Instrumental readings alone don't tell the whole story of drought on Hopi lands. Existing resource management and technical staff can use local observations to plan for mitigation tailored to a region's specific needs

How to help a community develop a drought impacts reporting system

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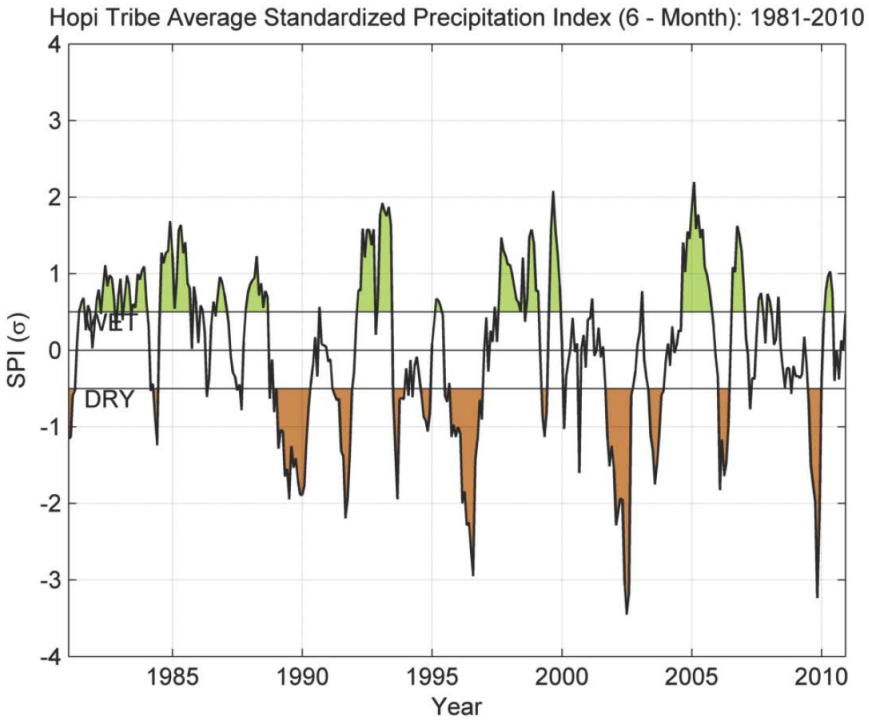
Drought is, of course, a shortage of precipitation, but shortage for whom and by how much? Arguably, those who experience its impacts best define drought.

Monitoring for drought, one might then assume, would rely heavily on observations of the impacts of drought. In fact, standard drought monitoring relies primarily on measurements of precipitation and streamflow to determine drought status in a particular region. Most experts in drought monitoring, planning, and response recognize the need for a greater focus on monitoring drought impacts, but such information remains a relatively small portion of drought status assessments due to the complex nature of the impacts and the difficulty in ascribing a particular impact directly to drought – particularly if the observer is not specifically trained in resource management or monitoring.

Our recent work with the Hopi Tribe's Department of Natural Resources (HDNR) has helped convince us that, depending on the circumstances of a particular community, impact observations can be at least as important as hydroclimatic data in determining drought status and selecting appropriate responses.



ABOVE: Drought index for Hopi Tribe showing increasing frequency of deep drought episodes over the past thirty years (brown areas indicate short-term drought conditions). This figure was created using average monthly precipitation data extracted from PRISM climate database; http://www.prism.oregonstate.edu/).

'We're not going anywhere so we have to take care of what we have'

The Hopi people have lived in the Four Corners region of the Southwest for at least 1000 years, with some notable periods of absence during previous severe droughts.

The region has been experiencing frequent deep drought events over the past several decades with interludes of average or even wet conditions. This pattern of climate variability has produced acute short-term impacts (e.g., poor forage for livestock) and longer-term impacts to water resources (e.g., drying of near-surface springs) across the region. Persistent drought conditions harm Hopi livelihoods by diminishing crop production from traditional farming, impairing culturally significant wild plants, and stressing livestock, which can drive ranchers to reduce herd size.

Tribal resource managers offer this message: the region is their home, they have neither intention or ability to move away, and they must, therefore, make the best possible management decisions to maintain the land and Hopi livelihoods. As one manager told us, "We're not going anywhere, so we need to take care of what we have."

Over the last three years we have been working with the HDNR to develop a drought status-monitoring program based largely on environmental indicators relevant to the region. In this case, impacts monitoring is a better choice than hydroclimatic data because it allows the community to work around the limited availability of long-term and readily available climate data in the region, characterize drought status according to local needs and for local decisions, and create a program that fits the current technological and resource capacities of the community.

The following summarizes our process and some of the lessons we learned. We present it here in hopes of inspiring others to consider the role of locally relevant and consistently collected impacts data in drought monitoring and status assessment.

