FINAL PROJECT REPORT INSTRUCTIONS
for projects funded by a Climate Adaptation Science Center (CASC)

SECTION 1. ADMINISTRATIVE INFORMATION:

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Project title: Shifting from Extractive to Self-determined: Enhancing Indigenous Research and Data Governance in Southwest Climate Adaptation Initiatives
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SECTION 2. *PUBLIC* SUMMARY:

Indigenous knowledge systems, such as traditional ecological knowledge, contain climate observations and adaptation strategies reaching back millennia. These include methods for caring for our natural resources and relations, such as through drought-resilient agriculture, soil health, and water management practices, flood mitigation (Ristroph, 2019), fire and forest stewardship (Adams, 2024), and drought resilience (McNeeley et al., 2018). Despite a growing global recognition among researchers and resource managers of the value of Indigenous knowledges and practices for enhancing human capacity to adapt to climate change impacts, we face historic inequities that hinder cross-cultural knowledge exchange and innovation. This includes a tendency towards extractive research, accessing Indigenous knowledges without regarding Indigenous decision-making needs, sovereignty, or rights for self-determination.

Our project efforts focused on identifying practical pathways for shifting from extractive to Indigenous self-determined research, with the aim of reducing barriers for Tribal governance and knowledge exchange in climate adaptation initiatives. Through analyses developed in partnership with our Indigenous Advisory Council, we identified current trends in policy and practice applied within Tribal-led climate adaptation initiatives in the Southwest and hosted an inter-Tribal knowledge exchange and participatory mapping workshop focused on learning from Indigenous-led climate adaptation resilience efforts. Through this project we have developed interactive learning modules in the form of a digital StoryMap. This StoryMap, along with peer-reviewed article publications being generated from this project provide, culturally responsive, evidence-informed training resource materials for researchers, managers, funders, and policymakers who engage with Indigenous knowledges and communities. These materials engage topics such as settler-colonial and Tribal relations, ethics protocols, and data sharing.

This work is timely in answering Tribal calls for access to data reflecting community priorities, values, and knowledge-bases, rather than external agendas. This works also provides contextual understanding to enhance federal agencies in their charge towards strengthening nation-to-nation relationships and engaging in meaningful Tribal consultation, as well as calls from science institutions for reconciling historical inequities and better engaging across diverse ways of knowing.

SECTION 3. PROJECT SUMMARY:

As the impacts of climate change grow more severe and widespread around the globe, there is an increasing call for place-based, resilient climate solutions that are deeply rooted in local contexts and traditional knowledge systems. Indigenous stewardship, worldviews, and practices exemplify embodied resilience and environmental wisdom, demonstrating intergenerational climate adaptation and attunement. While conventional climate data and meteorological records have been systematically collected for a little over a century, Indigenous knowledge offers a rich reservoir of climate observations, data, and adaptation strategies spanning thousands of years, providing invaluable insights into sustainability and resilience. In regions such as the Southwestern United States (U.S.), these Indigenous adaptations and observations are clearly reflected in various strategies aimed at mitigating floods, managing fire and forest health, and building drought resilience, among other initiatives. These examples underscore the deep, place-based understanding that Indigenous communities have developed through generations of living in and caring for their lands.

In sum, the review provided through our SWCASC project highlights a promising and integrated pathway toward resilient, community self-determined, and culturally grounded climate adaptation. Such an approach can reinforce Indigenous sovereignty through community leadership in managing their lands and resources. This work also advocates for the operationalizing of culturally aligned data governance frameworks that respect Indigenous epistemologies and rights, fostering inclusive, community-led monitoring and knowledge sharing. Building equitable partnerships and securing sustainable funding are critical to supporting long-term capacity, continuity, and adaptive expertise. Moreover, tailoring responses to locally defined climate risks ensures that solutions are relevant, timely, effective, and culturally appropriate. Together, these interconnected actions create a foundation that enables Indigenous communities to continue stewarding their lands, waters, and traditional knowledges into the future, sustaining both culture and environment.

Our study provided a detailed overview of regional patterns and emerging trends related to Indigenous-led climate adaptation initiatives, with an emphasis on Indigenous data sovereignty and governance structures. We identified specific, culturally rooted strategies designed to address diverse climate challenges, from variability to environmental change, that have been developed and maintained by Indigenous peoples over generations. Furthermore, the project

showcased tangible examples of contemporary community-led research efforts, highlighting the potential for collaborative, community-driven approaches to enhance resilience and adaptive capacity. Throughout the research process, under the guidance of our Indigenous Advisory Council, we prioritized the importance of building strong, trusting relationships, respecting Indigenous worldviews, and centering Indigenous value and knowledge systems in all aspects of the work. This approach was woven into the fabric of our entire Inter-Tribal Knowledge Exchange, ensuring that Indigenous leadership and knowledge remained at the forefront of our efforts.

SECTION 4. REPORT BODY:

Purpose and Objectives:

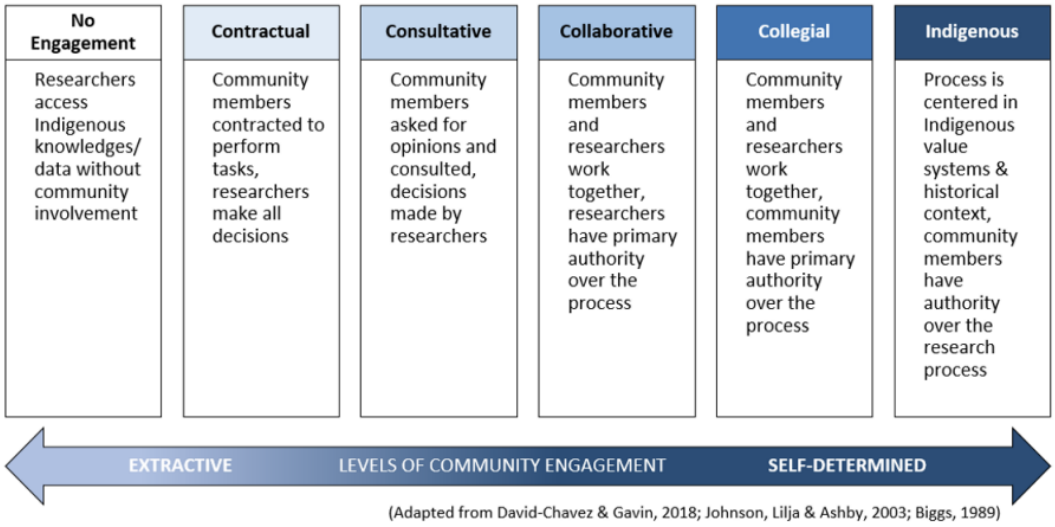
Our project aimed to address research and data governance priorities for climate adaptation initiatives that engage Indigenous Peoples, their knowledges, and territories, including through asking, *how are climate adaptation initiatives addressing calls for policy and practices that support rather than erode Tribal sovereignty and self-determination?* Our aims for this project focused on addressing persistent and historic challenges threading across numerous management topics and disciplines, including cross-cutting SW CASC science priorities and themes, such as, 1) Indigenous practices of ecosystem management and restoration in the context of climate change and adaptation; and 2) Building ongoing capacity for climate-adapted natural and cultural resource management through the development of training modules targeted for managers.

