National Integrated Drought Information System (NIDIS) for the Missouri River Basin Drought Early Warning Information System (DEWS)
& Runoff Trends in the Missouri Basin
& Latest Flood Outlook

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National Center for Environmental Information (NCEI)
National Integrated Drought Information System (NIDIS)

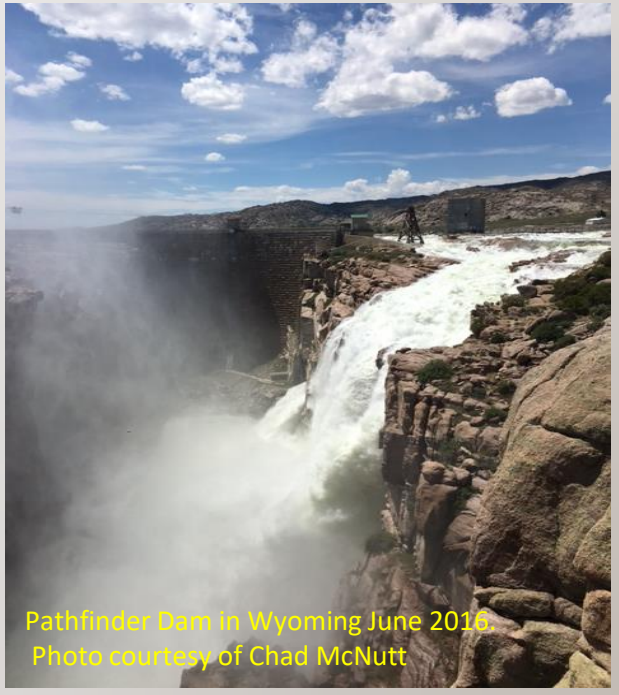
Western State Water Council Spring Meeting:
Water Resources Committee
April 13th, 2017
Lied Lodge, Nebraska City, Nebraska

NIDIS Goals

- Leadership and **networking** among all sectors of the economy and services to monitor, forecast, plan for and cope with the impacts of drought

- Support drought research- including indicators, risk assessment and resilience

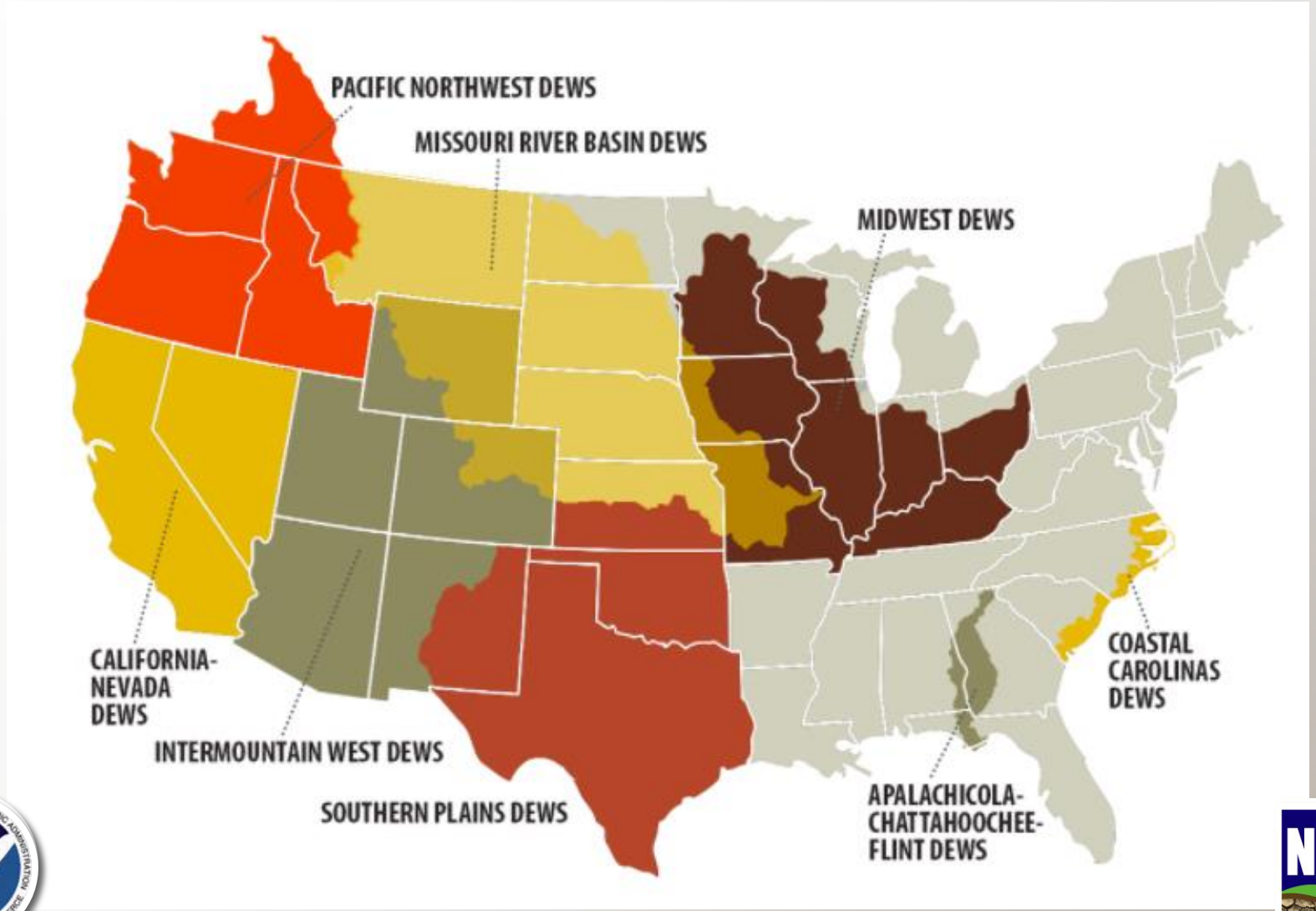
- Develop educational resources, interactive systems, and tools to promote sound decision making, drought awareness, and response



Pathfinder Dam in Wyoming June 2016.
Photo courtesy of Chad McNutt

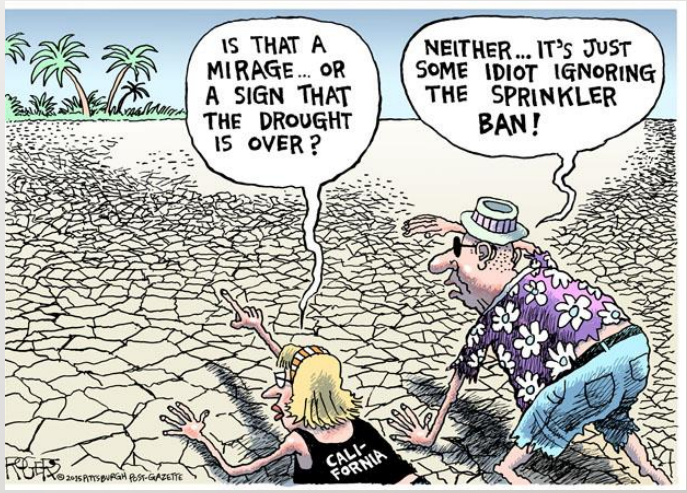
How? Development of Early Drought Warning Systems

NIDIS Regional Drought Early Warning Information Systems



Objectives of the Missouri River Basin DEWS

- Provide and develop a forum for a diverse group of federal, tribal, state, and local stakeholders that represent the water and land resource management communities, to strategize and develop appropriate, relevant, useful and readily available drought, climate, weather and water-related information.



- Develop an understanding of the existing observation and monitoring networks, data, tools, research and other planning and mitigation resources available for a DEWS.

- Identify the economic sector-specific and geographic needs for future monitoring, prediction, planning and information resources.

2014 Missouri DEWS Kickoff Meeting

Requested:

- Networks for regional drought monitoring and planning.
- Better understanding of drought as a hazard,
- Education and outreach to citizens, agencies and
- organizations in the basin.

Gaps identified:

- Create or revisit state drought plans.
- DEWS development in the context of floods/droughts

Next Steps:

- Improve understanding of vulnerability to drought.
- Partner with states and tribes to create new or improved drought plans.
- Initiate a series of regional or sub-basin meetings to understand impacts and ways to inform drought risk management.

Missouri River Basin DEWS Plan

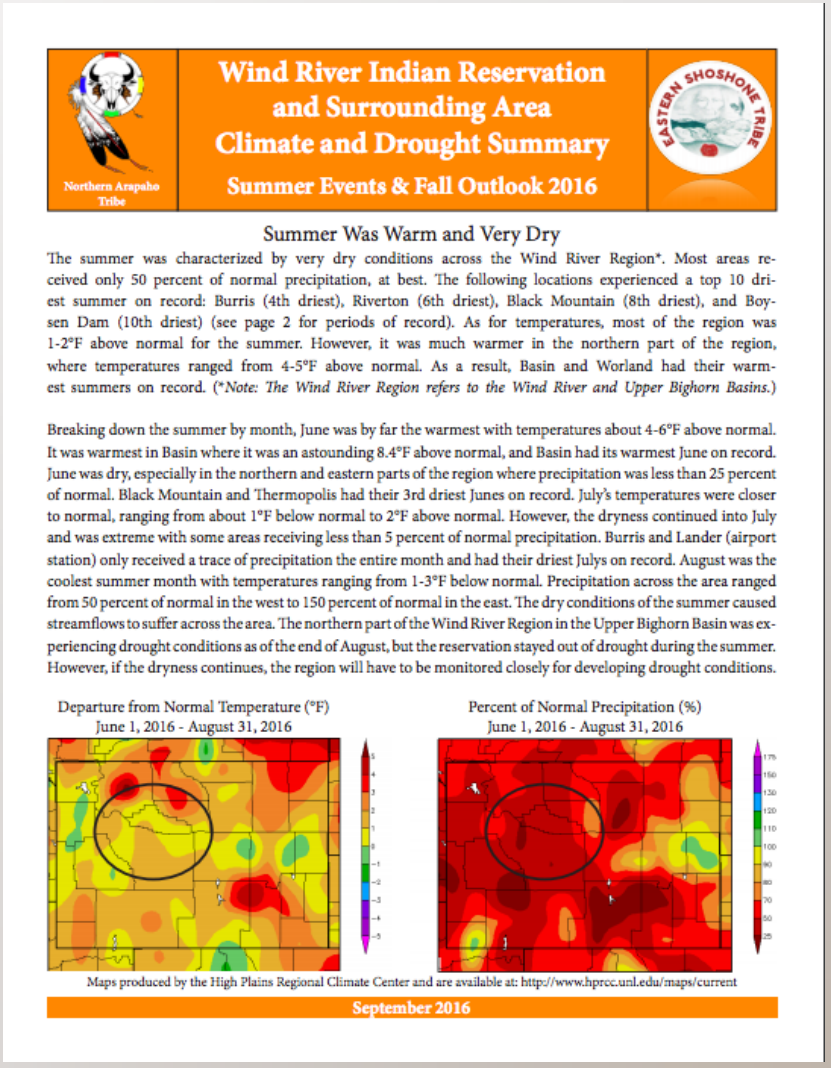
- **Task 1**: Working with Tribes on Drought Early Warning
- **Task 2**: Working with States on Drought Early Warning
- **Task 3**: Across Basin Activities (e.g. monitoring)

MRB Tribes and the DEWS

- September 2014: *Missouri River Basin Tribes Workshop on Extreme Events and Drought Resiliency* – Journey Museum, Rapid City, SD
- Next steps:
  - Exploring opportunities to expand and strengthen monitoring capabilities throughout tribal lands
  - Investigating partnerships with tribal colleges to build capacity for climate and drought planning efforts with their specific tribe
  - Continuing outreach to the tribes in the basin through several mechanisms, including direct outreach to tribal councils.
  - Expanding funding potential with other federal agencies and programs.

