U.S. Drought Monitor Process

Alaska Drought Webinar Series

Univ of Alaska Fairbanks | Alaska Center for Climate Assessment & Policy

NOAA NIDIS | NOAA National Weather Service

USDA Northwest Climate Hub

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• U.S. Drought Monitor -
  • What is it?
  • Who creates the weekly map?
  • What is the map used for?
  • What data goes into making the map?
• Drought in Alaska, climate data for Alaska
• Process behind making the map
What is the U.S. Drought Monitor?

- **Composite drought map** that communicates the state of drought in the U.S. on a **weekly** basis

- **Started in 1999**

- **Jointly produced** by National Drought Mitigation Center (NDMC) at the University of Nebraska-Lincoln, U.S. Department of Agriculture (USDA), and National Oceanic & Atmospheric Administration (NOAA)

- **Part of a Drought Early Warning (DEWS) system** - NOAA National Integrated Drought Information System (NIDIS)

- Integral part of drought planning, preparedness, and mitigation efforts at the national, regional, and local levels.
USDM “Page 2” map

- **U.S Affiliated Pacific Islands**
  - Marshall Islands, Federated States of Micronesia, Guam, Northern Mariana Islands, & American Samoa

- **North American Drought Monitor**
  - Canada (Agriculture & Agrifood Canada, Meteorological Service of Canada), Mexico (Servicio Meteorologico Nacional), & US (NOAA CPC/NCEI, USDA, NDMC)
Who uses the USDM?

• **USDA** – trigger for drought disaster declarations

• **Farm Service Agency** – helps determine eligibility for the Livestock Forage Disaster Program (LFP) (drought disaster relief for livestock producers)

• **IRS** – tax deferrals on forced livestock sales due to drought

• **NWS WFOs** – Drought Information Statements

• **State, local, tribal, and basin-level** decision makers – trigger drought responses

• **Media & general public** (over 12 million hits to USDM website annually)
Who creates the weekly map?

- 11 national authors
- Authors work at regional or national “centers” within the government or in academia/research institutions
- Authors work rotating shifts - typically two or three 2-week shifts annually
- Weekly “Page 2” author that was added in 2019 to cover analysis of the U.S. Virgin Islands and U.S. Affiliated Pacific Islands
Our Contributors - Backbone of the USDM

- ~450 contributors
- Include state, regional, or basin drought coordination teams
- Provide ground-truth for the data indicators
Drought Monitor Concept

- A consolidation of indices and indicators into one comprehensive national drought map
- Not a model, forecast, or based on a single indicator/index. Rather, a hybrid approach of objective measures (indicators/indices) & subjective measures (expertise & impacts)
- Snapshot of current drought conditions
- Try to capture these characteristics:
  - drought’s magnitude (duration + intensity)
  - spatial extent
  - probability of occurrence
  - impacts (short & long-term)
- Rates drought intensity by percentile ranks
Drought Severity Classification

Drought intensity based upon:

- **Key indicators** (PDSI, soil moisture, streamflow, SPI, objective drought blends, and dozens of additional indicators)

- **Drought impacts** (S=short-term [<6-month]; L-long-term [>6-month]; or SL [combination of both])

- **Local reports**

- Drought categories are associated with historical occurrence/likelihood (percentile rankings). It’s not anecdotal or subjective, like “it’s really, really dry” or I don’t ever remember is being this dry... we have to be D4.

