Upper Platte Basin Drought Contingency Plan

Drought Task Force Meeting #2

March 23, 2023

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Safety Moment

- Emergency exits
- Tornado shelter
- 911 caller
- CPR
- AED location
- Restrooms

Today's Agenda

I. Welcome and Introductions
II. Review of Meeting #1/Identified Drought Vulnerabilities
III. Discussion of Monitoring Protocols
IV. Vulnerabilities Discussion by Sector
V. Mitigation Actions by Sector
VI. Next Steps

Introductions

Tell us who you are! (Name, Role, Organization)

Review of Meeting 1

Held July 21, 2022

Upper Platte River Basin Planning Background

- The development of a Drought Contingency Plan for the basin was identified as key element in achieving a fully appropriated conditions as part of the 2nd increment of basin-wide Integrated Management Planning
- The Platte Basin Coalition (consisting of 5 NRDs and NeDNR) pursued and secured Bureau of Reclamation WaterSMART grant
  - Grant will cover 50% of costs

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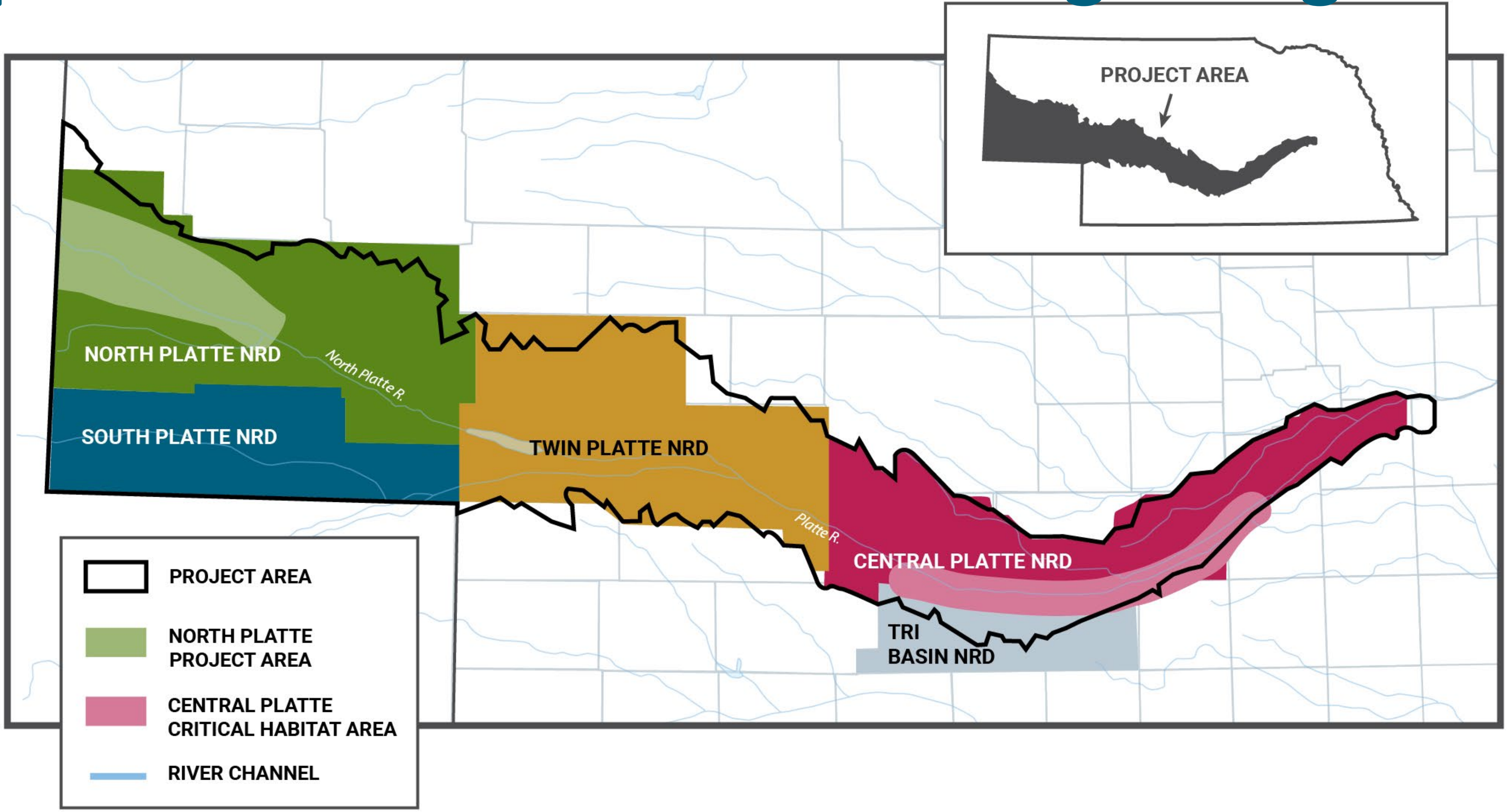
Upper Platte River Basin Planning Background



