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December Southwest Climate Outlook

Monthly Precipitation and Temperature: November precipitation was much above average in Arizona except for a pocket of below average precipitation in the four corners region. New Mexico was mostly above average or much above average (Fig. 1a). November temperatures were above average or much above average in most of Arizona and ranged from average to much above average in most of New Mexico (Fig. 1b). The daily average temperature anomalies for Nov 1 – Dec 18 (Fig. 2) highlight the fluctuations at select stations around the region.

Fall 2019: Fall precipitation (Sept-Nov) in Arizona ranged from much below average in the four corners region to much above average or even record wettest in the southern third of the state (Fig. 3a). Fall precipitation for New Mexico was average to below average in the northern third, and average to much above average across the rest of the state (Fig. 3a). Fall temperatures were generally above average across Arizona and New Mexico (Fig. 3b).

Annual: Total precipitation (Jan-Nov 2019) was mostly average to above average in Arizona except for the four corners region. New Mexico was average to below average across most of the state (Fig. 4a). Mean temperatures are mostly average to above average in Arizona and above average to much above average in New Mexico (Fig. 4b).

Snowpack & Water Supply: As of Dec 17, there is a wide range of snowpack values across Arizona and New Mexico, with more consistent above median snowpack in northern New Mexico and into Utah and Colorado (Fig 5). Many reservoirs in the region are at or above the values recorded this time last year, but most are below their long-term average (see reservoir storage on p. 4).

Drought: The Dec. 10 U.S. Drought Monitor (USDM) has scaled back some of the drought characterizations in the Southwest, particularly in southern Arizona and New Mexico (Fig. 6). This reflects the wetter than normal conditions in November, but it remains to be seen whether this pulse of moisture provides any substantive and long-term drought relief for the affected regions. A large pocket of "Severe Drought" (D2) remains centered on the Four Corners region, reflecting acute and accumulated precipitation deficits.

ENSO Tracker: Oceanic and atmospheric conditions are generally consistent with an ENSO-neutral outlook for 2019 and into 2020 (see ENSO-tracker on p. 3 for details).

Precipitation and Temperature Forecast: The three-month outlook for January through March calls for increased chances of below-normal precipitation along the U.S.-Mexico borderlands, Southern California, and eastern New Mexico, with equal chances of above or below normal precipitation across much of the rest of the Southwest. (Fig. 7, top). The three-month temperature outlook calls for increased chances of above-normal temperatures across most of Texas, New Mexico, and Southeastern Arizona, along with much of north central Mexico (Fig. 7, bottom).

Tweet Dec 2019 SW Climate Outlook

CLICK TO TWEET

DEC2019 @CLIMAS_UA SW Climate Outlook, ENSO Tracker, AZ & NM Reservoir volumes, Environment and Society Graduate Fellows - https://bit.ly/390wuTJ #SWclimate #AZWX #NMWX

December 2019 SW Climate Outlook

Online Resources

Figures 1,3-4
National Centers for Environmental Information
ncei.noaa.gov

Figure 2
Climate Assessment for the Southwest
climas.arizona.edu

Figure 5
Natural Resources Conservation Service
nrcs.usda.gov

Figure 6
U.S. Drought Monitor
droughtmonitor.unl.edu

Figure 7
Intl. Research Institute for Climate and Society
iri.columbia.edu

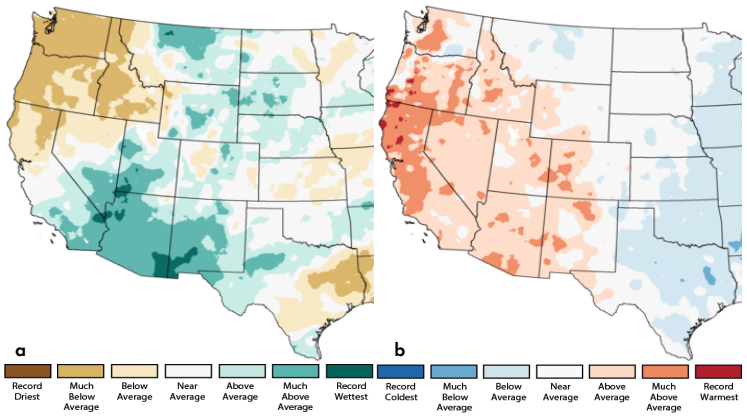


Figure 1: Nov 2019 Precipitation (a) & Temperature Ranks (b)

