

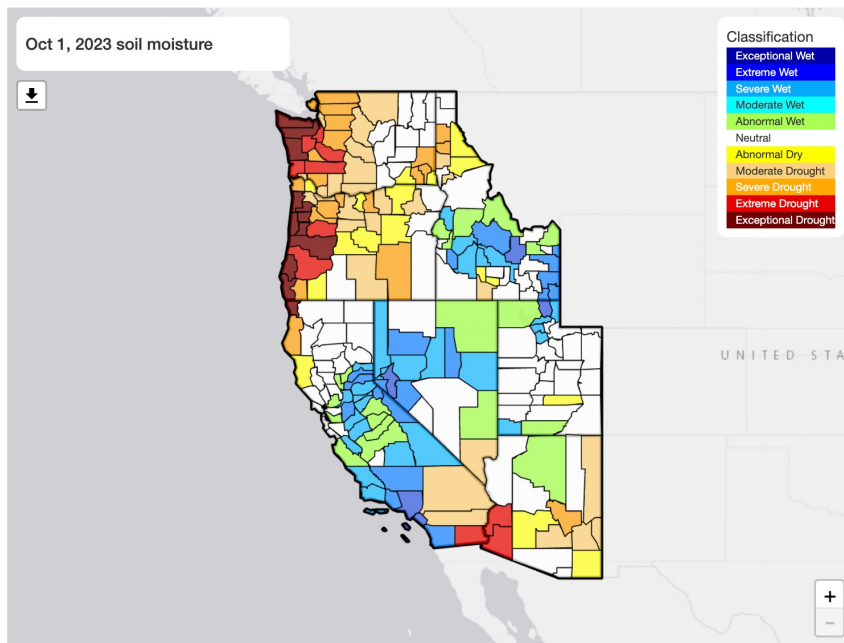
Estimating Drought Recovery in the Climate Toolbox



Katherine Hegewisch
University of California Merced

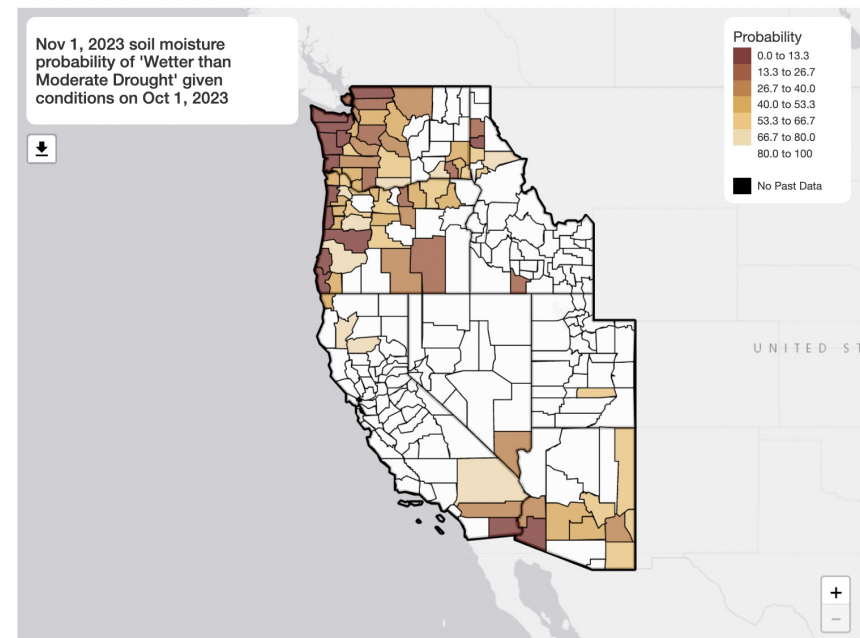


INITIAL MONTH



Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

FORECAST MONTH



Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate Drought'.

Other Drought Recovery Tools

Calculate the likelihood of recovering from a precipitation deficit or reaching a precipitation threshold

NOAA's Drought Reduction Tool

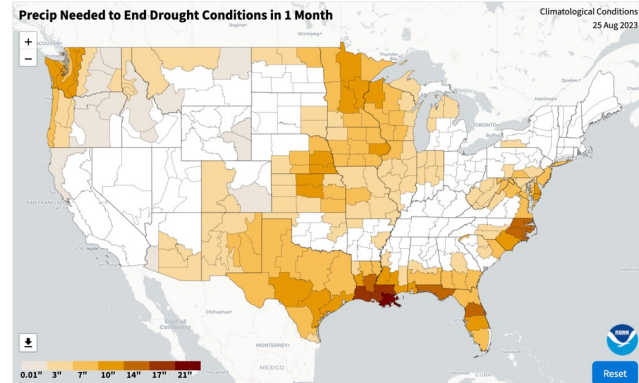
Current Drought Reduction

Select from the options below to view precipitation needed to end (PHDI value of -0.5) or ameliorate (PHDI value of -2.0) drought as it currently exists across the Contiguous U.S., assuming either a scenario of climatological conditions or a worst case scenario of no precipitation for the remainder of the month.

Scenario: Climatological Conditions
Reduction: Probability of Ending
Duration: 1 Month

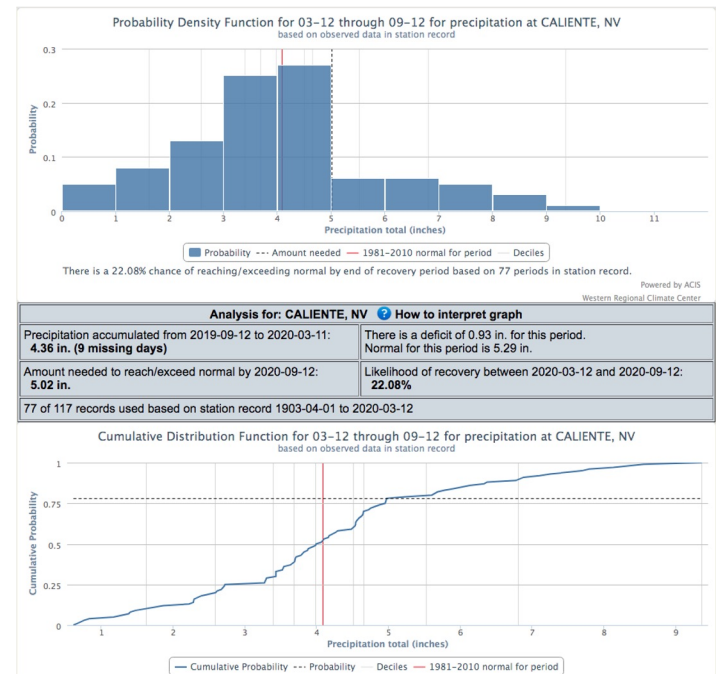
View

Basemap: Positron View: Recovery Data Opacity: 100%



Based on the PHDI, PHDI is a primary measure of long-term drought but may not apply to all areas, including those with heavily

