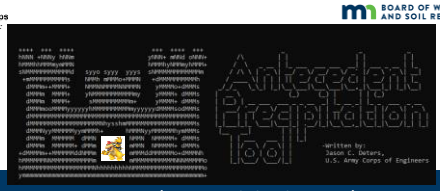
US Army Corps of Engineers

BOARD OF WATER AND SOIL RESOURCES



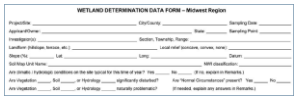
Antecedent Precipitation Tool

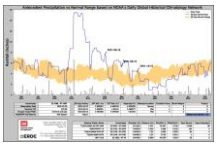
Ben Meyer (BWSR) & Marissa Merriman (USACE)

1

October 22, 2024 Agenda

- Introduction & Overview
- Background of APT
- User Guide
  - WebWIMP
- Group Exercise





2

Resources

- https://bwsr.state.mn.us/wetland-training-opportunities

3

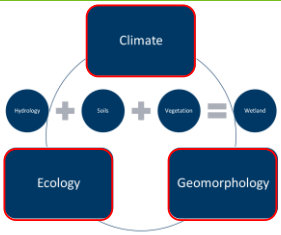
Resources

MWPCP Class Portal

4

Factors

- Overarching factors that determine much of the condition of an area
- Examples:
  - Climate determines antecedent precipitation
  - Ecology determines dominate plant communities
  - Geomorphology determines landscapes and soil parent material



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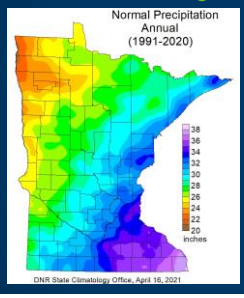
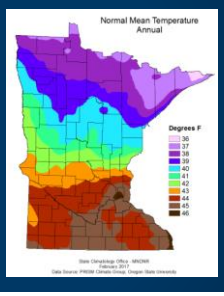
Climate- long term weather pattern of an area





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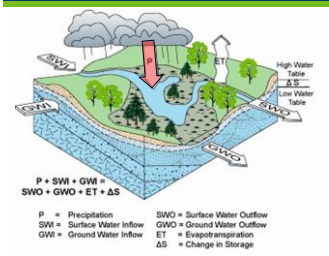
Hydrology



- Inputs
  - Precipitation
  - Surface water inflow
  - Groundwater inflow
- Outputs
  - Surface water outflow
  - Groundwater outflow
  - Evapotranspiration

7

Wetland Hydrology

1987 Corps Manual: "*The sum total of wetness characteristics in areas that are inundated or have saturated soils for a sufficient duration to support hydrophytic vegetation.*"

Regional Supplements: "*Wetland hydrology indicators are used in combination with hydric soil and hydrophytic vegetation to determine whether an area is wetland under the Corps manual.*"

8

Hydrology Technical Standard

…"inundated or saturated by surface or ground water at a frequency and duration"

Technical standard if hydrology indicators not observed:

- 14 or more consecutive days of flooding or ponding;
- Water table 12 in. or less below soil surface;

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Hydrology Indicators

- Regional Supplements: "…indicators involving direct observation of surface water or saturated soils often are present only during the NORMAL wet portion of the growing season and may be absent during the dry season or during drier-than-normal years."

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Guidance

St. Paul District REGULATORY
US Army Corps of Engineers®
Minnesota Board of Water & Soil Resources

March 4, 2015

Guidance for Submittal of Delineation Reports to the St. Paul District Army Corps of Engineers and Wetland Conservation Act Local Governmental Units in Minnesota, Version 2.0

3.7.6 Using Aerial Imagery to Assess Wetland Hydrology

Procedures have been updated and improved for the assessment of wetland hydrology based on aerial imagery. The interagency approach to off-site wetland determinations on agricultural lands (also referred to as the state "~~Mapping Conventions~~") is **required** for CWA and WCA purposes. Refer to the guidance

Guidance for Offsite Hydrology

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Guidance

US Army Corps of Engineers®
St. Paul District

Minnesota Board of Water & Soil Resources

July 1, 2016

Guidance for Offsite Hydrology/Wetland Determinations

This document replaces all previous Minnesota Board of Water and Soil Resources (BWSR) and St Paul

