



Cultivating Equitable Responses to Increased Aridity in the US Southwest: The Climate Assessment for the Southwest

Progress Report: June 1, 2023–May 31, 2024

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WHAT IS CLIMAS?

The Climate Assessment for the Southwest (CLIMAS) is a NOAA-funded program that connects researchers and professionals at the University of Arizona, New Mexico State University, and the Inter Tribal Council of Arizona to partners from the private sector, academia, and local, state, federal, and tribal governments. Since 1998, CLIMAS has brought the best available scientific knowledge to weather and climate-related challenges in the Southwest. CLIMAS is funded by the NOAA Climate Adaptation Partnerships (CAP) Program (formerly known as Regional Integrated Sciences and Assessments, or RISA), which is designed to improve the use of climate information in decision making.



Photo credit: Nathan Burton/Taos News

Grant Number Descriptions

#NA17OAR4310288 (2017–2024): The CLIMAS team’s five-year proposal includes the following objectives: First is to determine the baseline conditions that critical regional social-ecological system buffers were meant to address and how those baselines have changed. This will address how changing temperature and precipitation regimes affect drought, surface water supplies, and impacts on economically important agriculture, and how these changes may be reducing the effectiveness or capacity of systemic buffers based on changing baseline conditions. Another proposed objective is to assess how regional social-ecological system buffers are currently functioning and how they are likely to perform in the future. This will address how effective different infrastructural, institutional, and informational buffers are in mitigating climate risks, what regions, groups, or industries are most vulnerable, and how present and future conditions may increase vulnerability if systems fail or if climate and demographic changes increase pressure on these systemic buffers. The third objective of the proposed work is to evaluate and describe the most effective approaches for supporting Southwest climate resilience efforts with best-available science. This will include expanding existing and building new collaborative partnerships, and working to better understand why and how different groups use drought and other climate information in their decision-making process. These objectives integrate CLIMAS expertise across a series of inter- and transdisciplinary projects that emphasize use-inspired research that connects innovative science with the practical needs of decision makers and planners. These connections work in the service of describing systemic vulnerabilities in the Southwest, assessing the impact of disruptions to this system, and determining how to best enhance the resilience of this system to ensure a sustainable future for the Southwest.

#NA22OAR4310547 (2022–2027): The CLIMAS team’s five-year agenda proposes three primary aims. First, we will implement a program-wide strategy of structured engagement processes across the region designed to identify new partners, specific climate equity issues we have expertise to address, and a refined set of research questions. Second, we will carry out integrated inter- and transdisciplinary research projects focused on the three most pressing climate adaptation issues in our region: water availability, increasing aridity, and extreme heat events. Because human health and well-being are inextricably woven through climate research in these three areas, we will leverage the engagements, partnerships, and research being done within each project to formally assess how a health lens might further support ongoing projects which do not explicitly consider health impacts at present. Finally, through formal trainings, informal “learning-by-doing” approaches, ongoing outreach activities, and development of climate services to more effectively share climate information throughout the region, we will increase the capacity of Southwest researchers and practitioners—at all career stages but with a focus on the next generation—to work collaboratively on community-focused, problem-oriented, equity-centered climate research. To ensure progress on our goals and accountability to ourselves, partners, and funder we have designed a set of new structures and processes to systematically assess and evaluate project and program progress; identify connections between research projects; and make strategic decisions about both course corrections and new opportunities. This integrative learning agenda will support internal decision making to improve programmatic outcomes, provide opportunities for social learning within our extended networks, and help ensure that we make progress on addressing societal problems.



Photo credit: Heidi Brown



Photo credit: Stacie Reece



Photo credit: Gigi Owen



Photo credit: Anne-Lise Boyer

2023–2024 CLIMAS RESEARCH TEAM

Principal Investigators



Daniel Ferguson
Director, Climate Assessment for the Southwest (CLIMAS);
Associate Professor, Department of Environmental Science;
Associate Professor, Arizona Institute for Resilience;
University of Arizona



Heidi Brown
Associate Professor, Public Health,
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Michael Crimmins
Professor & Extension Specialist — Climate Science;
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New Mexico State Climatologist; Assistant
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Alison Meadow
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Gigi Owen
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Co-Principal Investigators



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Research Specialist, Public Health,
University of Arizona



Stephanie Carroll
Associate Professor, Public Health Policy
and Management; Associate Director, Native
Nations Institute, University of Arizona



George Frisvold
Professor, Agricultural and Resource Economics,
University of Arizona



Hatim Geli
Associate Professor , Agricultural, Consumer and
Environmental Sciences, New Mexico State University



Kelly Jendrisak
Air Quality Coordinator, Inter Tribal Council
of Arizona (ITCA)



Ladd Keith
Associate Professor, Landscape Architecture
& Planning, University of Arizona



Lara Prihodko
Associate Professor, Animal and Range Sciences
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CLIMAS Staff & Postdoctoral Researchers



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Matthew Meko
Applied Climatologist, CLIMAS,
University of Arizona



Stacie Reece
Program Manager, CLIMAS,
University of Arizona



Rachel Rosenbaum*
Research Professional, CLIMAS,
University of Arizona

Graduate Assistants & Undergraduate Student Researchers

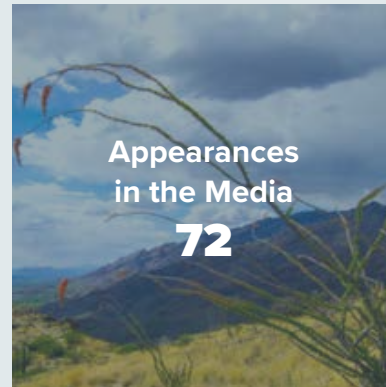
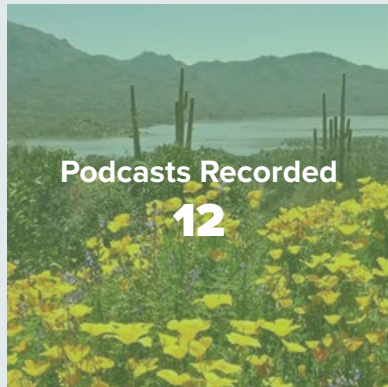
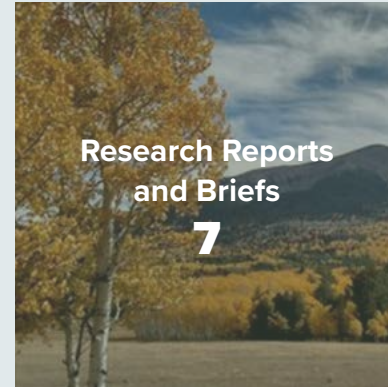
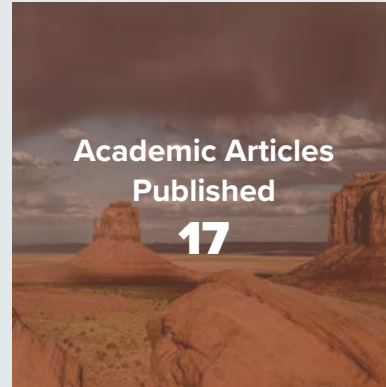
Tommey Jodie*, Jen Thorn*, Maile Urabe*, Kaitlyn Wolfe*, Rachel Zollinger*

Environment & Society Fellows

2023: Talia Anderson, Lucas Belury, Hannah Friedrich, Majerle Lister;
2024: Elise Arellano-Thompson*, Skylar Benedict*, David Manford*,
Patrick Robinson*

*denotes new additions to the CLIMAS team during the reporting period

CLIMAS BY THE NUMBERS 2023–2024



FEATURED ACCOMPLISHMENT

Southwest Burn Period Tracker



Photo credit: Zack Guido

The Southwest Burn Period Tracker (SBPT) is a tool that calculates and presents a simple fire weather index called Burn Period which is the number of hours per day where the hourly average relative humidity is less than or equal to 20%. This index, which was already informally used within the wildland fire management community but was not readily accessible through a common platform, is calculated daily at Remote Automated Weather Stations (RAWS) across the southwest U.S. The tool provides up-to-date Burn Period values at all RAWS in Arizona and New Mexico and adds climatological context and forecast information to these values.

The SBPT came about through long-term engagement and partnering with Chuck Maxwell, Predictive Services Manager at the Southwest Coordination Center. This long-term engagement allowed for the CLIMAS PIs and Maxwell to identify this fire weather information gap and explore how to meet this need to support fire management planning and response on the order of days to weeks. The team then was able to rapidly develop the system in 2021 using open-source data tools and existing web application programming interfaces to develop an

interactive website that provides real-time (daily) access to Burn Period values at over 120 RAWS across Arizona and New Mexico.

The SBPT is currently being used in regional to national briefings, is linked as a key resource on the Fuels/Fire Danger page of the Southwest Coordination Center website and has been accessed over 1400 times in 2023.

The overarching CLIMAS project consisting of an interdisciplinary team of PIs (climatologist, economist, social scientist) was focused on assessing the value of weather and climate information to wildland fire managers in the southwest U.S. This focus led to engaging with Mr. Maxwell as a key informant for the project but developed into a partnership where he became part of the team and helped drive additional research questions. This engagement and evolution into a partnership set the stage to identify new project ideas, like the need for the Southwest Burn Period Tracker.

Additional information can be found at the following links:

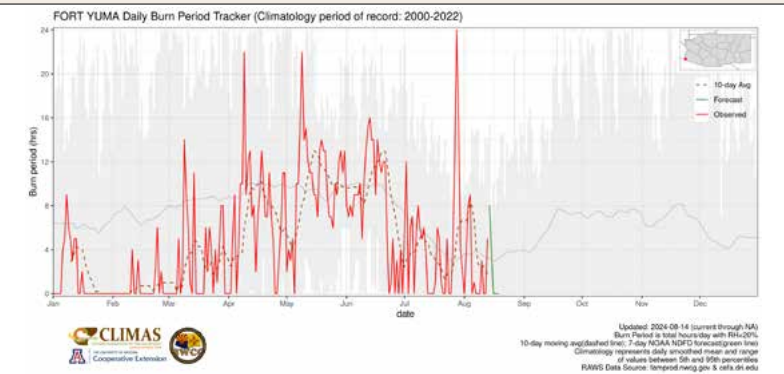
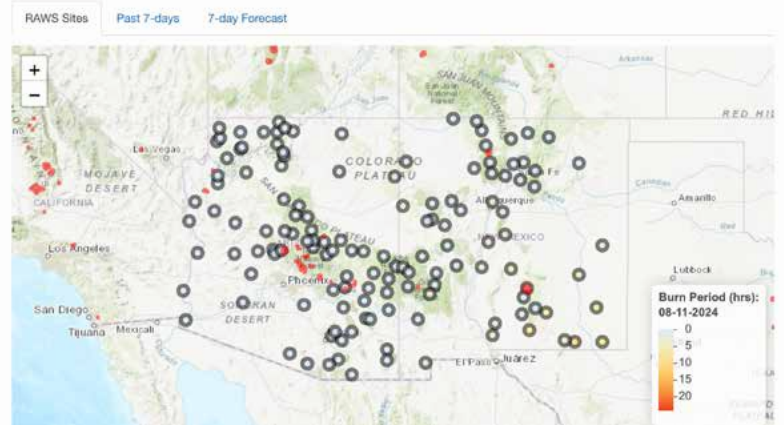
- [Climate Science Applications Program - University of Arizona Cooperative Extension: Southwest U.S. Burn Period Tracker](#)
- [Southwest Coordination Center - Predictive Services - Fuels / Fire Danger](#)
- [ArcGIS version of the Tracker for integration into national, wildfire assessment platforms](#)
- [Burn Period Tracker Archive \(requested by NIFC for training and research purposes\)](#)

Southwest U.S. Burn Period Tracker

Updated: 2024-08-12

This page provides access to an experimental fire weather monitoring product called the Burn Period Tracker. Burn period is defined as the number of hours per day where the hourly average relative humidity is less than or equal to 20% and is calculated at [Remote Automatic Weather Stations](#) with real-time data and several years of historical data. Values range from 0 to 24 hours per day with higher values associated with increased fire danger.