As the impacts of climate change are becoming increasingly severe and widespread, global calls for place-based climate resilience solutions are mounting. Indigenous stewardship, worldviews, and practices demonstrate embodied resilience and environmental wisdom through intergenerational climate adaptation and attunement. While conventional climate data and meteorological records have been collected for just over a century, Indigenous knowledges offer climate observations, data, and adaptation strategies spanning thousands of years (Kermoal & Altamirano-Jiménez, 2016). In the Southwestern United States (U.S.), for example, these adaptations and observations are evident in strategies for flood mitigation (Ristroph, 2019), fire and forest stewardship (Adams, 2024), and drought resilience (McNeeley et al., 2018).

Despite the wealth of climate data embedded in Indigenous knowledges, there remains a lack of recognition and support and process within settler colonial science initiatives and institutions for effectively engaging Indigenous knowledges to inform climate science solutions. A systematic review by David-Chavez and Gavin (2018) revealed that out of 125 climate studies engaging with Indigenous knowledges, 87% employed extractive research methods, which often involve minimal community participation and decision-making authority. With climate studies still using these extractive approaches, supporting a transition to Indigenous self-determined research

methods is vital for respecting and upholding Indigenous sovereignty and self-determination (Intergovernmental Panel On Climate Change (IPCC), 2023). As illustrated in Figure 1 below, moving from extractive to self-determined research methods requires engaging Indigenous value systems, maintaining awareness of the historical contexts of Indigenous Peoples, and ensuring community members impacted by research hold authority.

Figure 1: Levels of community engagement



Scale assessing Indigenous community engagement based on who holds self-determination and authority in the research process. David-Chavez, D. M., 2022 Testimony Before the U.S. House of Representatives Committee on Science, Space, and Technology Hearing on "Now or Never: The Urgent Need for Ambitious Climate Action." Adapted from David-Chavez & Gavin, 2018, Johnson, Lilja, & Ashby, 2003; Biggs, 1989

In comparison to non-Indigenous communities, climate change disproportionately affects Indigenous Peoples and communities across the globe (First Nation Development Institute, 2018). Impacts include displacement from ancestral homelands resulting in loss of traditional food systems and other natural and cultural resources that are central to Indigenous well-being; food scarcity; prolonged drought; permafrost melting; and declining air and water quality (Burkett et al., 2017; Farrell et al., 2021; First Nation Development Institute, 2018; Status of Tribes and Climate Change Working Group, 2025). In response to these impacts, Indigenous Peoples and communities draw on their Indigenous knowledge systems and resilience practices in climate adaptation initiatives (Long et al., 2020). Learning from these Indigenous knowledge-informed resilience strategies is particularly crucial in arid regions vulnerable to climate impacts, including large portions of the Southwestern United States

Historical harms compound and further drive climate change impacts on Indigenous lands. Numerous Indigenous guidance and policy frameworks emphasize strengthening and recovering ethical relationships in response to colonial harms. The Status of Tribes and Climate Change (STACC) Report developed by the Institute for Tribal Environmental Professionals, highlights

this, and also asserts that federal agencies must fortify their Nation-to-Nation relationships with Tribal Nations and engage in meaningful consultation with Tribal officials (Status of Tribes and Climate Change Working Group, 2025). Meaningful engagement requires honoring the rights and autonomy of Indigenous Peoples and communities, including their right to control their data, such as genomic, environmental, and community health data (Research Data Alliance International Indigenous Data Sovereignty Interest Group, 2019). Meaningful engagement requires respecting treaty and Tribal rights to manage data related to their communities, lands, and resources, as is also affirmed within the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP) (United Nations General Assembly, 2007). These inherent rights are upheld through Indigenous data sovereignty, including Indigenous Peoples' inherent rights to govern the collection, ownership, and application of their own data (Davis, 2016; Rainie et al., 2017).

Indigenous data sovereignty promotes respectful and equitable research practices when working with Indigenous Peoples and their data (Carroll et al., 2020). This requires, for example, that Indigenous communities have access to research findings and results that involve their knowledges and data, and that data and outputs are shared in ways that are easily understood and meaningful to the community in which the research is being conducted. The goal is to ensure transparency and enable communities to see how their knowledge and data are being used, to understand the implications the research may have for them, and to ensure that processes for free, prior and informed consent are engaged for future use of these data (Garba et al., 2023; Jennings et al., 2023). Indigenous data sovereignty also requires researchers to ensure that Indigenous communities receive tangible benefits for their knowledge and participation, while conducting research fairly and acknowledging and addressing power imbalances (Research Data Alliance International Indigenous Data Sovereignty Interest Group, 2019). Lastly, Tribal data governance, the application of Indigenous data sovereignty has been collective defined as meaning that "Tribal communities have the right to define, collect, protect, interpret, manage, and apply data in a way that respects Indigenous ethics, values, and relational responsibilities" to support these communities access to culturally relevant data for informed decision-making to enhance climate resilience (David-Chavez et al., 2019).

