Drought Primer

Drought is a regularly occurring characteristic of Montana's climate. Some portion of Montana has experienced drought in 20 of the last 21 years. Though a familiar term, drought can be a confusing concept because it is often defined by on-the-ground impacts such as reduced streamflow or agricultural crop losses. The broad range of drought impacts across water uses and geographies makes it difficult to pinpoint when a drought begins and ends. Characterizing drought severity also depends on local and regional distinctions. For instance, extreme drought in Libby looks different than extreme drought in Glasgow.

According to the Montana Climate Assessment, future droughts in Montana are likely to be more frequent and intense due to warming air temperatures and decreasing snowpack. Drought planning that combines robust stakeholder input with solid science is key to helping boost drought resilience of both human and natural systems.

Montana's Climate

Weather describes the short-term atmospheric conditions (temperature, humidity, precipitation, wind, etc.) in a particular place, while **climate** describes patterns in average weather for a particular place over a much longer time (e.g., 30 or more years). As a large and geographically diverse state, Montana has seven different climate regions with elevations ranging from 1,800 – 12,000 ft. Average annual precipitation is highly variable. Some areas in the northwestern Montana receive more than 32" of precipitation annually, southeastern Montana receives around 13.8" and some areas in southwestern Montana average only 9" annually.

While drought is a temporary moisture deficiency, **aridity** is a permanent characteristic that describes climates with low moisture.

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Defining Drought

There are five common definitions of drought. Definitions 2-5 are based on how meteorological drought (precipitation deficit) impacts natural and human systems.

1) **Meteorological drought** – Below normal precipitation (rain or snow) for an extended time - ranging from a season to several years.

2) **Hydrological drought** – A lack of water in the hydrologic system (both surface water and groundwater) due to precipitation shortfalls. Often, hydrological drought and its impacts lag behind meteorological drought by months or even years.

3) **Agricultural/Soil moisture drought** – Impacts to dryland and/or irrigated agriculture due to precipitation shortfalls, reduced groundwater or surface water supplies and soil water deficits. This can be exacerbated by high air temperature, low humidity, and wind.

4) **Socioeconomic drought** – Impacts of drought conditions on supply and demand of economic goods and services (e.g., lost income from crops and loss of tourism revenue from hoot owl fishing restrictions).

5) **Ecological drought** – A lack of water that negatively impacts ecosystem function and beneficial processes (e.g., nutrient cycling, habitat, water filtration).

Historic and Projected Drought in Montana

Formal, instrumented measurement and recording of weather began in the late 1800s, and from that time until now is referred to as the "period of record." To get a sense of what Montana's climate was like prior to the 1800s, scientists have examined tree rings to reconstruct ancient hydrologic conditions. Tree ring studies indicate periods of "megadrought" in Montana's climatological history that lasted for multiple years and even decades.

Drought has played an important role in Montana's history, and it will continue to shape the state's future. The Montana Climate Assessment notes that warming temperatures and reduced snowpack will intensify the frequency and severity of future droughts. These changes will become especially apparent in late summer and early fall when streamflow is already at a minimum in many parts of the state.

Assessing and Characterizing Drought

Drought assessment is complex and relies on a combination of multiple indicators, such as precipitation, snowpack, streamflow, groundwater, air temperature, wind, and soil moisture. Indicator values can also be combined mathematically into a single value or "index" of drought.

