Climate Justice and Climate Adaptation in California: Indigenous Community Climate Adaptation Leadership and Opportunities for Scientific Collaboration

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ABSTRACT: Climate and weather-related disasters in California illustrate the need for immediate climate change action—both mitigation to reduce impacts and adaptation to protect our communities, relatives, and the ecosystems we depend upon. Indigenous frontline communities face even greater threats from climate impacts due to historical and political legacies of environmental injustice. Climate change adaptation actions have proven challenging to implement as communities struggle to access necessary climate data at appropriate scales, identify effective strategies that address community priorities, and obtain resources to act at a whole-community level. In this paper, we present three examples of Indigenous communities in California that have used a climate justice approach to climate change adaptation. These communities are drawing upon community knowledge and expertise to address the challenges of adaptation planning and taking actions that center community priorities. The three cases address emergency preparation and response, cultural burning and fire management, and community organizing and social cohesion. Across these spheres, they illustrate the ways in which a community-based and climate justice-focused approach to adaptation can be effective in addressing current threats while also addressing the legacy of imposed, socially constructed vulnerability and environmental injustices. Because we recognize the need for multiple knowledges and skills in adaptation actions, we include recommendations that have emerged based on what has been learned through these long-standing and engaged participatory research collaborations for climate scientists who wish to contribute to climate justice-focused adaptation efforts by using scientific data to support—not supplant—community efforts, target funding toward genuine community engagement and adaptation actions, and become aware of the historical and political legacies that created the climate vulnerabilities and injustices evident today.

KEYWORDS: Adaptation; Community; Indigenous knowledge; Societal impacts

1. Introduction

The most recent report from the Intergovernmental Panel on Climate Change (IPCC) makes clear that we need immediate action to address the climate crisis (IPCC 2022). Even as mitigation policies are being enacted, we are experiencing impacts that highlight the weaknesses in our social, economic, health, and governance systems. In terms of both mitigation of climate change and adaptation to its impacts, actions that will protect communities from climate-induced harms are being outpaced by climate change. While these barriers are evident in many places and contexts, both the impacts and the barriers to action are acute for Indigenous nations and communities of color, who are often overburdened and bear the most risk of climate impacts. These inequities are rooted in far-reaching processes of colonialism (Moulton and Machado 2019), settler colonialism (Whyte 2018), white supremacy, structural violence, environmental racism, and racial capitalism (Mitchell 2020; Ranganathan and Bratman 2021), which have pushed low-income and communities of color into areas with higher exposure to pollutants (Bullard 2000), less access to amenities (Karpyn et al. 2019), and greater risk of extreme heat (Hoffman et al. 2020). For Indigenous peoples, these processes have removed communities from healthful lands to marginal areas and/or prevented them from actively stewarding the land in an environmentally responsive way (Jantarasami et al. 2018). Communities facing the most direct risks from climate and environmental change due to these historical, political, and economic processes are often referred to as "frontline communities."

Even for non-BIPOC (Black, Indigenous, People of Color) communities, multiple challenges slow the pace of climate planning and implementation, including inability to access the appropriate scientific data at community scale (Moss et al. 2013; Virapongse et al. 2022); the challenge of coming to agreement about priorities and actions (Owen 2020); the difficulty in obtaining sufficient and timely resources to act (Noble et al. 2014); and the training and capacity to monitor and evaluate actions (Moser and Ekstrom 2010; Pisor et al. 2022). For low-income and BIPOC communities, these barriers can be even higher. Additional factors hindering climate action in frontline communities, particularly Indigenous nations, include a failure on the part of the U.S. government to address the policy roots of vulnerability; insufficient recognition of the

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difference between rightsholders and stakeholders; and the diversity of community cultures, priorities, and knowledges in planning efforts, which can reduce communities' willingness to engage in the process or act on strategies, or even prove to be a form of structural violence (Egland and Kelley 2020; Fernandez-Bou et al. 2021; Makondo and Thomas 2018; Nkoana et al. 2018). We also observe failure on the part of Western institutions and governments to include frontline communities in relevant decisions from the very beginning and to provide space for communities' leadership where the institutions and governments are the ones supporting—not supplanting—communities' vision. Unfortunately, government agencies have engaged in tokenism when it comes to community participation whereby community members are technically invited but are excluded from wielding real decision-making power (Fernandez-Bou et al. 2021; Virapongse et al. 2022). Finally, Owen (2020) found that many adaptation plans created without community input ignore issues of justice and equity, raising questions about their effectiveness in meeting community concerns or priorities. Both tokenism and exclusion are ways in which dominant powers have excluded those that are most marginalized. Building adaptation plans through unjust processes leads to further entrenchment of the systems that make these communities vulnerable to climate change and environmental injustice.