Given the historic and ongoing infringements on Indigenous rights that undermine climate resilience, there is a need to cultivate an understanding and practice of engagement and climate collaboration centered on Indigenous relations and futures. Throughout this project, we made a point to focus on community defined needs rather than external interests. To achieve this, we established an Indigenous Advisory Council (IAC), further detailed in the 'Organization & Approach' section below, which we worked with from the proposal design stage onwards, comprised of Southwest Tribal decision makers and natural resource leaders to guide formation of the objectives, methods, and deliverables of our project. The IAC continually worked with us

to refine our key research questions and objectives throughout the project as well, which are detailed below.

Research Questions and Objectives

The primary purpose of this project was to understand how Southwest climate adaptation initiatives that engage Indigenous knowledges are addressing calls for policies and practices that support Tribal sovereignty and self-determination. To build this understanding our project focused on the following questions and objectives.

Q1: *What are current patterns and trends in Indigenous research and data governance for climate adaptation projects engaging Indigenous knowledges and practices in the Southwestern U.S.?*

Objective 1: Conduct a regional-scale scoping review that identifies baseline data on Indigenous knowledges and practice-focused climate adaptation projects and plans in the Southwest U.S. (Colorado, New Mexico, Utah, Arizona, California). Our Indigenous Advisory Council worked with us to determine analysis factors and indicators, which included: 1) geospatial distribution of study sites; 2) thematic analysis of applications of Indigenous knowledges and practices (e.g., culturally-responsive ecological restoration, traditional knowledge application for mitigating flood risk, drought resilient agriculture, etc.); 3) research methodologies and approaches (e.g., participatory, transdisciplinary, translational ecology, etc.); 4) assessment of research and data governance mechanisms (e.g., data sharing agreements, Tribal review boards, etc.); 5) types of partnerships (e.g., Tribal, non-Tribal, NGO, agency, etc.); 6) areas of climate change concerns (e.g., agriculture, drought, extreme weather, etc.); and 7) funding sources.

Q2) *What can we learn from sharing stories of Tribal resilience in an inter-Tribal exchange, particularly when it comes to the factors and indicators that drive Indigenous self-determined climate adaptation?*

Objective 2: Organize an inter-Tribal knowledge exchange and participatory mapping workshop with Southwest Tribes sharing the Colorado and Rio Grande River Basins, to identify strategies that uphold Tribal sovereignty and self-determination in climate resilience initiatives building from the findings from the regional scoping review.

Organization and Approach: *This section of the report should explain in task orientated terms how the research activities of the project were conducted. Briefly list which research methods were used to achieve results and why they were chosen by the team.*

Our research design drew from an Indigenous methodologies (Kovach, 2021; Louis, 2007) and mixed methods approach (Nash et al., 2018). We applied a relational science framework developed by the project lead (David-Chavez et al., 2024) engaging Indigenous rights-holders and decision-makers in every stage of our process, including project design and evaluation,

refining questions and methods, and determining useful and meaningful outputs. Additionally the Masters student co-leading our project (Natonabah) worked with project co-lead Franklin Sage to apply the Navajo Circular Model, a theoretical framework that grounded this research in Natonabah's Diné worldview and cultural context while providing a culturally grounded process for organizing the thesis development (Sage, 2017). In addition to the methods outlined within the individual objectives below, we also paid close attention to customary and legal protocols with the guidance of our broader research team, the Indigenous Advisory Council, and professionals at our institutions. Due to the nature of our project, we adjusted our timeline to allow adequate time for co-design and co-production with our Indigenous advisory council during our scoping review and data analyses (Objectives 1), and time necessary for preparing and hosting our Inter-Tribal exchange (Objective 2). We adjusted the scale of our scoping review (from national to regional), to adjust for time & capacity constraints, however otherwise all objectives remained the same, including the creation of actionable science products given the additional time granted for our no-cost extension.

Indigenous Advisory Council

To address research and data governance priorities for climate adaptation initiatives involving Indigenous Peoples, their knowledges, and territories, we formed a regional Indigenous Advisory Council (IAC). This council, comprised of Southwest Tribal decision-makers and natural resource leaders, also served as a means to counter a history of extractive research with Indigenous peoples and communities. The IAC guided all phases of the project, including the co-development and review of research questions, method protocols, and determining meaningful and effective research products. Through conversations with the IAC, we identified key factors to focus on during the analysis.

Project Results, Analysis and Findings:

This section presents the key results and findings of the project, highlighting the main insights gained through our analysis. The findings are organized around several core activities including a 1) regional scoping review, 2) inter-Tribal exchange opening dinner, 3) opening talking circle, 4) participatory mapping, and the validation of our initial scoping review, 4) Rez Café, 5) Ranking of inter-Tribal exchange outputs, and 6) inter-Tribal exchange closing talking circle as detailed below.

Scoping Review:

To address Objective 1—conducting a Southwestern regional-scale scoping review that identifies baseline data on Indigenous knowledges and practice-focused climate adaptation projects and plans—we used scoping review guidelines adapted for conservation and environmental

management research (Grant & Booth, 2009). A scoping review presents an overview of existing research on a topic of interest, providing helpful baseline data (Arksey & O'Malley, 2005; Chambers et al., 2018; Grant & Booth, 2009), and is useful for synthesizing emerging or complex evidence, or where the depth of evidence is not well established (Chambers et al., 2018).

We developed and identified the inclusion criteria for the literature search in collaboration with our project team and Indigenous Advisory Council (IAC), based on identifying the most relevant sources we could access pertinent to our research objectives. This included the following databases and resources: Web of Science, Google Scholar, the Institute for Tribal Environmental Professionals (ITEP), the Status of Tribes and Climate Change Report (STACC), the Tribal Resilient Action Database, the University of Oregon Tribal Climate Guide, and various documents recommended by the IAC. Documents included for analysis were required to meet the following inclusion criteria:

1. Describes applied climate adaptation initiatives, research, or projects.
2. Engages Indigenous knowledge systems and/or practices.
3. Includes Native Nations or Indigenous communities within the Southwestern United States, including, Colorado, New Mexico, Utah, Arizona, and California.