<table>
<thead>
<tr>
<th>Drought Category</th>
<th>Color</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4, Exceptional Drought</td>
<td>Red</td>
<td>once per 50 to 100 years</td>
</tr>
<tr>
<td>D3, Extreme Drought</td>
<td>Red</td>
<td>once per 20 to 50 years</td>
</tr>
<tr>
<td>D2, Severe Drought</td>
<td>Red</td>
<td>once per 10 to 20 years</td>
</tr>
<tr>
<td>D1, Moderate Drought</td>
<td>Yellow</td>
<td>once per 5 to 10 years</td>
</tr>
<tr>
<td>D0, Abnormally Dry</td>
<td>Green</td>
<td>once per 3 to 5 years</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Possible Impacts</th>
<th>Palmer Drought Severity Index (PDSI)</th>
<th>CPC Soil Moisture Model (Percentiles)</th>
<th>USGS Weekly Streamflow (Percentiles)</th>
<th>Standardized Precipitation Index (SPI)</th>
<th>Objective Drought Indications (Percentiles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0</td>
<td>Abnormally Dry</td>
<td></td>
<td>-1.0 to -1.9</td>
<td>21 to 30</td>
<td>21 to 30</td>
<td>-0.5 to -0.7</td>
<td>21 to 30</td>
</tr>
<tr>
<td>D1</td>
<td>Moderate Drought</td>
<td></td>
<td>-2.0 to -2.9</td>
<td>11 to 20</td>
<td>11 to 20</td>
<td>-0.8 to -1.2</td>
<td>11 to 20</td>
</tr>
<tr>
<td>D2</td>
<td>Severe Drought</td>
<td></td>
<td>-3.0 to -3.9</td>
<td>6 to 10</td>
<td>6 to 10</td>
<td>-1.3 to -1.5</td>
<td>6 to 10</td>
</tr>
<tr>
<td>D3</td>
<td>Extreme Drought</td>
<td></td>
<td>-4.0 to -4.9</td>
<td>3 to 5</td>
<td>3 to 5</td>
<td>-1.6 to -1.9</td>
<td>3 to 5</td>
</tr>
<tr>
<td>D4</td>
<td>Exceptional Drought</td>
<td></td>
<td>-5.0 or less</td>
<td>0 to 2</td>
<td>0 to 2</td>
<td>-2.0 or less</td>
<td>0 to 2</td>
</tr>
</tbody>
</table>
Assessment Tools

Quantitative Data
- Meteorological/climatic (temp/precip)
- Modeled soil moisture
- Streamflow levels
- Groundwater levels
- Reservoir levels
- Snowpack conditions (SWE)
- Satellite-based vegetation health/stress & fire danger
- Evaporative demand
- Palmer Drought Index
- Objective drought blends (combines various indices/indicators, e.g., Palmer Hydrologic Index, precipitation at various time scales, soil moisture)

Qualitative Data
- Impacts information/reports on the ground
- Photos
- Newspaper articles
- USDA NASS reports
Indicators & Indices

• Look at where **most** of the indicators are pointing (convergence of evidence approach). However, certain indicators may be weighted heavier based upon the region, season, climatology, & potential impacts.

• Most droughts **do not** have all the indicators in agreement.

• Reported **impacts** help to paint a clearer picture.

• **Less indicators** available for Alaska.
Convergence of Evidence Approach

Indices:
- SPI/PDSI
- Precipitation
- Snowpack
- Expert Local Input
- Soil Moisture
- Streamflow Reservoirs
- Remote Sensing
Drought Monitoring Challenges for Alaska

- **Very large spatial extent** (~660,000 sq. miles), **complex terrain** (coastlines, mountains) and associated high degree of spatial variability in weather/climate

- **Low** station density

- **Less data** products available as compared to the Lower 48

- **Limited** drought impacts reporting

- **What does drought look like in Alaska?**
  In a temperate rainforest ecosystem (SE AK) that receives 150+" of precipitation? Potential new impacts in a warming climate?

- **How does drought affect ecosystems** (fisheries, wildlife migrations, forest health) in AK and how do we integrate it into our assessments?
Alaska Weather & Climate Data Sources

- **Observational** - NWS COOP, ASOS/AWOS, RAWS, NPS RAWS, SNOTEL, CoCoRaHS
- **Climate data products** - HPRCC, WRCC (~60 long-term stations), Climate Engine, NOAA NCEI, ACCAP
- **NRCS SNOTEL** - ~49 stations (numerous w/ short records), snowcourse
- **Soil Moisture** - NASA SPoRT
- **Remote Sensing** - Climate Engine (NASA MODIS & Landsat (NDVI))

![Map of Alaska with data sources]

- [Video of precipitation analysis]
- [Map of Alaska climate data sources]
- [Graph of NDVI percent of average (MODIS Terra Daily)]
- [Map of 0-40 cm soil moisture percentile (04 Feb 2021)]
Alaska Weather & Climate Data Sources

- NWS COOP stations
- RAWS stations
- HPRCC ACIS SPI
- NRCS SNOTEL SWE
- Percent of Average Precipitation (%) 1/11/2021 – 2/9/2021
- WRCC ACIS PNP
- WRCC ACIS
• Since 2000, the longest duration of drought in Alaska lasted 79 weeks (7/17/18 to 1/14/20)
• Most intense period (9/27/19), 1.5% of the state in D3.
Hemlock sawfly outbreak in SE Alaska in 2018 & spruce beetle outbreaks in the mid-90's in Southcentral SE Alaska – Ketchikan, Prince of Wales Island, Wrangell Island, and other locations