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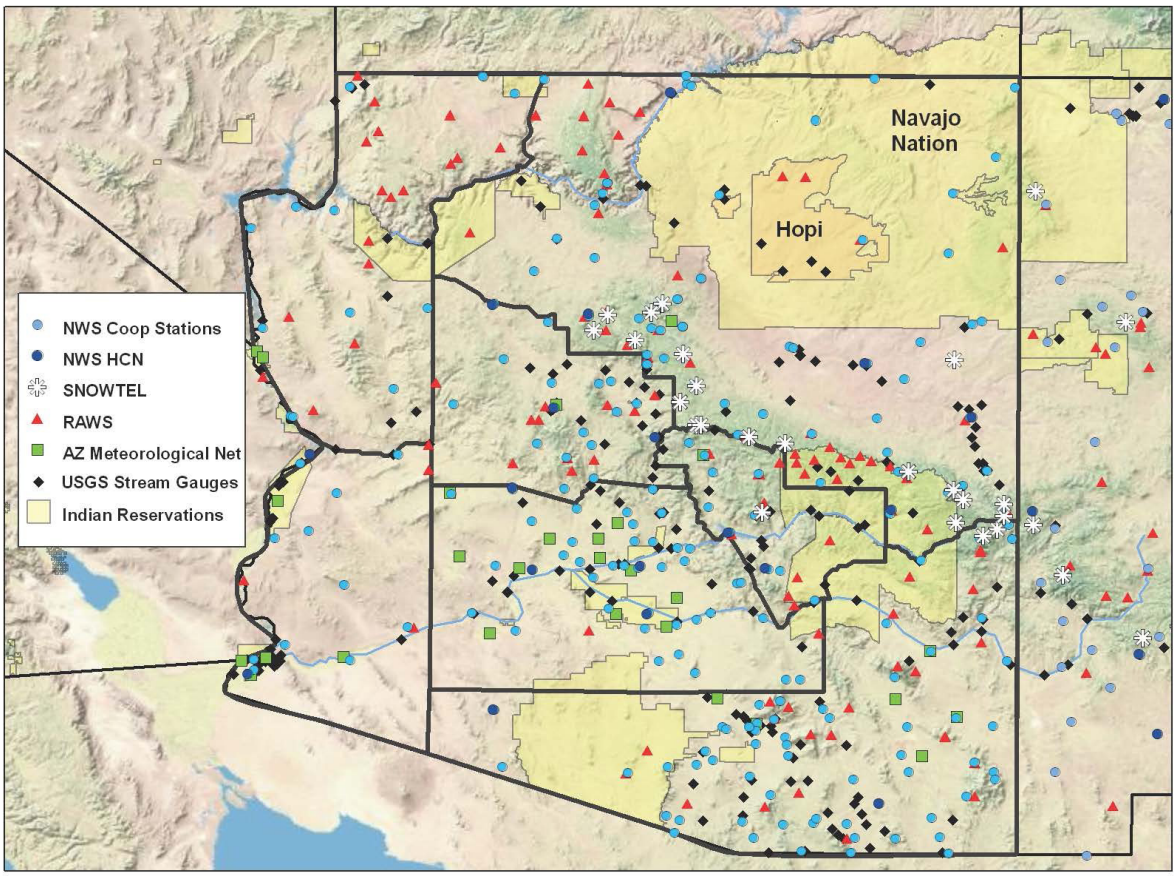

This map of weather and streamflow instruments across Arizona highlights the relative dearth of instrumental data available for tribal lands (indicated by yellow shading). Map by Zack Guido, Climate Assessment for the Southwest, University of Arizona.

Particular challenges on tribal land

As a complex natural hazard, drought affects different people and communities in vastly different ways that are not always captured by hydroclimatic data. Sparse rains may lead to immediate drought impacts in one community without water storage capacity and have little or no impact on another community with ample water storage.

Many Hopi people are dryland farmers and ranchers who rely on seasonal rains to support their crops and livestock. Here, the timing and form of precipitation matters as much as the amount. A heavy rain that simply runs off parched soils is of little value to ecosystems desperate for soil moisture, while a gentler storm may allow moisture to sink into the soil for greater benefit.

The sensitivity of the Hopi people to drought conditions has been especially acute in recent years. In 2009, the HDNR approached researchers at The University of Arizona with a problem. Tribal resource managers knew that drought conditions were severe, yet did not see their perception of conditions reflected in national drought monitoring products. Because drought monitoring is primarily focused on instrumental data, the fundamental problem for places like the Four Corners is a lack of reliable, long-term weather stations to generate that data. The lack of data in turn hindered the HDNR's ability to declare and retract drought warnings, take appropriate mitigation steps, or engage in public education about drought status and opportunities for drought aid.

While the lack of formal precipitation and temperature monitoring on reservation lands is a problem, this is a longer-term issue of funding for basic monitoring without an immediate solution. In partnership with the HDNR we have devised what we hope will provide a more immediate solution: utilize the existing resource management and technical staff within HDNR to develop a stream of monitoring information based on impact observations. By developing a local drought impacts monitoring program, the HDNR can tailor drought indicators to their own decision needs as well as their existing capacity for data management.

