long-term sustainability in the region.

DELIVERABLES: PUBLICATIONS

(1) Crimmins, M., N. Selover, K. Cozzetto, and K. Chief. 2013. Technical Review of the Navajo Nation Drought Contingency Plan–Drought Monitoring. Submitted to the Navajo Nation Water Management Branch in February.

(2) Meadow, A., D. Ferguson, and M. Crimmins. 2013. Helping a community develop a drought impacts reporting system. *Rural Connections* 7(1):15-18. Overview of drought impact monitoring strategy that is being explored with the Hopi Department of Natural Resources.

TOOLS: DROUGHTVIEW

A drought decision support tool developed to support tribal drought monitoring.
http://droughtview.arid.arizona.edu/

Other Funding Sources: NOAA-Sectoral Applications Research Program; NASA Space Grant

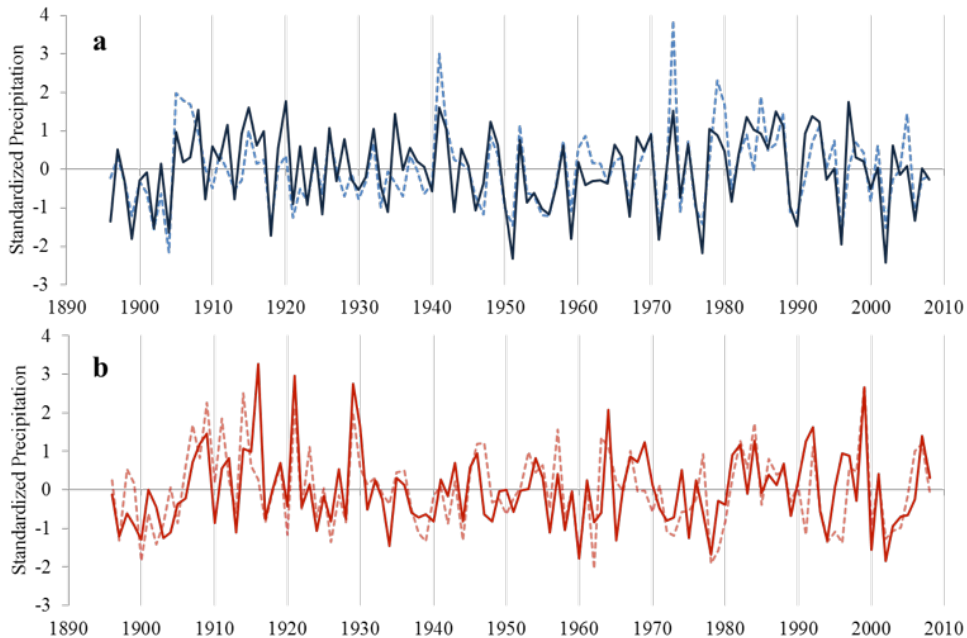
Dendrochronology in the Tribal Lands of Northeast Arizona Arizona

CLIMAS Investigators: C. Woodhouse (Lead PI), D. Ferguson, G. Garfin, M. Crimmins, A. Meadow, and H. Faulstich

Partners: Hopi Department of Natural Resources; Navajo Water Resources Program; Policymakers/Tribal Council

ABSTRACT

This project uses a collection of 15 tree-ring chronologies surrounding the Navajo and Hopi tribal lands in the Four Corners region to reconstruct climate history. More specifically, we identify and characterize multi-year droughts, investigate drought seasonality, and frame the ongoing 21st century drought in the context of the past four centuries. Historical research is used to assess the socioeconomic circumstances that coincided with notable periods of persistent drought and wetness on the tribal lands. The results from this project will be published in a peer-reviewed journal and used to generate a set of outreach materials, both in the form of a brief report written for a general audience and a presentation for tribal members.



Standardized precipitation values (z-scores) for the cool-season, Oct-Apr (a), and warm-season, Jul-Aug (b). Observed values (dashed line) are plotted against reconstructed values (solid line) for the calibration period, 1896-2008.

ZACK GUIDO

FINDINGS

The instrumental record does not adequately represent the full range of natural climatic variability possible on the tribal lands (i.e., pre-instrumental drought events have far exceeded anything witnessed by the Four Corners region in the modern era). Many of the historically significant droughts of the past (e.g., the 17th century Puebloan Drought) were not merely winter phenomena, but persisted through the summer season as well. This type of drought (winter deficits followed by a failed monsoon) can have devastating consequences on the tribal lands.