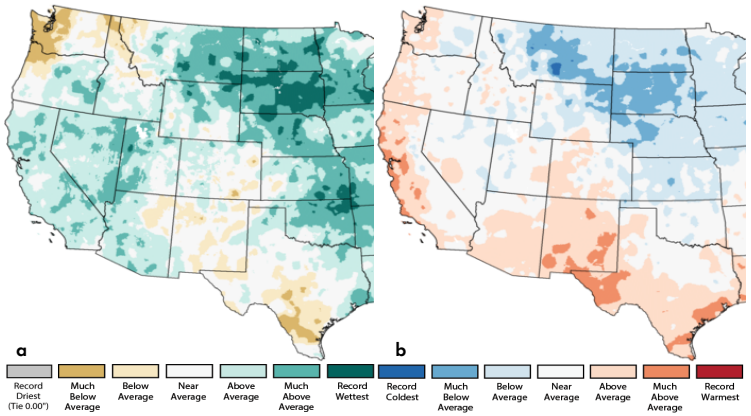


Figure 4: 2019 (Jan - Nov) Precipitation (a) & Temperature Ranks (b)

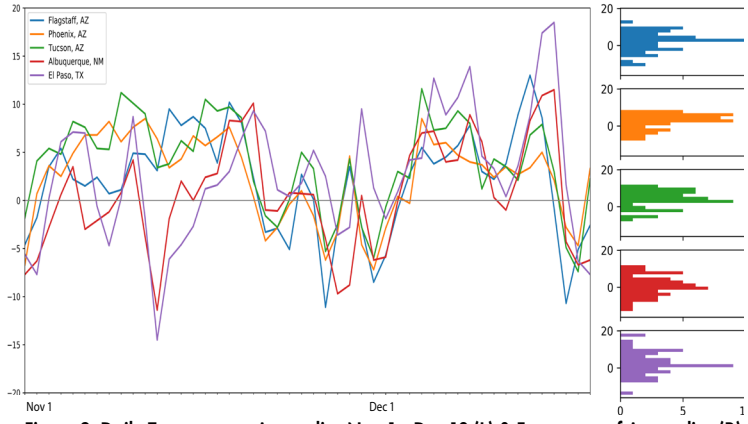


Figure 2: Daily Temperature Anomalies Nov 1 - Dec 18 (L) & Frequency of Anomalies (R)

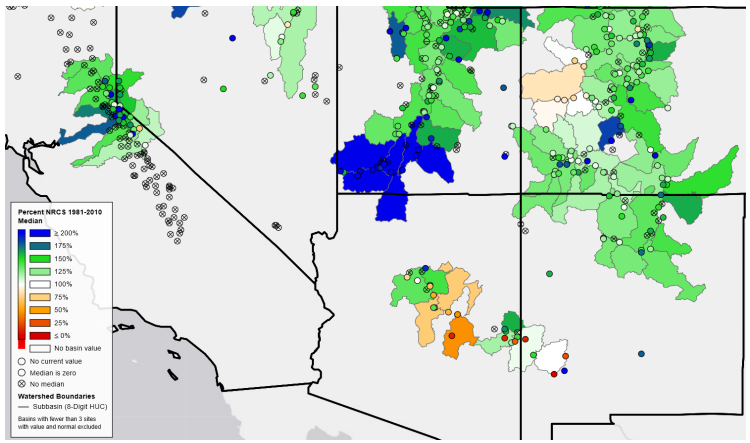


Figure 5: Dec 17 Snow Water Equivalent (Pct. 1981-2010 Median)

