



2018 - 2022

SOUTHERN CLIMATE IMPACTS PLANNING PROGRAM

PHASE III FINAL REPORT

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The Southern Climate Impacts Planning Program (SCIPP) Phase III was funded on award NA18OAR4310337. Please accept this final annual report entitled "Southern Climate Impacts Planning Program (SCIPP) Phase III Final Report" for the performance period 9/1/2018-8/31/2022.

OUR TEAM

For award NA18OAR4310337, Southern Climate Impacts Planning Program (SCIPP) was a collaborative effort between the Oklahoma Climatological Survey, the Cooperative Institute for Severe and High-Impact Weather Research and Operations and the South Central Climate Adaptation Science Center at the University of Oklahoma (OU), the Department of Geography and Anthropology and Southern Regional Climate Center (SRCC) at Louisiana State University (LSU), the School of Public Affairs & Administration Urban Planning Program at the University of Kansas (KU), the School of Natural Resources at the University of Nebraska – Lincoln (Nebraska), and Texas Sea Grant at Texas A&M University (Texas A&M).

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***Denotes SCIPP team members at time of report preparation.**

CAP/RISA

The National Oceanic and Atmospheric Administration (NOAA) Climate Adaptation Partnerships (CAP) (formerly known as RISA) program funds integrated teams of natural and physical scientists and social scientists at academic institutions, works with stakeholders to address complex climate-sensitive issues relevant to regional and local decision-makers, and defines the physical and social context in which regional decision-makers work. Regional teams interact with a variety of sectors, including water resources, climate adaptation, agriculture, public health, wildfire management, emergency management, planning, and fisheries. CAP/RISA teams use co-production to work together with stakeholders to identify, study, and solve complex problems. Many research projects deliver results to stakeholders at the end of a project, but CAP/RISA teams engage stakeholders in the earliest stages in order to assure that research and products are decision-relevant. This takes more time, effort, and resources, but two-way connections assure that NOAA-funded research is useful.

The RISA program was established in the 1990s, when Congress started funding useable science as part of the U.S. Global Change Research Program (USGCRP). NOAA launched RISA through their Office of Global Programs, with a primary focus on the then-new research on seasonal variability and capitalizing on forecast skill that was emerging related to El Niño and La Niña. By 2003, the network had grown to eight teams. SCIPP was added in 2008, with a focus on integrating drought into regional hazard planning.

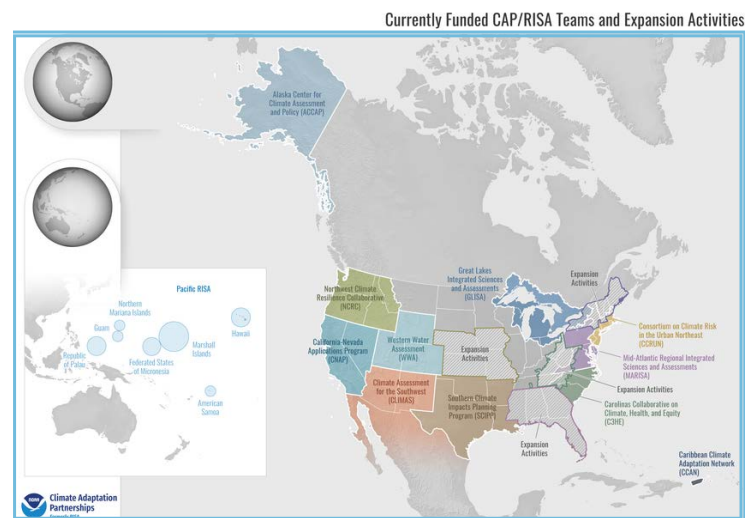


Figure 1. CAP/RISA teams and expansion activities funded as of Fall 2022.

The initial focus for SCIPP in Phase I (2008-2013) was on improving access to climate information for use in planning decisions. This was accomplished through the development of physical analysis and tool development. Stakeholder connections were established through broad climate services, introducing SCIPP to partners in the region and learning the landscape. In Phase II (2013-2018), SCIPP developed deeper relationships, still coupled with broad engagement. The primary foci were engagement, assessment (formal and informal research) and tool development. In Phase III (2018-2022), the focus shifted toward more specific decision processes and social dynamics. This involved more targeted engagement in the context of regional and local needs and opportunities. As will be highlighted here, these often entailed development of synthesized guidance and information management for stakeholders.

ROLE IN THE REGION

Originally, SCIPP served the states of Texas, Oklahoma, Arkansas, Louisiana, Mississippi, and Tennessee, coincident with the footprint of the Southern Regional Climate Center. As SCIPP's engagement grew deeper, it was difficult to maintain significant engagement in more distant parts of the region. Consequently, in Phase III the footprint shrunk to Texas, Oklahoma, Arkansas, and Louisiana - still the second largest and among the most populous of the regional teams.

One of SCIPP's primary roles in the region is that of a convener. Through workshops, community forums, and one-on-one conversations, SCIPP identifies areas for collaboration and provides a venue for those discussions to occur. These activities have resulted in development of new tools (such as the Simple Planning Tool for hazard mitigation planning), assessments, and contextual climate information that can be used for a variety of local applications. SCIPP's mission is to assist organizations with decision-making that builds resilience to extreme weather and climate, by collaboratively producing research, tools, and knowledge. We do this by immersing ourselves within the broader context of climate services in the South Central U.S.

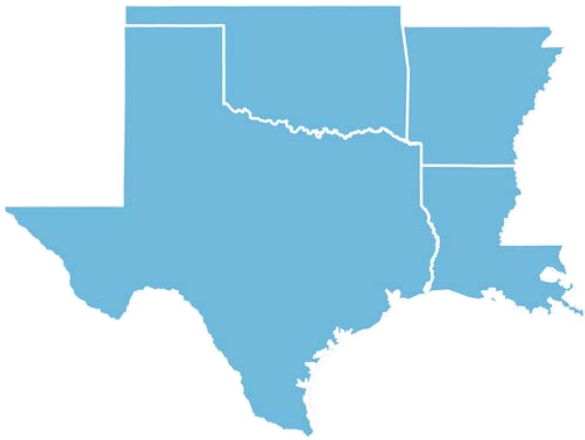


Figure 2. Map of the SCIPP region beginning in 2018.

SCIPP coordinates with other providers, including the South Central Climate Adaptation Science Center and the USDA Southern Plains Climate Hub. This assures that each organization can serve its primary clientele, share resources as appropriate, and minimize the burden of interaction on our stakeholders. During Phase III, SCIPP began participating in bi-monthly meetings with the leadership of the South Central CASC and Climate Hub. This enabled identification of projects where we could leverage resources; for example in conducting a workshop on wildfires in areas that had been affected recently by large fires. This involved discussion with farmers or ranchers - a core stakeholder for the Climate Hub - and utilized the expertise of community engagement that SCIPP possessed.

Another way in which SCIPP contributes to the region is through participation in the National Climate Assessment (NCA). SCIPP PIs have been involved in NCA3, NCA4, and NCA5. SCIPP team members were part of the author teams for the Southern Great Plains in each, and promoted public comment and shared results through social media and newsletters.