Bureau of Reclamation Drought Planning

- There are six elements to the plan development process

Establish Diverse Task Force Objectives → Develop Monitoring Plan → Conduct Vulnerability Assessment → Identify Mitigation & Response Actions → Develop Administrative Framework → Identify Plan Update Process

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Roles and Responsibilities – Drought Task Force

Drought Task Force:

- Consists of diverse group of water-related interests:
  - Agriculture
  - Environment / Wildlife
  - Financial
  - Groundwater Irrigators
  - Groundwater Users
  - Irrigation Districts
  - Municipalities
  - Public Power Districts
  - Surface Water Users
  - Recreation Users

Duties:

- Provide focused input to the plan development team
- Assist in the understanding of vulnerabilities and impacts of drought in the basin
- Provide input on potential mitigation and response actions

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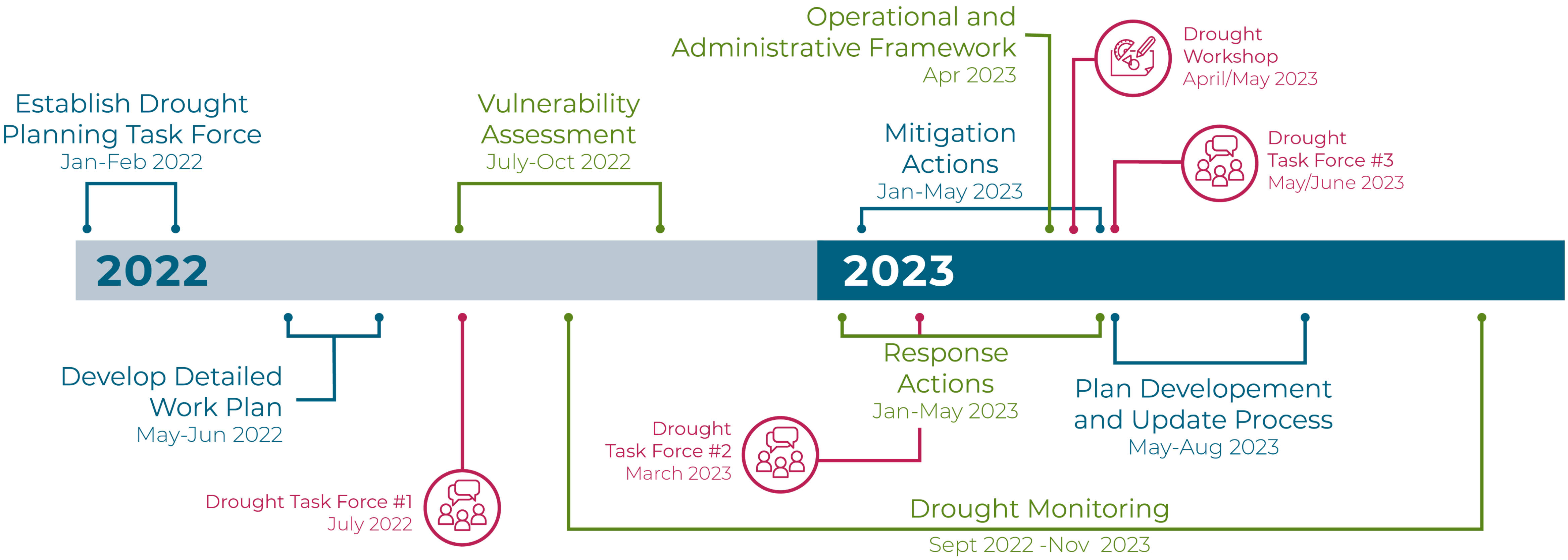
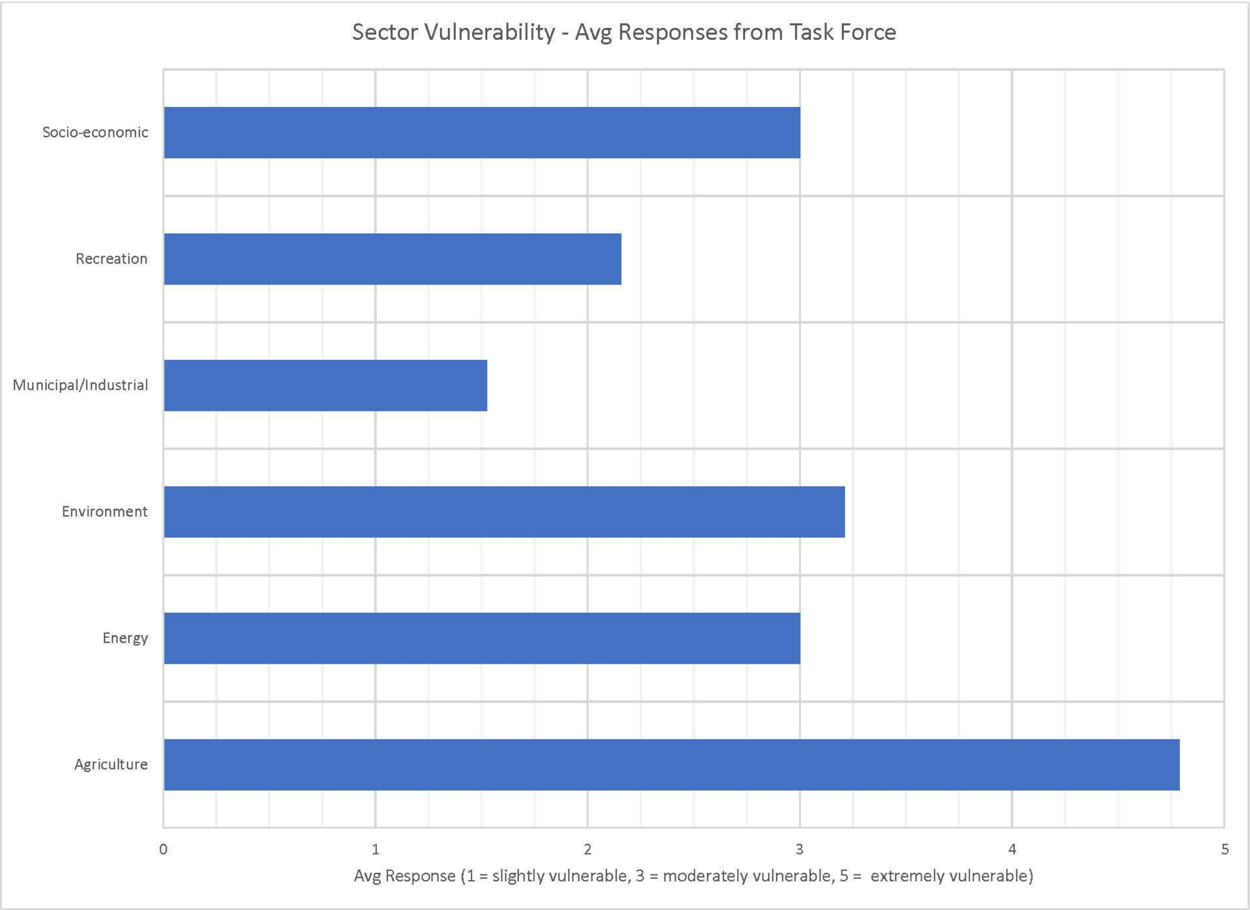
Project Timeline