WRCC's Climate Outcome Likelihood Tool



<https://www.ncei.noaa.gov/access/monitoring/drought-recovery/current>

<https://wrcc.dri.edu/col/> (No Longer Exists)

Drought Recovery Tool

Climate Toolbox APPLICATIONS TOOLS DATA VIDEOS CASE STUDIES TOOL SUMMARIES GUIDANCE NEWS CONTACT

The Climate Toolbox

A collection of web tools for visualizing past and projected climate and hydrology of the contiguous United States.

Applications

AGRICULTURE CLIMATE FIRE WATER

Tools

Find Your Variable
Variable Lookup: Find which tools in the Climate Toolbox have a certain variable.

Climate Mapper
Maps of historical agriculture climate information across multiple sectors.

Historical Water Watcher
Maps of real-time water monitoring over the contiguous US.

Historical Climate Tracker
Graphs and trend lines of historical climate variability for a location.

Historical Drought Stripes
Stripes of past short and long term droughts as a timeseries for a location.

Historical Drought Recovery
Maps of probabilities of drought recovery.

Historical Climate Scatter
Scatterplot graphs of two climate variables for a location.

Historical Climograph
Climographs of monthly average climate for a location.

Historical Seasonal Progression
Graphs of daily weather and forecasts for a location.

Historical Climate Dashboard
Dashboard of real-time climate for a location.

Subseasonal Forecasts Seasonal Forecast Graphs Future Boxplots Future Climate Scatter Future Time Series

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Choose View

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
 Harney County, Oregon

Show Region(s) on Map:
 Western US

Choose Data

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

Forecast Month:
 Nov 1, 2023

Definition of Drought Recovery:
 Wetter than Moderate Drought

Download

INITIAL MAP FORECAST MAP

Map Display Options

INITIAL MONTH

Oct 1, 2023 soil moisture

Classification

- Exceptional Wet
- Extreme Wet
- Severe Wet
- Abnormal Wet
- Abnormal Wet
- Neutral
- Abnormal Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Severe Drought (D2)
 Harney County
 9 Percentile in Soil Moisture on Oct 1, 2023

FORECAST MONTH

Nov 1, 2023 soil moisture
 probability of "Wetter than Moderate Drought" given conditions on Oct 1, 2023

20% Probability
 Harney County

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100
- No Past Data

Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1s in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as "Wetter than Moderate Drought".



Data

100 years of hydrology modeled data from UCLA's Drought Monitoring System

Model:

Variable Infiltration Capacity (VIC)

Variables:

Soil Moisture (Sum of 3 VIC soil layers)

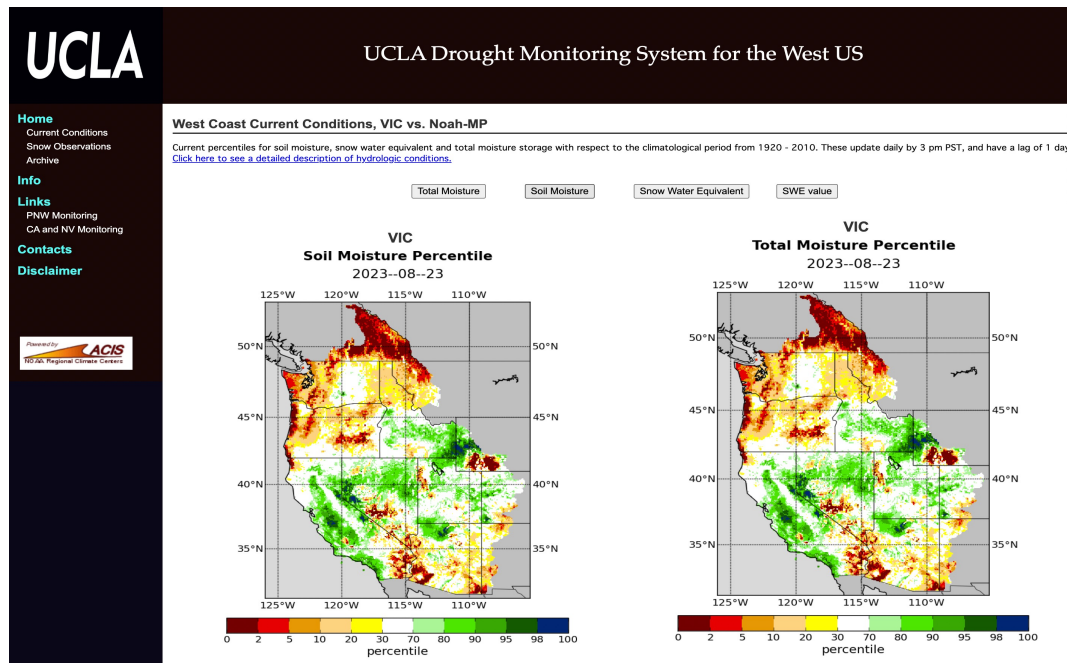
Total Moisture (Soil + Snow Water Equivalent)

Dates:

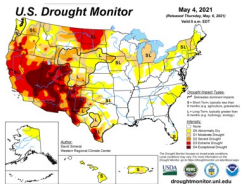
First of month from daily data (1920-2020)

Geography:

Western US (1/16-deg grids)



Drought Classification



US Drought Monitor (USDM) Colors & Classifications

Calculations:

