2018
Arizona Drought Preparedness Annual Report

For Water Year 2018: October 1, 2017 – September 30, 2018


Oak Creek Canyon

ARIZONA DEPARTMENT OF WATER RESOURCES
EST. 1980

PROTECTING
ARIZONA'S WATER SUPPLIES
for ITS NEXT CENTURY

2018 Arizona Drought Preparedness Annual Report

Acknowledgements

The *Arizona Drought Preparedness Plan* was adopted in 2004 and its continued implementation ordered in 2007 (EO 2007-10). The Arizona Department of Water Resources (ADWR) prepares an annual report each year based on drought updates from the Drought Monitoring Technical Committee (MTC), Governor's Drought Interagency Coordinating Group (ICG), Local Drought Impact Groups (LDIGs), and others. The Arizona 2018 Drought Preparedness Annual Report covers the drought conditions and preparedness activities for the 2018 water year, from October 1, 2017 through September 30, 2018. ADWR acknowledges and thanks all who contributed to this report.

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2018 Arizona Drought Preparedness Annual Report

1. Introduction

The current drought in Arizona began in the mid-1990s. Since then, only seven of the last 25 years have been wetter than the long-term annual average statewide. Total precipitation during the 2018 water year was below average for most of the state.

While the winter of 2016-17 was slightly wetter than average, the winter of 2017-18 brought only 50% of the average precipitation to the state. Snowpack and spring run-off were further reduced by warmer than normal temperatures. Northeastern and southwestern Arizona were hit especially hard by warm, dry conditions. The dry winter got an early start as the 2017 monsoon season shut down relatively early in late August, and never recovered.

The 2018 monsoon season lasted longer than usual with the remnants of two hurricanes bringing heavy rainfall to the state in early October. Monsoon rainfall was much wetter than average in central and western Arizona but the easternmost counties were drier than normal.

Salt-Verde reservoir system water storage has been reduced from 65% of reservoir capacity last year to 46% of reservoir capacity at the end of this water year. In addition, below average streamflow was observed throughout much of the Colorado River Basin during water year 2018.

Arizona's Drought Preparedness Plan activities continue to provide a framework to monitor drought conditions, improve understanding of drought impacts, and determine mechanisms for limiting future vulnerability.

2. Drought Status Summary

2.A. Winter Precipitation: October 2017 – April 2018

The winter of 2016-17 (**Fig. 1**) brought above average precipitation to the state and parts of the upper Colorado River basin. That wet winter was followed by 2017-18 winter that was one of the driest in the Colorado Basin (**Fig. 2**). Virtually all of Arizona received less than 50% of average precipitation during this past winter. Most of the upper Colorado basin received between 50% and 90% of average precipitation. The water year was extremely dry from the begining and never recovered. Lake Powell's elevation decreased by 36.28 feet and Lake Mead's elevation decreased by 3.71 feet this past year.

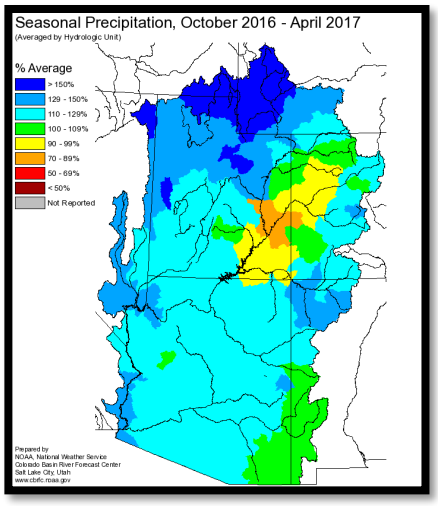


Figure 1. Precipitation Oct. 2016 - Apr. 2017

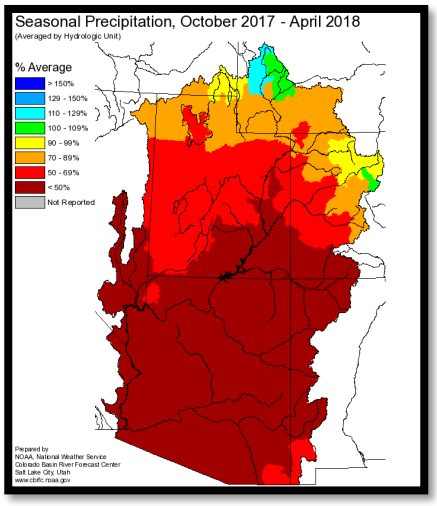


Figure 2. Precipitation Oct. 2017 - Apr. 2018

2.B. Monsoon Precipitation: June – September 2018

The 2017 monsoon rainfall (**Fig. 3**) was much lighter in central and southern Arizona compared to 2018 (**Fig. 4**). The Colorado Plateau, however, remained quite dry during both years and the exceptionally dry winter in Apache, Navajo and eastern Coconino counties in 2016-17 was followed by the dry summer exacerbating drought conditions in this area. La Paz and western Maricopa County were also passed over by the summer rainfall. This monsoon season lasted longer than usual with the remnants of two hurricanes bringing heavy rainfall to the state in early October. Though too late to affect water year 2018 totals, these storms eliminated short-term calendar year deficits in central Arizona.

2.C. Cumulative Precipitation and Streamflow Summary

Precipitation

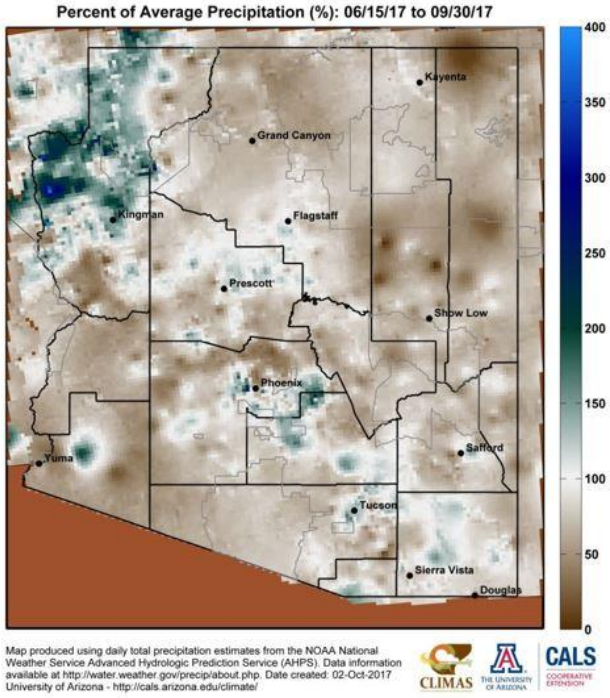


Figure 3. Monsoon 2017 percent of Normal Rainfall

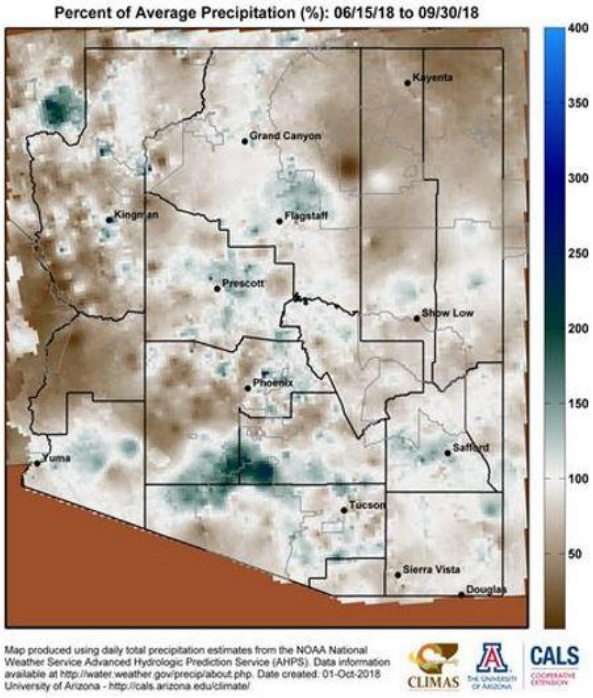


Figure 4. Monsoon 2018 percent of Normal Rainfall

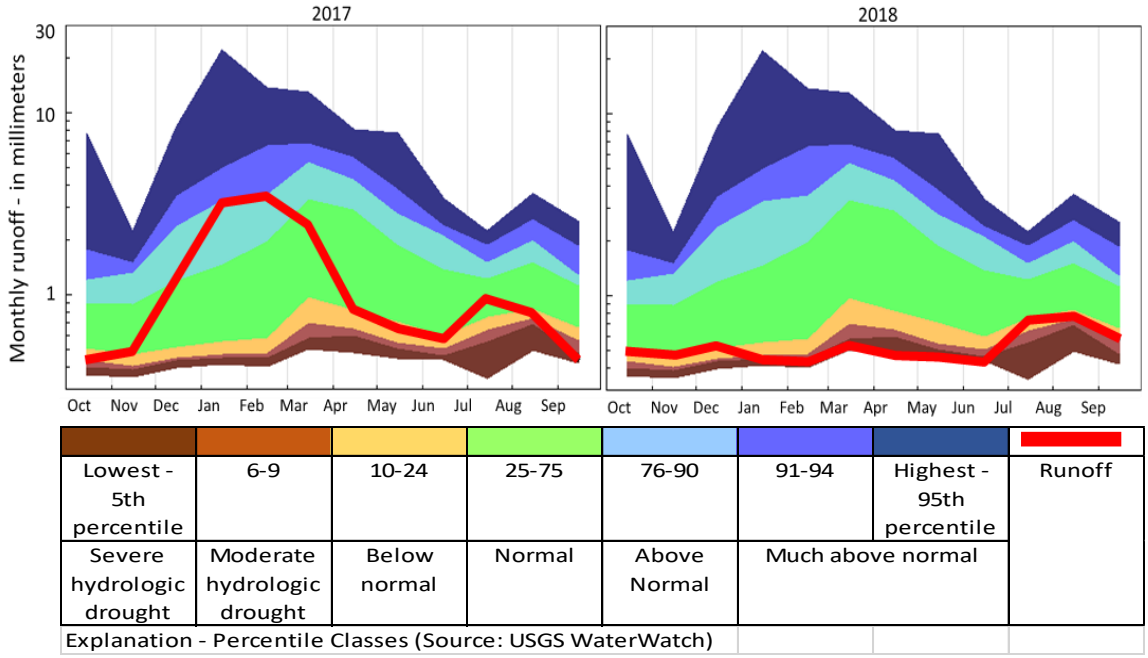
Cumulative precipitation for water year 2018 resulted in levels well below normal throughout the mountainous areas of Arizona, ranging from 54% to 58% of average in the major river watersheds. Above normal precipitation during the monsoon season was not enough to offset the well below normal winter, as the conditions for the entire water year remained below average (**Table 1**).

Table 1. Water Year 2018 Mountain Precipitation (as of September 30, 2018)

Major Watershed	Percent of 30-year Average Precipitation
Salt River Watershed	56%
Verde River Watershed	58%
San Francisco-Upper Gila River Basin	57%
Little Colorado River Watershed	54%

Streamflow

Drought status as indicated by streamflow data shows an increase in drought severity throughout Arizona from 2017 to 2018. Streamflow data collected in 2017 shows significantly more runoff during the winter, spring and Monsoon seasons than in 2018. Flows in 2017 from mid-November to mid-April were normal to above normal and July flows ranged within normal. In 2018, streamflow approached normal only from October to mid-December. From January to mid-June, 2018 streamflow was characterized by severe hydrologic drought. Even though 2018 Monsoon season was active, flows generally stayed below normal. During that time, several streamflow sites measured significant runoff, but this was not widespread throughout the state.



Lowest - 5th percentile	6-9	10-24	25-75	76-90	91-94	Highest - 95th percentile	Runoff
Severe hydrologic drought	Moderate hydrologic drought	Below normal	Normal	Above Normal	Much above normal		
Explanation - Percentile Classes (Source: USGS WaterWatch)							

Figure 5. Area-based monthly runoff as determined by USGS streamflow gages for 2017 and 2018 representing the entire state of Arizona. The hydrograph (red line) represents runoff per unit area and is plotted over the long-term statistics of runoff for each month and statistics are based on quality assured and approved data for the period of record include the maximum runoff during the period of record for each month of the year (top of the dark blue area); the 90th percentile runoff for each day or month (top of the light blue area); the interquartile range (the green area bounded by the 75th percentile on top and 25th percentile on the bottom); the 10th percentile runoff for each day (the bottom of the orange area); and the minimum discharge for each day or month (bottom of dark brown area). The plot covers a period of one year with the statistics being identical for each year.

2.D. Water Supply Status

Colorado River Basin and Reservoir Status[1]

Below average streamflow was observed throughout much of the Colorado River Basin during water year 2018. Unregulated[2] inflow to Lake Powell in water year 2018 was 4.622 million acre-feet (MAF), or 43% of the 30-year average[3], which is 10.83 MAF. Unregulated inflow for the 2018 runoff season

[1]Information in this section was taken from the United States Bureau of Reclamation's Sept 10 draft "Annual Operating Plan for Colorado River Reservoirs 2019." The information has been updated to the end of the 2018 water year, where appropriate and where data was available.
[2]Unregulated inflow adjusts for the effects of operations at upstream reservoirs. It is computed by adding the change in storage and the evaporation losses from upstream reservoirs to the observed inflow. Unregulated inflow is used because it provides an inflow time series that is not biased by upstream reservoir operations.
[3]All unregulated inflow, precipitation, and snowpack statistics are based on the 30-year period 1981-2010.

(April through July) to Flaming Gorge, Blue Mesa, and Navajo Upper Basin Reservoirs was 114%, 35%, and 21% of average, respectively.

Precipitation in the Upper Colorado River Basin was below average during water year 2018. Cumulative precipitation received within the Upper Colorado River Basin during water year 2018 was 65% of average. The Colorado River total system storage experienced a net decrease of 4.9 MAF (~8%) and reservoir storage in Lake Powell and Lake Mead decreased by 3.629 MAF and 0.312 MAF respectively in water year 2018. At the beginning of water year 2018, Colorado River total system storage was 55% of capacity. As of September 30, 2018, total system storage was 47% of capacity.

Snowpack conditions throughout the 2018 snow accumulation season (October – April) also trended below average across most of the Colorado River Basin. On April 1, 2018 basin-wide snow-water equivalent measured 73% of average. Total seasonal accumulation peaked at approximately 73% of average on March 30, 2018. On April 1, 2018, the snow-water equivalents for the Green River, Upper Colorado River Headwaters, and San Juan River Basins were 107%, 88%, and 56% of average, respectively.

