
RUSSIAN RIVER
WATERSHED
AND DROUGHT

The Recent Drought in
the Russian River Watershed

The Russian River recently experienced the worst 12 month drought (Feb. 2013 – Jan. 2014) in the middle of the worst 3-year drought (Feb. 2012 – Jan. 2015) in the historical record (Figure 1). During this 3-year dry period precipitation was 58% below average and was exacerbated by high temperatures[1] which caused enhanced drying. Other notable droughts include the 1976-1977 drought and several years during the 1920s. Drought indicators, which help to characterize historical and potentially future droughts in the Russian River watershed, include precipitation, temperature, reservoir levels, climatic water deficit (the thirst of the land), stream flow, and the water available to recharge the water table[1].

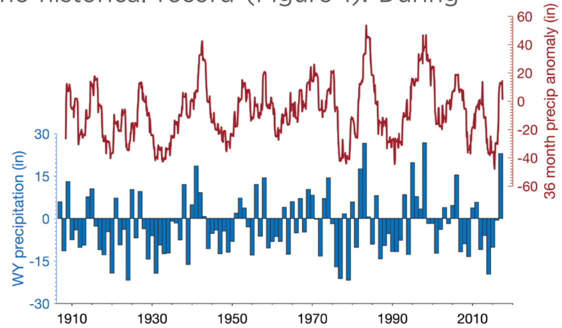

Figure 1. A historic record of precipitation in the Russian River watershed based on stations in Santa Rosa and Ukiah. The blue bars are the deviation from the mean and the maroon line is a 36 month running average of precipitation.

Impacts of the 2012-2015 Drought

- In January 2014, Lake Mendocino was at 40% of target storage and Lake Sonoma was at 82% of average storage (Figure 2).
- To maintain reservoir levels, reservoir releases and stream flows were reduced to some of the lowest levels since flow regulations began.
- Many water supply agencies reported lost revenue; some had to increase water rates to cover fixed costs.
- Mendocino County livestock, range, pasture and hay producers reported more than a 54% revenue loss and wine grapes reported a $14.7 million loss[2,3].
- More tributaries went dry by the end of summer contributing to reduced salmon abundance[4].

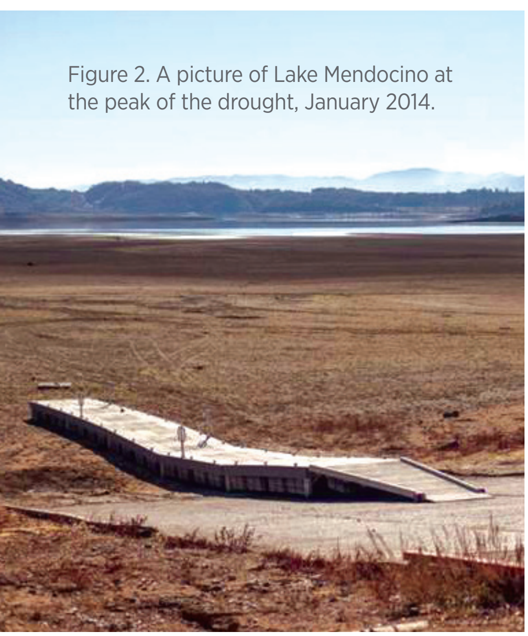

Figure 2. A picture of Lake Mendocino at the peak of the drought, January 2014.

The end to drought varied throughout the region. Although 2016 received 107% of normal precipitation, and both reservoirs in the region were at or above target storage by May 1, some parts of the Russian River watershed were still under drought stress (Figure 3). It was not until the end of winter of 2017, which was the 3rd wettest year in the Russian River, that the entire watershed was no longer in drought.

Climatic Water Deficit May 2016 % of Normal

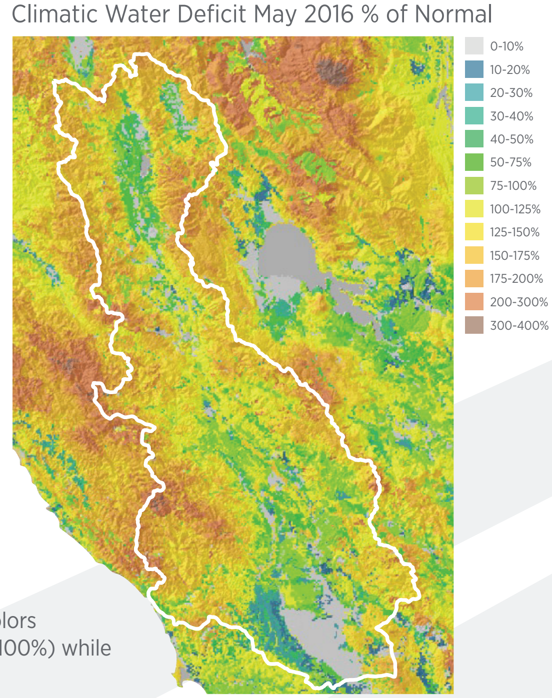

Figure 3: The climatic water deficit, or thirst of the landscape, in May 2016. Warm colors indicated a higher deficit (or thirst). Some of the region was back to normal levels (100%) while in other parts of the region the deficits were still 2 times more than normal.