Click on markers on the map below to access Burn Period Tracker plots and recent observations at available RAWS sites (Click on marker to bring up plot and observation links; click again to access either product). Active and recent fires are shown in red polygons on the map. Burn Tracker Plots and recent observations are also available through the table below the map.



Operational at SWCC

NEW AREAS OF FOCUS OR PARTNERSHIP

NOAA Cross-RISA Project: Health and Social Services in the Long-Term Wildfire Recovery of Rural Communities

In 2023, CLIMAS in partnership with University of Colorado Boulder were awarded \$473,798 through the Bipartisan Infrastructure Law for a four-year project to identify complex interactions between social infrastructure and wildfire risks to improve community adaptive capacity. The project will identify long-term wildfire recovery needs of rural frontline communities through engagement with social workers and public health providers in communities recovering from the impacts of wildfire in Colorado and New Mexico. Two workshops in Colorado and New Mexico will convene the social work and public health communities with wildfire planning and policy communities to jointly identify lessons learned and best practices that promote long-term recovery of rural frontline communities.

The role of social work and public health sectors in long-term wildfire recovery remains understudied and not well integrated into wildfire planning and policy. This project seeks to produce actionable knowledge on social infrastructure that reduces the long-term impacts of wildfire on frontline communities through the following objectives: 1) identify long-term wildfire recovery needs of rural frontline communities through engagement with social workers and public health providers in communities recovering from the impacts of wildfire in Colorado and New Mexico; and 2) build relationships, foster knowledge exchange, and identify lessons learned in wildfire community recovery between social workers, public health professionals, and wildfire recovery professionals.



Photo credit: Zack Guido

OUTREACH AND ENGAGEMENT

CLIMAS researchers engage with communities, including frontline and underserved communities through presentations, workshops, public events, and several online communication tools such as newsletters, data hubs, and interactive websites.

CLIMAS Project Engagement Activities

Building Regional Food System Resilience in Southern Arizona

G. Owen and CLIMAS partnered with the Pima County Food Alliance, a local food policy council, to co-host a community event in December 2023 at a community farm, Las Milpitas, in Tucson, AZ. Over 50 Tucson community members attended, with food, music, and art. A main goal was to share findings from data collection on community-identified needs, and provide opportunities for public participation in analysis, networking, and community building. Information gathered at the event was subsequently added to the analysis and final reports, which were used by Pima County Food Alliance to rebuild their organization. Participants included small scale farmers, food businesses, food-related organizations, and community members.

G. Owen and R. Zollinger, in collaboration with the Pima County Food Alliance and Tucson Museum of Contemporary Art, conducted an arts-based public engagement/research activity, held at the Museum's Free Third Thursday event in May 2024. Drawings and interview responses were collected about nourishment, community resilience, climate, and the local food system. These will be used for visual analysis and peer-reviewed publication. Participants were members of the general public, ranging from youth to adults. A main goal is to test arts-based research methods to broaden participation in climate research and expand the types of information gathered.

Supporting Heat Resilience in Frontline Communities

CLIMAS team members L. Keith, S. Reece, H. Brown, and K. Wolfe co-organized the 2024 Southern Arizona Heat Planning Summit in Tucson, AZ in February 2024. Other organizers included the City of Tucson, Pima County, the University of Arizona's College of Architecture, Planning, and Landscape Architecture, and the Mel and Enid Zuckerman College of Public Health. The workshop hosted over 200 key decision makers and stakeholders to provide input on local efforts to address extreme heat. Attendees included emergency managers, health practitioners, heat-related practitioners and community members. Attendees split into groups focused on different areas of heat planning (e.g., the built environment, public health, energy). In the afternoon, attendees generated ideas for heat mitigation and management strategies.

New Mexico Resilience

D. Dubois, S. Reece, and M. Meko assisted with the New Mexico Energy Minerals and Natural Resources Department's Climate Policy Bureau's series of community conversations and listening sessions across New Mexico to collect feedback on the first State Climate Adaptation and Resilience Plan. In-person events were hosted in six communities with additional opportunities for input online. Each event lasted 90 minutes and was followed by a social hour with food & refreshments. Audiences were composed of state and local agencies, NGOs, and members of the public.

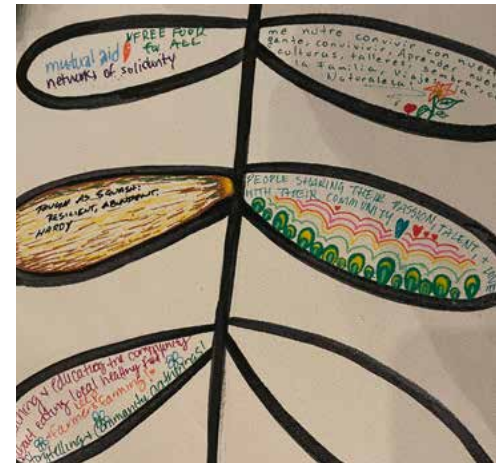


Photo credit (both): Gigi Owen

Climate Information Tools



[The Southwest Climate Outlook \(SWCO\)](#)

SWCO summarizes climate and weather information from disparate sources in nonscientific language, providing more than 1,600 people with monthly 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. Twelve issues were distributed between June 2023 through May 2024.

[Rainlog.org Monthly Climate Summary Email Newsletter](#)

M. Crimmins authored and sent twelve newsletter issues between June 2023–May 2024 to subscribers and those who log rain event totals.

Arizona Seasonal Climate Summary

Arizona Range and Livestock Newsletter. M. Crimmins authored quarterly climate summaries for this newsletter produced by University of Arizona Cooperative Extension.

[The Southwest Climate Podcast](#)

CLIMAS scientists discuss climate-related issues in monthly climate podcasts. The podcasts synthesize information from disparate sources that often do not have a Southwest bent, translating the national and global discussions into what it means for the Southwest. Twelve episodes aired between June 2023 through May 2024. In December the program engaged listeners to send in their questions for a special MailBag episode.

[University of Arizona Extreme Heat Network](#)

L. Keith distributes a monthly newsletter to 200+ subscribers from across the U.S. Other members of the network send requests to help promote their opportunities, such as grants or partnerships, related to heat.



Photo credit: Anne-Lise Boyer

Data Hubs and Online Tools

[Southwest U.S. Summer Monsoon Season Precipitation Mapping](#)

A near real-time monsoon season precipitation mapping system was developed in May 2019. Several updates were added to maps and charts in 2020 and 2021. This mapping product is often used for the SWCO and podcasts. In 2022, the product was integrated into a revised National Weather Service monsoon tracker: [NWS-Tucson: Monsoon](#). New state-level map pages for [Arizona](#) and [New Mexico](#) were added in 2022. This page continues to be updated and maintained.

[Southwest Monsoon Fantasy Forecasts](#)

Players estimate the total monthly precipitation at each of the five major cities in the U.S. Southwest Monsoon region: Tucson, Phoenix, Flagstaff, Albuquerque, and El Paso. Points are awarded each month depending on the accuracy of the estimate compared to the actual observed rainfall. The goal is to accumulate the most points over the July, August, September period. The game was piloted in 2020 via the [Southwest Climate Podcast](#), hosted by CLIMAS researchers M. Crimmins, Z. Guido, and S. Reece. The 2024 launch will feature groups for participants to join and compete against each other.

[Climate Reports for Natural Resource Management and Planning](#)

This site hosts climate reports generated for natural resource managers who use weather and climate information to make land management decisions. Through a collaborative process, highly-specialized and customized reports are designed for land management units using open source code and readily available data. So far, partners include: Kaibab, Coronado, Lincoln, Prescott, and Tonto National Forests, Major Land Resource Areas (USDA-NRCS), Hopi Department of Natural Resources, and Pima County Rangelands.

[Southwest U.S. Station Climate Summaries](#)

This hub houses station-based climate monitoring plots for 118 stations across Arizona and New Mexico. Interactive historical plots of temperature and precipitation were added in 2022 for each station with updated website and near-real time updates to plots each morning. This page continues to be updated and maintained.

[Standardized Drought Index Visualization Tool](#)

This interactive R-based Shiny app can be used to plot and explore drought indices calculated using NOAA NCEI climate division data. Plots are used in state level drought monitoring, by other climate monitoring efforts, and for general CLIMAS related outreach effort. Several updates were added in 2021 and the page continues to be updated and maintained.

[myRAINgeLog](#)

This online data management and visualization tool is designed for ranchers and land managers who collect and interpret cumulative precipitation observations at remote sites. The account-based tool allows users to collect, manage and analyze multiple gauges and share observations through a public mapping feature. Custom reports can be generated for each gauge with accompanying charts of observations against historical climate conditions and summaries of field notes and photos entered by the user. The site is updated daily. The tool has continued in development as part of a broader rangeland precipitation monitoring program that started in 2017. New features were added in 2022, with additional training workshops conducted online in 2021. A [YouTube channel](#) with videos was also added in 2021. This page continues to be updated and maintained.

[Arizona Station-based Drought Tracker](#)

A new, real-time station-based drought tracking page was posted in spring of 2021 to assist with short-term drought monitoring in Arizona. This tool accesses precipitation data from over 1300 rain gauges from different networks including volunteer observers (e.g., Rainlog.org, CoCoRAHS, and home weather stations) to develop drought index values at time periods from the most recent 30 days to the past 365 days. The intention of this tool is to support fine scale adjustments of the U.S. Drought Monitor map across Arizona using as much observation data as possible. This page continues to be updated and maintained.

Burn Period Tracker

A new monitoring tool developed in collaboration with the Southwest Coordination Center that provides access to an experimental fire weather monitoring product called the Burn Period Tracker. Burn period is defined as the number of hours per day where the hourly average relative humidity is less than or equal to 20% and is calculated at Remote Automated Weather Stations with real-time data and several years of historical data. Values range from 0 to 24 hours per day with higher values associated with increased fire danger. This tool is currently used by fire managers working across the Southwest. [ArcGIS version](#) of the Tracker for integration into national, wildfire assessment platforms and [Burn Period Tracker Archive](#) (requested by NIFC for training and research purposes).