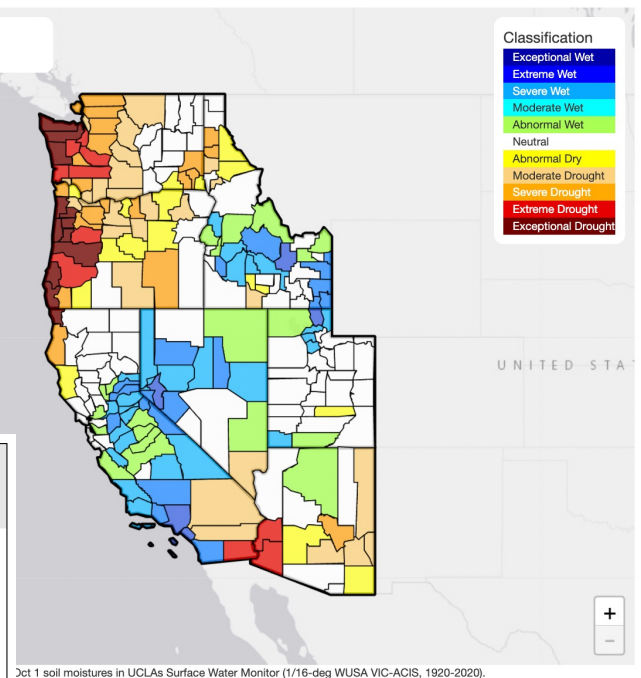
Percentiles (p) of soil moisture and total moisture

Classifications:

Percentiles map to USDM classifications & colors

INITIAL MONTH

Oct 1, 2023 soil moisture



Oct 1 soil moistures in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

Percentile (p)	Category	Description
$0 \leq p < 2$	D4	Exceptional Drought
$2 \leq p < 5$	D3	Extreme Drought
$5 \leq p < 10$	D2	Severe Drought
$10 \leq p < 20$	D1	Moderate Drought
$20 \leq p < 30$	D0	Abnormally Dry
$30 \leq p < 70$	N	Neutral or Wet

Percentile (p)	Category	Description
$70 \leq p < 80$	W0	Abnormally Wet
$80 \leq p < 90$	W1	Moderate Wet
$90 \leq p < 95$	W2	Severe Wet
$95 \leq p < 98$	W3	Extreme Wet
$98 \leq p \leq 100$	W4	Exceptional Wet

Drought Recovery

Examples of 'No Drought' in a Future Month:

- Wet Category
- Neutral
- Abnormally Dry (? For some states?)

We let the User Decide what 'No Drought' Looks Like:

- Wetter than Abnormally Dry (W0-4 + N)
- Wetter than Moderate Drought (W0-4 + N + D0)
- Wetter than Severe Drought (W0-4 + N + D0 + D1)
- ...

Percentile (p)	Category	Description
$0 \leq p < 2$	D4	Exceptional Drought
$2 \leq p < 5$	D3	Extreme Drought
$5 \leq p < 10$	D2	Severe Drought
$10 \leq p < 20$	D1	Moderate Drought
$20 \leq p < 30$	D0	Abnormally Dry
$30 \leq p < 70$	N	Neutral or Wet

Percentile (p)	Category	Description
$70 \leq p < 80$	W0	Abnormally Wet
$80 \leq p < 90$	W1	Moderate Wet
$90 \leq p < 95$	W2	Severe Wet
$95 \leq p < 98$	W3	Extreme Wet
$98 \leq p \leq 100$	W4	Exceptional Wet

Likelihood of Drought Recovery

Unconditional Probabilities

Since our wet/dry classifications are percentile based:
the unconditional probability of 'No Drought' is:

$$P(\text{Wetter than Moderate Drought (W0-4 + N + D0)}) = 80\%$$

Conditional Probabilities

Using current drought conditions,
the conditional probability of 'No Drought' is:

$$P(\text{No Drought in \{future month\} / Current Drought Conditions})$$

Percentile (p)	Category	Description
$0 \leq p < 2$	D4	Exceptional Drought
$2 \leq p < 5$	D3	Extreme Drought
$5 \leq p < 10$	D2	Severe Drought
$10 \leq p < 20$	D1	Moderate Drought
$20 \leq p < 30$	D0	Abnormally Dry
$30 \leq p < 70$	N	Neutral or Wet

Percentile (p)	Category	Description
$70 \leq p < 80$	W0	Abnormally Wet
$80 \leq p < 90$	W1	Moderate Wet
$90 \leq p < 95$	W2	Severe Wet
$95 \leq p < 98$	W3	Extreme Wet
$98 \leq p \leq 100$	W4	Exceptional Wet

Probability of Drought Recovery

Method:

Empirical drought recovery method based on 100 years of data used in the Masters thesis of D. Moruzzi (OSU, 2019) to look at drought in Washington state counties.

Drought Recovery Probability

$P(\text{No Drought in \{future month\} / Current Drought Conditions in \{current month\}})$

$$= \frac{\text{Number Years with No Drought in \{future month\} AND Current Drought Conditions in \{current month\}}}{\text{Number Years with Current Drought Conditions in \{current month\}}}$$

Drought Recovery Tool

Designed with help from state water managers:
J. Marti (WA), D. Hoekema (ID), K. Stahr(OR)

Drought Recovery

[Drought Recovery](#) [Documentation](#) [Cite Tool](#) [Take Tour](#)

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
Harney County, Oregon

Show Region(s) on Map:
Western US

Choose Data -

Variable:
Soil Moisture

Initial Month:
Oct 1, 2023

Forecast Month:
Nov 1, 2023

Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

[INITIAL MAP](#)

[FORECAST MAP](#)

Map Display Options -

INITIAL MONTH

Oct 1, 2023 soil moisture

Classification

- Exceptional Wet
- Extreme Wet
- Severe Wet
- Moderate Wet
- Abnormal Wet
- Neutral
- Abnormal Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Severe Drought (D2)
Harney County
9 Percentile in Soil Moisture on Oct 1, 2023

Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100
- No Past Data

20% Probability
Harney County

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar observations for soil moisture on Oct 1, 2023. Percentiles are defined as 'Wetter than Moderate'.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

- Summary Areas:**
- US Counties HUC8 Watersheds
- Location to Highlight:**
- Harney County, Oregon
- Show Region(s) on Map:**
- Western US

Choose Data -

- Variable:**
- Soil Moisture
- Initial Month:**
- Oct 1, 2023
- Forecast Month:**
- Nov 1, 2023
- Definition of Drought Recovery:**
- Wetter than Moderate Drought

Download -

- [INITIAL MAP](#)
- [FORECAST MAP](#)
- Map Display Options -**

Users can view data tables or maps.