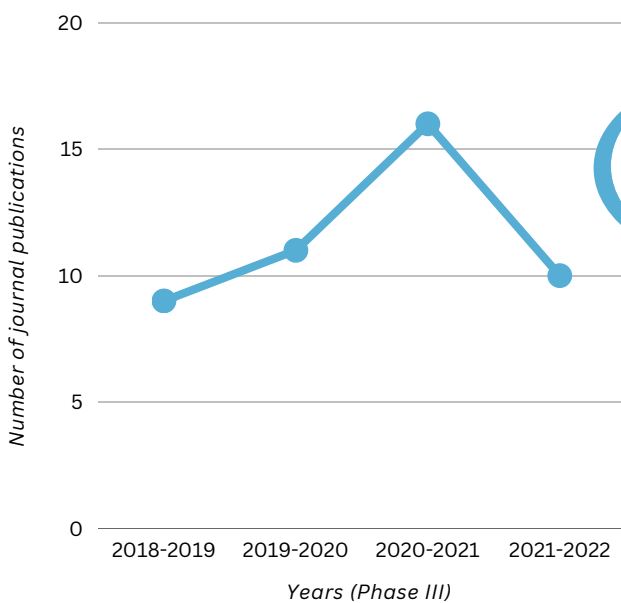


SCIPP
A NOAA CAP TEAM

BY THE NUMBERS

Phase III

Journal Publications



47

Total
Publications

16

Email newsletters

sent to a list that now has

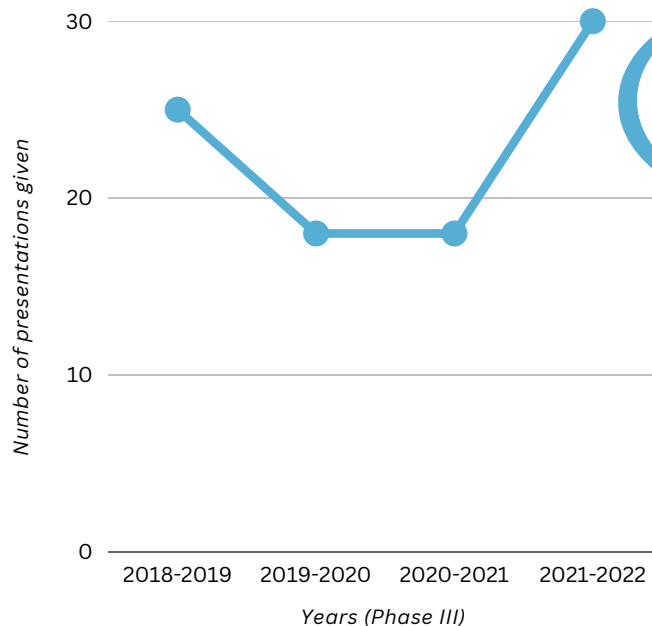
444

subscribers

36

News stories
posted on
SCIPP's website

Presentations Given



91

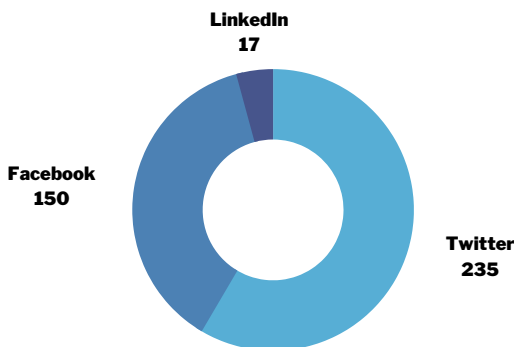
Total
Presentations

Social Media

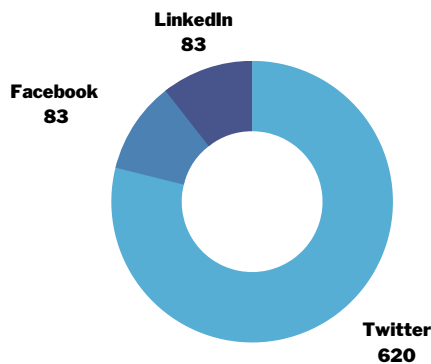
155,000

Total Social Media Impressions

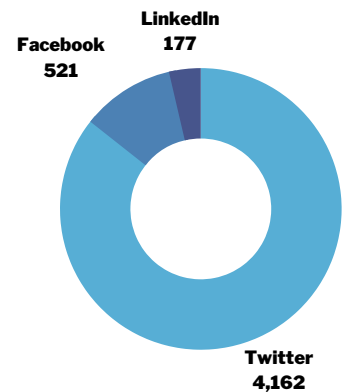
Posts Published



Link Clicks



Engagements



Best Performing Post



3,313
Impressions



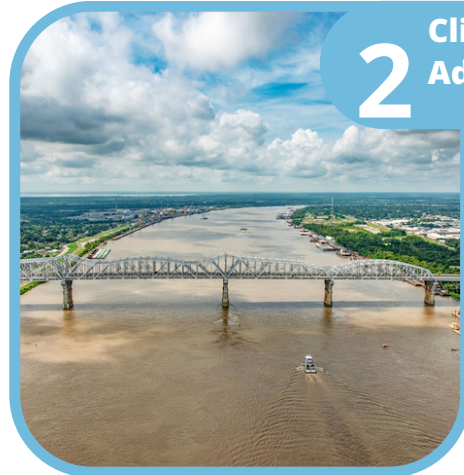
82
Engagements

15
Link Clicks

RESEARCH AREAS OF FOCUS



1 Planning and Preparedness



2 Climate Adaptation



3 Coastal Impacts



4 Drought

Managing complex hazards is as much of a social challenge as it is a physical challenge. The ability to prepare for a range of hazards involves improvements in the characterization of risk and application of existing knowledge. Lessening impacts and costs of disasters involves advancing physical understanding of processes, synthesizing existing knowledge, characterizing social vulnerability, connecting potential impacts to the likelihood of events, and identifying viable solutions that fit within existing institutional frameworks. SCIPP's primary goal for Phase III was to **improve the production and use of weather and climate information in hazard planning by building stronger relationships between community planners, emergency managers, researchers, climate services providers, and others to enhance near-term preparedness for high-impact events and long-term strategies to reduce risk**. This report highlights core research and engagement related to planning and preparedness, with additional focus on climate adaptation, coastal impacts, and drought.

PLANNING AND PREPAREDNESS

Overview:

The projects described in the following section sought to understand how information about climate extremes can be effectively incorporated into planning processes. They also examined the processes themselves to understand how all segments of the community may participate to reduce their vulnerabilities to extreme events. Findings from these projects support broader provision of climate information and outreach strategies throughout the region.

Primary Research Objective of this Research Focus:

- Improve the use of climate information, from sub-seasonal and seasonal forecasts to climate change projections, in planning processes

Objectives helped guide the research presented, but were viewed as larger concept ideas. Projects described refer to the objective in some way, but do not always answer an objective in its entirety.



Objective

Improve the use of climate information, from sub-seasonal and seasonal forecasts to climate change projections, in planning processes

Jazz on Tulsa Time: The Remarkable Story of the Network of Flood Mitigation Champions behind the Tulsa Turnaround

Investigators: Ward Lyles (SCIPP - KU), Penn Pennel (SCIPP - KU), Rachel Riley (SCIPP - OU)

Questions Answered:

- ★ How can the disconnects between planning and emergency management and their skill sets be addressed so that long-term climate risk reduction is more likely?
- ★ Does a nationally acclaimed model local hazard mitigation effort fit the standard model of hazard mitigation?
- ★ How have the characteristics and roles of local champions and the relationships between them shaped a national model hazard mitigation effort?

Summary:

In 2018, SCIPP began a focused research effort on addressing the disconnects between planning and emergency management to encourage long term disaster risk reduction. To answer the research questions listed above, SCIPP investigators conducted an in-depth case study of Tulsa, Oklahoma. Motivated by observations of Tulsa's remarkable transition from one of the most flood-prone cities in the nation in the 1970s to its present-day success in mitigating flood hazards, [*Jazz on Tulsa Time: The Remarkable Story of the Network of Flood Mitigation Champions behind the Tulsa Turnaround*](#)


found that Tulsa's hazard mitigation effort shared many of the principal features of the standard model of hazard mitigation, thus confirming its importance.



Tulsa, OK.
Credit: Lucas Alexander

The study offers four recommendations for practitioners and policy makers who are interested in replicating Tulsa's successes in other locations: 1) Foster and sustain a team of champions, 2) Make room for multiple models of leadership, 3) Acknowledge the personal sacrifices that can arise for a mitigation champion, and 4) Approach hazard mitigation primarily as a community planning issue, not an emergency management function. In 2021, the [journal article](#) produced from this research was selected as the Editor's Choice within the *Natural Hazards Review* peer-reviewed journal.

TAKEAWAY



The study offers four recommendations for practitioners and policy makers who are interested in replicating Tulsa's successes in other locations: **1)** Foster and sustain a team of champions, **2)** Make room for multiple models of leadership, **3)** Acknowledge the personal sacrifices that can arise for a mitigation champion, and **4)** Approach hazard mitigation primarily as a community planning issue, not an emergency management function.

Headwinds in the Heartland? Hazard Planning Lessons from Six Inland Jurisdictions in the Southern Plains

Investigators: Ward Lyles (SCIPP - KU), Penn Pennel (SCIPP - KU), Rachel Riley (SCIPP - OU)

Questions Answered:

- ★ How can the disconnects between planning and emergency management and their skill sets be addressed so that long-term climate risk reduction is more likely?
- ★ How does the quality of local hazard mitigation planning efforts in an inland region vary?
- ★ How do local hazard mitigation planning networks vary in terms of membership, structure, and activities?
- ★ How do local communities vary in the use and influence of consultants to assist with mitigation planning?

Summary:

Within the same project objective of addressing disconnect between planners and emergency management, SCIPP employed a comparative case study research design. This effort analyzed six non-coastal counties (see Figure 3) that included one principal city within and adjacent the SCIPP region. Historically, the locations have not paid much attention to long range climate planning but have high hazard exposure. Data collection took place in 2019-2020 and included

content analysis of plan documents and semi-structured interviews with key officials involved in local mitigation and land use planning (Table 1). The analytical approach included systematic comparison of plan contents, thematic analysis of interviews, and triangulation of core dynamics in the cases.

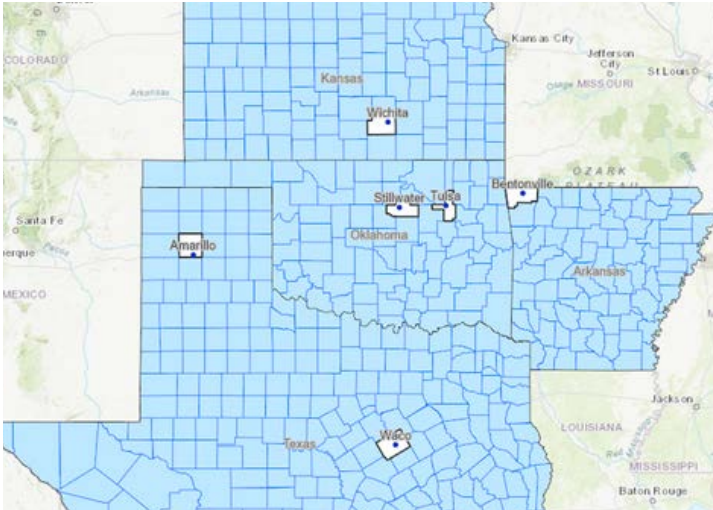


Figure 3. Locations of the cities and counties that were included in the study.

The analysis revealed three primary findings. **First**, as expected, the hazard mitigation plans tend to be of low to mediocre quality. Fortunately, interviewees were aware of the limitations of their existing hazard mitigation plans and in some cases were initiating changes, at least within the bounds imposed by their local political context. **Second**, the networks of hazard mitigation stakeholders vary widely in composition and leadership, some replicating emergency management networks suited to preparedness and response and some

much better suited to the quite different demands of long-term mitigation work. **Third**, the types of consultants and their roles also varied across the six cases, bringing expertise characteristic of narrow emergency management perspectives to more integrated expertise in long-range land use and infrastructure planning perspectives.

This descriptive and systematic understanding of relationships added to academic knowledge. Stakeholders who were directly engaged gained a more systematic understanding of how their plans and interactions are – or are not – well networked, something that few professionals have time to study and reflect on in detail during their normal course of work. This research produced a journal article that has been accepted for publication but not yet published. The pre-proof is available [here](#).

County / Principal City	Plans Analyzed (#)	Interviews (#)
Tulsa / Tulsa	4	5
Sedgwick / Wichita	2	0
Benton / Bentonville	2	1
McLennan / Waco	2	1
Potter / Amarillo	2	2
Payne / Stillwater	2	2

Table 1. Number of plans that were analyzed and interviews that were conducted with respect to the geographical locations that were included in the study. See Lyles et al. (2023) for more details.

TAKEAWAY

Evidence mounts that the current planning framework for long-term natural hazard risk reduction is mismatched to the problems at hand. Emergency management-driven planning initiatives are poorly integrated with other local planning efforts and generally perform poorly in terms of public participation, both of which are tasks more typical of the daily work of planners.

Evaluation of the Utility of a Stakeholder-Driven Climate Hazard Assessment Tool

Investigator: Rachel Riley (SCIPP - OU)

Question Answered:

- ★ What is the utility of a climate hazard assessment tool that was developed for planners and emergency managers?

Summary:

Many climate decision support tools have been developed to support a variety of sectors and scales, but evaluation of such tools has only recently begun to take place. In 2019, SCIPP conducted an evaluation of the Simple Planning Tool (SPT) for Arkansas and Oklahoma—a decision-maker driven climate hazard assessment tool developed in collaboration with stakeholders (read about the SPT on page 35). The [evaluation](#), published in the peer-reviewed journal *Weather, Climate, and Society*, found that the tool has high utility despite a relatively limited user base at the time of the study. Decision-makers in Oklahoma and Arkansas were surveyed to assess the SPT’s utility, including its **saliency, credibility, trustworthiness**, and **reasons for and impact of information use on decision-making**. The study advances knowledge on climate decision support tool utility evaluation and demonstrates the impact of a tool within planning contexts.

Table 2. SPT Users were asked to rate the following statements from 1 (strongly disagree) to 5 (strongly agree).