During the 2018 spring runoff period, inflows to Lake Powell peaked on May 29, 2018, at approximately 23,320 cubic feet per second (CFS). April through July unregulated inflow volume to Lake Powell was 2.6 MAF, which is 36% of average. Lower Basin tributary inflows above Lake Mead were also below average for water year 2018. Tributary inflow from the Little Colorado River totaled 0.039 MAF, or 27% of the long-term average. Tributary inflow from the Virgin River totaled 0.093 MAF, or 51% of average. Tributary inflows in the Lower Colorado River Basin below Hoover Dam were below average during water year 2018. Total tributary inflow from the Bill Williams River was 0.050 MAF, and total tributary inflow from the Gila River was 0.013 MAF.

At the beginning of calendar year 2018, the probability of a Colorado River Lower Basin shortage declaration in 2019 was 17%. The official operational forecast made by United States Bureau of Reclamation (Reclamation) in August 2018 shows a 57% chance of a shortage declaration in 2020. Lake Powell inflow/release projections, runoff from the snowpack in the Upper Basin, water supply delivery schedules, and conservation programs designed to leave water in Lake Mead contribute to shortage projections by Reclamation.

Salt and Verde Reservoirs

In 2018, the Salt River and Verde River watersheds experienced the lowest winter runoff season (January-May) on record dating back to 1913 with only 100,000 acre-feet of inflow. As a result, Roosevelt Lake saw little to no increase in storage remaining at approximately 58% throughout the winter. In addition, Bartlett and Horseshoe reservoirs on the Verde system declined from 59% to 31% following the dry winter. During the monsoon season, slightly above normal precipitation was received; however due to extremely dry conditions throughout the watershed, only minimal additional runoff occurred with little to no impact on overall storage. As of October 1, 2018, total storage of the Salt and Verde system was at 46% capacity compared to 65% at this time last year.

2.E. Drought Index Wells

ADWR maintains groundwater index wells throughout the state. Using criteria established by the United States Geological Survey (USGS) drought monitor, two wells in southeastern Arizona have been utilized as qualitative supplements to existing drought indicators. Depth to water measurements are collected at these sites four times a day, by means of a pressure transducer. Transducer measurements are later verified with less frequent discrete measurements taken by ADWR field staff. For additional information regarding the USGS climate response network criteria, please use this link: https://groundwaterwatch.usgs.gov/net/ogwnetwork.asp?ncd=crn.

Figures 7 and 8 are hydrographs showing groundwater levels of record and the historical daily median. Automated groundwater levels for each well site are plotted in blue and the historical daily median is plotted in green.

San Pedro River Watershed Groundwater Index Well

ADWR Index Well "D-15-20 09AAB2" is located within the San Pedro River watershed and in the Lower San Pedro groundwater basin. Situated on the banks of the San Pedro River, this well is completed in a shallow alluvial aquifer system and is in the river's floodplain.

Throughout this year, water levels at this site have consistently been below the record's historical daily median. The continuation of a clear seasonal pattern is visible in this year's water level record. This is observed in the groundwater level declines throughout much of the summer and the groundwater level rises taking place in the late summer and early fall.

Characteristic groundwater declines throughout much of this summer culminated in a new record maximum depth to water, on July 10th, 2018, at a depth of 34.13 feet below land surface.

Figure 6. Location of Drought Watersheds and Index Wells

Location	Depth of Well	Hole Depth	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water
N 32°09'02.74", W 110°17'53.34"	89 feet	89 feet	4647 feet	34.13 feet	26.10 feet

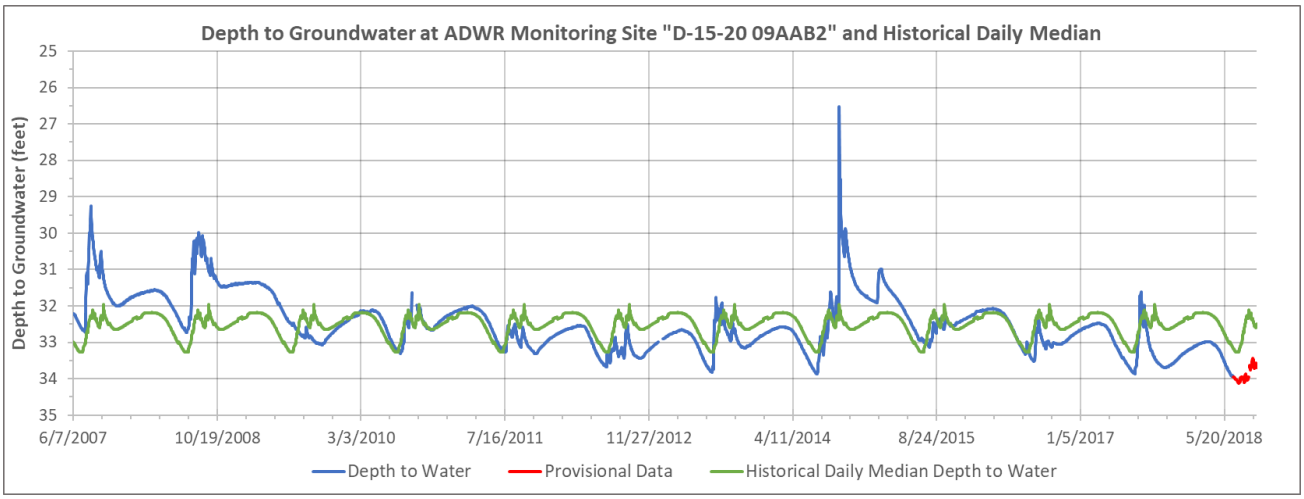


Figure 7. Automated groundwater level data for drought index well "D-15-20 09AAB2" plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located at this link: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=320901110175301.

Whitewater Draw Watershed Groundwater Index Well

ADWR Index Well "D-21-28 21BCB" is located within the Whitewater Draw watershed and in the Willcox groundwater basin. Adjacent to the Leslie Creek drainage, this well is completed in shallow alluvial materials.

While 2017 showed a considerable groundwater level rise at this site, water levels throughout 2018 have consistently been in decline. Despite these declines, water level values remained above the historical daily median for the entire year.

Location	Depth of Well	Hole Depth	Altitude (above sea level)	Record Maximum Depth to Water	Record Minimum Depth to Water
N 31°35'29.87", W 109°30'18.0"	24.5	18.35	3306	18.35	1.4

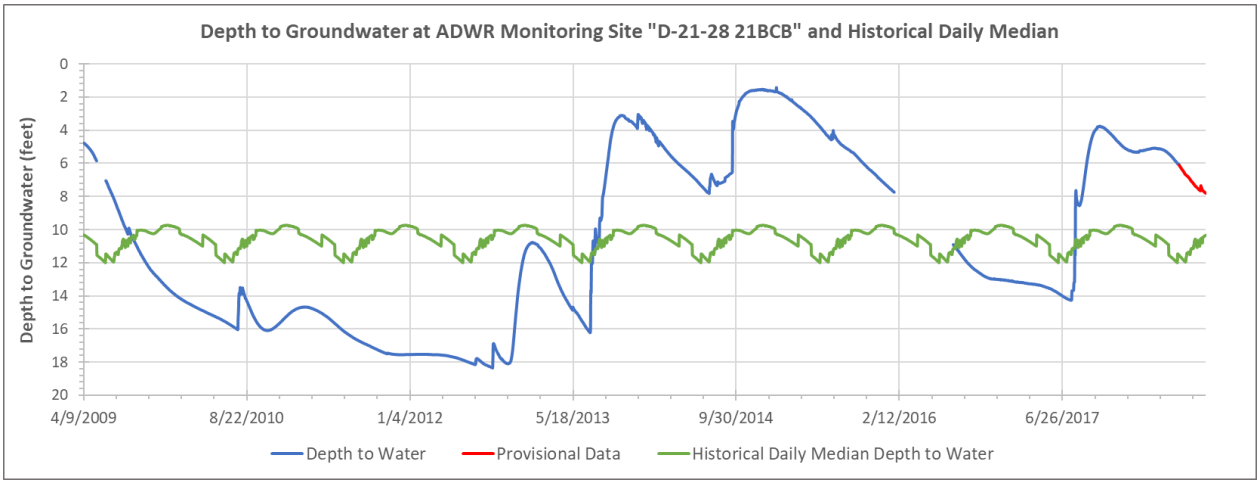


Figure 8. Automated groundwater level data for drought index well "D-15-20 09AAB2"plotted with historical daily median groundwater levels. (Water level data and additional information for this site is available through ADWR's GWSI web application, located at this link: https://gisweb.azwater.gov/gwsi/Detail.aspx?SiteID=313533109301801.

Additional Drought Index Wells

ADWR's Field Services Section collects groundwater levels statewide from approximately 1,800 index wells, including the state's two drought index wells. ADWR also maintains a statewide network of roughly 120 automated groundwater monitoring sites and an ORACLE database that contains field-verified data including discrete water level measurements, location, and other well specific information.

ADWR staff developed a Monitoring Well Network Optimization Plan in 2015, which includes identifying additional drought monitoring index wells within the state. Water level data from continuous monitoring sites are being reviewed and evaluated with respect to meeting drought index well criteria for the USGS Climate Response Network. Drought index wells identified will be integrated with USGS Climate Response Network monitoring sites in Arizona.

2.F. Forest Health and Drought

Aerial and ground detection surveys for dead and dying trees have been conducted in Arizona for more than 50 years. Arizona Department of Forestry and Fire Management uses this survey data to track changes in forest health, monitor emerging insect and disease agents, and provide land managers and the public with information about landscape-level forest health conditions. In times of significant drought, trees become increasingly stressed and highly susceptible to insect and disease infestation. Once tree mortality occurs, fire risk is altered.

Based on historic data, Arizona is experiencing bark beetle conditions similar to the onset of the 2002-2003 infestation that impacted 2.2 million acres of trees during these very dry years. Currently, the 2018 aerial and ground survey detected 275,934 acres of trees impacted by bark beetles compared to 45,003 acres in 2017, which is an increase of 513%.

2.G. Drought Declarations

A Drought Emergency Declaration has been in effect in Arizona since 1999. The current declaration, PCA 99006, was issued by the Governor in June 1999 and continued by Executive Order 2007-10. The declaration maintains the State's ability to provide emergency response if needed, and enables farmers and ranchers to obtain funding assistance through the Farm Service Agency if they experience significant production losses due to drought.

The ICG is responsible for providing recommendations to the Governor regarding drought declarations based on presentations and discussions at the spring and fall ICG meetings (see 3.B).

2.H. Disaster Designations

A disaster designation from the Secretary of the U.S. Department of Agriculture (USDA) is necessary for farm operators in both primary and contiguous disaster areas to be considered for assistance from the Farm Service Agency.

The USDA uses the U.S. Drought Monitor to help determine designations. Extreme Drought (D3) or Exceptional Drought (D4) qualify as automatic designations, while Severe Drought (D2) for eight consecutive weeks during the growing season qualifies for nearly automatic designation. This "Fast Track" authority designation process delivers fast and flexible assistance to farmers and ranchers.

The disaster designations by the U.S. Department of Agriculture in **Table 2** occurred this water year:

Table 2. Drought Disaster Designations in 2018

Date of Designations	Primary Disaster Counties	Contiguous Disaster Counties
January 10, 2018	Cochise, Pima, and Santa Cruz	Graham, Greenlee, Pinal, Maricopa, and Yuma
March 8, 2018	Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Mohave, Navajo, Pima, Pinal and Santa Cruz	Yuma, La Paz, Yavapai, and Santa Cruz
March 29, 2018	Yavapai	Gila, Coconino, Maricopa, Mohave, La Paz, Greenlee
March 30, 2018	Yuma	La Paz, Maricopa, Pima
May 3, 2018	Hidalgo (NM), Grant (NM), and Catron (NM)	Cochise and Greenlee

2.I. Drought Status Changes

Arizona's drought status is continually monitored and updated. The short-term drought status is updated weekly and monthly. The long-term drought status is updated seasonally at the end of each quarter.

The SPI graph (**Fig. 9**) shows the changes in drought over time: short-term drought conditions (0 – 15 months) are at the bottom, and longer-term drought conditions (48 – 60 months) are near the top. The bottom bar graph shows the monthly anomalies with green being wetter than average and brown being drier than average. Across the top of the SPI graph there are two wet long-term periods. The first from 1981 through spring of 1988, followed by a short abnormally dry period from spring 1990 through the summer of 1992. The second wet period began in the winter of 1992 and continued through the winter of 1994 when the current long-term drought began. The most intense period of the current drought for Arizona was 2002 through 2004, however the long-term drought continues in

the State. This past winter brought intensification of the drought in the short-term, seen at the bottom right of the graph. Whether this intensification will extend to the long-term will depend on the developing El Niño bringing enhanced precipitation to the state.

For more information about how the graph can be used to correlate precipitation and drought impacts, visit the University of Arizona Climate Science Application Program website at: http://cals.arizona.edu/climate/misc/spi/spicontour.png

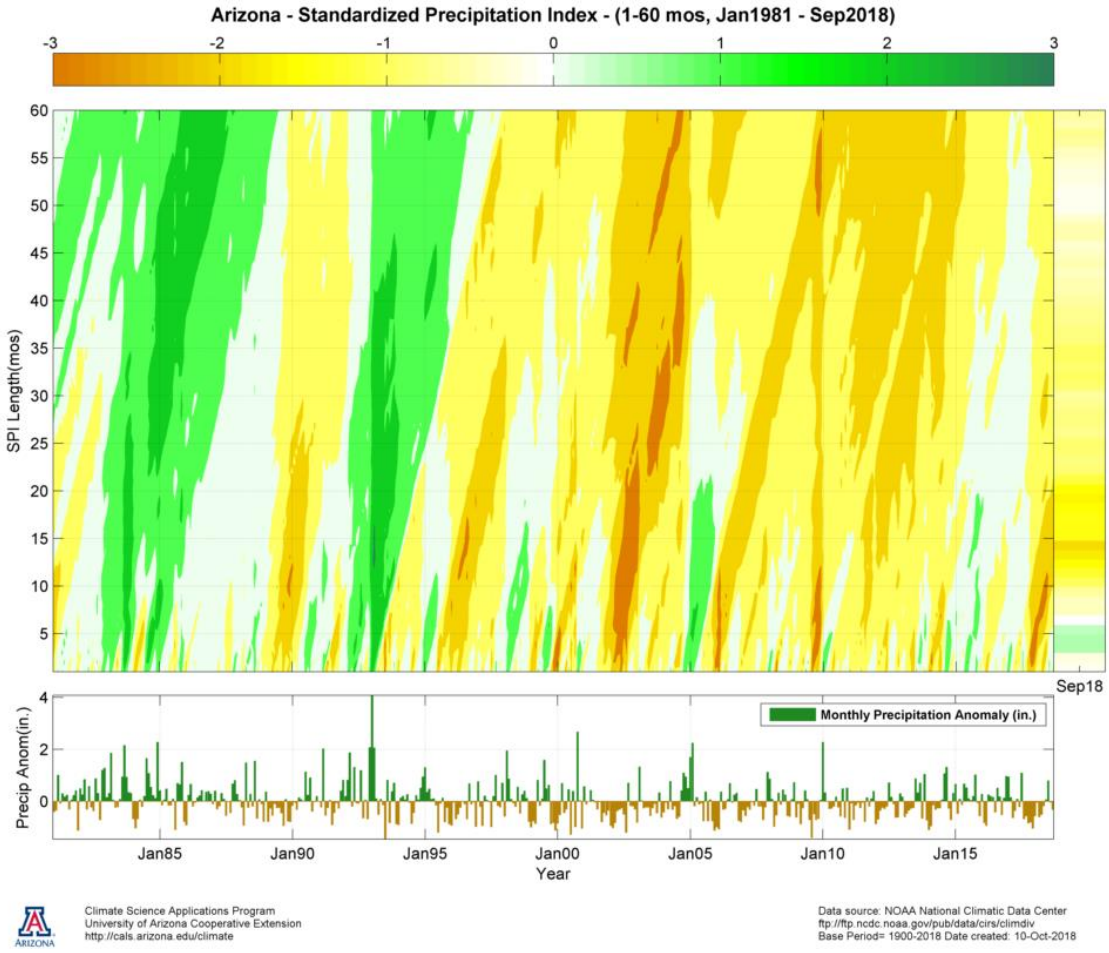


Figure 9. Standardized precipitation index and precipitation anomalies.