Steps in the project process

■ Identify community's needs

Together with the HDNR, we first assessed their observations, concerns, wishes, and capacity related to drought monitoring. Using a focus group of resource managers, we examined a seasonal calendar and identified the times during the year when precipitation is most important to Hopi livelihood. Managers also discussed whether they had perceived any changes in precipitation patterns in recent memory. Other topics included pressing concerns about the potential for loss of traditional farming methods and crops; the requirement to reduce herd sizes distressing households with little other income; and the loss of culturally important plants that suffer under drought conditions.

■ Identify community goals

Our next step was to determine the purpose of

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FIRST QUARTERLY DROUGHT STATUS REPORT DEBUTS

The Hopi Department of Natural Resources and a team from the University of Arizona's Climate Assessment for the Southwest program worked together to produce the first Hopi Quarterly Drought Status report in April 2014.

The report is the first product resulting from the work described in the accompanying article.

a Hopi drought monitoring system. Currently Hopi drought monitoring is used internally to guide tribal planning and mitigation activities such as providing financial support for ranchers who need to haul water for their livestock, to determine whether livestock reductions are necessary, and to inform the general public and elected officials about the state of the community's land and resources.

■ **Identify key impacts for that community**

To guide the development of a monitoring program, we attempted to determine impacts that were most detrimental to the community. The concerns about drought consistently raised by HDNR staff included poor forage for livestock, insufficient water for livestock (in springs or impoundments), and not enough precipitation (or at the wrong time) for the dryland agriculture.

■ **Identify community assets**

An important consideration in designing a monitoring program was that it fit the capabilities and resources available in HDNR. As with many resource agencies at all levels of government, the HDNR is financially strapped and lacks the technology to manage a data-intensive program. The HDNR is fortunate, though, to have technicians who are intimately familiar with the landscape and are regularly surveying the land as part of the tribe's resource management and grants reporting responsibilities. Because these technicians were out on the land, collecting ecological status information regularly, and were familiar with the landscape, we determined that implementing a drought impact monitoring program would essentially mean just tweaking the system already in place to incorporate a focus on drought impacts.

■ **Identify gaps in best practices.**

Our next step was to engage with the resource technicians and their managers to determine what kind of monitoring they were doing already, how they were recording the information, and how that information was managed and used within HDNR.

Through this process we learned that different parts of HDNR were charged with monitoring different resources, collected data in different ways, and had differing levels of expertise. By examining the data collection forms for each branch of DNR, interviewing technicians from each branch, and going out in the field with technicians, we were able to compile a list of resources that are regularly monitored, those that are not, and how that data is used. For example, springs are checked and flow-rates measured monthly, but water levels in earthen dams, which provide water for livestock, were not systematically assessed on the same schedule.

Based on these insights, we are currently in the process of developing a short drought monitoring protocol for HDNR resource technicians. Not all technicians will answer every question (for example, water resources technicians are not expected to contribute rangeland status observations), but the format is the same for all technicians, meaning that the data can be assimilated in one main database by the HDNR. Our recommended drought impacts monitoring protocol for Hopi DNR will draw on their concerns, is based on existing monitoring practices, and fits the resources available within the HDNR.

■ **Consider data management issues**

A key lesson for our team was the need to carefully assess the data management and technological capacities of our partners. In the case of HDNR, both are limited due to funding and the relative isolation of the community (which limits internet bandwidth and cellular connections).

While there are many technological tools that could be applied to monitoring drought conditions in an area with few weather stations—such as remote sensing technology—those were not an effective solution because they could not be easily integrated into existing technological or data management frameworks. By keeping the impacts monitoring list as short as possible (and to still remain useful for decision makers), we hope to allow the HDNR to quickly integrate this data into their management structures.

■ **Provide training to reporters**

In addition to the drought impacts monitoring protocols, we are developing a training module for the technicians who will be collecting the data. Although most are familiar with other ecological monitoring practices, our assessments demonstrated the need to provide some additional background on the importance of consistency in monitoring for drought.

We will use a scenario-based approach to training in which the technicians are presented with a range of realistic situations so that we can all come to better understand how drought impacts data could be used to support resource management decisions.

We will test the use of these protocols by accompanying resources technicians to the field to see how they work on-the-ground. We will also work with the data managers to see how information coming from the technicians is being uploaded to the drought database as well as what kinds of reports can and are generated based on the impacts data.

Once the monitoring protocols have been implemented in the Hopi DNR, we will periodically return to evaluate how well they are being followed, whether more protocols have been added to the program, and how drought impacts data are being used in decision making.

This collaborative project has provided us with ample opportunities to explore the importance and practicality of monitoring drought through systematic collection of impacts data. We are at a relatively early stage in this experiment. We hope the new monitoring protocols will prove useful to and useable by the Hopi Department of Natural Resources and will strengthen their drought planning and response program. We also hope this work will provide lessons for other communities struggling to better characterize and track drought in their region.