
Human Dimensions of Drought in Hawai'i

An Exploratory Study of Perceptions of
and Responses to Drought Risk by
Farmers, Ranchers, and Service
Providers in Hawai'i

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Executive Summary

Background

Drought is part of the natural climate cycle and will continue to occur in Hawai'i. To prepare optimally, agricultural decision makers need to consider drought impacts on both natural and human systems. However, information about drought risk perceptions, experiences, and responses are not quantified easily. In this study we used qualitative research methods to assess the human dimensions of drought impacts among farmers, ranchers, and service providers in the agricultural sector in Hawai'i. The specific aims were to: (1) Describe mental models of drought risk, with a focus on identifying specific socio-cultural impacts; and (2) Identify links between drought mental models and planning and management activities.

Methods

Twenty-five farmers, ranchers, and service providers across the Hawaiian Islands were interviewed from May 19 through July 13, 2009. We explored understandings of drought risk and values and traditions relevant to coping with drought. We also solicited reactions to a photograph of a drought-stricken landscape in Hawai'i and a screen shot from the US Drought Monitor showing a map and numeric information about current conditions for the State. Audiorecordings of the interviews were transcribed and analyzed using qualitative theme analysis.

Findings

Participants described drought as “a natural disaster in slow motion” and defined it predominantly in terms of a cyclical lack of rainfall. Articulating the social and cultural impacts was difficult for many. Nonetheless, significant adverse impacts were reported: increased burdens of responsibility, reduced cash flows, belt-tightening, restricted educational opportunities, interpersonal conflict, loss of cultural traditions, and physical and mental health problems.

Participants tended to characterize themselves and others in terms of their time working in the agricultural sector (newer vs. older) or in terms of their approach to understanding and responding to drought (analytic vs. holistic). These distinctions were linked with variation in the nature, amount, and timing of information and resources used in drought planning and management activities.

Only a few participants (typically those with a more “analytic” approach) reported using information and resources available from sources such as the Drought Monitor. Most participants tended to collapse the five levels of drought intensity portrayed by the Drought Monitor into three main categories: (1) no drought or dry; (2) drought; (3) extreme drought.

Participants emphasized practical experience and local knowledge as key sources of information, but also highlighted the difficulty in making decisions based on experience when current conditions no longer seem to reflect the past. Participants noted that more people should be helped to develop drought plans. Qualitative information delivered in “natural” modes of expression (e.g., narratives) might complement technical information about drought conditions and help people to develop drought planning and management strategies.

Conclusion

This study demonstrates methods that can be used successfully to recruit participants for an in-depth exploration of perceptions, experiences, and responses to drought. The study suggests that members of the agricultural sector in Hawai'i need to be better prepared for drought in the coming decades. Recommendations for drought policy include: helping farmers and ranchers enhance their economic, social, and cultural wellbeing; supporting the development of tools for multi-pronged drought planning and comprehensive impacts assessment; supporting the development and delivery of finer resolution climate information; enhancing access to support services; and encouraging research on risk communication strategies.

Introduction

Background

The State of Hawai'i has suffered from drought repeatedly in recent decades. The 2009-2010 El Niño conditions resulted in more than a third of the State suffering "severe to exceptional" drought. In 2008, all Hawai'i counties were designated primary natural disaster areas due to losses caused by drought. Severe droughts occurred also in 1983-1984, 1996, and the winters of 1997-2001. Drought is part of the natural climate cycle and will continue to occur in Hawai'i. This bodes poorly for residents of and visitors to the Hawaiian Islands because limited supplies of fresh water threaten food security, livelihoods, and public health.

To prepare optimally for drought conditions, policymakers need to consider the impacts on both natural and human systems. Several studies have examined the physical and economic impacts of drought, such as soil erosion and crop or livestock loss. However, the more intangible, socio-cultural impacts on agricultural communities have received less attention. The most effective strategies for managing drought risk will be firmly rooted in the dynamic socio-cultural factors that shape local vulnerability and resilience. Thus, we need better information about how decision makers in water-sensitive sectors such as agriculture are thinking about, experiencing, and responding to drought risks.

