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Winter 2018

## DroughtScape- Winter 2018

National Drought Mitigation Center

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NATIONAL DROUGHT MITIGATION CENTER  
AT THE UNIVERSITY OF NEBRASKA-LINCOLN

# DROUGHTSCAPE

QUARTERLY NEWSLETTER

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## DIRECTOR'S REPORT

The end-of-year edition of DroughtScape is always my favorite. Why? It is a time to look back and reflect on all we at the National Drought Mitigation Center have accomplished as a team and in collaboration with our partners around the world. At the same time, a new year with new challenges has started, and I always look forward to what it will bring.



**Mark Svoboda**

Last year brought continued growth to the NDMC; you can find out more about our newest hires in this edition. They include Dr. Tingting Liu, a drought policy specialist, and Dr. Jordan Watts, a post-doctoral mathematician. Both will help us continue to improve the U.S. Drought Monitor, our best-known product, and other decision-support services. Looking ahead, we anticipate hiring new staff in 2018 to enhance our services in the areas of water markets analysis and communications.

Good examples of my favorite “yearly” features are our annual drought and impact summaries. These reports allow us to build on a baseline of information, one that addresses the physical aspects of drought, as well as how it affects millions of people across the country. Even though 2017 was a relatively “quiet” drought year (recording the lowest percent area of drought (D1-D4) for the continental U.S. since the Drought Monitor was founded in 1999), a late fall and early winter dry spell influenced by La Niña has given drought a firm foothold over 40 percent of the Lower 48 states in early 2018.

It will be interesting to see how it all plays out, and we’ll be here to keep you up-to-date. Check back with DroughtScape in spring for the latest facts and figures.

### About the photo

*This Ponderosa Pine, showing dried resin, died from the cumulative effects of drought and soil compaction near Fallbrook, California. The photo was taken Dec. 3, 2017.*

*Photo by Kim Mulcahy/Flicker*

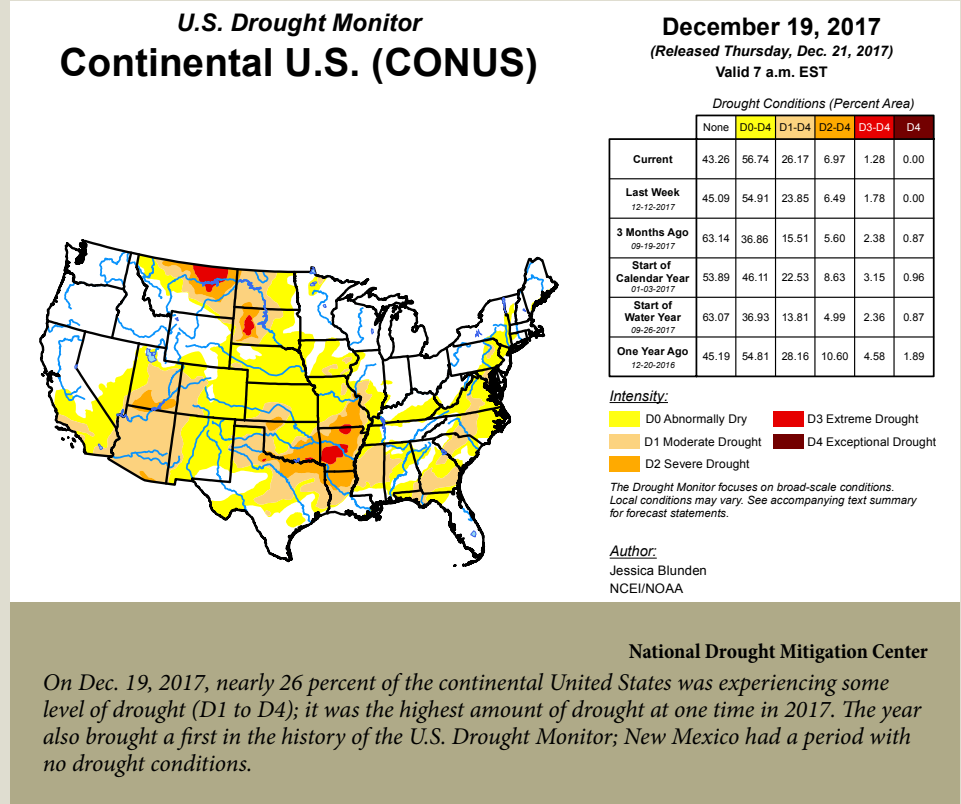
# Year in Review: California improved, Northern Plains saw drought

**BY BRIAN FUCHS**  
 NATIONAL DROUGHT MITIGATION  
 CENTER CLIMATOLOGIST

At the beginning of 2017, southern California was still emerging from long-term drought, and the Southeast and New England had patches of drought. By summer, drought was completely eliminated from the eastern states, but was emerging in the northern Plains, affecting Montana and the Dakotas. Although drought was nearly eradicated in southern California, a stubborn pocket of moderate drought remained.