DELIVERABLES: PUBLICATION

Faulstich, H., C. Woodhouse, and R. Griffin. 2012. Reconstructed cool- and warm-season precipitation over the tribal lands of northeastern Arizona. *Climatic Change* 118:457-468. DOI 10.1007/s10584-012-0626-y.
We generated separate, centuries-long reconstructions of both cool- (October-April) and warm-season (July-August) precipitation in the Four Corners region, which allowed for new insights into seasonal drought characteristics and indicated that the instrumental record fails to adequately represent precipitation variability over the past 400 years.

Other Funding Sources: National Science Foundation

Economics & Livelihoods

Sectoral Impacts of Drought and Climate Change

CLIMAS Investigators: G. Frisvold (Lead PI) and G. Jin

Research Collaborators: K. Konyar (California State Univ., San Bernardino-Department of Economics); S. Ponnaluru (Washington State Univ.-School of Economic Sciences Impact Center); and S. Hecht (Univ. of California Los Angeles-School of Law)

Partners: National Parks Conservation Association; U.S. Bureau of Reclamation; Central Arizona Project; Cotton Incorporated

ABSTRACT

This project examines the impacts of drought and climate change on climate-sensitive sectors in the Southwest, focusing on agriculture, outdoor recreation, and tourism. The effects of drought on income and employment are being estimated. Implications of climate change for the insurance industry are also being assessed.

FINDINGS

The costs of acreage abandonment (not harvesting planted crop acres) can be quite substantial. For U.S. cotton alone, the costs of abandonment approached $900 million in 2011, when drought conditions affected the crop. Weather variables are important predictors of crop abandonment, with irrigation significantly reducing abandonment risk. By examining crop insurance indemnity claims, results for Arizona show that cold and excess moisture are main sources of losses. In both Arizona and New Mexico, virtually all agriculture is irrigated. While drought is not listed as a major source of loss, irrigation supply disruption is. In New Mexico (with significant dryland farming) drought is a more prominent cause of crop insurance claims, but cold and excess moisture are also important.

DELIVERABLES: PUBLICATIONS

(1) Frisvold, G. and K. Konyar. 2012. Less water – how will agriculture in Southern mountain states adapt?


JOE ZLOMEK

Water Resources Research 48.W05534. Based on a multi-commodity, multi-region model of U.S. crop production, southwestern agricultural adjustment to a 25 percent reduction in irrigation water supplies would reduce farm income by $65 million using a 'land-fallowing only' approach, while allowing irrigators to change cropping patterns, practice deficit irrigation, and adjust use of other inputs reduced irrigator costs of water shortages to $22 million.

Frisvold, G. and G. Jin. 2013. Effects of weather extremes on cotton acreage abandonment and insurance indemnities. *Proceedings of the Beltwide Cotton Conferences.* (In press). Weather extremes are significant predictors of cotton crop abandonment, whose costs reached $900 million during the 2011 drought. Irrigation supply failures were an important source of crop insurance claims in Arizona and New Mexico. Cotton Incorporated was interested in information about impacts of drought and the role of irrigation and insurance in mitigating farm financial risk.

Other Funding Sources: USDA-National Agricultural Statistics Service; USDA-Risk Management Agency; USGCRP-National Climate Assessment

Climate Mitigation and Agriculture: Public Policy Education

CLIMAS Investigators: G. Frisvold (Lead PI), Z. Mirza, and X. Vu

Research Collaborators: B. Hurd (New Mexico State Univ.); D. Fort (Univ. of New Mexico Law School); and K. Konyar (California State Univ., San Bernardino)

Partners: Cotton Incorporated; National Cotton Council; American Farmland Trust; Ag Carbon Market Working Group; Climate and Energy Project

ABSTRACT

This project involves economic evaluations of the effects of actual and proposed climate change mitigation policies as applied to agriculture and ranching. Results will ideally be used to inform policy decisions.

FINDINGS

Proposed climate change mitigation policies (such as cap and trade or carbon taxes) would affect crop and livestock producers very differently. For example, under a cap-and-trade system with a domestic offset

program, crop producer income may actually increase as afforestation limits crop production and boost farm prices. Domestic offsets, however, increase costs to livestock producers through effects on feedgrain prices.