Using the search strategy outlined above, we conducted an initial search for literature, resulting in the inclusion of 210 documents. During this stage, our team, along with an undergraduate research assistant funded on our SWCASC project, manually examined each document to determine whether each document met the three specified inclusion criteria. Of these, 21 documents fully satisfied the inclusion criteria.

These documents included both Tribal climate adaptation plans (18), and climate research studies (3), varying in geographic and topical scope within the larger themes of the review. Scoping review results spanned five states (Colorado, New Mexico, Arizona, Utah, and California), two river basins (Colorado River Basin and Rio Grande River Basin), and twelve Tribal nations (Ute Mountain Ute, Navajo Nation, Mescalero Apache, Tesuque Pueblo, San Ynez Band of Chumash Indians, La Jolla Band of Luiseño Indians, Karuk Tribe, Bishop Paiute Tribe, and The Pala Band of Mission Indians).

Through our scoping review findings, we identified 8 interrelated themes concerning Indigenous research and data governance related to climate adaptation across the Southwestern U.S., 1) Indigenous knowledges and practices; 2) sovereignty and values; 3) research and data governance mechanisms; 4) community engagement; 5) knowledge sharing methods; 6) partnerships; 7) funding; and 8) climate change concerns. Together, these themes reveal

opportunities and blueprints for community-led, culturally grounded adaptation approaches that center Indigenous authority and application of Indigenous knowledges and practices.

Indigenous knowledges and practices reflect place-based strategies for resilience. Examples include traditional food preservation (drying, fermenting, smoking) adapted to local conditions (Karuk Tribe, 2019; Kelsey Jensen, 2022; Schramm et al., 2020), cultivation of drought-tolerant crops using context-specific planting (Jensen, 2022; Kelsey Jensen, 2022), water conservation (Cristina Gonzalez-Maddux, 2012), soil management techniques (Ute Mountain Ute Tribe, 2020); cultural burning for landscape stewardship and wildfire risk reduction (Cristina Gonzalez-Maddux, 2012; Karuk Tribe, 2019; Mahala Ray, n.d.); and community-designed flood mitigation measures such as early warning systems and natural-material barriers (Ute Mountain Ute Tribe, 2020). These practices are intergenerational and ecological in orientation, emphasizing stewardship, biodiversity, and sustained subsistence.

Indigenous sovereignty and values at the forefront of climate adaptation initiatives. Underpinning these practices is Indigenous sovereignty and a set of values that treat land, language, ceremony, and knowledge as integral to community wellbeing. Sovereignty manifests as the right to self-governance and control over decisions affecting lands and cultural practices, and is reinforced by cultural protocols, ceremonies, and language revitalization. Respecting these values means centering Indigenous decision-making authority in all aspects of adaptation planning, research design, and policy development.

Emerging research and data governance mechanisms prioritize Indigenous authority. Closely linked to sovereignty are emerging research and data governance mechanisms that prioritize Indigenous control. The literature gathered through this scoping review document an increased use of Data Management Plans, Data Sharing Agreements, culturally specific metadata and labeling, Tribal review boards, and explicit consent processes. These research and data governance mechanisms reflect broader adoption of CARE Principles for Indigenous Data Governance and aim to support alignment concerning data collection, access, use, and ownership with community priorities and cultural protocols, in turn strengthening trust and offering models of ethical collaboration.

Community engagement and knowledge sharing methods are central to Indigenous-led initiatives. Inclusive practices, engaging elders, youth, local experts, and diaspora members, alongside participatory methods such as storytelling, focus groups, participatory mapping, workshops, and arts-based documentation, helped to identify locally relevant priorities. When communities lead priorities, data collection, and interpretation, monitoring becomes meaningful for Tribal decision making and supports intergenerational knowledge transmission.

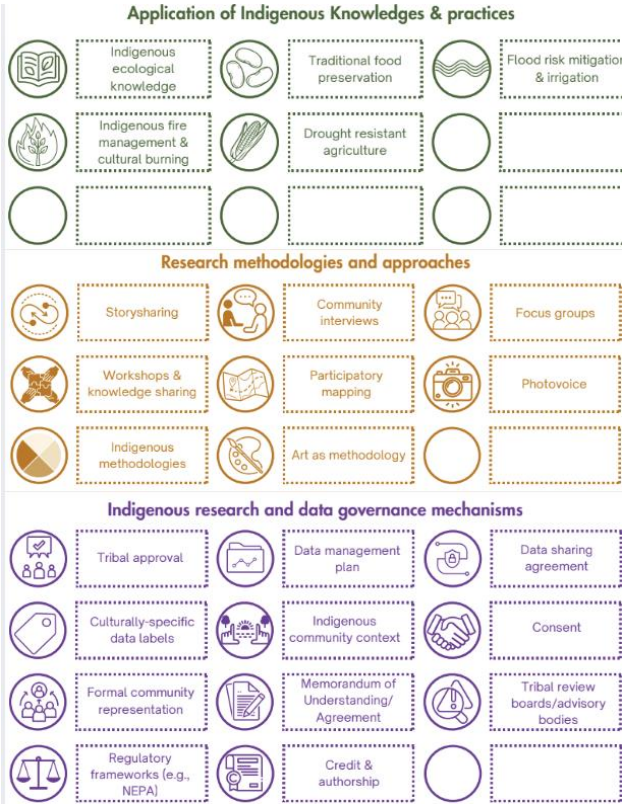
Partnerships and funding shape the capacity to implement community self-determined adaptation. Multi sector collaborations, inter-Tribal networks, Tribal–government agreements, Indigenous organizations, NGOs, and academic partners, offer complementary resources but must be structured to respect Tribal governance and reciprocity. Funding trends show growing but still constrained support for Indigenous leadership. The most effective financial models are multi-year, flexible, and designed to build local capacity rather than impose short term deliverables.