MRB Tribes and the DEWS

- **Wind River Indian Reservation** (USGS Grant)
  - Drought Climate Summary
  - Wind River Drought Plan
- **Great Plains Tribal Water Alliance** - (4 South Dakota tribes) Drought Vulnerability Assessment (BIA Tribal Climate Resilience Program)
  - Development of Water Resource Vulnerability Assessments Process and Guidebook
  - Development of Water Resource Vulnerability Assessments to Build Tribal Resilience
- 4 Kansas Based Tribes – Engagement Workshops & Grants
  - Kansas Indian Nations Drought Vulnerability and Resiliency Assessment (BIA Water Resources Management & Climate Resilience Grants)



Northern Arapaho Tribe

Wind River Indian Reservation and Surrounding Area Climate and Drought Summary

Summer Events & Fall Outlook 2016

EASTERN SHOSHONE TRIBE

Summer Was Warm and Very Dry

The summer was characterized by very dry conditions across the Wind River Region*. Most areas received only 50 percent of normal precipitation, at best. The following locations experienced a top 10 driest summer on record: Burris (4th driest), Riverton (6th driest), Black Mountain (8th driest), and Boysen Dam (10th driest) (see page 2 for periods of record). As for temperatures, most of the region was 1-2°F above normal for the summer. However, it was much warmer in the northern part of the region, where temperatures ranged from 4-5°F above normal. As a result, Basin and Worland had their warmest summers on record. (*Note: The Wind River Region refers to the Wind River and Upper Bighorn Basins.)

Breaking down the summer by month, June was by far the warmest with temperatures about 4-6°F above normal. It was warmest in Basin where it was an astounding 8.4°F above normal, and Basin had its warmest June on record. June was dry, especially in the northern and eastern parts of the region where precipitation was less than 25 percent of normal. Black Mountain and Thermopolis had their 3rd driest Junes on record. July's temperatures were closer to normal, ranging from about 1°F below normal to 2°F above normal. However, the dryness continued into July and was extreme with some areas receiving less than 5 percent of normal precipitation. Burris and Lander (airport station) only received a trace of precipitation the entire month and had their driest Julys on record. August was the coolest summer month with temperatures ranging from 1-3°F below normal. Precipitation across the area ranged from 50 percent of normal in the west to 150 percent of normal in the east. The dry conditions of the summer caused streamflows to suffer across the area. The northern part of the Wind River Region in the Upper Bighorn Basin was experiencing drought conditions as of the end of August, but the reservation stayed out of drought during the summer. However, if the dryness continues, the region will have to be monitored closely for developing drought conditions.

Departure from Normal Temperature (°F)
June 1, 2016 - August 31, 2016

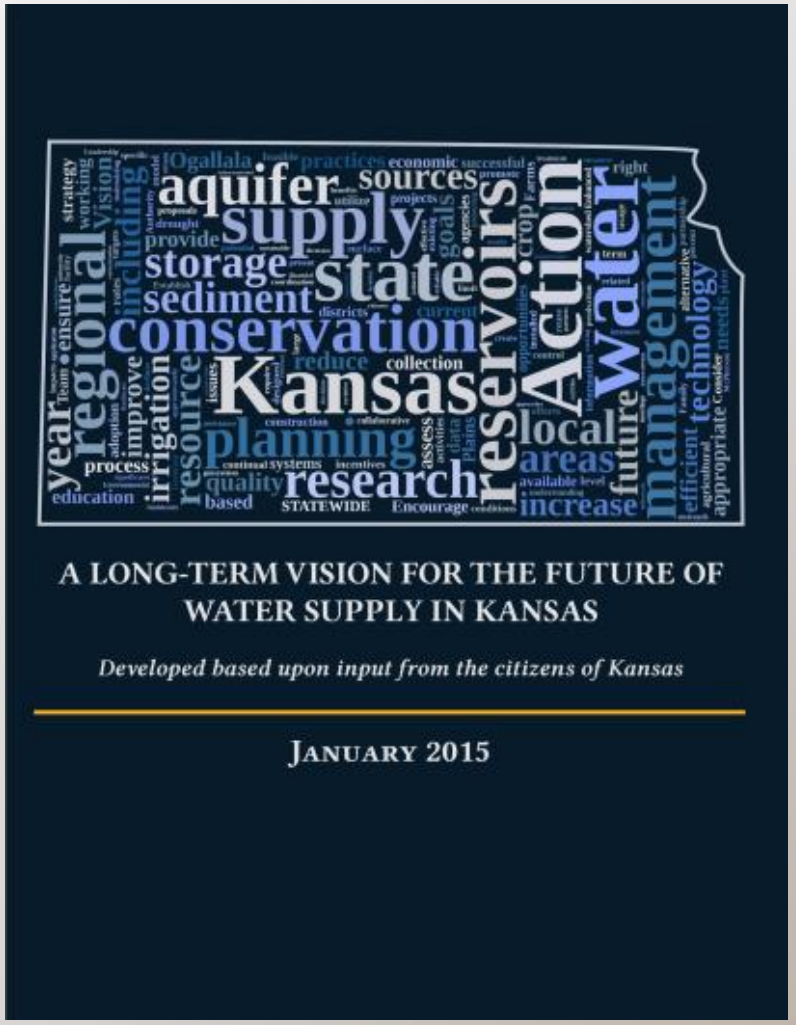
Percent of Normal Precipitation (%)
June 1, 2016 - August 31, 2016

Maps produced by the High Plains Regional Climate Center and are available at: http://www.hprcc.unl.edu/maps/current

September 2016

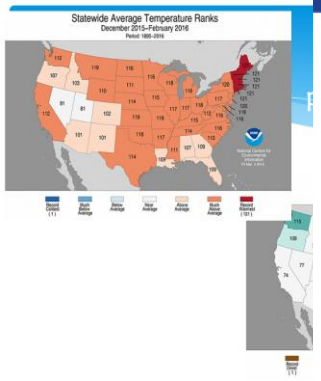
States and the DEWS

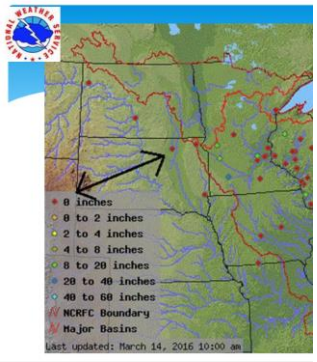
- Drought Simulations (tournament) with Vulnerable Communities in eastern Kansas (Dec. 2016)
- Identify states in the MRB that have incorporated drought into their multi-hazard mitigation plan (NDMC)
- Montana Demonstration Project (NDRP)
- Sub-State Mapping/Planning effort
- Wyoming Monthly Water Brief

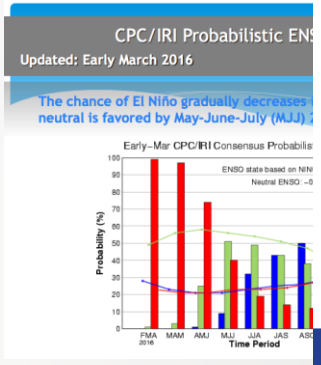


Across Basin Activities

North Central U.S.



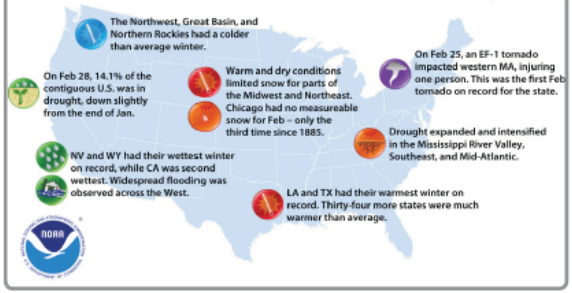




Quarterly Climate Impacts and Outlook — Missouri River Basin — March 2017

National - *Significant Events for December 2016 - February 2017*

U.S. Selected Significant Climate Anomalies and Events for February 2017



The average U.S. temperature during February was 41.2°F, 7.3°F above average, and the second warmest on record. The winter U.S. temperature was 35.9°F, 3.7°F above average, and the sixth highest on record. February U.S. precipitation was 2.21 inches, 0.08 inch above average. The winter precipitation total was 8.22 inches, 1.43 inches above average, and the eighth wettest on record.

Please Note: Material provided in this map was compiled from NOAA's State of the Climate Reports. For more information please visit: http://www.ncdc.noaa.gov/sotc

Highlights for the Basin

It was the sixth warmest winter for the U.S., with the majority of the extreme warmth to the south and east of the Basin. The exception was Missouri, which had its 4th warmest winter on record.

It was also the eighth wettest winter for the U.S. The Basin had extremes on both ends of the spectrum, with Wyoming (wettest), Colorado (5th wettest), and North Dakota (6th wettest) ranking among the wettest winters on record and Missouri ranking 10th driest.

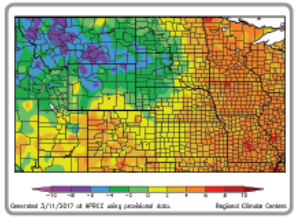
Numerous locations set new temperature records in February - even beating out those set in recent years. A new February record of 87°F in Goodland, KS crushed its old record by 5°F, set just last year. Meanwhile, Denver, CO had its earliest 80°F+ day on record with a high temperature of 80°F on February 10th. This beat the previous record, March 16, 2015, by over a month.

While upper portions of the Basin received heavy snowfall this winter, lower portions experienced a "snow drought." Season-to-date snowfall for Bismarck, ND ranked as the 4th highest on record (62.9 inches), while Lincoln, NE ranked as 2nd lowest (6.9 inches).

Regional - *Climate Overview for December 2016 - February 2017*

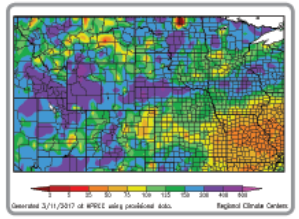
Temperature and Precipitation Anomalies

Departure from Normal Temperature (°F)
December 1, 2016 - February 28, 2017



There was a large contrast in temperatures across the Basin this winter, with departures ranging from 8°F below normal to 8°F above normal. Generally, areas to the north and west were below normal, while areas to the south and east were above normal. This general pattern held during December and January, but much above-normal temperatures were widespread during February. By the end of winter, records were nearly set on both ends of the spectrum, as several locations ranked in either the top 10 warmest or coolest winters on record.

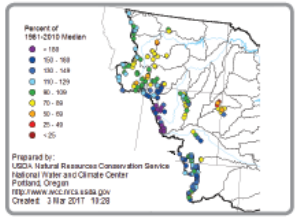
Percent of Normal Precipitation (%)
December 1, 2016 - February 28, 2017



Overall, precipitation was above to much above normal for the majority of the Basin. Most of Wyoming, central Colorado, northern Nebraska/southern South Dakota, and portions of Montana and North Dakota received at least 200 percent of normal precipitation. On the other hand, areas of eastern Colorado and eastern Kansas, along with the majority of Missouri were below normal. This resulted in improvements in drought conditions in wetter areas and the persistence or development of drought conditions in drier areas.

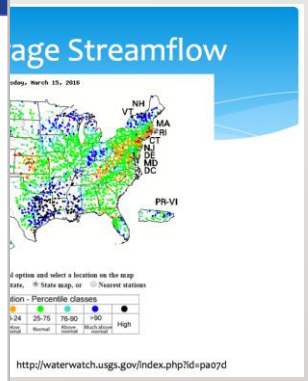
Mountain Snowpack

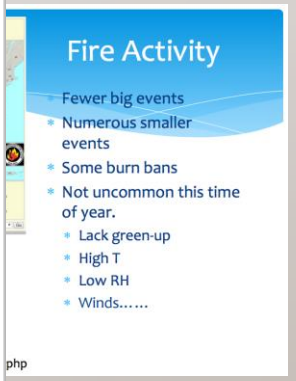
Missouri Basin Mountain Snowpack
03/01/2017



Rocky Mountain snowpack was off to a slow start this season, but then quickly rebounded. In some areas, snowfall was so heavy at times that ski resorts were forced to shut down. By mid-March, mountain snowpack was above average for the reach above Fort Peck Dam (104%) and for the reach between Fort Peck and Garrison Dams (137%). The U.S. Army Corps of Engineers and the Bureau of Reclamation are releasing water to make room for an above-normal runoff year due to the high snowpack. Plains snowpack has largely melted due to extreme warmth.