Many studies of agricultural impacts of climate change legislation use simple partial budgeting models to estimate economic impacts. Using data for western dairy operations, we found that simple partial budgeting methods are quite close approximations to estimates based on more sophisticated econometric modeling approaches. This is important given that partial budgeting analyses can be conducted quickly, with minimal data requirements.

Other Funding Sources: USDA-Economic Research Service; Cotton Incorporated; NSF-New Mexico Experimental Program to Stimulate Competitive Research

Climate Change Mitigation Strategies and Policies

CLIMAS Investigators: G. Frisvold (Lead PI), G. Pfeiffer, T. Marquez, G. Camara, and H. Richards

Research Collaborators: A. Barnhart (Univ. of Arizona-Institute of the Environment) and W. Ela (Univ. of Arizona-Department of Chemical and Environmental Engineering)

Partners: Tucson Water; Navajo Nation; U.S. Bureau of Reclamation

ABSTRACT

This project compares and contrasts state energy and carbon emission intensity and climate mitigation policies to examine how state resource endowments affect policy development and resource use. It also examines strategies to sequester carbon or reduce carbon emissions particularly through adoption of renewable energy technologies.

FINDINGS

Research estimated water requirements to meet electricity Renewable Portfolio Standards in western states if solar power supplied 100 percent of this demand. An ‘upper bound’ scenario assumes the most water-intensive solar thermal technology supplies all future demand while a ‘current technology’ scenario assumes water intensity will be comparable to the average of solar projects currently deployed. Water requirements by 2035

would be 0.8 percent of regional consumptive water under the upper bound and 0.2 percent under the ‘current technology’ scenario.

State-level per capita carbon dioxide emissions can differ significantly depending on whether emissions are estimated on a consumption basis versus a production basis. Accounting for emissions embodied in interstate electricity trade means that electricity-importing states have higher consumption-based emissions and electricity-exporting states have lower consumption-based emissions.

Other Funding Sources: USDA-National Needs Fellowship Program; U.S. Bureau of Reclamation; Arizona Technology and Research Initiative Fund

Health

Climate and Health

CLIMAS Investigators: A. Comrie, M. Butterworth, C. Morin, and H. Brown

Research Collaborators: P. Robbins, W. Van Leeuwen, E. Willott, J. Jones III (Univ. of Arizona-School of Geography and Development); K. Ernst, Y. Carriere, M. Riehle, K. Walker (Univ. of Arizona-College of Public Health)

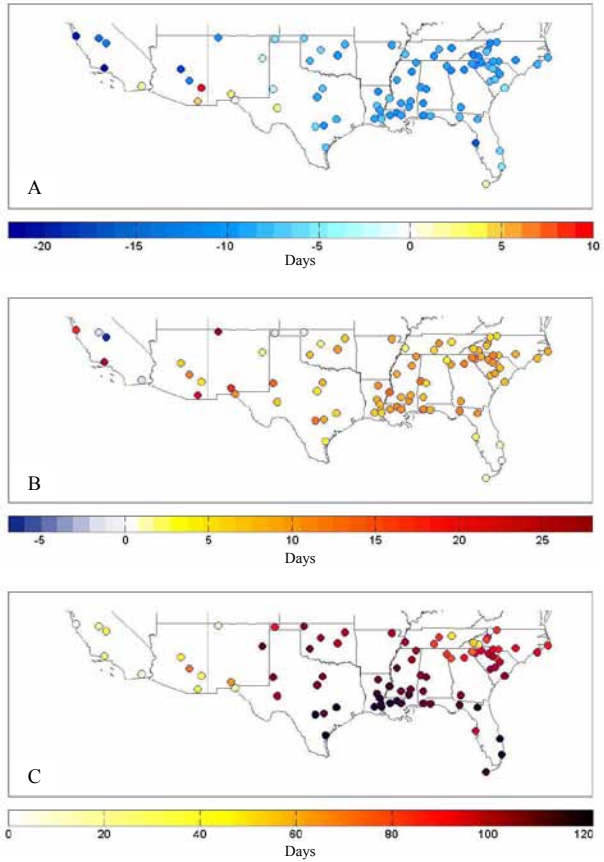
Partners: Santa Cruz County Health Department; Pima County Health Department; Arizona Department of Health Services

ABSTRACT

Climate change and variability can strongly control the population dynamics of disease vectors such as mosquitoes, altering their location and seasonality and possibly increasing the risk of disease transmission to humans. This project develops and implements a climate-based Dynamic Mosquito Simulation Model (DyMSiM) to understand and project climate effects on mosquito population dynamics and associated implications for public health, developing results that will help climate-health scientists and public health decision makers better understand and project the role of climate in actual disease cases.