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Recording on Data Sheet

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ ~~Iron Deposits (B5)~~
- ⚠ ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ ~~Crayfish Burrows (C8)~~
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes_____ No_____ Depth (inches):

Water Table Present? Yes_____ No_____ Depth (inches):

Saturation Present? (includes capillary fringe) Yes_____ No_____ Depth (inches):

Wetland Hydrology Present? Yes_____ No

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

2016 Joint Guidance for Offsite Hydrology was used.

Remarks:

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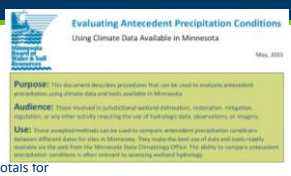
Other methods

- **Three-Prior Month Method**
  - Using State Climatology Tool
  - Manual Completion
- **Thirty Day Rolling Total**
  - Summing the prior 30-day precipitation totals for each day and plotting this "rolling total" on a daily basis
- **Hybrid Method**
  - Essentially combines above methods


Evaluating Antecedent Precipitation Conditions

Using Climate Data Available in Minnesota

May, 2015

Purpose: This document describes procedures that can be used to evaluate antecedent precipitation using climate data and tools available in Minnesota.

Audience: Those involved in jurisdictional wetland delineation, restoration, mitigation, regulation, or any other activity requiring the use of hydrologic data, observations, or imagery.

Use: These accepted methods can be used to compare antecedent precipitation conditions between different dates for sites in Minnesota. They make the best use of data and tools readily available via the web from the Minnesota State Climatology Office. The ability to compare antecedent precipitation conditions is often relevant to assessing wetland hydrology.

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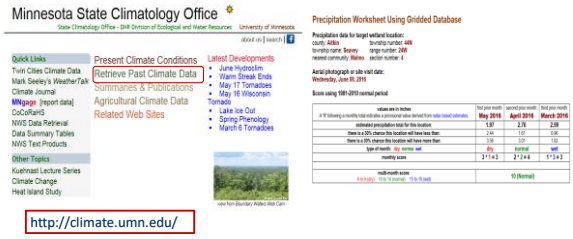
With the State Climatology Tool


Minnesota State Climatology Office

State Climatology Office - DNR Division of Ecological and Water Resources | University of Minnesota

about us | search |

Quick Links

Twin Cities Climate Data

Mark Seeley's WeatherTalk

Climate Journal

MNgage [report data]

CoCoRaHS

NWS Data Retrieval

Data Summary Tables

NWS Text Products

Other Topics

Kuehnast Lecture Series

Climate Change

Heat Island Study

Present Climate Conditions

Retrieve Past Climate Data

Summaries & Publications

Agricultural Climate Data

Related Web Sites

Latest Developments

- June Hydrostm
- Warm Streak Ends
- May 17 Tornadoes
- May 16 Wisconsin Tornado
- Lake Ice Out
- Spring Phenology
- March 6 Tornadoes

view from Boundary Waters Web Cam

Precipitation Worksheet Using Gridded Database

Precipitation data for target wetland location:

county: Aitkin township number: 44N

township name: Seavey range number: 24W

nearest community: Wainio section number: 4

Aerial photograph or site visit date:

Wednesday, June 03, 2015

Score using 1981-2010 normal period

values are in inches	3rd prior month	second prior month	Prior month
A "R" following a monthly total indicates a provisional value derived from radar-based estimates.	May 2016	April 2016	March 2016
estimated precipitation total for this location:	1.87	2.78	2.08
there is a 30% chance this location will have less than:	2.44	1.65	0.96
there is a 30% chance this location will have more than:	3.56	3.91	3.02
type of month: dry, normal, wet	dry	normal	wet
monthly score	3 * 1 = 3	2 * 2 = 4	1 * 3 = 3
multi-month score (1 to 3 dry, 4 to 6 normal, 7 to 9 wet)	10 (Normal)		

http://climate.umn.edu/

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Precipitation Analysis - Farmington MN 6/15/15

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Hydrology Indicators

Evidence that there is continuing hydrology and confirms that an episode of inundation/saturation occurred recently.

Wetland hydrology indicators are divided into two categories:

Primary – provide stand-alone evidence of a current or recent hydrologic event; and

Secondary – provide evidence of recent hydrology when supported by one or more other hydrology indicators.