Contact: Natalie Umphlett (numphlett2@unl.edu)

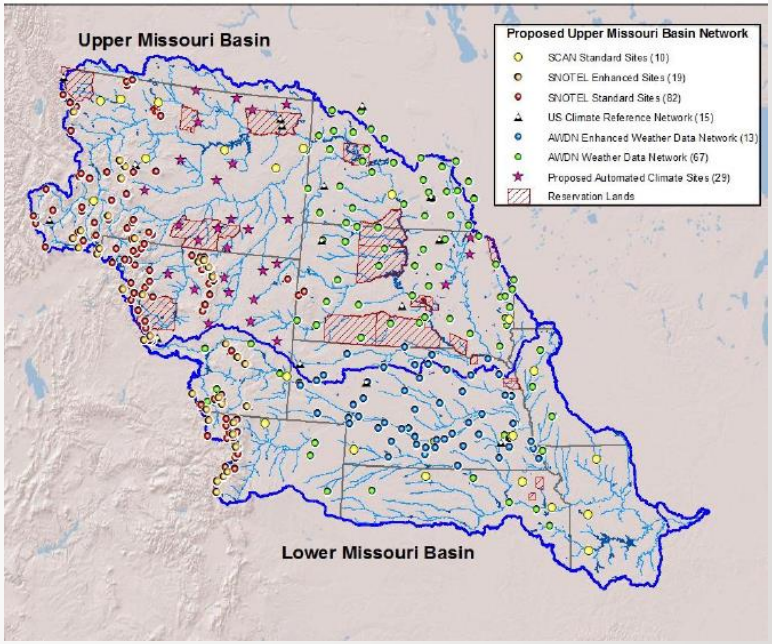




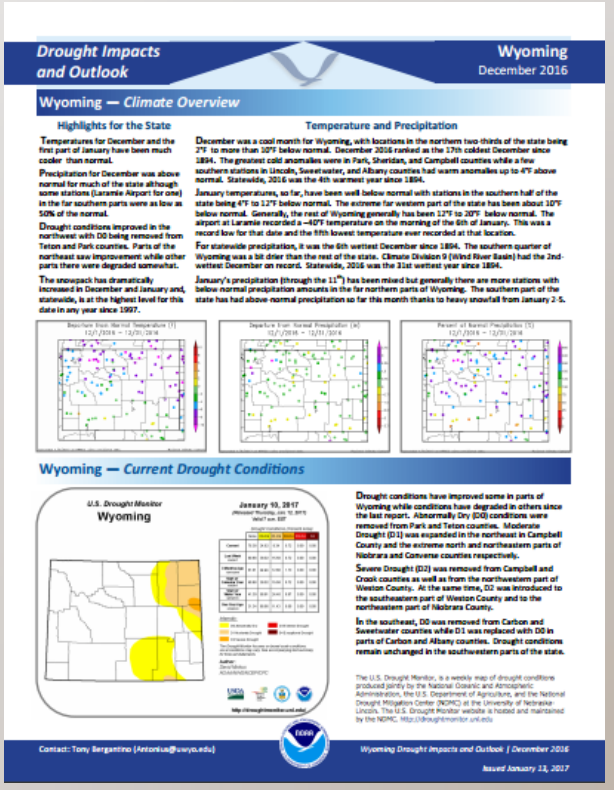
hived webinars:
rcc.unl.edu/webinars.php

Across Basin Activities

- Improving regional monitoring



- USDA Northern Plains Climate Hub



Across Basin Activities

- Identify federal, state and private (NGO) interest and funding streams and ways to leverage them for supporting drought planning and assessment
  - Example: FEMA's Pre-Disaster Mitigation program
  - Example: Bureau of Reclamation's Drought Response Program can be better utilized to support drought planning across the MRB.
  - Example: BIA's Water Management and Climate Grants

2017 Lower & Upper Basin Strategic Meetings

- **Purpose:** Assess the current status of drought monitoring and prediction; identify what tribes, states, watershed groups, and municipalities are doing for anticipating drought; the current status of drought planning and how early warning information matches these efforts; and identify next steps to improve the DEWS
- **Lower Basin**: March 2017 (here) (KS, NE, MO, IA, CO 7 Tribes, 7 fed agencies, etc…
- **Upper Basin**: May 23-25th, 2017 Rapid City, SD
  - **Participants:** State, Tribal, Federal governments, sectors (Ag., water supply, universities)
  - ½ day **tools workshop** + two days of prioritizing next steps

Recent Climate Studies: Findings for the Missouri Basin

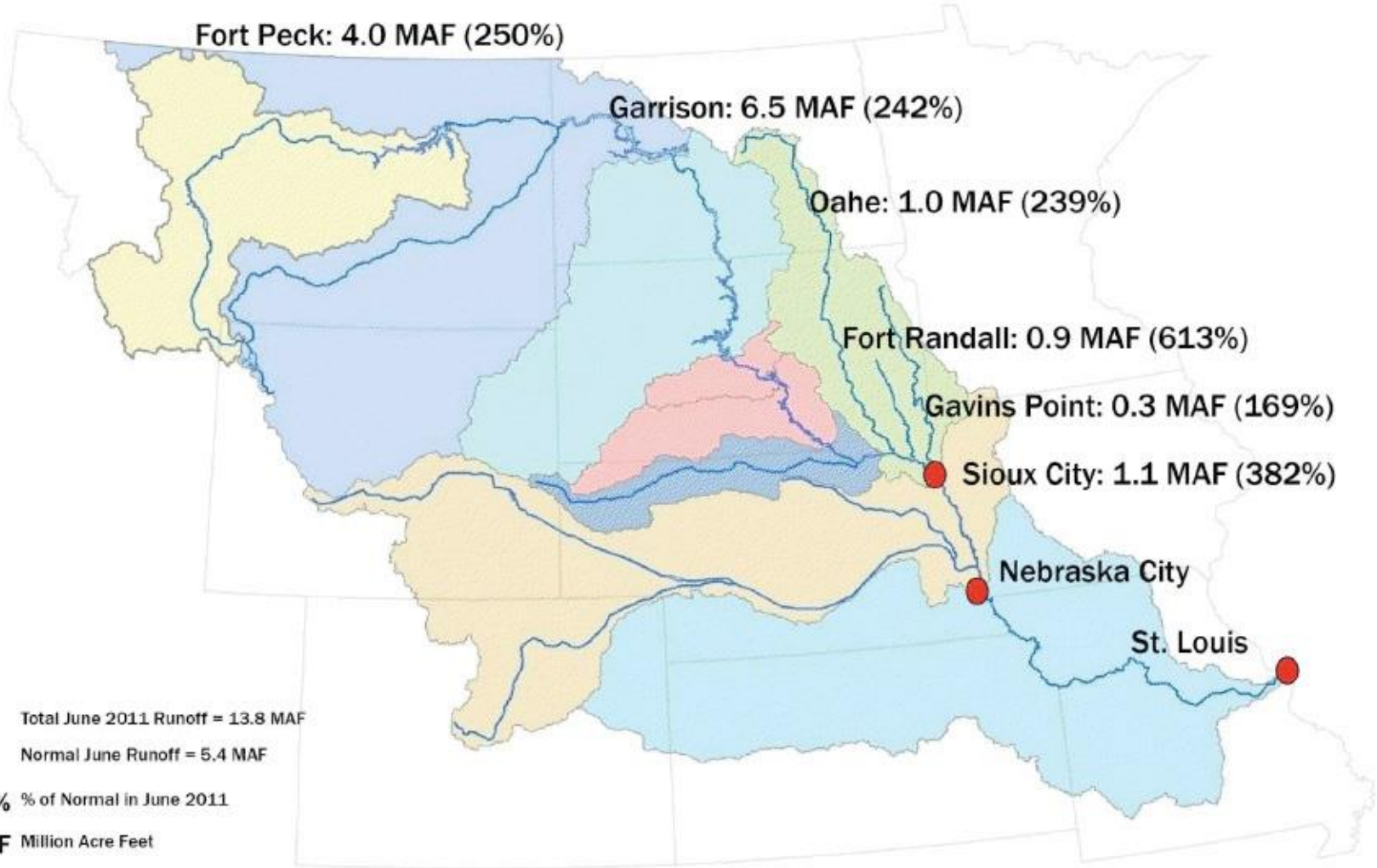
Interstate 29 underwater: Missouri River flooding in Omaha, NE June 2011. Photo by Larry Geiger. [https://franceshunter.wordpress.com/2011/06/20/great-missouri-river-flood-of-2011/]

The Missouri Basin had a bit of an extreme event in 2011

US Army Corps of Engineers
BUILDING STRONG

Missouri River Basin

June 2011 Runoff



Total June 2011 Runoff = 13.8 MAF

Normal June Runoff = 5.4 MAF

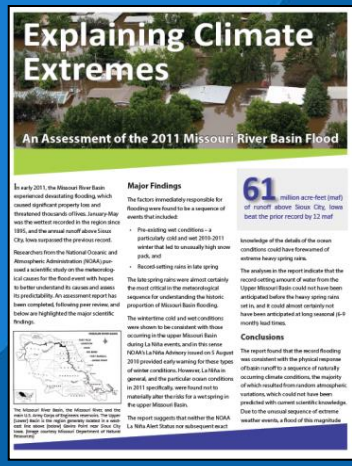
X% % of Normal in June 2011

MAF Million Acre Feet

*Fort Randall runoff includes Big Bend

Missouri Basin Climate Research

- **Climate Assessment Report: Causes for Hydrologic Extremes in the Upper Missouri Basin**
- **Seasonal Precipitation Forecasts Over the Missouri Basin**
- **Climate Assessment Report: Understanding and Explaining Climate Extremes in the Missouri River Basin Associated with the 2011 Flooding**
- **Explaining Climate Extremes: An Assessment of the 2011 Missouri River Basin Flood**


Explaining Climate Extremes

An Assessment of the 2011 Missouri River Basin Flood

In early 2011, the Missouri River Basin experienced devastating flooding, which caused significant property loss and threatened thousands of lives. January-May was the wettest recorded in the region since 1895, and the annual runoff above Sioux City, Iowa surpassed the previous record.

Researchers from the National Oceanic and Atmospheric Administration (NOAA) pursued a scientific study on the meteorological causes for the flood event with hopes to better understand its causes and assess its predictability. An assessment report has been completed, following peer review, and below are highlighted the major scientific findings.

Major Findings

The factors immediately responsible for flooding were found to be a sequence of events that included:

- Pre-existing wet conditions – a particularly cold and wet 2010-2011 winter that led to unusually high snow pack, and
- Record-setting rains in late spring

The late spring rains were almost certainly the most critical in the meteorological sequence for understanding the historic proportion of Missouri Basin flooding.

The wintertime cold and wet conditions were shown to be consistent with those occurring in the upper Missouri Basin during La Niña events, and in this sense NOAA's La Niña Advisory issued on 5 August 2010 provided early warning for these types of winter conditions. However, La Niña in general, and the particular ocean conditions in 2011 specifically, were found not to statistically alter the risks for a wet spring in the upper Missouri Basin.

The report suggests that neither the NOAA La Niña Alert Status nor subsequent exact

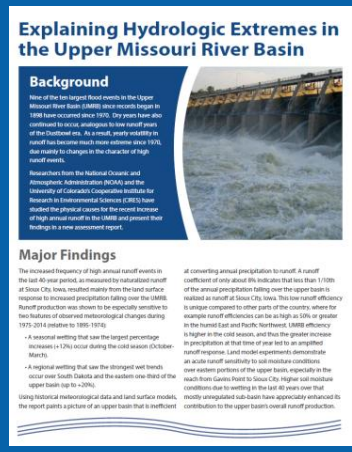
61 million acre-feet (maf) of runoff above Sioux City, Iowa beat the prior record by 12 maf

knowledge of the details of the ocean conditions could have forewarned of extreme heavy spring rains.