Southwest U.S. NFDRS Charts

A new monitoring tool developed in collaboration with the Southwest Coordination Center depicts real time and forecasted values of two standard fire danger indices part of the National Fire Danger Rating System: Energy Release Component and Burning Index. Charts are updated each evening using NFDRS data from the Weather Information Management System and plotted against climatological information generated for each Southwest Predictive Service Area by FireFamily+. This tool is currently used by fire managers working across the Southwest.



Photo credit: Anne-Lise Boyer



Photo credit: Anne-Lise Boyer



Photo credit: Stacie Reece

Selected Workshops and Seminars

D. Dubois co-led two **New Mexico NASA Earth to Sky workshops** with the South Central Climate Adaptation Science Center. These educational workshops on climate change were designed to help participants develop climate change action projects. 1. Rio Grande Nature Center, Albuquerque, NM. 24 participants from state, federal and private parks attended this workshop. 2. Tribal Earth to Sky workshop, Los Alamos, NM. 15 tribal members across the state attended.

L. Prihodko and D. Dubois co-organize the [CAMBIOS Seminar series at New Mexico State University](#). The series has existed since 2018 and each year hosts 4–6 speakers presenting on a range of topics connected to climate change. Speakers are local, regional and national in nature and present on topics such as art, science, economics, law, and defense. ([Cambios 2023–2024 Speakers](#)).

L. Keith moderated the **8th Annual Arizona Extreme Heat Planning Workshop** in April 2024, in collaboration with the Arizona Department of Health Services, National Weather Service, Arizona State University, and University of Arizona. Because of CLIMAS's current focus on rural, border, and tribal heat resilience, Keith organized and moderated a panel specifically on heat resilience across the state with perspectives from Yuma, AZ and the Navajo Nation in addition to Tucson and Phoenix.

D. Dubois, co-led a **Partners in Preparedness Heat Planning Workshop**, with the New Mexico Department of Health in Isleta, NM. 25 attendees from primarily state and local agencies. Follow-on information from this workshop was given at the National Weather Service Integrated Warning Team briefings at the NWS El Paso and Albuquerque offices.

Photo credit: Ladd Keith



Photo credit: Stacie Reece

Selected Presentations

D. Dubois. Tribal Drought Workshop, May 2024 at Southwest Indian Polytechnic Institute, Albuquerque, NM. This workshop convened to discuss issues related to tribal drought plans and sources of information for addressing drought in tribal areas.

D. Dubois. New Mexico Water Data Initiative Workshop 2024: Accessing Data, May 2024, Albuquerque, NM. This workshop explored issues related to accessing water resource data in New Mexico and related to the state's Water Data Act passed by the NM State Legislature.

D. Dubois. Navajo National Climate Adaptation Workshop, March 2024 at Diné College, Tsaile, AZ. Workshop provided a forum for farmers, ranchers, and community members to share successes, challenges, opportunities, and ideas for land stewardship in a changing climate. Dubois gave a drought and seasonal climate outlook.

D. Dubois. Drought Status Update and Outlook. Tribal Rainwater Harvesting and Soil Testing Workshop, September 2023. Pueblo of Santa Ana, NM. Workshop was jointly held by the USDA Southwest Climate Hub Drought Learning Network and the Pueblo of Santa Ana.

D. Ferguson. A Quick Tour through Arizona Climate and Water Connections. Water Wise Arizona, Arizona House of Representatives. March 2024. Phoenix, AZ.

D. Ferguson. Climate Trends and Projections for the Water Sector. Inter Tribal Council of Arizona, Annual National Tribal Water & Wastewater Operator Workgroup Meeting. September 2023. Phoenix, AZ.

C. Woodhouse. The Influence of a Variable and Changing Climate on Upper Gila River Streamflow. University of Arizona, Tumamoc Hill Lecture Series, Tucson AZ, March 2024.

Selected Online Content

Podcasts, Opinion Pieces, Interviews, Quotes, and Blog Posts

CLIMAS PIs were interviewed or quoted in 72 media stories this year. Selections include:

- *Arizona Science* (Arizona Public Media), about weather patterns that determine monsoon activity in our region and in other spots around the world: "[The Monsoon and Climate Change](#)." (M. Crimmins)
- KGUN9 News. "[Heat maps help plan cooling efforts](#)." September 11, 2023. (L. Keith)
- KRWG Public Media about drought, snowmelt, river runoff, and climate change in New Mexico—"Experts warn rising temperatures will impact water conservation efforts." (D. Dubois)
- *The New York Times*, about the 2023 summer heat and lack of precipitation: "[Heat Endures in the Southwest as the Monsoon Season Lags](#)." (M. Crimmins)
- *The New York Times*, about record heat in Phoenix: "[Phoenix Breaks Heat Record Set in 1974](#)." (M. Crimmins)
- *The Washington Post*, about spring weather and climate: "[When will spring come? Or has it already? Look up where you live](#)." (M. Crimmins)



Photo credit: Anne-Lise Boyer

Social Media

New Mexico Climate. David DuBois continued his use of Twitter via the NM Climate Center account (@nmclimate). This account had 3,373 followers as of June 2024. Activity on this Twitter account generates off-line conversations with local and national media. DuBois posts information, graphs, statistics, and photos of dust storms that impact southern New Mexico. NM Climate is also on [Instagram](#) with 1,390 followers.

CLIMAS Twitter. The CLIMAS program's Twitter account (@CLIMAS-UA) has 1,081 followers as of June 2024. Posts that generated the highest amount of interest were related to job announcements, guest speaking events, summer monsoon, the Southwest Climate Podcast, and the Southwest Climate Outlook.

CLIMAS LinkedIn. In 2023 the CLIMAS program created a LinkedIn profile to increase professional engagement. As of June 2024, there were 262 connections in the CLIMAS network.

CLIMAS PI M. Crimmins (Twitter @mike_crimmins) posts on climate conditions, drought impacts, tools/information and retweeting CLIMAS products like SWCO and podcasts. He has 997 followers and posted about 100 tweets over the past year.

CLIMAS PI L. Keith (Twitter @laddkeith) posts about extreme heat conditions, urban planning, and climate change in the Southwest. He has 1,789 followers and posts regularly. [Keith's LinkedIn](#) has 3,422 followers with a strong presence from planning and climate adaptation practitioners. He is also on Threads (@laddkeith) with 185 followers and Bluesky (@laddkeith.bsky.social) with 90 followers.



Photo credit: Kelly Jendrisak & Matt Meko

SELECTED RESEARCH FINDINGS AND HIGHLIGHTS

Building Regional Food System Resilience in Southern Arizona

This project analyzes cascading economic, climate, and societal risks in southern Arizona's local food system. The pandemic crisis that began in 2020 highlighted several long-standing issues in the local food system, including inequities in food access, food policy, food production and distribution, and food sovereignty. It also revealed strengths in the local food system and opportunities to address these issues while building a more equitable food system that is resilient to future environmental, climate, economic, and health risks. This research serves not only to identify these risks but to use them to support community-driven solutions and policy needs that address multiple issues at once. To support this effort, we engaged over 100 people across the county's food system through focus groups, interviews, and community events.



Photo credit: Gigi Owen

The top community-based priorities for local food policy in Pima County are:

- Increasing support for farmers and producers through workforce development, infrastructure, financial support, farm-to-institution channels, and increased access to local, climate adapted seeds.
- Promoting sustainable water and land use through reduced water rates for small local farms, exploring community ownership models for small-scale agriculture, combining efforts with city and county sustainability initiatives, and incentivizing passive water harvesting.
- Reducing food waste through education, financial incentives, and large-scale composting.
- Increasing food access through expansion of local markets and distribution hubs, assistance in applying for benefits like SNAP, and support for local businesses to accept SNAP as a form of payment.
- Identifying reasonable food safety regulations by building partnerships with the county health department, farms, and small businesses.

Water Availability



This project aims to investigate relationships between climate and streamflow at watershed scales that are meaningful to decision makers in northern New Mexico. This research evaluates these relationships for the period with recorded climate and streamflow data (the last 40–80 years), while also assessing changes in these relationships due to warming temperatures and changes in streamflow over time. Initial findings for the Rio Grande gage near Del Norte, Colorado include:

- Wet conditions during the 1980s and 1990s are driving a statistically significant decreasing trend in annual streamflow for 1980–2022, but significant trends are not apparent over other time periods.
- Analyses of monthly and daily streamflow suggest changes in peak runoff are occurring (e.g., a shift in volume of flow to earlier in spring; and the peak timing of streamflow has shifted 1–2 days earlier per decade).
- Runoff efficiency, largely influenced by temperature, has decreased over the period of continuous record.



Photo credit: Kelly Jendrisak



Photo credit: Anne-Lise Boyer

Tools and Weather/Climate Information Used by Wildland Fire Managers in the Southwest United States

Wildland fire management in the US is complicated, expensive, and requires a substantial amount of scientific data and information across a huge range of temporal and spatial scales. Although state and federal agencies as well as academic research groups have devoted substantial resources to develop data products, forecasts, outlooks, and decision support tools for wildland fire management there has been relatively little research done to assess how these have been used to inform wildland fire management decisions.

While there are a wide range of sources of weather and climate data available to Southwest wildland fire managers, most people consult only about one third of them. Most decision support systems are not used by wildland fire managers to inform decisions. The primary decision support system, the Wildfire Decision Support System (WFDSS) is widely perceived as a useful tool for documenting decisions, but not for informing decisions.

PROGRAM EVALUATION AND LEARNING AGENDA

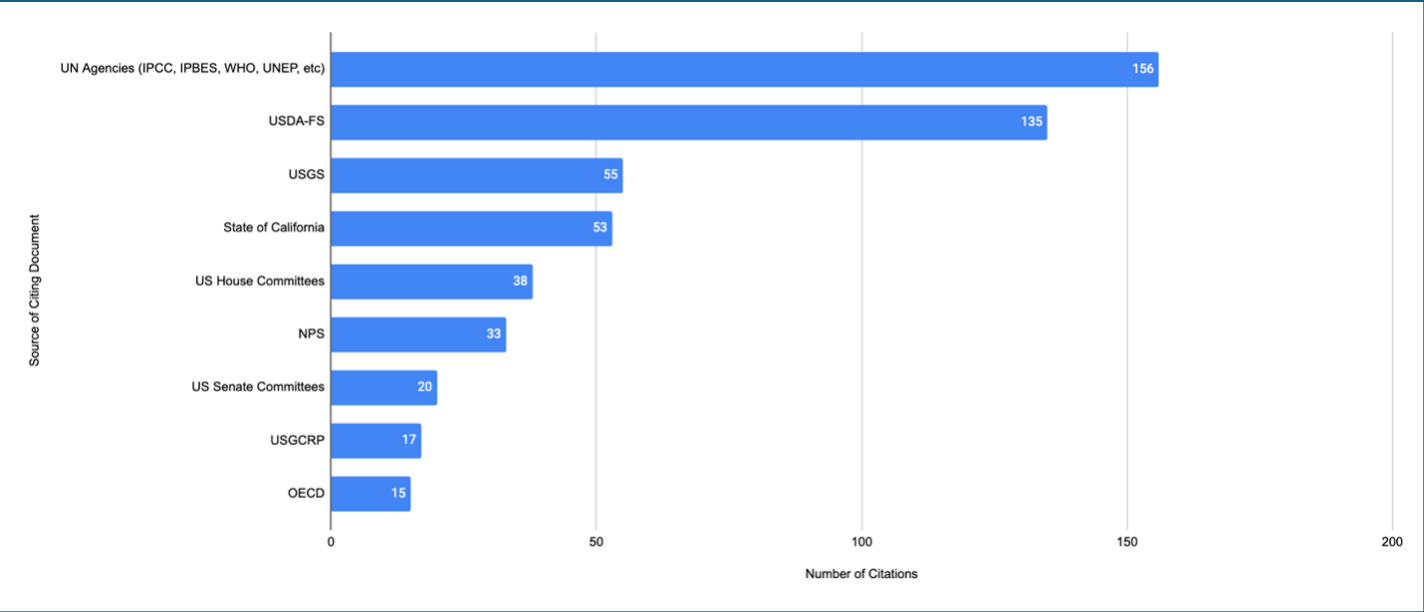
CLIMAS Investigators: A. Meadow, G. Owen, R. Rosenbaum

Transdisciplinary research, such as that done within the CLIMAS program, requires innovative evaluation to ensure that the research is robust, applicable to, and used by decision makers to increase resilience and improve well-being in our region. To connect science with decisions requires attention to the quality of engagement between researchers and societal partners—these relationships should be both substantive and equitable. And the outcome of these partnerships should be usable knowledge, as judged by those who need to use it.