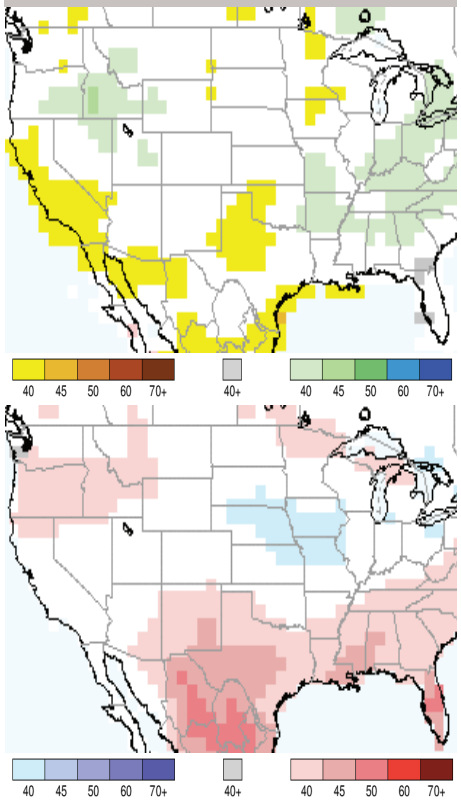


Figure 7: Three-Month (Jan-Mar) Forecast for Precip (top) and Temps (bottom)

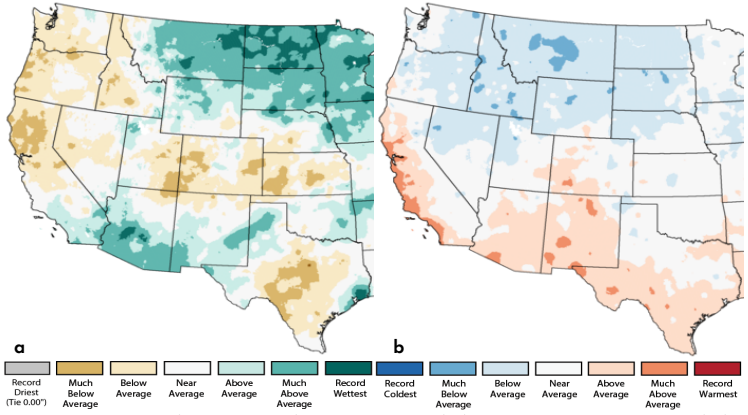


Figure 3: 2019 (Sept - Nov) Precipitation (a) & Temperature Ranks (b)

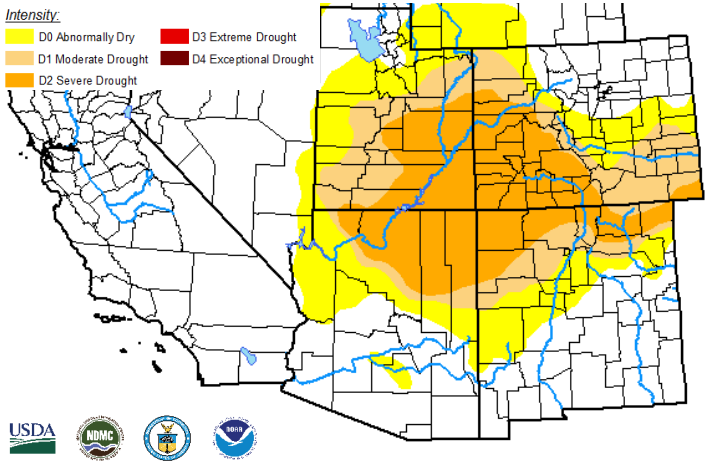


Figure 6: US Drought Monitor - Dec 10, 2019

Online Resources

Figure 1
Australian Bureau of Meteorology
bom.gov.au/climate/enso

Figure 2
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

Figure 3
International Research Institute for Climate and Society
iri.columbia.edu

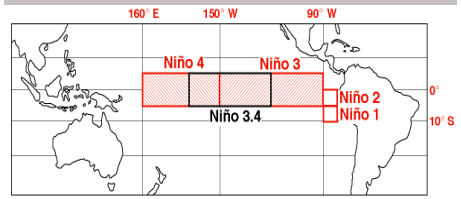
Figure 4
NOAA - Climate Prediction Center
cpc.ncep.noaa.gov