Short-term Drought Status

Drought conditions at the end of 2017 water year were minimal due to the relatively wet winter of 2016-17 and a reasonably wet, though short, monsoon season. Only the southwest remained in moderate drought, central and eastern Arizona were Abnormally Dry, and the northwest and southeast experienced no drought (**Fig. 10**). As the water year began in October 2017, however, the state had dried out and remained dry until mid-December. A few winter storms dropped scant precipitation through March, bringing Severe and Extreme Drought back to the state.

By April 2018, the entire state was in Moderate Drought or worse (**Fig. 11**). The northwest and southern third of the state were in Severe Drought, while central and northeastern Arizona were in Extreme Drought. Spring continued to be quite dry with forest fires around the state, and water hauling for livestock and wildlife. The fire threat became so extreme that state lands were closed to recreational use. Groundwater wells ran dry in a number of places around the state. By the time the

2018 monsoon activity began, the moisture deficits were significant, and the monsoon rainfall was not sufficient to make up the deficits on the Colorado Plateau and in southwestern Arizona (**Fig. 12**). However, the Mogollon Rim, southern Coconino and northern Yavapai counties, and the southeast corner of the state showed one-category drought improvement.

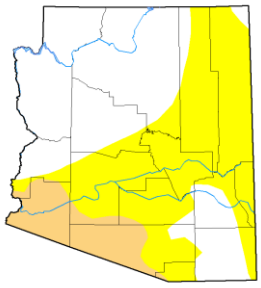


Figure 10. Sep. 26, 2017 short-term drought status

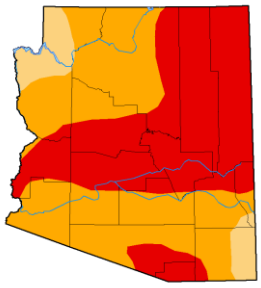


Figure 11. Apr. 3, 2018 short-term drought status

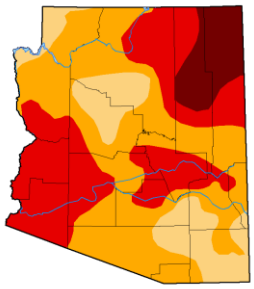


Figure 12. Sep. 25, 2018 short-term drought status

Level	Description	Percentile	Color
	No Drought	>30	
D0	Abnormally Dry	21-30	
D1	Moderate	11-20	
D2	Severe	6-10	
D3	Extreme	3-5	
D4	Exceptional	0-2	

Long-term Drought Status

The MTC had historically calculated long-term drought using the Standardized Precipitation Index (SPI) for the 24, 36, and 48-month periods. Previously this method was applied to watershed average precipitation, but the index is now calculated with gridded data across the state. The advantages are 1) the gridded data provide higher resolution across the watersheds and counties, accounting for elevation differences and 2) the period of record extends back to 1895, rather than just back to 1971. This incorporates more years that were wet and dry, so the results are not so biased toward the current drought.

Over the past year of testing the MTC found that the SPI alone shows very little drought across the State, which is contrary to drought impact data. The MTC now incorporates evaporation in the calculations using the Standardized Precipitation Evaporative Index (SPEI), which includes the water demand rather than just the water supply. Over the testing period, the SPEI had generally better correlation to the drought impacts data, though a few locations show No Drought or Abnormally Dry conditions due to the lack of data. Occasionally, a combination of the SPI and the SPEI provided the best correlation to the impacts across the state. The MTC continues to evaluate the gridded results, but this method provides a much better depiction of the long-term drought than the watershed averages with smoother transitions across watershed and counties. Even though drought declarations are made at the county level, the higher resolution data will provide better information about which parts of individual counties are having the worst drought problems.

Figure 13 demonstrates gridded long-term maps from beginning till the end of this water year

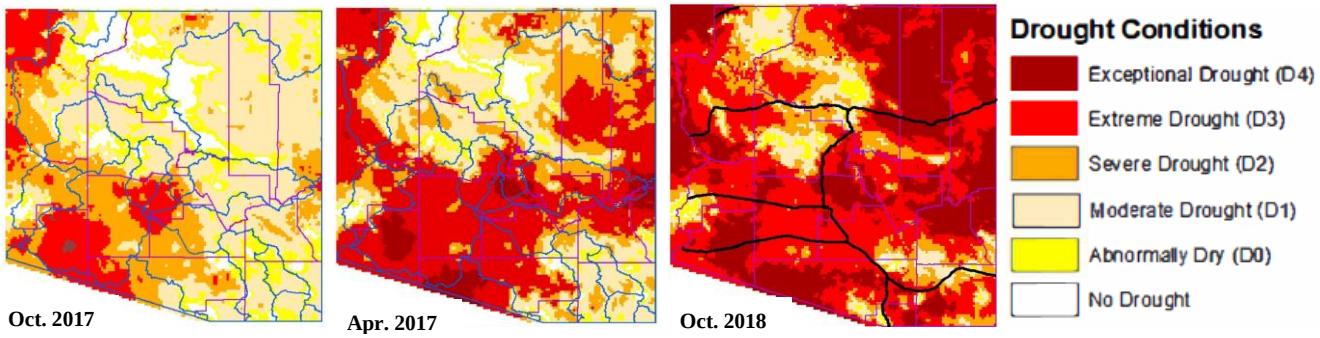


Figure 13. Quarterly long-term drought maps based on SPEI from Oct. 2017, Apr. 2018, and Oct. 2018.

2.J. Outlook for Water Year 2018-2019

Winter 2018-2019

Water temperatures in the tropical Pacific have warmed fairly rapidly during the late summer and fall of 2018 leading to the likelihood of an El Niño phase during the winter of 2018-19. There is better than a 75% chance of an El Niño persisting through the winter months before decaying in spring 2019. While many other factors can influence the winter weather patterns in Arizona, the El Niño phase has historically provided some influence in long-term winter predictions for the Southwest United States.

The El Niño phase this winter will likely peak only in a weak category, but could briefly touch a moderate stage. A more prolonged moderate El Niño is unlikely, but a period of more heightened warmer Pacific waters could tilt the odds towards a wetter than normal winter. The uncertainties in the strength of this El Niño interacting with other atmospheric patterns has limited the predictive capability for winter 2018-19 rain and snow forecasts across Arizona. In the end, it only takes a couple larger storm systems and a favorably wet pattern persisting for a few weeks of winter to make the difference between average and above average precipitation.

The official outlook from NOAA's Climate Prediction Center (**Fig. 14**) for January-March 2019 indicates a better chance that the average temperature will be above normal. This is supported by both forecast models and the longer term trend of distinctly warmer winters in the Southwest United States over the past 10-20 years (i.e. climate change). The precipitation outlook depicts a very slight tilt in odds towards wetter than average conditions, which is primarily a result of this winter's El Niño forecast.

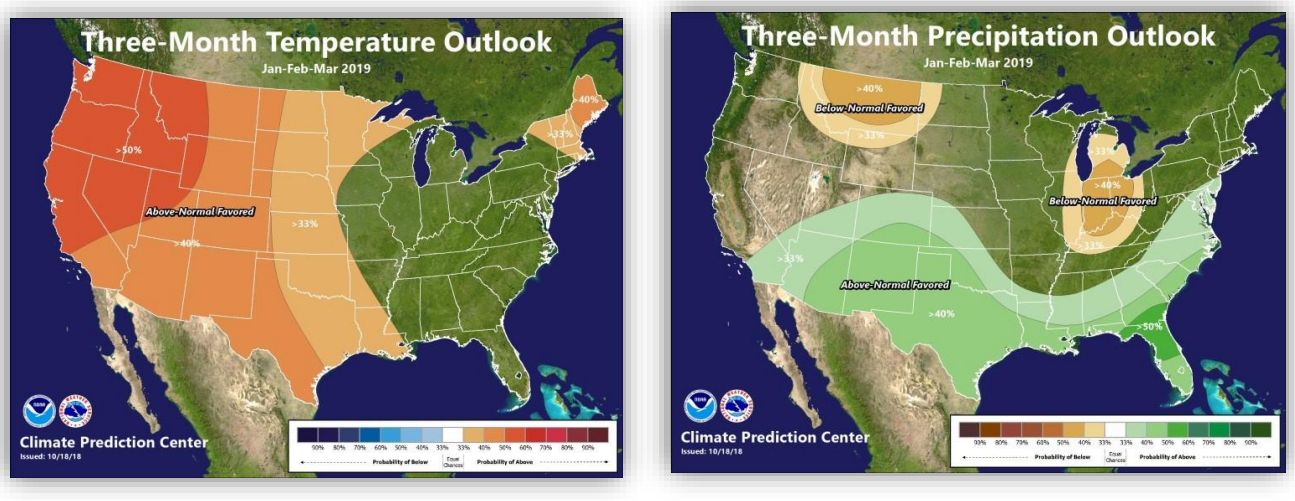


Figure 14. Climate Prediction Center outlooks for temperature (left) and precipitation (right) for January – March 2019. Shading indicates the increased odds of being above or below normal. Absence of color indicates equal chances of an above, below, or near normal outcome.

Summer 2019

The Climate Prediction Center's outlook for July-September 2019 (**Fig. 15**) suggests a much better chance that the average temperature during the summer of 2019 will be above normal. This outlook is based almost exclusively on indisputable trends of warmer Southwest summers over the past 10-20 years versus the longer term 30-year average. The precipitation outlook shows no dependable forecast signal during the 2019 summer over Arizona resulting in equal chances that the 2019 monsoon season will have above, below, or near normal rainfall. This is common during the Southwest monsoon where thunderstorm activity is usually quite localized and not influenced by larger scale climate systems.

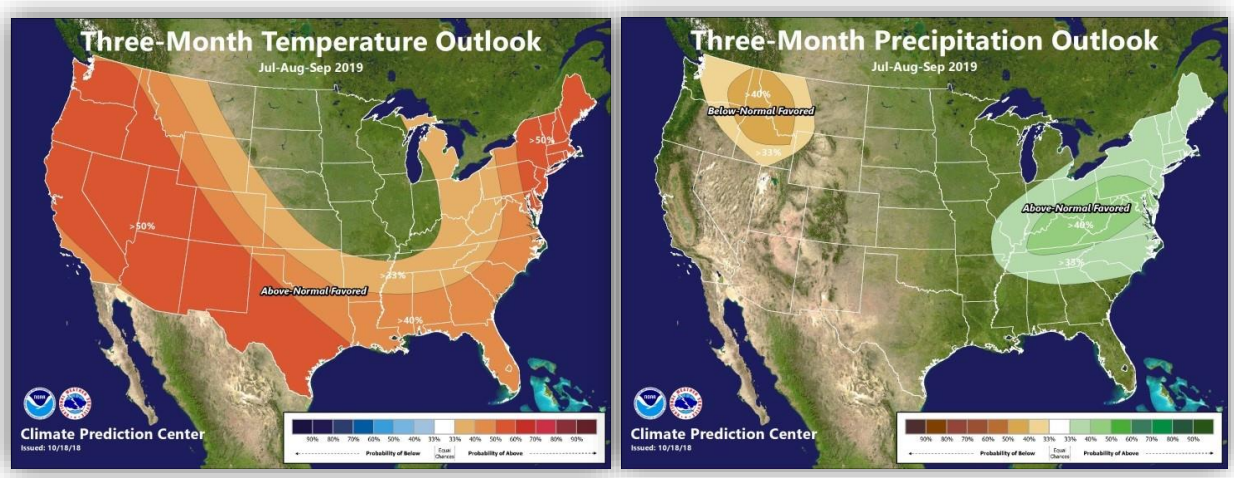


Figure 15. Climate Prediction Center outlooks for temperature (left) and precipitation (right) for July – September 2019. Shading indicates the increased odds of being above or below normal. Absence of color indicates equal chances of an above, below, or near normal outcome.

3. Drought Preparedness Plan Implementation Highlights

3.A. State Drought Monitoring Technical Committee Efforts

The MTC is responsible for gathering drought, climate, and weather data, and disseminating that information to water and land managers, policy-makers and the public. Specifically, the MTC prepares the short- and long-term drought status reports, briefs the ICG on drought conditions, and provides assistance to Local Drought Impact Groups (LDIGs). The MTC is currently working on incorporating the streamflow data into the gridded long-term drought status maps. The two co-chairs are Dr. Nancy Selover, State Climatologist, and Mark O'Malley, National Weather Service.

Communicating Drought Status

The MTC and ADWR coordinate to achieve the primary goal of improving the accessibility of drought information to resource managers, State decision-makers and the public. To further communication, information is updated on the ADWR Drought Status webpage (https://new.azwater.gov/drought) on a weekly, monthly and quarterly basis as follows:

Weekly - The MTC confers weekly with: the National Weather Service offices that cover Arizona; Flood Control Districts; LDIGs; water and rangeland managers; agricultural extension offices; and others who observe and report drought impacts. This is done to advise the U.S. Drought Monitor authors on the State's current drought conditions and provide recommendations on the drought boundaries for Arizona. The U.S. Drought Monitor is the official record of drought for federal drought relief claims. Information used by the MTC in advising the Drought Monitor authors includes numerous drought indices, precipitation and stream flow data, and impacts data. Every Thursday, ADWR's Drought Status webpage automatically updates with the latest U.S. Drought Monitor map of Arizona.

Monthly - At the end of each month, the MTC produces a web-based, short-term drought status update based on the U.S. Drought Monitor's maps for the past four weeks, with an explanation of how drought conditions have changed in Arizona over the preceding month. An email with the latest map and summary is sent to interested parties.

