

Toward Advancing the Use of Climate Adaptation Decision Support in California

Samuel Ikendi, Ph.D.

Academic Coordinator for Climate Smart Agriculture
University of California Agriculture and Natural Resources/Cooperative Extension
University of California, Merced
5200 N. Lake Road, Merced, CA 95343
sikendi@ucucmerced.edu

Andrew J. Lyons, Ph.D.

Program Coordinator for Informatics and GIS (IGIS) Program
University of California Agriculture and Natural Resources/Cooperative Extension
Department of Environmental Science, Policy, and Management
University of California, Berkeley
130 Mulford Hall, Berkeley, CA 94720.
ajlyons@berkeley.edu

Tapan Pathak, Ph.D.

Associate Cooperative Extension Specialist for Climate Adaptation
University of California Agriculture and Natural Resources/Cooperative Extension
University of California, Merced
5200 N. Lake Road, Merced, CA 95343
tpathak@ucmerced.edu

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Introduction

The agricultural sector of California is facing several climate extremes including reducing water stocks, increasing temperature, and disasters, affecting small-scale and large-scale farmers (Ikendi et al., 2024a; 2024b; Jasechko & Perrone, 2020) and ranchers (Ikendi et al., 2024b; Pinzón et al., 2025; Woodmansee et al., 2025). One of the climate smart agricultural strategies is advancing the use of climate adaptation decision-support information sources and tools designed to translate climate information into forms that support production decision-making (Lu et al., 2021; Pathak et al., 2023). Recent statewide stakeholders' needs assessments conducted on climate decision support sources and tools in California revealed that the use of these tools was overall less than 50% and further low among ranchers and extension technical providers (Ikendi et al., 2024c). Moreover, these studies further found that farmers and ranchers used different support tools other than those used by the advisors. Collectively these studies highlight the need to uncover the lived experiences with decision-support tools for climate adaptation in agriculture. To better understand and address both successes and gaps, this investigation leveraged a large gathering of adaptation professionals to engage in a focused dialogue around decision support needs and opportunities. This research aligns with the AAAE research value of enhancing environmental health, precisely, "examining climate variability and its impact on agriculture and related activities" (AAAE, 2023, p. 9).

Conceptual Framework

A needs assessment concept was the foundation of this inquiry (Donaldson & Franck, 2016). From the perspective of climate adaptation, needs assessment is the initial step toward developing strategies for advisors by understanding and documenting their perceptions, experience, and knowledge of climate change exposures, potential impacts, and social vulnerabilities (Prokopy et al., 2015). Also, to know what effective risk management practices their clients currently use, what tools and resources would assist them in advising growers to make strategic decisions, what types of extension education activities would help them, and where to find necessary resources. Farmers and ranchers have expressed a need for specific climate information that can serve their unique farm operations and render technical assistance in their communities (Ikendi et al., 2024a; 2024b; Jagannathan et al., 2023; Pinzón et al., 2025). Likewise, extension service providers also have to deal with questions related to climate extremes and their implications on agriculture and the broader economy. However, these service providers are often ill-equipped with locally relevant adaptation resources to assist farmers in implementing those decisions (Johnson et al., 2023).

Methodology

In this inquiry, we employed a constructivist theoretical orientation seeking knowledge that is socially constructed and whose meaning emerges inductively (Crotty, 1998). A case study design was adopted, utilizing a cross-case approach to data analysis (Creswell & Poth, 2018). Participants were 78 advisors who attended a session on adaptation decision support during the California Adaptation Forum in July of 2023 and 48.7% were from private organizations, 42.3% from government entities, and 9.0% from Cooperative Extension. The study oversight was under UC Davis IRB: 1841798-2. Data were collected using three questions with facilitation from the research team. To ease discussions, questions were displayed by a projector, and participants recorded their responses on sticky notes, and we also took field notes. Each question was clearly articulated during discussions to gain clarity and rich information on decision support. All sticky notes were collected, arranged by their colors, and counted; green ($n=45$), pink (part a, $n=50$; part b, $n=39$), and blue ($n=40$). Responses were typed in Word documents. Transcripts were shared with the team to facilitate engagement and process its meaning. Generating meaning from the transcribed data was done inductively by reading the transcript word by word and line by line for a particular question and developing codes that were merged into themes as presented in the results with participants' excerpts.