El Niño / La Niña

Information on this page is also found on the CLIMAS website:

climas.arizona.edu/sw-climate/el-niño-southern-oscillation

Equatorial Niño Regions



For more information: ncdc.noaa.gov/teleconnections/enso/indicators/sst/

Image source: aoml.noaa.gov/

ENSO Tracker

Warm waters continue to linger in western regions of the equatorial Pacific (Figs. 1-2), but are expected to fall within the range of ENSO-neutral for winter 2019-2020 and into spring 2020.

Forecast Roundup: On Dec 10, the Japanese Meteorological Agency highlighted a trend towards near-normal sea surface temperatures (SSTs) in the equatorial Pacific, despite recent positive SST anomalies. They maintained their call for a 60-percent chance of ENSO-neutral conditions to continue until spring 2020. On Dec 10, the Australian Bureau of Meteorology noted "abnormally warm sea surface temperatures in the western tropical Pacific" and their influence on regional weather patterns but maintained their ENSO Outlook at 'inactive' through early 2020. On Dec 12, the NOAA Climate Prediction Center (CPC) issued their ENSO diagnostic discussion with an inactive alert status and called for a 65-percent chance of ENSO-neutral through spring 2020. They noted that oceanic and atmospheric conditions were "consistent with ENSO-neutral" despite some above average SSTs, especially in the western equatorial Pacific, but forecasters also highlighted a 25- to 30-percent chance of El Niño. On Dec 12, the International Research Institute issued an ENSO Quick Look (Fig. 3), noting recent above normal SSTs had "returned to normal in December" and ENSO-neutral was most likely in 2019-2020, but with "slightly higher chances for El Niño than La Niña". The Dec 2019 North American Multi-Model Ensemble (NMME) shows the persistent positive SST anomalies in November but is predicted to return and remain within the range of ENSO-neutral through 2019 and into 2020 (Fig. 4).

Summary: Recent positive SST anomalies in the equatorial Pacific are mostly attributed to seasonal variability and not El Niño, although the recent CPC forecast discussion did include a forecast probability for El Niño, so we will keep an eye on any additional developments. The consensus remains that despite recent warming, most oceanic and atmospheric conditions are within the range of ENSO-neutral, and ENSO-neutral remains the most likely outcome for winter 2019-2010. In the Southwest, ENSO-neutral winters have produced some of the wettest and driest winters (and everything in between). We continue to monitor sub-seasonal and short term forecasts for insight into upcoming events. Given recent and long-term drought conditions in the Southwest, a sustained run of regular precipitation events spread out over the cool season would be most welcome.

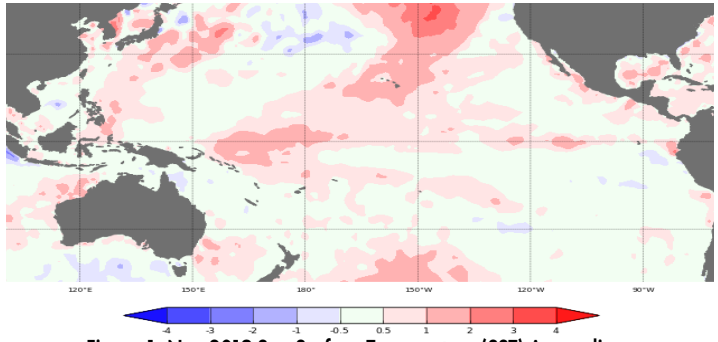


Figure 1: Nov 2019 Sea Surface Temperature (SST) Anomalies

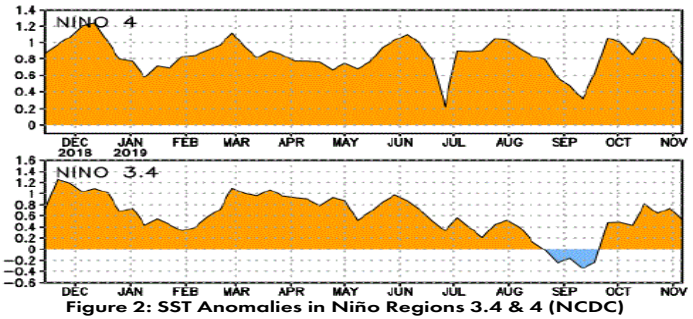


Figure 2: SST Anomalies in Niño Regions 3.4 & 4 (NCDC)

