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Ranch-Scale Drought Monitoring Tools for Arizona

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Introduction

Drought can impact ranching operations in numerous ways from directly reducing seasonally available water and forage to increasing wildfire risk and causing long-term impacts to rangelands. Monitoring weather and climate across a ranch can be a useful management tool when coupled with a detailed drought mitigation plan to anticipate impacts and trigger adaptive management decisions such as changing your grazing rotation schedule or in extreme circumstances, culling decisions (Tolleson 2016). Assessing drought conditions in the southwest U.S. is challenging because there are few long-term climate monitoring stations, especially in rural and remote areas, and monsoon rains can be very localized.

A collaboration between extension faculty, rangeland scientists, climatologists, ranchers, and the US Forest Service in central Arizona developed a set of tools and guides with the goals of improving planning and management decisions before, during, and after drought. These resources, all detailed in the University of Arizona Drought and Grazing website (https://cals.arizona.edu/droughtandgrazing/) include several tools aimed at tracking drought conditions using a combination of gridded estimates of climate (see Weiss and Crimmins 2016 for more information on how gridded climate datasets are developed) and rain gauges strategically installed at monitoring sites . Guidance on how to construct, read and utilize rain gauges at key areas are available in Crimmins et al. 2017a and 2017b.

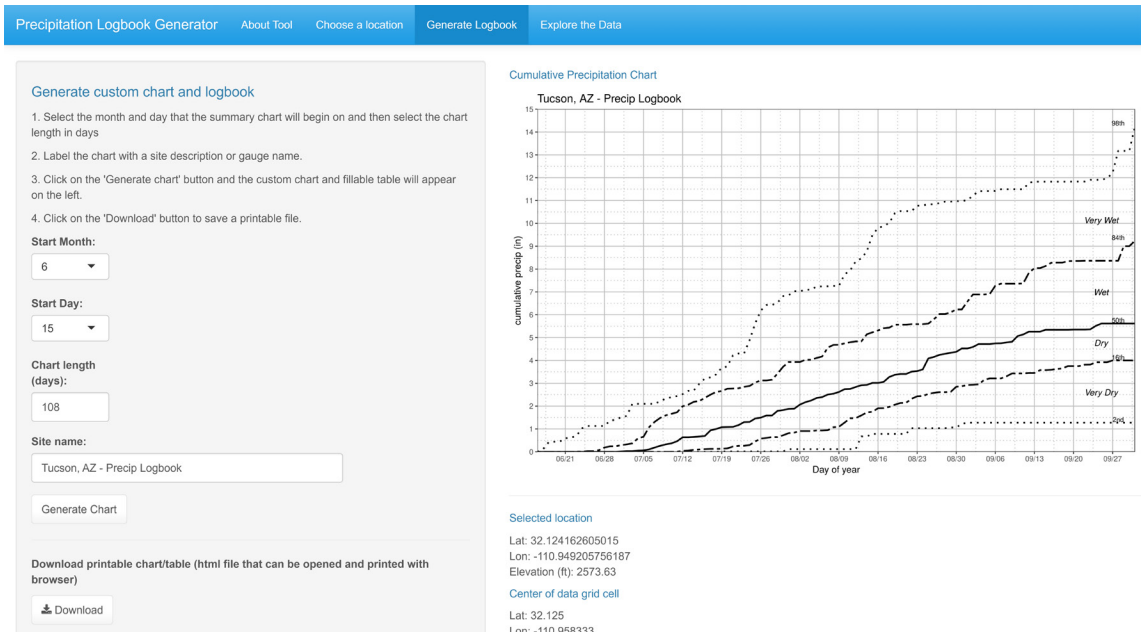

Figure 1. Example cumulative precipitation chart from Precipitation Logbook Generator (https://uaclimateextension.shinyapps.io/precipChart/)

Tools to support precipitation monitoring

Precipitation Logbook Generator:

The Precipitation Logbook Generator was developed to generate supporting reference climate information to be used with simple accumulation gauges, often deployed in remote locations. These types of gauges are often read infrequently and at irregular intervals with total precipitation measurements accumulating over varying lengths of time. These measurements are difficult to interpret with respect to expected amounts, because of this irregularity. This tool generates a reference chart (Figure 1) and table for a gauge location by leveraging a spatially continuous, gridded, long-term dataset of daily precipitation estimates (PRISM) for all locations in the continental United States. Daily PRISM spatial climate data are based on interpolating station data across the U.S. to 4 kilometer grid and are updated each day (https://www.prism.oregonstate.edu/, Daly et al. 2021). The chart and table indicate 'normal' and extreme wet and dry cumulative precipitation amounts for a specified season based on historical estimates for the gauge location. When an observation is made in the field, the entry for that date can be compared to the typical and extreme historical values to provide context and inform management decisions. This tool can be especially helpful when setting up a new gauge without a long-term record. A new chart can be printed and can serve as a logbook for each year and each gauge. https://uaclimateextension.shinyapps.io/precipChart/

myRAINge Log:

myRAINgeLog is an online data management and visualization tool specifically designed for ranchers and land managers who collect and interpret cumulative precipitation observations (Figure 2) at remote sites. The account-based tool allows users to collect, manage and analyze multiple gauges and share observations through a public mapping feature. Custom reports can be generated for each gauge with accompanying figures of observations against historical climate conditions (based on daily PRISM precipitation data) and summaries of field notes and photos entered by the user. The web application also works offline on smartphones and can be used to record data in remote locations. The application will synchronize data with your account when cell service is restored. PRISM-based estimates of local precipitation are updated daily. https://myraingelog.arizona.edu/