The analyses in the report indicate that the record-setting amount of water from the Upper Missouri Basin could not have been anticipated before the heavy spring rains set in, and it could almost certainly not have been anticipated at long seasonal (6-9 months) lead times.

Conclusions

The report found that the record flooding was consistent with the physical response of basin runoff to a sequence of naturally occurring climate conditions, the majority of which resulted from random atmospheric variations, which could not have been predicted with current scientific knowledge. Due to the unusual sequence of extreme weather events, a flood of this magnitude


Explaining Hydrologic Extremes in the Upper Missouri River Basin

Background

Nine of the ten largest flood events in the Upper Missouri River Basin (UMRB) since records began in 1898 have occurred since 1970. Dry years have also continued to occur, analogous to low runoff years of the Dustbowl era. As a result, yearly-volatility in runoff has become much more extreme since 1970, due mainly to changes in the character of high runoff events.

Researchers from the National Oceanic and Atmospheric Administration (NOAA) and the University of Colorado's Cooperative Institute for Research in Environmental Sciences (CIRES) have studied the physical causes for the recent increase of high annual runoff in the UMRB and present their findings in a new assessment report.

Major Findings

The increased frequency of high annual runoff events in the last 40-year period, as measured by naturalized runoff at Sioux City, Iowa, resulted mainly from the land surface response to increased precipitation falling over the UMRB. Runoff production was shown to be especially sensitive to two features of observed meteorological changes during 1975-2014 (relative to 1895-1974):

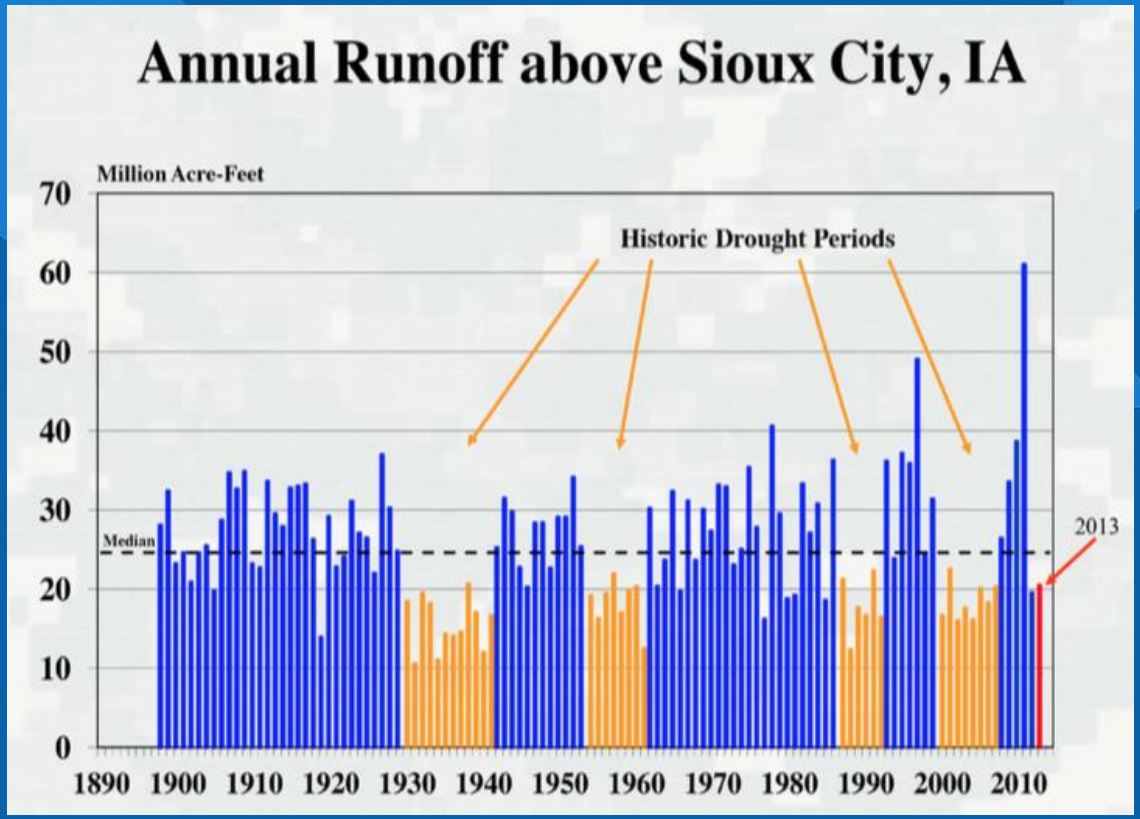
- A seasonal wetting that saw the largest percentage increases (+12%) occur during the cold season (October-March).
- A regional wetting that saw the strongest wet trends occur over South Dakota and the eastern one-third of the upper basin (up to +20%).

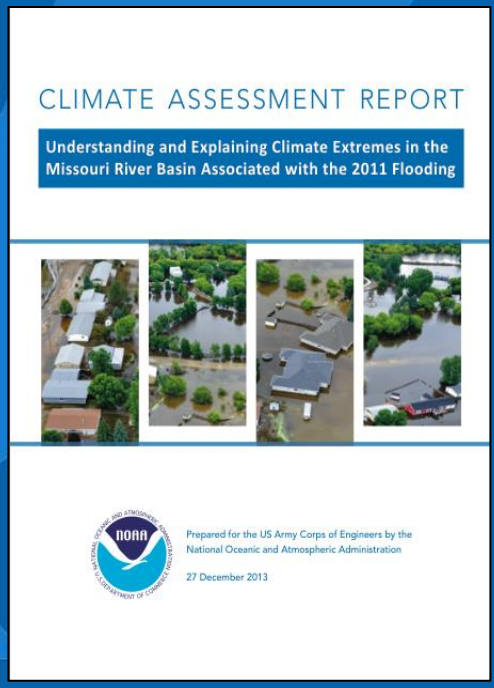
Using historical meteorological data and land surface models, the report paints a picture of an upper basin that is inefficient at converting annual precipitation to runoff. A runoff coefficient of only about 8% indicates that less than 1/10th of the annual precipitation falling over the upper basin is realized as runoff at Sioux City, Iowa. This low runoff efficiency is unique compared to other parts of the country, where for example runoff efficiencies can be as high as 55% or greater in the humid East and Pacific Northwest. UMRB efficiency is higher in the cold season, and thus the greater increase in precipitation at that time of year led to an amplified runoff response. Land model experiments demonstrate an acute runoff sensitivity to soil moisture conditions over eastern portions of the upper basin, especially in the reach from Gavins Point to Sioux City. Higher soil moisture conditions due to wetting in the last 40 years over that mostly unregulated sub-basin have appreciably enhanced its contribution to the upper basin's overall runoff production.

https://www.drought.gov/drought/dews/missouri-river-basin/reports-assessments-and-outlooks

Attribution of Missouri Basin Climate Variability

- 2011 prompted NOAA investigation into drivers
- Recent variability in annual flows emerged





Regimes of persistent low flows, denoted by orange bars, denote hydrologic droughts within the basin. Horizontal line shows the historical median value. Data source is USACE.

2011 Flooding Assessment

Explaining Climate Extremes

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The Missouri River Basin, the Missouri River, and the main U.S. Army Corps of Engineers reservoirs. The Upper (Lower) Basin is the region generally located in a westcast line above (below) Gavins Point near Sioux City Iowa. [Image courtesy Missouri Department of Natural Resources]

Major Findings

The factors immediately responsible for flooding were found to be a sequence of events that included:

- Pre-existing wet conditions – a particularly cold and wet 2010-2011 winter that led to unusually high snow pack, and
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The late spring rains were almost certainly the most critical in the meteorological sequence for understanding the historic proportion of Missouri Basin flooding.

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Conclusions

The report found that the record flooding was consistent with the physical response of basin runoff to a sequence of naturally occurring climate conditions, the majority of which resulted from random atmospheric variations, which could not have been predicted with current scientific knowledge. Due to the unusual sequence of extreme weather events, a flood of this magnitude was a rare occurrence, and a comparable event has low probability for recurring in the immediate future.

A caveat to the conclusion that the flooding was the result of a sequence of naturally occurring climate conditions is the fact that annual flow in the Upper Missouri Basin has been more volatile in recent decades compared to prior decades dating to 1898. Specifically:

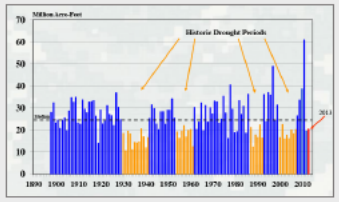
- Nine of the ten highest annual runoffs in the Missouri Basin historical record were found to have occurred after 1970, and
- Year-to-year variability of annual runoff has increased dramatically in recent decades principally due to an increase in high flow events.

The report does not address the underlying cause for post-1970 increase in the frequency of high runoffs events, but recommends further investigation of possible factors in order to better inform decision makers on the risks for future severe flooding events in the Missouri River Basin.

Given these events and the hydrology of the Missouri Basin, it was reasonable to expect that the subsequent 2012 year would also be susceptible to flooding. The previous five years had experienced above-average annual precipitation in the upper basin, resulting in progressively higher annual runoff from 2008-2011. However, the observed 2012 annual runoff in the Missouri Basin was below normal. The climate conditions themselves had not changed much between 2011 and 2012, and the concentrations of human-caused greenhouse gases were basically the same.

The fate of 2012 Missouri River runoff was apparently not set by the pre-existing conditions of 2011 anymore than pre-existing conditions determined the fate of 2011. Instead, in both 2011 and 2012 annual runoff depended primarily on meteorological factors, which abruptly returned the basin from flooding conditions in 2011 to drought conditions in 2012. The similar large-scale climate conditions of 2011 and 2012 serve as a lesson on the power of short-term variations in weather to cause contrasting impacts on the Missouri River Basin's annual runoff.

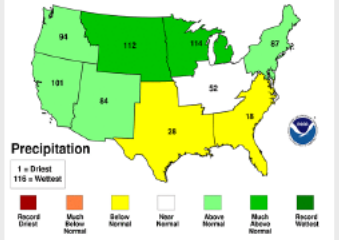
Annual Runoff above Sioux City, Iowa



Time series of the annual Missouri River runoff (million acre-feet) above Sioux City, Iowa for 1898-2012. The 2013 value (red bar) is a preliminary estimate. Regimes of persistent low flows, denoted by orange bars, denote hydrologic droughts within the basin. Horizontal line shows the historical median value. Data source is USACE.

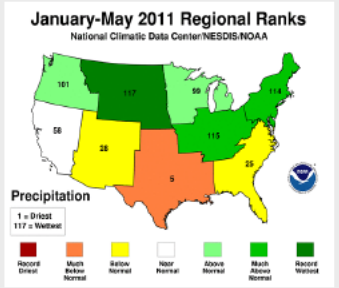
January-December 2010 Regional Ranks

National Climatic Data Center/NESDIS/NOAA



January-May 2011 Regional Ranks

National Climatic Data Center/NESDIS/NOAA



The historical ranking of regional precipitation for annual 2010 conditions (top), and for the subsequent January-May 2011 conditions (bottom). Over the Missouri River Basin region, 2010 ranked 5th wettest since 1895, whereas the subsequent 5-month period January-May 2011 ranked as the historical wettest since 1895. Note the dramatic contrast between conditions in the Missouri Basin versus those immediately south. Data source is NOAA.