In Year 2 we have focused most of our work on formative evaluation activities designed to support the research teams as they develop new partnerships and refine their research projects. We met with each research team to refine their project theories of change and logic models, noting any adjustments to research focus or questions since Year 1. We then facilitated actor-mapping sessions with each of the research teams. Actor mapping is a systematic process of identifying key actors (or groups) who are directly affected by the issue being researched and may be valuable research partners because of their direct experience (see example actor map below). Some common themes from the actor mapping exercise were a focus on community organizations or municipal- and county-scale governments. We continue to look for opportunities for teams to collaborate, integrate research activities where appropriate, and reduce potential burden on partners in our region.

As part of our learning agenda, we also met with the whole CLIMAS team periodically to identify shared learning goals and overlaps between CLIMAS learning goals and those identified by DOC-NOAA through the federal learning agenda process. As the CLIMAS teams generate research findings, we will coordinate opportunities for shared learning from the research and for sharing findings that could address NOAA learning goals.





We continue to use our societal impacts framework to evaluate our effectiveness in linking climate science with decision making. One example of how we are evaluating our instrumental impacts is by analyzing the policy impacts generated by CLIMAS research. Using the Overton database of policy documents, we found that 45% of all peer-reviewed publications generated by CLIMAS between 1999 and 2023 have been cited in a policy document by a government agency, intergovernmental organization, or think tank. Fifty-nine percent of the policy documents using CLIMAS work were generated by governmental entities (municipal, state, or federal); 22% were used by intergovernmental organizations (i.e IPCC, WMO, etc); 19% were cited by think tanks (i.e. Stockholm Environment Institute, Brookings Institute); and 1% were used by organizations like the Australian Analysis and Policy Observatory that aggregate policy-relevant materials for use by government policy makers. The most frequent single agency user of CLIMAS research to-date is the USDA Forest Service, which has cited CLIMAS research 135 times. However, UN agencies combined (e.g., UN Environment Programme, IPCC, World Health Organization) have cited CLIMAS research a total of 156 times.

In Year 3 we plan to repeat our formative evaluation check-ins by meeting with each research team to discuss research progress, barriers, and next steps. As teams intensify their collaborations with societal partners, we will begin the process of tracing research impacts by documenting any early outcomes.

Meadow, A.M. and G. Owen. 2021. *Planning and Evaluating the Societal Impacts of Climate Change Research Projects: A Guidebook for Natural and Physical Scientists Looking to Make a Difference*. University of Arizona, Tucson. <http://doi.org/10.2458/10150.658313>.

Meadow, A.M., G. Owen, N. Joshi, and E. Lodge Otto. 2024. Combining Impact Goal and Impact Descriptor Frameworks to Elucidate the Societal Impacts of Research: A Pilot Study. *Research For All*. <https://doi.org/10.14324/RFA.08.1.03>.

EVIDENCE AND CASE STUDIES OF SOCIETAL IMPACT

Supporting Heat Resilience in Frontline Communities

In February 2024, CLIMAS team members L. Keith, S. Reece, H. Brown, and K. Wolfe co-organized and participated in the Southern Arizona Heat Summit, held at the University of Arizona, in Tucson. Over 200 attendees provided input on local efforts to address extreme heat, including emergency managers, health practitioners, heat-related practitioners and community members. This workshop directly led to development of the [City of Tucson's Heat Action Roadmap](#), passed by Mayor & Council on June 5, 2024. L. Keith served as subject matter expert to develop the plan and his research was cited as the foundation of the plan's strategies. The workshop also led to the formation of a Joint Heat Action Team (J-HAT) run by Pima County and the City of Tucson, AZ. As part of this project, L. Keith also participated in working groups that led to [The Arizona Extreme Heat Preparedness Plan](#), a statewide heat planning effort, and provided heat data and research that was used to develop the plan.

Active and Collaborative Climate Services: Developing Customized and Automated Climate Reports to Support Natural Resource Management and Planning

Ongoing meetings and presentations and iterative engagement with land managers in the U.S. Forest Service in the Southwest have highlighted increased understanding of different climate datasets and drought indices like the Standardized Precipitation Index. The automated climate reports produced through this project are improving access to diverse climate datasets and providing local summarization. Managers have communicated that reports are helping them discuss local conditions with other land users like grazing permittees.

Building Regional Food System Resilience in Southern Arizona

In February 2023, the project team was invited to present results from this work to the Tucson Mayor and Council at their study session, in support of a reduced water rate for small-scale urban farmers in the City of Tucson. A pilot project was approved by the Mayor and Council in November and finalized in April 2024. While this lower water rate can improve economic yields for small scale farmers, the stipulations in accessing this rate also require farmers to use one or more water conservation practices and distribute their products in underserved and low-income communities in Tucson. It aims to improve local economic livelihood, reduce water consumption, and increase food security. CLIMAS will support monitoring this water rate pilot program to measure those outcomes.

New Mexico Resilience

For the New Mexico Resilience project in 2023, CLIMAS provided expertise and data to help determine the major climate risks for the State through charts, graphs and maps. Presentations were given by D. Ferguson, M. Meko, and D. DuBois to New Mexico State Agencies and their representatives covering these aspects to inform the development of the state's Climate Adaptation and Resilience Plan. In 2024, CLIMAS provided assistance in preparation for the Community Conversation sessions for climate risk visuals that would be printed on large poster board and displayed on easels during the open house portion of the session. One example is where CLIMAS provided resources in creating maps with a digital flood data layer to show the risks for that particular locality. CLIMAS also attended and facilitated discussions at these sessions to answer questions or clarify the data provided on the displays for attendees. Through these efforts, CLIMAS is now seen as a valuable resource to both the State of New Mexico agencies as well as community stakeholders.

ENVIRONMENT & SOCIETY FELLOWSHIP PROGRAM

The [Environment & Society Fellowship](#) was created in 2013 by CLIMAS, with support from the University of Arizona Office of Research, Innovation, and Impact. The fellowship, managed by CLIMAS Investigators G. Owen and C. Greene, provides training and funding for graduate students to practice use-inspired research and science communication. Since its inception, the Fellowship program has funded 35 graduate students.

2023 Environment and Society Fellowship Projects

Talia Anderson is a PhD candidate in the School of Geography, Development and Environment and in the Laboratory of Tree Ring Research. Her research focuses on climate variability and change and its impacts on ecosystems and communities. She uses a variety of data types, from satellite imagery to household surveys, to explore climate impacts in both local areas and large, multi-country regions. Talia is motivated to build collaborations with potential users of climate information, so that her research can more broadly inform decision-making and action surrounding climate change. [“What’s going on with the rains?”](#)

Lucas Belury (he/him/el) is a geography PhD student at the University of Arizona interested in centering the lived experience of communities on the margins. His research projects include environmental racism along the US-Mexico border, knowledge co-production, and queer archival research in South Texas. He has published articles on urban informality, environmental justice, and race equity. His current work utilizes the Latinx cultural concept of testimonios, or testimonies, to elevate underprivileged voices and move the needle on (in)equity and (in)justice. [“Flood Justice in South Texas”](#)

Hannah Friedrich is a PhD Student in the School of Geography, Development and Environment. With a background in remote sensing, she explores how to align satellite-based indicators of post-hurricane recovery with interview and survey data on household finance to identify limitations households encounter in adapting to changing climate risks.

Hannah’s longer-term research agenda is to work alongside disaster-impacted communities to translate inequities documented with satellite imagery to policymakers and advocate for more just climate adaptation. [“Mapping tarps and stories to spotlight inequitable disaster recovery”](#). This blog post was cited in a New York Times opinion article in October 2023 by Samantha Montano entitled, [America’s Disaster Recovery System Is a Disaster](#).

Majerle Lister is a Navajo Ph.D student in the School of Geography, Development, and Environment Department at University of Arizona. His work focuses on Navajo geography as it relates to land regimes, development, and extractive economies. His ethnographic research emphasizes Native sovereignty and self-determination. Working with local conservation volunteers, he collaborates with local community members to understand how archived soil surveys from the 1930s and 1940s shed light on historical questions and contemporary political and environmental issues in the Navajo Nation. [“Re-Thinking Land and History: Working with Navajo Mountain Soil Water Conservation District Members”](#)

Special Edition Southwest Climate Podcast—2023 E&S Fellows: This episode of the podcast features participants in the 2023 CLIMAS Environment & Society Fellowship program. They share more about their work and what they learned about conducting collaborative research over the past year. <https://climas.arizona.edu/podcast/special-edition-sw-climate-podcast-2023-es-fellows>

2024 Environment and Society Fellowship Projects

[Building Resilience Through Data: Co-producing a Flood Database](#)—Elise Arellano-Thompson, School of Geography, Development and Environment

[Supporting and Analyzing the Dynamics of Ecological Restoration Projects in Bahía de Kino, Sonora](#)—Skylar Benedict, Sociocultural and Applied Environmental Anthropology

[Promoting makerspace sustainability through education and open-source tools](#)—David Manford, Department of Systems and Industrial Engineering

[What is “Nature,” now? Science, Alliance, and Informed Local Self-Determination in Intag, Ecuador](#)—Patrick Robinson, Sociocultural Anthropology

COMMUNITY SMALL GRANTS PROGRAM

The community small grants program is intended to provide direct support to Indigenous communities in Arizona and New Mexico to work on pesticide management, an emergent and under-resourced climate and health challenge. The two overarching goals of the program are: 1) Provide regional Indigenous communities with training and information on safe and effective pest management and/or other climate related management strategies that promote community resilience in the facing of changing climate; and 2) Build connections between ITCA, members of the CLIMAS research team, and Indigenous communities to provide a foundation for ongoing work related to community health in the context of climate change.