Statement	Mean Agreement Rating
Using the SPT helped me include higher quality hazard information in my plan(s). (<i>credibility</i>)	4.4
Because of my use of the SPT I am more confident that the hazard information in my plan(s) can be trusted. (<i>trustworthiness</i>)	4.3
The SPT helped me gather hazard information that is more relevant to my jurisdiction. (<i>saliency</i>)	4.2
Overall, I feel more confident about using climate information in my job because of what I’ve learned from using the SPT.	4.3

Table 3. SPT Users were asked to rate the usefulness of each of the major sections of the SPT on a 5-point scale from 1 (not at all useful) to 5 (very useful).

Statement	Mean Agreement Rating
Future Trends Summaries	4.4
Historical Data Tools	4.3
Appendix B: Historical FEMA/Presidential Disaster Declarations	4.2
Appendix D: Incentive and Action Programs for Risk Reduction	4.2
Appendix A: Hazard Definitions	4.1
Appendix C: Climate Change Resources	4.0
Data Limitations Summaries	3.9

TAKEAWAY

The evaluation showed that the Simple Planning Tool was useful and informed plans, but for a limited user base. Climate decision support tool communicators can help raise awareness of their tool(s) by utilizing existing decision-maker trusted information channels. They should also recognize that the full impact of their tool may not be known for several years, especially within the context of long-range planning.



CLIMATE ADAPTATION

Overview:

The projects described in the following section examined effective ways to engage stakeholders about climate adaptation strategies. To respond to this task, discussions surrounding extreme weather events, climate variability, and changes in the frequency of events were necessary. Adaptation strategies related to extreme events help to prepare communities for the types of events that often reflect climate change in the region.

Primary Research Objective In This Section:

- Assess how climate information is used and accessed by stakeholders within the region and identify how it can be applied to climate adaptation and planning efforts

Objectives helped guide the research presented, but were viewed as larger concept ideas. Projects described refer to the objective in some way, but do not always answer an objective in its entirety.



Assess how climate information is used and accessed by stakeholders within the region and identify how it can be applied to climate adaptation and planning efforts

Investigators: William Howe (SCIPP - OU), Mark Shafer (SCIPP - OU), Rachel Riley (SCIPP - OU)

Question Answered:

Summary:

In 2019, SCIPP researchers began a project to improve connectivity between the National Climate Assessment (NCA) and stakeholders, allowing for bi-directional flow of information and application of state-of-knowledge practices and processes. The research was completed in 2020, and results from one of the studies entitled [*A Social Network Analysis of Climate-Related Information Exchange in the Southern Climate Impacts Planning Program \(SCIPP\) Areas of Operation*](#), were communicated in an official report. Researchers examined the relationships between SCIPP's primary stakeholders and sources of climate information. They examined familiarity with specific sources, such as the National Climate Assessment, U.S. Climate Resilience Toolkit, and NCEI/AMS State of the Climate Report. They also investigated stakeholders' familiarity of climate information providers such as SCIPP, the USGS South Central Climate Adaptation Science Center, NOAA Southern Regional Climate Center, and local NOAA National Weather Service Forecast Offices. The analysis identified 81 unique organizations, 130 unique connections, and eight distinct groups.

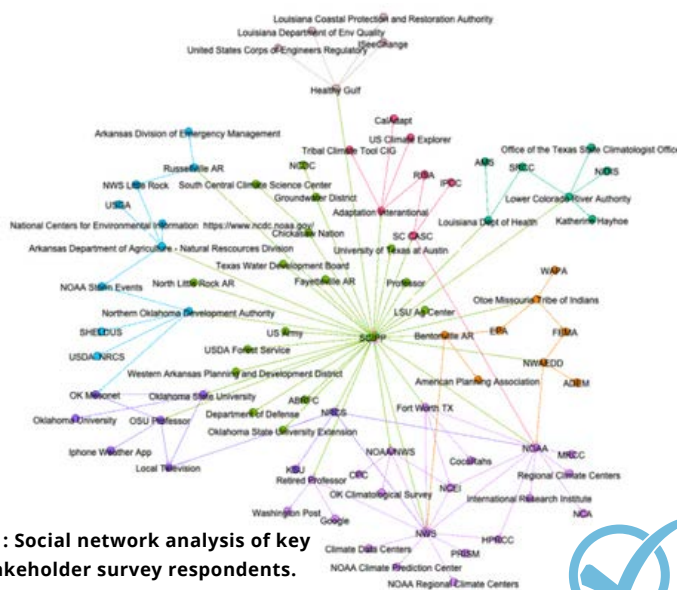


Figure 4. : Social network analysis of key SCIPP stakeholder survey respondents.

TAKEAWAY

The study showed a need for more accessible information to stakeholders and suggests that SCIPPs provide more timely updates to increase the relevance of its information. Furthermore, results highlighted the critical role of sustained assessment specialists in cultivating stronger relationships, particularly in two areas of focus: **universities** and **underrepresented populations**.

Cross-RISA Collaborative: Connecting Climate Adaptation and Hazard Mitigation Planning in Climate Discourse-Sensitive Regions

Investigators: Rachel Riley (SCIPP - OU), Darrian Bertrand (SCIPP - OU), Seth Arens (Western Water Assessment)

Question Answered:

★ What factors enable adaptation planning and action?

Summary:

In 2020, SCIPP collaborated with NOAA CAP/RISA's Western Water Assessment (WWA) to build the capacity of state and local hazard mitigation efforts to incorporate climate into their natural hazards planning efforts, and to use those planning efforts to support actionable climate adaptation. Phase 1 of the project focused on developing a [Simple Planning Tool for the state of Utah](#) (WWA's region) based on the template that was developed by SCIPP a couple of years prior. Phase 2 of the project investigated decision makers' adaptation enabling environment and the factors that made hazard mitigation and climate adaptation planning and implementation more likely across two states that underperform: Oklahoma and Utah. The research determined specific

needs that could potentially be met by CAP/RISA teams or other organizations. In 2021, SCIPP conducted four 2.5-hour workshops with 26 officials from rural and urban jurisdictions across Oklahoma to examine the aforementioned topic. Key takeaways from the workshops are identified on the following page. Additional details are available in the final [project report](#).



Wichita Mountains, OK.
Credit: Dana Wilkerson



TAKEAWAY



According to the workshop participants, factors that enable hazard mitigation planning and action include:

- Obtaining buy-in from community leaders (e.g., elected officials, businesspersons who have substantial community influence) and regional and state professional associations
- Being able to take advantage of federal programs that provide a few years of pilot funds to hire a staff person to focus on the issues
- Involving officials from multiple departments (e.g., public works, planning, emergency management, etc.) in planning and implementation processes
- Access to climate adaptation and hazard mitigation information that is concise and meaningful to the stakeholder contexts, demonstrates costs over time, and demonstrates costs of inaction
- Workforce training on the benefits of hazard mitigation and climate adaptation
- Clarity and standardization of planning requirements

Town Lake, Austin, TX.
Credit: Metschan



COASTAL IMPACTS

Overview:

Preparing for the combined threats of storm surge, sea-level rise, and frequent intense rainfall events (e.g., Hurricane Harvey in 2017; Louisiana Flood in 2016) requires engaging communities and organizations in vulnerable coastal zones to develop systematic action plans for municipalities and regions. Results from the projects described in this section were used to inform stakeholders in coastal zones of risks related to storm surge, inland flooding, and rapid intensification of storms.

Primary Research Objectives In This Section:

- Assess changes in the frequency of events that may change hazard exposure profiles in communities within the region
- Assess the impacts of storm surge and flooding events on infrastructure
- Evaluate information selection in assessing coastal risk

Objectives helped guide the research presented, but were viewed as larger concept ideas. Projects described refer to the objective in some way, but do not always answer an objective in its entirety.



Objective

Assess changes in the frequency of events that may change hazard exposure profiles in communities within the region

Precipitation Studies

Investigators: Vincent Brown (SCIPP - LSU), Alan Black (SCIPP - LSU), Barry Keim (SCIPP - LSU)

Questions Answered:

- ★ What types of weather events cause the greatest disruption for communities and how might the frequency and severity change in response to climate change?

Summary:

A key research focus of SCIPP Phase III, with leveraged funding from the Coastal and Ocean Climate Applications, was precipitation. Led by Vincent Brown, Alan Black, and Barry Keim, four manuscripts were published on precipitation (climatology, extreme events, and trends) across the Southeast United States (see Brown et al. [2019a](#), [2019b](#), [2020a](#), [2020b](#)). This body of work was of particular interest to the Sewerage and Water Board of New Orleans (SWBNO). They oversee storm water drainage in New Orleans and have endured repeated precipitation events that overwhelmed the city's drainage system in recent years. The events caused flooding, frustration, and loss across the city. SCIPP's precipitation research findings have helped inform SWBNO's adaptation efforts. This work also led SCIPP to partner with SWBNO on a two-year NOAA Adaptation Science Program (AdSci) grant titled "Planning a Flood Resilient Future for New Orleans, LA."

For that project, researchers conducted a 414-person survey of Orleans Parish residents to better understand their perceptions of climate change, flooding, and view of the SWBNO. The data from the survey is still being analyzed, but will help the SWBNO understand public perceptions of climate change and which projects should be given priority from the general public's standpoint (e.g., green infrastructure, limiting building, new fees, building restrictions, etc.).

Our interactions with the SWBNO throughout Phase III led to changes in water management that impact the nearly 400,000 residents of Orleans Parish and will hopefully make the City of New Orleans more resilient to flooding.



Flooded highway.
Credit: Brazzo

Below are a few key takeaways pertaining to the precipitation studies.



TAKEAWAY

Climatology and Trends in Hourly Precipitation for the Southeast United States

- Research results indicate hourly precipitation intensity significantly increased at 44% of the stations, accompanied by an increase in average hourly accumulation at 40% of the sites analyzed. Geographically, heavy hourly events are more frequent along the Gulf Coast and decrease inland.

Hourly Rainfall Climatology of Louisiana

- The study investigated possible changes in the hourly precipitation distribution, and links winter (DJF) Gulf of Mexico (GOM) sea surface temperatures (SST) to the frequency of hours with precipitation. For example, the duration of events is much longer in winter compared to summer, while the number of rainfall events is greater in summer. It was also determined that winter GOM SST significantly correlated with the number of hours with precipitation across coastal Louisiana, possibly related to the frequency of synoptic types such as frontal isentropic lift.

Trend Analysis of Multiple Extreme Hourly Precipitation Time Series in the Southeast United States

- Results indicated that the magnitude of annual maximum 1-, 3-, 6-, 12-, and 18-h periods did not broadly change at the sites analyzed; however, the numerical value that defines a (station specific) 90th percentile hourly accumulation significantly increased at 36% (18/50) of the stations. Six stations across Georgia showed significant decreasing trends in the annual maximum consecutive hourly period with measurable precipitation (duration), demonstrating that the longest precipitation events that occurred at these stations have decreased in duration since 1960.