One source of technical information for agricultural decision makers is the US Drought Monitor. A synthesis of multiple indices and impacts, the Drought Monitor detects and measures droughts via a consensus of federal and academic scientists. A rotating group of Drought Monitor authors relies on a network of more than 275 drought observers nationwide to fine-tune drought characterizations. Released weekly since 1999, the Drought Monitor shows a map summarizing drought conditions across the US. The map can be examined at the State level and is color coded to reflect 5 different intensity levels: Abnormally Dry (D0), Moderate Drought (D1), Severe Drought (D2), Extreme Drought (D3), and Exceptional Drought (D4). Also shown for each State is a numeric table reporting the percent area of drought conditions for different time periods (currently, last week, three months ago, etc). The Drought Monitor was established to help bring climatological rigor to policymakers' decisions on drought relief. Billions of dollars in drought relief funds have been distributed according to its drought designations.

While credible technical information like that provided by the Drought Monitor is crucial for robust decision making, "non-technical" information is also important. The fields of risk perception and behavioral decision research have demonstrated that risk responses are closely related to the socio-cultural landscape.¹ Sometimes, however, perceptions, socio-cultural impacts, and responses are not easily quantified, leaving policymakers poorly informed about the full range of human experiences during drought. Therefore, in this study we used qualitative research methods to assess the human dimensions of drought impacts among farmers, ranchers, and service providers in the agricultural sector in Hawai'i.

Goal and Specific Aims

The main goal of this exploratory project was to examine perceptions of and responses to drought in the agricultural sector in Hawai'i. We addressed several questions, including: How do people perceive drought risk? What socio-cultural impacts are experienced at different levels of drought? What attitudes, values, and socio-demographics influence drought planning and management activities? The specific aims were to:

1. Describe mental models of drought risk held by stakeholders in the agricultural sector, with a focus on identifying specific socio-cultural impacts.

2. Identify links between drought mental models and planning and management activities.

Method

Participants

We recruited a convenience sample of 25 diverse stakeholders involved in decision making about agricultural resources. Participants included farmers, ranchers, and service providers (e.g., agricultural extension agents) from across the Hawaiian Islands. We selected participants from areas representing a variety of drought levels. Figure 1 shows the type and location of each participant on a map of drought conditions during the last week of data collection for this study.