As 2017 came to a close, the La Niña impact over the southern United States was evident as drought developed over much of the Southwest, southern Plains and Southeast.

Just 18.83 percent of the country was in drought at the beginning of 2017, and 23.18 percent by year end. Severe drought improved during the year from 7.21 to 6.24 percent, and extreme drought also improved



from 2.63 to 0.69 percent. The year ended with no exceptional drought compared to 0.80 percent at the beginning of the year, all in California.

Drought peaked in January when 27.70 percent of the country was

*Continued on page 3*

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Continued from page 2

affected, while the smallest extent of drought was in late May, when just 4.52 percent of the country was in drought.

The number of people affected by drought also was quite variable in 2017. The year began with 119 million people affected and ended with 62 million affected. That January number, 119 million, was the most observed affected by drought during the year; the smallest number of people affected occurred in late June when 15 million people were in areas affected by drought. Over 29 million people were affected by extreme or exceptional drought in early January compared to none by the middle of June.

Climatologically, it was the third warmest year on record for the



### MONTHLY DROUGHT AND IMPACT SUMMARIES

For a more detailed review of conditions, please visit

[drought.unl.edu/newsoutreach/monthlysummary.aspx](http://drought.unl.edu/newsoutreach/monthlysummary.aspx)

United States and the 20th wettest year. Almost every state had a top-10 warmest year on record, and Arizona, New Mexico, Georgia, South Carolina and North Carolina recorded their warmest years on record with 123 years of data. Michigan had its wettest year on record, and North Dakota had its eighth driest year on record. Wisconsin and Ohio also had top-10 wettest years on record.

### Milestones

Statistical milestones for the U.S. Drought Monitor in 2017 for the United States:

**Greatest extent of D0-D4:** 56.74 percent of the continental United States on Dec. 19, 2017

**Greatest extent of D1-D4:** 27.70 percent of the continental United States on Jan. 2, 2017

**Greatest extent of D3-D4:** 3.15 percent of the continental United States on Jan. 3, 2017

**Greatest extent of D4:** 1.28 percent of the continental United States on Sept. 12, 2017

**Smallest extent of D0-D4:** 14.27 percent of the continental United States on May 23, 2017

**Smallest extent of D1-D4:** 4.52 percent of the continental United States on May 23, 2017

**Smallest extent of D3-D4:** 0.00 percent of the continental United States on June 13, 2017

## CLIMATE SUMMARY: OCTOBER TO DECEMBER 2017

### Dry conditions creeping across the country

BY BRIAN FUCHS

NATIONAL DROUGHT MITIGATION CENTER CLIMATOLOGIST

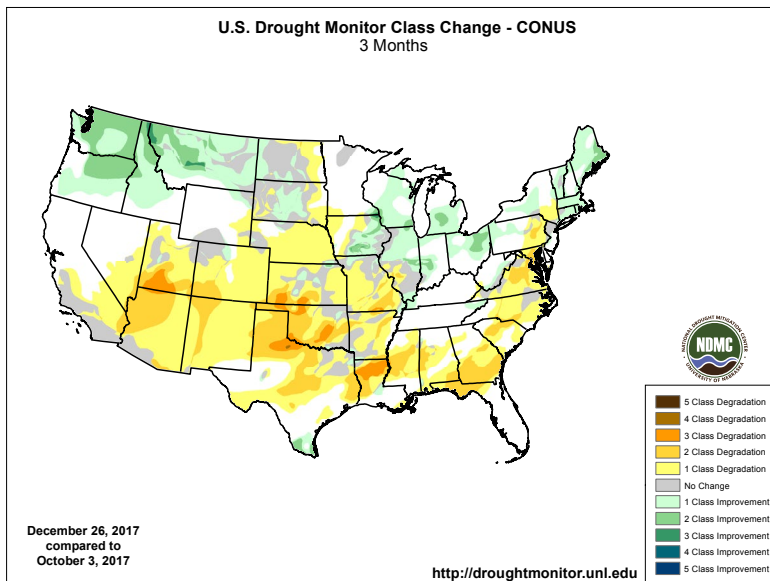
Drought classifications are based on the U.S. Drought Monitor. Details on the extent and severity of drought are online: [droughtmonitor.unl.edu](http://droughtmonitor.unl.edu).

The outlook integrates existing conditions with forecasts from the National Oceanic and Atmospheric Administration's Climate Prediction Center: [www.cpc.ncep.noaa.gov](http://www.cpc.ncep.noaa.gov).