Sea Level Rise and High Tide Flooding: A Review for the Gulf Coast

Investigators: Vincent Brown (SCIPP - LSU), Barry Keim (SCIPP - LSU), Renee Collini (Mississippi-Alabama Sea Grant), Carey Schafer (Mississippi-Alabama Sea Grant), Clay Tucker (LSU), Amanda Lewis (SCIPP - LSU), DeWitt Braud (LSU Dept. of Coast & Environment)



Question Answered:

- ★ What is the current “state of the science” on sea level rise and projections for the Gulf Coast, based on the newest IPCC and NOAA sea level rise research?

Summary:

Stakeholders are very concerned about current sea-level rise (SLR) and its impacts (high tide flooding ; HTF) and dire future scenarios. The population in coastal counties continues to increase, as well as risk. SCIPP’s goal for this project was to provide a published review document that serves as the backbone for future collaboration and engagement. Within the document, an overview of current tools (how to use them) and how to access and use projections of SLR and HTF was provided.

TAKEAWAY



The Gulf Coast, particularly the northern-Gulf Coast, is experiencing some of the highest rates of relative sea level rise in the world. High relative sea level rise rates are driven by subsidence and glacial isostatic adjustment. There is also a correlation between proximity to oil/gas exploration and increases in subsidence/land loss. The rate of relative sea-level rise has increased in the last 25 years, primarily due to increases in eustatic sea level. The occurrence of high tide flooding is rapidly increasing along the Gulf Coast as well. As the sea-level continues to rise, storm damage (tropical/frontal) will likely increase due to further inland penetration of seawater.

Stalling North Atlantic Tropical Cyclones

Investigators: Jill Trepanier (LSU), Vincent Brown (SCIPP - LSU), Barry Keim (SCIPP - LSU), Derek Thompson (SCIPP - LSU), Texas A&M, Southern Regional Climate Center

Question Answered:

- ★ What is a “stalled” tropical cyclone?

Summary:

This research endeavor provided a climatology of stalled tropical cyclones for the North Atlantic 1900-2020 and investigated trends in stalling tropical cyclones during the satellite era (1967-2020). Researchers offered a quantitative definition of a “stalled” tropical cyclone, provided a climatology of stalled events, and assessed the recurrence interval of stalls in the Gulf of Mexico, Caribbean, and Atlantic. Identifying and understanding the climatology of stalling events is important because slower storms, particularly within the coastal zone, often lead to increases in local rainfall accumulation. That, coupled with tracks that recurve or loop through a region, can cause not one but multiple landfalls that further devastate an area. The project advanced tropical cyclone research and was helpful for stakeholders (e.g., planners, water utilities, etc.)

interested in tropical cyclone risk (and rainfall). One of the most prolific examples of a stalled storm is Hurricane Harvey, which devastated the Houston area in 2017. A final paper for this project is still in review for the *International Journal of Climatology*.

TAKEAWAY

This study provides a climatology of stalling tropical cyclones (TCs) in the North Atlantic from 1900–2020. The distance traveled over 72-hour periods is defined as a corral with stalls defined as events remaining within a corral radius of ≤ 200 km. The minimum radius for all TCs occurred with Tropical Storm Gilda in 1973 at 61 km. Hurricane Harvey stalled over Houston, Texas in 2017 with a 123 km radius. Stalling TCs cluster in three locations. The shortest recurrence interval (3.5 years) occurs along the eastern seaboard over the Gulf Stream. Stalls occur throughout hurricane season, but the proportion of TCs that stall in October is 18.1% compared to the 6.6% in August. Stalling TCs are more likely to reach category 3+ intensity at some point in their lifecycle. The annual frequency of stalled TCs is significantly increasing using satellite era data at a rate of 1.5%/yr–1.



Examining Extreme Rainfall Forecast and Communication Processes in the South Central United States

Investigators: Anna Wanless (SCIPP - OU), Rachel Riley (SCIPP - OU)

Questions Answered:

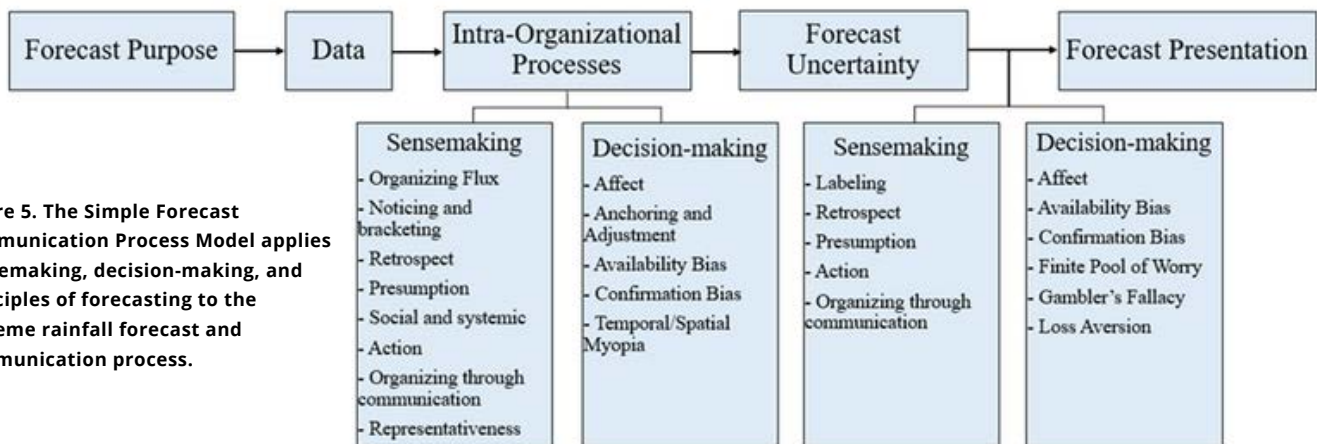
- ★ What types of weather events cause the greatest disruption for communities and how might the frequency and severity change in response to climate change?
- ★ How do forecasters internally process model outliers?
- ★ How do forecasters externally communicate model outliers and outlier events?
- ★ Do forecasters consider climate change when forecasting extreme rainfall events?



Summary:

This study investigated how National Weather Service (NWS) forecasters in the SCIPP region internally process and externally communicate extreme rainfall events. As these events are projected to increase in frequency and intensity in parts of the United States, forecasters must be able to effectively communicate the potential impacts of these events to their audiences. However, how forecasters translate their meteorological knowledge into useful forecast information has not been widely studied. This research bridged that knowledge gap. It also investigated the forecasting and communication processes of these events, which are impacting hazard exposure profiles in the SCIPP region.


Twenty-one NWS forecasters across the South Central U.S. region were interviewed about how they internally processed and externally communicated model outliers and anomalous rainfall events overall. The study also explored forecasters' perceptions of the relationship between these events and climate change and if those perceptions impacted the forecasts for the event. Deductive qualitative analysis was used to apply an existing social science theory and framework to the responses. Using sensemaking and decision-making conceptual frameworks as well as principles of forecasting, a Simple Forecast Communication Process Model (Figure 5) can be used to depict the forecasting and communication processes that involve model outliers and outlier events.



Rainfall on street.
Credit: Christian Lue

Practically speaking, the study revealed that forecasters process model outliers by mentally acknowledging them and monitoring subsequent models to see how that outlier evolves. Second, forecasters sometimes communicate outliers as possible worst-case scenarios to sophisticated partners and emphasize impacts rather than specific rainfall amounts. Finally, while the increase in frequency and intensity of rainfall events does not impact their real-time forecast and communication processes, the role of climate change is sometimes considered after an event has passed. A [masters thesis](#) was produced from this research and provides more details about the study. A journal article based on the thesis has been submitted to *Weather, Climate, and Society*. Half of the funding that made this research possible was provided by NOAA/Office of Oceanic and Atmospheric Research under NOAA-University of Oklahoma Cooperative Agreement #NA16OAR4320115.

TAKEAWAY



While forecast and communication processes are complex and vary between offices and forecasters, the Simple Forecast Communication Process Model provides a high-level understanding of how forecasters translate their knowledge to usable information for their audiences. The study also found that forecasters do not consider the impacts climate change might have on an extreme rainfall event when forecasting such an event. However, climate change is a consideration for some forecasters when they reflect on the event afterward.



Objective

Assess the impacts of storm surge and flooding events on infrastructure

Regional Probable Maximum Precipitation Study for Arkansas, Louisiana, Mississippi, and Oklahoma

Investigators: Barry Keim (SCIPP - LSU), Bill Kappel (Applied Weather Associates LLC), Whitney Montague (Arkansas State Climatologist), Ed Knight (Louisiana Department of Transportation), Devan Mahadevan (Federal Energy Regulatory Commission), Zachery Hollandsworth (Oklahoma Water Resources Board)

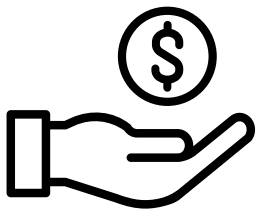
Question Answered:

- ★ What updates to NOAA's Hydrometeorological Report 51 (HMR 51) need to be made for Oklahoma, Arkansas, Mississippi, and Louisiana?

Summary:

Throughout Phase III, SCIPP's Barry Keim played a key role in overseeing the development of new and improved Probable Maximum Precipitation (PMP) estimates for Louisiana, Mississippi, Arkansas, and Oklahoma conducted by Applied Weather Associates. PMP is defined as the extreme upper capacity of the atmosphere to produce rainfall if every worst case variable came together to produce the worst storm possible. These estimates were derived for durations from 1-hour to 120-hours and for area sizes of 1 square mile to 20,000 square miles. HMR 51 was published in 1978 and numerous PMP-caliber storms have occurred since (e.g., Hurricane Harvey) that are relevant to PMP in the region. Furthermore, we have an improved knowledge of heavy rainfall characteristics and where storms can occur geographically leading to an improved product.

This research was used to inform design of dams and served as the guiding document that is recognized by the Federal Energy Regulatory Commission for the design of dams across the 4-state region. Values from this document are also relevant to nuclear power plants which need to contain runoff from their installations. It is estimated that the economic impact of this study saved dam owners between \$50-100 million in design and remediation costs in the first year of the study alone. The complete report can be found [here](#).



TAKEAWAY

This study led to larger PMP values relative to HMR 51 in some limited regions of the study, e.g., in coastal Louisiana, because of the influence of Hurricane Harvey rains. Values also increased slightly in eastern Oklahoma and parts of western Arkansas. However, our improved understanding of storm dynamics and storm geography led mostly to reductions in PMP values across the region, which saved dam owners from over-designing their structures.



