An overview of drought in Montana

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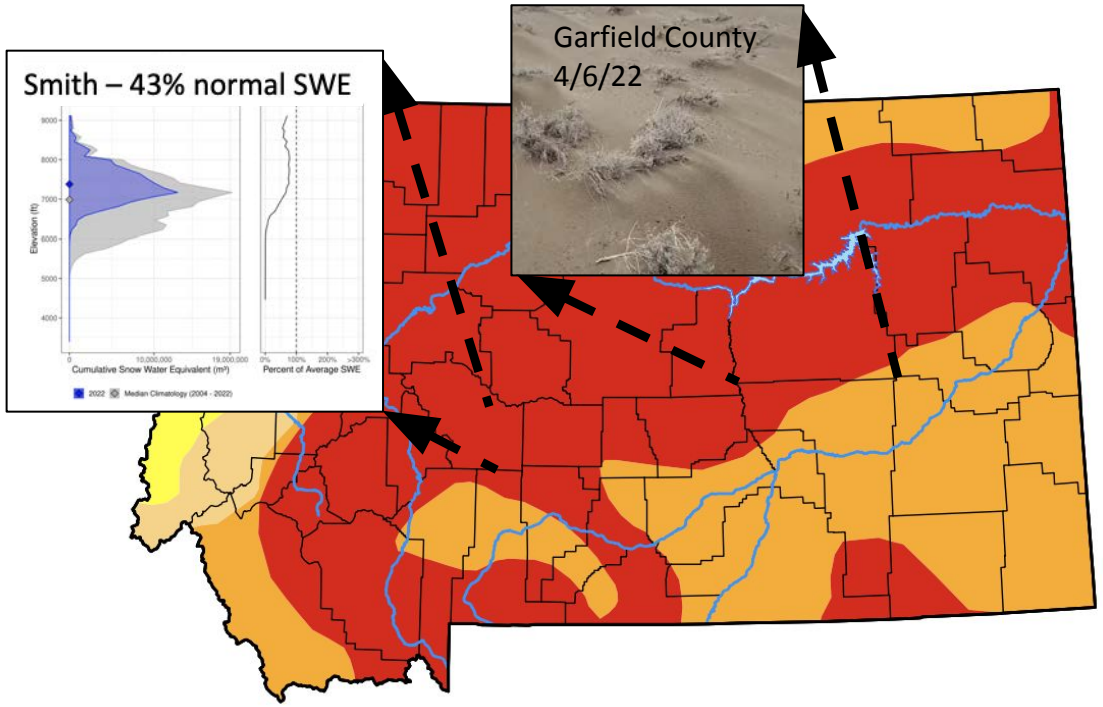
Professor of Watershed Hydrology
Montana State Climatologist
MT DWSAC – Monitoring Subcommittee

Is Summer 2022 going to be “bad”?



Map released: Thurs. April 7, 2022

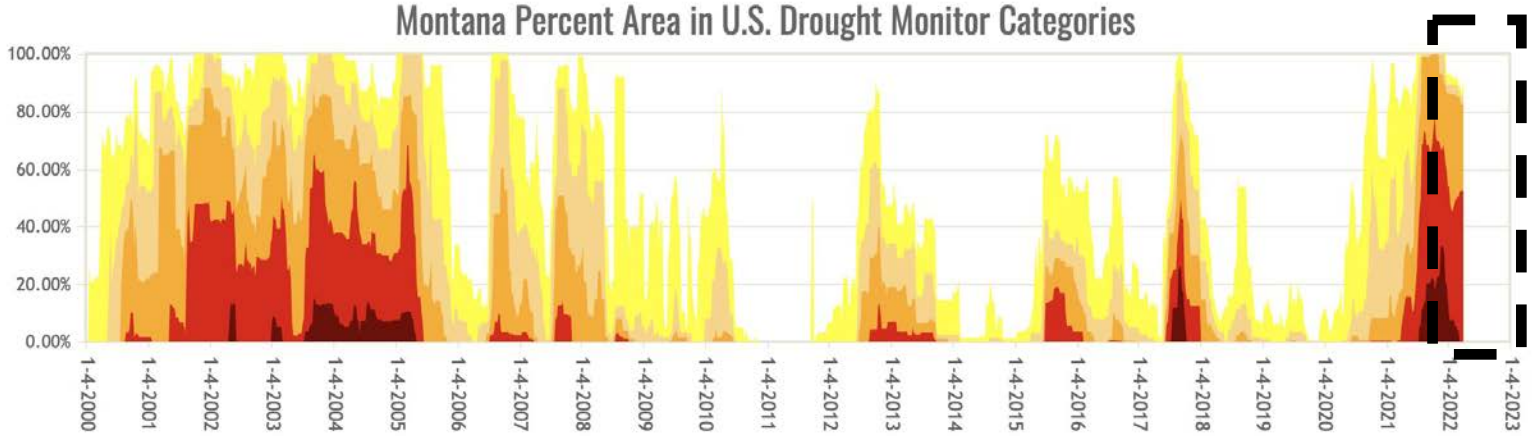
Data valid: April 5, 2022 at 8 a.m. EDT

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 Author(s):
Deborah Bathke, National Drought