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Hydrology Indicators

Wetland Hydrology Indicators

- Inundation visible on aerial imagery
- Saturation visible on aerial imagery
- Surface water
- Saturation
- Dry-season water table

MUST ALL BE PLACED IN THE CONTEXT OF ANTECEDENT PRECIPITATION!!!

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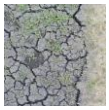
Hydrology Indicator Groups

Group A – direct observation of *water*



Group B – evidence of *flooding/ponding*

Group C – evidence of *current or recent saturation*.

Group D – *Landscape and veg. characteristics* that indicate contemporary wetland conditions.

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B7: Inundation on aerial imagery

Category: Primary

One or more* recent aerial photographs or satellite images that show the site to be inundated during the growing season.

* Use Off-site Guidance Methods.

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C2: Dry season water table

Category: Secondary

Visual observation of the water table between 12 and 24 in. (30 and 60 cm) below the surface during the normal dry season or during a drier-than-normal year.

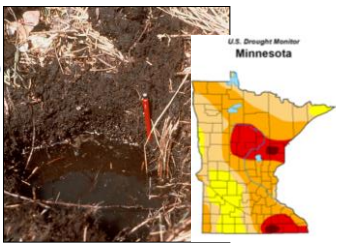
Dry Season Dates per Region:

Great Plains (F): July 1

Midwest (M): July 15

NC/NE)K): August 1

Reference: Corps of Engineers Drought Newsletter



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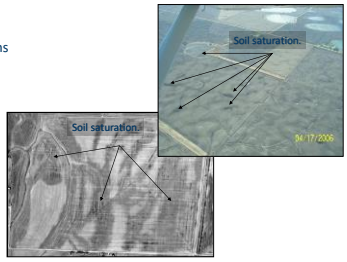
C9: Saturation visible on aerial imagery

Category: Secondary

One or more* recent aerial photographs or satellite images indicate soil saturation. Saturated soil signatures must correspond to field-verified hydric soils, depressions or drainage patterns, differential crop management, or other evidence of a seasonal high-water table.



* Use Off-site Guidance Methods.

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Two-Step Process

Step 1: Delineate Wetlands, if Present, Within a Site

Every Data Sheet

- Normal Circumstances?
- Normal Environmental Conditions?
- Disturbed (Atypical Situations)?
- Problem Area (Naturally Problematic)?

Step 2: Apply regulations, policy and guidance

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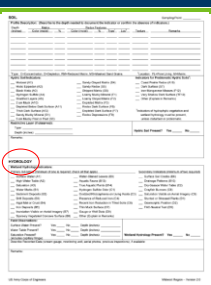
It's all about the documentation!



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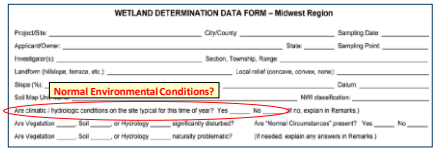
Normal Environmental Conditions vs. Normal Circumstances



WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: _____ City/County: _____ Sampling Date: _____

Applicant/Owner: _____ State: _____ Sampling Point: _____

Investigator(s): _____ Section, Township, Range: _____

Landform: (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____

Slope (%): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: _____ NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes _____ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

Normal Environmental Conditions?

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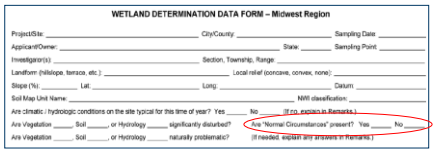
Normal Circumstances



WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: _____ City/County: _____ Sampling Date: _____

Applicant/Owner: _____ State: _____ Sampling Point: _____

Investigator(s): _____ Section, Township, Range: _____

Landform: (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____

Slope (%): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: _____ NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes _____ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

If "Yes", data collection is based on current conditions.

If "No", data collection is based on conditions that would exist in absence of recent disturbance(s).