Quarterly - The MTC meets on a quarterly basis and produces a long-term drought status map and summary report using watershed precipitation averages to calculate the SPI and SPEI. This report

incorporates the 24, 36, and 48-month precipitation and evaporation. Vegetation indices, snowpack, temperature, reservoir levels, and county-scale drought impact information are used to verify or modify the result of the calculations. The long-term drought status reports are posted on the ADWR website and disseminated via email seasonally: in May (for January – March); August (for April – June); November (for July – September); and February (for October – December).

Arizona DroughtView

DroughtView, a University of Arizona program that replaced DroughtWatch, is an online tool for collecting drought impact data that incorporates several remote sensing and climate drought monitoring products. The tool can be used to track high-resolution (~250 meters) changes in remotely sensed 'greenness' (Normalized Differenced Vegetation Index) data collected on a bi-weekly basis from the National Aeronautical and Space Administration's (NASA) Moderate Resolution Imaging Spectroradiometer (MODIS) satellite. This index can be particularly useful for tracking changes in rangeland conditions related to livestock forage production and forest drought stress which can indicate longer-term drought impacts and wildfire risk. For more information, visit the University of Arizona DroughtView website at http://droughtview.arizona.edu/.

Community Collaborative Rain, Hail, and Snow (CoCoRaHS) Network

The CoCoRaHS network of citizen precipitation observers in Arizona continues to expand. There is a new drought impact reporting tool called "Condition Monitoring" where some of the 1,351 observers in Arizona are adding weekly observations of the condition of vegetation, water bodies and wildlife that reflect drought impacts. Since the observers simply note the conditions they observe every week, they do not require extensive training to provide useful information. In addition to the drought reports, the CoCoRaHS precipitation reports are incorporated into the precipitation products used by the Drought Monitor authors and by the PRISM group who generate the gridded SPI and SPEI data for our long-term maps.

Drought Detection for Ranch-Scale Tools

Drought creates both production and legal risks to ranches as they typically rely on federal lands for 50%-90% of their forage, and policies for these rangelands dictate responses regarding herd reduction, reduced access to forage, and a lengthy approval process to change infrastructure and management. The patchy spatial distribution of drought in Arizona means that some ranches experience drought while others do not. However, the spatial resolution of drought information is too coarse to represent this difference among ranches.

Mike Crimmins, an MTC Member, and his team held three workshops and developed two online tools to support the deployment of rain gauges for ranchers and federal managers in Arizona to more precisely detect drought at the ranch-scale. Workshop participants indicated these new precipitation monitoring tools will help reduce production and legal risk by focusing responses only on drought-affected ranches. View a specific example of this new tool here: https://myraingelog.arizona.edu/.

Drought Impact Reports from State and Federal Agencies

Drought impact data is used by the MTC in its efforts to correlate on-the-ground drought conditions with precipitation and streamflow data. Impact information is received from hydrologists, researchers and other field staff from the Bureau of Land Management, USGS, USDA Natural Resources Conservation Services, Arizona Department of Forestry and Fire Management, Arizona Game and Fish Department, Arizona State Parks, Native American Communities and other state and federal groups.

The USDA Arizona Natural Resources Conservation Service (NRCS) submits a water year report (**Appendix A**), which identifies the impacts of drought on range and farmland. The 2018 survey sent to all NRCS field offices in the State collected drought impacts on dryland farming, irrigation water

supply, rangeland water supply, rangeland forage supply, and rangeland precipitation. Losses of crop production, shortages of water supply, and shortages of forage were reported.

MTC Presentations and Workshops

Drought Response Plan Workshop, July 17-18, 2017

Einav Henenson (ADWR Deputy AMA Director) and Zack Richards (ADWR Drought Program Coordinator) presented on Arizona's Drought Program and drought preparedness activities at the Drought Response Plan Workshop, hosted by the Utah Division of Water Resources and the National Integrated Drought Information System (NIDIS). The workshop provided attendees with different States' perspectives on drought management issues and strategies.

Intermountain West Drought Early Warning System Webinar, July 25, 2018

Dr. Nancy Selover discussed drought impacts on Arizona and the Four Corner States. This included a report of deceased wild horses due to the lack of forage and water holes drying up and volunteers hauling water and hay to feed the horses on the Navajo Nation and within the Salt River Canyon. Dr. Selover also noted that groundwater wells were drying up in Mohave County due to increased pumping from water users, and springs were depleted after the lack of rain during the winter season.

The Burning Desert: A Workshop on Drought Recovery, September 11-12, 2018

Nancy Selover, Mark O'Malley, MTC co-chair and NWS Lead Forecaster, and Zack Richards attended The Burning Desert: A Workshop on Drought Recovery at ADWR, hosted by the National Centers for Environmental Information (NCEI) and NIDIS. The focus of the workshop was to evaluate and develop recommendations for improvements to the NCEI drought amelioration web page, and review other drought recovery tools.

31st Arizona Hydrological Society Symposium, September 20, 2018

Nancy Selover and Mark O'Malley were invited as luncheon speakers to the Arizona Hydrological Society Symposium at the Desert Willow Conference Center in Phoenix, where they discussed the history of drought in Arizona and potential future drought scenarios in the state.

Native Waters on Arid Lands Tribal Summit, October 17-18, 2018

Carlee McClellan, MTC member and Senior Hydrologist for the Navajo Nation, presented on satellite-based drought reporting at the Native Waters on Arid Lands Tribal Summit in Reno, Nevada. This event featured two days of presentations and interactive discussions related to climate change, water resources, agriculture, traditional knowledge, livestock, and ranching, and conservation practices.

3.B. Interagency Coordinating Group Efforts

ICG has met biannually since 2006 and advises the Governor on drought status, impacts, and any necessary preparedness and response actions.

The 2017 Fall meeting included a review of 2017 drought status, winter 2017-2018 weather outlook, 2017 wildfires review, 2017 forest and woodland health, the impact of the ongoing drought on wildlife, Colorado, Salt, and Verde River water supplies update as well as an overview of the efforts of the Governor's Water Solutions Conversation.

The 2018 Spring meeting included a review of 2017-2018 winter precipitation, Summer 2018 and winter 2018-2019 weather outlook, 2018 wildfire season outlook and forest health, water supply updates for the Salt River and Verde River Watersheds as well as the Colorado River, and an overview of the restoration projects completed by the Northern Arizona Forest Fund.

At both the 2017 Fall meeting and 2018 Spring meeting, the ICG recommended continuation of the Drought Declaration for the State of Arizona (Executive Order 2007-10) and the Drought Emergency Declaration (PCA 99006).

The presentations and subsequent decisions are on the ADWR ICG webpage: https://new.azwater.gov/drought/interagency-coordinating-group.

3.C. Drought Planning for Community Water Systems

Drought planning requirements and water use reporting regulations for Community Water Systems (CWSs) were recommended in the 2004 Arizona Drought Preparedness Plan and established by the State Legislature in 2005 to help CWSs reduce their vulnerability to drought and water shortages. These reports provide a means for the State to gather water use data and offer assistance to CWSs that need it. ADWR provides assistance to water providers in meeting these requirements through web-based resources, online reporting tools and phone or in-person consultations. For more information, see ADWR Community Water System webpage here: https://new.azwater.gov/cws.

All CWSs in the State are required to submit a Drought Preparedness Plan to ADWR every five years. The Drought Preparedness Plan is part of the required System Water Plan (SWP), which also includes a Water Supply Plan and a Conservation Plan. The Drought Plan requires water systems to describe their drought stages and triggers, emergency sources of water, customer communication strategies, and other planning actions. To date, ADWR has received SWPs from 828 or 92% of CWS.

The number of annual water use reports received from active CWS located outside the State's Active Management Areas (AMAs) can be seen in **Table 3**. Annual water reports have been required for systems inside the AMAs since the passage of the 1980 Groundwater Act.

Table 3. Annual Water Use Reports Received from Active CWSs Located Outside Active Management Areas

2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007
Number (and percent) of reports received out of total active CWSs for that year:										
369/465 (80%)	388/466 (83%)	389/465 (84%)	383/462 (83%)	382/468 (82%)	382/461 (83%)	394/461 (85%)	390/469 (83%)	383/484 (79%)	396/481 (82%)	387/463 (84%)
Percent of non-AMA population represented by CWS reports received:										
90%	92%	96%	97%	96%	93%	97%	96%	95%	96%	97%

3.D. Local Drought Impact Group Efforts

LDIGs participate in monitoring, education and local mitigation, mainly through cooperative extension and county emergency management programs. Initial planning efforts included 10 LDIGs, and as many as eight LDIGs have been active in the past. Since 2008, in response to local fiscal and staffing limitations, LDIG focus has been entirely on drought impact monitoring and reporting. Currently, Pima County and Mohave County have active LDIG programs. See **Appendix B** for the Mohave County LDIG report and **Appendix C** for the Pima County LDIG Report.

3.E. Colorado River Drought Planning Efforts

The Colorado River is a highly variable system, subject to dramatic changes in runoff from year to year. In general, the average annual natural flow of the Colorado River at Lee's Ferry over the 110-year period (water years 1906 through 2015) has averaged around 15 MAF, but has ranged from as little as 5.4 MAF to as much as 25.4 MAF in a single year. Reservior elevations of the entire Colorado River System, including Lake Mead,the primary storage reservoir for the Lower Basin States, have continued to decline in the last 18 years. Reclamation's projections indicate that this may continue into the foreseeable future.

In December 2007, the Secretary of Interior adopted the Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead (Interim Guidelines). The Interim Guidelines, which apply through 2026, define criteria for shortages in the Lower Basin based on the elevations in Lake Mead.

In 2014, the following voluntary drought mitigation planning efforts were initiated: the Pilot System Conservation Program (PSCP), Other System Conservation Water and the Lower Basin Drought Memorandum of Understanding (MOU) agreements. These efforts are focused on conserving water to be left in Lake Mead to reduce the risk of reaching critical reservoir elevations. Since their inception through 2017, Reclamation's estimates a cumulative conservation volume of 185,320 acre-feet.

Given the continued drought, the seven basin states recocognized the need for additional actions and amendments to the 2007 Interim Guidelines. In 2013, all seven basin states started joint discussions after recognizing that additional actions must be taken to supplement the Interim Guidelines and protect the Colorado River system.

Following initial negotiations, the states have decided that the Upper and Lower Basins should each develop its own Drought Contingency Plan (DCP) to address the unique conditions and challenges within their basins. The Upper Basin DCP (UBDCP) and Lower Basin DCP (LBDCP) would be implemented through a set of agreements and federal legislation.

Lower Basin Drought Contingency Plan

The LBDCP is designed to protect Lake Mead from declining to critically low elevations by requiring water delivery reductions at higher elevations than specified in the Interim Guidelines and providing enhanced incentives for conservation of water to be stored in Lake Mead by Arizona, California and Nevada.

The LBDCP was drafted through negotiation by principal representatives of the Lower Division States, certain water users, and Reclamation to develop a proposal to avoid catastrophic volumetric reductions in the Lower Basin. The LBDCP would supplement the 2007 Interim Guidelines to improve the long-term sustainability of the system.

Adoption of the LBDCP is important to Arizona, which is at risk of potentially catastrophic reductions in water deliveries if elevations in Lake Mead continue to fall to critically low elevations. To achieve this, Arizona established a Steering Committee, comprised of key water leaders, water users, and representatives from all sectors across the state, to discuss how to adopt and implement the LBDCP within Arizona in a way that is acceptable to Arizona water users.

The Steering Committee identified four essential elements needed to successfully implement the LBDCP in Arizona – Tribal Intentionally Created Surplus (ICS), Central Arizona Project (CAP) Agricultural Pool Water Mitigation, Excess Water Plan and Arizona Conservation Plan.

Discussions are ongoing, and many Arizona stakeholders are working hard to develop and finalize agreements within Arizona so that the necessary authorization from Arizona's Legislature can be obtained early in 2019.

3.F. Arizona Water Initiative Activities

The Arizona Water Initiative (Water Initiative) was implemented through Executive Order 2015-13 on December 16, 2015, and established the Governor's Water Augmentation Council (GWAC) and the Planning Area Process. The GWAC is investigating long-term water augmentation strategies and other opportunities to secure water supplies for the future. The Planning Area process is currently focused on development of improved water demand information.

Governor's Water Augmentation Council (GWAC)

GWAC members represent a wide array of experts including water providers and leaders in Arizona agriculture, mining, agribusiness, homebuilding, watershed groups and government. ADWR Director Tom Buschatzke serves as chairman. In the first year of operation, GWAC members agreed upon recommendations regarding the general operation of the GWAC and ADWR staff activities and topics of focus for the GWAC. Additional information regarding the recommendations can be obtained from any of the GWAC annual reports. As none of the recommendations have been amended or rescinded, the GWAC has continued to act in accordance with those recommendations, primarily through the activities of the four committees that were created and ADWR activities.

Desalination Committee: The original goal of the Desalination Committee was to prepare a brackish groundwater project proposal to be submitted to the GWAC for approval no later than the end of calendar year 2017. Although the Committee did not achieve this original goal, the Committee had a number of meetings to discuss opportunities for brackish groundwater desalination in the West Salt River Valley and the Yuma Groundwater Mound.

Long-Term Water Augmentation Committee: The original goal of the Long-Term Water Augmentation Committee was facilitation of a project that would establish a portfolio of statewide augmentation options. The scope of work for the project was completed, funding was secured and the consultant began work on the project in April 2018.

Recycled Water Committee: The Recycled Water Committee was tasked with evaluating the potential for augmentation through re-use and the utilization of reclaimed and poor quality water to significantly reduce future demand and supply imbalances. The committee made two recommendations regarding the underground storage of effluent to the chair of the GWAC. One recommendation was forwarded to the Governor's Office and the other recommendation was retained at the GWAC for additional discussion. The recommendation that was forwarded to the Governor's Office was related to the legislative removal of the sunset date associated with the ability to store effluent underground to obtain long-term storage credits. Additional information regarding these recommendations can be found in the GWAC annual report.

Finance Committee: The Finance Committee did not meet during this reporting period.

Planning Area Process

While the most populated areas of the State are subject to stringent groundwater management, have mandatory water conservation requirements, and generally have access to diverse water supply portfolios, most of rural Arizona relies exclusively on groundwater as its primary water source, and lacks comprehensive groundwater management regulation. The lack of targeted groundwater management along with the effects of the ongoing drought can result in water supplies being more stressed in some areas of rural Arizona.

As a part of the Planning Area Process portion of the Water Initiative, ADWR has committed resources to improving knowledge regarding water resources, including water use sector demand, in each of the 22 Planning Areas identified in the Arizona's Strategic Vision for Water Supply Sustainability.

More information regarding the Arizona Governor's Water Initiative is available at: http://www.azwater.gov/AzDWR/Arizona_Water_Initiative/index.htm.