Impacts – water restrictions/shortages, hydro-power disruptions, low streamflows, fish kills, threats to forest health, increased fire danger, increased electricity costs

Potential Drought Impacts - Alaska

D0 - Abnormally Dry
- Some lingering water deficits
- Hydro-power conservation efforts to mitigate economic impacts

D1 - Moderate Drought
- Reservoirs/hydro-power limitations; wells low, water shortages imminent
- Recreation and fish migrations affected by low stream
- Increased threat to forest health (pest/insect)
- Fish hatcheries affected, increased wildlife

D2 - Severe Drought
- Drinking water shortages common
- Water-use restrictions imposed (seafood processing plants, watering plants)
- Fish kills (low flow, high water temps)
- Significant reduced hydro-power generation

D3 - Extreme Drought
- Widespread water shortages or restrictions
- No hydro-power generation
- Widespread fish kills
- Drought emergency declaration

D4 - Exceptional Drought
- Shortages of water in streams and wells creating water emergencies
- Widespread no hydro-power generation
- Drought disaster declaration

Source(s): NDMC, NOAA, USDA

Image credit: https://droughtmonitor.unl.edu/Data/StateImpacts.aspx
Drought Impact Reporting

https://droughtreporter.unl.edu/map/
Drought Impact Reporting - CMOR

Condition Monitoring Observer Reports on Drought (CMOR-Drought)

- NDMC, USDA Climate Hubs, & NOAA NIDIS
- Effort to work with states, tribes, and others to collect info on how drought is affecting you
- https://go.unl.edu/cmor_drought
Potential Drought Impacts

- Alaska

Image credit: Juneau Empire 6/12/18

http://highlights.accap.uaf.edu/tools/climate_highlights#date/2021-01

SE Alaska – Ketchikan, Prince of Wales Island

Hemlock sawfly outbreak in SE Alaska in 2018

https://universityofne.maps.arcgis.com/apps/MapSeries/index.html?appid=cc2ff32fb53d44976a3f781839ddf7d4

Drought Impact Reporting

https://universityofne.maps.arcgis.com/apps/MapSeries/index.html?appid=cc2ff32fb53d44976a3f781839ddf7d4
Drought Impacts Reporting – CoCoRaHS

Partly to mostly cloudy and cold with a light breeze and light flurries at the end of the observation period. The high temperatures were around sixty-nine degrees and the low around nine degrees Fahrenheit. Songbirds are eating consciously. Snowcrashes are hazardous due to ice. Field work is difficult in some areas due to drifting.

Silver Springs DOAP
Set Feb 13 2021
Weekly precipitation: 0.2" with only 0.2" total on ground. Unusual for high February. Snow is eating everything and everything is blooming. Day seven of subzero stretch. Another week of cold. Smaller Creek running low.

Austin S.4 W
Set Feb 13 2021
Cold. Mostly with snow covering most of the yard. Comment less for plants. Temperatures in the morning are still in the teens. We turn the heat down at night.

https://www.cocorahs.org/Maps/conditionmonitoring
USDM Map Creation & Timeline

- **Thursday, Friday, and over the weekend** – ramp up looking at indicators, obtain Dx shapefiles, look at 5-day forecast, review transition email from the previous week’s author, & address lingering issues

- **Monday** – Draft #1 goes out, respond to emails, and various coordination calls

- **Tuesday** – respond to emails from contributors, more conference calls, & input verification. Data cutoff is 8 a.m. Draft #2/3 goes out

- **Wednesday** – author responds to final comments. Author writes narrative for each region. Final map goes out to the USDM listserv. Final GIS files sent out to NDMC and NOAA CPC for processing

- **Thursday** - final map and narrative are released at 7:00 a.m. (ET) every Thursday
Data Analysis & Map Creation

- Map created in ESRI ArcMap GIS software (geospatial processing software)
- Transitioning to ESRI ArcPro in 2022
- Data – dozens of datasets are pulled into ArcMap
- Data – centralized GIS data repository at NDMC in 2021

Data Analysis – Begins with pulling the latest Dx shapefiles into ArcMap.
Data Analysis – Overlay the NWS Advanced Hydrologic Prediction Service (AHPS) 7-day observed precipitation totals over the Dx layers and identify “areas of interest”
Data Analysis – Overlay radar beam coverage (at or below 10,000 ft AGL) layer to help verify the radar data
Data Analysis – Zoom in to take a closer look and add other spatial layers (towns/cities, administration boundaries, roads, shaded relief) to provide context.
Data Analysis – Add other indices (SPI – Standardized Precipitation Index) to see how the precipitation event impacted the numbers at various time scales.
Data Analysis – Add streamflow layers at various time scales (real-time, 7, 14, 28-days averages)

Percentile ranking

Gauging station
Data Analysis – add VHI layer (seasonally) to check vegetative health/rangeland conditions
Data Analysis – start editing the drought polygons as needed

Most droughts **do not** have all the indicators in agreement
During a typical shift, email traffic is very heavy with 100's of emails in addition to numerous coordination calls with state & regional drought coordination teams.