#### Drought

Over the Plains, South, and Midwest, conditions dried out after a wet start to October. By the end of the year, abnormally dry conditions had spread to 46.48 percent of the United States, up from 32.63 percent from

Continued on page 4



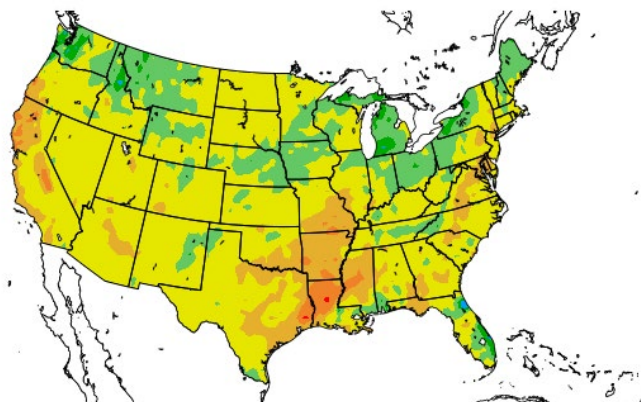
National Drought Mitigation Center

The last quarter of 2017 saw drought improve in the Northern U.S., but it expanded across the central and southern states.



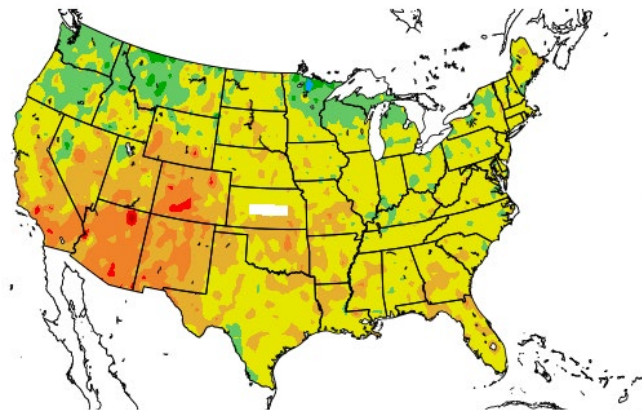
## DEPARTURE FROM NORMAL PRECIPITATION (IN)

Oct. 1 to Dec. 31, 2017



## DEPARTURE FROM NORMAL TEMPERATURE

Oct. 1 to Dec. 31, 2017



High Plains Regional Climate Center

*Continued from page 3*

the beginning of October. Moderate drought conditions also spread from 12.12 to 23.18 percent of the country. Severe drought conditions increased from 3.98 to 6.24 percent. Extreme and exceptional drought conditions improved, with exceptional drought being eliminated from Montana and extreme drought down to just 0.69 percent of the country. December ended with 62 million people affected by drought, which was more than double the number from the beginning of October, when 31 million people were affected.

### Precipitation

October started off very wet over much of the Plains and South before the precipitation almost completely stopped for the rest of the year.

Areas from southern Missouri into Arkansas, Mississippi, Louisiana, and east Texas ended the quarter 8 to 12 inches below normal precipitation with widespread areas 4 to 8 inches below normal. The water year started off slowly out West as well, with much of California and Oregon below normal precipitation. Areas such as the northern Rocky Mountains and Great Lakes region were wet during the quarter, with some areas up to 4 inches above normal. Portions of the Mid-Atlantic also dried out with departures of 4 to 8 inches below normal from Maryland south into the Carolinas.

### Temperatures

During the quarter, most of the United States recorded normal- to above-normal temperatures except for portions of the Pacific Northwest,

northern Rocky Mountains, and upper Midwest, where temperatures were slightly cooler than normal. The greatest departures were in the Four-Corners region, where temperatures were 4 to 6 degrees above normal, and the central Plains, where temperatures were 2 to 4 degrees above normal.

### Outlook

The seasonal drought outlook has much of the drought over the southwest United States persisting and continuing to develop through the end of May. Improvements to the drought situation are likely over the northern Plains and Midwest with much of the drought in these regions improving to the point of removal from the designation on the United States Drought Monitor map.

# A year of wildfires, little snow and more drought

BY DENISE GUTZMER

NATIONAL DROUGHT MITIGATION  
CENTER DROUGHT IMPACT SPECIALIST

## California drought mostly ended

The 2016-17 winter was the one Californians had been waiting for to rescue the state from drought, refill reservoirs and end the years-long drought emergency. A record amount of snow piled up in the northern Sierra Nevada after years of meager storms and snowpack, with the Sierra snowpack topping out at 164 percent of average water content on March 30, according to electronic sensors. Although storms funneled by atmospheric rivers inundated some parts of the Golden State, causing structural damage, mudslides and the near spillway failure, overall the moisture was welcome after five years of drought. California's drought emergency, which began in January 2014, finally ended April 7, when Gov. Jerry Brown lifted the drought state of emergency in most of the state.

The drought-quenching precipitation also brought lush grass growth to California's hillsides as spring turned to summer. With hot temperatures, grasses cured. With millions of dead trees left from the drier years, massive wildfires spread across the West and in California. The fire season started early and was brutal.