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Funding for this project was provided by U.S. Army Corps of Engineers (USACE)

Visit us online at:
www.esrl.noaa.gov/psd/csi/

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION U.S. DEPARTMENT OF COMMERCE

Observational Analysis of Change in the Missouri River Basin

Observed Discharge from UMRB:

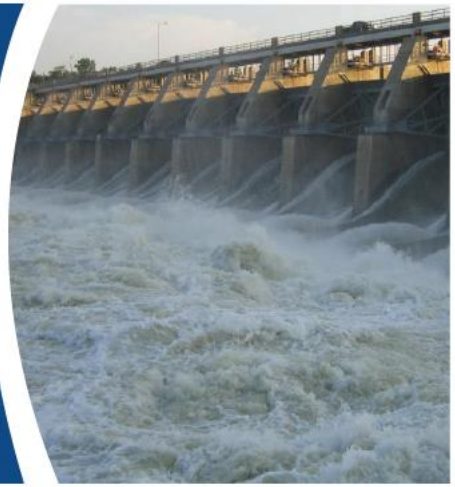
- During the 117 years of record-keeping (1898-2014)---
  - the 4 highest flow years have occurred in the last 40 years (1975-2014)
  - 10 of the highest 13 runoff years in the UMRB have occurred in the last 40 years
  - 9% increase in average annual flow in last 40-yrs compared to prior 77 year average
  - doubling of the coefficient of variability in last 20yrs compared to first 20yrs

Explaining Hydrologic Extremes in the Upper Missouri River Basin

Background

Nine of the ten largest flood events in the Upper Missouri River Basin (UMRB) since records began in 1898 have occurred since 1970. Dry years have also continued to occur, analogous to low runoff years of the Dustbowl era. As a result, yearly volatility in runoff has become much more extreme since 1970, due mainly to changes in the character of high runoff events.

Researchers from the National Oceanic and Atmospheric Administration (NOAA) and the University of Colorado's Cooperative Institute for Research in Environmental Sciences (CIRES) have studied the physical causes for the recent increase of high annual runoff in the UMRB and present their findings in a new assessment report.

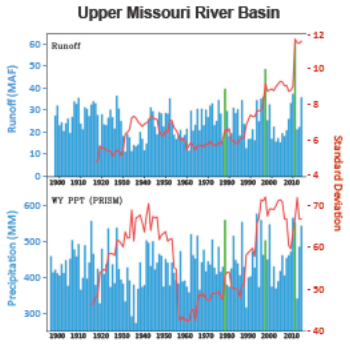


Major Findings

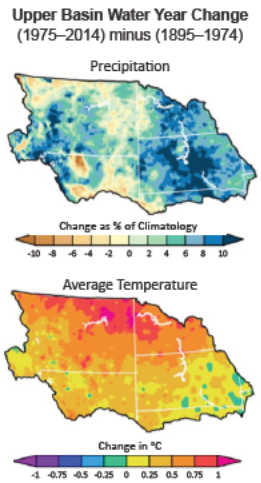
The increased frequency of high annual runoff events in the last 40-year period, as measured by naturalized runoff at Sioux City, Iowa, resulted mainly from the land surface response to increased precipitation falling over the UMRB. Runoff production was shown to be especially sensitive to two features of observed meteorological changes during 1975-2014 (relative to 1895-1974):

- A seasonal wetting that saw the largest percentage increases (+12%) occur during the cold season (October-March).
- A regional wetting that saw the strongest wet trends occur over South Dakota and the eastern one-third of the upper basin (up to +20%).

Using historical meteorological data and land surface models, the report paints a picture of an upper basin that is inefficient at converting annual precipitation to runoff. A runoff coefficient of only about 8% indicates that less than 1/10th of the annual precipitation falling over the upper basin is realized as runoff at Sioux City, Iowa. This low runoff efficiency is unique compared to other parts of the country, where for example runoff efficiencies can be as high as 50% or greater in the humid East and Pacific Northwest. UMRB efficiency is higher in the cold season, and thus the greater increase in precipitation at that time of year led to an amplified runoff response. Land model experiments demonstrate an acute runoff sensitivity to soil moisture conditions over eastern portions of the upper basin, especially in the reach from Gavins Point to Sioux City. Higher soil moisture conditions due to wetting in the last 40 years over that mostly unregulated sub-basin have appreciably enhanced its contribution to the upper basin's overall runoff production.



Time series of water-year (1 October-30 September) UMRB runoff (million acre-feet) above Sioux City, Iowa for 1898-2014 (top), and water-year precipitation average for the upper basin above Sioux City (mm; bottom). Green bars highlight the three highest runoff years in the record. A measure of the year-to-year volatility is shown in the red curves that plot standard deviation of water-year values for 20-yr moving windows. Runoff at Sioux City from USACE; precipitation is PRISM.



The observed change in water-year (1 October-30 September) precipitation (% of climatology, top), and average surface air temperature (°C, bottom). Changes are calculated by differencing the 40-yr average (1975-2014) from the 80-yr average (1895-1974). Data source is PRISM.

Conclusions

The report demonstrates a strong physical connection between the increased frequency of high annual runoff events in the UMRB and the increase in precipitation falling over the upper basin. Each of the nine highest annual runoff years since 1975 were abnormally wet years. A concentration of wetting during the cold season has been key, leading to higher soil moisture conditions that further acted to increase efficiency in runoff production. The upper basin has warmed, which may have slightly reduced runoff efficiency, though this effect has been far eclipsed by the increased precipitation.

The cause for these changes in meteorological conditions was also briefly explored in the report. Most of the magnitude in observed precipitation increases, and hence much of the runoff increases, occurred via natural variations in the region's climate. The warming trend, by contrast, was consistent with an emergent signal of human-induced climate change.

Wetter and warmer conditions in the UMRB are anticipated in the future due to human-induced climate change. Under an aggressive emissions scenario, the upper basin is expected to warm by about 6°C by the end of the 21st century. It is currently unclear whether the impact of such unprecedented warming on future upper basin runoff will dominate over precipitation changes, or even over the typical natural precipitation variability. Further investigation is required on how annual runoff efficiency will change and whether year-to-year runoff volatility will increase.

In the immediate future, runoff variations including extreme high and low runoff years, will continue to be dominated by natural variability in the upper basin. The report indicates that predictions of such variability will benefit from improved soil moisture monitoring, whose antecedent land surface states were found to correlate with subsequent annual runoff. However, the direct effects of precipitation will continue to prevail in driving runoff variability. Overall, improved outlooks for annual runoff and likelihood of flooding will benefit most substantively from improvements in precipitation predictions at monthly, seasonal and longer time scales.

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Funding for this project was provided by U.S. Army Corps of Engineers (USACE)

CIRES

Summary of Station-Based Analysis for *Cold Season*

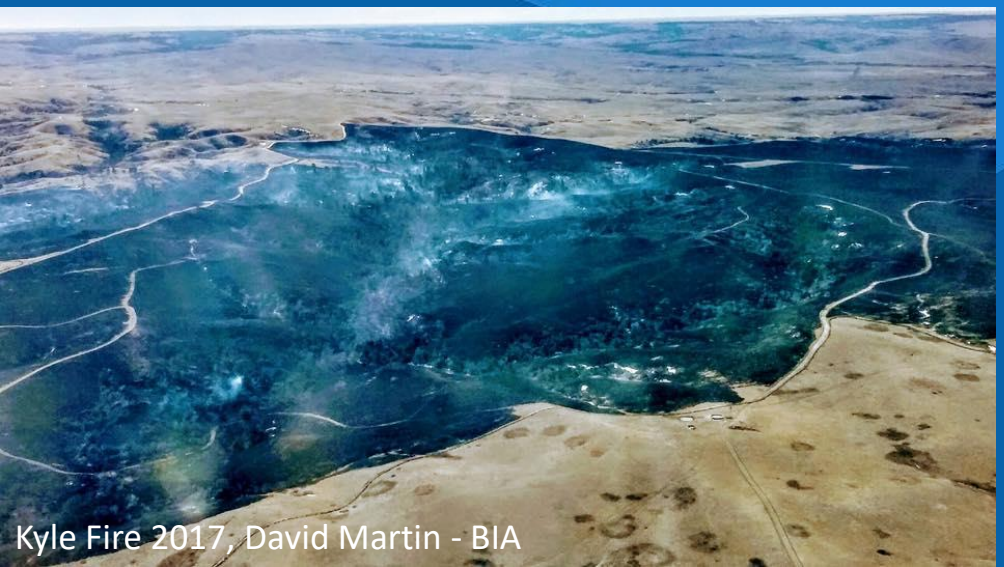
- Mean pcpn has increased in the UMRB (1975-2014) vs (1901-2014) at most stations, except western Montana
- Frequency of very heavy rain days has increased, is aligned with mean pcpn change
- A greater proportion of seasonal pcpn total is now contributed by very heavy rain days

Summary of Station-Based Analysis for Warm Season

- Mean pcpn has increased in the UMRB (1975-2014) vs (1901-2014) at most stations
- Frequency of very heavy rain days has increased, is aligned with mean pcpn change
- Most stations show little change in proportion of seasonal pcpn contributed by very heavy rain day except a few stations just above Sioux City.

Missouri Basin Status

Kyle Fire 2017, David Martin - BIA



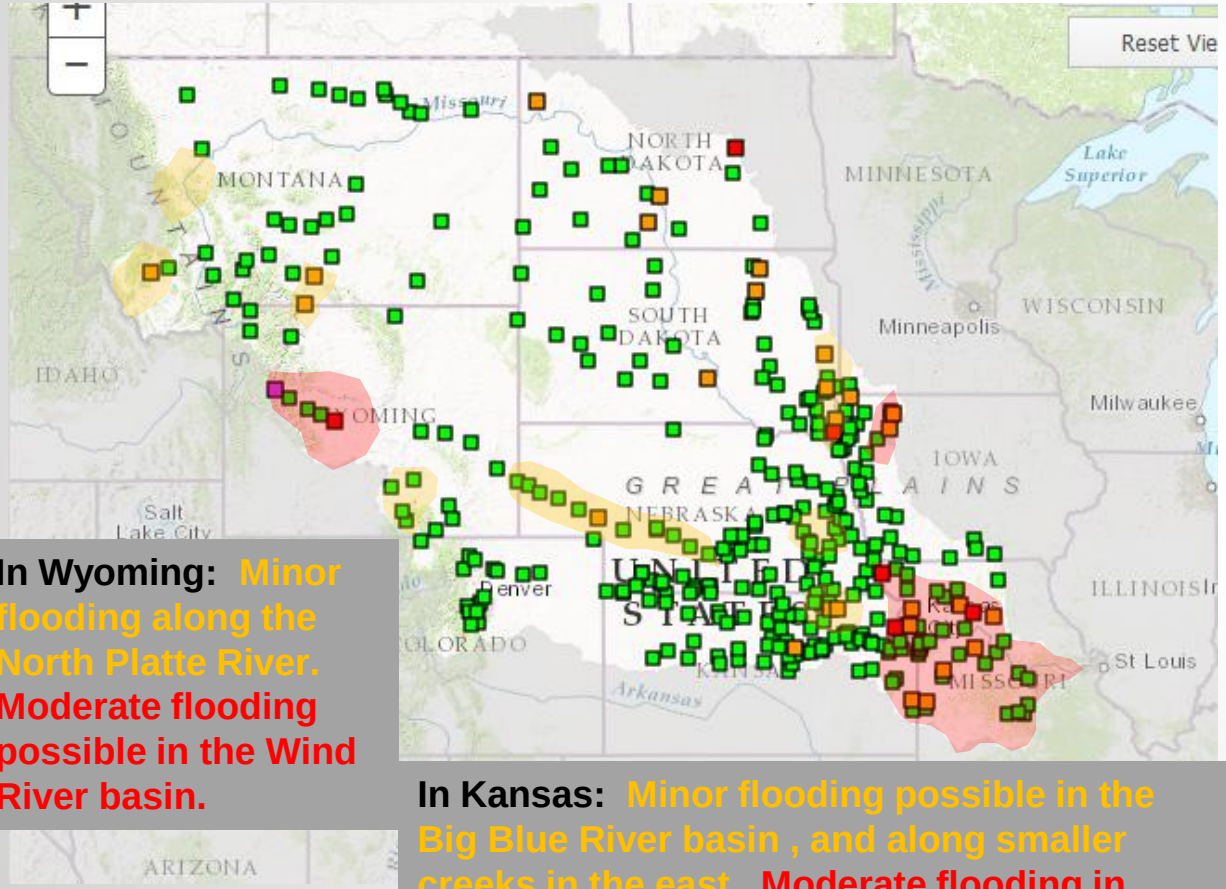
Kyle Fire 2017, David Martin - BIA

MISSOURI BASIN
FLOOD POTENTIAL OUTLOOK

In Montana: Minor flooding possible in the Big Hole, Sun, and Clarks Fork Yellowstone River basins.