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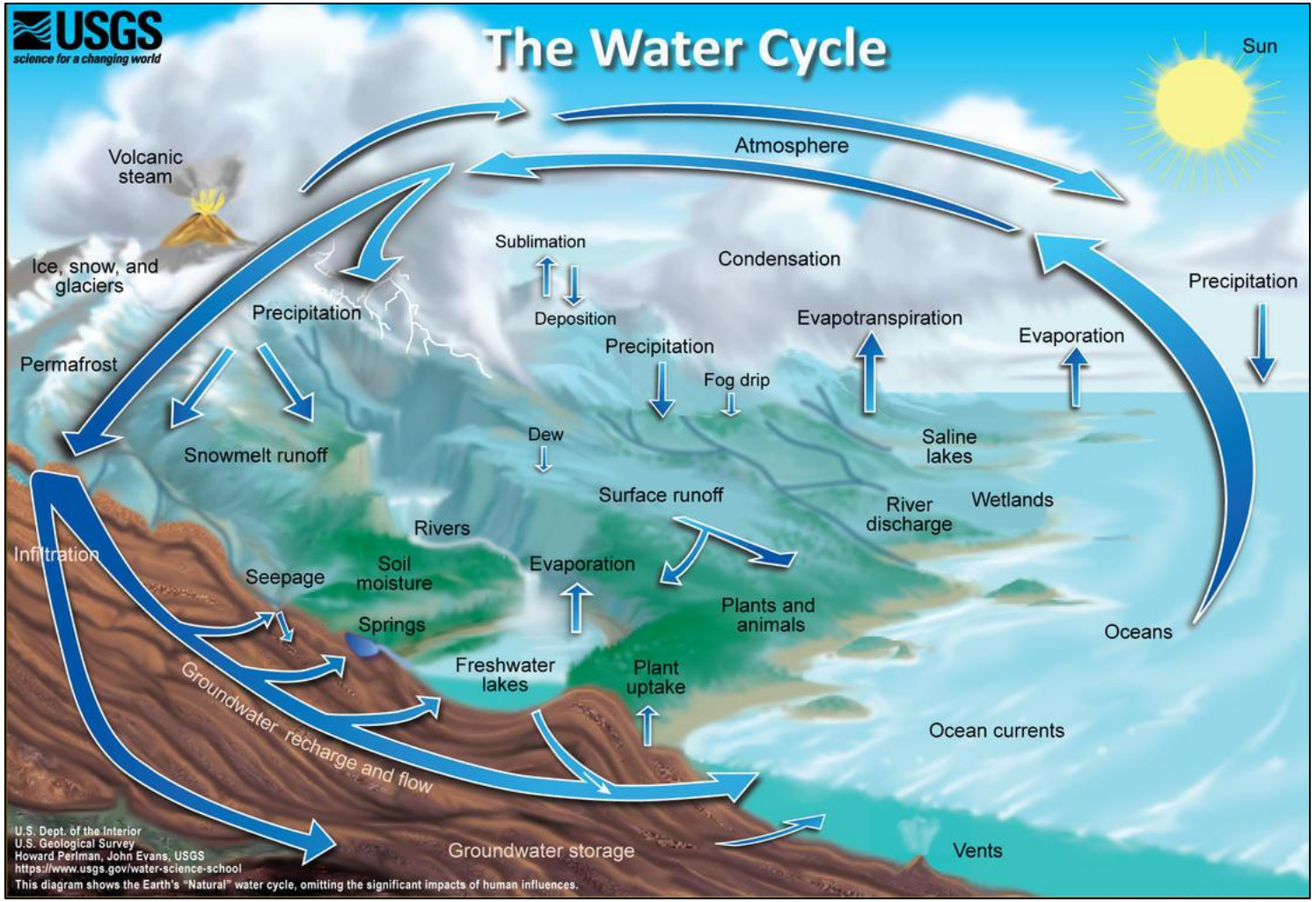
Objectives:

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

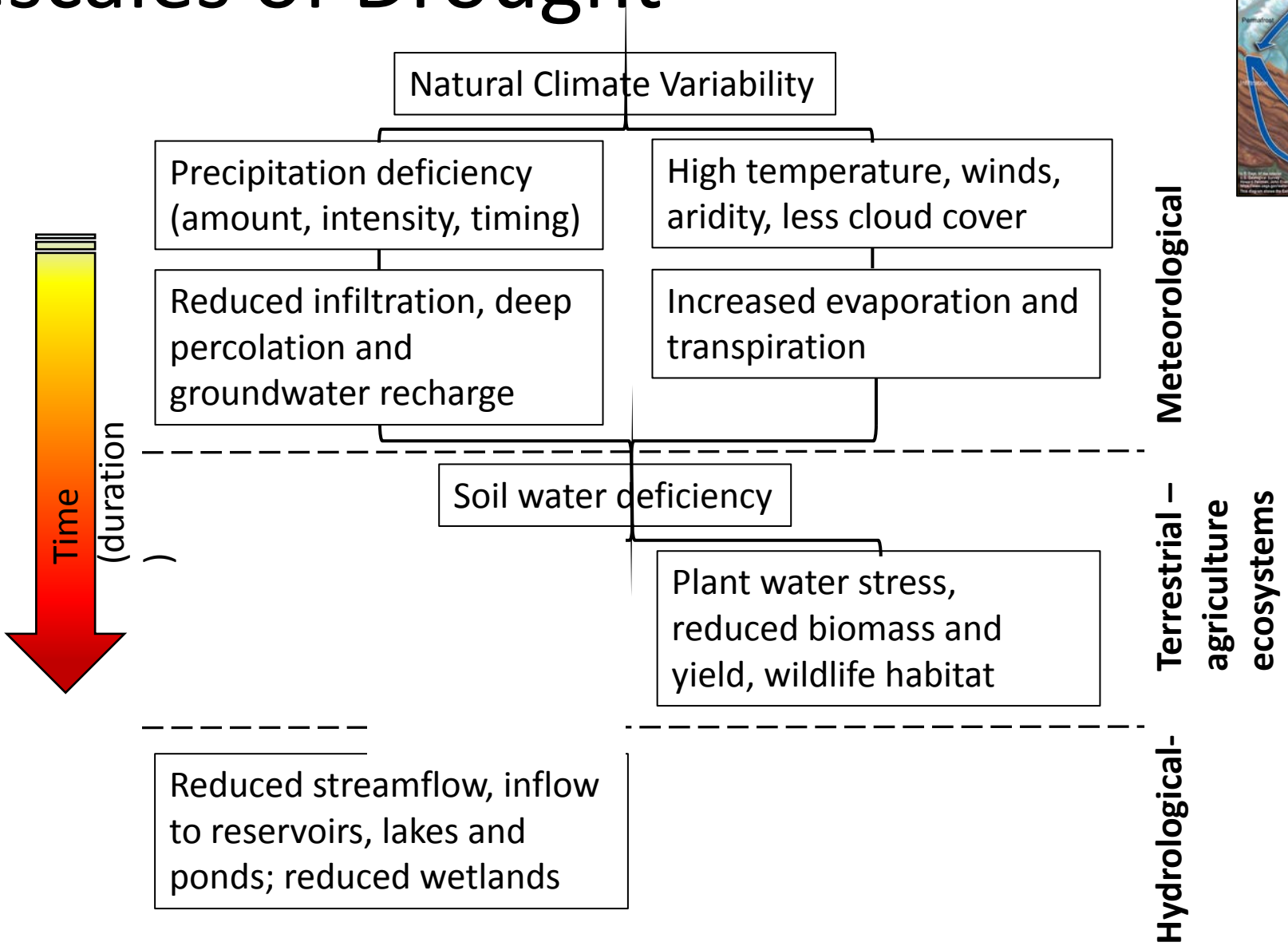
Hydrological – low water supply in rivers, lakes, aquifers and reservoirs

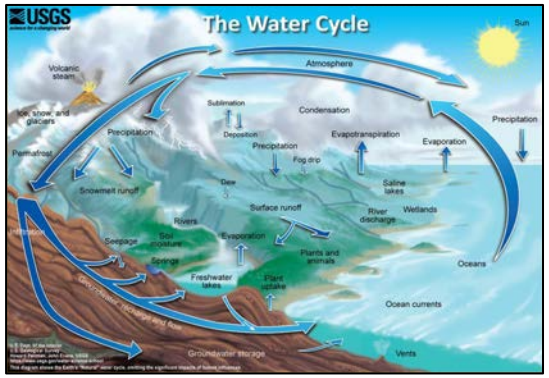
Agricultural – water shortages significantly damage or destroy seasonal crops