["Governor's Drought Declaration," California Department of Water Resources \(Sacramento, Calif.\).](#)

## Drought development in the Northern Plains

In the Dakotas and eastern Montana, dryness developed rapidly during May and resulted in unusually high cattle sales as pastures and hay growth slowed, leading to a



Colleen Gustafson/Drought Impact Reporter

*At the Gustafson ranch south of Glacier County, Montana, purchased straw is unloaded to supplement the short hay crop after a lack of rain cured the pasture grass by mid-summer. "It has had no green re-growth for over 90 days since there has been no measurable precipitation," Colleen Gustafson wrote in the Drought Impact Reporter.*



County agent for Hettinger County, North Dakota

*Dugout watering ponds for cattle range from dry to barely any water at all, wrote the county agent for Hettinger County, North Dakota, in the Drought Impact Reporter. The little water left in some ponds is undrinkable. "All cattle in the county are being watered by wells," he wrote.*

challenging growing season of feeding livestock hay or culling herds and selling early. Auctions were busy, moving as many as three to five times the usual number of livestock

in June. Governors of the Dakotas and Montana declared drought emergencies for all or parts of their states. The U.S. Department of

*Continued on page 6*



Continued from page 6

Agriculture gave authorization for emergency grazing of Conservation Reserve Program acres in late June to help farmers and ranchers. Drought also adversely affected the production of most crops in the Dakotas, according to statistics released by the U.S. Department of Agriculture.

["Latest North Dakota Crop Report Shows Impact of Drought," U.S. News & World Report, Jan. 15, 2018](#)

["Latest South Dakota Crop Report Shows Impact of Drought," U.S. News & World Report, Jan. 15, 2018](#)

### Extensive wildfire activity in Montana

Numerous wildfires raged in Montana, sparked largely by hundreds of lightning strikes in early July. By the end of August, more than 1,500 fires burned nearly 600,000 acres, or 937 square miles. About that time, a lightning storm that offered little

rain sparked another 45 fires, as much of the state was in moderate to exceptional drought and was primed to burn. On Sept. 1, Gov. Steve Bullock issued an executive order declaring a state of disaster due to the multitude of wildfires. By the end of September, more than 1.2 million acres had burned in Montana since the start of the year, with fire suppression costs nearing \$400 million.

["Lightning sparks western Montana blazes: fire danger raised," by Perry Backus and Eve Byron, The Missoula Missoulian \(Montana\), July 10, 2017](#)

["Montana Wildfire Roundup For August 31, 2017," Montana Public Radio News \(Missoula\), Aug. 31, 2017](#)

["\\$400 million spent on Montana wildfires this year," by Tom Kuglin, Helena \(Mont.\) Independent Record, Sept. 30, 2017](#)

### Snow drought in the Colorado River Basin

The lack of snow in Colorado alarmed ski resort operators who

expected to have plenty of powder to entertain their visitors over the Christmas break. Instead, trails remained bare, preventing some resorts from opening or allowing only a limited number of trails to open. Resorts, in some cases, could not offer full-time employment and tried to support employees with food assistance. Ski areas in northern New Mexico and other parts of the Southwest also were enduring a snow drought and were facing some of the same struggles.

["Colorado ski area making the most of snow dearth," by John Stroud, Park City Record \(Utah\), Jan. 8, 2018](#)

["At New Mexico's snow-challenged ski resorts, mountains of anxiety," by Cynthia Miller and Sami Edge, Santa Fe New Mexican, Jan. 8, 2018](#)

For more details, visit the [Drought Impact Reporter](#).

## IMPACT SUMMARY: OCTOBER TO DECEMBER 2017

# Drought expands in last quarter of 2017

BY DENISE GUTZMER

NATIONAL DROUGHT MITIGATION CENTER DROUGHT IMPACT SPECIALIST

Drought expanded in the southern U.S. in the last quarter of 2017 while it eased in some of the northern areas, notably Montana, which endured intense drought during the summer. Impacts were heaviest in the South, where the Drought Impact Reporter recorded 39 impacts for Texas, and Arizona and Oklahoma had 18 each. Altogether, 297 impacts were added to the Drought Impact Reporter during the last three months of 2017 with most of the impacts describing changes to plants and wildlife during the dry fall.

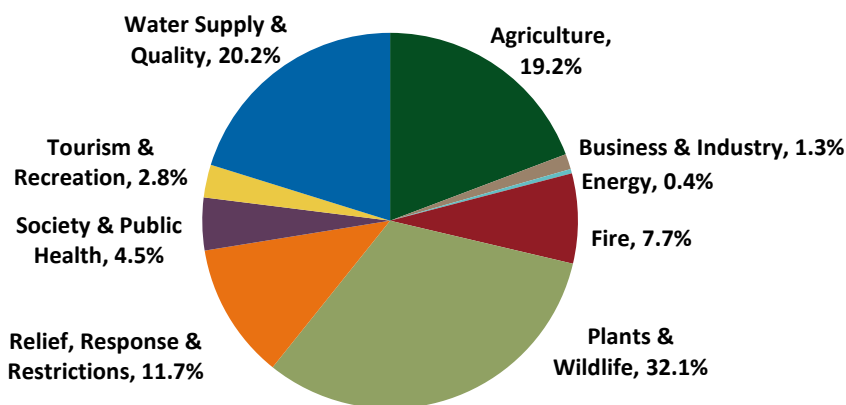
### Texas: From deluge to drought

Texas saw weather extremes. Hurricane Harvey inundated Houston with more than 5 feet of rain in late