In South Dakota: Minor flooding possible along the Big Sioux River.

In Nebraska: Minor flooding possible along the lower North Platte River, the Platte River, as well as along smaller streams in eastern Nebraska.



In Iowa: Minor flooding along the Big Sioux River. Moderate flooding possible along the Little Sioux.

In Missouri: Minor flooding possible along the Chariton River. Moderate flooding possible in the Grand, Osage, and Platte River basins, as well as along many of the smaller creeks.

In Wyoming: Minor flooding along the North Platte River. Moderate flooding possible in the Wind River basin.

In Kansas: Minor flooding possible in the Big Blue River basin , and along smaller creeks in the east. Moderate flooding in Marais des Cygnes-Osage basin.

U.S. Army Corps Weekly Update

http://www.nwd-mr.usace.army.mil/rcc/reports/pdfs/weeklyupdate.pdf

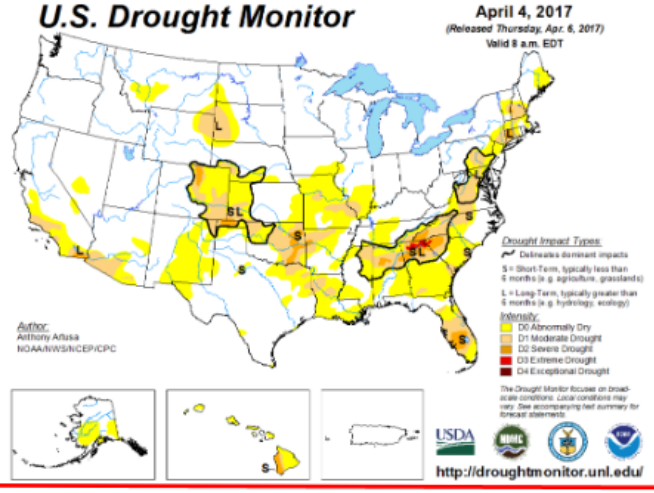
Missouri River Basin – Weekly Update – 10 Apr 2017

Mainstem Reservoir Status:

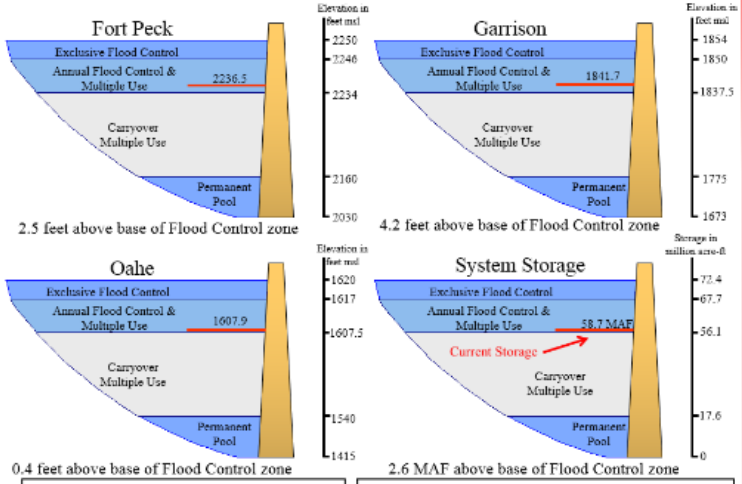
- System storage is 58.7 million acre-feet (MAF), 2.6 MAF above the base of the Annual Flood Control and Multiple Use Zone.
- System storage increased 0.2 MAF during the past week.
- More than 84 percent of the 16.3 MAF flood control storage zone remains available to capture runoff.
- Fort Peck, Garrison and Oahe reservoirs are capturing and storing runoff, which is expected during this time of the runoff season.
- As a result of the updated monthly runoff forecast, the navigation service level has been increased 5,000 cfs:
  - Longer evacuation period at lower rate to reduce flood risk,
  - Provides enhanced service to authorized purposes.

Snowpack Conditions:

- Mountain snowpack is slightly below average for the reach above Fort Peck and is above average for the reach between Fort Peck and Garrison.
- Traces of plains snow are present in western South Dakota, Montana and Wyoming.



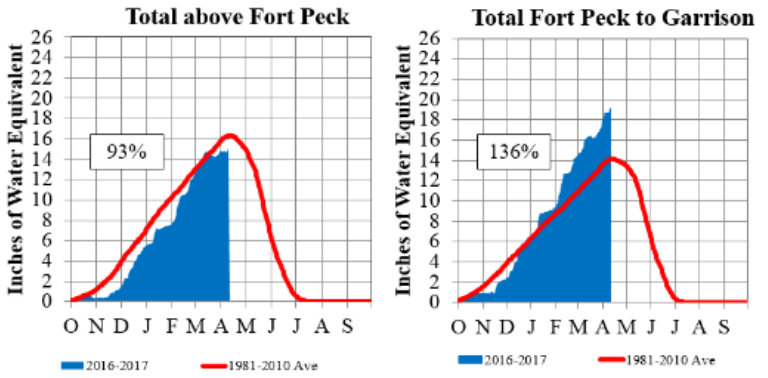
Current Reservoir Levels



Click Here for Comparison Plots

Click Here for Latest 3-Week Forecast

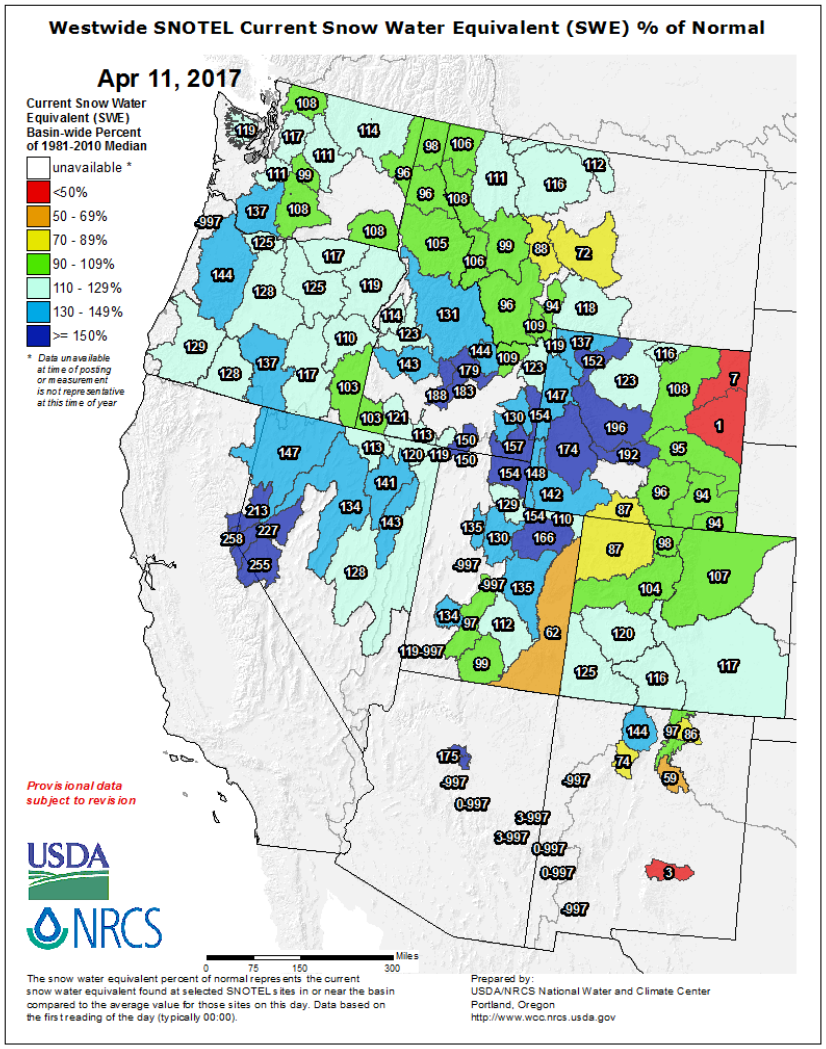
Mountain Snowpack

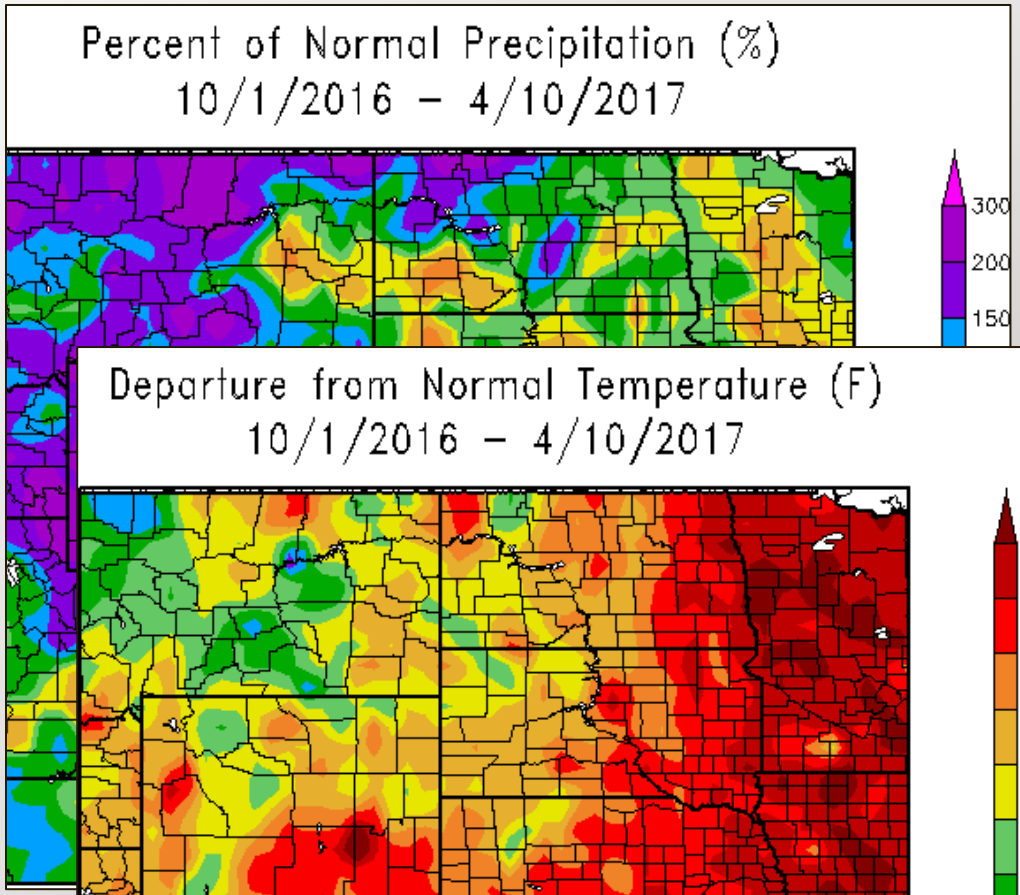


The Missouri River Basin snowpack normally peaks near April 15th.