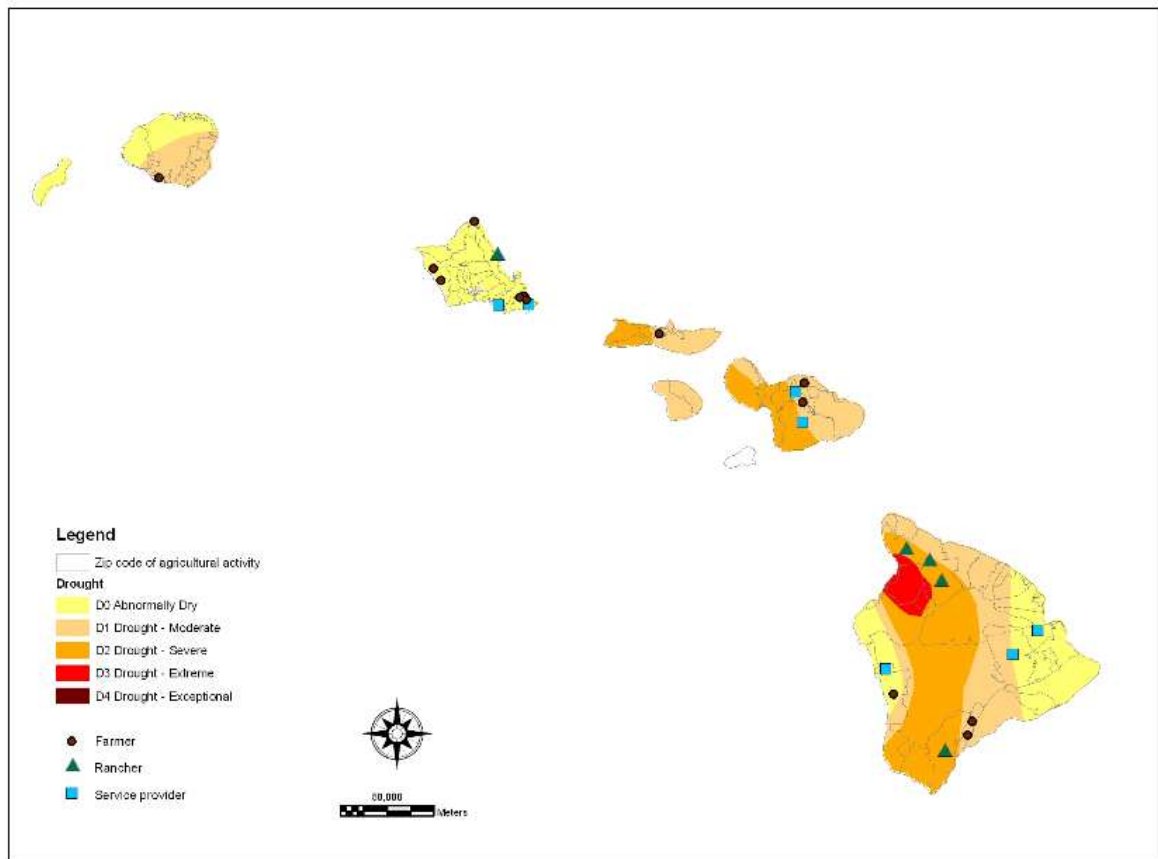


Figure 1. Type and location of each study participant (map of drought conditions in Hawai'i from the US Drought Monitor for 7/14/09, obtained with permission from the National Drought Mitigation Center).

The sample included people from a variety of farming and ranching operations (rain-fed/irrigated, various crops/livestock, small/large farms/ranches), with a range of knowledge and experience related to drought planning and management. Participant characteristics are shown in Table 1.

Table 1. Participant Characteristics

Age, y, range (mean)	40-67 (53.9)
Gender, n (%)	
Male	18 (72)
Female	7 (28)
Education, n (%)	
Some college or 2-year degree	5 (26)
4-year college graduate	9 (48)
More than 4-year college degree	5 (26)
Income, n (%)	
\$10,000 - \$49,999	4 (18)
\$50,000 - \$79,999	10 (46)
\$80,000 or more	3 (14)
Refused to answer	5 (22)
Ethnicity, n (%)	
Native Hawaiian	1 (5)
Chinese	3 (13)
Filipino	2 (9)
Japanese	4 (18)
White	10 (45)
Latino	1 (5)
Refused to answer	1 (5)
Occupation, n (%)	
Farmer	13 (52)
Rancher	5 (20)
Government Service Provider	7 (28)
Years resident in Hawai'i, y, range (mean)	9-61 (44.9)
Years in Occupation, y, range (mean)	5-50 (22.3)
Drought level at time of interview, n (%)	
None	3 (12)
D0: Abnormally Dry	10 (40)
D1: Moderate Drought	7 (28)
D2: Severe Drought	5 (20)

Note: Incomplete responses on returned surveys mean that n < 25 for age (n=18), education (19), income (22), ethnicity (22), years resident (18), and years in occupation (18).

Research Design

A qualitative research design was used to explore risk perceptions, attitudes, values, and socio-demographic variables that influence drought experiences and responses. In-depth interviews allowed participants to describe beliefs and experiences in their own words, rather than as a choice between predetermined survey responses. These methods illuminate how people conceptualize, experience, and talk about drought impacts and are useful in defining the range and variability of beliefs, behaviors, and experiences of participants.

Procedure

Participants were interviewed individually or in pairs, in person or via telephone from May 19 through July 13, 2009. After obtaining informed consent, we followed a standard interview protocol that used a “funneling” technique. We started with broad questions such as: “What is the first thought or feeling that comes to mind when you hear the word drought?” “How does drought affect you and your community?” More specific probes were asked about participants’ understanding of drought risk exposure processes, moderators, and impacts, and values and traditions relevant to coping with drought. We asked about social and cultural impacts of drought and how drought compared with other societal risks. We also solicited reactions to a printed photograph depicting a drought-stricken landscape in Hawai‘i and a screen shot from the Drought Monitor showing information about current conditions for the State of Hawai‘i. We asked participants to explain what information was being provided in the screen shot and to describe impacts they might experience at each level of drought. Participants were asked to describe their actions at each drought level and the likely effectiveness and acceptability of each action.

All but one of the interviews were audiorecorded (one participant declined). Twenty-three interviews were transcribed verbatim using standardized transcription protocols; one recording could not be transcribed as the audiofile was lost due to clerical error. All participants were asked to complete a short (4-page) questionnaire designed to collect background information (e.g., age, education, income, ethnicity). Twenty-two participants returned completed surveys.