August, then dry weather led to drought development across the state by the end of the year. In East Texas, the dry conditions turned into brown grass and dry pastures and bans

on outdoor burning until rain fell. By early December, the wheat crop and rangelands in the Panhandle had dried out, leading producers to move

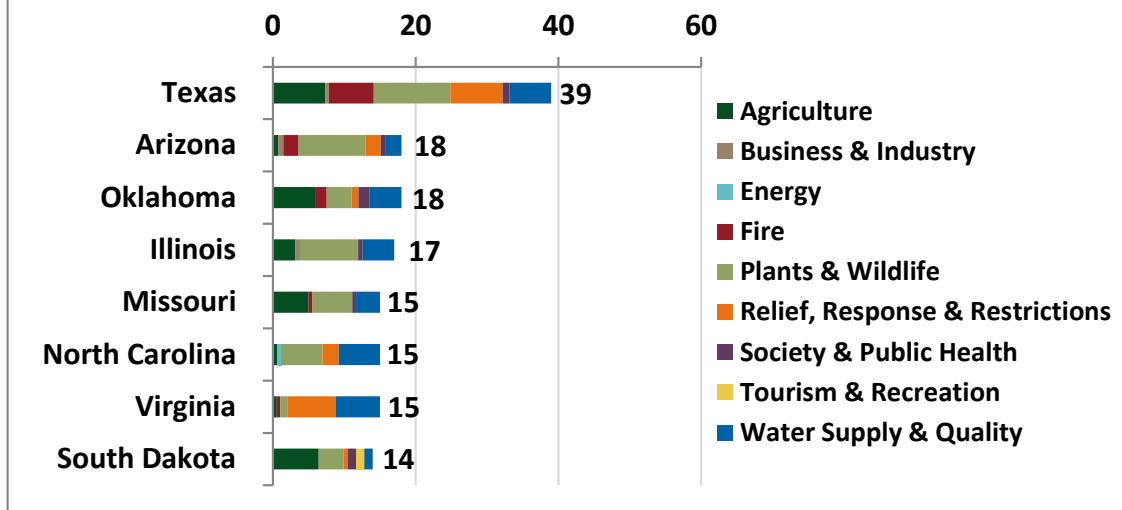
Impacts in the Drought Impact Reporter, October - December 2017



Total impacts: 297

National Drought Mitigation Center

## Impacts in the Drought Impact Reporter, October - December 2017



National Drought Mitigation Center

Continued from page 6

livestock off dryland pastures.

CoCoRaHS observers documented many of these landscape changes, such as dry and crunchy grass, excessive dust and other similar events.

["Texas Crop and Weather Report – Nov. 14, 2017," by Adam Russell, Texas A&M, North Texas e-News \(Fannin, Texas\), Nov. 15, 2017](#)

["From deluge to drought: Texas endures severe drought after Harvey," by Doyle Rice, USA Today \(McLean, Virginia\), Dec. 4, 2017](#)

["Dry temperatures effecting \(sic\) wheat crops in the Panhandle," by Nyzah McDonald, KFDA-TV Newschannel 10 \(Amarillo, Texas\), Dec. 7, 2017](#)

### Drought in Colorado River Basin

The fall was unusually dry and warm in Colorado, prompting many CoCoRaHS observers to describe brown, crunchy lawns and landscaping. Residents began watering lawns when they ought to be buried under a blanket of snow. They also were urged to water trees and shrubs. Some plants went dormant in September for lack of moisture, while in other circumstances, extra watering kept plants going. In

Denver, parks workers aerated grass at the Civic Center and watered the lawn to help it endure the 65-day dry spell that finally ended with a thin layer of snow.

["Denver has been so dry that sprinklers are springing back to life, but is snow on the way?" by Shannon M. Hoffman, The Denver Post, Dec. 13, 2017](#)

December snow totals averaging as little as 20 percent in parts of the Colorado River Basin led to a dire outlook for the coming year. The National Weather Service's Colorado River Forecast Center predicted the river would flow at about 54 percent of its average volume during the key runoff period from April to July. Snowpack could still improve, as it typically accumulates through March.

["Dry start to winter prompts ugly forecast for Colorado River," by Henry Breaun, Las Vegas Review-Journal, Jan. 3, 2018](#)

### Slow start to wet season in California

With California's rainy season getting off to a slow start, some began wondering if the Golden State

was headed back into drought, but the state receives much of its winter precipitation from January through March. To cope with the dryness, farmers in the Sacramento and San Joaquin valleys began irrigating in December. Farmers typically do not need to start irrigating until mid-May, but the absence of significant rain brought the need for early irrigation.