In spite of these barriers, innovative climate actions are emerging from within communities that have been effectively excluded from western mainstream efforts. In this paper, we offer several case studies of Indigenous communities in California who are using a climate justice approach to climate change adaptation by 1) centering climate justice in the process and 2) working at a community scale in ways that center community knowledge, practices, and commitment to place. Tribes in the Southwest have been consistent leaders in climate action and have articulated the relationship between climate-induced impacts and colonialism and offered pathways forward, building on both tribal policy innovation and ethics of relationality, responsibility, and reciprocity (Whyte 2018; Martinez et al. 2023; Wildcat 2009). Some reasons that Indigenous communities have been able to enact successful adaptation strategies include separate governance structures that allow for more innovation (also needing to innovate around constraints from outside); deep, long-term knowledge of ecosystems that can be drawn upon for adaptation strategies; an ethic of intergenerational decision-making and planning for the future; and being driven by necessity, as many communities have been relegated to more marginal, frontline landscapes. This latter condition is also the case for many communities of color.

Because sustainable climate change adaptation is likely to require an "all hands on deck" approach, we also reflect on several ways that climate scientists can contribute to this effort by listening and responding to community needs and priorities, right-scaling analyses based on community decisions and community areas of concern; respecting local knowledge as fundamental to this process, and treating engagement as a skill that is integral to the adaptation process. It is critically important to highlight adaptation actions that are working, so we can all learn about effective approaches—particularly those approaches that are effective for frontline communities (Owen 2020).

a. Principles of adaptation planning and current state of knowledge

A common framework for the adaptation planning cycle includes five steps: awareness, assessment, planning, implementation, and monitoring and evaluation (Lempert et al. 2018). Adaptation practitioners stress the importance of using this framework iteratively—continuing to repeat the cycle as new information about the effectiveness of plans and actions becomes clear. Many practitioners recommend "mainstreaming," or incorporating climate change adaptation planning into existing planning processes, such as general plans, land-use plans, and hazard mitigation plans, in an effort to reduce the administrative and resource burden on communities (Lempert et al. 2018).

As the impacts of climate change become more obvious, the pace of climate change adaptation planning is increasing, with more and more communities engaged in the process. However, implementation of adaptation strategies is not yet commonplace [U.S. Global Change Research Program (USGCRP) 2018]. We note several barriers along the path to implementation of adaptation strategies. Three major barriers are as follows: Adaptation can be at odds with community priorities, adaptation can work at a scale that does not address community concerns, and funding for adaptation actions lags behind funding for adaptation planning.

1) COMMUNITY PRIORITIES

First, the focus of adaptation actions can be at odds with community priorities or even be perceived as damaging to communities' sense of place and culture.

Climate science frameworks, such as the 2018 U.S. National Climate Assessment, often note that

> Communities have focused more on actions that address current variability and recent extreme events than on actions to prepare for future change and emergent threats. Communities are currently focused more on capacity building and on making buildings and other assets less sensitive to climate impacts. Communities have been less focused on reducing exposure through actions such as land-use change (preventing building in high-risk locations) and retreat (Lempert et al. 2018).

Supporting communities as they consider long-range change and actions is important to community well-being. However, statements about communities not being as focused on adaptations such as "retreat" must be contextualized, or we run the risk of using a common trope that the people themselves are the barrier to climate actions. It is also important to consider the context for why retreat would not be a focus, particularly for place-based communities. A focus on "retreat" can fuel historical injustices and current environmental racism; "retreat" is often the last resort in a community's adaptation decision-making when there are no other options left. The framework of "retreat" itself is problematic, as it often excludes "the very people who bear the most extreme burdens of the climate crisis," and can exacerbate underresourcing and overburdening

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groups on the frontlines (Maldonado et al. 2020). The 2018 statement also argues that, by focusing less on reducing exposure, communities are not as focused on preparing for future change. This is a hazard-centric focus in which vulnerability is equated with exposure (Marino 2015). This framing also does not account for the layered impacts and cascading effects as disasters become more frequent and people are still recovering from one event when the next one hits, falling farther and farther behind in recovery without the ability to prepare well even in the short term, let alone for the future. The framing of adaptation actions has significant policy and practical implications and can result in exacerbating inequities and furthering climate injustices, or be utilized for justice-centered adaptation planning in a holistic, whole-community context.

Similarly, many frontline communities have questioned the focus on resilience in adaptation planning efforts. A "resilience" framing can imply that the goal is maintenance of the status quo (i.e., "bounce back" after a disturbance), despite the fact that the status quo for frontline communities is not healthful and sustainable (Hayward 2013; Meerow and Newell 2019; Weichselgartner and Kelman 2015). The resilience narrative can be used as an excuse for not making broad societal changes because of a perception that communities that have survived hardship in the past can continue to do so because they are "resilient" (Ranganathan and Bratman 2021). In fact, communities that are described as resilient often face "resilience fatigue," or the exhaustion that comes after a prolonged period of having to stay motivated and positive in a situation of duress (National Academies of Sciences, Engineering, and Medicine 2023).