3.G. ADWR Outreach & Assistance

ADWR Leadership Drought Activities

During water year 2018, Tom Buschatzke, ADWR Director, and Clint Chandler, ADWR Assistant Director, actively promoted drought preparedness efforts and activities around the State not only by leading many of these efforts, but also by discussing and presenting on these activities to a wide array of stakeholders, groups and organizations such as those listed below. Their discussions included topics such as Governor Ducey's Arizona Water Initiative, Arizona's water resource challenges, probabilities of a Lower Colorado River Basin shortage, and drought contingency planning. ADWR is committed to transparency and dedicated to providing water information to interested parties.

- Southern Arizona Water Users Association Water Forum, October 20, 2017
- Minute 323 Negotiating Group Meeting, October 20, 2017
- Lower Basin States Meeting, October 23, 2017
- Central Arizona Groundwater Replenishment District (CAGRD) – Quartzite Public Meeting, November 6 & 9, 2017
- CAGRD – Quartzite Public Meeting, November 9, 2017
- Drought ICG Meeting, November 16, 2017
- Water Bank Meeting, November 30, 2017 & March 21, 2018
- Binational Desalination Work Group Meeting, December 8, 2017
- Colorado River Water Users Association (CRWUA) Conference, December 13-15, 2017
- Irrigation and Electrical Districts' Association of Arizona Annual Meeting, January 5, 2018
- Phoenix Chamber of Commerce, January 16, 2018
- Minute 323 Desalination Work Group Meeting, January 25, February 28, March 14, May 18 & July 6, 2018
- Western Water Law Conference, February 8, 2018
- Minute Oversight Work Group, March 7, 2018
- Kyl Center for Water Policy Advisory Board Meeting, March 8, 2018
- Arizona-Mexico Commission (AMC) Inter-Plenary, March 20, 2018
- Maris Water Conference, April 17, 2018
- Legislative Roadshow (Safford, AZ), April 27, 2018
- Lower Basin States Meeting, May 2, 2018
- CRWUA Mid-Year Meeting, May 10, 2018
- Arizona Municipal Utilities Leadership Institute (Show Low, AZ), May 10, 2018
- Arizona Mining Associtation Annual Meeting, May 31, 2018
- Meeting with the Arizona Republic Editorial Board, June 6, 2018
- Meeting with the Colorado River Indian Tribe Leadership, June 6, 2018
- Lower Basin Drought Contingency Plan & Arizona Colorado River Water Supply, June 28, 2018
- Interview with Horizon TV to discuss the Drought Contingency Plan, July 5, 2018
- Lower Basin Drought Contingency Plan, July 10, 2018
- Lower Basin States Meeting, July 30, 2018
- Agricultural Mitigation Work Group, August 15 & 21, 2018
- Drought Contingency Plan Steering Committee, August 23, 2018
- Tribal ICS Work Group Meeting, August 31, 2018

ADWR Communication Activities

ADWR promotes and encourages efficient use of water throughout Arizona by developing conservation tools and resources, assisting Arizona communities and water providers, presenting on drought and conservation issues and solutions, collaborating with regional and national partners, and participating

in outreach activities. Staff provides materials and answers inquiries from the public, businesses, press, water professionals, students, researchers, and others about water conservation and drought. Below are a few highlighted efforts and activities conducted by ADWR staff during the 2018 water year that promoted water conservation and awareness:

Arizona Water Conservation Website Redesign

As part of ADWR's website redesign process, the Arizona Conservation Program webpages were completely revamped. Redundant or outdated pages were removed, and other applicable information was added to improve the relevancy of the site and the accessibility to conservation information. The Conservation Program website (https://new.azwater.gov/conservation) now includes these pages: Public Resources, Landscaping, Technologies, Kid's Education, Water Planners & Providers, Commercial, Industrial & Technical, and Agriculture.

Arizona Water News

ADWR's *Arizona Water News*, a weekly newsletter featuring articles regarding the latest in Arizona and Colorado River issues allows stakeholders to stay up-to-date on the latest happenings regarding Arizona water. Since its launch *Arizona Water News* articles have received over 51,371 views. Visit this link to read past news articles: https://new.azwater.gov/news.

Water Awareness Month

ADWR has coordinated Arizona's Water Awareness Month campaign since the Governor's executive order in 2008. In 2018, ADWR conservation personnel participated in and exhibited during Water Awareness Month while distributing conservation information to the public. In addition, personnel distributed free educational materials through social media and other media platforms.

Useful Websites

Arizonawaterfacts.com

This website is dedicated to promoting Arizona's success in managing its water resources, presenting current water resource challenges, and planning for the future. Arizona Water Facts is intended to build confidence in our water resources – a necessity for fostering a thriving economy and for a healthy livelihood.

https://new.azwater.gov/drought

The ADWR Drought Program website features the weekly, monthly, and quarterly drought statuses for Arizona as well as updates regarding MTC, ICG, and LDIG activities. The website also provides a historical background on drought planning in Arizona, and an archive for past drought preparedness annual reports easily accessible to the public.

Appendix A

Arizona Natural Resources Conservation Services (NRCS)

2018 Drought Report

Natural Resources Conservation Services (NRCS) 2018 Drought Report

SUMMARY OF SURVEY PROVIDED BY NRCS FIELD OFFICE'S

Prepared by E. Carrillo – Acting State Rangeland Specialist

General

A survey was sent out in early Oct. 2018 to all NRCS Field Office's in Arizona soliciting feedback on drought conditions in their respective work areas. Responses were gathered and are summarized below.

Survey questions were broad and focused on drought conditions relating to:

1) Did the office work area experience drought conditions?
2) Dryland Farming
3) Irrigation Water Supply
4) Rangeland Water Supply
5) Rangeland Conservation Practices (specifically to address drought).
6) Rangeland Forage Supply
7) Rangeland Precipitation data

Results

Of the 23 NRCS Field Office's (FO's) in Arizona 15 (65%) responded to the survey.
13 of the 15 offices reported drought conditions. **Figure A-1** depicts FOs that experienced effects of drought in their work area. Although not all offices responded, statewide coverage was attained. All counties had some, if not all, portions included in the survey.

Of the offices that participated in the survey, 87% reported their work areas experienced drought conditions. Those offices are:

- Avondale
- Chinle
- Douglas
- Flagstaff
- Fredonia
- Holbrook
- Keams Canyon
- Kingman
- Prescott
- Springerville
- Tucson
- Whiteriver
- Willcox

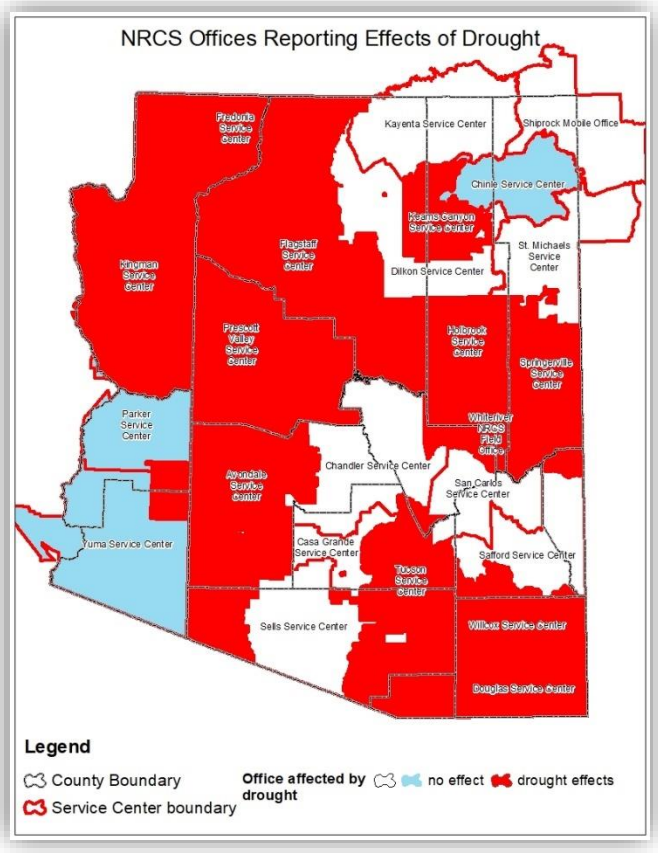


Figure A-1. Map of FO's reporting drought.

Table A-1 NRCS Field Offices and counties in respective work areas.

Field Office	Reported drought	County(ies) covered
Avondale	Yes	La Paz, Maricopa, Yavapai
Chinle	Yes	Apache, Navajo
Douglas	Yes	Cochise, Pima, Santa Cruz
Flagstaff	Yes	Coconino, Yavapai
Fredonia	Yes	Coconino, Mohave
Holbrook	Yes	Navajo
Keams Canyon	Yes	Apache, Coconino, Navajo
Kingman	Yes	Coconino, Mohave

Field Office	Reported drought	County(ies) covered
Parker	No	La Paz
Prescott	Yes	Yavapai
Springerville	Yes	Apache, Greenlee
Tucson	Yes	Cochise, Gila, Pima, Pinal, Santa Cruz
Whiteriver	Yes	Apache, Gila, Navajo
Willcox	Yes	Cochise, Graham, Pima
Yuma	No	La Paz, Yuma

Dryland Farming

Three Office's with land in dryland farming reported effects of drought. These offices are located on Indian Reservations. Crops reported to be affected are; **corn**, **bean**, **squash**, **wheat, oats** and **barley**.

Table A-2 - Dryland Farm FO's

Field Office	**Holbrook**	**Keams Canyon**	**Whiteriver**
Acres of cropland affected	300	3,000	100
% loss of crop production expected	81-100%	61-80%	20-40%

Irrigation Water Supply

10 Offices reported water supply shortages. Water sources affected were wells and surface diversions. Crops affected are: **alfalfa, cotton, tame pasture, corn, small grains, beans, pecans, apples, vegetables, sudan grass and milo**.

Percent crop loss due to drought, by Field Office, were separated into 5 classes. Classes are 0, 1-20, 21-40, 41-60, 61-80 and 81-100 percent crop loss. **Figure A-2** shows which of the NRCS offices reported crop loss by percent class. **Figure A-3** is a map depicting the geographic area of each office and percent class of crop loss.

Figure A-2. Percent crop loss by FO

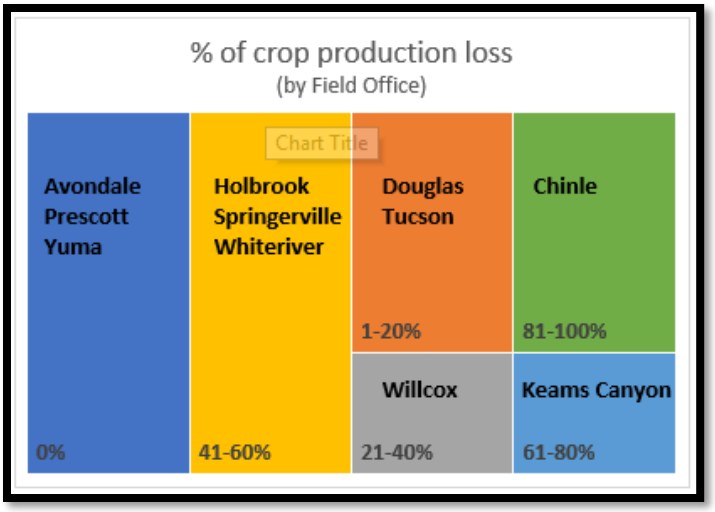
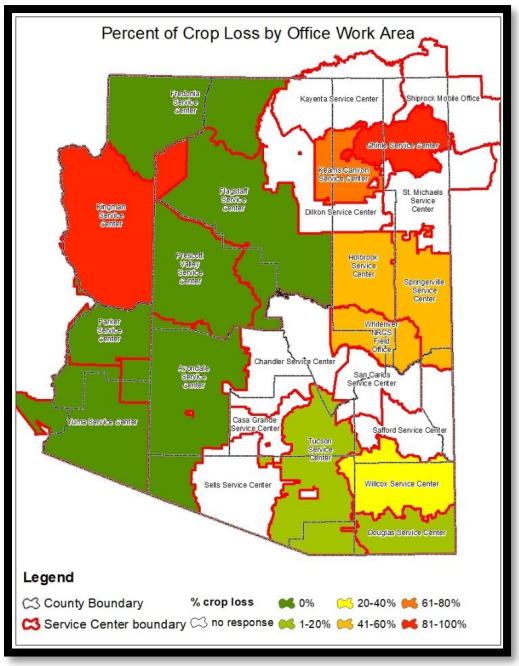


Figure A-3. Crops loss by FO



Rangeland Water Supply

12 Offices reported water supply shortage on rangelands. Sources that were affected are wells, ponds, springs, creeks/rivers and water harvest catchments. Percent classes were also used to summarize drought conditions for the following data in **Table A-3**. An additional question was asked this year in relation to rangeland water supply: "What is the primary source of livestock water in your work area?".

Offices were asked to classify the percent of their work areas without livestock water. Percent classes were 0-25%, 26-50%, 51-75% and > 75%. **Figure A-4** shows the results. Seven offices reported that 0-25% of their work area was out of livestock water, while 1 office reported > 75% of their work area out of livestock water.