Qualitative theme analysis was used to distinguish salient constructs and issues and to identify words or phrases commonly used to describe attitudes and experiences. All transcripts were read by the two authors. Core themes that repeatedly appeared in the data were identified by the first author and confirmed by the second author. Consensus on common and differentiating themes was achieved via discussion.

Findings

Aim 1: Describe mental models of drought risk

Characterizations of Drought. Participants varied in their definitions of drought, but all focused on the lack or timing of rainfall (compared with “normal” conditions). No participant referred to other indices of drought such as soil moisture or streamflow. Most participants identified drought as cyclical. Most indicated that they were uncertain how future drought patterns would be affected by a changing climate; others indicated that conditions would become drier or that there would be more extremes (drier and wetter). No participant felt that humans could control drought, though several mentioned ways to address the impacts of water scarcity (e.g., improve irrigation, limit development). The availability of water was considered key to farming and ranching activities. One farmer, pointing to the water irrigating his banana trees said: “That there is gold.” Another farmer (kalo) said “Water is gold. *Wai ola*, the source of life.”

Drought was described often as “a natural disaster... in slow motion.” Participants contrasted

the hard-to-pinpoint beginning of a drought with the quick strike of a hurricane or flood. They also noted that drought seemed more predictable and could extend for a long time, whereas hurricanes and floods tended to be less predictable and quicker events. There was little consensus among participants about the severity of drought compared with other environmental risks. Some suggested that drought was more serious because its impacts occurred over a long period. Others suggested that the long timeline provided a chance to react and protect themselves. When compared with social risks, nearly all participants said they were more concerned with crime, health, or financial issues than with drought.

Characterizations of Stakeholders. Participants tended to characterize themselves and others in terms of their time working in the agricultural sector. A “newer” versus “older” distinction emerged. Newer farmers and ranchers were perceived as having started their agricultural activities within the last decade, often as a second career or simultaneously with their (unrelated) current career (e.g., as a computer scientist). Newer farmers and ranchers were perceived as being more likely to intervene when a drought occurred (e.g., to set up a new irrigation system) and as having more resources to support such intervention. In contrast, older farmers and ranchers reflected families who have been in the industry for generations, were less likely to want to intervene, and to have less resources to intervene. They were perceived as having a better understanding of nature and their crops or livestock and being “more in touch with the cycles.”

A second characterization distinguished participants in terms of their “analytic” versus “holistic” conceptualizations of drought impacts and responses. Participants who were more analytic tended to focus on empirical data (e.g., rainfall levels, economic costs) and to adopt more formulaic approaches to preparing for and managing drought (e.g., “at 50% of normal rainfall, I will cull X% of my herd”). This contrasted with descriptions of more intuitive approaches: “As soon as I start worrying I just harvest it. And I don’t have to worry anymore.” More holistic participants emphasized the interconnectedness of the natural and human systems, discussing the impact of dry conditions on multiple species and the need for management strategies that addressed several components of the system simultaneously. For instance, one kalo farmer said:

“You’re very directly related to nature, you know... a lot of times water comes in and water goes back into the stream. So it’s a continuously open ecological system.”

Similarly, a tree farmer noted:

“A system that’s healthy, it looks harmonious. You can see that things are not overrunning one another. But when you see a system that’s not harmonious, you see that something is out of control.”

Participants emphasized that farmers and ranchers want to be seen as self-sufficient and independent. They often expressed an intrinsic value to farming and ranching. That is, working in the agricultural sector is considered more than a way of generating an income. For farming and ranching families, their operations are often where people live, raise their children, have their memories, improve the land, and care for and raise their crops and livestock. One participant noted:

“One rancher—he recently passed away—he said, you know, it’s a business of love, you know, cattle ranching. It’s not a business you’re going to make money out of, especially (when) you’re at the mercy of the elements, yeah.”

Characterization of socio-cultural impacts. Participants had great difficulty articulating socio-cultural impacts of drought. Typically, illustrative examples from the interviewer were needed to initiate discussion (e.g., “Some people have mentioned that they become more stressed during drought. Has drought impacted you like this?”).