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1931	D4	D1	D2	D2	D1	D2	D2
1933	D4	D1	D2	D2	D3	D3	D4

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

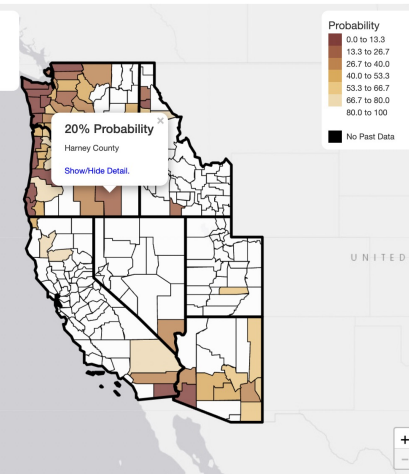
Moderate Drought (D1) on Oct 1 -

Abnormally Dry (D0) on Oct 1 -

Not Dry or Wet (N) on Oct 1 -

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023



Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate Drought'.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

[Drought Recovery](#) [Documentation](#) [Cite Tool](#) [Take Tour](#)

Choose View -



Map of Initial Month &
Map of Forecast Month



Table of Past Data &
Map of Forecast Month

Choose Location -

Summary Areas:

US Counties HUC8 Watersheds

Location to Highlight:

Harney County, Oregon

Show Region(s) on Map:

Western US

Choose Data -

Variable:

Soil Moisture

Initial Month:

Oct 1, 2023

Forecast Month:

Nov 1, 2023

Definition of Drought Recovery: ⓘ

Wetter than Moderate Drought

Download -

INITIAL MAP

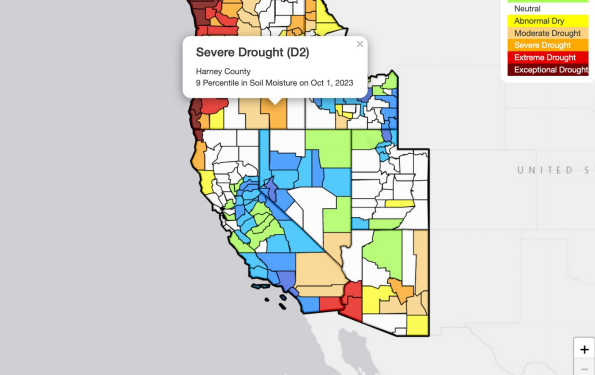
FORECAST MAP

Map Display Options -

Map View

INITIAL MONTH

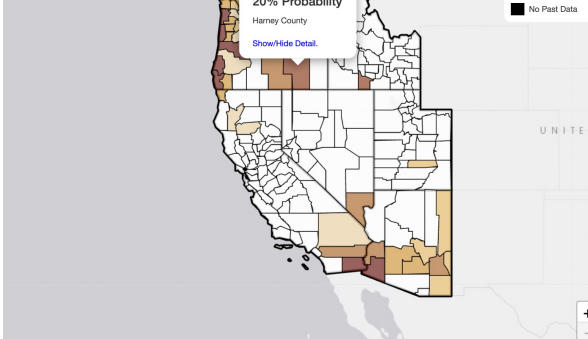
Oct 1, 2023 soil moisture



Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-AGIS, 1920-2020).

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023



Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (VIC-AGIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate'.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

Map of Initial Month &
Map of Forecast Month
Table of Past Data &
Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
Harney County, Oregon

Show Region(s) on Map:
Western US

Choose Data -

Variable:
Soil Moisture
Initial Month:
Oct 1, 2023
Forecast Month:
Nov 1, 2023
Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

INITIAL MAP

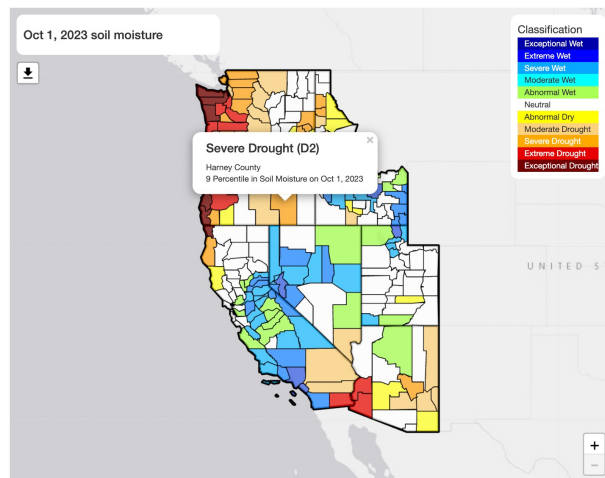
FORECAST MAP

Map Display Options -

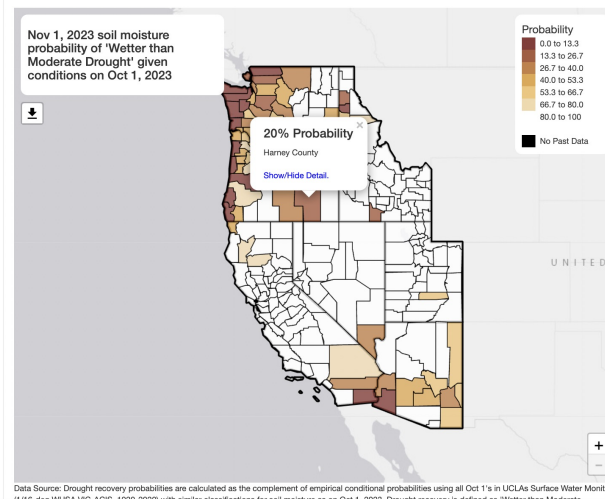
Users can select to view results over counties or watersheds.

State drought decision making is at the county & watershed level.