One key critique of resilience is that it means something different to people across academic disciplines and communities (Tierney 2015; Meerow and Newell 2019; Methmann and Oels 2015). However, Western science definitions too often ignore other conceptualizations of the term, particularly those rooted in Indigenous knowledges. For example, Whyte (2018) explains that resilience in many Indigenous communities is viewed as the maintenance of a moral relationship between people and their environment. Although efforts have been made to refine and clarify the use of resilience in ways that account for power and politics, such as the concept of "equitable resilience," which accounts for social vulnerability and differential access to power, knowledge, and resources (Matin et al. 2018), these efforts may just reinforce the point that resilience is not the best theoretical or practical foundation for work that will require transformation (Redman 2014).

2) SCALE

Second, efforts to scale up adaptation—in response to well-founded concerns about large-scale disasters—can exacerbate the pattern of ignoring community-specific needs and knowledge and focusing at the wrong scale. In an effort to increase the pace of adaptation, practitioners are often focused on how to "scale up" adaptation planning. Use of decision support tools that aim to provide necessary climate data at appropriate scales is often advocated as an efficient method for helping communities plan and act (Noble et al. 2014). However, the technoscientific approaches can overlook important community resources, experiences, knowledges, and expertise, as well as the indicators that matter most to socioecological well-being, to support effective adaptation—and the importance of community leadership and guidance in the sustainability of adaptation actions. Such approaches, if they consider communities at all, often do so as an add-on, as opposed to being driven and guided by the communities from the very beginning, all the way through implementation. Given the central place of Western science and scientists in the current adaptation planning approaches, the existing tools, which are often inaccessible in format, presentation, relevance, and more, can even be perceived as a further imposed form of injustice (Nalau and Verrall 2021; Jasanoff 2021).

There has been movement in recent years toward community-based adaptation (CBA) that places community needs at its core (Piggott-McKellar et al. 2019). CBA attempts to address concerns about lack of justice, equity, and community knowledge in adaptation planning. CBA uses an approach similar to community-based participatory research or community-based natural resource management to place individual community needs at the center of the process and advocates for extensive community engagement to ensure that plans meet community needs, have community support, and result in outcomes that further communities' adaptation efforts. The principles of CBA rest on the idea that the community (however defined in the process) is the entry point for inquiry and action, rather than using a "model-based problem statement about the situation" (Reid and Schipper 2014). CBA recognizes the role of scientific knowledge in the process—and places it alongside local knowledge when compiling evidence regarding climate impacts. However, even CBA faces scaling challenges. CBA requires a place-based approach. Current approaches to increasing the use of effective CBA approaches include expanding the movement beyond its current set of theorists and practitioners, linking local efforts to regional and national levels of government, and integrating CBA into development planning (Reid and Schipper 2014). CBA faces many of the same challenges of all approaches to adaptation planning, including lack of resources, lack of capacity, and difficulty accessing the scientific information. A challenge more specific to CBA is a lack of evaluation of the process, which has contributed to many projects being inadequately participatory. It is difficult to evaluate the effectiveness of CBA if the process within a particular planning effort has not adhered to the tenets of CBA (Reid and Schipper 2014).

3) FUNDING

Third, funding for implementation still lags funding for adaptation planning, leaving communities with no way to act on their plans. At the time of writing, significant funding for adaptation actions has been promised through the Inflation Reduction Act (Yarmuth 2021). Allocation of these funds for community adaptation actions, hopefully, will reduce the implementation funding barrier. A related concern is the disproportionate level of funding for natural and technical climate research as compared to human dimensions or social science

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research or projects that center on Indigenous knowledge that can help shed additional light on community-based and community-designed adaptation strategies (Overland and Sovacool 2020).

b. *Climate justice*

The concept of climate justice is beginning to supplant older concepts of climate resilience or adaptation, particularly in Black, Indigenous, and other communities of color, who are often the frontline communities (Mitchell 2020; Moulton and Machado 2019; Ranganathan and Bratman 2021; Whyte 2018). Climate justice, as a concept, recognizes that climate change is a "social issue that both breeds [in]equalities and exacerbates long-standing ones" (Mattar et al. 2020). A climate justice framing views climate stress as "one of many—and not necessarily overriding—intersectional drivers that impede the ability to lead healthful and dignified lives" (Ranganathan and Bratman 2021).

Using climate justice as a framing for adaptation efforts can allow communities to directly address some of the weaknesses in the current adaptation planning models discussed above including an ahistorical perspective on the roots of community vulnerability in colonial and racist policies and practices, and ignoring community priorities in favor of actions favored by (and beneficial to) dominant institutions (Fernandez-Bou et al. 2021; Porter et al. 2020). Current adaptation planning models have a preference for Western scientific knowledge, which can lead to an outsized faith in technoscientific solutions at the expense of local knowledge, expertise, wisdom, and priorities. Current adaptation planning also often fails to acknowledge, draw upon, and incorporate community knowledge and expertise, and the types of data that are most significant for community and socioecological well-being (Fernandez-Bou et al. 2021; Whyte 2018). It often views climate impacts in a silo, as opposed to a holistic, whole-community, and cross-sectoral approach recognizing that to address climate risk we need to focus on, for example, housing justice, key human rights, and the roots of inequities, and take an intersectional approach (Maldonado and Peterson 2021; Pastor et al. 2006).