The main impact reported by nearly all participants (prompted or not) focused on community and individual stress. One participant commented on the “creeping” nature of stress that people adjust to until they reach a “crisis situation”:

“(They) keep adjusting to decreased... quality, in terms of their life or their environment. But when it gets to be a crisis situation, then people get anxious and depressed, or do things that are maybe inappropriate, out of anxiety. There becomes more... theft, stealing, and hoarding—not being as generous. When there’s a lot—when there’s an abundance of rainfall and food—there’s more generosity. And people become more anxious when there’s drought situations.”

Financial concerns seemed to be the main stressor. As one participant said, “Drought lowers your ability to support yourself. It’s very stressful.” Participants often commented that they needed to “tighten their belts” by cutting out unnecessary spending (e.g., dining out, recreation). They noted the hardship was absorbed by the whole family, including children who might be denied educational or extracurricular opportunities available in non-drought periods. Participants highlighted the trend towards farmers and ranchers abandoning agriculture, suggesting it was motivated in part by the hardships of drought: “Some just quit because it’s a pennies business.”

Another source of stress related to the physical demands of drought management strategies. Greatest difficulty was experienced by people on farms or ranches that are not irrigated and not connected to the county water supply. Participants reported that several drought-response activities (e.g., hauling water, providing food for livestock, and culling) were time consuming and labor intensive. An increase in interpersonal conflict was noted also, for instance due to disagreement over who has the right to use diminishing water resources.

In addition to feeling stressed or anxious, participants reported feeling at times helpless, fearful, and angry. Some also reported feeling isolated and becoming reclusive because they perceive people outside of agricultural communities (e.g., in cities like Honolulu) don’t understand the need to conserve water during drought. As one participant noted: “A large part of the community is somewhat removed from... the real effects of drought.” Others, however, believed that some communities were actively working together to support farms. One participant pointed to a cultural reluctance to talk about drought because talking about it might make it more likely to happen:

“...that’s why you have that kind of attitude of let’s not think about it and it won’t come. There’s that saying, ‘if say yes, yes, yes, yes, it’s going to be yes. If you say no, no, no, no, it’s going to be no.’ But you say drought, drought, drought, drought, then it’s probably going to happen.”

Several participants highlighted the challenge drought poses to maintaining cultural traditions. For instance, one kalo farmer referred to kalo as “economically prohibitive to develop” but continued on to describe its importance culturally:

“... these streams... have once been and still can be the main source of a community... They do it primarily to maintain the culture, not to make money... they get such great cultural satisfaction in trying to perpetuate a culture that, you know, that they have so much appreciation for, and it’s so tied directly with the land. They do it because they get a great deal of satisfaction, and to eat freshly-pound poi is like a delicacy... it’s nothing like what you can buy in the store.”

In contrast, other participants voiced concern that current water laws and policies protect water for domestic, environmental, and cultural uses over agriculture. One participant emphasized the need for “a level playing field” where the public decide what activities should be prioritized in the face of drought.

Aim 2: Identify links between drought mental models and planning and management activities

Many participants indicated that they do not have a drought plan, despite believing that a plan would be effective in mitigating the impacts of drought. A drought plan was also believed appropriate given the cyclical nature of drought and the potential for mitigating environmental and economic impacts. Some participants indicated that the unclear onset and uncertain duration or intensity of a drought made it difficult to respond to drought as it was unfolding, highlighting the need for advanced planning.

Regardless of whether farmers and ranchers considered themselves “newer,” “older,” “analytic,” or “holistic,” practical experience was considered the main source of information used to deal with drought. Similarly, knowledge of the land, crops, animals, and farming and ranching practices that has been handed down through generations was considered key in shaping approaches to drought-response strategies. One participant, however, highlighted the difficulty in making decisions based on past experience when current environmental conditions no longer seem to reflect the past:

“...it’s been very confusing in the last several years because almost nothing has really been the same... they refer to ‘before, you know, it wasn’t like this.’ That’s a real common comment. And now, nothing is really—you can’t really predict the season... I think that things have changed—are changing—quicker than a person can intuitively put together their interpretation of what is happening and why. And so it becomes more difficult to kind of understand, or to have a feeling of what to expect.”