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





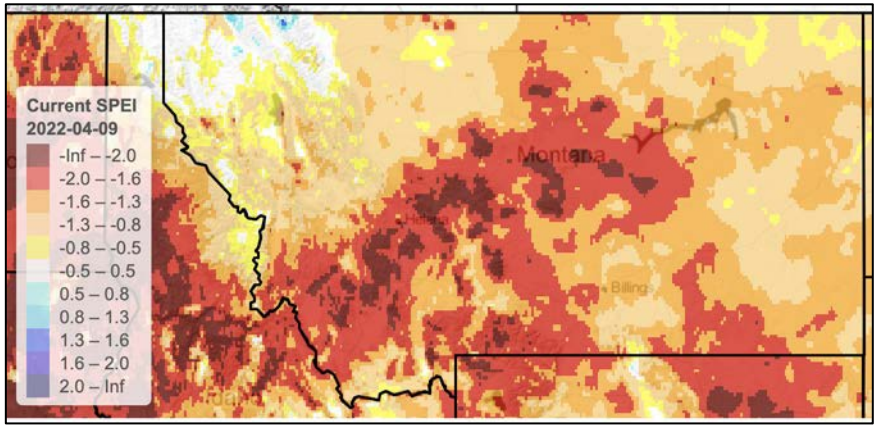
Drought Indicators and Indices

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

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



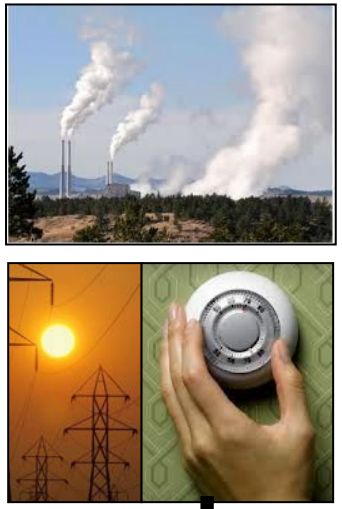
Impacts of drought depend upon its intensity, duration and location

Ecosystems and Natural Resource Management

Water Quantity and Quality

Natural Hazards

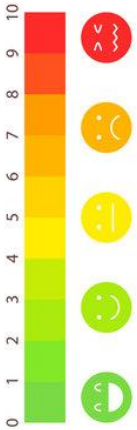
Energy and Utilities



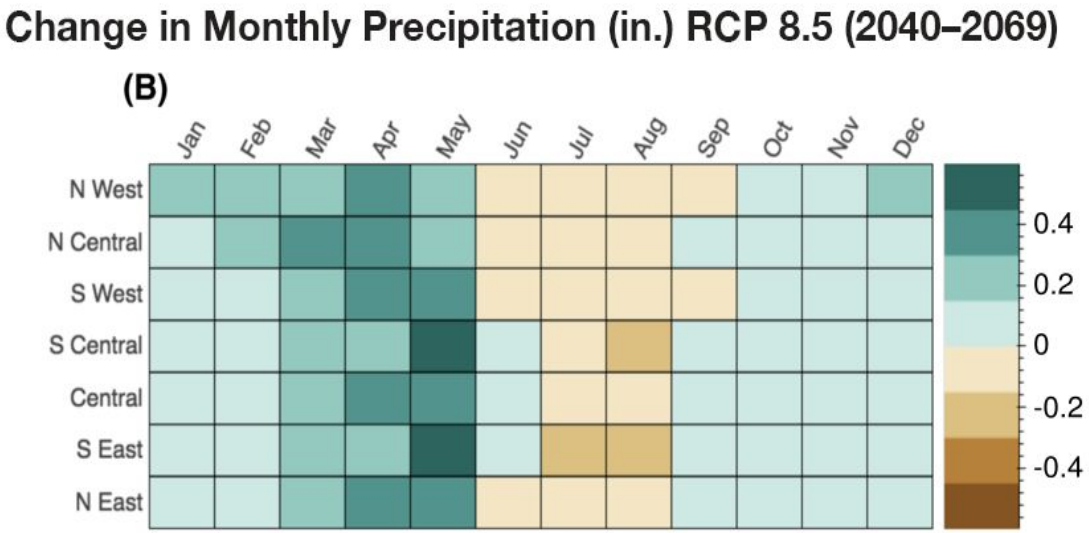
Agriculture and Livestock

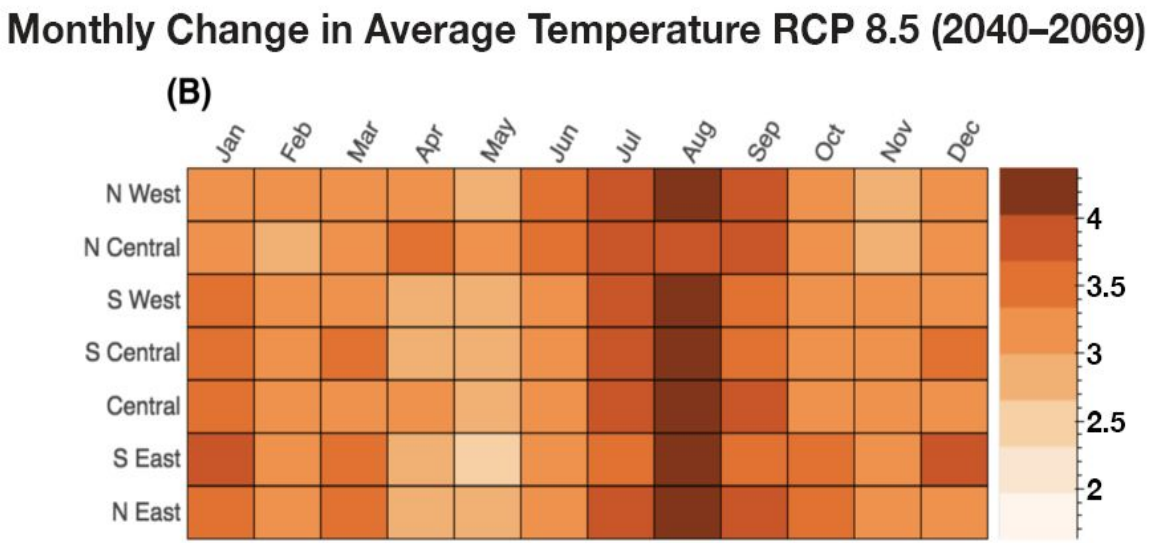
Physical and Mental Health

- 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.