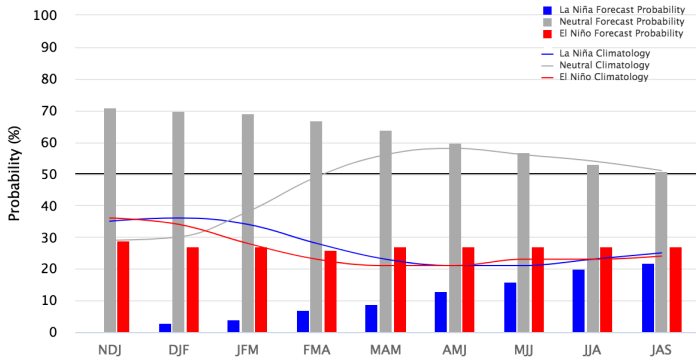


Figure 3: Early-Dec IRI/CPC Model-Based Probabilistic ENSO Forecast

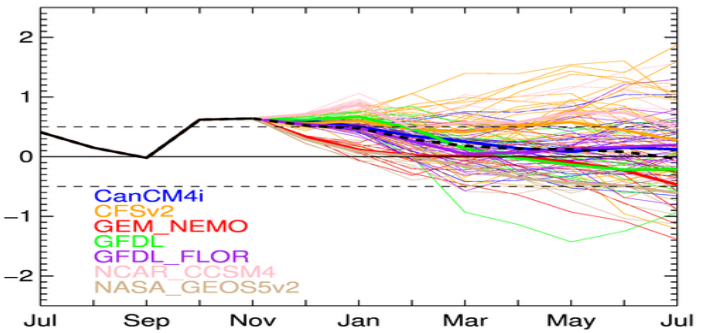


Figure 4: North American Multi-Model Ensemble Forecast for Niño 3.4

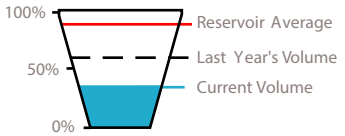
Online Resources

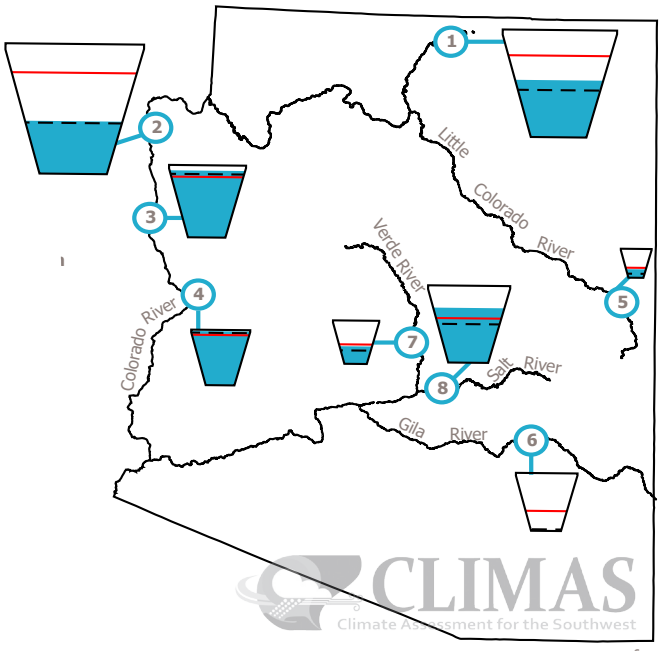
Portions of the information provided in this figure is available at the Natural Resources Conservation Service
www.wcc.nrcs.usda.gov/BOR/basin.html