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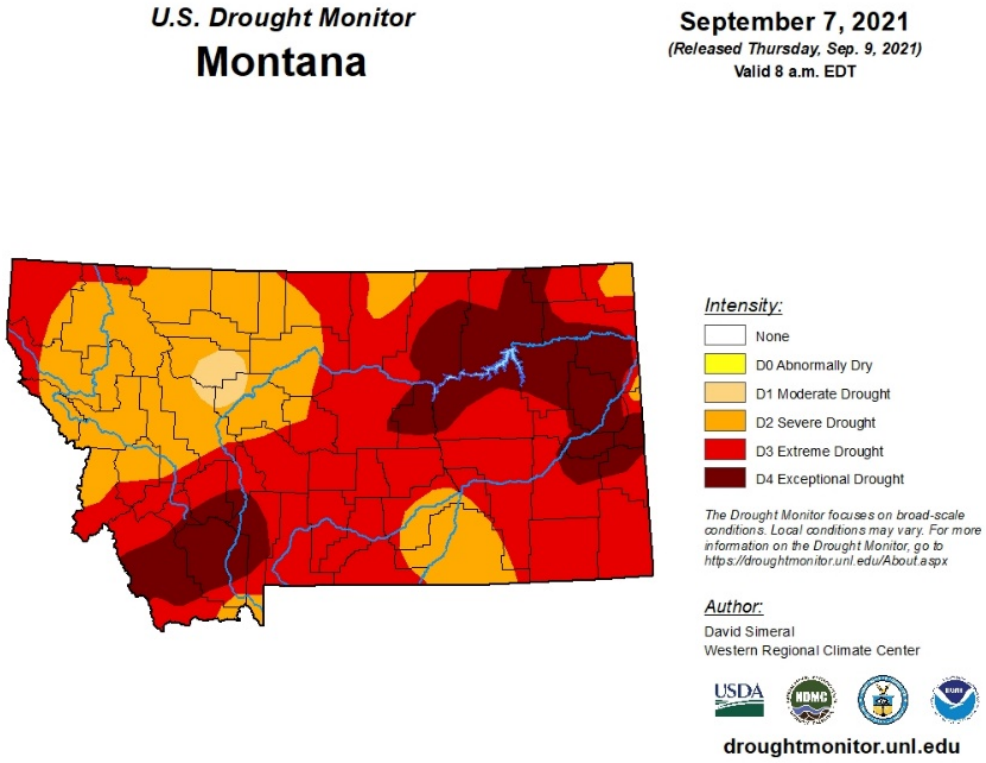
Drought indices have changed over time as monitoring capabilities and our understanding of drought have improved. Drought indices are used to characterize the level of drought severity (i.e., D0 – D4) and often provide the basis for financial response programs (e.g., USDA's Livestock Forage Program that provides compensation for grazing losses due to drought).

The Upper Missouri River Basin Drought Indicators Dashboard displays a variety of drought indicators used by the Montana drought monitoring subcommittee (subcommittee) to evaluate drought conditions in Montana. The subcommittee operates under the authority of the Governor's Drought and Water Supply Advisory Committee and is comprised of local, tribal, federal, state, university and nonprofit partners. Subcommittee members correspond via email on a weekly – often daily – basis to review the latest drought data, solicit input from other experts across the state, consider local drought impact reports, and provide weekly recommendations on statewide drought status to the U.S. Drought Monitor (USDM).

The USDM was launched in 1999 as a combined effort of the National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of Agriculture. The USDM publishes a weekly map of drought classification across the United States each Thursday, year-round. Drought intensity ranges from "none" (in white) to D4 (exceptional drought) in dark red. As of early September 2021, all of Montana is in some form of moderate to exceptional drought.



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Responding to Drought

Drought response involves actions taken *during* or *after* a drought. Drought response actions may focus on a relatively uniform, defined area like a city or watershed or a much larger, more complex area like a state. Drought response sometimes involves predefined triggers that initiate actions (e.g., hoot owl fishing restrictions or voluntary irrigation reductions) when indicators such as water supply or water temperature reach or exceed certain drought thresholds.

As a state-level example, the Washington State Drought Contingency Plan uses water supply thresholds such as deficient streamflow, groundwater, precipitation, soil moisture and/or reservoir storage to declare drought advisories and, in more severe cases, emergencies. These declarations trigger actions in three areas including communications (following a pre-determined plan); mobilization of resources; and more intensive monitoring and reporting of water supply conditions. Washington's approach is relatively straightforward and provides a formal structure for drought response that can be invaluable when coordinating resources across agencies and among various impacted groups.

Assessing Drought Vulnerability

Preparing for drought requires first identifying how the state and its communities (ecological and human) are susceptible (vulnerable) to drought impacts. State-level drought plans often focus on assessing vulnerabilities within economic or water use sectors (e.g., agriculture, stock, municipal, domestic, industrial, recreation, tourism and fish and wildlife). It is important to consider the range of potential vulnerabilities across all sectors to inform strategies to reduce drought impacts.

Identifying drought vulnerability relies on local knowledge, stakeholder input and a comprehensive assessment of the indices mentioned above (drought monitoring) combined with other, objective measures of drought severity (e.g., precipitation).