- Drought's effects also vary from region to region due to climatic differences (e.g. western versus eastern MT)…..And climate is changing!!

NOAA NIDIS Drought Assessment

NORTHERN PLAINS DROUGHT ASSESSMENT

National Integrated Drought Information System
Drought.gov

Purpose of the Assessment

The 2017 Northern Plains drought was a rapid-onset, catastrophic event for northeast Montana, the Dakotas, and the Canadian Prairies in the spring and summer of 2017. The unique circumstances of this drought created an opportunity to evaluate and improve the efficacy of drought-related coordination and management within the Missouri River Basin Drought Early Warning System.

Drought Evolution

- Abnormally-warm conditions in the fall of 2016 lengthened the growing season and increased the depletion of soil moisture. Fall is typically a time when vegetation growth has ended and soil moisture is conserved or gained with rainfall.
- A warm February caused the early melt of snowpack, so moisture was unavailable as soils warmed later in the spring season.
- Warmer-than-average temperatures continued into the spring and unusually persistent winds increased evapotranspiration.
- April and May rainfall was much below average, which is a critical stage for pasture, rangelands, foraging, and both winter and spring wheat.

Impacts

- Early impacts were noted in the agricultural sector, and impacts persisted for the duration of the 2017 drought.
- Cool-season grass species, which dominate much of the region, suffered from the lack of spring precipitation. The subsequent reduction in grass production for grazing in May led to a decline in pasture and range conditions.
- Lower grass production for grazing forced ranchers to significantly reduce their herds by selling cattle early in May and June.
- Stock ponds for livestock water supply were depleted and surface water samples showed signs of poor water quality (containing salts and total dissolved solids).
- Livestock perished or exhibited poisoning symptoms due to poor water quality across the region.
- Poorly-performing crops and a shortage of pasture and forage led producers to harvest crops for feed.
- Some spring planted crops failed to germinate resulting in a total loss.
- Despite near-normal stream flows for the entire 2017 season, water supply to rural water providers was reduced in some areas. Rural water systems were restricted by their infrastructure and providers were not able to keep up with increased water demand, leading to water restrictions being enforced.
- Similar impacts to agriculture, livestock, and in some areas human health and domestic water supplies, were reported from Native American Tribes in the region.
- Agriculture in the southern Saskatchewan Prairies experienced poor spring germination, stunted crop development, heat stress, accelerated crop maturity, poor grain fill, below-normal yields, water supply shortages, poor pasture conditions, feed shortages, and wildfires. Livestock production was especially hard-hit due to the widespread scarcity of feed and water.

- 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?

Musselshell

Flood Prediction and Early Warning

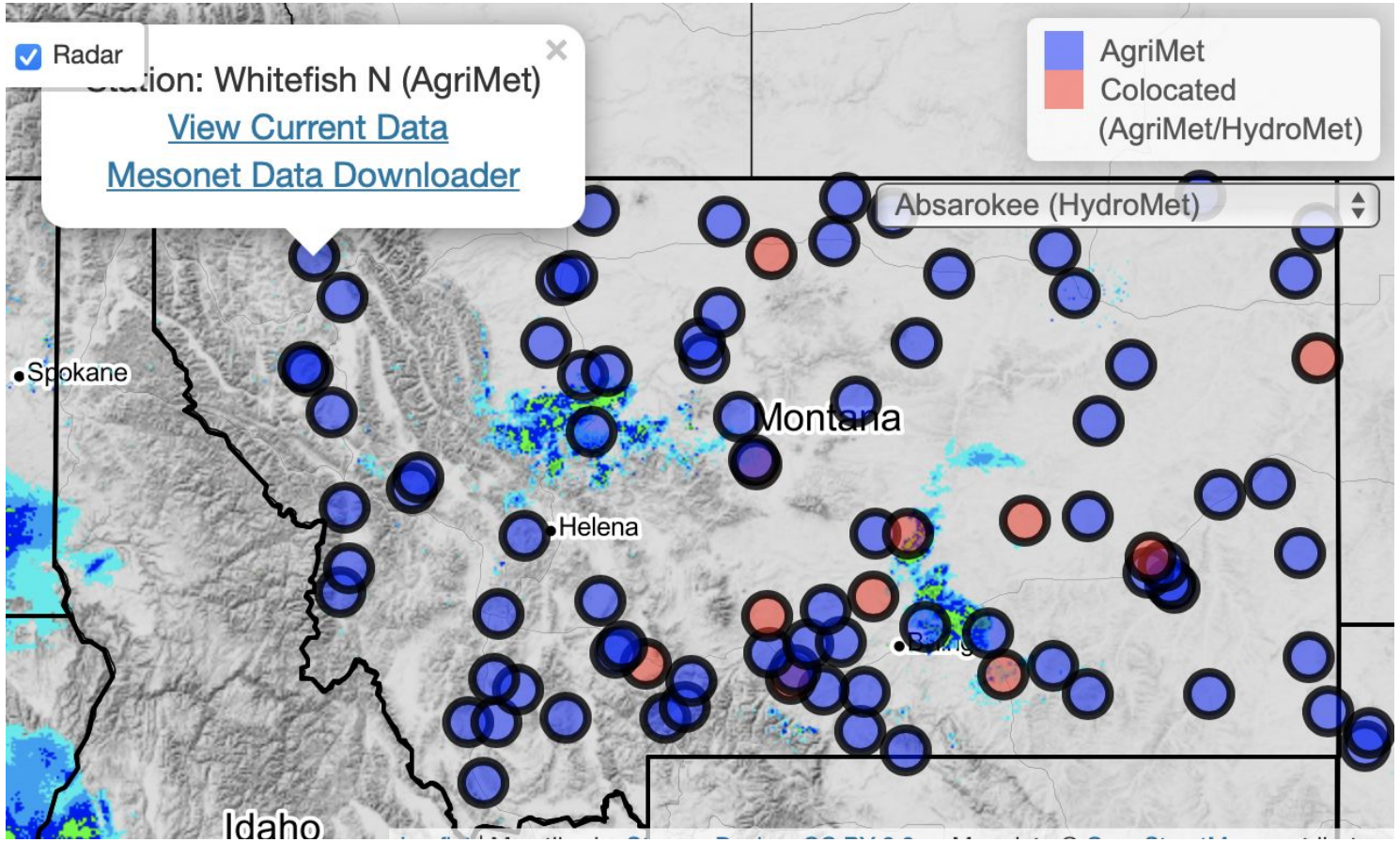
- Improved knowledge of moisture conditions for modeling of flood potential
- Timing and amounts of reservoir releases to mitigate downstream flooding