The study is
estimated to have
SAVED
dam owners

\$50-\$100
MILLION MILLION



IN DESIGN
AND
REMEDICATION
COSTS IN THE
FIRST YEAR
ALONE

Morganza Floodway, LA.
Credit: Flickr

Effect of Meteorological variables on crawfish harvest in Louisiana, USA

Investigators: Vincent Brown (SCIPP - LSU), Barry Keim (SCIPP - LSU), Mark Shirley (Louisiana AgCenter), Charles G. Lutz (Louisiana AgCenter), Brian D. Marx (Department of Experimental Statistics at Louisiana State University)

Question Answered:

- ★ How do meteorological variables impact crawfish yields in research ponds in Baton Rouge, LA?

Summary:

In 2019, through leveraged funding from the NOAA Coastal and Ocean Climate Applications program, SCIPP researchers worked with Louisiana Marine Extension Agents to investigate how meteorological variables (eg: temperature, precipitation, humidity, cloudiness, etc.) impact crawfish yields in research ponds in Baton Rouge, LA. Crawfish yield is of high importance to farmers in the region, as 90% of all crawfish is produced in Louisiana, and an estimated \$209.5 million is generated for pond-reared crawfish.

To complete this work, researchers' quality controlled eight years of crawfish harvest data and then used statistical models to relate the harvest data to the weather conditions. Findings showed statistically significant relationships between precipitation, temperature, and other more complicated variables and crawfish harvests at various time steps (months). Those results led to further collaboration with Louisiana Sea Grant for an analysis of dissolved oxygen in crawfish ponds and the weather effects (specifically, abrupt weather fluctuations) on the pervasiveness of the White Spot virus in crawfish ponds. This study is evidence of societal impact, as crawfish farmers were able to use these findings to test established best practices for harvest, which may result in saving money on bait, labor, and time. The [manuscript](#) can be found in *Climate Research*.



Crawfish in the Spring.
Credit: Sidney Pearce



TAKEAWAY

Eight years (2006-2013) of harvest data were collected spanning February, March, and April of each year. Using multiple regression and model selection processes, the effect of meteorological variables was assessed at three different monthly lags (lag 0, 1, and 2) to determine which combination of variables best explained variance in average monthly crawfish pounds per trap (AMPT). The final model selected for lag 0 (adj-rsq = 0.73, $p < 0.01$), lag 1 (adj-rsq = 0.71, $p < 0.01$), and lag 2 (adj-rsq = 0.69, $p < 0.01$) generally included the same variables: monthly average low temperature, precipitation, and the preceding October/November precipitation (ON).

Both monthly average low temperature and ON exhibited a statistically significant ($p \leq 0.05$) positive effect on AMPT while controlling for other variables in the model, revealing the importance of warm temperatures and precipitation during October/November for crawfish harvests. Precipitation during the harvest month was not significant, but increased precipitation 1 and 2 mo before harvest significantly decreased AMPT. The number of hours with temperatures $\leq 0^\circ\text{C}$ was also a significant variable negatively associated with AMPT 1 and 2 mo before harvest and, along with precipitation, could potentially be an early indicator for AMPT before harvests begin in southern Louisiana.



Objective

Evaluate information selection in assessing coastal risk

Information Sources and Planning for Flood by Water and Wastewater Managers

Investigator: Renee Edwards (SCIPP - LSU)

Question Answered:

★ What factors affect how water and wastewater managers prepare for flooding?

Summary:

An essential element of public health is the ability to provide water and properly treat wastewater. Flood and other extreme weather events put water systems at risk, and this is particularly a problem in SCIPP coastal regions. During Phase III, SCIPP examined factors associated with flood planning for water managers in coastal Louisiana. The project assessed what motivates some people and groups to act while others do not? Researcher Renee Edwards conducted interviews where water managers identified several factors that affect planning and preparation for flood.



TAKEAWAY

Leadership appeared to be particularly important. Interviewees identified past and present leaders who work to maintain existing systems and others who promote and implement new systems to improve their services. **Resource limitations** also affected water management. For example, additional financial resources permitted one organization to provide on-site housing to employees during extreme weather. **Labor** was a challenging resource, especially for wastewater treatment. It is difficult to keep employees when better-paying (and more pleasant) work is available.

Some water systems are under the jurisdiction of political entities that control their finances and decisions. Water managers described political bodies who typically approve requests as well as instances of political interference. When interference occurs, leadership within the organization is a key factor in the outcome. Interviews reflected a range of priorities for water management systems. While some were focused on getting by, others could implement upgraded systems more able to withstand extreme events. Systems located in larger communities were in a stronger position to make investments because of greater financial resources.

Cypress Swamp, LA.
Credit: Jaimie Tuchman



DROUGHT

Overview:

Over the past decade, there have been tremendous efforts to assess drought conditions and reduce risk. National and regional partnerships have been formed to better understand regional impacts and variations in the types of information needed in making decisions. What was less clear was how national investments in drought early warning connected to local communities' planning, preparedness, and response. Increased integration of drought into state and local hazard plans, mitigation planning, risk assessment, and hazards communication, proved to be valuable. This section of the report highlights work pertaining to gaps in research related to drought.

Primary Research Objective In This Section:

- Assess gaps in research, products, and services applied to sector needs

Objectives helped guide the research presented, but were viewed as larger concept ideas. Projects described refer to the objective in some way, but do not always answer an objective in its entirety.



SCIPP
A NOAA CAP TEAM



Objective

Assess gaps in research, products, and services applied to sector needs

Improving the Effectiveness of Early Warning Systems for Drought

Investigators: Mark Shafer (SCIPP - OU), Commission for Environmental Cooperation

Questions Answered:

- ★ What indicators are most commonly used to detect and monitor drought?
- ★ How does drought vulnerability and management practices vary across North America?

Summary:

The Commission for Environmental Cooperation (CEC), a multinational organization of Canada, Mexico, and the United States, commissioned a study of the use of drought information and guidance for more effective use of available drought information. The project had three objectives: (1) to produce a set of guidelines for use of North American drought indicators, (2) to increase local capacity to use available drought information for planning and risk management, and (3) to strengthen existing trilateral partnerships across North America related to use of the North American Drought Monitor. To achieve these objectives, the consultants developed and executed surveys of drought information users and local officials who manage drought in each of the three nations. In addition, the consultants organized an online drought summit to discuss local needs for information. The [Guide to Drought Indices and Indicators Used in North America](#) was published in May 2021.

SCIPP's participation in the project focused on objective 2. The initial draft of the survey and format for the summit built upon SCIPP's previous work, [Local Drought Management: A summary of how counties and parishes use drought information in the South Central United States](#). SCIPP assisted the consultants in developing survey questions, identified presenters for the summit, and reviewed the draft summary document. NIDIS and NOAA NCEI were also actively involved in the summit.



Dry River Bed at Big Bend Nation Park, TX.
Credit: Different_Brian

More than 80 professionals from the three nations participated in the online Drought Summit. Presenters highlighted local decision processes affected by drought, tools used to monitor drought, and discussion of use of the North American Drought Monitor and U.S. Drought Monitor. The transboundary nature of drought was a key discussion point, as impacts do not end at jurisdictional boundaries. The Summit led to recommendations to improve the awareness of resources and data related to drought, improve the efficacy of drought reporting and forecasting, creating tools that support multi-sectoral drought coordination, develop training and support peer-to-peer networks, and create enabling policy and resources for collaboration in early warning systems. A summary can be found [here](#).

TAKEAWAY



The tri-national CEC study confirmed earlier findings from SCIPP of a disconnect between local practitioners and national and international drought monitoring efforts. The multitude of drought indicators available is confusing to practitioners; many do not know which indicators are best suited to their climate region and applications. The Summit also highlighted the importance of local and indigenous knowledge. It is not sufficient to provide resources and training; rather there needs to be consideration of local knowledge in developing strategies to manage drought impacts.

Drought Land Texture.
Credit: Engin Akyurt



A Pathway to Action: SCIPP Climate Adaptation Summer Academy

In an effort to build interest and increase understanding of climate adaptation in the region, SCIPP hosted 18 undergraduates from Texas, Oklahoma, Louisiana, and Arkansas at its first-ever Climate Adaptation Summer Academy, in June 2022. There, students heard from a variety of speakers on topics including but not limited to: climate-related hazards in the South-Central U.S., social factors and equity in climate adaptation, climate policy, administrative authorities and their responsibilities, and planning and development skills such as geographic information systems and hazard mitigation techniques. As part of SCIPP's focus to promote diversity in climate adaptation, we were intentional about recruiting students from minority serving institutions, under-resourced and rural communities, and first generation college students (Figure 6).



Summer Academy students at Scissortail Park.

RECRUITMENT SCOPE

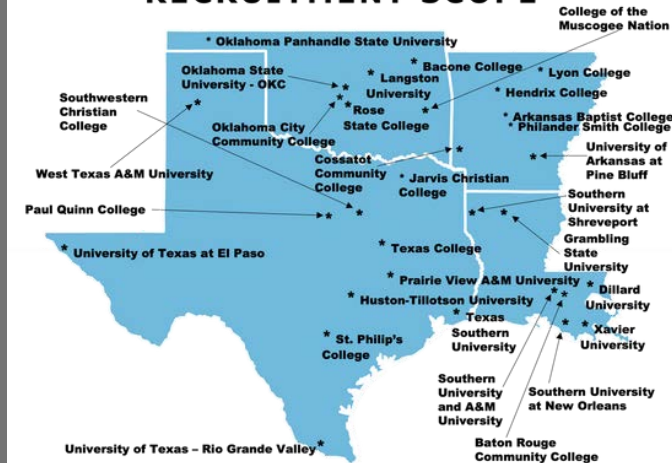
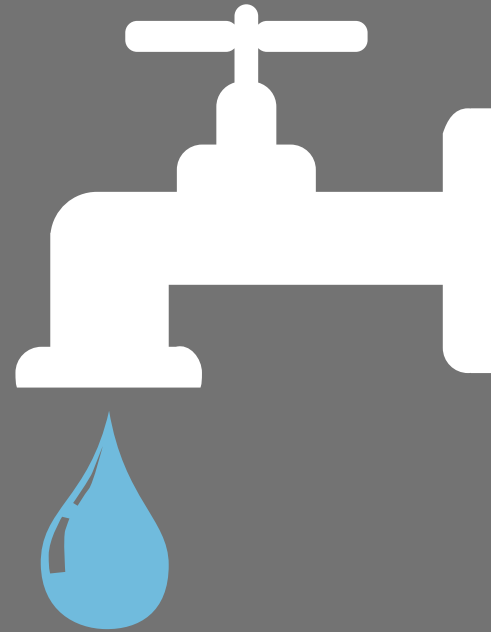


Figure 6. Map depicting the recruitment scope across the four SCIPP states.