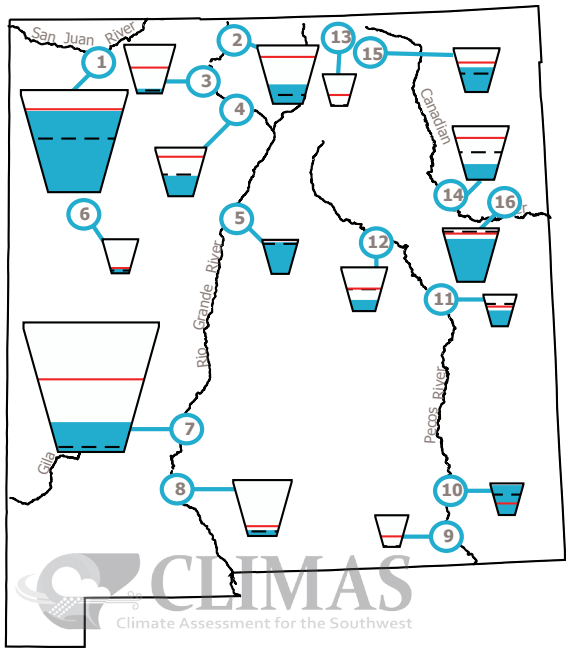
Contact Ben McMahan with questions/comments.

Reservoir Volumes

DATA THROUGH DEC 1, 2019
Data Source: National Water and Climate Center, Natural Resources Conservation Service







* in KAF = thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Lake Powell	53%	12,854.5	24,322.0	-179.1
2. Lake Mead	40%	10,336.0	26,159.0	108.0
3. Lake Mohave	92%	1,672.0	1,810.0	102.0
4. Lake Havasu	97%	603.4	619.0	25.3
5. Lyman	29%	8.6	30.0	-0.2
6. San Carlos	1%	9.8	875.0	3.9
7. Verde River System	40%	114.2	287.4	-9.1
8. Salt River System	71%	1,437.7	2,025.8	29.8

*KAF: thousands of acre-feet

Reservoir	Capacity	Current Storage*	Max Storage*	One-Month Change in Storage*
1. Navajo	79%	1348.3	1,696.0	-13.3
2. Heron	33%	131.8	400.0	-2.8
3. El Vado	10%	18.5	190.3	-50.7
4. Abiquiu	42%	78.1	186.8	-3.1
5. Cochiti	93%	46.5	50.0	0.5
6. Bluewater	17%	6.7	38.5	-0.1
7. Elephant Butte	23%	500.3	2,195.0	64.4
8. Caballo	10%	32.1	332.0	2.4
9. Lake Avalon	0%	0.0	4.5	-0.4
10. Brantley	94%	39.7	42.2	3.9
11. Sumner	50%	17.9	35.9	4.2
12. Santa Rosa	25%	26.0	105.9	0.0
13. Costilla	33%	0.0	16.0	-5.4
14. Conchas	29%	74.5	254.2	-1.1
15. Eagle Nest	56%	44.4	79.0	-0.5
16. Ute Reservoir	80%	160	200	-1.0

The map gives a representation of current storage for reservoirs in Arizona and New Mexico. Reservoir locations are numbered within the blue circles on the map, corresponding to the reservoirs listed in the table. The cup next to each reservoir shows the current storage (blue fill) as a percent of total capacity. Note that while the size of each cup varies with the size of the reservoir, these are representational and not to scale. Each cup also represents last year's storage (dotted line) and the 1981–2010 reservoir average (red line).

The table details more exactly the current capacity (listed as a percent of maximum storage). Current and maximum storage are given in thousands of acre-feet for each reservoir. One acre-foot is the volume of water sufficient to cover an acre of land to a depth of 1 foot (approximately 325,851 gallons). On average, 1 acre-foot of water is enough to meet the demands of four people for a year. The last column of the table lists an increase or decrease in storage since last month. A line indicates no change.