INITIAL MONTH



FORECAST MONTH



Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

- Summary Areas:
 US Counties HUC8 Watersheds
- Location to Highlight:
Harney County, Oregon
- Show Region(s) on Map:
Western US

Choose Data -

Variable:
Soil Moisture

Download -

INITIAL MAP

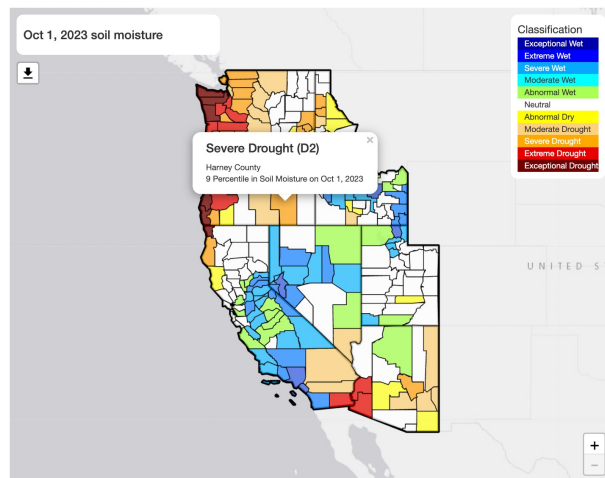
✓ Soil Moisture

Soil Moisture and Snow Water Equivalent (Total Moisture)

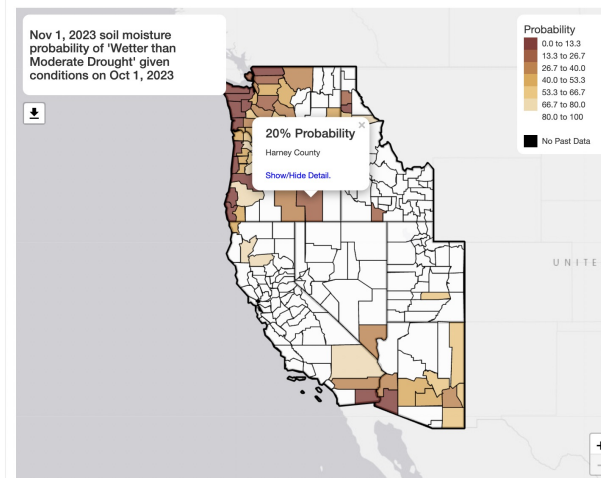
Users can select to look at drought in either soil moisture or total moisture.

These metrics have good memory of drought conditions and are good indicators of agricultural & ecological drought

INITIAL MONTH



FORECAST MONTH



Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

- US Counties
- HUC8 Watersheds
- Location to Highlight: Harney County, Oregon
- Show Region(s) on Map: Western US

Choose Data -

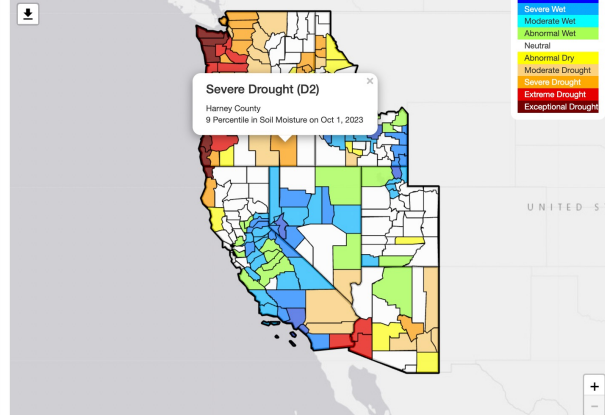
- Variable: Soil Moisture
- Initial Month: Oct 1, 2023

Download -

- INITIAL MAP
- FORECAST MAP

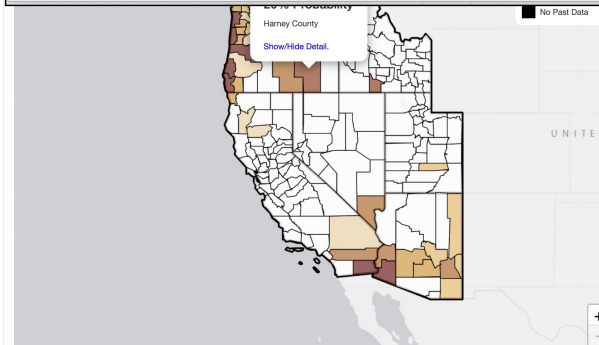
INITIAL MONTH

Oct 1, 2023 soil moisture



Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-AGIS, 1920-2020).

- ✓ Oct 1, 2023
- Sept 1, 2023
- Aug 1, 2023
- Jul 1, 2023
- Jun 1, 2023
- May 1, 2023



Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (VIC-AGIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate'.

Users can look at current month or a previous month in the last 5 months.

Drought managers expressed to us their interest in looking back at data from previous months to understand how things are evolving.

Drought Recovery Tool

Current drought conditions are assessed using the USDM classifications plus a wet side.

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

[Drought Recovery](#) [Documentation](#) [Cite Tool](#) [Take Tour](#)

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

- Summary Areas:**
 US Counties HUC8 Watersheds
- Location to Highlight:**
Harney County, Oregon
- Show Region(s) on Map:**
Western US

Choose Data -

- Variable:**
Soil Moisture
- Initial Month:**
Oct 1, 2023
- Forecast Month:**
Nov 1, 2023
- Definition of Drought Recovery:**
Wetter than Moderate Drought

Download -

- INITIAL MAP
- FORECAST MAP
- Map Display Options -

INITIAL MONTH

Oct 1, 2023 soil moisture



Severe Drought (D2)
Harney County
9 Percentile in Soil Moisture on Oct 1, 2023

- Classification**
- Exceptional Wet
 - Extreme Wet
 - Severe Wet
 - Moderate Wet
 - Abnormal Wet
 - Neutral
 - Abnormal Dry
 - Moderate Drought
 - Severe Drought
 - Extreme Drought
 - Exceptional Drought

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023



20% Probability
Harney County

- Probability**
- 0.0 to 13.3
 - 13.3 to 26.7
 - 26.7 to 40.0
 - 40.0 to 53.3
 - 53.3 to 66.7
 - 66.7 to 80.0
 - 80.0 to 100
 - No Past Data

Data Source: Department based reanalysis of 48 Oct 1 soil moisture in UCLAs Surface Water Monitor (DSR) for USA (UC-62R, 1920-2020)

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (DSR) for USA (UC-62R, 1920-2020) with color classification for soil moisture on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate'.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

- Summary Areas:
- US Counties
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- Location to Highlight:
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Choose Data -

- Variable:
- Soil Moisture
- Initial Month:
- Oct 1, 2023
- Forecast Month:
- Nov 1, 2023

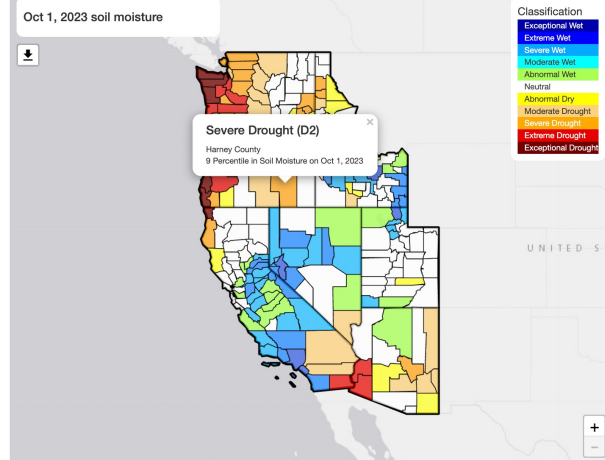
Download -

- INITIAL MAP
 - FORECAST MAP
- Map Display Options -

Users can look forward to months up to 6 months ahead.