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Problem Areas (Naturally Problematic)

- **One or more parameters are absent due to normal seasonal or annual variability, or permanently due to the nature of the soils or plant species**
  - Seasonal wetlands
  - Prairie potholes
  - Red clay parent materials
  - FACU-dominated wetlands
  - Inter-dunal swales

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Problem Areas

WETLAND DETERMINATION DATA FORM – Midwest Region

Project/Site: _____ City/County: _____ Sampling Date: _____

Applicant/Owner: _____ State: _____ Sampling Point: _____

Investigator(s): _____ Section, Township, Range: _____

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____

Slope (%): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: _____ NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes _____ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

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Problem Areas and Normal Circumstances

- **EXAMPLE:** Vernal pools are naturally dry outside of the first few weeks of the growing season
  = **Normal Circumstances**

Vernal Pool: Late Summer

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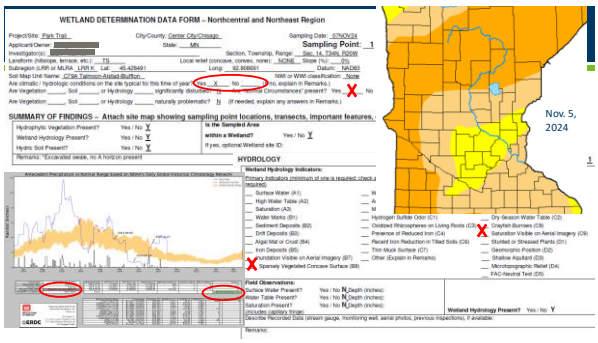

WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: Park Trail City/County: Center City/Chisago Sampling Date: 07NOV24

Applicant/Owner: [redacted] State: MN Sampling Point: 1

Investigator(s): [redacted] Section, Township, Range: Sec. 14, T34N, R20W

Landform (hillslope, terrace, etc.): TB Local relief (concave, convex, none): NONE Slope (%): 0%

Subregion (LRR or MLRA): LRR K Lat: 45.428491 Long: 92.926931 Datum: NAD83

Soil Map Unit Name: CP94 Talmoon-Alstad-Bluffton NWI classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes X No (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? N Are "Normal Circumstances" present? Yes X No

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? N (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features,

Hydrophytic Vegetation Present? Yes / No Y

Wetland Hydrology Present? Yes / No Y

Hydric Soil Present? Yes / No Y

Is the Sampled Area within a Wetland? Yes / No Y

If yes, optional Wetland site ID:

Remarks: "Excavated swale, no A horizon present

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- Surface Water (A1)
- High Water Table (A2)
- Saturation (A3)
- Water Marks (B1)
- Sediment Deposits (B2)
- Drift Deposits (B3)
- Algal Mat or Crust (B4)
- Iron Deposits (B5)
- X Inundation Visible on Aerial Imagery (B7)
- Sparsely Vegetated Concave Surface (B8)
- Hydrogen Sulfide Odor (C1)
- Oxidized Rhizospheres on Living Roots (C3)
- Presence of Reduced Iron (C4)
- Recent Iron Reduction in Tilled Soils (C6)
- Thin Muck Surface (C7)
- Other (Explain in Remarks)
- Dry-Season Water Table (C2)
- X Crayfish Burrows (C8)
- Saturation Visible on Aerial Imagery (C9)
- Stunted or Stressed Plants (D1)
- Geomorphic Position (D2)
- Shallow Aquitard (D3)
- Microtopographic Relief (D4)
- FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes / No N Depth (inches):

Water Table Present? Yes / No N Depth (inches):

Saturation Present? (includes capillary fringe) Yes / No N Depth (inches):

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Wetland Hydrology Present? Yes / No Y

Nov. 5, 2024

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Background

- From the 1987 Manual: *"Determine whether normal environmental conditions are present."*
- *"Weight of Evidence"* approach combined with BPJ

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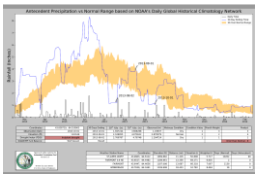
APT at-a-glance

- Combines 30-day rolling total with the NRCS Engineering Field Handbook weighting factors in an automated fashion.
- Advantages:
  - ✓ automates the process which takes it from hours to minutes
  - ✓ more accurate because the GHCN weather stations used are generally closer to observation point of interest
  - ✓ Rolling 30-, 60-, and 90- day totals instead of monthly totals
  - ✓ Uses 30-year record preceding the observation date and not the static 1970-2000 data from WETS Table.