Climate change adaptation work done within a climate justice framing can be a more effective approach for frontline communities (and by extension, all communities). By recognizing existing social and racial stratification (Anguelovski and Pellow 2020) and the political and historical roots of vulnerability, climate justice work can help identify long-term solutions to climate risk for those who have been overburdened and forced to bear the climate risks. Climate justice work moves past the resilience framing that implies that communities should seek to sustain the status quo and, instead, centers community priorities for their future. Climate justice also moves away from a reliance on technocratic solutions that individualize the responsibility for responding to climate change solutions and instead considers power, politics, and historical context in framing both the problem and the solution. Finally, climate justice-driven adaptation work draws upon the capabilities, knowledge (Anguelovski and Pellow 2020), and "ethic of care and healing practices by those deemed most at risk" (Ranganathan and Bratman 2021) and seeks to pair local knowledge with additional information in ways that benefit communities.

2. Case studies

The following cases offer examples of specifically Indigenous leadership in response to climate stressors. These initiatives are informed by Indigenous understandings of the epistemological context for climate change, the frameworks of exploitation, racism, and extraction that resulted in the climate crisis. These projects are guided by Indigenous values of responsibility to place, to human and nonhuman beings, and to past, present, and future generations. We offer examples that we are aware of through collaboration, participation, and partnerships, and we acknowledge respectfully that there are numerous other inspirational Indigenous-led projects that are reframing what climate justice looks like when Indigenous communities guide climate adaptation.

The first example comes from the Sogorea Te' Land Trust (STLT) in urban California and illustrates the use of a community care model that draws on community resources to address the impacts of urban disinvestment and respond to community members' emergency needs. The second example demonstrates how traditional knowledge regarding cultural burning is being used by Indigenous communities to address food security and sovereignty needs and improve the health of ecosystems that have been impacted by climate change. The third example, from the area of Northern California and southern Oregon, focuses on using Indigenous concepts of relationality to strengthen community ties and relationships and harness the strength of community relationships to organize around climate justice issues.

a. *Emergency preparation from the grassroots*

SOGOREA TE' LAND TRUST

Emergency preparation is key to the well-being of communities in case of disaster. However, communities that have been marginalized and disenfranchised are often the most disconnected from government processes that execute emergency response. Communities understand their needs as well as their strengths and recognize this is at the core of community-based climate adaptation. As climate change intensifies and communities are increasingly exposed to climate disasters, using climate justice principles can help emergency planners and responders build on community knowledge and leadership while not overburdening them in the middle of a crisis. For example, centering Indigenous strengths can mean consciously disrupting imposed gender norms and hierarchies to ensure that community knowledge can be brought to bear on climate adaptation challenges. In Indigenous communities, women are often at the forefront of climate change leadership because of their cultural responsibilities to Earth and their communities (Whyte 2014). As climate change threatens many Indigenous communities' ability to carry out their responsibilities, cultural identity and gender identity can be impacted (Whyte 2014; Norgaard 2019) along with physical

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health and well-being. Colonialism violently disrupted traditional leadership structures that favored women and transgender individuals and climate change threatens to disrupt these gendered practices and leadership again (Vinyeta et al. 2015). However, many Indigenous people have adapted and taken on climate leadership in ways that honor their cultural responsibilities and identities. Centering Indigenous gender roles in leadership is not just culturally responsive; it also ensures that community knowledge and leadership is truly considered by including leaders and knowledge holders of all genders. One example of this type of leadership is the work of the Sogorea Te' Land Trust.

The STLT is an urban Indigenous women-led land trust located in the east San Francisco Bay Area. STLT has become recognized as a grassroots leader in creating sites of renewal, hope, and sustenance in densely populated urban areas. The land trust arose from grassroots activism by Indian People Organizing for Change (IPOC) against the rampant desecration of sacred sites in Vallejo, Berkeley, and other Bay Area cities. After attending a convening of native land trusts at Sycuan in 2012, STLT cofounder Corrina Gould selected the land trust model as a structure to assist with protecting cultural places, enabling access and subsistence, and reinvigorating land-based stewardship and ceremony in Huchin, the traditional homeland in the area now known as Oakland and surrounding areas (Gould and Young 2020; NoiseCat 2021).

Following incorporation in 2015, and numerous land-based projects from the San Francisco Bay to the hills of Oakland and beyond, STLT's work has come to include building sites of community-based care in underserved areas of the East Bay. The historical and contemporary context of these areas includes intensive ecological contamination (i.e., industry and brownfields) and socioeconomic disinvestment. Despite these realities, communities retain proud and vibrant networks of mutual aid, as exemplified by the legacy of the Black Panthers in Oakland, California, and the development of early urban American Indian programs, such as the Intertribal Friendship House, one of the oldest urban Indian centers in the nation (Lobo 2002; IFH 2022).