The Academy, which was a 5-day all-expenses-paid opportunity, built interest and increased understanding of climate adaptation by introducing undergraduate students to climate adaptation concepts and professionals who regularly address solutions to the impacts of the changing climate. The initiative **elevated a sense of agency** by building the expertise, confidence, and capability of partners (i.e., Academy attendees in this case) to act. Specifically, students provided feedback about being more knowledgeable about climate adaptation and the various aspects connected to it (e.g., grant management, fiscal policies, city planning), which offered them a more nuanced and well-rounded understanding of the topic. In addition, the Academy empowered participants to make career choices related to climate adaptation. For instance, in a follow-up survey, one participant indicated that "I feel more prepared for whatever comes my way because of this Academy." The Summer Academy is an example of SCIPP's commitment to advancing climate knowledge in the region through innovative community engagement approaches.

NOAA Water Utilities Workshop

In July 2020, SCIPP hosted a virtual workshop to provide climate information to water, wastewater, and stormwater managers along the Gulf Coast, especially those in rural communities. There were approximately 45 attendees at maximum participation, including local water utility managers and employees from Coastal Louisiana and Texas, and representation from NOAA and non-governmental organizations. The stakeholder participants identified several information needs during the workshop including **(1)** further research/data regarding past and future heavy rainfall events in the Gulf Coast region, **(2)** scientific information that is more accessible and digestible for elected officials and the public, and **(3)** tools to overlay physical science with social data to understand vulnerability. This workshop led to a key partnership between SCIPP and one of the workshop participants, the Sewerage and Water Board of New Orleans (SWBNO), as SCIPP later assisted the SWBNO with planning for future flood events (see page 17).



This initiative leveraged funding from NOAA and the Water Research Foundation.

Top 3 Lessons Learned:

- Small and medium-sized water utilities in the Gulf Coast region seem to “piggyback” on the work and resources of the larger utilities.
- Smaller utilities in the region are operating with very little resources to devote to long-term planning.
- The utilities feel that there is a lack of actionable information.

Making Gulf Communities More Resilient: Scaling-up Customized Vulnerability Assessment for Extreme Events in Gulf Cities

SCIPP collaborated with the Great Lakes Integrated Sciences and Assessments (GLISA), Stanford University, Headwaters Economics, and Adaptation International to extend GLISA's stormwater vulnerability assessment tool to communities along the Gulf of Mexico coast. The Floodwise Communities project enrolled 57 cities, counties, and parishes in the study. Communities were assigned to one of three treatments: in-person workshop, online workshop, or self-guided. The goal was to test the degree to which in-person interaction was required to assist community officials as they assessed various components of their stormwater system and identified upgrades to promote resilience to extreme precipitation. In addition, customized climate profiles for each community were developed by SCIPP and demographic profiles developed by Headwaters Economics. A [regional report](#) on Climate of the Gulf States was produced, which may be beneficial to other SCIPP projects. The study design was developed pre-COVID, when online interaction was considerably less evolved. In addition to using the tool (which was upgraded from an Excel spreadsheet in GLISA's earlier work to an online tool), participants completed a pre-intervention survey, a post-intervention survey, interviews, and participant observation during the workshops or online training. Results are being synthesized to determine ways to optimize interaction that would reduce the time investment for both the practitioners and the trainers.



Figure 7. Floodwise Communities project logo.

One lesson learned was the effort required to enroll cities in the study. The project team used advertisements through boundary organizations, webinars to explain the project, and personalized emails and phone calls in order to encourage cities to participate. With recruitment occurring during the pandemic, when city officials had more pressing priorities, along with the lingering effects of being overburdened by the pandemic, it proved difficult to obtain and maintain local commitment to the project. Nonetheless, efforts by the project team assured that most communities completed their assessments. Connections with communities in Texas and Louisiana will also prevent further opportunities for stakeholder collaboration with other projects SCIPP hosts in the future.

SCIPP's Contribution to the City of Oklahoma City's First Sustainability Plan

In 2020, SCIPP's Rachel Riley collaborated with the City of Oklahoma City's Sustainability Manager to contribute to the City's first ever sustainability plan "[adaptokc](#)". Riley provided text and an image about historical and projected extreme heat and heavy rainfall information that was relevant to the city, and that would resonate with readers of the plan. Riley used information from the future trends sections of SCIPP's [Simple Planning Tool for Oklahoma Climate Hazards](#) along with the Fourth National Climate Assessment to help edit a portion of the draft plan.

On June 11, 2020, [adaptokc](#) was unanimously adopted as an amendment to the city's comprehensive plan by the Oklahoma City Planning Commission. The plan was presented to the City Council on July 7, 2020.

"The perspective and knowledge SCIPP provides are absolutely vital for our climate planning and adaptation efforts."

– T.O. Bowman, City of Oklahoma City Sustainability Manager

Texas Resilience Conference

The Texas Resilience Conference aimed to convene about 200 representatives from all levels of government, non-governmental organizations, community groups, private industry, and academia that work on resilience and climate change adaptation in Texas. While the conference was initially rescheduled for Spring 2021 due to COVID, it was later canceled all together. The conference would have provided a venue for practitioners and researchers to share information about current activities, plans, and opportunities for collaboration. SCIPP was listed as one of 20 organizations represented on the conference's steering committee. SCIPP's Rachel Riley had devoted countless hours to conference planning as the chair of the Program Committee and member of the Steering Committee. Though this event was planned during Phase III, there is a possibility to host it again in the future.



Figure 8. Official Texas Resilience Conference logo.

Educators, Artists, and Scientists Engaging Learners

Educators, Artists, and Scientists Engaging Learners (EASEL) began as an effort to research the “impact of a fully participatory approach to the performing arts on learning of science concepts and environmental decision- making” (<https://www.art-sci-ed.org/>). This joint initiative, primarily funded by the National Science Foundation, but with contributions from SCIPP (Barry Keim), Dillard University, STEM Nola, A Studio in the Woods, State University of New York- Buffalo, and ArtSpot Productions, fused the arts and sciences, and resulted in on-stage performances about the local impacts of climate change. Two predominantly Black neighborhoods in New Orleans (Gentilly and New Orleans East) were the focus of this engagement initiative. These neighborhoods were selected to give a voice to residents who live in a part of New Orleans that has largely been forgotten in the overall recovery of the city in the post-Hurricane Katrina era. The acting participants for the project were drawn from the area.



Barry Keim engages with local artist.



Figure 9. Official flyer for the final performance.

This innovative engagement approach was a testament to trust building among underserved communities in the SCIPP region. As SCIPP continues to seek effective ways to engage with communities of interest, this initiative was helpful in exploring new approaches to involve community leaders.

A Simple Planning Tool for Climate Hazards

With the first version of the tool produced in 2018, SCIPP's Simple Planning Tool (SPT) is a compilation of relatively easy-to-use online interactive tools, maps, and graphs that depict historical climatologies. It also provides state-of-the-science summaries regarding what is known about how each hazard is being and is expected to be impacted by climate change. It is primarily designed for planners and emergency managers who serve small- to medium-sized communities but may also be of interest to those who serve larger areas. While it may not answer every question one has about hazard climatologies and future trends, it aims to cut through the internet clutter and point to relatively simple data tools that can be used during planning processes and in plans.



Figure 10. Cover page for SCIPP's Simple Planning Tool for Oklahoma Climate Hazards.

Simple Planning Tools were developed for Oklahoma and Arkansas during Phase III. SCIPP plans to develop versions for Texas and Louisiana during its next grant cycle.



Figure 11. Award given by the Oklahoma Chapter of the American Planning Association.

Award 1: The Oklahoma SPT received the Oklahoma Chapter of the American Planning Association's 2019 award for Outstanding Public Outreach, Program, Project, Tool, or Community Initiative. The award category emphasizes results and demonstrates how innovative and state-of-the-art planning methods and practice help create communities of lasting value.



Figure 12. Paula Dennison, Rachel Riley and Rob Hill receiving the award from Alisha Powell Gillis, *Route Fifty* Senior Editor, at the awards ceremony in San Antonio, Texas.

Award 2 ("2019 *Route Fifty* Navigator Tech Innovators Award"): SCIPP's Rachel Riley, along with stakeholder partners Paula Dennison and Rob Hill from the City of Stillwater, Oklahoma, were given the award for "developing the Simple Planning Tool for planners and emergency managers to assess the local, long-term climate risks in Oklahoma communities." The *Route Fifty* awards honor individuals and teams who work in or with state, county, and municipal governments across the United States.

Temperature Trends Dashboard

SCIPP, in collaboration with Texas Sea Grant, created a tool that shows historical trends in temperatures for locations across the state of Texas. The [Temperature Trends Dashboard](#) displays trends in extreme heat, extreme cold, warm nights, heating and cooling degree days, seasonal average temperatures, seasonal extreme temperatures, and yearly average temperatures from 1970-2019 for 75 stations (point locations) in Texas. Some stations (point locations) have longer periods of record, but 1970-2019 was selected to compare temperatures at all stations during the same 50-year period. The graphs show both individual data points for each year and overall trend lines, and they can be downloaded as images. The dashboard also includes a link to a [fact sheet](#) discussing the temperature indicators shown in the tool and their importance. While the tool was originally developed for locations across the state of Texas, SCIPP staff is expanding the tool to the rest of the region (Oklahoma, Louisiana, and Arkansas), and hope to implement the upgrade in 2023.

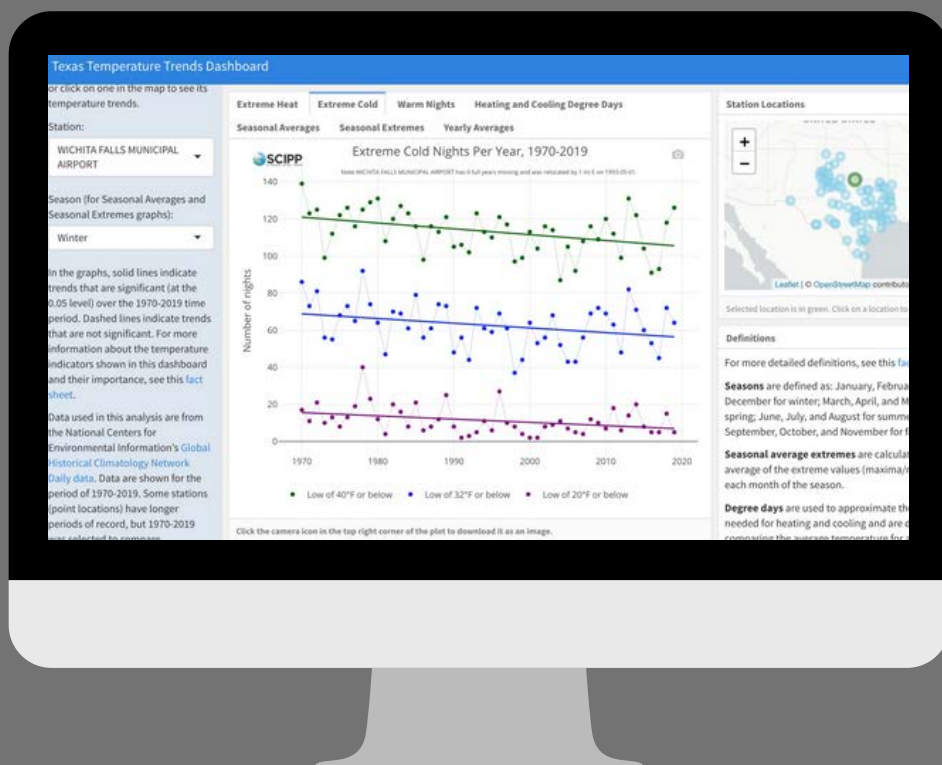


Figure 13. Display of Texas Temperature Trends Dashboard depicting "Extreme Cold Nights Per Year, between 1970-2019" for Wichita Falls Municipal Airport.