This project has not yet been implemented; however, we have been collaborating with ITCA pesticide management staff to identify potential gaps in tribal pesticide program needs that align with the focus of the program but do not duplicate efforts. A main area of potential need is to not only focus on agricultural staff working with pesticides, but to also consider public health staff working on structural integrated pest management.

CHALLENGES

Challenges over the past year were mostly related to hiring and personnel which caused changes in moving project activities forward as originally planned. As well, many of the current projects aim to work with new partners in underrepresented parts of the Southwest region and this relationship building phase takes time. However, CLIMAS investigators have adjusted their expectations to allow for these changes and shifted to other project activities as needed.



Photo credit: Anne-Lise Boyer

NEXT STEPS FOR 2024–2025

Over the next year, CLIMAS project teams will continue to build the relationships and conduct the research needed to collaboratively design and implement their research. Several projects from the previous phase of CLIMAS research will be submitting final research reports and peer-reviewed publications. Supported by the CLIMAS evaluation and learning agenda, we will continue to document our engagement and research development process. Below are selected next steps for current CLIMAS projects:

Climate Services:

- Refine climate reports through ongoing meetings with land managers
- Develop new reports for remaining National Forests in Region 3 and for Hopi Department of Natural Resources
- Develop evaluation and assessment strategies to gauge impact of reports

CLIMAS Training and Education

- Develop ways to track the use and application of the CLIMAS ethical engagement guidelines
- New cohort of four Environment & Society Fellows at the University of Arizona and two at New Mexico State University

Community Small Grants Program

- The creation and release of the Community Small Grants Program will begin operation to support Indigenous communities to deal with climate and pest management issues.

Increasing Aridity

- Publish paper on complex drivers of fire risk across the Southwest U.S. in a changing climate. Results will also be shared at the Southwest Fire Ecology Conference in November 2024.

Heat Resilience

- Two new postdoctoral research associates beginning in summer 2024 will analyze results from a rural heat survey in Arizona and New Mexico and submit a literature review for publication.

Water Availability

- Develop new fact sheets for basins of interest with scenarios for future streamflow under warming conditions
- Potentially pursue a collaborative qualitative case study of New Mexico acequia water resources

Photo credit: Gigi Owen



Photo credit: Hannah Friedrich



Photo credit: Dave DuBois



Photo credit: Stacie Reece

APPENDIX A: PUBLICATIONS 2023–2024

Austhof, E., S. Warner, K. Helfrich, K. Pogreba-Brown, **H.E. Brown**, Y.C. Klimentidis, E. Scallan Walter, R.H. Jervis, and A.E. White. 2024. Exploring the association of weather variability on *Campylobacter* - a systematic review. *Environmental Research* 252(1):118796. This review explores what is known about the influence of weather events on *Campylobacter* and identifies previously underreported negative associations between low relative humidity and sunshine on *Campylobacter* infections. <https://doi.org/10.1016/j.envres.2024.118796>

Bhakta, A., K. Bartels, **R. Gildersleeve**, **G. Owen**, **R. Leih**, S. Thompson, L. Bellante, and **A. Hilton**. (2024). Community Priorities for Food System Action in Pima County, Arizona: Report of Interview and Focus Group Findings. Food Systems Research Lab and Climate Assessment for the Southwest (CLIMAS), University of Arizona. This report presents community identified needs and priorities for the local food system in Pima County, AZ.

Brown, H.E., **E. Austhof**, P.M. Luz, and **D.B. Ferguson**. 2023. Economics, health, or environment: What motivates individual climate action? *PLOS Climate* 2:e0000177. A highlighted finding from this paper is that respondents who expect to experience impacts of climate change in their lifetime are more likely to engage in climate action. <https://doi.org/10.1371/journal.pclm.0000177>

Chambers, S., **H.E. Brown**, **L. Keith**, and **E. Austhof**. 2023. Application of the geographic human heat balance equation to public health in the Arizona urban sun corridor. *Remote Sensing Applications: Society and Environment* 34:101009. <https://doi.org/10.1016/j.rsase.2023.101009> Rather than relying on land surface temperature, this paper argues that body heat storage more accurately reflects experienced heat. This paper has been used for ongoing work to map cooling centers and support optimization of new cooling center locations.

CLIMAS. 2024. Principles and Practices for Ethical Socially Engaged Research. Tucson, AZ: Climate Assessment for the Southwest. This document was developed and revised by the CLIMAS team as a guiding document for how we aim to ethically engage and collaborate with community partners. It stemmed from discussions after some CLIMAS team members took a course on Indigenous Research Governance. https://climas.arizona.edu/sites/climas.arizona.edu/files/2024-05/CLIMAS%20ethical%20principles%20may%202024_5-20-24.pdf

Gerlak, A.K., Z. Guido, **G. Owen**, M.S. Rodriguez McGoffin, E. Louder, J. Davies, K.J. Smith, A. Zimmer, A.M. Murveit, **A.M. Meadow**, P. Shrestha, and N. Joshi. 2023. Stakeholder engagement in the co-production of knowledge for environmental decision-making. *World Development* 170:106336. This systematic review synthesizes how co-production is applied in collaborative research studies around the world to better understand the nature of stakeholder engagement in science production processes. <https://doi.org/10.1016/j.worlddev.2023.106336>

Gildersleeve, R., **R. Leih**, **G. Owen**, S. Thompson, A. Bhakta, K. Bartels, L. Bellante, and **A. Hilton**. 2024. Considerations for a More Sustainable and Equitable Organizational Structure for the Pima County Food Alliance: Report of Interview and Focus Group Findings. Food Systems Research Lab and Climate Assessment for the Southwest (CLIMAS), University of Arizona. This stakeholder report offers detailed suggestions for building a sustainable and equitable food policy council in southern Arizona.

Greene, C. and **D.B. Ferguson**. 2024. Equity, Justice, and Drought: Lessons for Climate Services from the U.S. Southwest. *Bulletin of the American Meteorological Society* 105:E45-E58. This paper recommends that climate services for drought address equity issues by 1) integrating both physical and social dimensions of drought in climate services, 2) investing in engagement and trust building with diverse communities, and 3) better integrating place-based knowledge to reconcile scaling challenges. <https://doi.org/10.1175/BAMS-D-22-0185.1> Based on this publication, C. Greene was asked to write an entry on drought for the Encyclopedia of Environmental Justice to be published in 2025. Authors were also asked to summarize the paper for the SW Fire Science Consortium: <https://www.swfireconsortium.org/2024/05/31/centering-equity-and-justice-in-drought-and-wildfire-planning-in-u-s-southwest>

Hoy, D., R.L. Granillo, L. Boeman, B. McMahan, and **M.A. Crimmins**. 2023. Data aggregation, ML ready datasets, and an API: leveraging diverse data to create enhanced characterizations of monsoon flood risk. *Frontiers in Climate* 5:1107363. This paper describes a Machine-Learning ready dataset structured to train ML models to facilitate predicting and characterizing flood risk. Findings offer opportunities for new inputs into management and decision making, in addition to describing precipitation and flood patterns after an event. <https://doi.org/10.3389/fclim.2023.1107363>

Jagannathan, K., G. Emmanuel, J. Arnott, K.J. Mach, A. Bamzai-Dodson, K.A. Goodrich, R. Myer, M. Neff, K.D. Sjoström, K.M.F. Timm, E. Turnhout, G. Wong Parodi, A.T. Bedanarek, **A. Meadow**, A. Dewulf, C.J. Kirchoff, R.H. Moss, L. Nichols, E. Oldach, M.C. Lemos, N. Klenk. 2023. A Research Agenda for the Science of Actionable Knowledge: Drawing from a Review of the Most Misguided to the Most Enlightened Claims in the Science-Policy Interface Literature. *Environmental Science & Policy* 144:174-86. This paper systematically catalogs assumptions on the science-policy interface and distills them into a set of 26 claims. Authors elicit 16 expert perspectives about these claims to assess the extent to which they are accurate or merit further examination. <https://doi.org/10.1016/j.envsci.2023.03.004>

Leih, R., and R. Gildersleeve. 2023. Cultivating Equitable Food Policy in Pima County. Fall 2023 Research Brief. <https://www.pimafoodalliance.org/written-products/fall-2023-research-brief>. This research brief highlights top community priorities for food policy in southern Arizona and offers suggestions for restructuring a local food policy council to address those community needs.

McKellar, T., M.A. Crimmins, M. Schaap, and C. Rasmussen. 2023. Defining the Multiscalar Index Timescale – Soil Water Depth Continuum for the Southwestern United States. *Journal of Geophysical Research – Atmospheres*. This paper presents a regional analysis of the Southwest to define the relationship between drought index timescale length and soil water availability at different depths. Results show this relationship generally operates in a linear fashion for both indices but changes by depth and soil texture—with clay soils producing shallower sloped relationships compared to sandy soils. <http://doi.org/10.1029/2023JD039348>

Meadow, A.M., G. Owen, N. Joshi, and E. Otto. 2024. Combining impact goal and impact descriptor frameworks to elucidate the societal impacts of research: a pilot study. *Research for All* 8(1). Universities, researchers and funders are increasingly asking how research contributes to positive changes in society and the environment and seeking ways to document and describe impacts consistently across diverse disciplines and organizational scales. The societal impacts framework (which stems from the CLIMAS evaluation) in this pilot study uses a combination of impact goal and impact descriptor frameworks to elucidate the societal impacts of research. <https://doi.org/10.14324/RFA.08.1.03>

New Mexico Climate Adaptation and Resilience Plan. 2023. New Mexico Energy, Minerals, and Natural Resource Department, Climate Policy Bureau. Contributing Authors: R. Finkelstein, M. Lohmann, R. Gomez, A. Petersen, M. Ferris, R. Pierce, A. Bell, T. Harrison, T. Even, K. Williams, A. Sussman, **S. Reece, M. Meko, D. DuBois, D. Ferguson**, K. Glabo. This Plan provides a framework for action and serves as a next step in ongoing efforts to enhance resilience across New Mexico. State agencies will continue to engage with communities, Tribes, and Pueblos, to gather feedback on this version of the plan and make updates as necessary. https://www.climateaction.nm.gov/wp-content/uploads/sites/39/2024/04/NM-C.A.R.P._03.06.24-1.pdf

Wilmer, H., **D.B. Ferguson**, M. Dinan, E. Thacker, P.B. Adler K. Bills Walsh, J.B. Bradford, M. Brunson, J.D. Derner, E. Elias, A. Felton, C.A. Gray, C. Greene, M.P. McClaran, R.K. Shriver, M. Stephenson, and K. Nash Suding. 2024. Resilience Is Not Enough: Toward a More Meaningful Rangeland Adaptation Science. *Rangeland Ecology & Management* 95:56-67. Through analysis of a completed research project on rangeland resilience, this paper provides lessons learned for social and ecological researchers to move towards more transdisciplinary approaches. <https://doi.org/10.1016/j.rama.2024.04.003>.