Some participants talked about the value of the Native Hawaiian watershed management approach, *ahupua’a*, which recognizes that water flows from the mountains to the sea and everything in between relies on that flow. Participants also highlighted that drought management strategies can be found in Native Hawaiian chants, for instance, that refer to observations of the *limu* (seaweed):

“When a certain kind of *limu* begins to appear it’s a solid sign of a drought because (it reflects) the changing water temperatures of the ocean. And so (when) these different kinds of *limu* began appearing they said, ‘Now is the time to start getting your fields ready for sweet potato.’ And you know these were observations of a great amount because sweet potato can stand a drought.”

Only a few participants (typically those with a more “analytic” approach) reported using information and resources available from sources such as the Drought Monitor. Most participants indicated that they had not seen the Drought Monitor before. When given a few minutes to study the screen shot of information provided for the State of Hawai’i, most participants suggested that it provided a good overview of conditions. However, many commented that its applicability to their drought management activities was limited. Their main reason for not using the Drought Monitor was that the complex topography of Hawai’i meant that to be useful at the farm or ranch level, information needed to be provided at a finer resolution. Some participants were surprised to learn from the map that their area was considered to be at a higher level of drought than they thought to be the case.

When participants were asked what specific actions they took to prepare for and manage drought, most did not differentiate actions for each level of the five levels of the Drought Monitor. Rather, comments revealed that participants tended to collapse two or more levels, resulting in perceptions of only three main drought intensities guiding actions: (1) no drought or dry; (2) drought; (3) extreme drought. An intensity of D0 or less was considered “no drought or dry” and required no action. Intensities of D1 (moderate) and D2 (severe) were considered as being in “drought” and required a range of actions to save crops and animals or to minimize

losses. Finally, D3 (extreme) and D4 (exceptional) were considered as “extreme drought” for which little could be done.

Some participants noted that farmers and ranchers in Hawai'i seem to have become better prepared for drought over time. Reasons given included awareness about the need for a drought plan due to government education programs and more proactive networking among agencies and communities. Despite the trend towards being better prepared, participants indicated that **additional efforts should be made to help more people to develop drought plans.** Some noted the resources (government or private) made available to support agricultural communities were inadequate and that this had changed little over time.

Participants suggested that those who were well prepared for drought were less likely to feel anxiety or stress. Two participants commented that stress was highest prior to implementing a drought plan, but that once a plan was in place they felt more relaxed, in part because there was nothing more they could do. Another participant emphasized the importance of partnerships that facilitate dialogue (among federal and state agencies and local communities) about how to manage drought effectively. Disaster relief from the government was either strongly supported or a source of dissatisfaction, depending on participants' eligibility and perception of the complexity and relevance of the process for determining eligibility.

Discussion

Drought is perceived as a simple yet difficult-to-respond-to risk faced by decision makers in the agricultural sector in the State of Hawai'i. Drought is viewed as a natural disaster in slow motion and defined predominantly in terms of a cyclical lack of rainfall. Consistent with previous research,² drought is perceived as risky because of its uncontrollability and potentially catastrophic consequences. The often intangible nature of the social and cultural impacts on agricultural communities make drought risk hard to fully capture for many. Nonetheless, drought clearly has adverse impacts. Increased burdens of responsibility, reduced cash flows, belt-tightening, restricted educational opportunities, interpersonal conflict, and loss of cultural traditions are a cause great stress for farmers, ranchers, and their families. Physical and mental health impacts can be severe. In general, the socio-cultural impacts of drought are difficult to separate from longer-term demographic trends that are contributing to the decline of some rural populations. However, the burden of drought seems to motivate farmers and ranchers to think about abandoning agriculture in favor of more lucrative and secure professions.

During drought, agricultural decisions are made under stress and oftentimes in the absence of planning. Given the cyclical nature of drought (and presumably the production and income fluctuations associated with it), it seems surprising that more people are not better prepared. The most resilient farmers and ranchers seem to be those who plan well for drought conditions and/or have non-agricultural sources of income.

Since drought is part of the natural climate cycle and will continue to occur in the Hawaiian Islands, agricultural families and communities who do not have a drought plan need to be better prepared. How the changing climate will affect drought intensity and severity in Hawaii is uncertain, but rainfall patterns are expected to change.³ Government agencies and other organizations need to help members of the agricultural sector to understand climate patterns and manage their impacts (tangible and intangible) better. A key component of this effort should emphasize how sound preparation will support farmers' and ranchers' self-sufficiency and independence and the intrinsic value of agricultural activities.