The group of local women leaders building STLT recognize the ongoing context of colonialism that results in a simmering crisis in urban BIPOC communities faced with food insecurity, environmental contamination, and increasing impacts of storms and/or unpredictable weather patterns. Simultaneously, they celebrate and mobilize the strength of diverse and active multicultural communities in the East Bay. STLT exemplifies inclusive leadership-in-action in the face of adversity, as Ramirez explains in her article about STLT and Moms 4 Housing, both grassroots organizations working for justice in the East Bay: "people resist these crises in their cities, in organized, creative, and mundane ways . . . the future of urban geography is . . . being written by the people resisting urban crises on the ground" (2020, p. 683).

Further, STLT foregrounds an ethic of women's leadership to rematriate ancestors and homelands: As Gould describes, "That's part of re-matriation—women's work, women's jobs to bring life" (NoiseCat 2021, p. 243). Celebrated journalist Julian Brave NoiseCat reflected on his conversations with Gould and observations of the work of Sogorea Te, noting "The Bay and its first peoples have suffered . . . Sogorea Te rises with an intriguing idea: that under the care of Indigenous women, the land and the people it sustains could fare much better. Perhaps there is another way—a more feminine way—to relate to this land that could help return the Bay to the place of wild plenty it once was . . . This idea . . . is the subject of Gould's prayers and strivings" (NoiseCat 2021, p. 245).

As a community-based organization in an underserved region, STLT recognizes clearly that external bodies (i.e., county social services) will not necessarily prioritize building capacity or disaster readiness in their home communities. A significant site of STLT's work is Deep East Oakland, a predominantly BIPOC and largely low-income area of the city (Ramírez 2020, p. 688). In an interview with Ramirez in 2019, STLT cofounder Johnella LaRose explained some of the context for their work: "They're not coming for us. We want to be the place that people can go. We're setting up a disaster preparedness center, we'll have an outdoor kitchen with propane stoves and tents and sleeping bags, storing rainwater in these 50-gallon tanks . . . we're going to have first aid classes in English and Spanish. People will feel better if they know something . . . It's going to get wild and wooly out there. When terrible things happen, people become human beings again and take care of each other" (Ramírez 2020, p. 688).

STLT and partners focus on building upon existing community strengths, heritage, knowledge, and relationships, in part, to create sites of community care such as Himmetka, which translates to "in one place, together." Multiple Himmetka sites in STLT gardens in east Oakland include ceremonial space, medicines, food, seeds, and tools. Himmetkas provide physical as well as cultural and spiritual sustenance—providing places to be in community and share concerns and ideas, as well as cultivate food, water, and medicine, together. As Gould explains, "we . . . need places to be. Places to stand. Places to sit. Places to think. Places to grow food. Places for us to be part of the land again" (Anti-Eviction Mapping Project 2021, p. 221). This approach encompasses the broader meaning of food sovereignty, which includes not just access to grow food, but to be in community and to care for the land and one another (Wires and LaRose 2019, p. 31, p. 33). With Himmetka and garden spaces, STLT asserts resilience as a grassroots, joyous strategy of building systems of community-based care in the face of predicted climate catastrophes. In the process of building this project, relationships among and between diverse community members are strengthened. Leadership emerges from the community and in response to community needs. Their leadership takes in climate predictions and responds to them on the community's terms, foregrounding inclusive leadership by Indigenous women in a diverse and densely populated region.

b. Fire stewardship: Keepers of the flame project in partnership with North Fork Mono and Wintun community practitioners

Indigenous advocacy to transcend barriers to the application of cultural burning has been ongoing since contact and

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the introduction of fire suppression. The violence and timber prioritization of early settlers led to direct violence on Indigenous communities using fire as a stewardship tool. Using documented racist logic, the United States Forest Service (USFS) advanced a largely unsubstantiated fire suppression policy (Vinyeta 2022). Fire was outlawed and actively suppressed as one of the first actions of the state of California. This policy continued for over 100 years and led to increased vulnerability for both California forests and the Indigenous communities that depend on them for cultural sustenance. This ongoing violence is still a threat to fire stewardship in California today. Recognizing the roots of community vulnerability requires attention to community priorities, histories, and knowledge.

This work has taken on new urgency in a context of climate change. In her collaborations with Karuk tribal members, Norgaard elucidates the ways in which fire suppression is both an expression of and an ongoing extension of settler colonial violence toward Indigenous peoples (Norgaard 2019). The application of specific settler colonial economic theory, including the view of nature/nonhumans as capital to be transformed into financial assets, both creates the conditions that have exacerbated anthropogenic climate change, and is in direct conflict with Indigenous views of relationality and responsibility to conduct land stewardship (Norgaard 2019; Yazzie and Risling Baldy 2018).