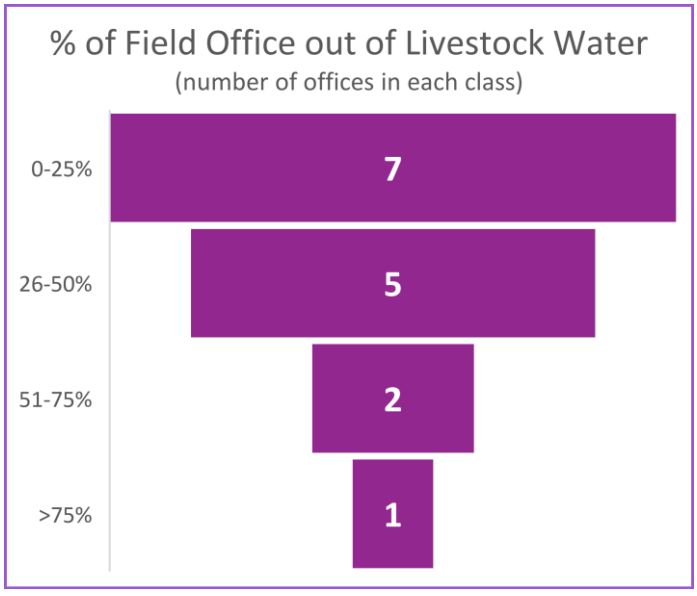
Table A-3. Rangeland Water Supply by FO

Field Office	Avondale	Chinle	Douglas	Flagstaff	Fredonia	Holbrook
% of area out of water	26-50%	0-25%	0-25%	26-50%	26-50%	51-75%
% of ranchers hauling water	0-25%	>75%	0-25%	51-75%	>75%	51-75%
% of wells dry	0-25%	0-25%	0-25%	0-25%	0-25%	0-25%
% of ponds dry	51-75%	>75%	26-50%	26-50%	51-75%	>75%
% of springs dry	0-25%	0-25%	26-50%	0-25%	0-25%	>75%
% capacity of all ponds	No data	No data	50%	No data	<40%	No data
Primary water	Well	Well	Well	Pond	Pond	Pond

Field Office	Keams Canyon	Kingman	Prescott	Springerville
% of area out of water	26-50%	26-50%	0-25%	>75%
% of ranchers hauling water	51-75%	26-50%	0-25%	26-50%
% of wells dry	26-50%	0-25%	0-25%	0-25%
% of ponds dry	>75%	>75%	26-50%	>75%
% of springs dry	51-75%	51-75%	0-25%	>75%
% capacity of all ponds	<25%	No data	20-30%	15%
Primary water source	Well	Well	Well	Well

Field Office	Tucson	Whiteriver	Willcox
% of area out of water	0-25%	51-75%	0-25%
% of ranchers hauling water	0-25%	26-50%	0-25%
% of wells dry	0-25%	51-75%	26-50%
% of ponds dry	0-25%	51-75%	0-25%%
% of springs dry	0-25%	51-75%	0-25%
% capacity of all ponds	65%	20%	40%
Primary water source	Well	Pond	Pond

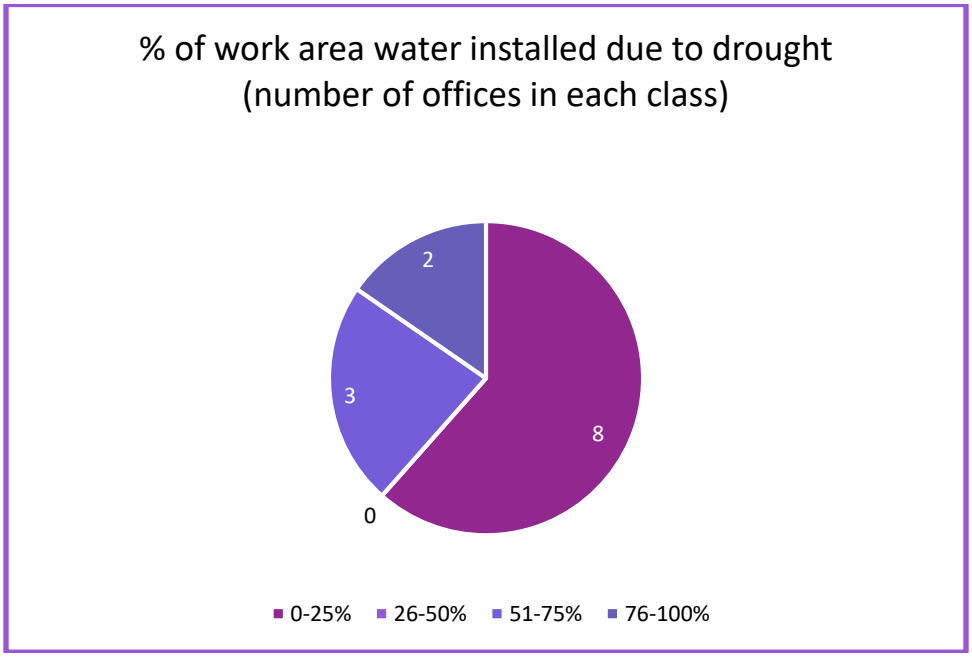
Figure A-4. Number of Offices reporting percentage of work area without livestock water.



Rangeland Conservation

This year's survey asked if any water projects on rangelands were installed in direct response to cope with drought conditions. Eight offices reported that 0-25% of their respective areas installed water projects. **Figure A-5** shows information for additional offices.

Figure A-5



Rangeland Forage Supply

Thirteen offices reported shortage of forage for livestock on rangelands. Although precipitation for this water year were at average or above average for much of Arizona, rains did not occur at the opportune time for forage growth. Many offices across the state reported poor to no existent moisture in the spring and summer. Late July brought some precipitation, but not nearly enough to sustain plant growth. Rain did not resume until August, which is close to the end of the growing season. Forage growth resumed in August and September, however, the growth was not enough to make average annual production. Forage capacity is considerably low in many parts of the State because of prolonged drought and die-off of sod base. Rains have been good the last two summers and have grown excellent forage, but the production is not adequate as large amounts of perennial forage have died. Most livestock reductions are not necessarily due to this year's lack of forage production, but are carried over from the long-term drought. **Table A-4** shows data related to forage production.

Table A-4. Forage production by FO

Field Office	**Avondale**	**Chinle**	**Douglas**
% of normal year production at spring	26-50%	0-25%	51-75%
% of normal year expected at end of growing season	26-50%	0-25$	76-100%
% of normal livestock numbers being grazed	51-75%	>100%	76-100%
% of ranchers feeding supplemental forage	51-75%	26-50%	0-25%

Field Office	**Flagstaff**	**Fredonia**	**Holbrook**
% of normal year production at spring	51-75%	51-75%	0-25%
% of normal year expected at end of growing season	26-50%	51-75%	0-25%
% of normal livestock numbers being grazed	76-100%	51-75%	26-50%
% of ranchers feeding supplemental forage	26-50%	0-25%	>75%

Field Office	**Keams Canyon**	**Kingman**	**Prescott**
% of normal year production at spring	26-50%	0-25%	51-75%
% of normal year expected at end of growing season	26-50%	26-50%	51-75%
% of normal livestock numbers being grazed	26-50%	51-75%	76-100%
% of ranchers feeding supplemental forage	51-75%	51-75%	>75%

Field Office	**Springerville**	**Tucson**	**Whiteriver**
% of normal year production at spring	0-25%	0-25%	26-50%
% of normal year expected at end of growing season	26-50%	26-50%	51-75%
% of normal livestock numbers being grazed	51-75%	26-50%	76-100%
% of ranchers feeding supplemental forage	>75%	0-25%	0-25%

Field Office	**Willcox**
% of normal year production at spring	26-50%
% of normal year expected at end of growing season	51-75%
% of normal livestock numbers being grazed	76-100%
% of ranchers feeding supplemental forage	0-25%

Ranch Precipitation

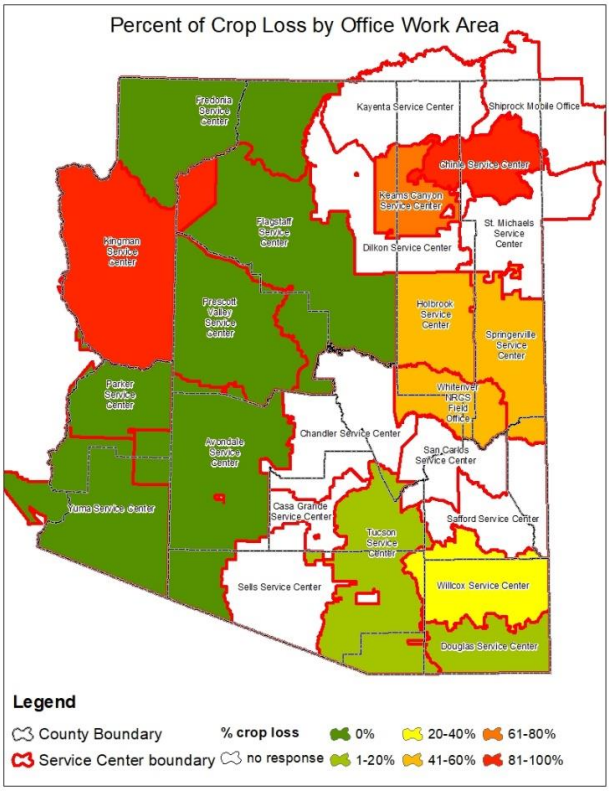
This year, nine Field Offices have reported that their clients recorded rainfall data. More ranchers are installing rain gauges across their ranches and many are coupled with vegetation monitoring sites. This information provides a better picture of spatial variability of rainfall events and amounts. **Table A-5** lists responses to the survey questions regarding rain gauge data.

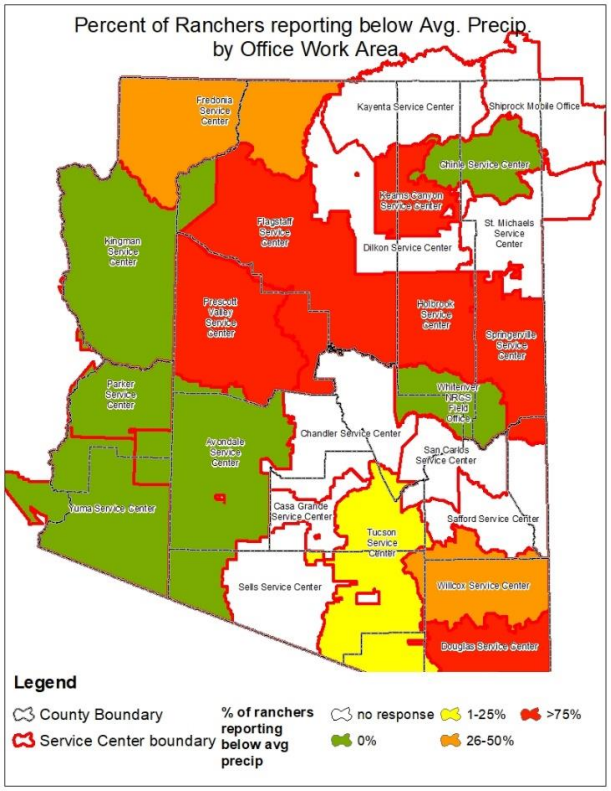
Table A-5 - Ranch precip. by FO

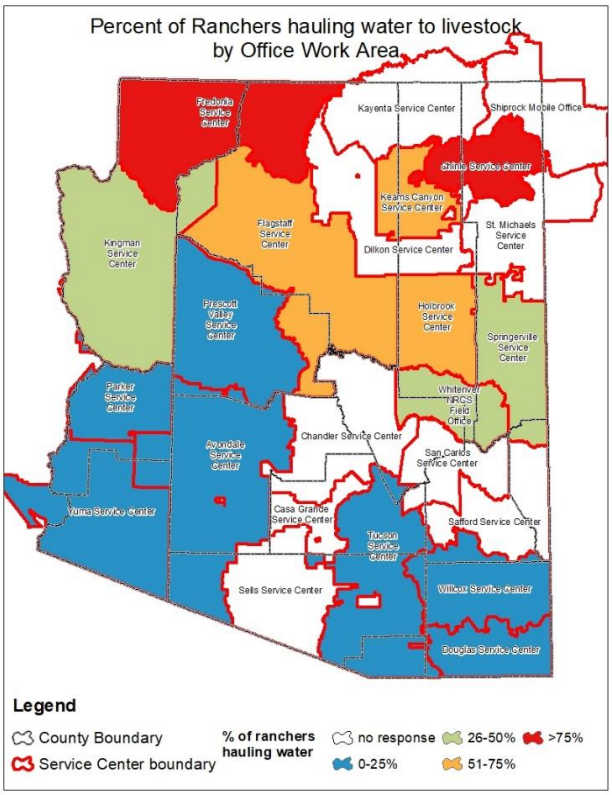
Field Office	**Douglas**	**Flagstaff**	**Fredonia**	**Holbrook**	**Keams Canyon**
% of ranchers that keep rainfall data	26-50%	0-25%	0-25%	>75%	26-50%
% below average precipitation	>75%	>75%	26-50%	>75%	>75%
Did rain occur at the right time and amount for forage growth?	No	No	Yes	No	No

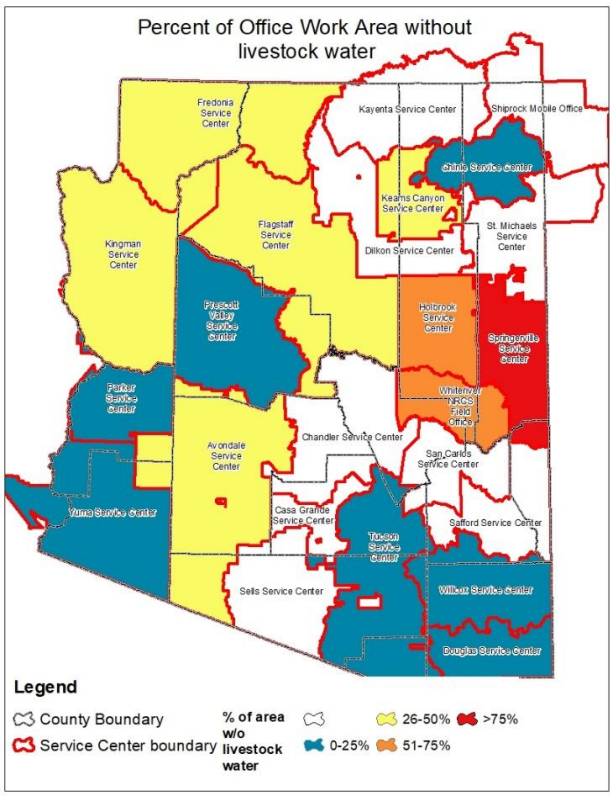
Field Office	**Prescott**	**Springerville**	**Tucson**	**Willcox**
% of ranchers that keep rainfall data	26-50%	>75%	>75%	0-25%
% below average precipitation	>75%	>75%	1-25%	26-50%
Did rain occur at the right time and amount for forage growth?	No	No	No	No