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Data

- The precipitation data comes from local weather stations within the NOAA Global Historical Climatology Network daily precipitation dataset or the US Climate Gridded precipitation dataset
- The Global Historical Climatology Network - Daily (GHCN-Daily/GHCNd) dataset integrates daily climate observations from approximately 30 different data sources. The dataset is routinely reconstructed (usually every week) from its roughly 30 data sources to ensure that GHCNd is generally in sync with its growing list of constituent sources. During this process, quality assurance checks are applied to the full dataset. Where possible, GHCNd station data are also updated daily from a variety of data streams. Station values for each daily update also undergo a suite of quality checks.

Source: https://www.ncei.noaa.gov/products/land-based-station/global-historical-climatology-network-daily

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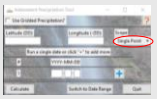
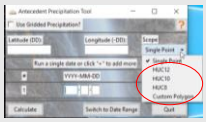
How to generate Antecedent Precipitation Score

- Single-Point Analysis
  - Typical method for wetland delineation
  - Score for single observation point (lat/long) and date (month/day/year)
  - Option to do date range or link to .csv file to run many dates at once
- Watershed Analysis
  - Developed to assist in stream jurisdictional determinations
  - Not applicable to wetland delineation
  - Score for multiple random observation points within user-defined area





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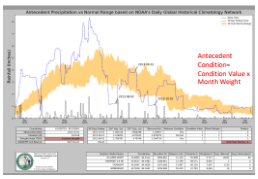
How to Read APT Output



Condition Value is a sum of the three preceding values:
Wetter than normal Value is >15
Normal= 10-15
Drier than normal=<10

- For a date or date range, a table will be generated which includes:
  - Daily total (black lines)
  - 30-day rolling total for current year (Blue line)
  - 30-year normal range (leap years have been accounted for)
  - Antecedent condition calculations (Wet=3, Normal=2, Dry=1)
  - Bottom of the orange shaded region represents the 30th percentile value
  - Top of the orange shade represents the 70th

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Single Point Analysis

- Step 1: identify the primary station
- Step 2: fill in data gaps
- Step 3: Build dataset
- Step 4: Compare 30-day rolling totals – observation date, 30 days prior, 60 days prior
- Step 5: APT output and score

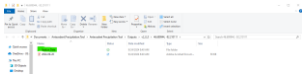

Table 1. Antecedent Precipitation Score categories derived from NRCS (1997).

Antecedent Precipitation Score (α) Range, where $n = 3$	Antecedent Precipitation Condition
Antecedent Precipitation Score < 10	Drier than Normal
10 ≤ Antecedent Precipitation Score < 15	Normal Conditions
15 ≤ Antecedent Precipitation Score	Wetter than Normal

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Primary Station Analysis

- Selects a primary weather station to pull data from. The closest weather station is NOT necessarily the primary station- The APT considers both distance from the observation point and the station's dataset completeness.
- Default - APT looks within 30-mile radius of the observation point.
- Also considers elevation data for the observation point vs. the elevation of the weather stations used.

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Primary Station Analysis

- In MN, the APT's search radius will increase in 10-mile increments up to 60 miles. The APT will use additional stations as needed to complete the 30-year record - up to 15 GHCN stations.
- Primary station needs at least 68/90 daily records and at least 6,000 historic records for 30yr period.
- If station requirements are not met for an observation point, the analysis will fail. Switch to using the Gridded Precipitation Dataset.

"Searching for primary station… No suitable primary station locations were found by the APT."

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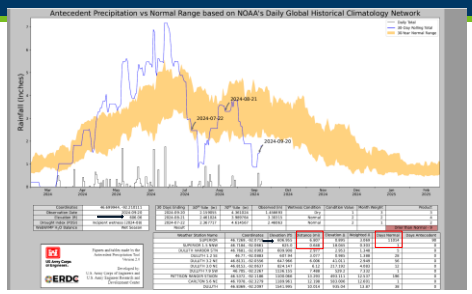
Primary station Analysis