APPENDIX B: CLIMAS PROJECTS INDEX

Projects active under current CLIMAS Grant #NA22OAR4310547 (2022–2027)

Active and Collaborative Climate Services: Developing Customized and Automated Climate Reports to Support Natural Resource Management and Planning

CLIMAS Investigators: M. Crimmins, D. Ferguson, T. McKellar

Project Abstract: A U.S. Geological Survey project to develop innovative climate services for land managers began in fall 2022 and led to a research partnership with the U.S. Forest Service Kaibab National Forest (KNF). Land managers at KNF expressed the need for local drought and climate information provided in regular updates. This project developed a prototype automated climate report generator in fall 2022 and led to a long-term funding contract with the USFS to continue this work from 2024-2026 and expand reports to new land management units across Arizona and New Mexico.

Partners: U.S. Forest Service; U.S. Department of Agriculture - Natural Resource Conservation Service; Pima County Natural Resources; Hopi Department of Natural Resources

End Users: U.S. Forest Service Kaibab National Forest managers; all National Forests across of AZ and NM; land managers working with Pima County Department of Natural Resources and Park; USDA-NRCS range conservation managers; Tribal land managers and wildland fire managers

Key Resource Support: DOI Climate Adaptation Science Centers (CASCs); USDA US Forest Service, USDA Agricultural Research Service

Outputs

Data and Informational Tools: Climate Reports for Natural Resource Management and Planning. New reports pages added monthly at: <https://cales.arizona.edu/climate-reports>

Workshops and Events: Climate Report Working Group Meeting, Tucson, AZ. June 2023. Attended by project partners from USFS, NRCS, and UA Extension.

Presentations:

- Custom, automated climate reports for the Kaibab National Forest, US Forest Service – Region 3 Meeting, Tucson, AZ. November 2023.
- Developing an Open-Source Climate Report Generation System for Land Managers, Society for Range Management - Arizona Section Winter Meeting, Sierra Vista, AZ. March 2024.
- Developing an Open-Source Climate Report Generation System for Land Managers, U.S. Fish and Wildlife Service - Tucson Office Quarterly Meeting, Tucson, AZ. May 2024.

Impacts:

Conceptual: Ongoing and iterative meetings with managers have highlighted increasing understanding of different climate datasets and drought indices like the Standardized Precipitation Index.

Capacity Building: Reports are improving access to diverse climate datasets and providing local summarization. Managers have communicated that reports are helping them discuss local conditions with other land users like grazing permittees.

Connectivity: Project presentations have introduced report concepts to new partners like the US Fish and Wildlife Service.

Community Small Grants Program

CLIMAS Investigators: K. Jendrisak, D. Ferguson

Project Abstract: The community small grants program provides direct support to Indigenous communities in Arizona and New Mexico to work on pesticide management, an emergent and under-resourced climate and health challenge. The two overarching goals of the program are: 1) provide regional Indigenous communities with training and information on safe and effective pest management and/or other climate related management strategies that promote community resilience in the facing of changing climate 2) build connections between the Inter Tribal Council of Arizona, members of the CLIMAS research team, and Indigenous communities to provide a foundation for ongoing work related to community health in the context of climate change.

Partners: Inter Tribal Council of Arizona's Pesticide Management Program

End Users: Tribes and Pueblos in Arizona and New Mexico, including epidemiology departments, environmental departments, and public health departments.

Impacts

Connectivity: ITCA had preliminary discussions with tribal environmental staff about pesticide program needs to ensure program goals are aligned with the needs of tribes. ITCA's Pesticide Management Program has also been involved in the discussion of program details, goals, and implementation strategy. Arizona Pest Management Center, a long-standing collaborator of ITCA's Environmental Programs, has also been briefed on the program and expressed interest in being a distributor of the program announcement once released.

Health and Social Services in the Long-Term Wildfire Recovery of Rural Communities

CLIMAS Investigators: C. Greene

Project Abstract: The role of social work and public health sectors in long-term wildfire recovery remains understudied and not well integrated into wildfire planning and policy. This project seeks to produce actionable knowledge on social infrastructure that reduces the long-term impacts of wildfire on frontline communities through the following objectives: 1) identify long-term wildfire recovery needs of rural frontline communities through engagement with social workers and public health providers in communities recovering from the impacts of wildfire in Colorado and New Mexico; and 2) build relationships, foster knowledge exchange, and identify lessons learned in wildfire community recovery between social workers, public health professionals, and wildfire recovery professionals.

In the first year of the project, we are working on building relationships with potential project partners. Investigators attended wildfire conferences in Ruidoso, NM (2023 NM Wildland Urban Fire Summit) and Estes Park (2024 After the Flame). Several conversations with local community-based organizations and the Ruidoso Emergency Manager highlight the need for more research on the long-term needs of communities after a wildfire.

End Users: Social service and public health organizations; Local community-based organizations working on wildfire recovery; Emergency managers; Wildfire planners and policy makers

Health Core, Initial Project Scoping



CLIMAS Investigators: H. Brown, D. Ferguson, E. Austhof, L. Keith, M. Crimmins

Project Abstract: Human and animal health is affected by the climate they experience. However, this connection is not always explicitly recognized. The Health Core seeks to identify places to integrate health across the spectrum of climate resilience. So far, the team has identified policy around fire and green infrastructure as two areas of particular interest. This year we extracted data for a systematic review of interventions and refined our research questions.

Partners: Pima County Health Department; Arizona Department of Health and Human Services

End Users: City planners; fire responders and managers

Increasing Aridity and Impacts to Rural Landscapes across the Southwest



CLIMAS Investigators: C. Greene, M. Crimmins, H. Geli, L. Prihodko, M. Meko

Project Abstract: Increasing aridity in the Southwest, along with factors such as insect outbreaks and fire suppression policies, is contributing to substantial increases in wildfires in the region. These large, high-severity fires impact livelihoods as well as the human health and well-being of rural communities. To better understand how increasing aridity is affecting wildfire across the Southwest, we will collaborate with stakeholders across the region to explore how changes in rural landscapes are impacting wildfire risk and events. Through this partnership, we aim to develop a shared understanding of 1) changes to wildfire in rural landscapes as experienced by rural communities and natural resource managers and captured through participatory action research that combines local social-ecological knowledge with analyses of remote sensing and climate data; and 2) the implications of those changes for the communities most impacted. Identifying trends in wildfire risk and impacts under increasing aridity will help rural communities and natural resource managers plan and advocate for a changing wildfire landscape.

Ongoing literature review and analysis examines seasonal climate patterns associated with large wildfires of different vegetation types in the region (conifer, shrubland, and grassland). A comparison of antecedent climate conditions and wildfire activity across these different vegetation types demonstrates the nuanced role of climate and the need for more research in shrubland and grassland regions.

End Users: U.S. Forest Service; Bureau of Land Management; natural resource managers; local community wildfire planners and practitioners; communities creating new or updating Community Wildfire Protection Plans; rural community members living in wildfire risk areas

New Mexico Resilience

CLIMAS Investigators: S. Reece, D. Ferguson, D. DuBois, M. Meko

Project Abstract: Through the Federal Emergency Management Agency Building Resilient Infrastructure and Communities (BRIC), a New Mexico Climate Adaptation and Resilience Planning grant was awarded to the State of New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Energy Conservation and Management Division (ECMD). They are part of a consulting team that will convene stakeholders to draft and finalize a statewide Climate Mitigation, Adaptation, and Resilience Plan. Stakeholders include state agencies, local and tribal governments, stakeholders in academia, industry, and non-government organizations. The plan will specify actions that individual agencies will take to a) mitigate climate related hazards and b) support other entities in the state to incorporate climate resilience and adaptation principles to enhance natural hazard mitigation planning and projects statewide. The statewide Plan (will be included as an annex in the update of the State Hazard Mitigation Plan, conducted by the New Mexico Department of Homeland Security and Emergency Management (DHSEM).

Partners: State of New Mexico; Adaptation International; Groundwork Studio; Toole Design Group; KLA (Kim Lundgren Associates, Inc.)

End Users: State of New Mexico Departments and Agencies

Key Resource Support: Federal Emergency Management Agency (FEMA)

Outputs

Non-Peer Reviewed Publications: [New Mexico Climate Adaptation and Resilience Plan](#). (2023). New Mexico Energy, Minerals, and Natural Resource Department, Climate Policy Bureau. [Contributing Authors: Finkelstein, R., Lohmann, M., Gomez, R., Petersen, A., Ferris, M., Pierce, R., Bell, A., Harrison, T., Even, T., Williams, K., Sussman, A., Reece, S., Meko, M., DuBois, D., Ferguson, D., Glabo, K.].

Online Content: The Climate Policy Bureau at the Energy, Minerals and Natural Resources Department developed a website to house the Climate Adaptation and Resilience Plan as well as create a landing page for the Community Conversation sessions held in May and June 2024. Future resources to be added include a FAQ to address questions raised during the Community Conversations. <https://www.climateaction.nm.gov/carp/>

Workshops and Events: The New Mexico Energy, Minerals and Natural Resources Department (EMNRD)'s Climate Policy Bureau (CPB) hosted a series of community conversations across the state to debut and collect feedback on New Mexico's first ever State Climate Adaptation and Resilience Plan (CARP). CPB hosted in-person events in 6 communities with opportunities for input online. Each in-person event lasted approximately 90 minutes and was followed by a social hour with food & refreshments. Attendees included families, students, business leaders, and government officials.

Impacts

Capacity Building: The New Mexico Energy, Minerals and Natural Resources Department (EMNRD)'s Climate Policy Bureau (CPB) staff used CLIMAS produced climate data and analysis for their Community Conversations sessions during the introductory presentations. Not only were they able to speak to the information, they were also able to connect the climate impacts to specifically affected population groups (i.e. elderly).

Connectivity: Partnerships were strengthened between CLIMAS and other organizations who were part of the project team who have on the ground knowledge and connections in New Mexico. Specific connections were made with stakeholders and community members that have a direct relevance to other CLIMAS projects. CLIMAS is now seen as a valuable resource to both the State of New Mexico agencies as well as community stakeholders. In preparation for one of the Community Conversation sessions, CLIMAS provided resources to assist in creating maps with a digital flood data layer to show climate risks for that locality.

Supporting Heat Resilience in Frontline Communities



CLIMAS Investigators: L. Keith, H. Brown, E. Austhof, D. DuBois, K. Wolfe

Project Abstract: Persistent and increasing chronic heat and extreme heat events present a complex challenge for communities in the U.S. Southwest. There is growing attention to urban heat resilience, how cities are addressing heat risk through heat mitigation strategies such as urban forestry and cool corridors, and heat management strategies, such as cooling centers. Less focus to date has been on how rural, tribal, and border communities, which face their own unique challenges and have different governance structures and resource availability, are being impacted by and can address increasing heat hazards. The objectives of this research are to better document the impact of heat on rural, tribal, and border communities; explore the current and emerging governance structures for rural heat resilience; and work with community partners on solutions to support increased rural heat resilience.