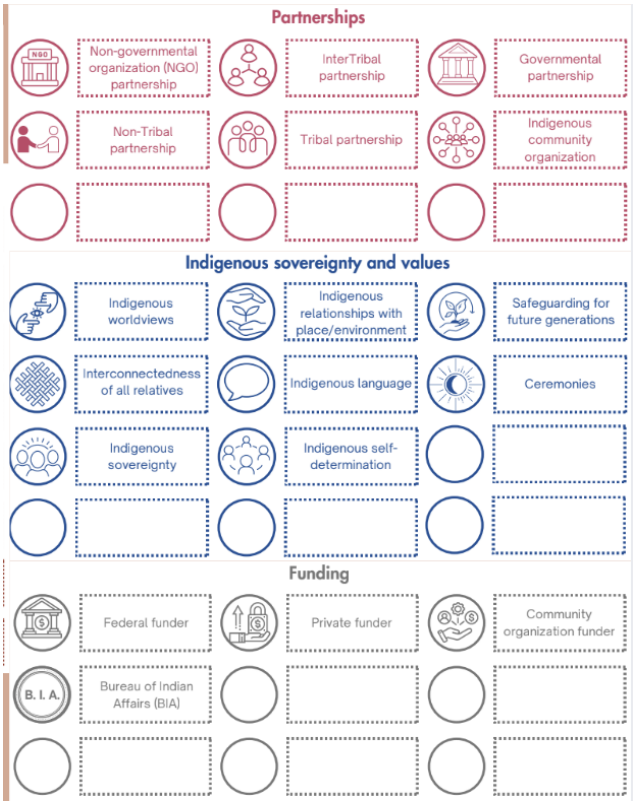
Numerous climate adaptation concerns affect Tribes across the Southwestern U.S. Finally, the literature reviewed highlighted specific climate concerns that drive adaptation priorities which are engaging Indigenous knowledges and practices, including, altered seasonal cycles affecting planting and food security, increased drought and water scarcity, wildfire risk, extreme weather events, threats to sacred sites and biodiversity, and health impacts from heat and pollution. These stressors underscore the urgency of approaches that blend traditional ecological knowledge with culturally appropriate monitoring, governance, and policy reforms.

In sum, this scoping review direct us to an integrated pathway for resilient, community self-determined, culturally grounded adaptation which can serve to reinforce Indigenous sovereignty; operationalize culturally aligned data governance mechanisms; foster inclusive, community-led monitoring and knowledge sharing; structure partnerships and funding to support continuity and capacity; and target responses to locally defined climate risks. Together, these interconnected actions create conditions necessary for Indigenous communities to continue stewarding their lands and knowledges into the future.

The findings from this scoping review resulted in a data set with the coded data that will be hosted on the SWCASC repository - ScienceBase and published with open access within a journal article and supplemental data file. The development and findings from this scoping review contributed to the development of the visual icons below which were then used in our participatory mapping activity further described below in our report as well.

Figure 2: Scoping Review Icons





Inter-Tribal Knowledge Exchange

To address our 2nd objective—organize an inter-Tribal knowledge exchange and participatory mapping workshop with Southwest Tribes to identify strategies that uphold Tribal sovereignty and self-determination in climate resilience initiatives building from the findings from the regional scoping review—we hosted an inter-Tribal knowledge exchange focused on Tribes sharing connections to the Rio Grande and Colorado River Basins as determined in collaboration with our IAC. The knowledge and guidance from this exchange informed the development of culturally-responsive training resources for researchers, managers, and decision-makers working on climate adaptation initiatives that engage Indigenous knowledges, including inter-Tribal and Tribal/non-Tribal partnerships through the form of an interactive StoryMap which will be hosted on ArcGIS and the Indigenous Land & Data Stewards public website (indigenouslandstewards.org) pending Inter-Tribal exchange attendee review and consent.

Our Inter-Tribal exchange included a series of story sharing circles (Tachine et al., 2016) and talking circles, designed to facilitate a culturally responsive method of sharing worldviews, stories, and building trust among participants. Engaging with these cultural protocols was essential to create a space that acknowledged and fostered relationship building and responsibility throughout the exchange (Rieth, 2023; Tachine et al., 2016). The exchange included four main parts: 1) an opening sharing circle, 2) a story sharing circle embedded in a participatory mapping activity where participants shared Indigenous self-determined climate resilience stories, 3) a Rez Café where attendees discussed four key questions about the future we want to create and the paths to get there, and 4) a closing sharing circle. The agenda and process were co-developed with the project team and Indigenous Advisory Council. Additionally, we prioritized time on the land with the attendees to help ground our exchange in place and community context, through activities hosted at Wa:k Hikdan, an Indigenous water restoration site established and stewarded by Tohono O'odham Tribal Nation.

Prior to hosting our exchange, we obtained approval from the Colorado State University (CSU) Institutional Review Board (IRB) and reviewed our IRB protocol with the CSU Native American and Indigenous Affairs office.

During our opening dinner the night before our first full day at the exchange, we began with a blessing from a local Tribal leader and shared a meal while discussing the agenda for our time together in recognition of the value of offering food as an important way to foster community. We worked with our project partners at University of Arizona to fund an Indigenous graphic recording artist, Derrick Gonzalez, from Tohono O'odham Tribe to visually record the key themes of the discussions and activities throughout the exchange. We also took time to identify our community principles, which are fundamental to guiding our collaborative efforts throughout

this project. These principles, vital for building trust and ensuring respectful engagement, can be found below in figure 3.

Figure 3: This graphic recording was created by Derrick Gonzales (Tohono O'odham) and shows the "Principles for Engagement" that we co-developed for our Inter-Tribal exchange.

Key Themes Identified through the Method of Story Sharing & Talking Circles

To begin our time together, we started off the morning of our first full day with a convocation and prayer from one of our elder attendees to help ground our time together. We also shared a meal with one another. We then traveled to Wa:k Hikdan, a local Tohono O'odham restoration site. During this time spent on the land, participants walked and visited together, building trust and relationships with one another in the process. Our first talking circle, hosted at Wa:k Hikdan aimed to help participants learn about one another's work, to continue this process of building relationships and trust, and also served to focus our discussions on Indigenous self-determined climate adaptation in the context of the work we do. We also asked attendees to collectively

identify hopes for the exchange as noted in the prompts below. For the talking circle, we began by establishing a shared foundation for what we mean by Indigenous self-determined climate adaptation, with an emphasis on how we are engaging Indigenous knowledges for climate adaptation initiatives. We then invited the participants to introduce themselves in any manner they chose and to respond to the prompts below.