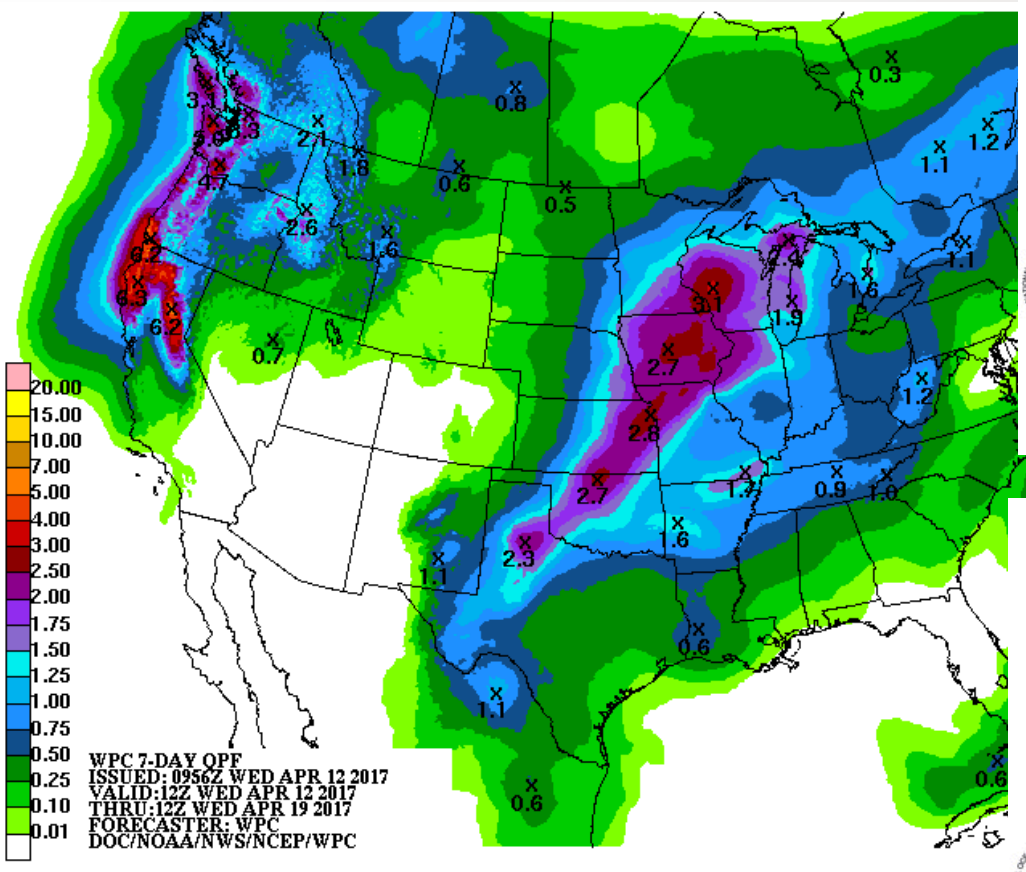
Click Here for Comparison Plot to 1997 and 2011

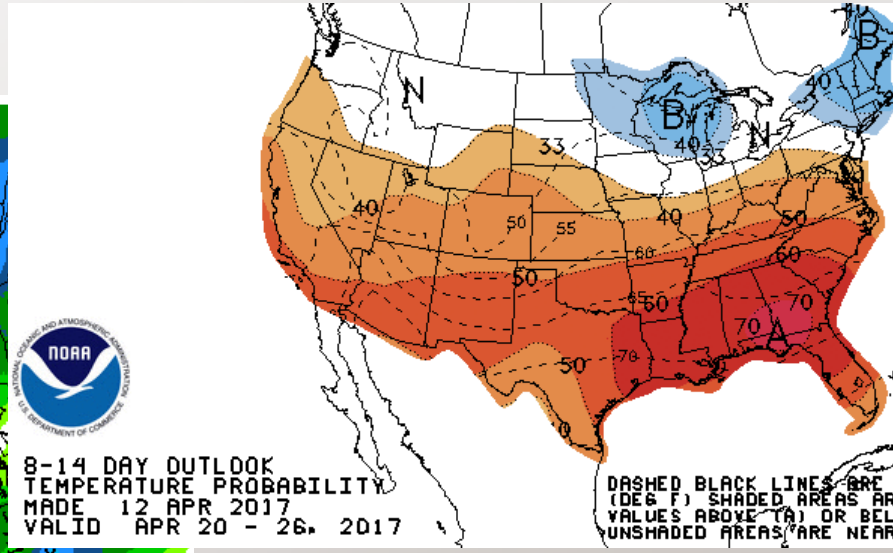
Missouri Basin Conditions and Outlook

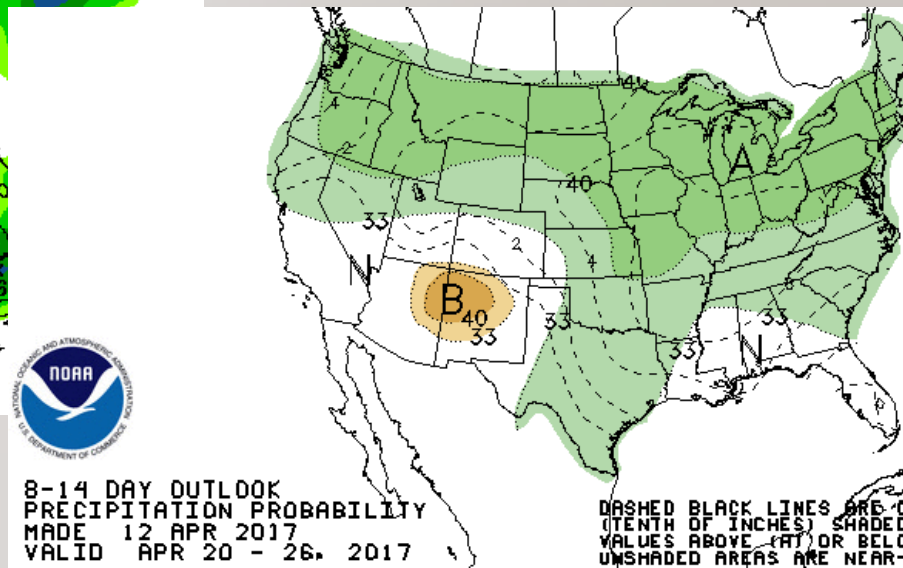




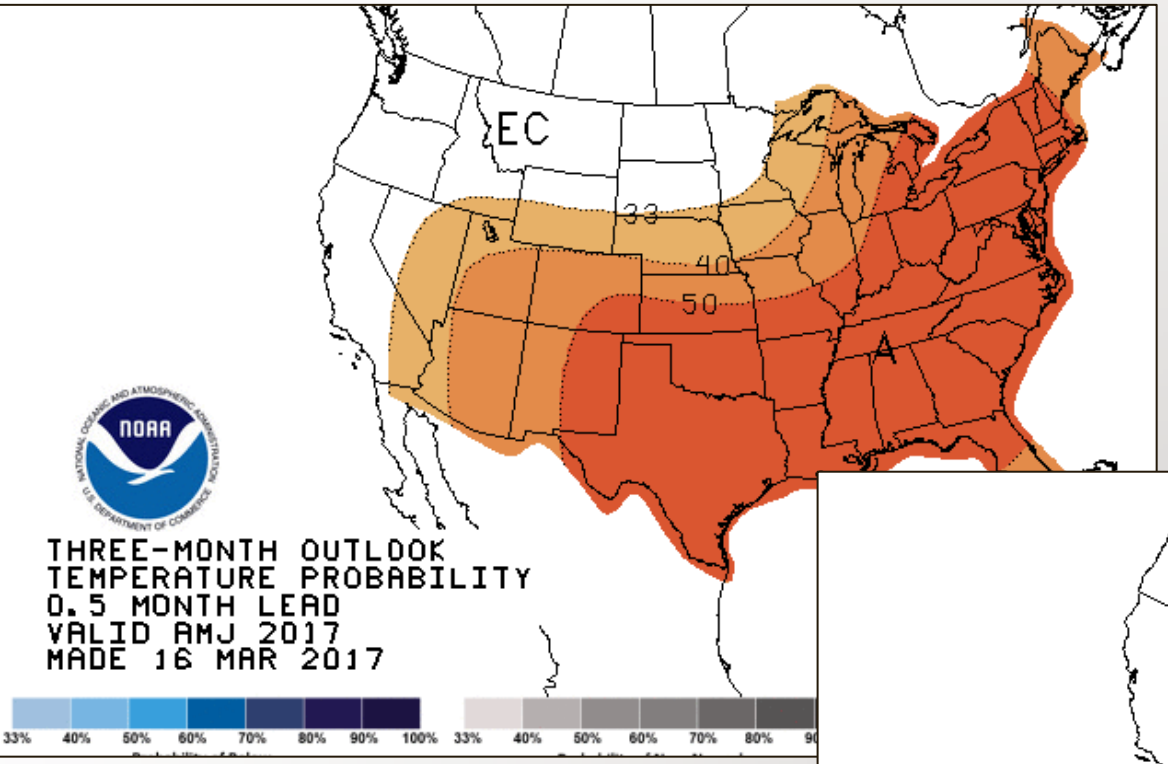
Near Future (7 days & Week 2)