Preparing for (Adapting to) the Next Drought

Drought adaptation encompasses a range of actions taken *before* a drought occurs to minimize drought impacts. Drought adaptation planning involves examining multi-sector vulnerabilities and identifying actions, policies or programs designed to reduce vulnerability before drought onset. Potential adaptation strategies are often long-term investments and may involve municipal water conservation programs, comprehensive riparian and floodplain management, and improved irrigation conveyance systems to name a few.

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Updating Montana's Drought Management Plan

Montana is currently updating its Drought Management Plan (Plan). The Plan will build upon Montana's drought resilience using a collaborative, stakeholder driven process that expands and improves statewide monitoring, preparedness, response, and adaptation. The Plan is based on six key elements that are considered essential to any drought planning effort - and that are critical to all aspects of drought management.

1. **Monitoring** – Montana's Drought and Water Supply Monitoring Subcommittee has a progressive, collaborative process to assess and characterize drought. The subcommittee reviews and discusses drought indicators and indices on a weekly basis and submits suggested changes (improvements or degradations) to the USDM. The Plan will evaluate and document this process. In addition, the Plan will analyze the effectiveness of drought indicators and indices and provide recommendations for best seasonal and geographic applications.

2. **Vulnerability Assessment** – Montana is a large state with substantial diversity in its geographies, economies, and demographic patterns. As a result, drought affects different parts of the state in different ways. This diversity creates a complex challenge for assessing drought vulnerability at the statewide scale. The planning process will examine

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vulnerabilities across Montana's seven, predetermined areas based on NOAA climate divisions (areas) and used in the Montana Climate Assessment (2017).

Interested stakeholders from each area will join regional groups to share information about on-the-ground impacts of drought. Individuals within each group will represent the breadth of water use sectors in the area (irrigation, domestic use, recreation, and others). A social scientist will solicit detailed information about impacts and vulnerabilities to each water use sector through individual interviews. Both regional group members and other interested stakeholders from each region may participate in the interview process. Interview data will be combined with climate and demographic data to develop vulnerability scores for the water use sectors. Collectively, this information will help policy makers to better understand the sectors and regions that are most vulnerable to drought.

3. **Adaptation Strategies** – Regional stakeholders will also help develop a suite of strategies that can be implemented before a drought to lessen the impacts of future droughts. Adaptation strategies can be broad, such as state programs or policy recommendations, or more local and specific, such as small-scale water conservation techniques.

4. **Response Actions** – Despite efforts to proactively prepare for and adapt to drought conditions, more severe droughts will inevitably cause limitations in water supply that require immediate attention. Although state agencies do not have the authority to proactively manage water supply, they can make recommendations, facilitate communications, and provide technical support. Plan recommendations will include a combination of all these actions and provide a clear and detailed overview of drought response.

5. **Operational and Administrative Framework** – This framework will clearly identify responsibility for each element of state drought management.

6. **Plan Development and Update Process** – Documenting how this plan was developed will lend transparency to the process and establish a procedure for future plan updates and evaluations.

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Key Planning Groups

Group	Membership and duties	Contribution
Task Force *Quarterly meetings*	Representation is based on the Governor's Drought and Water Supply Advisory Committee (DNRC, FWP, DEQ, Livestock, Agriculture, Commerce, and Disaster and Emergency Services). Responsible for: • General oversight of plan development process • Liaising with respective agencies • Assisting with development of response plan • Helping incorporate existing state plans, if appropriate	Ensures all state agencies involved in drought monitoring and response participate in plan development and plan progress is communicated to these agencies.
Regional Stakeholders Groups and Interviewees *3 meetings per group/1 interview per stakeholder*	Seven groups will be formed, one in each of the climate areas, and membership will include representatives from major water use sectors (10-15 people per group). Stakeholders will participate in three facilitated meetings to provide input on drought impacts, key regional subsectors, and local adaptation strategies. Stakeholders and other water users may participate in individual interviews to elicit information on impacts, risks, and adaptations.	On-the-ground, local perspective and assurance that stakeholder knowledge will be incorporated as a tangible component of the plan.
Technical Advisory Committee *As needed*	State, federal, and university partners in drought science (e.g., monitoring, adaptation, or climate science). Duties may include reviewing technical information for accuracy and clarity, contributing helpful information and resources, and providing guidance on technical information.	Ensures technical and scientific accuracy.