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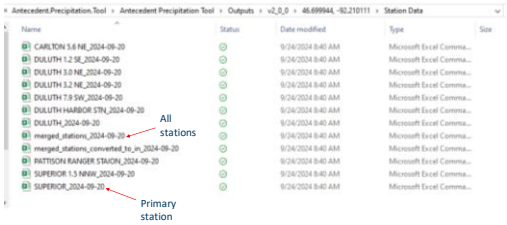
Primary station analysis



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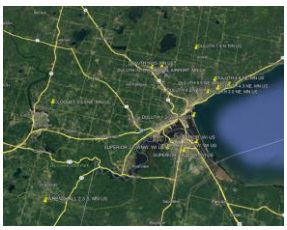
Weather Stations KMZ file

- https://gis.ncdc.noaa.gov/kml/ghcnd.kmz



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Grid-based analysis

- Quality-controlled version of GHCN station input into an interpolation algorithm that creates an initial gridded precipitation dataset.
- Dataset is preliminary until 4th day of subsequent month
- Takes observation point lat/long and finds the nearest nClimGrid-Daily grid cell centroid.

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Grid-based analysis

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Other Resources

- **WEB WIMP:** Web-based, Water-Budget, Interactive, Modeling Program
- -A product of the University of Delaware
- What it does: Tells the user if the selected location at the selected date SHOULD be in the wet season or dry season.

- **PSDI**: Palmer Drought Severity Index
- A product of the USDA
- What it does: Gives user a cumulative index estimated by calculating a water balance using observed precipitation and calculated PET

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WebWIMP

- St. Paul District does not use the WebWIMP tool to assess wet/dry seasonality. Instead, the district developed approximate dry season dates for each region based on soil survey and climatological records:
  - Great Plains: July 1
  - Midwest: July 15
  - NC/NE: August 1

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PDSI

Table 3. Palmer Drought Severity Index (PDSI) values and associated categories (adapted from Palmer [1965]).	
PDSI Range	**Range Descriptor**
PDSI = −99.99	Not available
4 < PDSI	Extreme wetness
2.99 < PDSI ≤ 4	Severe wetness
1.99 < PDSI ≤ 2.99	Moderate wetness
0.99 < PDSI ≤ 1.99	Mild wetness
0.49 < PDSI ≤ 0.99	Incipient wetness
−0.51 < PDSI ≤ 0.49	Normal
−1.01 < PDSI ≤ −0.51	Incipient drought
−2.01 < PDSI ≤ −1.01	Mild drought
−3.01 < PDSI ≤ −2.01	Moderate drought
−4.01 < PDSI ≤ −3.01	Severe drought
PDSI ≤ −4.01	Extreme drought

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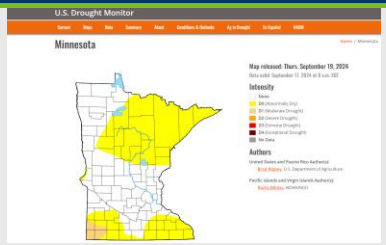
U.S. Drought Monitor



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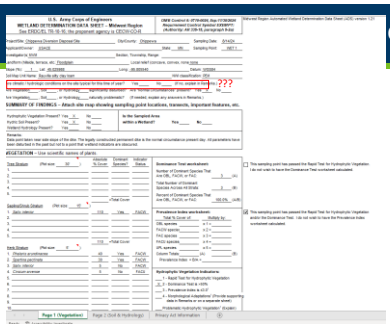
Class Exercise



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Class Exercise - Short

- Run a single-point analysis

Coordinates: 45.025988, -95.805540

Observation date: 8/14/2024

How does the primary station analysis compare to the Duluth example? (Look at the weather station KMZ file)

Why is the AP score "Normal" but the PDSI indicates "severe wetness?"

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Class Exercise - Long

- Center City, Chisago County, MN

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Class Exercise - Long

- Run analysis based on image(s) dates
- Run a single-point analysis

Coordinates: 45.429191, -92.806616

Observation dates:

- 5/28/2023
- 5/27/2021
- 6/5/2017
- 4/25/2015
- 8/2/2011
- 6/23/2010
- 6/2/2009
- 5/21/2008
- 5/31/2006

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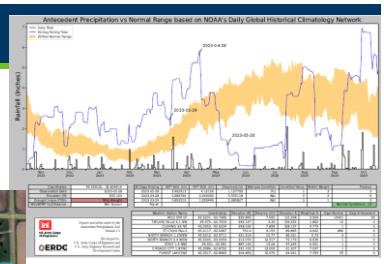
- 2023