While other resources exist that present regional or national trends in temperatures, few tools offer such information on a local level. This dashboard helps to fill that gap by providing location-specific information about changes in temperature in the last 50 years. By incorporating trends in indicators such as extreme heat and warm nights to data of overall temperature trends, the dashboard delivers insight into changes in heat that can bring public health and economic ramifications to communities. Other indicators, such as heating and cooling degree days, are relevant to analyses of energy use and emissions.

February 2021: Extreme Cold, Snow and Ice in the South Central U.S.

SCIPP produced a report of the February 2021 winter weather event that greatly impacted the south central U.S. It was the coldest event to occur in the SCIPP region in over 30 years, and the prolonged extreme cold coupled with wintry precipitation caused numerous waterline breaks, power outages, and nearly 200 fatalities, amongst other impacts. The summary was produced by SCIPP's Darrian Bertrand and Simone Speizer. *February 2021: Extreme Cold, Snow and Ice in the South Central U.S.* is a 30-page document that begins with information about the weather pattern and describes records that were broken, the context of the event compared to climatology, and past historic events.

The second half of the document describes impacts to various sectors including energy, water, health, infrastructure, the economy, the environment, and society. Examples of hazard mitigation successes in the region are also provided to encourage stakeholders to reduce their vulnerability for future extreme cold events, especially in the energy sector. These distinct sections allow for easy navigation through the document. To help meet stakeholder needs, this summary was written for a general audience with the goal of helping individuals compare the south central U.S. February 2021 extreme cold event to past events.



Figure 14. Rime ice formed along the shores of Lake Thunderbird in Norman, OK. Credit: L. Forney.

This summary was used as evidence to the Oklahoma Senate Energy Committee's investigation of the energy prices impacted by the extreme cold, as it answered many important questions about the event.

On this same topic, Vincent Brown, Barry Keim and other researchers, also assessed the significance of the storm from a climatological perspective in *An assessment of the extremes and impacts of the February 2021 South-Central U.S. Arctic outbreak, and how climate services can help*. While they found that this event was extreme, most aspects of this storm were not unprecedented. Even in the context of a warming climate, cold events such as this should be considered when assessing risk and hazard mitigation planning. The magnitude of impacts associated with this event suggested a lack of preparedness that needed to be addressed. Researchers discussed the importance of using climate services in planning for future extreme events. While there are documented benefits to users engaging with climate service providers and integrating climate information into their decision-making, the February 2021 event served as an example of the failures that can occur when climate services have not been integrated into planning. They recommended the use of climate services when assessing risk and planning for future climate and weather extremes.

PARTNERSHIPS

Below is a list of key partner organizations throughout the timeframe of SCIPP's Phase III award. A short, bolded description of the relationship is given to highlight a few major links.

A Studio in the Woods

Adaptation International

- **Adaptation International provided expertise on recruitment and conducting local workshops and online training for communities in the Floodwise Communities Project. Other past collaborations included the NOAA SARP-funded Critical Thresholds project and other interactions with numerous stakeholders**

Alaska Center for Climate Assessment and Policy

American Planning Association

Applied Weather Associates

- **Developed estimates of Probable Maximum Precipitation (PMP) for the SCIPP region.**

ArtSpot Productions

City of Stillwater, Oklahoma

Commission for Environmental Cooperation

Consortium for Climate Risk in the Urban Northeast

Cooperative Institute for Severe and High Impact Weather Research and Operations

Dillard University

Disaster Resilience Network

- **Assisted with analysis of flood vulnerabilities in lower socio-economic neighborhoods in Tulsa. Collaborated on Tulsa's Program for Public Information.**

FEMA Region VI

Great Lakes Integrated Sciences and Assessments

- **Floodwise Communities project, funded by the Gulf Research Program, expanded GLISA's Stormwater Vulnerability Assessment tool to 57 Gulf Coast communities.**

Headwaters Economics

- **Collaborated on Floodwise Communities project (led by GLISA). Provides analysis of social vulnerabilities that informs SCIPP's community-based interactions.**

Louisiana Department of Health

Louisiana Sea Grant

Louisiana State University Agricultural Center

Louisiana State University College of Humanities & Social Sciences

Meshek & Associates, LLC

Mississippi-Alabama Sea Grant

- **SCIPP partnered with Mississippi-Alabama Sea Grant and LSU's Dept. of Coast & Environment to create a review paper on sea-level rise along the Gulf Coast.**

National Centers for Environmental Information

PARTNERSHIPS - CONT'D

National Drought Mitigation Center

National Hazard Mitigation Association

National Institute of Standards and Technology

National Integrated Drought Information System

National Renewable Energy Laboratory

NOAA Climate Program Office

NOAA National Severe Storms Laboratory

Oklahoma Climatological Survey

Oklahoma Department of Emergency Management and Homeland Security

- **Collaborations have occurred in several instances through conversations and report and information sharing. ODEMHS used the Simple Planning Tool for Oklahoma Climate Hazards, and SCIPP provided knowledge and capacity to conduct a hazard mitigation planning survey that was of interest to ODEMHS.**

Oklahoma National Guard

- **Partner on an assessment of predictability of wildfire and winter storms that can affect National Guard operations.**

Pacific Regional Integrated Sciences and Assessments

Pawnee County, Oklahoma

Sea Grant Texas at Texas A&M University

South Central Climate Adaptation Science Center

- **Coordinated and collaborated on numerous engagement projects in the region. Provided funding for studies of wildfire and drought.**

Southern Regional Climate Center at Texas A&M

State University of New York-Buffalo

STEM Nola

Strategic Petroleum Reserve

The City of Oklahoma City Planning Department, Office of Sustainability

- **The department has used the Simple Planning Tool for Oklahoma Climate Hazards. SCIPP provided content that was included in the city's first sustainability plan, adaptOKC.**

The Sewerage & Water Board of New Orleans

The University of Oklahoma College of Atmospheric and Geographic Sciences

The University of Oklahoma College of Engineering

U.S. Geological Survey, Wetland and Aquatic Research Center

USDA Agricultural Research Service

- **Hosts the Southern Plains Climate Hub. Collaborated on workshops in areas affected by large wildfires.**

WBRZ Baton Rouge

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"2021 Hurricane Season." The Hurricane and Extreme Weather Experts Media Briefing, June 15, 2021, Baton Rouge, LA (Keim).

"4th National Climate Assessment", American Association of State Climatologists meeting, June 2018, Nebraska City, Nebraska (V. Brown).

"A Freeze Climatology for Southeast Louisiana." The American Society of Sugar Cane Technologists – Louisiana Division Annual Meeting, February 4, 2020, Baton Rouge, LA (Keim).

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"A Freeze Climatology for Southeast Louisiana", Southeast Climate Adaptation Science Center Annual Meeting, November 14, 2019, New Orleans, LA (Keim).

"A Model of Networked Planning? Evaluating the Plans and People of Tulsa's Award-Winning Risk Reduction Efforts", Association of Collegiate Schools of Planning, October, 2019, Greenville, SC (Lyles and Pennell).

"An Evaluation of the Utility of a Decision Maker-Driven Climate Hazard Assessment Tool", 16th Symposium on Societal Applications: Policy, Research and Practice, American Meteorological Society, January 14, 2021, Virtual (Riley).

"Arkansas Natural Hazards Resilience Workshop II: Debut of the New Climate Hazard Planning Tool", Organized and presented at the workshop in conjunction with the Arkansas State Chapter of the American Planning Association's Fall Conference, September, 2018, Siloam Springs, AR (Riley, Kos).

"Assessing and Responding to the Impacts of 2016-2018 Wildfires on Agricultural Systems in the Southern Great Plains", 24th Conference on Applied Climatology, American Meteorological Society Annual Meeting, January, 2019, Phoenix, AZ (Shore, Shafer on behalf of D. Brown and S. Robertson due to government shutdown).

"Baton Rouge Flood: August 2016", South-Central Climate Adaptation Science Center Early Career Researcher Professional Development Training Workshop, August 8, 2018, Baton Rouge, LA (Keim).

"Building Community Resilience", Presented to Oklahoma Weather Lab students, October, 2018, Norman, OK (Shafer).

"Climate and Climate Change", Greater New Orleans Clean Air Coalition Meeting, April, 2019, New Orleans, LA (Brown, Keim).

"Climate and Data Science for Hazard Mitigation and Resilience at the Local Level" (panel), National Academies of Sciences, Engineering, and Medicine, Committee on Applied Research Topics for Hazard Mitigation and Resilience, May 25, 2021, Virtual (Shafer).

"Climate Change & Health", Class lecture (invited), Educational Health (EDU 311), February 27, 2020, University of Central Oklahoma, Edmond, OK (Shafer).

"Climate Change & Health", Contemporary Issues in Public Health (HLTH 5223) guest lecture, November 12, 2020, University of Central Oklahoma, Virtual (Shafer).

