An overview of drought in Montana

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Is Summer 2022 going to be “bad”?

Garfield County
4/6/22

Currently, 53% of the state is in D3 drought conditions – only rivalled in the USDM for spring of 2005.

Yes, I think so… In certain parts of the state and with varying impacts. Knowledge of how we will fare this summer requires:

• Understanding of the physical conditions contributing to different drought types, intensity and duration.
• Understanding how these physical conditions contribute to impacts in different sectors (eg. agriculture, tourism, health, ecosystems) and locations.
• Accurate monitoring and coordination.

Map released: Thurs. April 7, 2022
Data valid: April 5, 2022 at 8 a.m. EDT

Intensity

- None
- D0 (Abnormally Dry)
- D1 (Moderate Drought)
- D2 (Severe Drought)
- D3 (Extreme Drought)
- D4 (Exceptional Drought)
- No Data

Authors
United States and Puerto Rico

Deborah Bathke National Drought

Montana Percent Area in U.S. Drought Monitor Categories
Objectives:

1. Overview – the multifaceted nature of drought and its impacts
2. Montana’s drought monitoring process
3. Improvements in monitoring capabilities and response
Drought arises from “anomalies” in the water and energy balances

Types of Drought:

**Meteorological** – extended period of dry, warm weather

**Hydrological** – low water supply in rivers, lakes, aquifers and reservoirs

**Agricultural** – water shortages significantly damage or destroy seasonal crops

**Ecological** - widespread ecological damage caused by lack of soil moisture

**Socioeconomic** – water shortage affects the supply and demand of drought commodities – eg. feed, food, tourism, etc.
Timescales of Drought

Natural Climate Variability

Precipitation deficiency (amount, intensity, timing)

Reduced infiltration, deep percolation and groundwater recharge

High temperature, winds, aridity, less cloud cover

Increased evaporation and transpiration

Soil water deficiency

Plant water stress, reduced biomass and yield, wildlife habitat

Reduced streamflow, inflow to reservoirs, lakes and ponds; reduced wetlands

Meteorological

Terrestrial - agriculture ecosystems

Hydrological
# Drought Indicators and Indices

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Percentile Ranges</th>
<th>Drought Index Values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>e.g. precipitation, soil moisture, streamflow, snowpack</td>
<td>Drought Index Values</td>
<td>e.g. SPI, SPEI, EDDI, SEDI</td>
</tr>
<tr>
<td>D4</td>
<td>Exceptional Drought</td>
<td>0 to 2</td>
<td>-2 or less</td>
</tr>
<tr>
<td>D3</td>
<td>Extreme Drought</td>
<td>2 to 5</td>
<td>-1.6 to -2.0</td>
</tr>
<tr>
<td>D2</td>
<td>Severe Drought</td>
<td>5 to 10</td>
<td>-1.3 to -1.6</td>
</tr>
<tr>
<td>D1</td>
<td>Moderate Drought</td>
<td>10 to 20</td>
<td>-0.8 to -1.3</td>
</tr>
<tr>
<td>D0</td>
<td>Abnormally Dry</td>
<td>20 to 30</td>
<td>-0.5 to -0.8</td>
</tr>
<tr>
<td></td>
<td>Normal Conditions</td>
<td>30 to 70</td>
<td>-0.5 to 0.5</td>
</tr>
</tbody>
</table>

**Indicators** are variables used to describe current conditions – e.g. measured precipitation, snowpack, temperature, soil moisture, groundwater, streamflow and reservoir levels.

**Indices** - computed numerical representations of drought severity, assessed using climatic or hydrological inputs, including the indicators listed above.

They aim to measure the quantitative state of droughts on the landscape for a given time period (e.g. 30, 60, 90, 180 days) with reference to historic conditions.
Impacts of drought depend upon its intensity, duration and location

- Impacts on Ecosystems and Natural Resource Management
- Impacts on Water Quantity and Quality
- Impacts on Natural Hazards
- Impacts on Energy and Utilities
- Impacts on Agriculture and Livestock

Physical and Mental Health
- Excessive heat and smoke lead to physical harm to vulnerable populations
- Financial losses and costs, reduced recreation and physical stress contribute to mental health declines
So, why is drought so difficult to understand and detect?

- Drought is a “creeping phenomenon” that results from absence of precipitation and dry down over time – unlike events such as hurricanes or tornados.
- It slowly impacts many sectors of the economy and can last from just a few weeks or months to multiple years - it’s difficult to monitor—particularly to mark the beginning and end of a period of drought.
- Drought’s effects also vary from region to region due to climatic differences (e.g. western versus eastern MT)…..And climate is changing!!
55 page analysis that reviews the conditions leading to 2017 flash drought, its impacts and tribal, state, federal and provincial (Canada) responses

Opportunity to identify improvements for drought monitoring and response

MT Drought and Water Supply Advisory Committee (DWSAC) approach highlighted
Some Key Lessons Learned and Future Priorities

1. **Monitoring** - more ground based stations for verification of drought conditions and for filling monitoring gaps in the context of soil moisture in our mountains and plains

2. **Data availability** - need up to date drought and climate information that is validated for the state of Montana

**Drought Early Warning System for Montana**
Why install more stations in Montana?

**Flood Prediction and Early Warning**

- Improved knowledge of moisture conditions for modeling of flood potential
- Timing and amounts of reservoir releases to mitigate downstream flooding