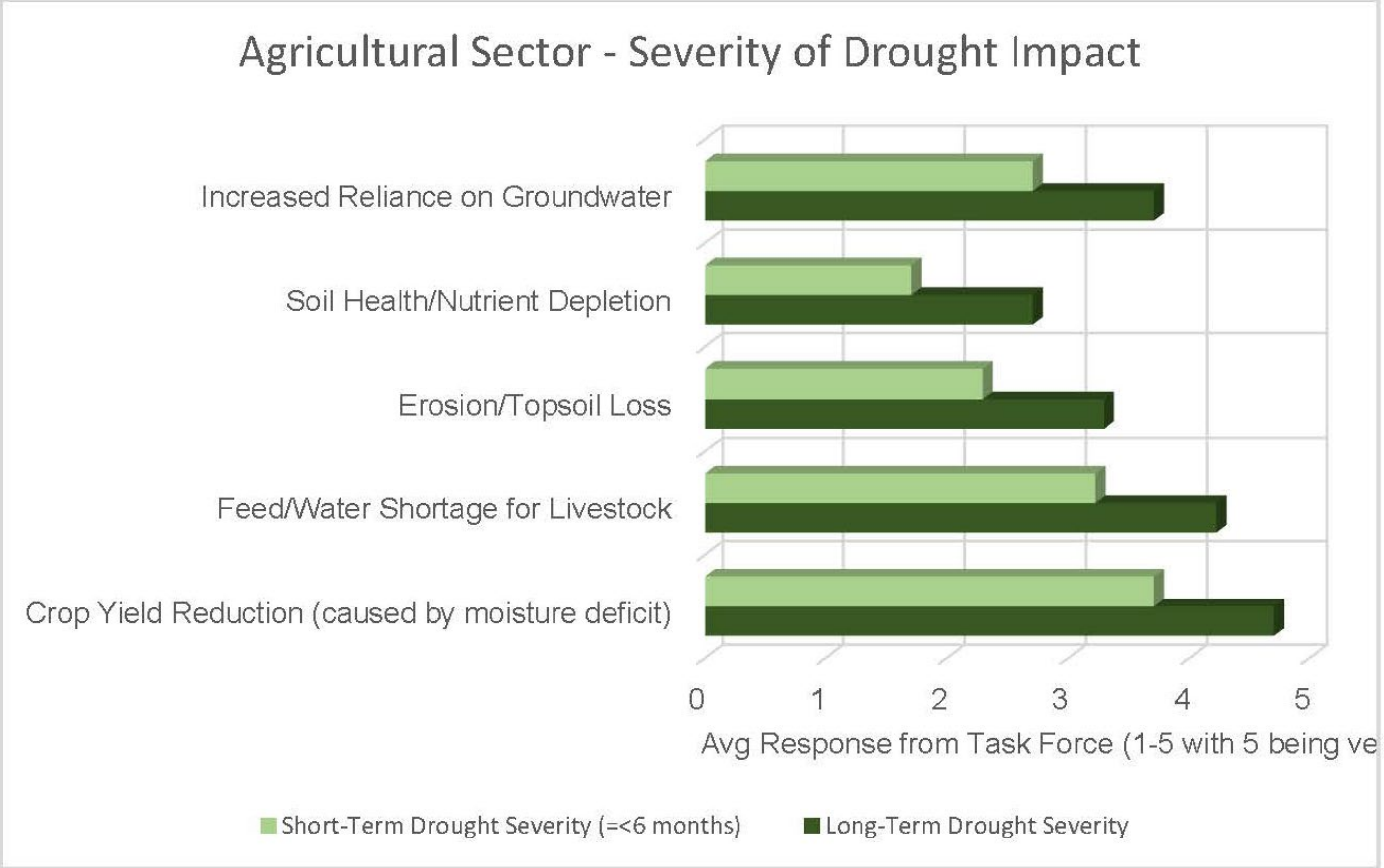


Vulnerabilities

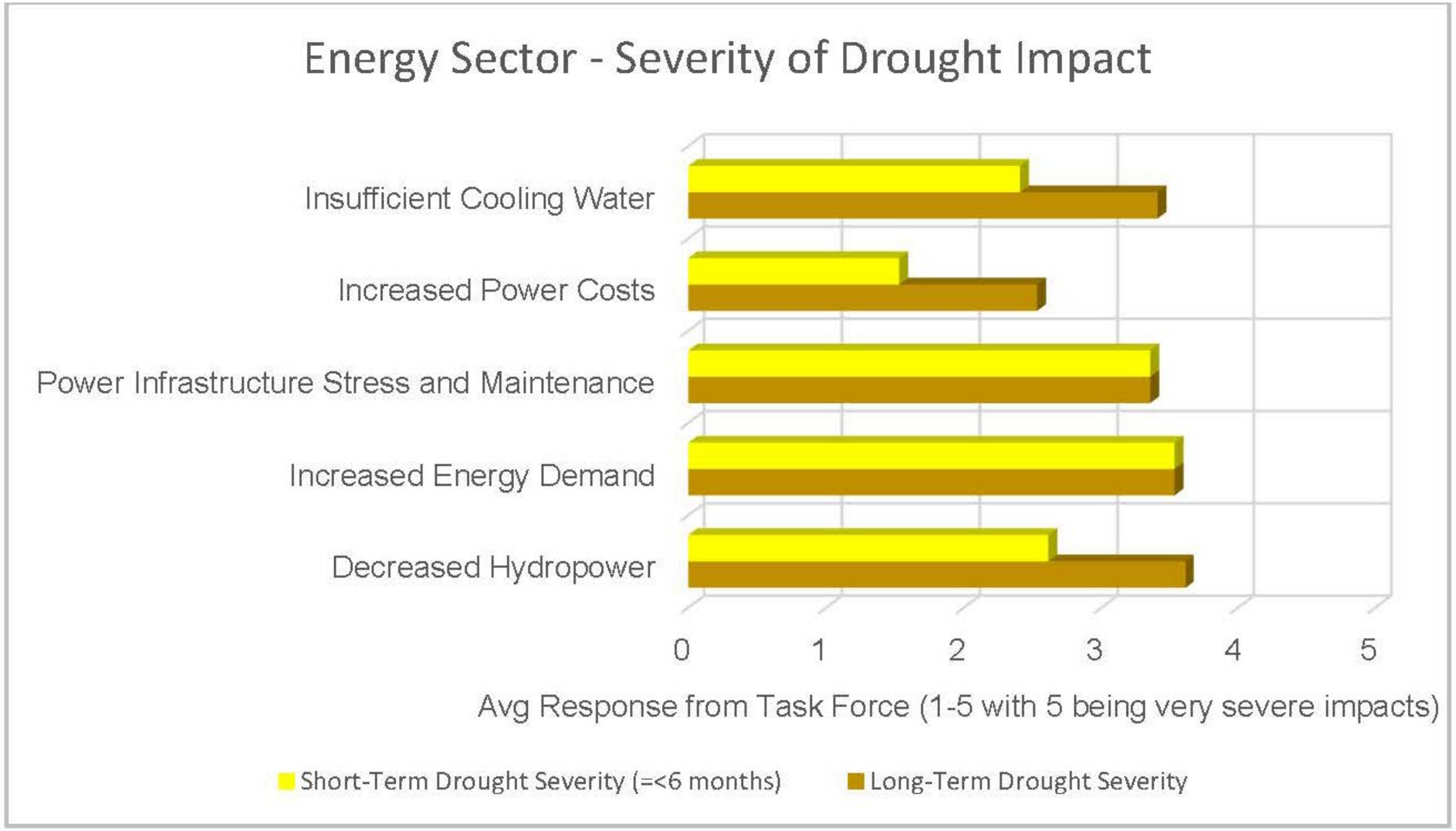
- Participants filled out worksheets asking for their feedback on the vulnerability of different sectors
- Participants were also asked for their input on the severity of impacts to each sector during short-term droughts (<6 months) versus long-term droughts