The Russian River Watershed

The Russian River watershed, located in Mendocino and Sonoma counties, drains 1458 square miles (Figure 4). The watershed provides water to approximately 600,000 people, supports a productive agriculture community and is home to several at risk salmon species. Two reservoirs are managed by the US Army Corps of Engineers (USACE) for flood control and by Sonoma County Water Agency (SCWA) for water supply, habitat and recreation. Lake Mendocino is used to meet water supply demands and river flow requirements along the length of the Russian River. Water released from Lake Sonoma, which joins the Russian River just south of Healdsburg, provides water to nine cities and water districts in Sonoma and Marin Counties and is required to meet flow requirements in Dry Creek and the Lower Russian River.

Figure 4. Map of the Russian River watershed.

Atmospheric Rivers (ARs) and Droughts

As in the case of the winter of 2017, atmospheric rivers (ARs) can act as drought busters but the absence of ARs can lead to drought. ARs are narrow (~300 miles), elongated (often greater than 1500 miles) corridors of high water vapor (IWV) that often yield heavy precipitation when they reach the Russian River basin (Figure 5). In Northern California, research has shown that about 40% of droughts end as a result ARs[5]. The largest storms, defined as the wettest 10% of wet days, explain 81% of the year-to-year variability in rainfall (Figure 6). Many of these large storms are ARs, thus, years without ARs that produce significant rainfall are dry years, and can lead to drought.

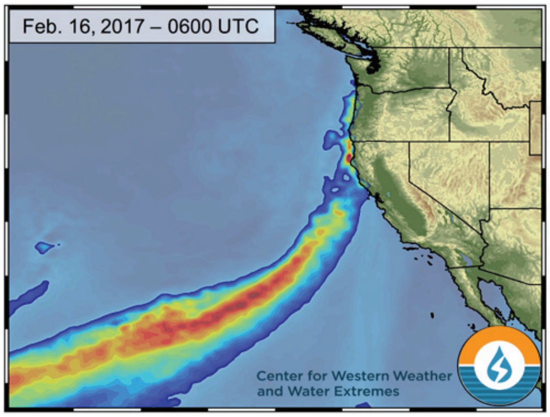

Figure 5: A example of a strong AR making landfall over the Russian River watershed and which produced 3 inches of precipitation in the coastal mountains.

On average, ARs deliver 51% of water-year total precipitation[6] in the Russian River; however, the more extreme ARs can cause flooding. Since 1948, 87% of the floods in the Russian Rivers have been related to land-falling ARs[7], resulting in the Russian River having the highest recurrent flood damage claims in California. ARs can cause flooding even during droughts, such as the 2014 flood in Healdsburg, which caused $8.8 million in damages.

Future Droughts

Future droughts are predicted to be similar to what the region has experienced over the last 6 years; extreme drought punctuated by a very wet year. This kind of "climate whiplash" is projected to intensify, even though average precipitation totals are not projected to change much[8]. The frequency of occurrence of an extreme dry year, like 1976-1977, is projected to increase by about 60% by around 2050, while an extreme wet year, like 2016-2017, is projected to increase by 100%[8]. The most significant factor for future droughts will be increased temperatures, which can cause enhanced drying even with the same amount of precipitation[9].

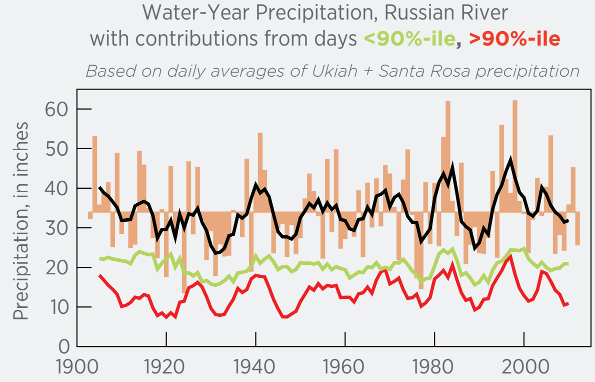

Figure 6. The water-year (Oct-Sept) precipitation and associated contributions from the top 10% of wet days versus the other 90%.