Drought managers are interested in certain target months for water demand.

INITIAL MONTH



✓ Nov 1, 2023

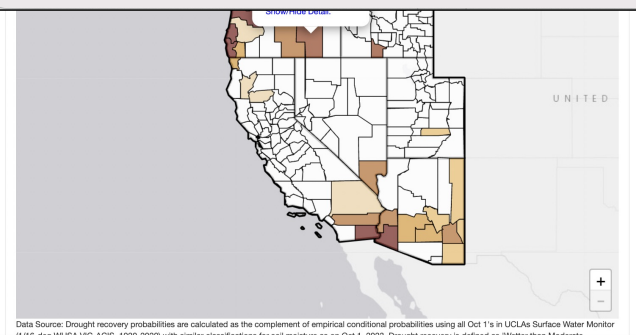
Dec 1, 2023

Jan 1, 2024

Feb 1, 2024

Mar 1, 2024

Apr 1, 2024



Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

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Forecast Month:
Nov 1, 2023

Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

INITIAL MAP

FORECAST MAP

Map Display Options -

INITIAL MONTH

Oct 1, 2023 soil moisture

Severe Drought (D2)
Harney County
9 Percentile in Soil Moisture on Oct 1, 2023

Classification

- Exceptional Wet
- Extreme Wet
- Severe Wet
- Moderate Wet
- Abnormal Wet
- Neutral
- Abnormal Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-AGIS, 1920-2020).

Wetter than Abnormally Dry

Wetter than Moderate Drought

Wetter than Severe Drought

Wetter than Extreme Drought

Wetter than Exceptional Drought

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (VIC-AGIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate'.

Users can select the intensity of drought they are concerned with.

Drought managers have different thresholds for drought that will trigger decision making actions. This provides flexibility.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery
Documentation
Cite Tool
Take Tour

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

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Choose Data -

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

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 Nov 1, 2023

Definition of Drought Recovery:
 Wetter than Moderate Drought

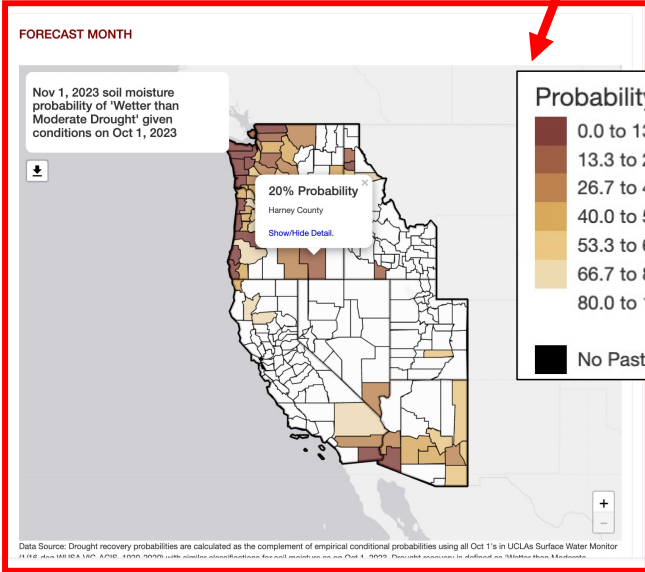
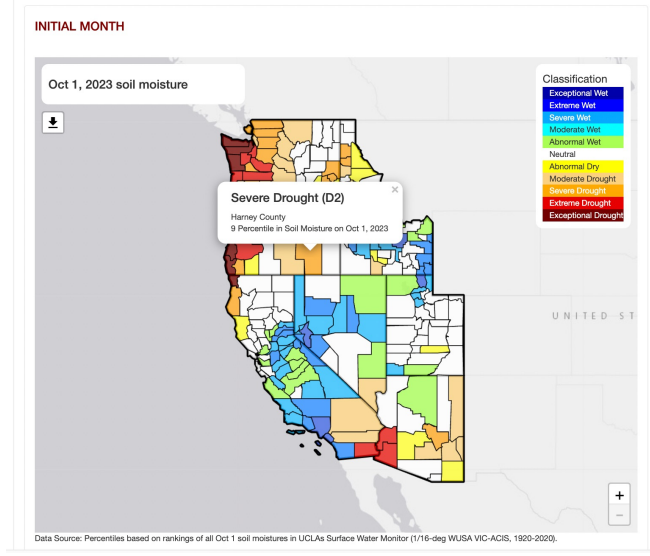
Download -

INITIAL MAP

FORECAST MAP

Map Display Options -

Probabilities of no drought are shown with the same colors as NOAAs Drought Reduction Tool for consistency.



Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
Harney County, Oregon

Show Region(s) on Map:
Western US

Choose Data -

Variable:
Soil Moisture

Initial Month:
Oct 1, 2023

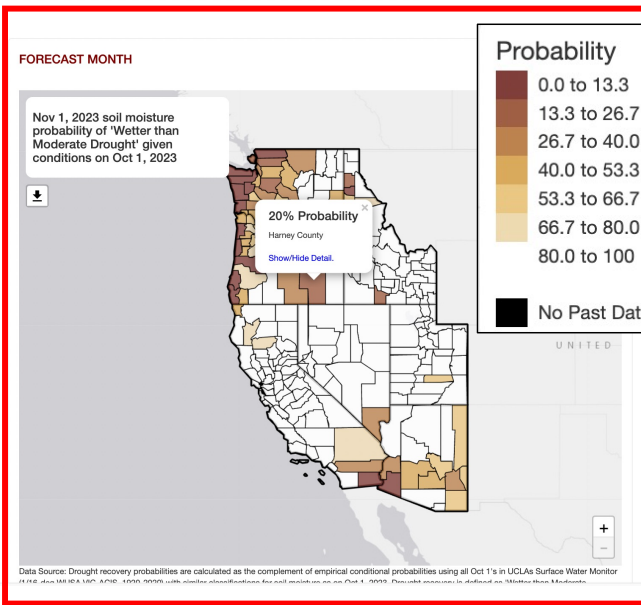
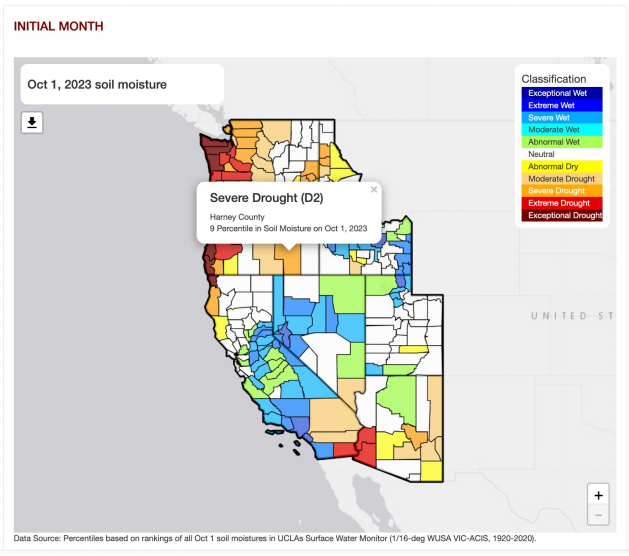
Forecast Month:
Nov 1, 2023

Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

INITIAL MAP FORECAST MAP

Map Display Options -



Brown colors are where persisting (or new) drought is likely.

White colors are where no drought is likely.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

Map of Initial Month & Map of Forecast Month

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 US Counties HUC8 Watersheds

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Harney County, Oregon

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Western US

Choose Data -

Variable:
Soil Moisture

Initial Month:
Oct 1, 2023

Forecast Month:
Nov 1, 2023

Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

INITIAL MAP

FORECAST MAP

Map Display Options -

INITIAL MONTH

Oct 1, 2023 soil moisture

Classification

- Exceptional Wet
- Extreme Wet
- Severe Wet
- Moderate Wet
- Abnormal Wet
- Neutral
- Abnormal Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Severe Drought (D2)
Harney County
9 Percentile in Soil Moisture on Oct 1, 2023

Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

20% Probability
Harney County
Show/Hide Detail.

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100
- No Past Data

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

Popups show the probabilities for each region.

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

- Map of Initial Month & Map of Forecast Month
- Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
Harney County, Oregon

Show Region(s) on Map:
Western US

Choose Data -

Variable:
Soil Moisture

Initial Month:
Oct 1, 2023

Forecast Month:
Nov 1, 2023

Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

INITIAL MAP

FORECAST MAP

INITIAL MONTH

Oct 1, 2023 soil moisture

Classification

- Exceptional Wet
- Extreme Wet
- Severe Wet
- Moderate Wet
- Abnormal Wet
- Neutral
- Abnormal Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Severe Drought (D2)

Harney County
9 Percentile in Soil Moisture on Oct 1, 2023

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

20% Probability

Harney County

- Severe Drought" on Oct 1st: 5 past years.
- Of these years, 4 years had "Drier than or Moderate Drought" on Nov 1st
- 1 had "Moderate Drought" on Nov 1st
- 0 had "Severe Drought" on Nov 1st
- 2 had "Extreme Drought" on Nov 1st
- 1 had "Exceptional Drought" on Nov 1st

Show/Hide Detail.

Click the 'Show/Hide Detail' to expand more detail.

Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with county classification to soil moisture on Oct 1, 2023. Percentages is defined as "Wetter than Moderate".

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:

US Counties HUC8 Watersheds

Location to Highlight:

Harney County, Oregon

Show Region(s) on Map:

Western US

Choose Data -

Variable: Soil Moisture

Initial Month: Oct 1, 2023

Forecast Month: Nov 1, 2023

Definition of Drought Recovery: Wetter than Moderate Drought

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INITIAL MAP

FORECAST MAP

Map Display Options -

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture
Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D3
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Moderate Drought (D1) on Oct 1 -

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

20% Probability
Harney County
[Show/Hide Detail.](#)

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100

■ No Past Data

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate Drought'.

You can explore the data with tables of past data.



Drought Recovery Tool

Drought Recovery Drought Recovery | Documentation | Cite Tool | Take Tour

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
 Harney County, Oregon

Show Region(s) on Map:
 Western US

Choose Data -

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

Forecast Month:
 Nov 1, 2023

Definition of Drought Recovery:
 Wetter than Moderate Drought

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INITIAL MAP

FORECAST MAP

Map Display Options -

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture
 Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D3
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Moderate Drought (D1) on Oct 1 -

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

20% Probability
 Harney County
[Show/Hide Detail](#)

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100
- No Past Data

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate Drought'.

5 years of 'Severe Drought' (D2) on Oct 1



YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D3
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Drought Recovery Tool

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Drought Recovery Documentation Cite Tool Take Tour

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
 Harney County, Oregon

Show Region(s) on Map:
 Western US

Choose Data -

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

Forecast Month:
 Nov 1, 2023

Definition of Drought Recovery:
 Wetter than Moderate Drought

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INITIAL MAP

FORECAST MAP

Map Display Options -

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture
 Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D3
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Moderate Drought (D1) on Oct 1 -

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

20% Probability
 Harney County
[Show/Hide Detail.](#)

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100
- No Past Data

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate Drought'.