Results

Question one [green] was what kinds of decisions or issues do you face in your work related to climate? Five themes emerged including *climate impacts*, *equity*, *adaptation programs*, *adaptation resources*, and *cost analysis* illustrating the lived experiences of stakeholders relating to climate. In *equity*,

for instance, a participant wrote that they make decisions or face issues on *who is informed, involved, and leading [adaptation] projects*, and added *breaking down barriers of mistrust and building meaningful relationships*. In *adaptation programs*, a participant wrote about *urban cooling using trees* and faced issues on *what information clients need before getting a tree*. In the adaptation resources theme, one participant wrote a decision [they] make relating to *who/when/how to engage the community* and added, *prioritizing climate action implementation in the context of limited resources and addressing multi-benefit potential in climate projects*.

Question two [pink] part (a) asked what information sources do you currently turn to, to help you make those decisions. The themes that emerged were *community and tribal knowledge, environment tools, Cal-Adapt, reports and guides, research studies*, and the *Health Places Index* tool. Part (b) of question two asked where are the gaps or shortfalls in those information sources and six themes emerged including issues to do with *translation, data update, accessibility, data weight, and resources*. Data translation was the major issue, and a participant wrote that they use *CIMIS [California Irrigation Management Information System]* and added that [they] are *looking for interpretations like those found in PRISM [Parameter-elevation Regressions on Independent Slopes Model] data*. In *data updates* limitation, a participant wrote, *most recent data is often not available, so we always work with outdated data which makes it hard*. Another participant wrote *we need a real-time data source/tool that brings in many factors for investment decisions*.

The third question asked participants what can researchers do to help, and five themes emerged including *community engagement, translation, dissemination, training, and cost analysis*. In the *community engagement*, one participant wrote that *research needs to be in the community* and added that they *make connections with the people around you and all the connections and industries they represent*. Related to *translations* one participant wrote, *make tools as simple as possible* and illustrated a scenario like *what will happen if I plant X crop in this location in year Y?* This scenario matches one of the responses to what decision do you make relating to *assessing future crop locations with clearly illustrated uncertainty*. In *training and dissemination*, one participant wrote, *disseminate your data and findings in ways that are accessible to local practitioners, the lay public, and work with local staff to set a research agenda*.

Conclusions/Implications/Recommendations

Climate scientists have developed several climate impact and adaptation models; however, their interpretation and use have been limited among technical audiences. This inquiry uncovered the lived experiences around adaptation decision support information sources and tools summarized in three main themes including *community engagement, data translations and visualization, and improving data accessibility through dissemination and training*. This inquiry also identified a lot of useful information for *adaptation tool builders*, starting with the fact that the data show the most commonly used resources for adaptation are not *apps and data*, but rather *networks of trusted people, communities of practice, and reports*. What these resources have in common is that they help people learn, build connections, bridge the trust gap, and develop a toolbox of adaptation strategies. Another body of scholarship this pattern speaks to is how extension has evolved from a top-down model where experts provided the info, to the modern day where universities and experts are but one of many resources people turn to for information, often referred to as Extension 3.0 (Lubell et al., 2014).

The findings also highlight an understanding of why people choose not to use a decision support tool, which very few studies try to look at because it is a difficult question, and the results can be uncomfortable (Cravens, 2018). The study also identified connections between the calls for better *visualization and translation* of data and models to actionable information, both of which might be able to explain by the inherent uncertainty and complexity in weather, climate, and production systems. These revelations define how adaptation decision support can be relevant and also elaborate on what researchers can do to advance adaptation efforts. These strategies can be used through designing adaptation curricula (Parker et al., 2023), decision support tools (Pathak et al., 2023), and dissemination through regional workshops to facilitate knowledge acquisition and implementation through advising farmers and ranchers.

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