["Long dry spell prompts early irrigations," by Kevin Hecteman, Ag Alert \(Sacramento, Calif.\), Jan. 10, 2018](#)

The first manual snow survey at Phillips Station in the Sierra Nevada Mountains in early January 2018 revealed just 3 percent of normal snowpack in some areas, as the start to the winter season remained unsettlingly dry. Thanks to last year's atmospheric rivers, the state's reservoirs still were in good shape. The state's electronic sensors showed a less dire picture with the snowpack at 24 percent of normal on Jan. 3.

["California's first 2018 survey finds little snow," by Associated Press, KRON TV NBC 4 \(San Francisco\), Jan. 3, 2018](#)



# 'Drought and Water Crises' resource gets update in 2017

BY SUZANNE PLASS  
NATIONAL DROUGHT MITIGATION  
CENTER COMMUNICATIONS SPECIALIST

*"These 11 Cities May Completely Run Out of Water Sooner Than You Think." "Buffalo City faces water restrictions, Senegal residents fight over water." "Global water woes: Australia's looming water crisis." "Worsening drought, clean water scarcity affect millions in Indonesia." \**

Given the increasing frequency of headlines like those above, someone working globally on drought issues for more than 30 years might be forgiven for becoming either discouraged or militant. A career in drought monitoring and planning, however, has given Don Wilhite, founding director of the National Drought Mitigation Center at the University of Nebraska-Lincoln, a more considered response to the headlines.

"I guess I have learned to be patient while still promoting my vision of preparedness and proactive actions," the internationally-renowned drought specialist mused.

Fortunately the number of climate scientists, managers and policymakers working toward drought risk reduction alongside Wilhite is growing. It is for that rapidly expanding drought community and others in the wings that Wilhite updated, "Drought and Water Crisis: Integrating Science, Management, and Policy (Second edition)", published recently by CRC press and available for [purchase here](#).

The new book, co-edited by Wilhite and Roger Pulwarty, NOAA senior science advisor for climate research, includes 19 new chapters and significant revisions to others from the 2005 edition. Updated chapters on policy development are complemented by sections showcasing advances in information



Courtesy Don Wilhite  
Roger Pulwarty, NOAA senior science advisor for climate research, left, and Don Wilhite, founder of the National Drought Mitigation Center, recently updated the "Drought and Water Crisis" resource book to meet current standards.

technology for drought monitoring, warning, decision support and management; and by a section providing case studies giving concrete examples of drought and water management from many political and geographical perspectives.

Contributing authors include many of Wilhite's former colleagues at the drought center within the School of Natural Resources at Nebraska, along with climate and remote sensing technology experts at the school.

According to Mark Svoboda, current NDMC director and a contributing author, the new edition of "Drought and Water Crises" has been getting a lot of appreciative notice. "I've been at the recent professional meetings and had people comment that they were really happy with the breadth of content.

"The expanded case studies from a variety of scales just weren't there

in the first book because it was an emerging technique," Svoboda said. "The number of new satellites and the number of new sensors and the amount of people that can get access to the data — and a lot of it is free, which wasn't the case in the past — is more than ever before."

Wilhite's target audience for the first edition of the book was a small group of scientists, managers, academics and practitioners who were actively working in the area of drought science and management in the early 2000s. Wilhite saw another important audience in those working in United Nations' agencies, development banks and key government agencies, who could pave the way for changes in drought management given their important role in the international community and the allocation of

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funds for programs, research and development.

In the decade since the first edition appeared, Wilhite has watched the “drought community” grow substantially. He cites the work of the NDMC as playing a significant role in advancing both the science and management of drought, particularly in shifting the conversation from crisis response to risk reduction. At the same time, worldwide concern about climate change was growing, spurring interest in drought as a natural hazard.

Wilhite hopes the new, expanded edition of “Drought and Water Crises”

will provide a way forward for scientists and managers trying to sort through options, whether it be for development of a drought early warning system, or investigating drought triggers or water conservation tools.

“There is an urgent need to change the paradigm for drought management, i.e., moving to an approach focused on risk reduction,” Wilhite said. He has learned that staying focused and continually pointing to alternative approaches to current practices is an essential component of the increasing willingness of individuals and policymaking bodies to engage in

drought planning. “A state or country might want to change, but unless you provide them with a process to implement change, they will likely see the process as insurmountable.”

Svoboda agreed. “If people can get great access to a lot of information on drought, they can put it to use. Just like water, access is more than half the battle.”