**Drought and Fire Monitoring**

- Improved knowledge of soil moisture conditions
- Triggers state and federal emergency response

Infrastructure that forms the basis for additional measurements and tools - eg. precision agriculture, air quality and natural resource management
Montana Mesonet: A Collaborative Framework

climate.umt.edu/mesonet

- 98 stations across the state

Federal, State, and Private Partnerships

- National Oceanographic and Atmospheric Administration (NOAA)
- DOI Bureau of Land Management
- USDA Forest Service
- MT Department of Agriculture
- Bruce Maxwell – MSU
- Lee Schmelzer – MSU Extension
- MSU Agricultural Research Centers
- Stillwater County (Maureen Davey)
- Montana Bureau of Mines and Geology
- Bureau of Indian Affairs: Little Big Horn College, Crow Agency
- Montana Department of Natural Resources and Conservation
- Lolo Watershed Group
- Blackfoot Challenge - E Bar L
- Trout Unlimited
- National Drought Resiliency Partnership
- Community Collaborative Rain, Hail and Snow Network (CoCoRahs)
- Roberts L7 Ranch
- Private land owners
Data Availability

- Publicly available
- Map based and graphical summaries
- Updated every 10 minutes
- Data used by NWS and USACE for weather forecasting, flood prediction and reservoir management

climate.umt.edu/mesonet
Expansion & Improvements to Climate Infrastructure

UM awarded $21M contract

Researchers given Army Corps contract to expand climate monitoring network

$21 million government contract, bringing more support and longevity to what has been a great effort to build a climate monitoring network across the state. The project, from the U.S. Army Corps of Engineers, will expand and enhance a collaborative project spearheaded by UM’s Montana Climate Office in 2015 that aims to fill in gaps in weather and soil moisture data throughout the state.

“This project is very unique,” said Kathy Hensel, a lead researcher of water and watershed hydrology at UM. “This is a very applied project. It has a particular goal, which is to better monitor soil moisture, snowpack, weather hazards and climate conditions.” Through partnerships with government agencies, including the Montana Department of Agriculture and the U.S. Army Corps of Engineers, the project will help to fill in gaps in the climate monitoring network.

Bozeman Pilot Station (2020)

U.S. Army Corps

- S.4444 - Missouri River Basin Drought and Snowpack Monitoring Act
- Introduced by Senator Thune and Rounds
- 205 stations in MT – one every 500 square miles
- Upper Missouri River Basin and elevations below 5,500 feet
2021 - 10 stations installed
2022 – 8 stations – Musselshell
2023 – 36 stations
2024 – Looking for new partners!
The Big Picture!

https://zhoylman.users.earthengine.app/view/usace-umrb-app

- Candidate sites screened based upon representative soils, climate, topography and land use conditions
- 540 sites across Montana, Wyoming, North Dakota, South Dakota and Nebraska
- Each site will undergo full soils analysis by the NRCS
A dense network leads to better models of drought conditions

“No one trusts a model except the person who wrote it; everyone trusts an observation, except the person who made it.”

The UMRB Drought Dashboard

- Daily modeling of precipitation, temperature, snow, soil moisture, evapotranspiration and drought indices across Montana
- Science based tool for drought mapping by the state of Montana and for evidence based reporting to the USDML
Identify and apply relevant drought indicators in support of the MT DWSAC

1. Identify available drought metrics
2. Assess their strengths and weaknesses as triggers for different forms of drought at varying magnitudes (D0-D4)
3. Perform analyses of their predictive ability
4. New Drought Mgmt. Plan (in prep)
5. Selection of relevant indices for MT drought assessments by the DSWAC sub-committee

Operational drought assessments by county and watershed on a weekly interval

Mesonet, NOAA, NRCS, USGS streamflow, BOR, etc.

Gridded drought data
Montana Drought Impacts Reporter
Troy Blandford – MT State Library

Web based survey for reporting of drought impacts by sector and county

Used by monitoring subcommittee to key in on areas where observations and data suggest impacts….or areas that we may be missing

https://nris.mt.gov/drought
Montana’s Drought Monitoring Process

**Sunday & Monday Morning:**
Montana author assembles proposed changes to USDM based upon analysis of station data, modelled data and impact reports –

Authorship rotates every two weeks between five volunteers: Michael Downey (DNRC), Arin Peters (NOAA), Troy Blanford (DNRC), Zach Hoylman (MCO) and Kelsey Jencso (MCO).

**Monday Early Afternoon:**
Author sends initial analysis and summary to Montana Drought Listserv for review and consensus.

**Tuesday:**
MT author makes changes and sends the proposed map with a justification to the National Drought Monitor author. The USDM author releases a series of 3 drafts with “back and forth” between state authors.

**Wednesday:**
USDM author makes final decisions and the final national map is released Thursday morning.

It takes objective data, impact reports and a well justified argument to make our case to the USDM each week!
Section Summary

We’ve come a long way since the 2017 Flash Drought

1. Mesonet
2. Drought Dashboard
3. Weekly Reporting

We still have a ways to go….
Questions?

Montana Climate Office

state.climatologist@umontana.edu

Web Resources:

MCO Web Page: https://climate.umt.edu
Climate Data Explorer: https://mco.cfc.umt.edu/datasets
Drought Tracker: https://drought.climate.umt.edu
Seasonal Newsletters: https://climate.umt.edu/mtdrought
Montana Mesonet: https://climate.umt.edu/mesonet