Partners: National Integrated Heat Health Information System; National Weather Service local offices; Arizona Department of Health Services; New Mexico Department of Health; Global Heat Health Information Network (GHHIN, a UN/WMO/WHO heat-health initiative)

End Users: Local rural planners; housing and community development practitioners; emergency managers; hazard mitigation planners; public health practitioners; Arizona and New Mexico state governments; U.S. National Integrated Heat Health Information System

Key Resource Support: Complementary work is being done with the following research programs: DOE-funded Southwest Urban Corridor Integrated Field Laboratory (SW-IFL) (L. Keith, Univ. of Arizona PI; H. Brown, Co-I) and CDC-funded Building Resilience Against Climate Effects (BRACE) (H. Brown, PI; L. Keith, Co-I)

Outputs

Workshops and Events:

- Southern Arizona Heat Summit. University of Arizona, ENR2 Building, Tucson, AZ. February 3, 2024. 200 attendees. CLIMAS participation: L. Keith (co-organizer, speaker, facilitator), S. Reece (co-organizer), H. Brown (participant), K. Wolfe (facilitator and notetaker). This workshop led to the [City of Tucson's Heat Action Roadmap](#), passed by Mayor & Council on June 5, 2024. It also led to the formation of the Joint Heat Action Team (J-HAT) run by Pima County and the City of Tucson, AZ. A [summary of the event](#) is online.
- New Mexico Heat Summit. Albuquerque, NM. April 30, 2024. 50 attendees. CLIMAS participation: D. Dubois (co-organizer and facilitator).

Presentations:

- 8th Annual Arizona Extreme Heat Planning Workshop. Arizona Department of Health Services, National Weather Service, Arizona State University, and University of Arizona. Virtual. April 2024.
- Urban Heat Resilience. All-In Meeting. Third Act Arizona. (Virtual). November 16, 2023.
- Urban Heat Resilience. World Town Planning Day (WTPD): Learn Globally; Apply Locally. University of Hawai'i at Mānoa and American Planning Association, Hawai'i Chapter. Waikiki, Hawaii. November 2023.
- Improving Urban Heat Planning and Media Coverage of Extreme Heat. Tucson Urban Heat Island Workshop. City of Tucson, Tucson Water, and CLIMAS. Tucson, AZ. October 2023.
- UA: Identifying Solutions to Mitigate and Manage Extreme Heat. Fourth Annual DC Summit: Health & The Environment. University of Arizona. Washington, D.C. October 2023.
- Tools to Assist Planners to Achieve Urban Heat Resilience. 5th UEF and 59th ISOCARP World Planning Congress. Urban Economy Forum (UEF) and International Society of City and Regional Planners (ISOCARP). Virtual. September 2023.
- Resilience Webinar: Extreme Heat #SummerReady. FEMA Hazard Mitigation Assistance. U.S. Federal Emergency Management Agency (FEMA). Virtual. August 2023.

Media Interviews and Engagement:

Researchers from this project participated in 8 television interviews, 5 radio appearances, 3 podcast appearances, and 25 print media interviews. Selected examples include:

- Heat maps help plan cooling efforts. *KGUN9 News*. September 11, 2023.
- Extreme heat around the world. *BBC News*. July 19, 2023.
- Climate Change and Extreme Heat End of Summer. *America Adapts: The Climate Change Podcast*. September 11, 2023.
- Heat governance scholar Ladd Keith's collaboration with NOAA. U.S. National Oceanic and Atmospheric Administration. September 27, 2023
- When every minute counts: Dashboard maps emergency response to extreme heat. *Route Fifty*. August 18, 2023.
- Extreme heat is the deadliest natural disaster. FEMA can't treat it like one. *CNN*. August 8, 2023.
- As extreme heat rises, so do concerns for worker safety. *The Christian Science Monitor*. August 3, 2023.
- Too Damn Hot - and Getting Hotter: Dealing With Extreme Heat. *Governing*. July 21, 2023.
- The Heat is On. *Sierra: The Magazine of the Sierra Club*. June 21, 2023.

Social Media:

- LinkedIn: <https://www.linkedin.com/in/laddkeith> (3,422 followers/connections). [A post on the City of Tucson's Heat Action Roadmap and worker protection ordinance passing](#) had 5,311 impressions or views.
- X: <https://twitter.com/laddkeith> (1,789 followers)
- Instagram Threads: <https://www.threads.net/@laddkeith> (185 followers)
- Bluesky: <https://bsky.app/profile/laddkeith.bsky.social> (90 followers)

Advisory Roles: Management Committee, Global Heat Health Information Network; Member, Joint Heat Action Team (J-HAT, City of Tucson and Pima County)

Impacts

Instrumental: The [City of Tucson Heat Action Roadmap](#), resulted from the Southern Arizona Heat Summit, co-organized by CLIMAS. L. Keith served as subject matter expert to develop the plan. His research was cited as the foundation of the plan's strategies.

L. Keith also participated in the working groups that led to [The Arizona Extreme Heat Preparedness Plan](#), a statewide planning effort, and provided heat data and research that was used to develop the plan.

Conceptual: CLIMAS's focus on rural, tribal, and border heat resilience has raised awareness among AZ and NM state health departments, who are eager for initial project results to improve their decision making and support. They have demonstrated interest in better understanding how they can serve and prepare rural areas for extreme heat. This project has flagged rural heat as an important issue for decision makers and has raised awareness that these are underserved areas in heat planning, policy, and governance. Media coverage has led to increased attention to heat as a hazard.

Training and Education



CLIMAS Investigators: G. Owen, S. Carroll, A. Meadow

Project Abstract: CLIMAS team members have developed collective expertise in the theory and practice of collaborative and ethical transdisciplinary research. In this current phase of the program, we are continuing to build and evolve these skill sets within and beyond the CLIMAS team through a set of training initiatives and programs. CLIMAS training initiatives fall under three main categories: 1) collaborative and transdisciplinary research methods and processes; 2) ethical research collaborations with community partners, Indigenous Peoples, and frontline communities; 3) societal impacts of climate-related research.

Key Resource Support: University of Arizona, Office of Research, Impact, and Innovation

Outputs

Publications: CLIMAS. 2024. [Principles and Practices for Ethical Socially Engaged Research](#). Tucson, AZ: Climate Assessment for the Southwest. This document was developed and revised by the CLIMAS team as a guiding document for how we aim to ethically engage and collaborate with community partners. It stemmed from discussions after CLIMAS team members took a course on Indigenous Research Governance in January 2023.

Podcast: [Environment & Society Fellowship Podcast](#), May 22, 2024. In this special edition of the Southwest Climate podcast, three graduate students who were part of the CLIMAS Environment & Society Fellowship program in 2024 reflect on their collaborative research projects and progress over the past year.

Blog Posts: CLIMAS Environment & Society Fellows wrote blog posts in Fall 2023 introducing their project, how they came to this work, and what they planned to do in their fellowship year:

- H. Friedrich: [Mapping tarps and stories to spotlight inequitable disaster recovery](#). This blog post was cited in a New York Times opinion article in October 2023 by Samantha Montano entitled, [America's Disaster Recovery System Is a Disaster](#)
- Lucas Belury: [Flood Justice in South Texas](#)
- Talia Anderson: [What's going on with the rains?](#)
- Majerle Lister: [Re-Thinking Land and History: Working with Navajo Mountain Soil Water Conservation District Members](#)

Professional Development Training: Nine CLIMAS researchers took part in the University of Arizona's College of Law January in Tucson courses in 2024. These intensive 3-day courses are taught by faculty in the field of Indigenous governance and Indigenous rights, and are open to Indigenous leaders, community members, and anyone interested in Indigenous affairs. CLIMAS researchers took classes on: Making Change Happen; Indigenous Peoples' Rights under International Law; Indigenous Data Sovereignty; Indigenous Data Governance; and Indigenous Research Governance.

Presentations: The following presentations were given to increase awareness of collaborative research, societal impacts planning, and evaluation.

- The Collaborative Research Process. Guest Lecture – Global Change Research, Application, and Decision-Making, University of Arizona. Presentation for graduate students outlines a collaborative research process with tangible examples of methods, outputs, and impacts.
- Collaborative Science, Co-produced Knowledge, and the Societal Impacts of Research. Department of Epidemiology and Biostatistics Seminar, Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ. This introductory seminar for graduate students in Public Health provided a brief overview of collaborative research and knowledge co-production including examples of knowledge co-production, exploring how collaborative research differs from basic research, and some of the logistics, challenges, and benefits of the collaborative research process.
- Planning and Evaluating the Societal Impacts of Research. Southwest Climate Adaptation Science Center. San Diego, CA. This presentation outlined the societal impacts framework for researchers affiliated with the USGS Southwest CASC and offered insight into how to use it for an upcoming proposal. They incorporated the framework and evaluation plan into their 2024 proposal.
- Making Waves: Designing Research for Real-World Impact. The Climate Adaptation Research Program. University of Arizona. Virtual. This presentation was designed for African-based researchers who were conducting or planning adaptation research projects.

Impacts:

Instrumental: [Ethical Guidelines for Collaborative Research](#): As a result of CLIMAS PIs participating in the January in Tucson courses, the CLIMAS team developed a collective set of ethical principles to guide our research and engagement with community partners, and in particular Indigenous Peoples and communities at the frontlines of climate change. These principles were adopted by the CLIMAS team in Spring 2024.

CLIMAS work on ethical research engagement and CLIMAS participation in the January in Tucson training on Indigenous research governance has informed progress toward institutional changes at New Mexico State University (NMSU). L. Prihodko was invited to present to the NMSU University Research Council (URC) in March 2024 about Indigenous Research and Engagement. This presentation was an expansion of the presentation L. Prihodko gave to the Council of Associate Deans for Research in May 2023. The presentation focused on the need for formal policy, procedures, and training at NMSU for researchers on Indigenous Research Engagement and reached ~20 members of the URC. This is part of a larger effort to make NMSU aware of the need for formal policies and training for Indigenous research engagement.

Capacity Building Impacts: In the Environment & Society Fellowship, four graduate students learned from CLIMAS team members and one another as they practiced collaborative research methods. Reflections on what they learned over the year included: A) how participatory research takes longer than anticipated; B) capacity to develop different strategies to work with partners at local to national scales; C) the power of history and archives to inform decisions in the present; and D) how to maintain relationships with partners when not physically in the field.

Water Availability



CLIMAS Investigators: C. Woodhouse, D. Ferguson, G. Owen, G. Frisvold, K. Jendrisak, M. Meko

Project Abstract: This project aims to investigate and clarify the relationships between climate and streamflow at watershed scales that are meaningful to decision makers, primarily in northern New Mexico. This research evaluates these relationships for the period with recorded climate and streamflow data (approximately the last 40-80 years), while also assessing changes in these relationships due to warming temperatures. This work also includes an assessment of changes in streamflow (e.g., changes in the timing of peak flow) over time. An overarching goal is to identify and provide data or information that is directly relevant to communities and other groups that may not have capacity or resources to conduct these kinds of analyses. Specifically, we hope to work with frontline communities including pueblos if possible. Any work with New Mexico pueblo communities would be designed to work directly with them to support their sovereignty, self-determination, and resource and data governance. We have set out to do a project that is as collaborative as is feasible, from the research questions, identification of watersheds of interest, and data to be used in analysis, to the analysis of results and dissemination of information at the end of the project.