FINDINGS

Climate can have a strong influence on dengue fever incidence by regulating vector populations and viral development. Although temperature and precipitation may support vector populations, temperature may be insufficient to promote viral replication within the vector. Conversely, temperatures may support vector population growth and viral replication, but insufficient precipitation can limit mosquito populations, resulting in limited virus transmission. These two scenarios were observed when using DyMSiM to model dengue transmission in San Juan, Puerto Rico.



Change in the start date (A) and end date (B) of the mosquito season. Number of days during summer when the mosquito population under baseline climate conditions exceeds that under projected future climate conditions (C).

HOLLY FAULSTICH

DELIVERABLES: PUBLICATION

Morin, C. 2012. Climate and Environmental Influences on the Ecology of Vectors and Vector-borne Diseases. Ph.D. Dissertation. School of Geography and Development, University of Arizona. Expands upon the Dynamic Mosquito Simulation Model to include a human transmission component and reviews the current research on climate-dengue connections.

OUTREACH

Butterworth, M. Snakes, Scorpions, and… Mosquitoes?! Mosquito life in Desert Environments. Flaundrau Science Center Installation. Summer 2012.

This public installation explained mosquito habitat and ecology in southern Arizona, communicating the climate-mosquito science conducted as part of this project. The specific focus was on micro-climates and micro-ecologies, seasonal climate and mosquito populations, possible future impacts of climate change on local mosquito vectors, and tools used to answer these questions.

Other Funding Sources: NSF ULTRA Project: Award # DEB- 09483334

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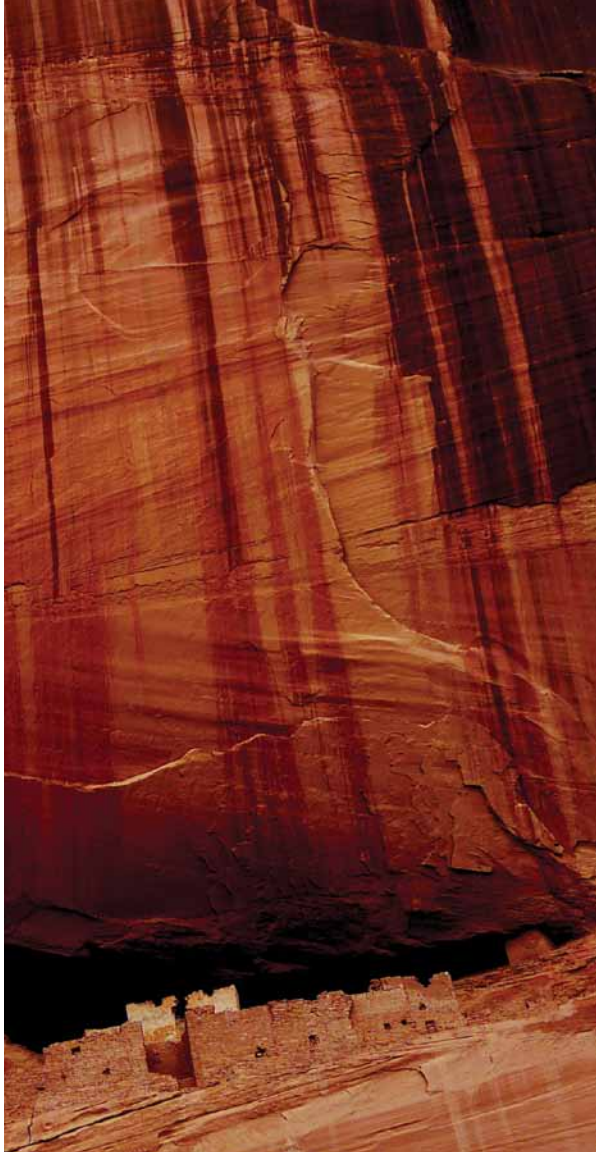

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