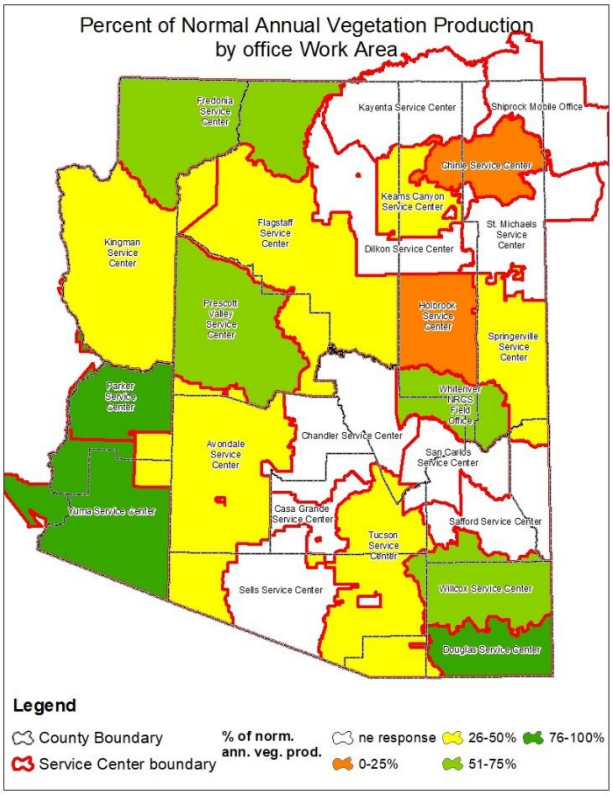
Maps

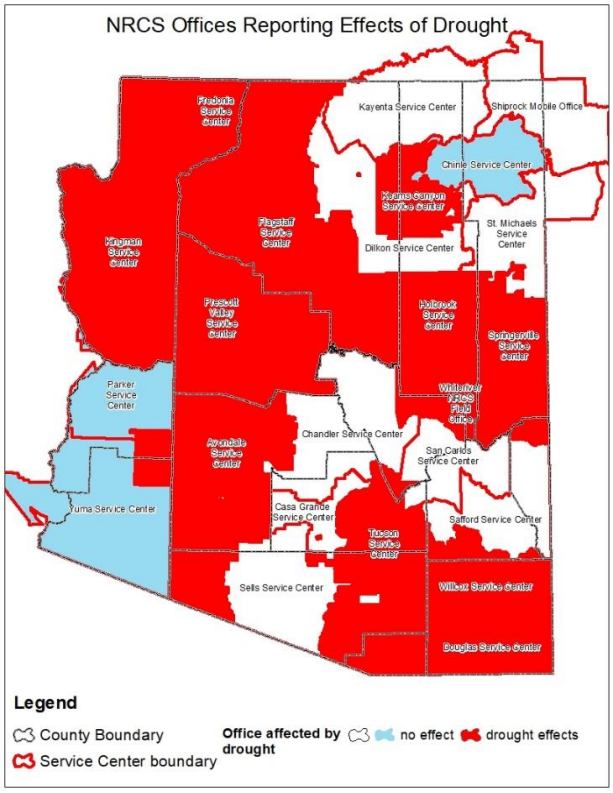

Percent of Crop Loss by Office Work Area
Fredonia Service Center
Kayenta Service Center
Shiprock Mobile Office
Chinle Service Center
Keams Canyon Service Center
St. Michaels Service Center
Flagstaff Service Center
Dilkon Service Center
Kingman Service Center
Prescott Valley Service Center
Holbrook Service Center
Springerville Service Center
Parker Service Center
Whiteriver NRCS Field Office
Chandler Service Center
Avondale Service Center
San Carlos Service Center
Yuma Service Center
Casa Grande Service Center
Safford Service Center
Tucson Service Center
Sells Service Center
Willcox Service Center
Douglas Service Center
Legend
County Boundary
Service Center boundary
% crop loss
no response
0%
1-20%
20-40%
41-60%
61-80%
81-100%


Percent of Ranchers reporting below Avg. Precip. by Office Work Area
Fredonia Service Center
Kayenta Service Center
Shiprock Mobile Office
Chinle Service Center
Keams Canyon Service Center
St. Michaels Service Center
Flagstaff Service Center
Dilkon Service Center
Kingman Service Center
Prescott Valley Service Center
Holbrook Service Center
Springerville Service Center
Parker Service Center
Whiteriver NRCS Field Office
Chandler Service Center
Avondale Service Center
San Carlos Service Center
Yuma Service Center
Casa Grande Service Center
Safford Service Center
Tucson Service Center
Sells Service Center
Willcox Service Center
Douglas Service Center
Legend
County Boundary
Service Center boundary
% of ranchers reporting below avg precip
no response
0%
1-25%
26-50%
>75%


Percent of Ranchers hauling water to livestock by Office Work Area
Fredonia Service Center
Kayenta Service Center
Shiprock Mobile Office
Chinle Service Center
Keams Canyon Service Center
St. Michaels Service Center
Flagstaff Service Center
Dilkon Service Center
Kingman Service Center
Prescott Valley Service Center
Holbrook Service Center
Springerville Service Center
Parker Service Center
Whiteriver NRCS Field Office
Chandler Service Center
Avondale Service Center
San Carlos Service Center
Yuma Service Center
Casa Grande Service Center
Safford Service Center
Tucson Service Center
Sells Service Center
Willcox Service Center
Douglas Service Center
Legend
County Boundary
Service Center boundary
% of ranchers hauling water
no response
0-25%
26-50%
51-75%
>75%


Percent of Office Work Area without livestock water
Fredonia Service Center
Kayenta Service Center
Shiprock Mobile Office
Chinle Service Center
Keams Canyon Service Center
St. Michaels Service Center
Flagstaff Service Center
Dilkon Service Center
Kingman Service Center
Prescott Valley Service Center
Holbrook Service Center
Springerville Service Center
Parker Service Center
Whiteriver NRCS Field Office
Chandler Service Center
Avondale Service Center
San Carlos Service Center
Yuma Service Center
Casa Grande Service Center
Safford Service Center
Tucson Service Center
Sells Service Center
Willcox Service Center
Douglas Service Center
Legend
County Boundary
Service Center boundary
% of area w/o livestock water
0-25%
26-50%
51-75%
>75%


Percent of Normal Annual Vegetation Production
by office Work Area
Fredonia Service Center
Kayenta Service Center
Shiprock Mobile Office
Chinle Service Center
Keams Canyon Service Center
St. Michaels Service Center
Dilkon Service Center
Kingman Service Center
Flagstaff Service Center
Prescott Valley Service Center
Holbrook Service Center
Springerville Service Center
Parker Service Center
Whiteriver Agency Field Office
Chandler Service Center
Avondale Service Center
San Carlos Service Center
Yuma Service Center
Casa Grande Service Center
Tucson Service Center
Safford Service Center
Sells Service Center
Willcox Service Center
Douglas Service Center
Legend
County Boundary
Service Center boundary
% of norm. ann. veg. prod.
ne response
0-25%
26-50%
51-75%
76-100%


NRCS Offices Reporting Effects of Drought
Fredonia Service Center
Kayenta Service Center
Shiprock Mobile Office
Chinle Service Center
Keams Canyon Service Center
St. Michaels Service Center
Dilkon Service Center
Kingman Service Center
Flagstaff Service Center
Prescott Valley Service Center
Holbrook Service Center
Springerville Service Center
Parker Service Center
Whiteriver Agency Field Office
Chandler Service Center
Avondale Service Center
San Carlos Service Center
Yuma Service Center
Casa Grande Service Center
Tucson Service Center
Safford Service Center
Sells Service Center
Willcox Service Center
Douglas Service Center
Legend
County Boundary
Service Center boundary
Office affected by drought
no effect
drought effects

Appendix B

Mohave County Local Drought Impact Group

2018 Annual Report

Mohave County Local Drought Impact Group

Annual Report 2018

Introduction

This report summarizes the Local Drought Impact Group (LDIG) activities conducted in Mohave County in 2018. The LDIG is an informal advisory body to the Mohave County Risk and Emergency Management Department and the County Extension Office.

The University of Arizona County Extension Agent, Andrew Brischke and Climate Extension Specialist, Dr. Mike Crimmins, survey the local ranching community bi-weekly or monthly (depending on the season) to keep informed about current drought conditions and impacts. Impact reports are summarized and recommendations are suggested to the authors of the US Drought Monitor (USDM).

Status of Drought

Coming off a relatively productive monsoon season in 2017, the 2018 water year had an abysmal start. Throughout most areas in Mohave County, no precipitation was received from early September 2017 until well into January or February where only relatively minor events occurred. USDM started documenting abnormally dry conditions in Mohave County to the west as early as late October. By early December, all of Mohave County was in Moderate Drought. The Arizona Strip region north of the Colorado River was the first to experience Severe Drought in Mohave County. By the end of March, the southern areas of Mohave County were downgraded to Extreme Drought conditions. Precipitation from the monsoon season was about average in most areas. However, due to the Extreme Drought conditions from the winter and spring seasons, long-term drought persisted at the end of this water year throughout Mohave County with all areas in at least Moderate Drought and ranging to Extreme Drought in the southern areas of the county.

Drought Impacts

The lack of precipitation from fall through the summer monsoon season resulted in agricultural, hydrologic, and economic drought impacts to varying degrees. Drought Emergency Declaration remains in effect for Arizona based on long-term precipitation deficits, along with ongoing short-term negative impacts across the state. The short-term drought impacts early in the year triggered drought mitigation plans of varying degrees through local, county, state, and federal agencies.

Agricultural drought that occurred more locally included many ranchers reporting no to very little growth on cool season perennials, winter annuals, and shrubs that experienced unseasonable leaf drop and perhaps mortality due to drought stress, which severely affected their forage base. In more severe cases, ranchers were forced to sell animals due to lack of forage or water resources. Summer monsoons seemed to have produced enough adequate forage to carry ranchers through the spring growing season.

Despite extremely severe wildland fire threat due to Moderate to Extreme Drought conditions there were no large fires in Mohave County. However, Hualapai Mountain Park is experiencing

a bark beetle outbreak which typically occurs when trees have experienced extreme or prolonged water stress from drought conditions.

Hydrologic drought observed by respondents included stock tanks and ponds for livestock and wildlife going dry and ranchers having to haul water until larger monsoon events were able to fill the tanks and ponds.

Economic impacts were seen with many ranchers having to sell more of their herd than under average conditions. Drought Emergency Declarations and other federal drought relief programs were triggered by the USDM including the Livestock Forage Disaster Program, Emergency Loan Program and tax deferral programs, as well as other drought insurance programs.

Drought Related Actions

Prior to monsoon season precipitation, municipalities and agencies triggered their drought mitigation responses to varying degrees. Despite average precipitation during the monsoon season, much of Mohave County remains in Moderate to Extreme Drought. There appear to be no extensive mitigation measures in effect by Mohave County municipalities at the time of this report.

Appendix C

Pima County Local Drought Impact Group

2018 Annual Report

Pima County Local Drought Impact Group

2018 Annual Report

The Pima County LDIG has been an active component of County operations since 2006 when the Board of Supervisors adopted the Drought Response Plan and Water Wasting Ordinance (Chapter 8.70).

The LDIG consists of water providers and local, state and federal agencies that have an interest in the cause and effect of drought conditions in Pima County. LDIG meets bimonthly to monitor the short-term and long-term drought status, discuss drought impacts and coordinate drought declarations and responses.

The County's Drought Response Plan and Water Wasting Ordinance established a four-stage trigger category that corresponds to the USDM Report and its degradation of drought conditions. Each Stage degradation within the county triggers drought stage reduction measures.

The LDIG explores the impacts of drought on various sectors in Pima County including agricultural water use, ranching, wildfire, hydrology, and flooding. Because many water providers depend on Central Arizona Project water, the LDIG also monitors the status of the Colorado River, El Niño Southern Oscillation (ENSO) and other climate weather patterns in relation to their effect on drought conditions and climate variability in the southwest. The LDIG also monitors the status of the summer monsoon season and convenes roundtable discussions of drought and water conservation outreach programs. For a list of presentations and agendas, please visit Pima County's LDIG website:

http://webcms.pima.gov/cms/one.aspx?portalId=169&pageId=70243

This report is provided for inclusion in the Arizona Drought Preparedness Annual Report and submitted to the Pima County Administrator's Office.

Weather (National Weather Service-Tucson)

In Pima County, the 2018 water year began following a warm and dry period from mid-August through September that would lead into a record warm and dry fall season (**Fig. C-1**). October 2017 was warm with temperature extremes and a few scattered showers but no officially recorded rainfall. November was dry and the warmest on record as high-pressure systems brought excessive heat. Fall 2017 was the hottest and driest on record. Record heat and dryness continued through January 2018.

February lurched from average high temperatures of 10.9º above normal and no rain to average highs 6.6º below normal and localized rainfall, ranging 2-6", due to Pacific systems moving in sub-tropical moisture. Despite the late month cooling, Winter 2017-2018 ended as the warmest on record. A dry Pacific system lowered temperatures in March but heat returned in April along with record dryness. With similar conditions in May, Spring 2018 ended as the driest on record and 4th warmest.

In mid-June, leftover hurricane moisture ended a dry streak of over 100 days, with 0.71" above normal rainfall for the month. Monsoon activity brought normal rainfall with localized amounts as high as 5". August weather delivered the first above normal rainfall for that month in over a decade. Overall, Summer 2018 had an inch above normal rain and was ranked as the 7th warmest.

September high pressure brought a near record streak of triple digit temperatures as well as reduced thunderstorm activity until moisture from Hurricane Rosa poured into the state, though in Tucson the month ended with below normal precipitation. Overall, the 2018 water year total precipitation was 9.59" with the normal being 11.59", or 2.00" below normal.

Precipitation (in inches, recorded at Tucson Intl Airport)

WY17-18	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Precip.	0.00	0.09	0.50	0.02	1.96	0.00	0.00	0.00	0.91	2.26	2.71	1.14
PrecipNorm	0.89	0.57	0.93	0.94	0.86	0.73	0.31	0.23	0.20	2.25	2.39	1.29
D+/-	-0.89	-0.48	-0.43	-0.92	1.10	-0.73	-0.31	-0.23	0.71	0.01	0.32	-0.15
C	-0.89	-1.37	-1.80	-2.72	-1.62	-2.35	-2.66	-2.89	-2.18	-2.17	-1.85	-2.00
Rank	1st Dry	34th Dry	54th Dry	14th Dry	10th Wet	1st Dry	1st Dry	1st Dry	11th Wet	51st Wet	35th Wet	58th Wet

Average Temperature (in °F, recorded at Tucson Intl Airport)

WY17-18	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
AvgTemp	77.3	69.1	57.3	59.1	57.5	63.0	72.6	78.5	86.8	89.0	86.5	84.9
TempNorm	71.0	59.8	51.9	52.6	55.3	60.1	67.0	76.0	84.8	87.0	85.3	81.6
D+/-	6.3	9.3	5.4	6.5	2.2	2.9	5.6	2.5	2.0	2.0	1.2	3.3
Rank	2nd Hot	1st Hot	2nd Hot	1st Hot	19th Hot	15th Hot	2nd Hot	11th Hot	14th Hot	8th Hot	15th Hot	1st Hot

2017-2018 Season Ranking (NWS-Tucson)

WY17-18	Fall	Winter	Spring	Summer	Monsoon
Precp Rank	1st Dry	49th Wet	1st Dry	31st Wet	37th Wet
Temp Rank	1st Hot	1st Hot	4th Hot	7th Hot	8th Hot

Pima County Drought Conditions

WY 17-18	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Short Term	D1(57) D0(43)	D1(90) D2(10)	D1(90) D2(10)	D1(90) D2(10)	D2(73) D3(27)	D2(73) D3(27)	D2(73) D3(27)	D2(70) D3(30)	D3(80) D2(20)	D3(80) D2(20)	D2(80) D1(20)	D2(80) D1(20)
Long Term	D2, D3	D2, D3	D2, D3	D3, D4	D3, D4	D3, D4	D3, D4	D3, D4	D3, D4	D3, D4		

D0-Abnormally Dry, D1-Moderate, D2-Severe, D3-Extreme, D4-Exceptional. (percentage)

Figure C-1. Precipitation, average temperature, seasonal rankings, and drought conditions for Pima County for WY 2018.