Partners: D. Llewellyn, E. Metcalf, Bureau of Reclamation, Albuquerque; J. Fleck, University of New Mexico

End Users: Many potential end users, including the Office of the State Engineer; Soil and Water Conservation Districts; New Mexico Acequia Association; Water Resources Research Institute - New Mexico State University; Bureau of Reclamation

Research Findings:

- Wet conditions during the 1980s and 1990s are driving a statistically significant decreasing trend in annual streamflow for 1980-2022, but significant trends are not apparent over other time periods.
- Analyses of monthly and daily streamflow suggest changes in peak runoff are occurring (e.g., a shift in volume of flow to earlier in spring; and the peak timing of streamflow has shifted 1-2 days earlier per decade).
- Runoff efficiency, largely influenced by temperature, has decreased over the period of continuous record.

Outputs

Data and Informational Tools: We developed a prototype climate and streamflow fact sheet to demonstrate the sort of information we could provide to gauge interest in a science-related product. This fact sheet is a 4-page document with graphics and text descriptions for records of observed climate, streamflow, and related measures (i.e. runoff efficiency) for the Rio Grande near Del Norte, CO. The goal of this fact sheet is to show how the relationships between climate and streamflow have changed over the period of instrumental data, including warming and decreases in streamflow measures. The prototype was developed to see if the information and format were useful to potential stakeholders. Responses were positive so we identified gage records in the middle Rio Grande, and have developed additional fact sheets to share.

Presentations: C. Woodhouse gave a short overview of this project and its goals at the Rio Grande Basin Study Summer 2023 All Partners Meeting, June 28, 2023, virtual. 50 attendees from the various water sectors (agriculture, community orgs, tribal, NGO, local governments). One result was an email from the Valencia Soil and Water Conservation District seeking opportunities for collaborative work.

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Building Regional Food System Resilience in Southern Arizona

CLIMAS Investigators: G. Owen

Additional Investigators: S. Thompson, Pima County Food Alliance; University of Arizona: R. Leih, R. Gildersleeve, Community Research, Evaluation & Development; A. Hilton, Bureau of Applied Research in Anthropology; L. Bellante, Center for Regional Food Studies.

Graduate and Undergraduate Assistants: K. Bartels, A. Bhakta, J. Thorn, R. Zollinger, T. Jodie, M. Urabe

Project Abstract: This project analyzes cascading economic, climate, and societal risks in southern Arizona's local food system. From 2020 through spring 2021, the team documented the impacts of the COVID-19 pandemic. The evolving crisis highlighted several long-standing issues in the local food system, including inequities in food access, food policy, food production and distribution, and food sovereignty. The crisis also revealed strengths in the local food system and opportunities to address these issues while building a more equitable food system that is resilient to future environmental, climate, economic, and health risks. This research serves not only to identify these risks but to use them to support community-driven solutions and policy needs that address multiple issues at once.

The next phase of research began in 2021, in partnership with the Pima County Food Alliance (PCFA), a food policy council, to develop community-driven plans, policies, and programs that address local food systems challenges. Our collaborative team is called the [Food Systems Research Lab](#). Together we conducted focus groups, interviews, and held community events to support the revitalization of PCFA to support community needs. We engaged over 100 individuals working across the county's food system.

Research Findings

Top priorities for local food policy in Pima County are:

- Increasing support for farmers and producers through workforce development, infrastructure, financial support, farm-to-institution channels, and increased access to local, climate adapted seeds
- Promoting sustainable water and land use through reduced water rates for small local farms, exploring community ownership models for small-scale agriculture, combining efforts with city and county sustainability initiatives, and incentivizing passive water harvesting
- Reducing food waste through education, financial incentives, and large scale composting
- Increasing food access through expansion of local markets and distribution hubs, assistance in applying for benefits like SNAP, and support for local businesses to accept SNAP as a form of payment
- Identifying reasonable food safety regulations by building partnerships with the county health department, farms, and small businesses

Outputs

Publications:

- Leih, R., R. Gildersleeve. [Cultivating Equitable Food Policy in Pima County](#). Fall 2023 Research Brief.
- Bhakta, A., K. Bartels, R. Gildersleeve, G. Owen, R. Leih, S. Thompson, L. Bellante, A. Hilton. 2024. Community Priorities for Food System Action in Pima County, Arizona: Report of Interview and Focus Group Findings. Food Systems Research Lab and Climate Assessment for the Southwest, University of Arizona.
- Leih, R., and R. Gildersleeve. 2024. Considerations for a More Sustainable and Equitable Organizational Structure. Report of Interview Findings for the Pima County Food Alliance. Food Systems Research Lab and Climate Assessment for the Southwest, University of Arizona.

Workshops and Events:

- Pima County Food Alliance, Community Kick Off Event. December 2, 2023, Las Milpitas Farm, Tucson, AZ. Engaged with 50 Tucson community members to share initial analysis conducted over the past year, provided opportunities for community analysis, and facilitated networking and community building.
- Focus Groups: We conducted 16 focus groups with organizations, representing diverse sectors of the local food system, to learn about their work, build relationships, understand their food policy needs and priorities. We engaged a total of 82 individuals. Findings were developed into reports for the Pima County Food Alliance.
- Pima County Food Alliance monthly meetings: Facilitated and organized three meetings (January, February, and March 2024). Presented research findings and facilitated discussion on how to rebuild and restructure the organization based on community-identified needs.
- Museum of Contemporary Art - Free Third Thursday Community Event. May 16, 2024. Collected arts-based and interview responses about nourishment, community resilience, and local food from attendees to be used for visual analysis.

Presentations:

- Town Hall Panel - Best Practices in Research and Engagement for Advancing Equitable Climate Adaptation Alongside Frontline Communities. American Geophysical Union Annual Meeting, San Francisco, CA. Co-presented with S. Thompson, Pima County Food Alliance.
- Building Resilience in Southern Arizona's Local Food System. NOAA CAP/RISA and NIST portfolio on Small and Medium Business Disruption and Resilience to Complex Climate Events. Virtual.
- Cultivating Equitable Food Policy in Southern Arizona. Water Justice Knowledge Exchange, University of Arizona. Virtual. Co-presented with S. Thompson, Pima County Food Alliance.

Advisory Role: Arizona Food Systems Network, Climate Smart Foodways sub-committee member

Impacts

Instrumental: In February 2023, G. Owen presented research results to Tucson Mayor and Council, in support of a reduced water rate for small-scale urban farmers. Invited by Pima County Food Alliance, Community Food Bank of Southern AZ, and Tucson's Ward 3 Councilmember. In November 2023, results were again cited to support a 1-year pilot for the water rate program. The pilot was approved and finalized in April 2024. While this lower water rate can improve economic yields for small scale farmers, the stipulations in accessing this rate require farmers to use one or more water conservation practices and distribute their product in underserved and low-income communities. The program aims to improve local economic livelihood, reduce water consumption, and increase food security. CLIMAS will monitor progress on this water rate to measure those outcomes.

Capacity Building Impacts: Helped PCFA build communication capacity through supporting design and development of a new website. Students provided written content for the website.

Helped PCFA develop a new list-serv through participant sign ups from focus groups, interviews, and public events. Students helped develop list-serv content.

Connectivity Impacts: Helped PCFA connect and reconnect to community organizations in Tucson and Pima County in efforts to rebuild itself as a functional local food policy council.

Tools and Weather/Climate Information Used by Wildland Fire Managers in the Southwest United States

CLIMAS Investigators: G. Frisvold, D. Ferguson, M. Crimmins

Project Abstract: Wildland fire management in the US is complicated, expensive, and requires a substantial amount of scientific data and information across a huge range of temporal and spatial scales. Although state and federal agencies as well as academic research groups have devoted substantial resources to develop data products, forecasts, outlooks, and decision support tools for wildland fire management there has been relatively little research done to assess how these have actually been used to inform wildland fire management decisions. This study initially focused on related research two questions: 1) how do weather and climate products and tools inform wildland fire management decisions in the Southwest? 2) How are existing decision support systems used by wildland fire managers in the Southwest? Eventually the project evolved to take a transdisciplinary research approach with the addition of wildland fire meteorologist and regional wildfire expert Chuck Maxwell to the team. In addition to research to answer the two primary research questions above, the team also has developed operational weather and climate information products for the Southwest wildland fire management community, including the Burn Period Tracker.

Partners: C. Maxwell, U.S. Fish and Wildlife Service

End Users: U.S. Forest Service; National Weather Service; Bureau of Land Management; Bureau of Indian Affairs; National Park Service; Arizona Department of Forestry and Fire Management; New Mexico Forestry Division

Key Resource Support: U.S. Fish and Wildlife Service

Research Findings: While there are a wide range of sources of weather and climate data available to Southwest wildland fire managers, most people consult only about one third of them. Most decision support systems are not used by wildland fire managers to inform decisions. The primary decision support system, the Wildfire Decision Support System (WFDSS) is widely perceived as a useful tool for documenting decisions, but not for informing decisions.

Outputs

Data and Informational Tools: The [Burn Period Tracker](#) is an experimental fire weather monitoring product. Burn period is defined as the number of hours per day where the hourly average relative humidity is less than or equal to 20% and is calculated at Remote Automated Weather Stations with real-time data and several years of historical data. Values range from 0 to 24 hours per day with higher values associated with increased fire danger. This tool is updated daily and is being used by fire managers working across the Southwest. An [ArcGIS version of the Burn Period Tracker](#) is available for integration into national, wildfire assessment platforms. The National Interagency Fire Center requested an [Archive of the Burn Period Tracker](#) for training and research purposes.

Impacts

Instrumental: The Burn Period Tracker is now part of the [SWCC Fire Danger Intelligence webpage](#). We are forwarded reports of how the tracker is being used in operational decision making regarding the execution of prescribed fires and wildland fire management planning.

Capacity Building: Training materials have been developed by the National Interagency Fire Center using historical Burn Period plots.

An assessment of drought and climate vulnerability and resilience in the Rio Grande basin in New Mexico

CLIMAS Investigators: C. Greene, D. DuBois

Project Abstract: The complexity of drought makes it a challenging natural hazard to monitor. Droughts come in many different forms and the impacts of drought on society and the environment are not always easily identified. Drought monitoring, which identifies the presence and severity of drought, is a critical step in drought governance. A drought monitoring system needs to account for the environmental and social complexities of drought and produce drought information that can guide drought planning and response. This project engages with the New Mexico Drought Monitoring Working Group (NM DMWG) to understand current challenges in drought monitoring in New Mexico and identifies opportunities for strengthening the monitoring process. A final report may be used to advocate for investments in drought monitoring that go beyond collecting observed physical data (e.g. precipitation, streamflow, etc) to include more drought impact data on local communities.

Partners: NOAA/National Weather Service

End Users: Members of the New Mexico Drought Monitoring Working Group, which includes state experts in water, environment, wildfire, recreation, tourism, agriculture, and health.

Key Resource Support: National Integrated Drought Information System (NIDIS)

Research Findings: Opportunities for strengthening drought monitoring in New Mexico include greater investments in physical drought data as well as investments in community engagement. Community engagement that builds trust between drought researchers, agencies, and local communities will support drought monitoring that is better aligned with decision-making.