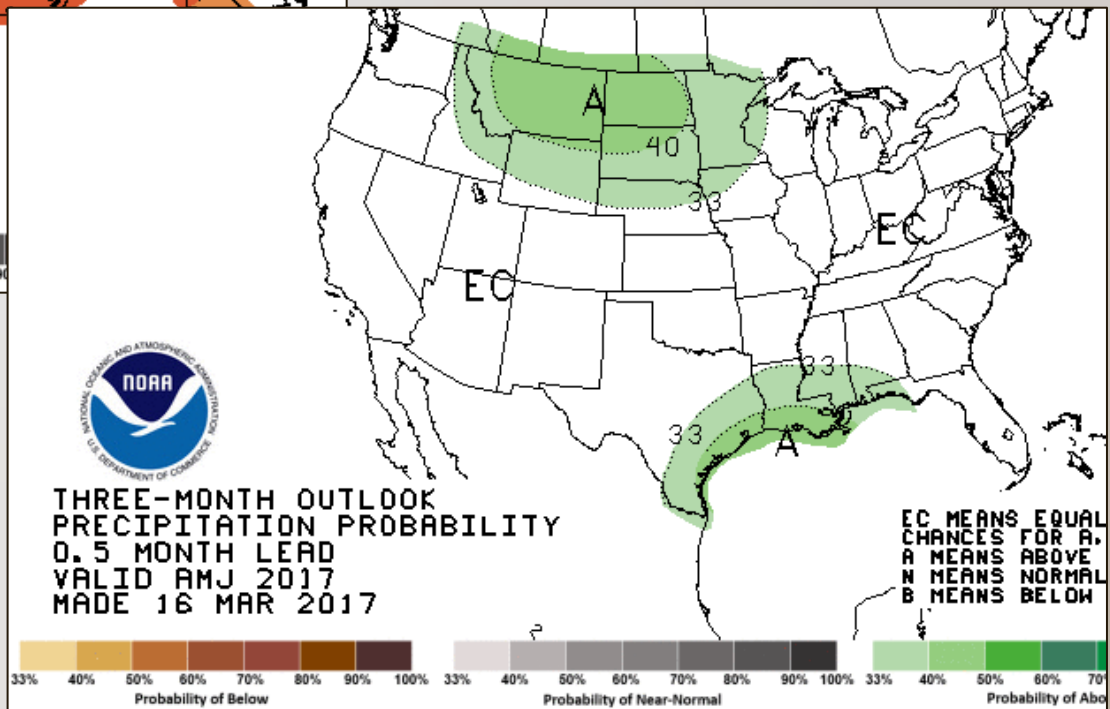




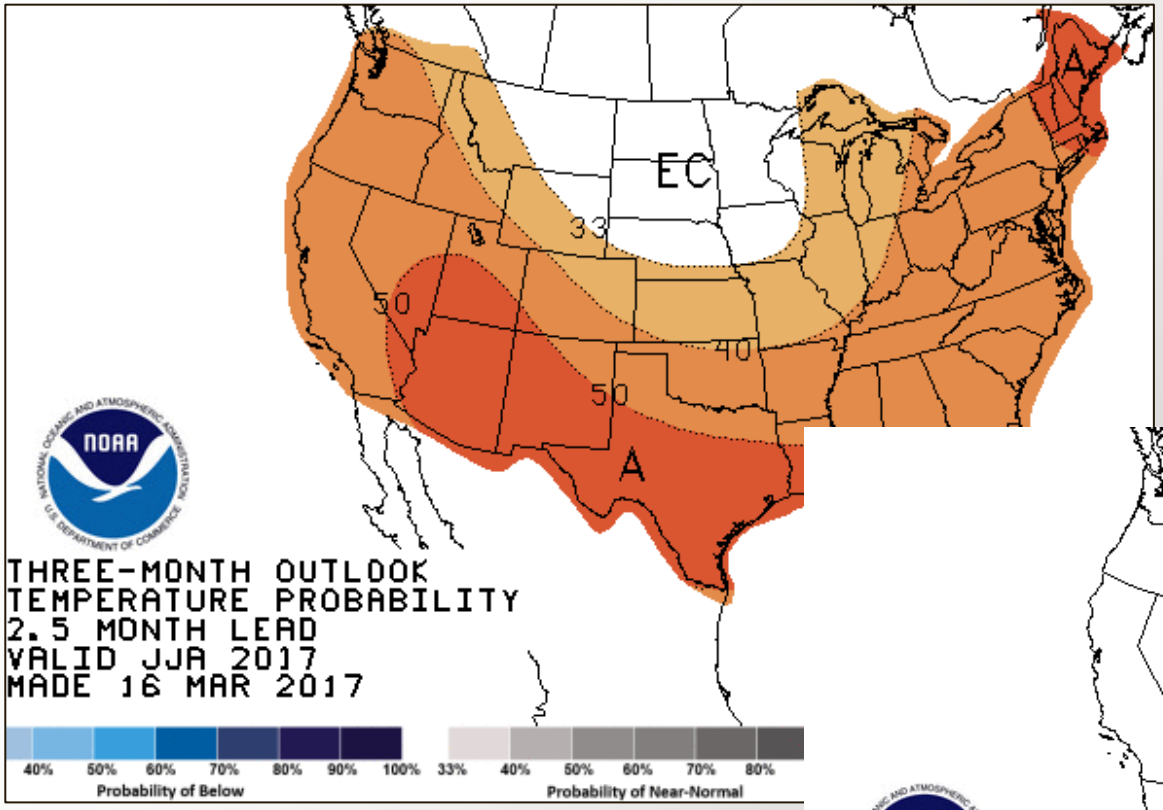


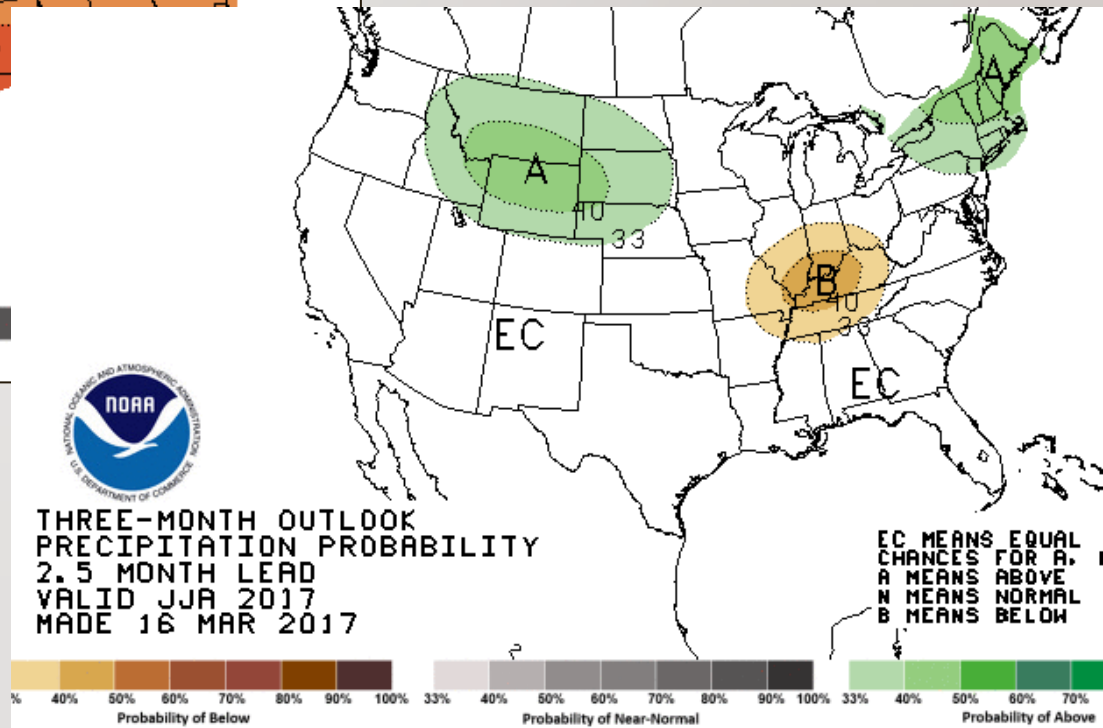
Next 3 Months (April – June)



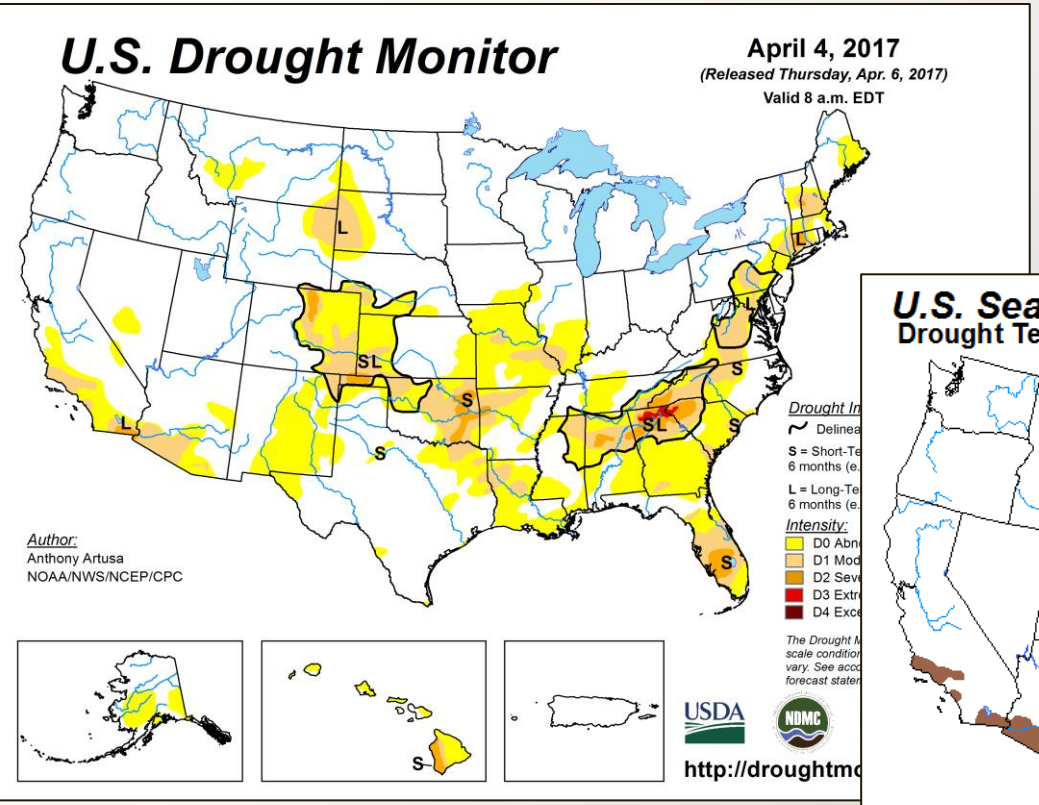


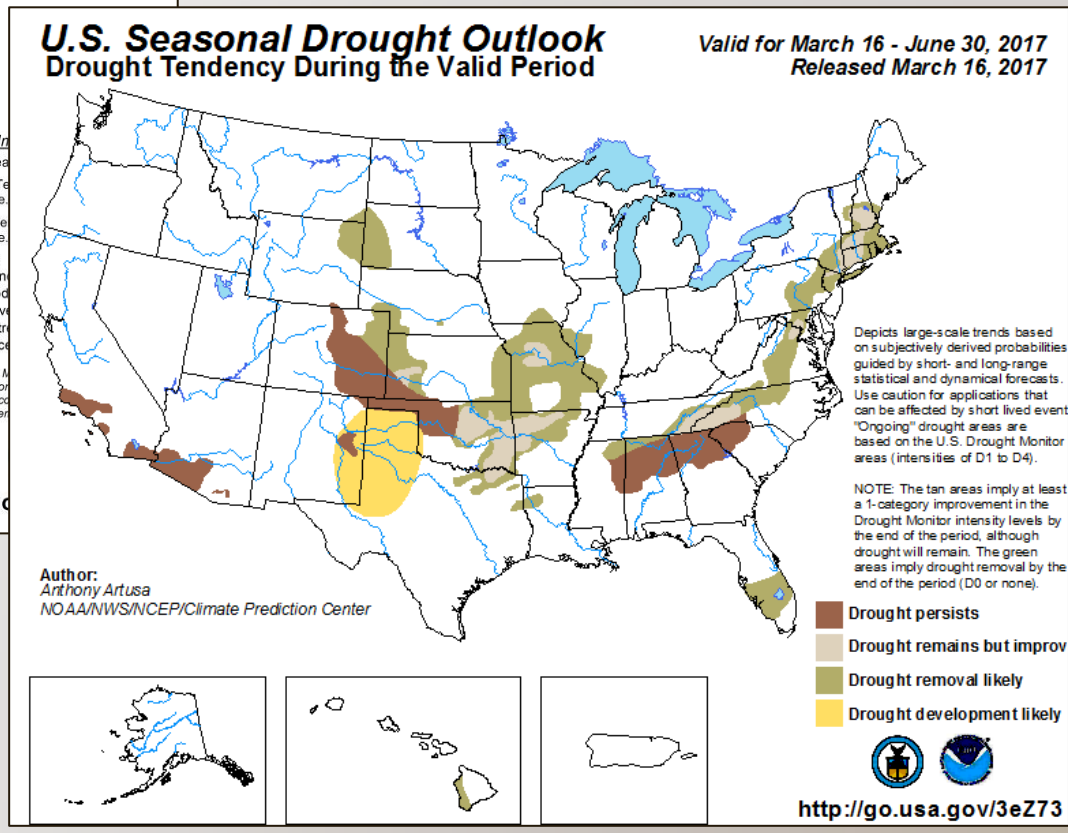
Summer Outlook (June-August)





Drought


U.S. Drought Monitor
April 4, 2017
(Released Thursday, Apr. 6, 2017)
Valid 8 a.m. EDT
Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC
USDA
NDMC


U.S. Seasonal Drought Outlook
Drought Tendency During the Valid Period
Valid for March 16 - June 30, 2017
Released March 16, 2017
Author:
Anthony Artusa
NOAA/NWS/NCEP/Climate Prediction Center
Depicts large-scale trends based on subjectively derived probabilities guided by short- and long-range statistical and dynamical forecasts. Use caution for applications that can be affected by short lived event "Ongoing" drought areas are based on the U.S. Drought Monitor areas (intensities of D1 to D4).
NOTE: The tan areas imply at least a 1-category improvement in the Drought Monitor intensity levels by the end of the period, although drought will remain. The green areas imply drought removal by the end of the period (D0 or none).
Drought persists
Drought remains but improv
Drought removal likely
Drought development likely
http://go.usa.gov/3eZ73

Thank You!

- Doug Kluck
  - Regional Climate Services Director
  - Doug.kluck@noaa.gov
  - 816-944-3008

NIDIS Priorities for 2016-2020

- Improve the characterization of the onset, duration, and severity of drought across a variety of timescales
- Assess and respond to regionally-specific drought impacts, leveraging pre-existing networks and improved coordination
- Explore the role of extreme weather events in drought planning and risk management, and incorporate into drought early warning systems
- Strengthen National, tribal, regional, state, local, and international partnerships
- Expand the breadth of resources and accessibility of information available on the U.S. Drought Portal