Pima County Drought (US Drought Monitor & Monitoring Technical Committee)

Short-Term

The 2018 water year started with a mix of Moderate Drought in western Pima County and an eastern pocket of Abnormally Dry. Through November, Moderate drought expanded across all of Pima County as Severe Drought began in the southwest corner. By late January, there was rapid development of Severe Drought covering the County with Extreme Drought in the southwest corner. In May, Extreme Drought expanded from the northwest all across Pima County leaving only a small area of Severe Drought in the eastern portion. By August, Extreme Drought had receded to the west leaving Moderate and Severe Drought conditions in the east. Improvement continued through August and remained steady through September as the County recovered from Extreme Drought leaving Severe Drought and a small eastern portion of Moderate Drought.

Long-Term

From October to December of 2017, western Pima County was in Extreme and Severe Drought radiating to the east with only small portions of Moderate drought in the northeast and southeast corners. By January, Exceptional Drought had developed in the western areas. Drought condition continued unchanged through June 2018.

Colorado River Basin & Central Arizona Project

Table C-1. Pima County CAP Water (acre feet annually).

CAP Agriculture Pool	
Cortaro Marana Irrigation Dist.	4,313
Farmers Investment Co.	2,323
Kai-Avra Farm	1,575
BKW Farms	1,226
Kai-Red Rock Farm	750
Total	10,187
CAP NIA Water	
Freeport	5,678
Rosemont Copper	1,124
Town of Marana	515
Total	7,317
CAP Tribal Allocations	
Tohono O'odham	74,000
Pascua Yaqui	500
Total	74,500
CAP M&I Contracts	
City of Tucson	144,191
Metro DWID	13,460
Town of Oro Valley	10,305
Spanish Trail Water Co.	3,037
Community Water Co-Green Valley	2,858
Flowing Wells Irrigation Dist.	2,854
Town of Marana	2,336
Green Valley DWID	1,900
Vail Water Co.	1,857
Total	182,798

Impact in Pima County

Wildfire

Southern Arizona's fire season activity decreased in 2018 in comparison to previous years. Southen Arizona wildfires burned over 75,000 acres in 2017, the Sawmill and Burro fires accounting for most of that total. In 2018, the total acreage was a tenth of that at just over 7,500 acres.

Agriculture and Ranching

Agriculture in Pima County is largely irrigated and there are six permitted groundwater savings facilities using CAP water. There were no agricultural drought impacts reported.

Groundwater

Pima County Regional Flood Control District (RFCD) monitors groundwater levels within various watersheds to help assess the effects of climate and land use changes on the overall health of floodplains in Pima County. There are a few areas of shallow groundwater in the region along Cienega Creek, Davidson Canyon, and Tanque Verde Creek. Groundwater levels have recovered in many of the areas since 2014 though there is an established long-term downward trend in groundwater levels for most of the areas. RFCD will continue to monitor to ascertain whether the more recent recoveries are just a temporary delay in a downward trend.

Energy

In August, the western energy market was disrupted by heat and wildfire in California causing supply problems as less energy was available to western states. Power companies were not able to prepare for the pricing and availability problems. For several days power companies in southern Arizona asked customers to do everything possible to conserve energy in order to prevent a brownout.

Kino Environmental Restoration Project (KERP)

KERP is an environmental restoration project that harvests urban storm water and controls flooding in Tucson. KERP covers 141 acres with 28 acres of open water and riparian habitat. A central pond banks storm water and stores the water for irrigation within the KERP basin and Kino Park. The six acre "Deep Pond" is 50' deep when full. This year, KERP had no inflow from mid-August through January and the pond receded to two acres; a record dry period that has not occurred since the project was completed in 2002.

Cienega Creek

Cienega Creek, in eastern Pima County, continues to show the impacts of sustained drought. Pima Association of Governments' (PAG) drought reporting uniquely depicts the localized drought impacts on a shallow groundwater dependent system, important for habitat and rural residents dependent on this water source. With long-term support and interest from its member jurisdictions, PAG has consistently monitored the shallow groundwater-dependent riparian area of Cienega Creek Preserve on a monthly and quarterly basis since 1989 and reported the findings to ADWR for compilation into state records.

In the monitoring year 2017-2018, PAG observed a decrease in Cienega Creek's and Davidson Canyon's perennial flow extent. Both are Arizona Outstanding Waters. Monitoring during the driest time of year (May/June) maps the segments that contain perennial (year-round) surface water. PAG's long-term consistent inventory of Cienega's hydrologic conditions shows a long-term downward trend. To illustrate, in June 2018, Cienega Creek flows were present in less than 15% of the 9.5-mile monitoring area, which had flowed perennially in 1985. Since 2010, during the wettest season of the year, Cienega Creek's base flow has only reached up to 4 miles

of flow. In Davidson Canyon, 2010 to 2016 were peak drought years in which the perennial segment occasionally stopped flowing during the driest part of the year, with flowing extent ranging from 0.00 to 0.033 miles in June. In June 2017, there was recovery with 0.124 miles of flow but a drop to 0.077 miles in 2018.

The graphs below illustrate the history of decline in annual discharge from Cienega Creek (**Fig. C-2**) and drought conditions (**Fig. C-3)**. Medium annual discharge was measured at the Pantano gage. The Evaporative Demand Drought Index (EDDI) shows drought conditions (in red) and increased occurrence since 2000 (green box). Higher positive values on the Y axis indicate more extreme drought.

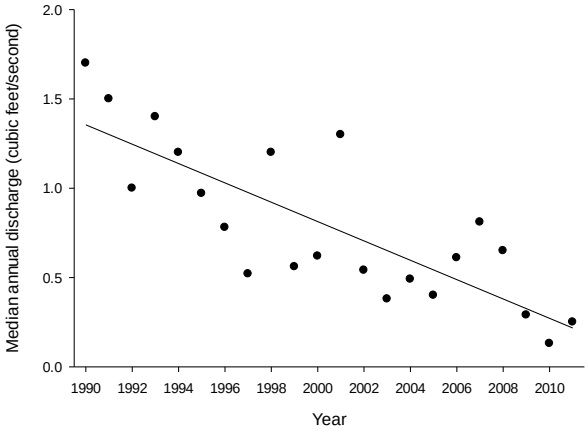


Figure C-2. Historical decline trend in annual discharge from Cienega Creek.

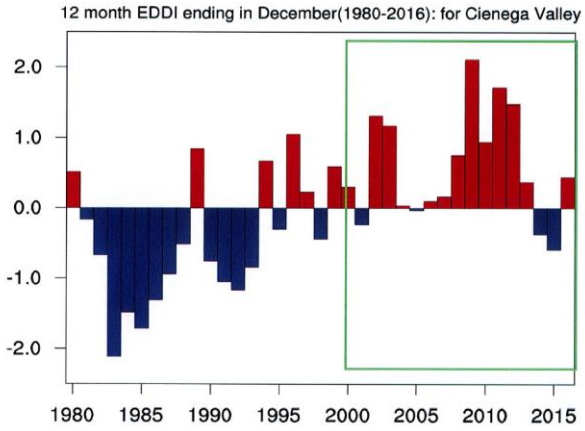


Figure C-3. Drought conditions from the Evaporative Demand Drought Index.

Agua Caliente Park

Agua Caliente Park, located northeast of Tucson, has historic and cultural significance. The park's focal point is a natural artesian spring that feeds a creek and produces an abundant variety of oasis vegetation and a habitat for native species. The natural spring originally flowed naturally into two constructed ponds dating to the late 1800s, but in recent years, the spring has stopped flowing. Water is currently being pumped to feed the first pond to maintain the wetland habitat, which also produces a recreational element for neighborhood residents and park visitors. Well pumping, however, only sustains one pond after failure of the spring.

Over the last few years, the well discharge was increased to maintain the main pond at Agua Caliente Park. In order to reduce water loss at a second pond, it was divided into two separate lined ponds. A natural unlined area was retained for seasonal wildlife habitat. The well discharge has maintained the main pond and one lined pond. A proposed plan to renovate and seal the main pond at Agua Caliente Park will help reduce groundwater pumping.

Sabino Canyon

Sabino Canyon is a popular destination and tourist attraction in the Coronado National Forest northeast of Tucson with numerous hiking trails along Sabino Creek. Due to the dry fall and winter, Sabino Creek had no stream flow for 153 days, beginning in mid-September and finally recording measured flow from February's precipitation.

Drought Response Actions

Pima County Regional Wastewater Reclamation Department (RWRD) produces highly treated reclaimed water that is reused in three ways; direct reuse in the reclaimed system, aquifer

replenishment through recharge, and for environmental projects. A significant portion of reclaimed water is released into the Lower Santa Cruz River. Storm water runoff provided over 15,000 acre feet of water to the river during the water year, whereas discharge of effluent provided around 40,000 acre feet. Daily discharges of reclaimed water have maintained persistent flows along the channel downstream of the two County water treatment facilities despite the regional drought. Discharges to the river decreased by an average of 11% from a 2013 baseline.

Pima County continues to support Conserve to Enhance (C2E), which urges water conservation that translates into donations to support environmental enhancement. C2E participants have saved 10 million gallons of water since the program inception in 2011, through conservation strategies ranging from behavioral changes to rainwater harvesting installations. C2E has awarded funding to local neighborhood projects totaling approximately $100,000 in investment. Pima County employees can now donate to C2E through the County's Employees Combined Appeal Program (ECAP).

The Conservation Effluent Pool (CEP) is an effluent allocation set aside pursuant to intergovernmental agreements between the City of Tucson and Pima County for use in riparian restoration projects. No recent formal requests for CEP projects have been submitted. In 2017, the Gila topminnow was detected in the Santa Cruz River and confirmed by subsequent surveys in the effluent stream. CEP water may be useful in maintaining a minimal flow that would safeguard this endangered species.

Pima County continues to adhere to its policy framework regarding water resources and drought management. This framework includes goals and recommendations from planning documents and annual reports cataloging progress and resources. These documents are posted on the County's Drought Management webpage:

- Water and Wastewater Infrastructure, Supply and Planning Study, Action Plan and Annual Report Cards
- Water Resources Asset Management Plan
- Strategic Plan for Use of Reclaimed Water
- Sustainable Action Plan for County Operations
- Drought Response Plan and Water Wasting Ordinance

The County is currently updating its Strategic Plan for Use of Reclaimed Water to account for population growth and infrastructure development resulting in changes to effluent volumes in different regions of Pima County. The updated Plan will project future effluent supply and demand and recommend actions to maximize effluent use at both metropolitan and regional water reclamation facilities.

An Underground Storage Facility (USF) application for the Green Valley Water Reclamation Facility was withdrawn to be resubmitted pending data collection for hydrologic modeling.

Pima County Resolutions 2017-39 and 2017-51 reaffirm the County's commitment to address climate change and align County operational efforts and Sustainable Action Plan with the Paris Agreement to reach carbon emissions reduction targets. As part of this effort, the County plans to install green infrastructure on County property and right of ways. The Green Infrastructure and Low Impact Development with Trees (GI-LID+Trees) report was drafted by an inter-departmental working group to identify and recommend appropriate sites for GI and tree installations. The report analyzes return on investment from the financial, social and environmental benefits. Pilot projects have been approved and the project has been expanded.

In order to ensure the County is prepared for water resource impacts resulting from climate change, staff reviewed drought management strategy in relation to current and expected climate change risks to various sectors, producing a Drought and Climate Change report which can be found here:

http://webcms.pima.gov/UserFiles/Servers/Server_6/File/Government/Drought%20Management/DroughtClimateChange_PC.pdf.

In the past twenty years, Pima County has experienced a 14% decline in precipitation, a deficit of 34.81" of rain. During the same time, annual average temperatures have been increasing, part of the long-term trend evident for decades (departure from average annual precipitation and temperature graphs in **Fig. C-4**). The four-year period of 2014-2017 ranks as the warmest on record. As a connection is extrapolated between the probability of increased drought and severity of impacts and higher temperature, County drought management strategy will be informed by accepted climate and drought research and adaptation and mitigation strategies.

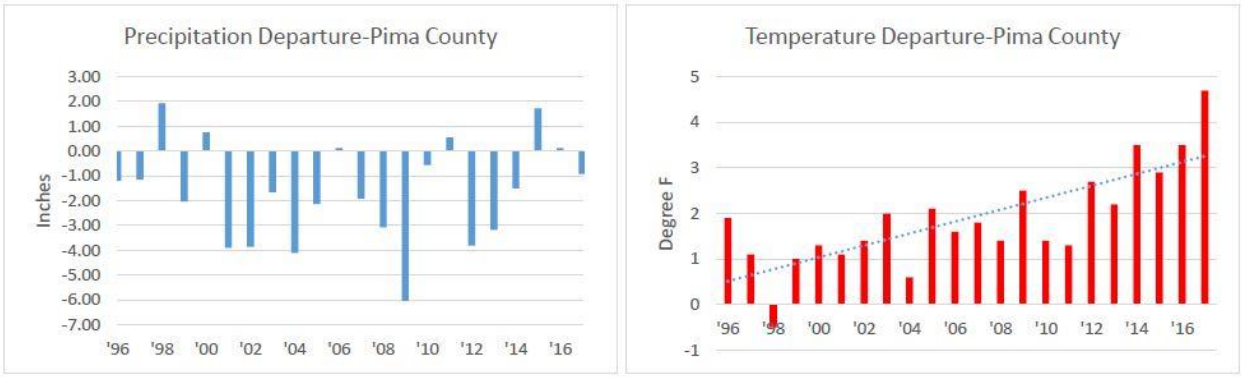


Figure C-4. Precipitation and temperature departure from average, Pima County 1996-2017.

Source: NOAA National Centers for Environmental information, 1981-2010 mean.

The Lower Santa Cruz River Management Plan (LSCRMP) is purposed to develop a management strategy to balance flood risk management, drainage infrastructure protection, water recharge, recreation opportunities and riparian habitat preservation for the Santa Cruz River from Grant Road to Trico Road. This multi-benefit project will maximize recharge of effluent within the channel. Stakeholder comments have been received and responsible parties are collaborating on a task list.

Pima County is acting as co-manager with the Bureau of Reclamation in a three-year study of the Lower Santa Cruz River Basin (LSCRB). The in-kind study offers Reclamation's technical expertise in applying climate change models to water supply and demand scenarios, charting the potential range of water imbalance in the region and developing adaptive management strategies to mitigate imbalance and climate change.

As of now, many of the region's water providers and other entities with established drought plans are at Drought Stage 1 or its equivalent (voluntary reductions).

Summary

Pima County had a record warm fall and winter along with a record dry spring. Monsoon activity was not sufficient to overcome a water year precipitation deficit. Severe drought persisted from February through September. While the fire season in Pima County was minimal, creeks and springs are continually impacted by each year of drought.

Pima County has effective water resource and drought management plans established with new management plans and studies underway to maximize efficient use of available water resources. The County will continue to monitor local, state and regional drought conditions, assess direct and indirect impacts and analyze cascading effects.