Figure 4: Opening Talking Circle Prompts

Talking Circle Prompts	
1.	Who you are and what roles do you carry in your work?
2.	What does Indigenous self-determined climate adaptation mean to you?
3.	What are your hopes for this exchange?

Opening Talking Circle: Emergent Themes and Shared Experiences

Figure 5: This is a graphic recording created by Derrick Gonzales during our Opening Talking Circle. This graphic visually shows the discussion our attendees had while answering the prompts in figure 4 above.

The key points and themes from our opening talking circle included the historical misappropriation of Indigenous knowledges, the significance of cultural practices, and the role of Indigenous traditional ecological knowledge in climate resilience as seen in the graphic recording in figure 5. Specific initiatives discussed included community-led land-based workshops, language preservation, and Indigenous traditional agriculture. This talking circle also addressed the challenges of decolonization, land sovereignty, and the vital role of community-based solutions.

Insights from the Mapping Activity: Mapping Indigenous-led Climate Resilience Strategies

During another activity at the Inter-Tribal Knowledge Exchange, attendees engaged in a participatory mapping exercise. This portion of the exchange focused on understanding how Southwest climate adaptation initiatives that engage Indigenous knowledges are addressing calls for policies and practices that support Tribal sovereignty and self-determination, providing crucial context for validating and contextualizing findings and themes from the scoping review. This activity allowed us to physically identify additional locations and grassroots community led efforts beyond the scoping review where these initiatives are taking place and to gather insights directly from those involved about key aspects of their projects, relevant to our study questions. Figure 6 presents the prompts posed to participants to assist in articulating their Indigenous self-determined climate adaptation initiatives. These prompts were used as starting points to consider while using the icons and drawings to help narrate their stories. We presented this activity to the participants and gave them time to create their stories while physically embedding the icon themes. Once each participant finished creating their stories on each paper, we invited them to share their stories with the larger group. To help guide the conversation, we provide three story-sharing prompts for each participant to keep in mind while presenting.

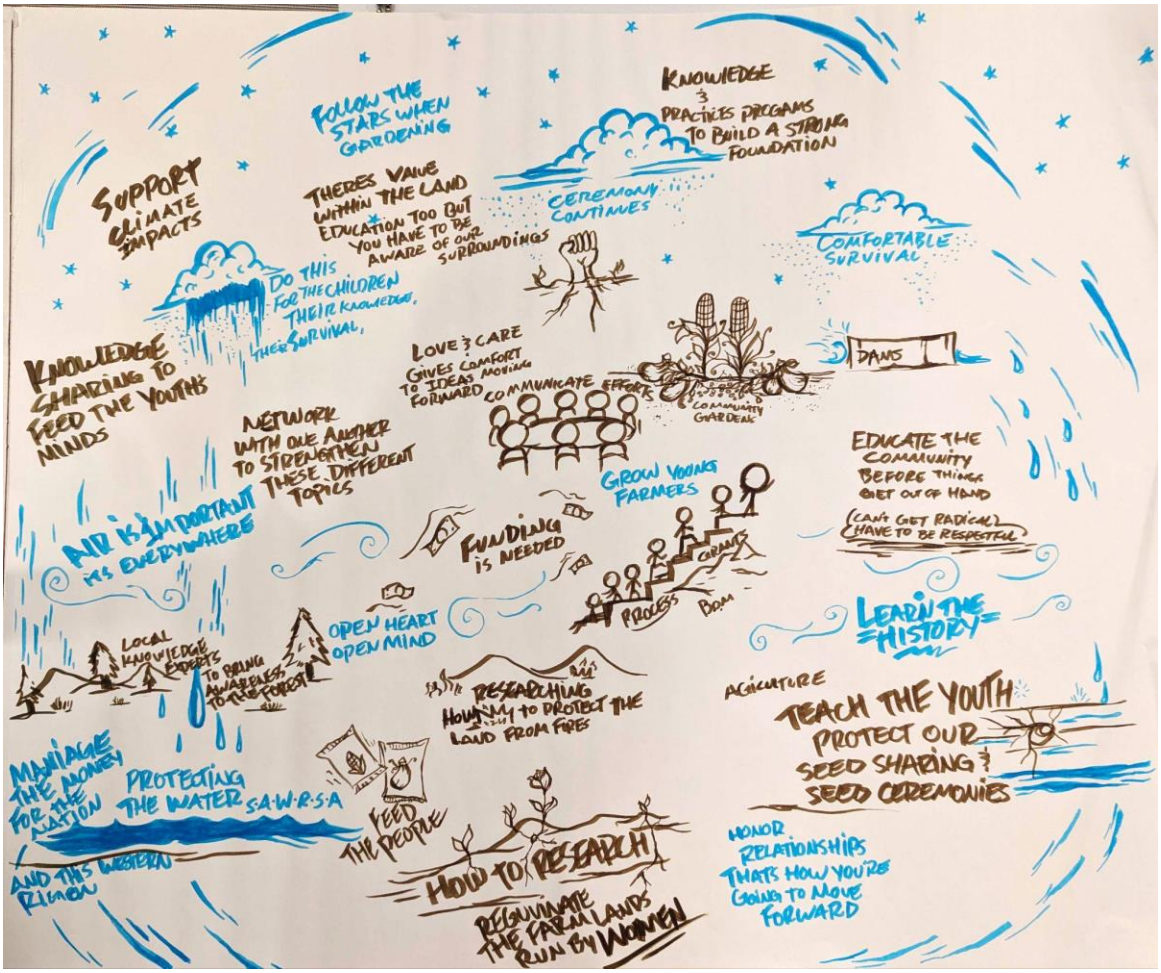
Figure 6: Story-Sharing Prompts

Story-Sharing Prompts	
1)	Initiative overview: description of the project or adaptation strategy
2)	Key supporting factors
3)	Challenges, lessons learned, insights

Each participant was given time to present their stories and then physically tape their initiatives to where the stories are located geographically on the map of the Rio Grande River Basin and the Colorado River Basin. A total of seventeen stories were shared, 15 of these were not identified in the regional scoping review so also helped us to expand our dataset.