\* [“These 11 Cities May Completely Run Out of Water Sooner Than You Think.”](#)

[“Buffalo City faces water restrictions, Senegal residents fight over water.”](#)

[“Global water woes: Australia’s looming water crisis.”](#)

[“Worsening drought, clean water scarcity affect millions in Indonesia.”](#)

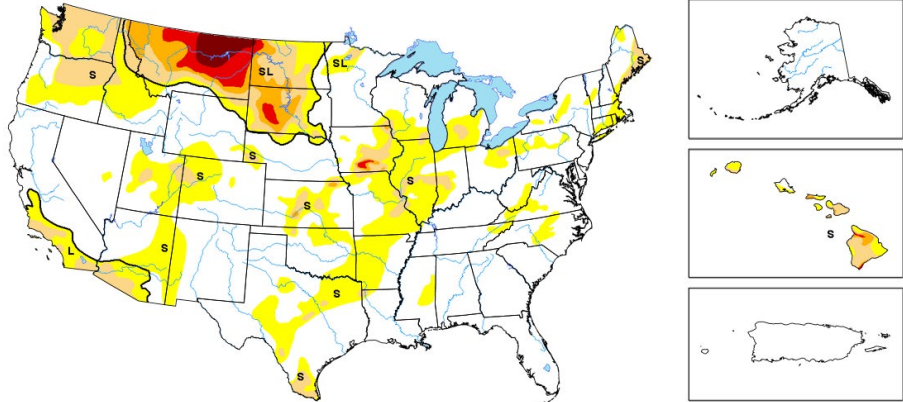
## U.S. Drought Monitor now available in Spanish

The U.S. Drought Monitor national map and narrative are available in Spanish, in keeping with the U.S. Department of Agriculture’s effort to better engage underserved populations, including Spanish-speaking agricultural producers.

Spanish-language versions of the national map and narrative are now being posted on the drought monitor website. They will be the centerpiece of a Spanish-language drought monitor website, which will include translated drought monitor maps for each of the USDA Climate Hub regions, said Brian Fuchs, monitoring coordinator at the National Drought Mitigation Center, based at University of Nebraska.

After favorable response from agencies serving Spanish-speaking populations, including the National Weather Service, USDA and its Climate Hubs, and state climatologists, the drought center and the department of agriculture decided to expand the Spanish-language

Mapa para septiembre 28, 2017  
Datos válidos: septiembre 26, 2017 | Autor: Brad Rippey, U.S. Department of Agriculture



NDMC

*El mapa nacional y la narración del Monitor de Sequía (US Drought Monitor) ahora están disponibles también en español. The US Drought Monitor national map and narrative are now available in Spanish.*

offerings beyond the initial maps. The NDMC hosts the drought monitor website and associated data and information.

Spanish-language drought monitor maps are funded through a

contract with the U.S. Department of Agriculture’s Office of the Chief Economist.

[Spanish map archive page.](#)

[US Drought Monitor site.](#)





Jonathan Schelmann/Drought Impact Reporter

*The Platte River channel above the confluence of Elkhorn and Platte rivers was completely dry on August 21, 2012, with minimal flows down-river from the confluence. The Platte River experienced record low flows in 2012 with many areas running completely dry. Fish kills were reported, including endangered pallid sturgeon.*

## Letting lawns go brown can preserve water for others during drought

NATIONAL DROUGHT  
MITIGATION CENTER

People may assume drought always causes conflict between urban residents and farmers over water supplies. But a new study of Nebraska's Platte River Basin finds that cities can ease tensions during drought by reducing their consumption and allowing other users, such as agriculture, to take priority.

"The traditional view of urban and agricultural water users is two straws competing for water from the same glass, contributing to conflict," said Sam Zipper, lead author on the paper published in *Ecology and Society* and postdoctoral fellow at the University of Victoria in British Columbia. "We showed that cities can actually be key sites of adaptive management because urban water use can be reduced rapidly through outdoor watering restrictions."

"We found urban and agricultural water users in Nebraska actually viewed drought as a common enemy," said Kelly Helm Smith, study co-author and communications specialist at the National Drought Mitigation Center, based at the University of Nebraska-Lincoln. "But the drought in 2012 was relatively short-lived and Lincoln residents really only had mandatory restrictions on lawn watering for a few weeks. Things might have been very different had the drought had gone on for multiple years."

The interdisciplinary team of researchers, supported by the University of Maryland's National Socio-Environmental Synthesis Center in Annapolis, studied water use in the Platte River Basin in Nebraska, which includes the city of Lincoln, as an example of how different sectors respond during times of water stress. The group included experts in ecohydrology, resource management and policy, geography, and landscape ecology. They drew on that mix of backgrounds to analyze a novel

are highest during and immediately following drought, and the share of water-intensive crops being planted in the watershed is increasing," Zipper said.

During drought in 2012, which affected the whole state, Lincoln residents generally complied with the city's voluntary and then mandatory restrictions on outdoor water use. The city subsequently added a well to its wellfield under the Platte River and has introduced the idea of pulling water from the Missouri River.