Contemporary analyses of Indigenous cultural burning reveal multiple cobenefits for improving landscape resilience to climate change, including but not limited to reducing the vulnerability of ecosystems to catastrophic fire, improving the vitality of native species, and contributing to increased water quality and quantity (Kimmerer and Lake 2001; Marks-Block et al. 2021). Fire is also critical to food and cultural sovereignty as many traditional food and fiber species rely on fire to grow abundantly and successfully (Anderson 2013; Risling Baldy 2013). Food sovereignty is an extension of cultural and political sovereignty and is essential to climate and environmental justice for Indigenous people. Traditional foods are integral to culture, health, ceremony, and land stewardship practices. In fact, because many traditional foods come from the homelands of Indigenous peoples, food justice is inextricably linked to environmental justice and ecosystem health. The globalization of food production and supply chains might mean that many people do not see their immediate environment as a source of food. However, Indigenous communities continue to practice the foodways that rely on local environments (Hoover 2020). Cultural foods provide healthy nourishment as well as cultural empowerment, community connection, and learning. Food is valued for its connection to native language, community cohesiveness, cultural gathering practices, and healing (Whyte 2016). For this reason, it is important to consider not only access to healthy and affordable food but also access to cultural foods.

For Indigenous communities, food sovereignty requires an ecosystem-level approach as well as broader conversations around environmental decision-making and implementation. Tribes throughout the nation are leading the way in ensuring their access to cultural food and fiber plants. In the Southwest, food sovereignty is a key piece of tribal climate adaptation plans and the goals of land stewardship. Though cultural fire can address issues around fuel management, food and cultural sovereignty is often centered in cultural burn plans and continues to be emphasized by cultural practitioners throughout the state (Adlam et al. 2022).

Cultural burning is one of the most important community land stewardship practices in the Southwest. Wildfires driven by colonial land management practices and climate change have made the western United States a consistent site of crisis. Wildfire is one of the key issues of the climate crisis; however, fire itself is also an integral part of California ecosystems. Indigenous people throughout California have created fire-adapted and fire-dependent communities that view fire as an important tool and cultural practice (Adlam et al. 2022; Kimmerer and Lake 2001). These practices are important to ecosystem function, food and cultural sovereignty, and ultimately our climate future. Indigenous leaders are revitalizing cultural fire practices after over a century of colonial fire suppression tactics violently removed the practice from California forests.

Working with the Southwest Climate Adaptation Science Center, a University of California (UC) Davis team including Native American Studies and Ecology graduate students and faculty have been engaged with Indigenous fire practitioners in the development and implementation of cultural burning workshops. These workshops bring together tribal and agency fire practitioners, native youth, students, land managers, funders, researchers, and policymakers to learn from Indigenous leaders and culture bearers (Adlam et al. 2022). Workshops occur at two principal locations, the Jack Kirk estate in Miwuk homelands in Mariposa County, California, and the Tending and Gathering Garden in Patwin homelands in the Cache Creek Nature Preserve in Yolo County, California. The workshops are led by Chairman Ron Goode of the North Fork Mono Tribe and Diana Almendariz, a Nisenan/Wintun/Hupa cultural bearer and practitioner. Workshops led by Chairman Goode happen on the Jack Kirk estate in Mariposa, California, while those led by Diana Almendariz happen at the Tending and Gathering Garden of the Cache Creek Nature Preserve. Workshops have resulted in an increase of harvestable basketry and food plants such as sourberry, redbud, deergrass, tule, and elderberry. As a result, cultural practitioners have a safe and reliable place to gather these important plant species. Materials from these workshops contribute to broader community learning about basket weaving and traditional food preparation (Adlam et al. 2022).

In addition to increasing the abundance, quality, and resilience of culturally important plant species, the workshops also create stakeholder and rightsholder relationships that extend beyond the context of this project. By inviting important stakeholders and making space to build relationships based in intercultural understanding, land-based caretaking, and storytelling, Indigenous workshop leaders are setting a foundation for long-term collaborations. This sort of relationship-building in community-based climate adaptation is critical for shared decision-making and trust-building. By foregrounding and making space for relationship-building, workshop leaders build regional networks of students, community members, and allies working to return cultural fire throughout the state. Participants

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return year after year to continue their relationships with each other and with the land. Some participants have felt empowered by their experiences in these workshops and built their own gatherings to return fire in different regions and communities. This and other efforts to return fire to the land are innovative in that they simultaneously build community capacity for stewarding land and deepen partnerships between local agencies, communities, and tribal members.