What happened
In those years
on Nov 1



Drought Recovery Tool

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Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Choose View -

Map of Initial Month & Map of Forecast Month

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Location to Highlight:
 Harney County, Oregon

Show Region(s) on Map:
 Western US

Choose Data -

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

Forecast Month:
 Nov 1, 2023

Definition of Wetter than

Download -

INITIAL MAP

FORECAST MAP

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture
 Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D3
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Moderate Drought (D1) on Oct 1 -

FORECAST

Nov 1, 2023 probability of Moderate condition

20% Probability

Harney County

- Severe Drought" on Oct 1st: 5 past years.
- Of these years, 4 years had "Drier than or Moderate Drought" on Nov 1st
- 1 had "Moderate Drought" on Nov 1st
- 0 had "Severe Drought" on Nov 1st
- 2 had "Extreme Drought" on Nov 1st
- 1 had "Exceptional Drought" on Nov 1st

[Show/Hide Detail.](#)

What happened
In those years
on Nov 1

1 year of 'Moderate Drought' (D1) on Nov 1

Drought Recovery Tool

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Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

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Summary Areas:
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Location to Highlight:
 Harney County, Oregon

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 Western US

Choose Data -

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

Forecast Month:
 Nov 1, 2023

Definition of Wetter than

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INITIAL MAP

FORECAST MAP

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture
 Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D0
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Moderate Drought (D1) on Oct 1 -

FORECAST

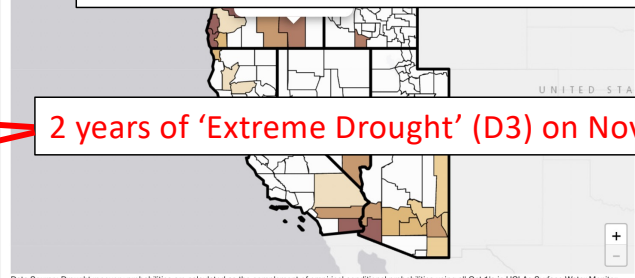
Nov 1, 2023 probability of Moderate condition

20% Probability

Harney County

- Severe Drought" on Oct 1st: 5 past years.
- Of these years, 4 years had "Drier than or Moderate Drought" on Nov 1st
- 1 had "Moderate Drought" on Nov 1st
- 0 had "Severe Drought" on Nov 1st
- 2 had "Extreme Drought" on Nov 1st
- 1 had "Exceptional Drought" on Nov 1st

Show/Hide Detail.



What happened
In those years
on Nov 1

2 years of 'Extreme Drought' (D3) on Nov 1

Drought Recovery Tool

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Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

Choose View -

Map of Initial Month & Map of Forecast Month

Table of Past Data & Map of Forecast Month

Choose Location -

Summary Areas:
 US Counties HUC8 Watersheds

Location to Highlight:
 Harney County, Oregon

Show Region(s) on Map:
 Western US

Choose Data -

Variable:
 Soil Moisture

Initial Month:
 Oct 1, 2023

Forecast Month:
 Nov 1, 2023

Definition of Wetter than

Download -

INITIAL MAP

FORECAST MAP

PAST MONTHS DATA

Past Year 'Drought' Transitions in Soil Moisture
 Harney County, Oregon

Show Percentiles instead of Drought Categories

Exceptional Drought (D4) on Oct 1 -

Extreme Drought (D3) on Oct 1 -

Severe Drought (D2) on Oct 1 -

YEAR	OCT 1	NOV 1	DEC 1	JAN 1	FEB 1	MAR 1	APR 1
1937	D2	D3	D0	D4	D4	D4	D3
1939	D2	D1	D3	N	N	N	D0
1955	D2	D4	D2	D0	D1	D2	D3
1992	D2	D0	D1	N	N	N	D0
2009	D2	D3	D3	D1	D2	D2	D3

Moderate Drought (D1) on Oct 1 -

FORECAST

Nov 1, 2023 probability of Moderate Drought condition

20% Probability

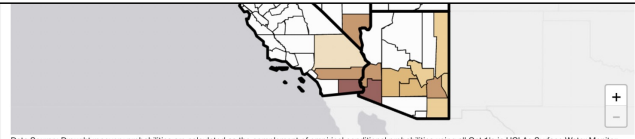
Harney County

- Severe Drought" on Oct 1st: 5 past years.
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- 2 had "Extreme Drought" on Nov 1st
- 1 had "Exceptional Drought" on Nov 1st

[Show/Hide Detail.](#)

1 year of 'Wetter than Moderate Drought' (D0+N+W) on Nov 1

1/5= 20 % Probability of Drought Recovery



Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLA's Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020) with similar classifications for soil moisture as on Oct 1, 2023. Drought recovery is defined as 'Wetter than Moderate Drought'.

Conclusions

- The Climate Toolbox's Drought Recovery Tool is:
 - Applicable – data at scales useful for decisions
 - Flexible – several ways to tailor drought question
 - Interactive – more detail available through clicks or data views

The Climate Toolbox's Drought Recovery Tool

<https://ClimateToolbox.org>

Drought Recovery

Investigate the probability of recovering from drought conditions based on past observations 1920-2020.

[Drought Recovery](#) [Documentation](#) [Cite Tool](#) [Take Tour](#)

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Initial Month:
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Forecast Month:
Nov 1, 2023

Definition of Drought Recovery:
Wetter than Moderate Drought

Download -

INITIAL MAP

FORECAST MAP

Map Display Options -

INITIAL MONTH

Oct 1, 2023 soil moisture

Severe Drought (D2)
Harney County
9 Percentile in Soil Moisture on Oct 1, 2023

Classification

- Exceptional Wet
- Extreme Wet
- Severe Wet
- Moderate Wet
- Abnormal Wet
- Neutral
- Abnormal Dry
- Moderate Drought
- Severe Drought
- Extreme Drought
- Exceptional Drought

Data Source: Percentiles based on rankings of all Oct 1 soil moistures in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020).

FORECAST MONTH

Nov 1, 2023 soil moisture probability of 'Wetter than Moderate Drought' given conditions on Oct 1, 2023

20% Probability
Harney County

Show/Hide Detail.

Probability

- 0.0 to 13.3
- 13.3 to 26.7
- 26.7 to 40.0
- 40.0 to 53.3
- 53.3 to 66.7
- 66.7 to 80.0
- 80.0 to 100
- No Past Data

Data Source: Drought recovery probabilities are calculated as the complement of empirical conditional probabilities using all Oct 1's in UCLAs Surface Water Monitor (1/16-deg WUSA VIC-ACIS, 1920-2020). Probabilities are defined as: Moderate Drought (53.3-66.7%), Severe Drought (26.7-53.3%), Extreme Drought (13.3-26.7%), Exceptional Drought (0.0-13.3%).



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