These data are based on reservoir reports updated monthly by the National Water and Climate Center of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS).

Environment & Society Graduate Fellows

The Environment & Society Fellowship was created in 2013 as a funding opportunity for graduate students to practice use-inspired research and science communication. The Fellowship supports projects that connect social or physical sciences, the environment, and decision-making.

Projects must be use-inspired and address research and information needs voiced by the students' project partners. The Fellowship is funded and supported by the University of Arizona Office of Research, Discovery, & Innovation and CLIMAS.

climas.arizona.edu/education/fellowship-program

Working on Projects with Students at Naco Elementary

Alma Anides Morales

Energetic middle schoolers fill the classroom air with excitement. Three UA graduate students are standing in the way between their final hours of summer school and unlimited summer fun. We better make this engaging! I think to myself. Today, we are there to talk about environmental science, and how the quality of our environment- the air that we breathe, the water that we drink, the soil that we run on- affects our every day lives, including our health. Read more:

climas.arizona.edu/blog/working-projects-students-naco-elementary

Mining and Groundwater in Southern Arizona

Sean Schrag-Toso

As I drive southwest along highway 82 from Sonoita, Arizona toward the Town of Patagonia, Red Mountain emerges on the skyline. The north face of the mountain is covered in vegetation, cloaking the red rhyolite that is visible from the south. Even more concealed are the systems of fractures, faults and old mining tunnels that complicate the hydrology of the area. I turn off the highway, ascend a winding dirt road, park my car and walk down a steep valley south of Red Mountain, keeping an eye on my GPS. I soon find myself at the entrance a gaping hole in the rock. The hole appears to be a cave, but it is not. Old mine adits; the mouths of snaking underground tunnels of abandoned mines, leak water, sludge, and a cool, ominous, vapor. The entrance of some are covered in a tongue of green moss; the opportune plant making the most of the moist mouth of the adits. Historic mines create a unique plumbing system in a mountain of fractured rock and act as massive pipes that drain out groundwater from the mountain. Read more:

climas.arizona.edu/blog/Mining-and-groundwater-southern-arizona

The Story of H2O: Informal Water Provision in Nairobi's Low-income Settlements

Nupur Joshi

"Nairobi is a city of opportunities" said Mwangi – a 26-year old man who worked as an assistant to a private water provider. Mwangi's job was to keep a check on the water pipes and kiosks that this employer recently installed in the settlements of Mukuru to sell water at a price of 5 Kenyan Shillings ($0.05) per 20-liter jerrycan. Mwangi aspired to start his own water business one day, as he explained, "Sister, in this city, water is the most valuable possession one would have. If I can run a water business consistently, it is pesa ya haraka – cash cow/quick money." Responding to the perplexed expression on my face, he said, "It is simple, just work on making the right connections, with the right people." Every year I go to Nairobi to conduct fieldwork, Mwangi's words echo in my mind. Read more:

climas.arizona.edu/blog/story-h2o-informal-water-provision-nairobi's-low-income-settlements

Save it for a rainy day: Roof-Harvesting Rainwater in the Sonoran Desert

Norma Villagomez-Márquez

Energetic middle schoolers fill the classroom air with excitement. Three UA graduate students are standing in the way between their final hours of summer school and unlimited summer fun. We better make this engaging! I think to myself. Today, we are there to talk about environmental science, and how the quality of our environment- the air that we breathe, the water that we drink, the soil that we run on- affects our every day lives, including our health

climas.arizona.edu/blog/save-it-rainy-day-roof-harvesting-rainwater-sonoran-desert

Online Resources

Figure 1
Climate Program Office
cpo.noaa.gov

RISA Program Homepage

cpo.noaa.gov/Meet-the-Divisions/Climate-and-Societal-Interactions/RISA

UA Institute of the Environment

environment.arizona.edu

New Mexico Climate Center

weather.nmsu.edu

CLIMAS Research & Activities

CLIMAS Research

climas.arizona.edu/research

CLIMAS Outreach

climas.arizona.edu/outreach

Climate Services

climas.arizona.edu/climate-services

CLIMAS

Climate Assessment for the Southwest
A NOAA RISA TEAM

The Climate Assessment for the Southwest (CLIMAS) program was established in 1998 as part of the National Oceanic and Atmospheric Administration's Regional Integrated Sciences and Assessments program. CLIMAS—housed at the University of Arizona's Institute of the Environment—is a collaboration between the University of Arizona and New Mexico State University.