Consistent with recent research on human decisions under conditions of uncertainty,⁴ diverse approaches to decision making were evident among members of the agricultural sector. Distinguishing newer versus older farmers and ranchers helps to pinpoint variation in the

nature, amount, and timing of resources being used in drought management activities. Similarly, an analytic versus holistic distinction highlights the type of information decision makers seek and how they use that information in their decision processes. One implication of these different approaches is that strategies for communicating about drought risk may need to be tailored to different stakeholders. For instance, people who viewed themselves as more analytic seemed to be more likely than others to use a resource such as the Drought Monitor and thus be more receptive to additional information provided in this format or to technical training that enhances their usage of this tool. Given the common emphasis across stakeholders on practical experience and knowledge as a key source of information, more “natural” modes of expression (e.g., narratives) might provide a complementary approach to conveying the nature of drought and the applicability of alternative planning and management strategies in the Hawaiian Islands. Providing more qualitative information would also be more compatible with the local emphasis on “talk story” as an informal way of sharing (via storytelling, chants, myths, etc.) historical information, current experiences, values, and traditions.

Users of the Drought Monitor may benefit from more education about how the five levels of drought intensity are calculated and the restrictions that current data collection sites place on the optimal resolution of maps. Moreover, serious consideration should be given to whether the five intensity levels are compatible with the simpler mental models (no drought or dry/ drought/ extreme drought) typically held by lay people.

Limitations

Two main limitations of this study should be noted. First, the sample was drawn from people willing and able to participate in a one-hour interview conducted in English and may not represent the general population of farmers, ranchers, and service providers in the State of Hawai‘i in terms of ethnicity, immigration history, or other socio-demographic variables. The consistency of the findings from this study with those reported elsewhere,⁵ however, encourages confidence that many of the observations will be relevant in other settings.

Another limitation concerns the small sample size of this study. It is possible that additional information would have been obtained through more focus groups and interviews with a broader sample of individuals. Within this sample, however, we believe the questions posed were thoroughly addressed because little new information was obtained in the final interviews. This phenomenon is called saturation in qualitative research and indicates that a topic has been adequately sampled (i.e., enough interviews conducted or enough text analyzed).

Specific Recommendations

Based on the findings of this study, recommendations for policymakers working on drought planning and management in the agricultural sector in Hawai‘i include:

1. Review government drought policy to improve existing or to develop new initiatives to enhance the economic, social, and cultural wellbeing of agricultural families and communities in advance of and during drought.
2. Develop drought planning tools that help farmers and ranchers focus not only on business and natural resource management issues, but to plan also for sustainable approaches to personal and family wellbeing.
3. Develop and implement tools to help people identify and articulate more precisely the social and cultural impacts of drought so that agricultural policymakers and decision

makers have a full understanding of local vulnerability and resilience when they make decisions about when and how to mitigate and respond to drought impacts.

4. Provide up-to-date information and tools to assist farmers, ranchers, and their communities to manage changing circumstances (e.g., finer resolution climate projections are needed to provide decision makers with increased surety in their annual planning processes).
5. Identify strategies for encouraging farming and ranching families to properly assess and access health-care and other support services. Existing services might be made more responsive to drought-affected communities via incentives to help rural people become more aware of their physical and mental health needs and via mechanisms that reduce barriers (e.g., affordability). Such services should be provided in a way that supports self-reliance and independence.
6. Conduct research that examines how best to interpret climate science and communicate it effectively to agricultural decision makers choosing among alternative approaches to drought planning and management.
7. Conduct research that examines whether the findings of this study generalize to individuals from more diverse types of agricultural operations and expertise, geographic or topographic settings, drought experiences, and expertise, and socio-demographic contexts across the Hawaiian Islands.

Conclusion

Perceptions of drought risk and its socio-cultural impacts on agricultural decision makers in Hawai'i are poorly documented. This study demonstrates methods that can be used successfully to recruit participants for an in-depth exploration of perceptions, experiences, and responses to drought. The findings of this study suggest how the agricultural sector can be better prepared for the increased risk of severe drought across the Hawaiian Islands in coming decades. The findings suggest that drought policy needs to: help members of the agricultural sector enhance their economic, social, and cultural wellbeing; support the development of tools for multi-pronged drought planning and comprehensive impacts assessment; support the development and delivery of climate information; enhance access to support services; and encourage research aimed at facilitating risk communication.

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