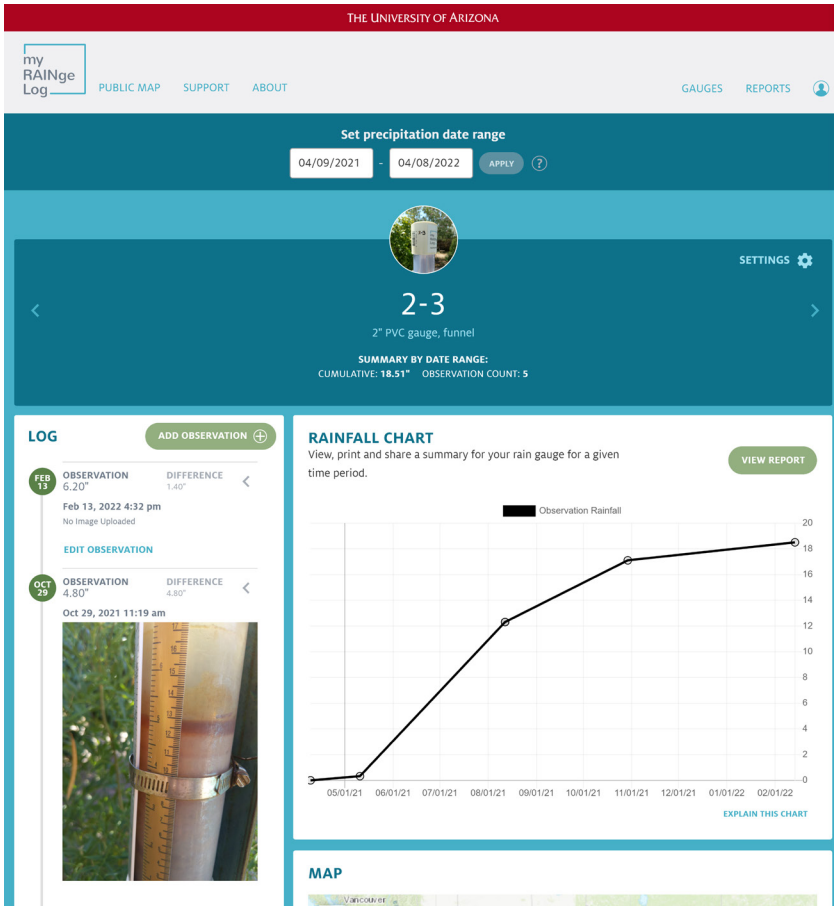

Figure 2. Example gauge chart page from myRAINge Log (https://myraingelog.arizona.edu/)

Exploring local drought conditions

Collecting and systematically recording precipitation data throughout a ranch (not just at HQ) can help interpret monitoring data, inform management decisions, and can detect when and where drought conditions are developing on a ranch. Having rain gauges collecting information at key areas is the best way to know if drought conditions are developing across your ranch, but other datasets and tools can help you estimate local precipitation amounts. Several gridded climate datasets exist in the U.S. (like PRISM) to estimate precipitation based on statistical relationships between nearby weather stations and topography. These datasets are updated at daily and monthly timescales and can provide estimates of local drought index values based on long-term records. A drought monitoring dashboard for Arizona on the Drought and Grazing website displays several drought index maps constructed using these data, but we developed a tool that allows you to dig deeper on local drought conditions.

Standardized Precipitation Index (SPI) Explorer Tool:

The Standardized Precipitation Index (SPI) is a widely used drought index that has several strengths (McKee et al. 1995). These include the ability to provide precipitation anomalies at different timescales and the ability to interpret SPI units (standard deviations, how frequently values occur in a historical record) in terms of frequency of occurrence (e.g. how often have current drought conditions occurred in the past 100 years?). This tool allows users to explore SPI values (see Figure 3; and also Standardized Precipitation Evapotranspiration Index, SPEI – includes impact of temperature, Vicente-Serrano et al. 2010) and other historic climate data at specific locations by accessing, analyzing and plotting gridded climate data (PRISM Climate). https://uaclimateextension.shinyapps.io/SPItool/

Together, these tools can help guide you towards systematically collecting, recording, and monitoring precipitation data to track and respond to drought

Figure 3. Example SPI timescale comparison plots from the Standardized Precipitation Index Explorer Tool (https://uaclimateextension.shinyapps.io/SPItool/)

conditions as they develop throughout your ranch. Additional resources including more information on each of these tools are available on the Drought and Grazing website (https://cals.arizona.edu/droughtandgrazing/). These resources will help you think through developing drought mitigation and management plans custom to your operation and how and when to use these drought indices to trigger different management decisions. Droughts are inevitable in the southwest U.S. and proper planning and monitoring can help you weather these events.

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This is a summarization bulletin for the soon to be updated Rancher's Management Guide and additional details for each tool can be found in related articles and associated references.

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