Contributor inputs come in many forms.
Final Steps - Weekly Narrative

- Written Wednesday morning after the map is completed
- Describes the significant weather events of the week, provides an overview of the regional changes on the map & drought impacts, and what to expect weather-wise for the week ahead
- Final step for the USDM author

National Drought Summary for December 8, 2020

Summary
This U.S. Drought Monitor week saw intensification of drought across parts of the western U.S., including California, Nevada, and Colorado where precipitation has been below normal since the beginning of the Water Year (Oct. 1). In California, statewide snow water content (SWE) is currently at 36% of the historical average for the date (Dec. 7) and Water Year to Date (WYTD) precipitation (statewide) is ranging from the bottom 10% to the bottom 33% with some areas in the Mojave Desert experiencing the driest on record for the period. According to NOAA’s National Centers for Environmental Information (NCEI), the 6-month period from June to November 2020 was the hottest and driest on record for both Arizona and California. Current snowpack conditions across the Western US are generally reflective of a La Niña-like precipitation pattern with the mountain ranges in the Pacific Northwest and some areas of the northern Rockies observing near normal to above-normal snowpack conditions. Further south in the Four Corners states, basin-wide drought conditions SWE is below normal in nearly all drainage basins in the region. Elsewhere on this week’s map, areas of Texas including the Panhandle and central Texas saw some minor degradation in conditions where both long and short-term precipitation deficits exist. In the Northern Plains, unreasonably warm temperatures and dry conditions continued this week leading to intensification of drought conditions in North Dakota where statewide precipitation for the September-November 2020 period ranked 3rd driest on record, according to NOAA NCEI. In New England, drought-related conditions significantly improved in response to heavy rains and snow associated with a nor'easter that impacted the region during the weekend. The storms delivered heavy rains and strong winds to coastal areas as well as heavy snowfall in the mountains of New Hampshire and northern Maine.

Alaska, Hawaii, and Puerto Rico

On this week’s map, no changes were made in the Hawaiian Islands. Across the island chain, dry conditions prevailed during the past week except for some light rainfall accumulations (less than 2 inches) on the windward side of the Big Island in the North Hilo and Hamakua districts. Average temperatures for the week ranged from 1 to 4 degrees F above normal with the greatest departures observed on the Big Island and Molokai. For the month of November, rainfall totals were as follows: Hilo AP—18.70 inches (121% of normal), Kona AP—0.95 inches (23% of normal), Kahului AP—0.25 inches (11% of normal), Molokai AP—0.68 inches (21% of normal), Honolulu AP—0.16 inches (7% of normal), and Lihue AP—5.19 inches (116% of normal). In Alaska, average temperatures for the week were well above normal (10 to 16 degrees F) on the North Slope, eastern-central Interior, and in the Panhandle while temperatures were 2 to 4 degrees F below normal across Southcentral and 6 to 12 degrees F below normal in Southwest Alaska. On the map, areas of Abnormally Dry (D0) were removed on the Kenai Peninsula and in parts of Southcentral where precipitation has been above normal during the last 30-day period. On the Kenai Peninsula, nearly all SNOWTELL stations are reporting above-normal SWE with stations ranging from 71% to 236% of normal on Dec 7. Additionally, two areas of Abnormally Dry (D0) were added in the vicinity of the Wrangell Mountains and north of the Alaska Range near Ft. Greely in the interior where SNOWTELL stations at both locations are reporting below-normal SWE. In Puerto Rico, areas of Abnormally dry (D0) expanded in response to below-normal precipitation during the past 30-day period and low streamflows.
Thursday Morning Map Release

- Map released every **Thursday** morning at 7 a.m. EST
- Authors respond to emails and calls regarding changes on the map & respond to media interview requests
- Write our transition email for the next author to provide continuity
- Then, the process starts over again (52 weeks a year)

USDAM Website - http://droughtmonitor.unl.edu/
Thank You!

Questions or comments?

Contact: dave.simeral@dri.edu