Drought Preparedness

There are several drought preparedness efforts occurring in the region, some of which are highlighted below.

Forecast Informed Reservoir Operations (FIRO)

FIRO is a management strategy that uses data from monitoring and water forecasting to help guide water release or retention from reservoirs according to current and forecasted conditions. FIRO is intended to optimize the use of limited resources and represents a viable climate adaptation strategy. FIRO is being tested at Lake Mendocino with support from USACE and leadership of an inter-agency Steering Committee co-chaired by SCWA and the Center for Western Weather and Water Extremes. Model results suggest that FIRO can lead to a 36% increase in median end of water year reservoir storage[10]. For more information: cw3e.ucsd.edu/FIRO.

LandSmart Program

LandSmart® is a regional collaborative that helps land managers meet their conservation and management goals while supporting productive lands and thriving streams. LandSmart was developed by the Sonoma Resource Conservation District (RCD), Napa County RCD, Mendocino County RCD and Gold Ridge RCD in collaboration with the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), land managers, and environmental agencies. This program provides support for alternative water supply development, water use efficiency, stormwater management and carbon farming. For more information and multiple resources: landsmart.org.

Sonoma County Venture Conservation Partnership

NRCS awarded $8 million to protect natural and working lands against drought. The award has been matched by $12.75 million, leveraging over $20 million in partnership efforts. Led by Sonoma County Agricultural Preservation & Open Space District and including 30 regional and local partners, this partnership will develop a countywide decision-support system using high-resolution mapping and downscaled climate modeling to inform planning and conservation efforts. For more information: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/ca/programs/farmbill/rcpp/?cid=nrcseprd1382825.

Water Use Efficiency Improvements

SCWA and 10 local water utilities have been working together to increase water use efficiency through education and cost- effective technologies. Per capita water use dropped from 142 gallons per day in 2005 to 100 gallons per day in 2015. In 2010, the formalization of Sonoma-Marin Saving Water Partnership helped ensure regional collaboration, which resulted in a coordinated drought response and average per-person daily water use saving exceeding state requirements. The utilities in the Upper Russian should consider joining the Sonoma-Marin Saving Water Partnership or developing a similar partnership, to evaluate and implement new water-use efficiency improvements.

Additional efforts include development of a Storm Water Resource Plan, identifying over 90 multiple benefit drought resiliency projects, led by the Russian River Watershed Association and a groundwater banking pilot study lead by SCWA.

Next Steps

Great strides have been made to prepare for drought in the region; nonetheless, additional research, education and communication are needed to improve drought preparedness. Improvements to seasonal and subseasonal forecasts are an active and challenging area of research. In addition, research has begun to enhance understanding of how management of natural and working lands impact water supply (both groundwater and surface water) and water quality in the region. An increased awareness of the connectivity between urban and natural/working lands will facilitate collaboration between sectors to mitigate drought impacts. Similarly, enhancements to communications, interactions and planning between Sonoma and Mendocino counties will further support protection of water supplies and ecosystems in the watershed.

Many watersheds across the west are facing similar drought challenges, including the role of atmospheric rivers as drought busters and those at the interface of urban and natural/working lands. In support of the National Integrated Drought Information System (NIDIS), lessons learned and best practices from this region will be shared with other watersheds planning and preparing for drought.

References

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5. Dettinger, 2013, *J. of Hydrometeorology.*
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11. Dettinger and Cayan, 2014, *SF Estuary and Watershed Science.*

Photo Credits

Cover: Lake Mendocino 1977 *(UC Agricultural and Natural Resource Repository)*, Cows *(Kyle Farmer)*, Stream Bed *(CA Sea Grant)*; Drought Preparedness: Lake Mendocino, 2014 *(JT Williams, UC Cooperative Extension)*

Private Industry Drought Preparedness

Agriculture is preparing for droughts and climate variability through a variety of strategies. One example is Parducci Wine Cellars water reclamation. The process includes filters, settling, removal of organics in trickle towers, aeration through waterfalls and natural filtration in wetlands (images below). The wetlands and adjacent holding pond provide habitat for diverse wildlife. Parducci has reduced water consumption by 20% while doubling its production, illustrating an economically viable drought preparedness strategy.

COLLABORATORS

UC San Diego

Scripps Institution of Oceanography

Center for Western Weather and Water Extremes

NOAA SARP Sectoral Applications Research Program

USGS

NIDIS National Integrated Drought Information System

Sonoma County Water Agency

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July 2018