Normal



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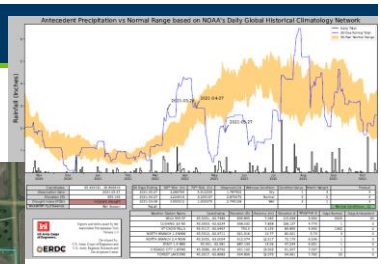
- 2021

Normal



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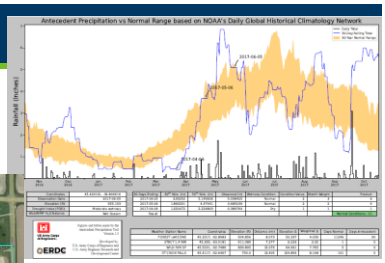
- 2017

Normal



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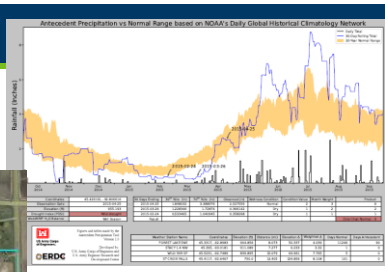
- 2015

Dry



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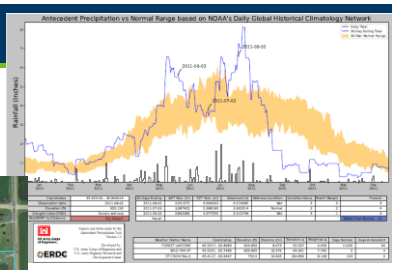
- 2011

Wet



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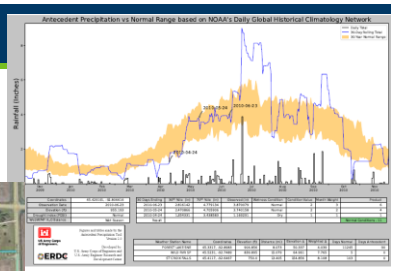
- 2010

Normal



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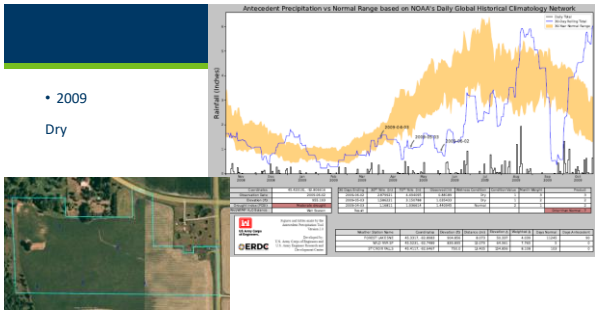

- 2009

Dry

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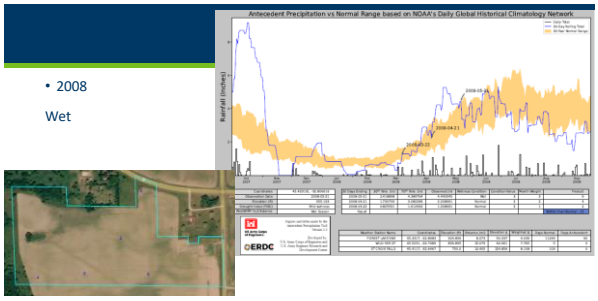

- 2008

Wet

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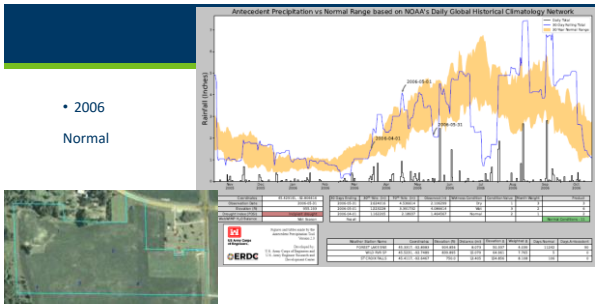

- 2006

Normal

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Class Exercise - Results

- Which method?
- Use tool, automated, recent precipitation data and 30-year climate info
- Still need to interpret data (BPJ, weight of evidence)

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