c. *Community organizing: Winnemem Wintun Run4Salmon*

Climate adaptation is a complex social and community process. One limiting factor in adaptation is collective action (Adger 2003). Building the social capital necessary for collective action is a key form of climate adaptation and disaster response (Aldrich and Meyer 2015). Indigenous scholars have framed this kind of community building in the context of resilience and building moral relationships in terms of relationality and kincentricity (Whyte 2018). Relational capacity building is important for the climate justice movement in particular because it supports the creation of a collective identity that shifts people away from despair and toward hopeful action (Divakaran and Nerbonne 2017). This kind of organizing has a long tradition within Indigenous communities who have organized to address immense social, political, and environmental injustices. In California, Indigenous communities have been at the forefront of environmental organizing, working throughout the state to return Indigenous stewardship practices and philosophies. Tribes have succeeded at mounting large campaigns for the protection of land, water, and nonhuman relatives and built coalitions, public support, collaborations, and community mobilization that creates change and moves us closer to climate justice. As climate change progresses, it becomes more and more necessary to understand how to create political change. Indigenous leaders need to be a part of collective efforts toward climate justice, not just because of the immense ecological toolkit offered by different communities' Indigenous science but because of the deep relationship-building expertise that has moved many communities toward collective action.

The Winnemem Wintu Tribe has a deep relationship with the McCloud River watershed that is both historical and ongoing. The tribe was displaced from their homelands by the Central Valley Project, a large water infrastructure project in California, that erected a dam that continues to flood Winnemem Wintun villages and sacred sites (Dallman et al. 2013; Houck 2019). This ongoing violence is threatening both Winnemem Wintun sovereignty and the well-being of endangered species like "winter-run Chinook Salmon, Spring-run Chinook Salmon, Central Valley Steelhead, threatened Southern Oregon/Northern California Coast Coho Salmon, and threatened Central California Coast Steelhead, and designated habitats in accordance with section 7 of the federal Endangered Species Act (ESA)." (Houck 2019). The issue of the dam is highly contentious; however, the Winnemem Wintun Tribe has been able to build large coalitions in support of their effort to protect and bring back the salmon run that is so integral to Winnemem Wintun culture and well-being. One solidarity-building event is the annual Run4Salmon, a nearly 300-mile run that brings together community members of all ages to engage in community-building and direct action. The run brings awareness to the ways in which the Winnemem Wintu continue to protect the McCloud River, the salmon, and the land. It also builds and extends intergenerational knowledge sharing and relationship to land (2019). This awareness-building is critical to community relationships, empowerment, and advocacy and is thus critical to climate justice.

The Run4Salmon has created community coalitions that expand the region's capacity for climate adaptation. Community coalitions spawn networks of communication, activism, and decision-making that can be mobilized to plan and respond to climate and environmental change (Divakaran and Nerbonne 2017). Run4Salmon also creates the foundation for planning at larger scales by creating a scaffolding that is responsive to community-specific needs while also balancing broader regional needs. Community activism like Run4Salmon also creates spaces where members of different communities can come together to imagine and cocreate a climate just future. These spaces of imagination help communities name goals and share strategies for achieving justice that cannot always be replicated in stakeholder meetings. For this reason, it is critical to include activists and movement leaders in climate adaptation planning.

3. Conclusions and recommendations

As several other authors have noted recently, the work of successful adaptation planning is likely to require multiple knowledges and skills—including both community expertise and climate science data and expertise (Egland and Kelley 2020; Virapongse et al. 2022). In our examples above, we have highlighted the ways in which several communities are acting through a climate justice lens to use the knowledge, expertise, and priorities of their communities in the adaptation process. We consider the community-centered approach fundamental to the process of successful adaptation. We also see important roles for climate science and scientists in these efforts. Climate science has the power to bring in additional information including forward-looking projections that will help communities anticipate and prepare for additional climatic changes. Climate science can also harness knowledge gained through multiple adaptation actions in a diversity of contexts around the world to help identify effective strategies communities can consider as part of their planning efforts. However, to be effective partners in this process, climate scientists may need to alter their approach to adaptation planning and build new skills in engagement and collaboration. Below, we offer some thoughts that have emerged from our collective engaged research collaboration experiences about how climate science and scientists can become stronger partners in community-based, climate justice-focused adaptation efforts.

a. *Engage and collaborate*

We generate more useful, used, and actionable science when we work in collaboration with communities and others directly

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involved in adaptation decisions. These collaborations help us tap into deep experiential knowledge of place (Latulippe and Klenk 2020), expert knowledge about facilitating action in a particular context (sometimes called know-how) (Hulme 2014), and the scientific predictions about which climatic and ecosystem changes are likely and how quickly to expect them. Collaboration takes skills, time, active listening, a values-focus, long-term commitment, and trust- and relationship-building, recognizing that there is often a trust deficit due to colonial histories, including historical harms and traumas in which Western science is implicated (Lazrus et al. 2022). But it is possible to be a dedicated community collaborator by building key skills (or building a team with key skills) and approaching the process with humility, radical empathy, reciprocity, and respect for all people and knowledges who are similarly respectfully engaged in the process (Ferguson et al. 2022; Wilmer et al. 2021; Montgomery and Blanchard 2022).