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

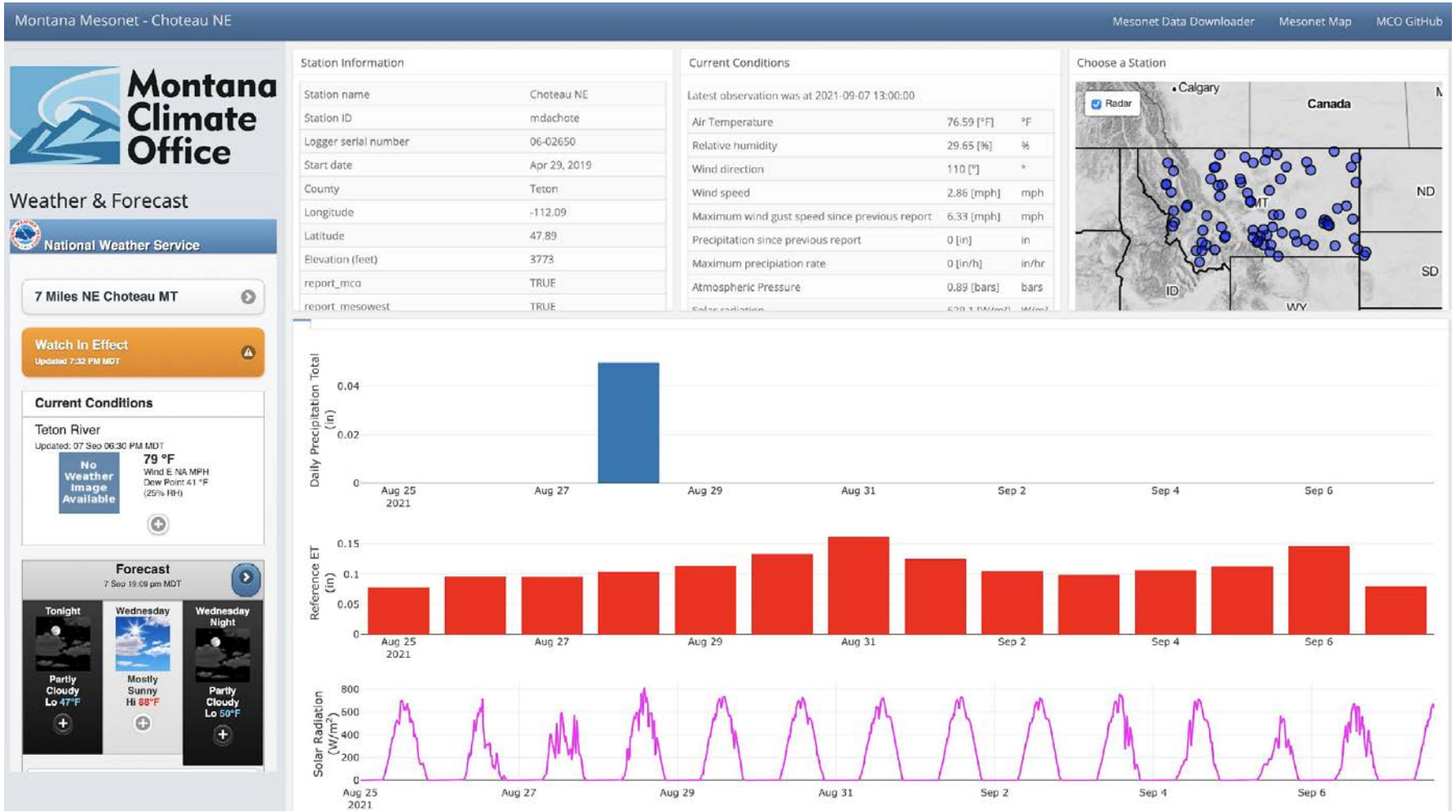
Kevin Hyde

- 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



climate.umt.edu/mesonet

- 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

NATIONAL MESONET Program Partner

Expansion & Improvements to Climate Infrastructure

TOM BAUER, MISSOULIAN

Carly Andlauer, a University of Montana senior finishing up a bachelor's degree in ecology restoration, processes soil samples Thursday from across the state for a climate monitoring project. UM researchers recently received a $21 million government contract for the project to better monitor soil moisture, snowpack, weather hazards and climate conditions.

UM awarded $21M contract

Researchers given Army Corps contract to expand climate monitoring network

LAURA SCHEER
laura.scheer@missoulian.com

University of Montana researchers recently received a $21 million government contract, bringing more support and longevity to what has been a grassroots effort to build a better climate monitoring network across the state.

The funding from the U.S. Army Corps of Engineers will pay to expand and enhance a collaborative project spearheaded by UM's Montana Climate Office in 2016 that aims to fill in gaps in weather and soil moisture data throughout the state.

"This project is very unique," said Kelsey Jencso, a lead researcher and associate professor of 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 Bureau of Land Management, Montana State University, watershed groups, and private farmers and ranchers, the Montana Climate Office, part of the W.A. Franke College of Forestry and Conservation, has installed 80 weather stations