***"THE TRADITIONAL VIEW OF URBAN AND AGRICULTURAL WATER USERS IS TWO STRAWS COMPETING FOR WATER FROM THE SAME GLASS, CONTRIBUTING TO CONFLICT. WE SHOWED THAT CITIES CAN ACTUALLY BE KEY SITES OF ADAPTIVE MANAGEMENT ... ."***

*Sam Zipper,  
postdoctoral fellow at the University of Victoria in British Columbia*

combination of data including drought intensity, urban water use, farmer crop choices, well installations, and media coverage to get a sense of how different users reacted to the drought.

They found that farmers in Nebraska are highly dependent on irrigation as a source of water for their crops, particularly in the drier western portion of the state. In response to drought, they were more likely to rely on irrigation infrastructure, and even install more of it, to ensure crops were getting sufficient water. "Irrigation well installations

The team used media reports logged in the drought center's Drought Impact Reporter to create a preliminary historic account of drought impacts and responses, and augmented what was in the media stories with other publicly available reports, plans and information. The researchers found evidence that Nebraska's water governance institutions were able to learn from a 2002 drought, with a law that requires the conjunctive

*Continued on page 11*



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management of surface water and groundwater.

Water experts have long advocated conjunctive management of surface and ground water as a strategy for sustainable water use, and Nebraska has recently implemented it. With its strong agricultural heritage, recurring drought incidents over the past few

decades, and the recent legislation to conjunctively manage groundwater and surface water resources, the researchers hope that the lessons learned in the Platte River Basin will be useful in other locations dealing with similar water issues.

“As a whole, we demonstrate that urban water use may represent a flexible use of water that can be more

rapidly and effectively curtailed during drought conditions when compared to agricultural users,” Zipper said. “We also conclude that although the existing governance mechanisms appear to protect water supplies, there is a concerning trend of increasing reliance on agricultural irrigation, which may create vulnerability to longer or more severe droughts of the future.”

## Policy analyst, mathematician and student researcher join NDMC

### Dr. Tingting Liu

Liu joined the National Drought Mitigation Center in September 2017 as a drought policy and impact analyst following a three-year appointment as a postdoctoral fellow at the Oak Ridge Institute for Science and Education at the U.S. Environmental Protection Agency’s Cincinnati office.

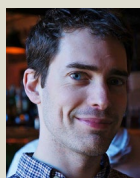
She had been an assistant professor at the Guangxi Normal University School of Economics and Management in Guilin, China, prior to coming to the U.S. in 2009 to do graduate research in land use change, agriculture and ecosystem services.

Liu’s research in both China and the U.S. has integrated hydrological modeling, economic valuation methods, land use change forecasting and optimization techniques in order to more accurately value natural capital and ecosystem services in ways that better inform policy development and decision-making. Her work at the NDMC will focus on the impact analysis and economic valuation of drought early warning and planning, including the economic measurement of both tangible and intangible costs and benefits of drought early warning and planning.

“The focus will be on three sectors: land management, transportation and health,” Liu said. “These are the areas



Liu



Watts



Hillis



### WHO WE ARE

The NDMC is made up of climatologists, remote sensing experts, social scientists, communicators, researchers, graduate students and visiting scientists.

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where the costs (of drought) are less obvious.”

### Dr. Jordan Watts

Watts joined the drought center in January 2018 as a post-doctoral researcher. He is a mathematician and researcher in applications of geometry and topology to data whose recent work includes looking at shapes created by data points and detecting holes or places where the data branches in various directions — features not easily detected by standard statistical methods. He is now applying these techniques to the extensive drought data set utilized by the NDMC.

Watt’s recent postdoctoral positions have been as a lecturer in mathematics at the University of Colorado-Boulder, and as a research assistant professor at the University of Illinois at Urbana-Champaign.

The focus of his research is generalizations of calculus for singular spaces and the invariants of the singularities.

### Mary Hillis

Mary Hillis is a master’s degree student at the University of Nebraska-Lincoln’s School of Natural Resources. She has a bachelor’s degree from California Polytechnic State University-San Luis Obispo in Earth Sciences, with minors in soil science and sustainable environments.

Hillis developed an interest in water resources through her senior project, Estimation of Spatial Variation in Hydraulic Conductivity Using Geoelectrical Methods at Swanton Pacific Ranch.

The goal of her master’s thesis research is improvement of drought impact tools and management plans. Her research is possible through a partnership of the NDMC and the National Integrated Drought Information System.

— NATIONAL DROUGHT  
MITIGATION CENTER

## DROUGHT SUMMIT



The National Drought Mitigation Center and National Integrated Drought Information System convened a drought planning summit in December 2017 to start working toward a more integrated set of drought planning recommendations. Participants included representatives from the Bureau of Reclamation, the Federal Emergency Management Agency, the Institute for Tribal Environmental Professionals, private sector consultants who work on drought planning, the Nebraska Emergency Management Agency and the American Planning Association.