The CLIMAS team is made up of experts from a variety of social, physical, and natural sciences who work with partners across the Southwest to develop sustainable answers to regional climate challenges

What does CLIMAS do?

The CLIMAS team and its partners work to improve the ability of the region's social and ecological systems to respond to and thrive in a variable and changing climate. The program promotes collaborative research involving scientists, decision makers, resource managers and users, educators, and others who need more and better information about climate and its impacts. Current CLIMAS work falls into six closely related areas: 1) decision-relevant questions about the physical climate of the region; 2) planning for regional water sustainability in the face of persistent drought and warming; 3) the effects of climate on human health; 4) economic trade-offs and opportunities that arise from the impacts of climate on water security in a warming and drying Southwest; 5) building adaptive capacity in socially vulnerable populations; and 6) regional climate service options to support communities working to adapt to climate change.

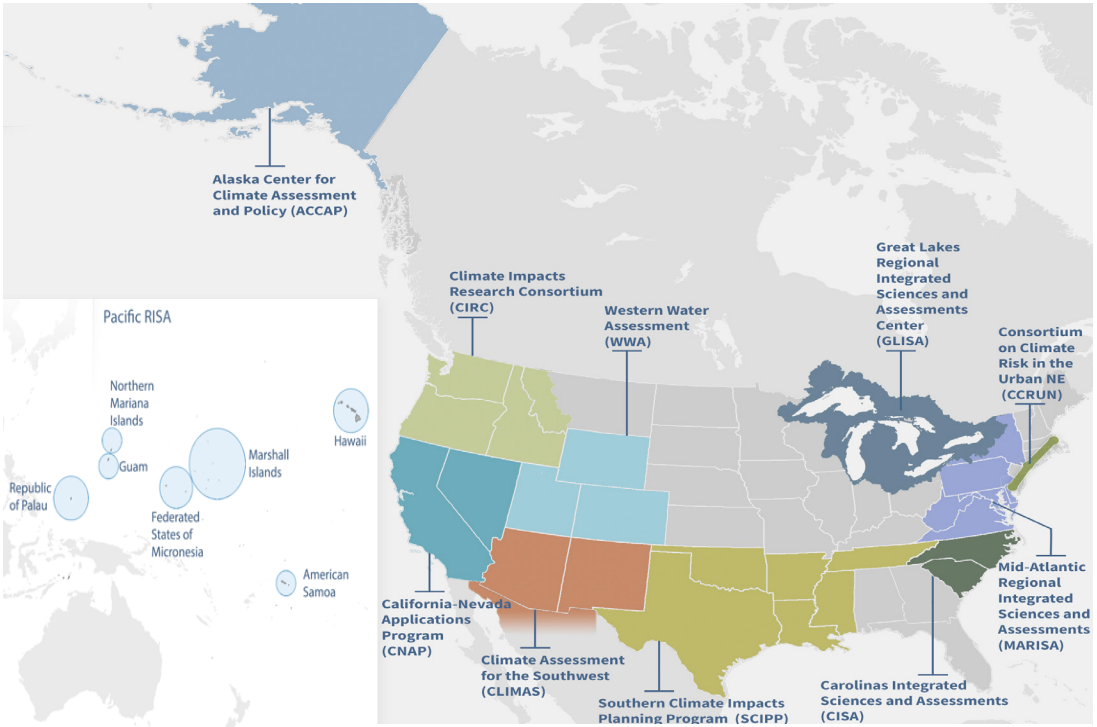


Figure 1: NOAA Regional Integrated Sciences and Assessments Regions