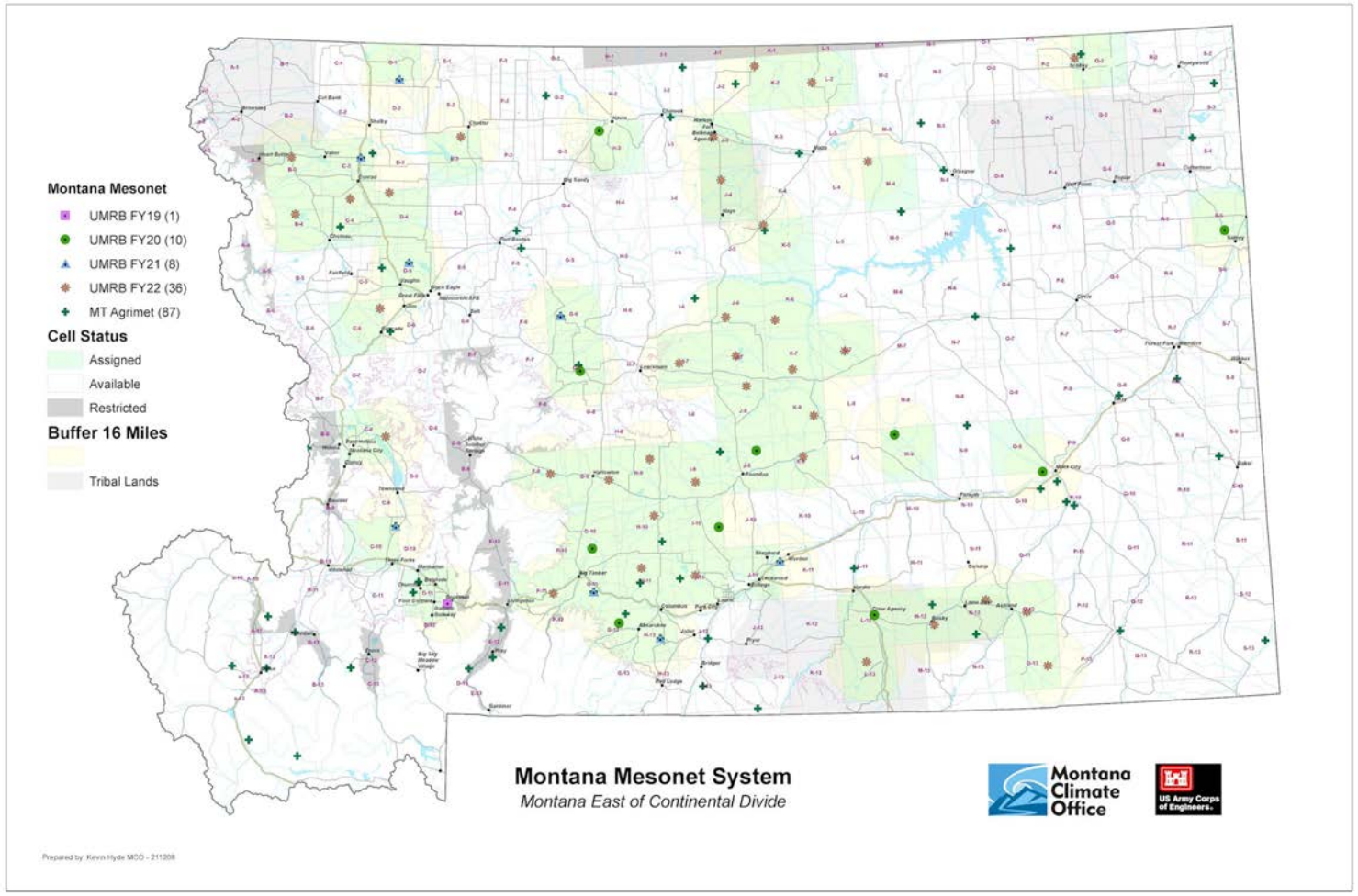
Please see CONTRACT, Page A3

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

Progress



2021 - 10 stations installed

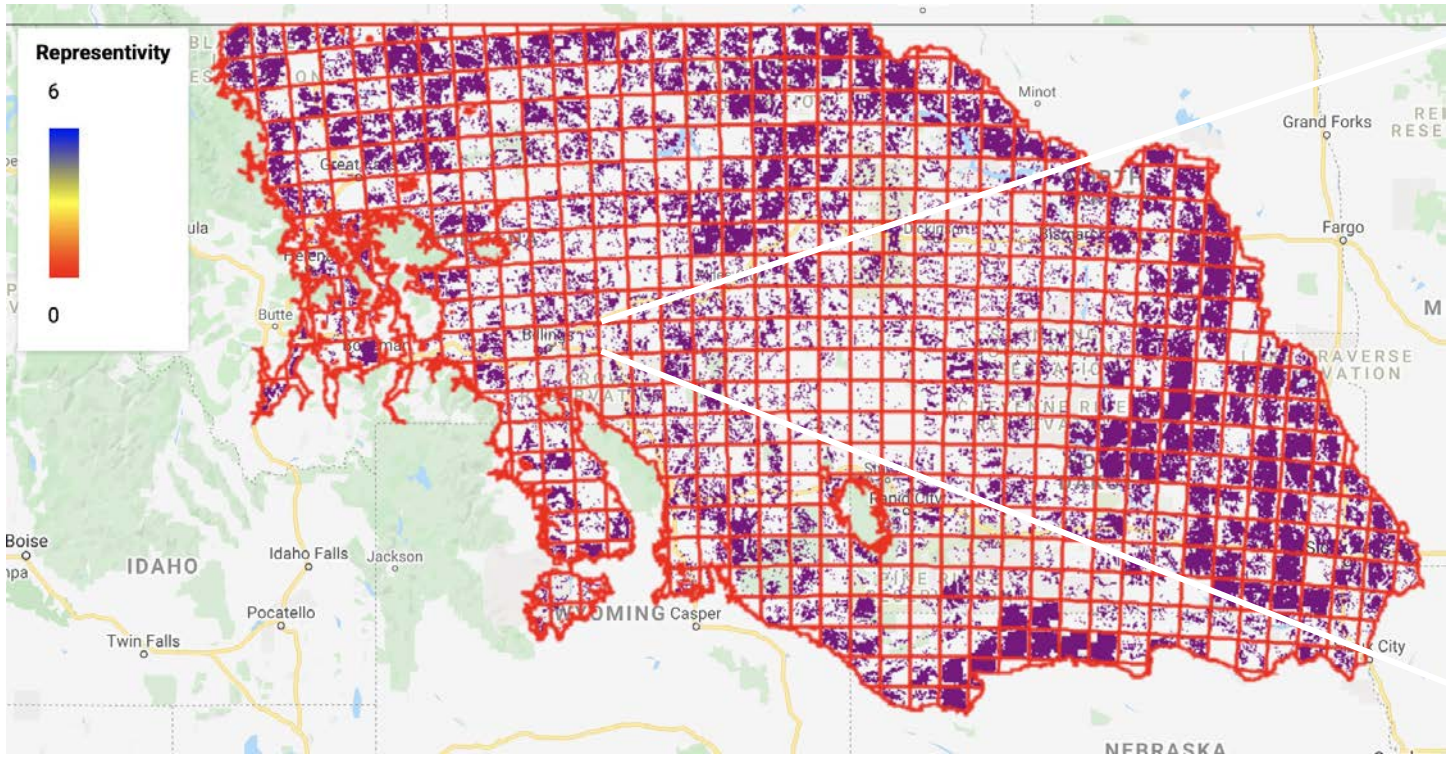
2022 – 8 stations – Musselshell

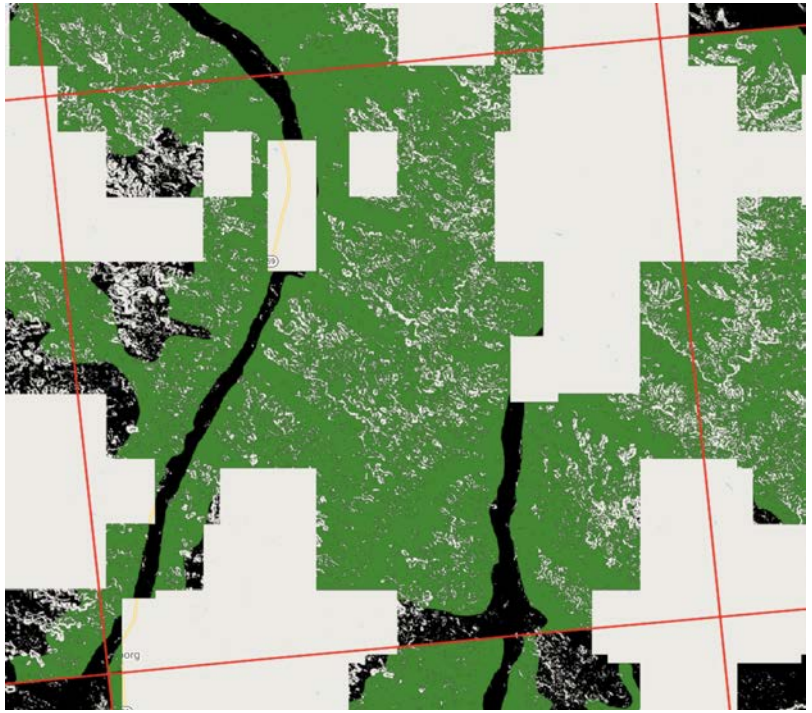
2023 – 36 stations

2024 – Looking for new partners!

The Big Picture!

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



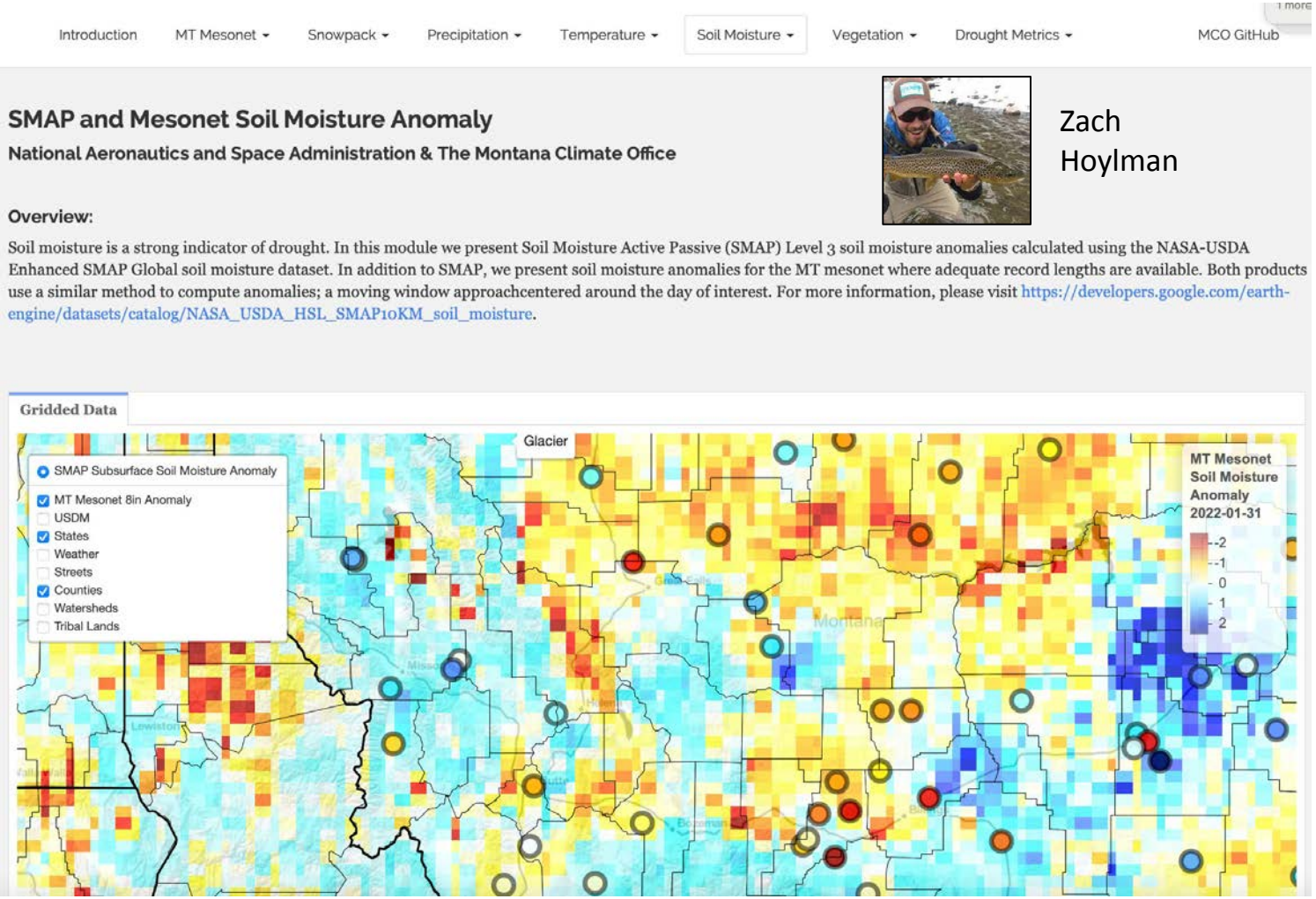


- 540 sites across Montana, Wyoming, North Dakota, South Dakota and Nebraska
- Each site will undergo full soils analysis by the NRCS