Thematic Results from Participatory Mapping Activity

Figure 7: This is a graphic recording created by Derrick Gonzales during our Participatory Mapping Activity. This graphic visually shows the resiliency stories our attendees shared during this activity.



Key themes identified in this activity included environmental justice and climate change initiatives, focusing on greenhouse gas emissions and water resources. Participants emphasized the significance of traditional ecological knowledge, community-based watershed plans, and Indigenous land stewardship. Specific projects mentioned included mountain hydrology studies, forest management, and initiatives to address climate change impacts such as wildfires and erosion. The presentations also discussed the challenges posed by fracking, the necessity for food sovereignty, and the revival of traditional farming practices to promote community resilience and cultural continuity.

Key Themes Identified through Rez Café Activity:

On the second day of the exchange, we facilitated a 'Rez Café,' a series of small group discussions modeled after the World Café format. During this activity, participants were divided into four groups. These groups comprised a diverse mix of Tribes, age groups (including youth and elders), and professions (students, community leaders, knowledge-holders, and practitioners). Participants moved between stations, answering one of the four questions at each one. At each station, a research team member facilitated the discussion and took notes via post-it notes. Key findings from the exchange highlighted critical gaps to attune to within the focal areas we are addressing through our project (Indigenous self-determined climate adaptation initiatives), while also allowing us to evaluate the impacts of our gathering, and next steps we can look to for our overarching goals (what future we are working towards), based on the prompts below. We also shared a synthesis following the Rez Cafe and discussion to close out this portion of our exchange:

Figure 8: Rez Café

Rez Café Prompts
1. What gaps in guidance resources, policy, and practice need to be addressed?
2. What have we learned from our story-sharing and time together?
3. What can we envision for our future in light of these topics?
4. What is our path to reach this future?

Figure 9: This is a graphic recording created by Derrick Gonzales during our Rez Café Activity. This graphic visually shows the discussion our attendees had while answering the prompts in figure 8 above.

Ranking outputs from exchange with participants

To keep our potential outputs from the exchange aligned with the priorities of the participants, we facilitated an activity that invited direct feedback. Through conversations with our Indigenous Advisory Council, we identified four offerings that could be co-developed from this exchange. During this activity, we highlighted these offerings via post-it notes and asked participants to rank each offering from highest to lowest priority. This ranking happened through stickers where participants were then asked to rank the most important outputs. We also gave the opportunity to allow attendees to add any output that we did not initially include.

Figure 10: Ranking Exchange Outputs

Offerings initially identified to co-develop from this Exchange:
1. A summary report/manuscript on the Exchange (with possibility to co-author)
2. GIS StoryMap–an interactive atlas sharing Tribal success stories, with links to support mechanisms for guiding Indigenous knowledge, resource, data, and capacity sharing.
3. Interactive learning modules (multimedia) for Tribal and non-Tribal decision-makers and researchers focused on supporting Indigenous self-determined research and data governance in climate adaptation
4. Policy brief - key findings and recommendations from Exchange for Tribal decision-makers, policymakers, funders, & researchers engaging Indigenous knowledges
5. Any additional outputs

The results from this activity clearly indicated that attendees placed the highest value on maintaining connections within the network, emphasizing the importance of ongoing collaboration and communication. The production and co-authoring of the peer-reviewed article was a key outcome highlighted by the attendees, offering participants a reference point and supporting the contribution and dissemination of knowledge. Additionally, the development of interactive learning modules, which we ultimately integrated with the StoryMap was confirmed as a priority output from our exchange.

Closing Talking Circle

To close our time together, we facilitated a final talking circle, similar to the opening circle, where we asked participants to reflect on the exchange, share their key takeaways, and start thinking about where we go from here. We sat together in a circle and gave each attendee the floor to address the question below in any way they saw fit.

Figure 11: Closing talking circle prompts.

Closing Talking Circle Prompt
What will you carry from this Exchange with you and what do you want us to keep in mind going forward?

Through the stories and thoughts shared in this closing talking circle, it was reiterated how vital it is for our communities to continue collaborating across Tribal nations and supporting each other. Building on this, the session emphasized the importance of community, resilience, and strategic planning when facing challenges. Participants shared their experiences, highlighting the need for intergenerational collaboration, cultural preservation, and radical thinking. Key points

included the significance of traditional knowledge, the role of elders, and the importance of maintaining cultural identity. Furthermore, the discussion underscored the necessity of technological upgrades, administrative vigilance, and sustaining relationships across different administrations. The session concluded with a focus on youth involvement, community support, and the collective responsibility to uphold cultural and environmental stewardship.

This collective effort is crucial in addressing climate change within our communities. The conversations underscored the importance of Indigenous climate adaptation initiatives that actively engage Indigenous knowledge systems. Emphasizing how the integration of traditional ecological knowledge can lead to more effective, culturally rooted solutions, these Indigenous-led initiatives enhance our ability to develop sustainable strategies that respect and leverage the deep environmental understanding inherent in Indigenous cultures.

Conclusions and Recommendations:

Our study provided a detailed overview of regional patterns and trends related to current Indigenous-led climate adaptation initiatives, Indigenous data sovereignty, and Indigenous governance. We also identified specific strategies rooted in Indigenous knowledges and practices to address climate variability and environmental changes. Additionally, the project demonstrated processes for community-led research efforts, highlighting the potential for collaborative, community-driven approaches. Throughout the process, with the leadership of our Indigenous Advisory Council, we emphasized the importance of relationship-building, trust, and centering Indigenous worldviews, which was woven into our entire Inter-Tribal Knowledge Exchange.

Overall, this project affirmed for us the importance of process and value of engaging community leaders and decision-makers in every phase of a project, from design through dissemination. Our early conversations during the proposal development with regional decision-makers allowed us to identify two additional project leads (Tsinnajinnie and Sage) whose regional expertise and culturally responsive mentorship significantly enhanced the quality standard of our work. We funded the time of our Indigenous Advisory Council members from the project lead's startup funds, however, we also recommend that funding institutions support seed-funding to encourage this co-design process. During the project, the original timeline proposed was not adequate for the time necessary for community partnered collaboration with the research team, the Indigenous Advisory Council, and attendees of the Inter-Tribal Knowledge Exchange. However, through adapting and extending our timeline, we were able to more fully engage with these busy expert practitioners in our process, while also strengthening relationships across a network comprising knowledge-holders, practitioners, community members, and leaders.