- "Climate Change & Health", Educational Health (EDU 311) guest lecture, October 15, 2020, University of Central Oklahoma, Virtual, (Shafer).
- "Climate Change & Health", Educational Health (EDU 311) guest lecture, April 6, 2021, University of Central Oklahoma, Virtual (Shafer).
- "Climate Change and Health", University of Central Oklahoma, March 8, 2022, Virtual (Bertrand).
- "Climate Change and Impacts to the Hydrologic Cycle", Mississippi River: Delta Blues hosted by the Kurt Vonnegut Museum and Library, May 13, 2021, Greenville, MS (Brown).
- "Climate Change and its Implications for the United States and Oklahoma", Resilient Futures Symposium, April 14, 2022, Norman, OK and Virtual (Riley).
- "Climate Change and Oklahoma", UCO Sustainability Faculty Workshop, October 22, 2019, Edmond, OK (Shafer and Boone).
- "Climate Change and Potential Impacts", Mississippi River: Delta Blues, June 5, 2022, Virtual (Brown).
- "Climate Change and Precipitation", Filling the Gaps: Climate and Weather Information for Small to Medium Sized Water Utilities, Southern Climate Impacts Planning Program, July 13, 2020, Virtual (Brown).
- "Climate Change, Precipitation, and Crawfish", Parkview Baptist Church, April 13, 2021, Baton Rouge, LA (Keim and Lewis).
- "Climate Extremes: Impacts on Infrastructure", EPA Region 6 Storm Water Conference, October 19, 2021, Virtual (Keim).
- "Climate Science: The Basics", American Planning Association, February 18, 2022, Virtual (Riley).
- "Climate-Related Resiliency in Central Texas", Brazos Valley Council of Governments (Texas), February 15, 2022, Virtual (Riley).
- "Coastal Vulnerability in a Changing Climate", Louisiana Ag Leadership Conference, December, 2018, New Iberia, LA (Keim).
- "Coastal Vulnerability in a Changing Climate", New Orleans Office of Homeland Security and Emergency Preparedness, August 8, 2019, New Orleans, LA (Brown and Keim).
- "Communication Challenges and the Use of Climate Tools by Coastal Stakeholders", International Environmental Communication Association, June, 2019, Vancouver, Canada (Edwards).
- "Connecting Climate Adaptation and Hazard Mitigation Planning in Climate Discourse–Sensitive Regions", American Meteorological Society, January 24, 2022, Virtual (Bertrand).
- "Connecting Climate Science with Regional Stakeholders: the NOAA RISA Sustained Assessment Specialist Network", American Association of State Climatologists, June 11, 2021, Virtual (Bertrand).
- "CRS on Compassion", Federal Emergency Management Administration, Region 7 Symposium on Community Rating System program, Keynote Address, February 19, 2020, Kansas City, MO (Lyles).
- "Deciphering Drought Through Technology and Tools" (panel discussion), Water for Texas 2019, January, 2019, Austin, TX (Shafer).
- "Defining Resilience to Action", National Science Foundation, May 9, 2022, Virtual (Brown).
- "Developing a Simple Planning Tool for Texas Climate Hazards", American Planning Association Cross Chapter Collaborative (AR, NM, OK, TX), November 3, 2021, Fort Worth, TX (Riley and Bertrand).

"Developing Resilient Oyster Populations", Louisiana Ag Center Conference, May 6, 2021, Virtual (Brown).

"Evaluating the utility of a new local climate risk assessment tool", 4th Biennial National Adaptation Forum, April, 2019, Madison, WI (Riley and Kos).

"Examining Extreme Rainfall Forecast and Communication Processes in the South-Central United States", National Weather Center Weather & Climate Systems Seminar, April 14, 2021, Virtual (Wanless).

"Examining Extreme Rainfall Forecast and Communication Processes in the South-Central United States", 16th Symposium on Societal Applications: Policy, Research and Practice, American Meteorological Society, January 9, 2021, Virtual (Wanless).

"Extreme Events in a Changing Climate", Louisiana Ag Leadership Program, November 30, 2021, New Iberia, LA (Brown & Keim).

"Flood Mitigation Champions, Networks, and 'Soft Skills'", FEMA Region VII's Community Rating System Symposium: CRS 2021: Building Partnerships for Advancing CRS in R-VII, Wednesday, March 17, 2021, Virtual (Lyles).

"Framing Climate Change on Social Media: Evaluations of Information from Texas Residents According to Message Framing and Source Credibility", The Rural Communication Institute (RCI) and the Texas Social Media Research Institute (TSMRI), April 22, 2022, Fort Worth, TX (Howe).

"Hazard Mitigation Planning Tools", Central Oklahoma Emergency Management Association Meeting, October, 2018, Oklahoma City, OK (Riley).

"Heavy Rainfall and Thunderstorms", National Association of State Radio Networks Annual Meeting, December 10, 2019, Las Vegas, NV (Keim).

"Helping Communities Become More Resilient to Climate Hazards", American Planning Association Quad State Conference, October 11, 2019, Tulsa, OK (Riley).

"Hurricane History of the Gulf of Mexico", Plaquemines Parish Historical Society, August 6, 2019, Belle Chasse, LA (Keim).

"Hurricane Ida Recap -- 1 Year Later", WBRZ News, May 2022, Baton Rouge, LA (Keim).

"Hurricane Signatures." The LSU Science Café, August 25, 2020, Virtual (Keim).

"Hurricane Vulnerability and Precipitation Change in the Southeast US", New Orleans Sewerage and Water Board, September 5, 2019, New Orleans, LA (Brown and Keim).

"Hurricanes and Storm Surge in a Changing Climate and other SCIPP Projects." The Southern Plains Science Seminar, August 12, 2020, Virtual (Keim).

"Hurricanes over the Past 2 Years", LSU Weather Experts Media Briefing, May 31, 2022, Virtual (Keim).

"Hurricanes, Storm Surge, Heavy Rainfall, and Freezes in a Changing Climate." National Academy of Sciences Gulf Research Program, September 27, 2020, Virtual (Keim).

"Hurricanes, Storm Surge, Heavy Rainfall, and Freezes in a Changing Climate", American Public Health Association, October 24, 2021, Virtual (Keim).

"Hurricanes, Storm Surge, Heavy Rainfall, and Freezes in a Changing Climate", EPA Region 7 Storm Water Conference, October 19, 2021, Virtual (Keim).

"Hurricanes, Storm Surge, Heavy Rainfall, and Freezes in a Changing Climate", Federal Home Loan Banking Meeting, August 9, 2021, Virtual (Keim).

"Improving Hazard Planning: Simple Planning Tool Introduction and Mitigation Strategy Discussion", Oklahoma Emergency Management Association Annual Conference, August, 2018, Norman, OK (Riley and Kos).

"Improving Hazard Planning: Simple Planning Tool Introduction and Adaptation Strategy Discussion", Oklahoma Chapter of the American Planning Association Annual Conference, October, 2018, Midwest City, OK (Riley and Kos).

"Information-Needs of Water Managers in South-Central U.S.", International Environmental Communication Association Biannual Meeting, November, 2019, Vancouver, Canada (Edwards).

"Jazz on Tulsa Time", KU Hall Center for Humanities Nature and Culture Seminar, February 7, 2020 (Lyles and Pennell).

"Jazz on Tulsa Time", NSF-sponsored workshop at East Carolina University, February 27, 2020, Greenville, NC, (Lyles and Pennell).

"LSU professors discuss climate change, 2022 IPCC report and global protests", Reveille, May 2, 2022, Baton Rouge, LA (Brown).

"LSU researchers take closer look at climate change effects", BRProud Local News, February 16, 2022, Baton Rouge, LA (Brown and Thompson).

"OU A&GS Career Fair", University of Oklahoma, March 1, 2022, Norman, OK (Bertrand and Cruickshank).

"Overview of Sea Level Rise and Coastal Flood Risk", NAACP Experience, Environmental Climate Justice, Sea Level Rise, Coastal Flood Risk, and Social Vulnerability Training, October, 2018, Baton Rouge, LA (Keim).

"Research Experiences for Undergraduates (REU) Climate Careers Panel", Research Experiences for Undergraduates, July 27, 2021, Virtual (Bertrand).

"Risk Communication and the Role of Self-Efficacy, Numeracy, and Training Materials in the Comprehension of Climate Tools", National Communication Association, June, 2019, Baltimore, MD (Edwards).

"Several reports find Texas electric grid not ready for another winter storm", CNHI News, November 23, 2021, Virtual (Bertrand).

"Simple Planning Tool for Climate Hazards in Oklahoma and Arkansas", 24th Conference on Applied Climatology, 99th Annual American Meteorological Society Meeting, January, 2019, Phoenix, AZ (Riley and Kos).

"South-Central Louisiana Flooding Event: August 2016", Louisiana Geological Survey Symposium 'The Baton Rouge Flood Event of 2016: What Happened, What We Did, What We Lost, and What We Learned', August 13, 2018, Baton Rouge, LA (Keim and Brown).

"Southern Climate Impacts Planning Program: A NOAA RISA Team", 2019 NOAA Water Meeting, October 16, 2019, College Park, MD (Keim).

"Spatiotemporal Patterns and Recurrence Intervals of Tropical Cyclone Strikes for the Caribbean Islands from 1901 to 2017", American Meteorological Society Annual Meeting, January, 2019, Phoenix, AZ (Thompson and Keim).

"Summary of the 2020 Hurricane Season and Forecast for 2021", LSU Weather Experts Media Briefing, June 14, 2021, Virtual (Keim).

"The Influence of Cultural Worldviews and Risk Perceptions on Severe Weather Preparation", 14th Symposium on Societal Applications, American Meteorological Society Annual Meeting, January, 2019, Phoenix, AZ (Shafer on behalf of A. Franklin, J. Le, M. Brucks).

"The Southern Climate Impacts Planning Program and Climate Hazard Resources for Planners", American Planning Association Cross-Chapter Collaborative (AR, NM, OK, TX), November 3, 2021, Fort Worth, TX (Riley).

"The Value of Relationships in Hazards and Disaster Work", 46th Annual Natural Hazards Research and Applications Workshop, July 13, 2021, Virtual (Lyles).

"Thunder and Lightning", Baton Rouge Chapter of the Lions Club, October 7, 2019, Baton Rouge, LA (Brown and Keim).

"Tornadoes", Lion's Club of Baton Rouge, June 7, 2021, Baton Rouge, LA (Keim).

"Tulsa's Climate Hazards", City of Tulsa, OK Mitigation Planning Progress Meeting, September 2018, Tulsa, OK (Riley).

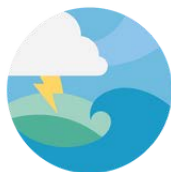
"UCO Masters of Public Health Oral Exam Judging", University of Central Oklahoma, April 1, 2022, Edmond, OK (Bertrand).

"US coast to see century's worth of sea level rise by 2050. Louisiana projected to see worst of it", Reveille, February 16, 2022, Baton Rouge, LA (Brown).

"Using hazard planning as an avenue for climate action", 4th Biennial National Adaptation Forum, April, 2019, Madison, WI (Riley).

"Weather, Climate, and Litigation", Keogh-Cox Law Firm, June 9, 2021, Virtual (Keim).

"What Does the Climate Hold for Agriculture?", 2018 Texas Section Society for Range Management Annual Meeting, October, 2018, Lubbock, TX (Shafer).



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