Some specific examples of how climate scientists can engage with community-based climate justice efforts include adapting the ways in which climate data are "owned," shared, presented, accessed, and managed. Whenever possible, climate scientists can work to generate and present climate data at the decision scale of their partner communities and based on the indicators and measurements that are most important and relevant for community, social, and ecological well-being (Virapongse et al. 2022). Decision scale is context dependent and will change depending on individual communities but might include traditional lands of Indigenous communities, a particular watershed, or a specific planning region (Meadow 2017). While presenting climate and environmental data at these scales does not necessarily make it more accurate (there are limits to the power of downscaling climate models, for example), having the data presented at a scale and in a format that communities can use can speed their uptake and application of the data in decision-making. Further in dialogue with community members, climate scientists can work to identify the type of data that are most helpful for community decision-making and ability to not only survive but thrive into the future.

A second approach to consider is the practice of Indigenous data sovereignty. The term not only applies directly to Indigenous peoples' sovereign rights to control data about their lands and people but also embodies principles about respect for communities and community knowledge that make it good ethical practice in all scientific processes (Carroll et al. 2019, 2021). Ethical, collaborative data management includes treating community knowledge as a valid form of expertise that can shed significant light on climate science data through shared data interpretation (see, for example, Gearheard et al. 2010; Carroll et al. 2021). Prioritizing community control of data can appear to be at odds with the movement for open data, as summarized in the Findable, Accessible, Interoperable, and Reusable (FAIR) principles. However, including the Collective benefit, Authority to control, Responsibility, and Ethics (CARE) principles in research involving or impacting Indigenous communities can help researchers manage data ethically.

Finally, scientists can be self-reflective about the extent to which additional or new data are tangibly contributing to adaptation processes (Jasanoff 2021). If communities have sufficient data to move forward, as the Fourth U.S. National Climate Assessment noted, we can turn our attention and expertise to supporting adaptation actions and helping to monitor and evaluate their effectiveness for the communities concerned (Jay et al. 2018).

b. *Funding*

Climate science and climate adaptation funders can play an important role in facilitating engagement, collaboration, and community-centered adaptation practices. Funders can make funds available for engagement activities like travel and participant support—including for community members' time and expertise—so that communities have access to climate scientists when desired for direct engagement (Arnott et al. 2020; Ford et al. 2013). This funding could support community members who are often juggling many unpaid leadership roles and for whom participating would otherwise be a burden.

Funders can also prioritize community-based projects and expertise by providing funds directly to communities. Requests for proposals should be driven by community concerns and priorities and not those of the funder or researchers or practitioners adding communities in. Rather, the starting point should be community needs and priorities. The entire funding process—from the initial application through to reporting—should be flexible so that it does not act as a barrier to a community with lower technical capacity but significant needs, ideas, and commitment to adaptation actions (Bull and Steinberg 2021; Chan and Fischer 2016; Francis et al. 2018).

Funders can expand their support to fund work beyond the physical sciences and expand how science is defined. For example, Indigenous knowledges are science, based on long-term, generational, place-based observations, hypothesis, testing, monitoring, and evaluation, over time (Lazrus et al. 2022). In 2022, the White House Office of Science and Technology Policy reinforced the scientific basis of Indigenous knowledges when it released guidance to federal departments and agencies on the use of Indigenous knowledge in federal policymaking (Prabhakar and Mallory 2022). Solutions to adaptation and mitigation challenges require the social sciences—and they require community know-how. The vast majority of funding for climate change research goes to natural and technical science research (Overland and Sovacool 2020). However, mitigation of climate change is going to depend on behavior and attitude changes that are the domain of social science research, and communities themselves identifying and acting upon adaptation strategies that support their communities (Jasanoff 2021).

c. *Rethink the narrative*

When non-Indigenous and/or white climate scientists begin community collaborations, they can start by rethinking some of the dominant narratives about the roots of vulnerability and resilience. They can, as explored here, recognize that the roots of much of climate change vulnerability are colonialism and racism. They can listen to scholars and community members

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from frontline communities as they describe how seemingly common terms like resilience do not land with neutral (or positive) connotations within many communities of color. They can recognize the expertise that comes from lived experience, alongside the expertise that comes from education and training—and the ability for both forms to exist simultaneously and synergistically within communities or individuals. They can look for the examples of strength and knowledge coming from frontline communities—not as a valorization of "resilience," but as sound, practical approaches to adaptation built around community strengths and intended to address community priorities now and in the future. And they can center the idea of climate justice in the work of adaptation, which helps illuminate the interwoven nature of community health, community knowledge, threats from climate change, and social and economic justice. None of these factors exist in a vacuum, so our efforts at adaptation work should not attempt to separate them. Most importantly, we can all recognize and support the ways in which Indigenous communities ensure community resilience through systems of relationality and accountability (Whyte 2018). Rethinking our narrative around climate resilience will take critical dialogues with communities about the power dynamics that often exist between scientists and community members. Uplifting narratives that recognize the knowledge held within community practices and culture is critical and involves listening to those communities sharing their own narratives, knowledges, wisdom, and strategies to address climate impacts.

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