Moving forward, we are exploring opportunities to sustain networks, such as the one formed through our Inter-Tribal exchange even after funding concludes, to support ongoing

collaboration and shared learning. We also recommend continuation of flexible funding and budget arrangements to accommodate the typical changes and unforeseen needs that projects of this nature encounter. For future efforts, we intend to build in budgeting for graphic design and collaboration with community artists, as this visual process was well received and provided a helpful, accessible visual synthesis that will accompany our project data.

Initially, our goal was to complete a comprehensive national scoping review, however due to the volume of documents collected, we recognized that there would not be sufficient time to review all materials thoroughly. Given additional time, we still recommend a national scale synthesis of this nature that includes federal and state-recognized Tribes, as well as relationally recognized (non-federally recognized) Indigenous Peoples to further our understanding of self-determined climate adaptation strategies across different Tribal recognitions and jurisdictions that can inform policy and practice.

Journal Articles in preparation

Natonabah, S., Sage, F., Tso, D. C, Tsinnajinnie, L, Ferguson, D., Jennings, L., Carroll, S., Suina, P., Walker, A., Wates, A., David-Chavez, D. *Southwest Regional Scoping Review Analysis Regarding Indigenous Self-Determined Research in Climate Adaptation.* In preparation (journal TBD)

Narrative & role: This article is led by current master's student and also co-authored by our undergraduate research assistant, Tribal advisory members, and USGS Southwest Climate Adaptation Science Center project team, detailing findings from Natonabah's thesis work and scoping review.

Natonabah, S., Sage, F., Tso, D., Tsinnajinnie, L, Ferguson, D., Jennings, L., Carroll, S., Suina, P. C, Walker, A., Wates, A., Quintana, A., David-Chavez, D. *Insights Learned from Indigenous Climate Resilience Stories - a Rio Grande & Colorado River Basin cross-case analysis.* In preparation (journal TBD)

Narrative & role: This article is led by current master's student and also co-authored by our undergraduate research assistant, Tribal advisory members, and USGS Southwest Climate Adaptation Science Center project team, detailing findings from our Southwest Inter-Tribal knowledge exchange.

Undergraduate Research Experience

We were able to fund one Indigenous undergraduate student (Wates) to assist us on multiple project efforts. While working on the SW CASC project this student concurrently enrolled in a research experience for undergraduates (REU) program and was able to present on her research at multiple professional conferences (detailed below).

StoryMap

We are finalizing our ESRI StoryMap in collaboration with the project graphic design team (Martinez & Jorgensen) highlighting the findings from the Inter-Tribal Knowledge Exchange. The StoryMap content is currently under review with Inter-Tribal exchange attendees per our consent protocol and then will be hosted for public access via the Indigenous Land & Data Stewards Lab website (indigenouslandstewards.org), as well as the SWCASC repository, ScienceBase.

Conference presentations

(upcoming, accepted abstract) April, 2026. Layden, T., Fernandez, S., Natonabah, S., David-Chavez, D. "Reflections and storysharing on participatory approaches for strengthening Indigenous data stewardship protocols in rural contexts" U.S. Indigenous Data Sovereignty & Governance Summit. Tucson, AZ. Oral presentation.
November 13, 2025. Natonabah. S. "Indigenous Sovereignty in Climate Adaptation and Data Governance: Moving from Extractive Practices to Self-Determined Research in the Southwest U.S." Intermountain West Transformation Network: Indigenous Data Sovereignty for Climate Resilience Workshop. Albuquerque, NM. Poster presentation.

August 6, 2024. Natonabah, S. , Layden, T., David-Chavez, D. "Funding and payment governance for working with community partners." IndigeLab Network - building justice-based labs workshop. Oral Presentation. Virtual.

June 8, 2024. Wates, A., Natonabah, S. "Indigenous self-determination in climate adaptation initiatives in the southwestern United States." Native American and Indigenous Studies Association 2024 Conference. Bodø, Norway. Oral presentation.

May 6-8, 2024. Wates, A., Natonabah, S., David-Chavez, D. "How to aid in shifting from extractive research to self-determined research: Indigenous Climate Adaptation Initiatives in the Southwest." Rising Voices: Collaborative Science with Indigenous Knowledge for Climate Solutions Meeting. Boulder, CO. Poster presentation.

April 11, 2024. Wates, A., Natonabah, S. "How to aid in shifting from extractive to self-determined research: Indigenous climate adaptation in the Southwest." US Indigenous Data Sovereignty and Governance Summit: Building Action and Power. Tucson, AZ. Oral presentation.

March 29, 2024. Wates, A. "What does transdisciplinary research look like in practice?: Partnering with Indigenous rights-holders and decision makers for climate adaptation in

the Southwest..” Colorado State University MURALS. Fort Collins, CO. Oral and poster presentation.

Communications with decision makers

From proposal design onwards through every phase of our project, we have engaged Tribal leaders and decision-makers. Two of our initial Indigenous Advisory Council members joined our core project team, one as Co-PI (Lani Tsinnajinnie, Navajo Nation Water Rights Commission & University of New Mexico) and one as a consultant, providing ongoing mentorship, especially for our graduate student lead (Franklin Sage, Navajo Technical University, and Pro-Temp Counselor Chapter President). Additional decision-makers we regularly exchange with to provide guidance and oversight on our project include Phoebe Suina (High Water Mark LLC, Cochiti, and San Felipe Pueblos), Daniel Tso (Former Chairman, Navajo Nation Council), Althea Walker (Climate Science Alliance), Jaime Yazzie (Navajo Nation Forestry Dept.), and Lydia Jennings (Pascua Yaqui and former SW CASC Fellow). We have connected with the decision-makers noted above via phone and Zoom calls, and at regional meetings with a frequency of 1-3 months, depending on availability.

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