Candidate sites screened based upon representative soils, climate, topography and land use conditions

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**."



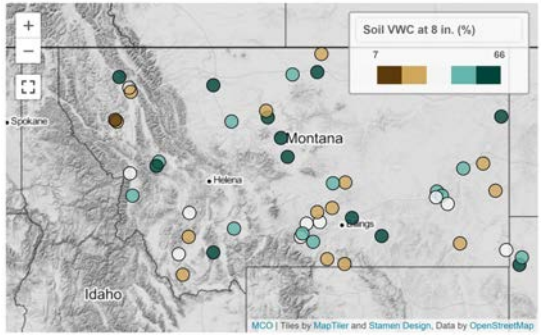
Zach Hoylman

drought.climate.umt.edu

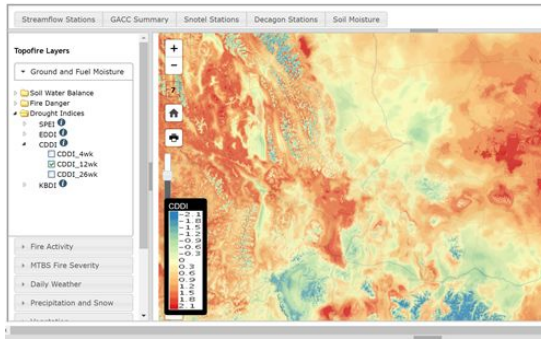
The UMRB Drought Dashboard

- **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 USDM**

Identify and apply relevant drought indicators in support of the MT DWSAC



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



Gridded drought data

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)

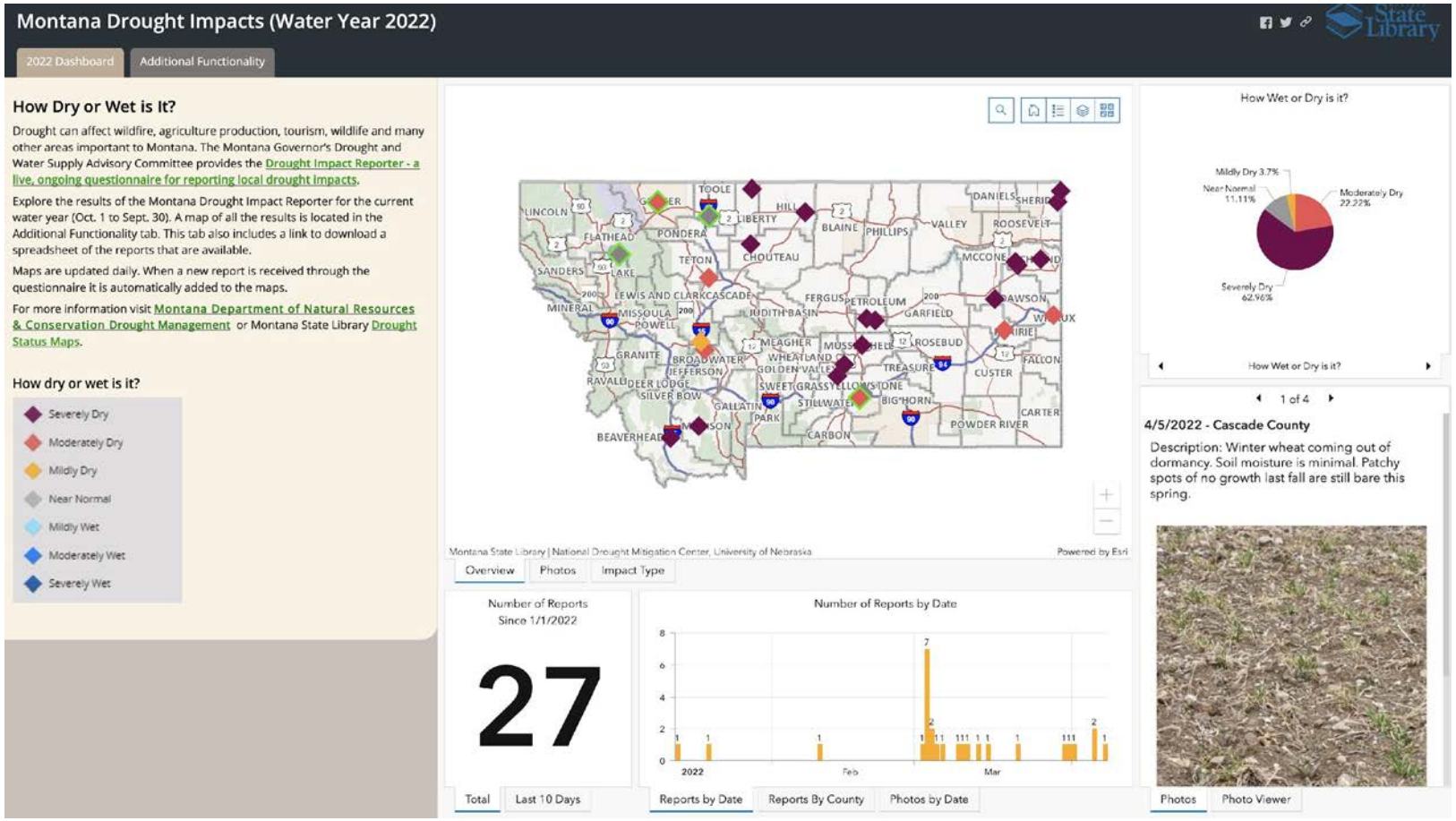
5. Selection of relevant indices for MT drought assessments by the DSWAC sub-committee

Operational drought assessments by county and watershed on a weekly interval

NIDIS
NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM

Montana Drought Impacts Reporter

Troy Blandford – MT State Library



https://nris.mt.gov/drought

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

Montana's Drought Monitoring Process

Michael Downey

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.

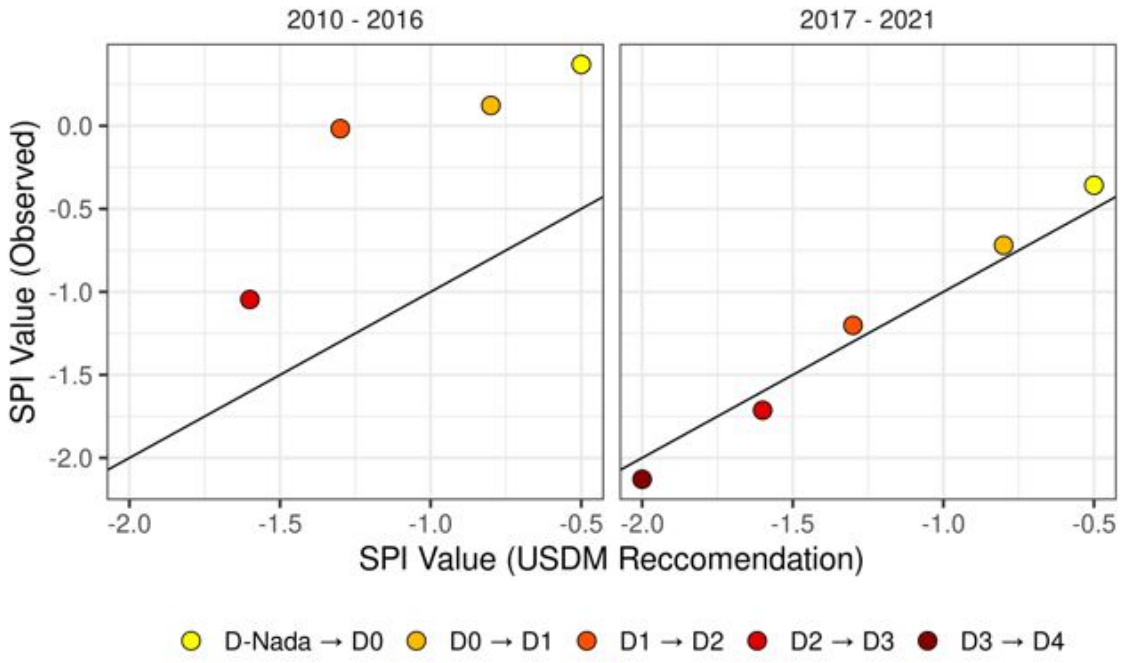
Repeat this process 52 times each year

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