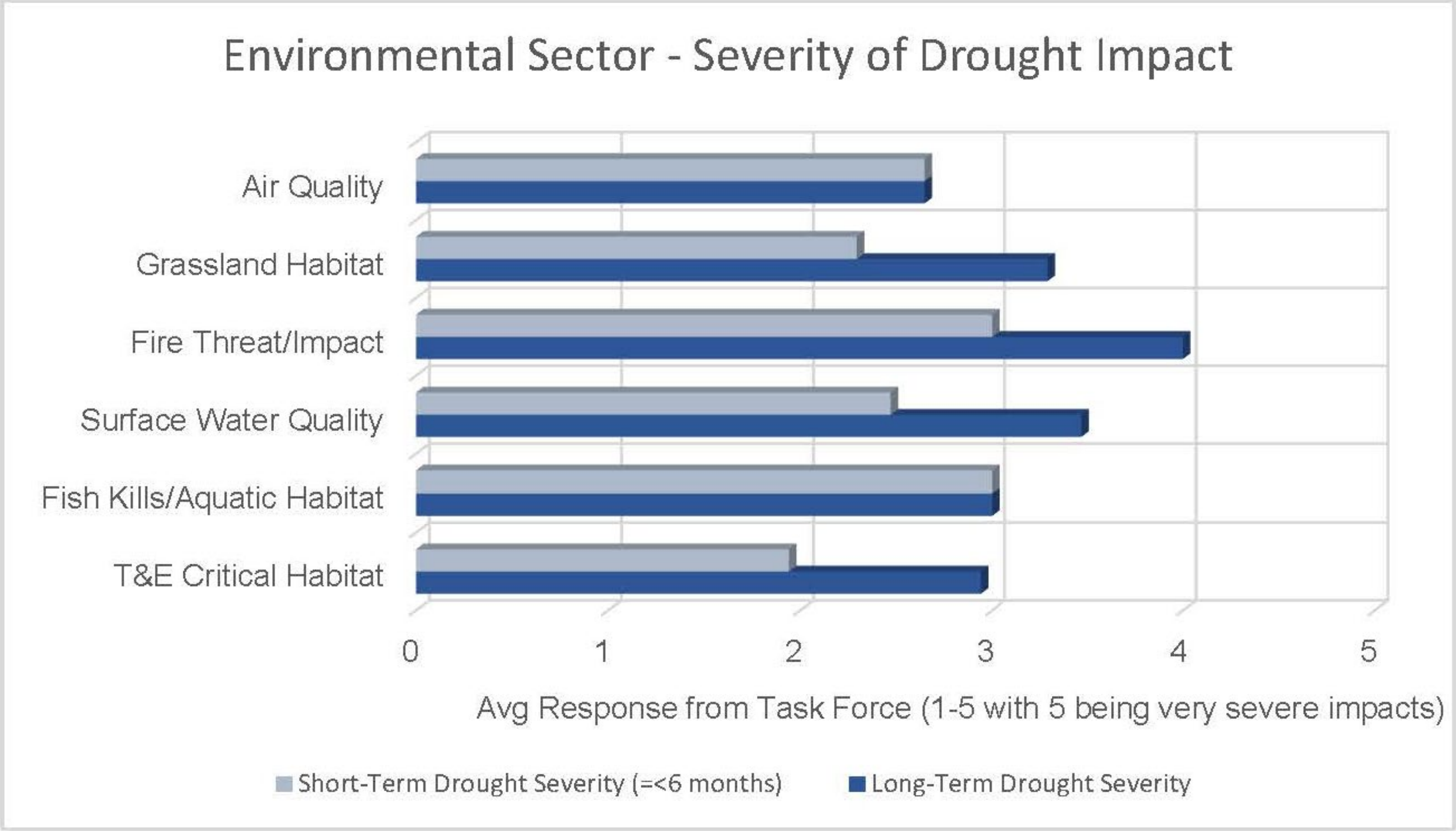
Vulnerabilities - Agriculture



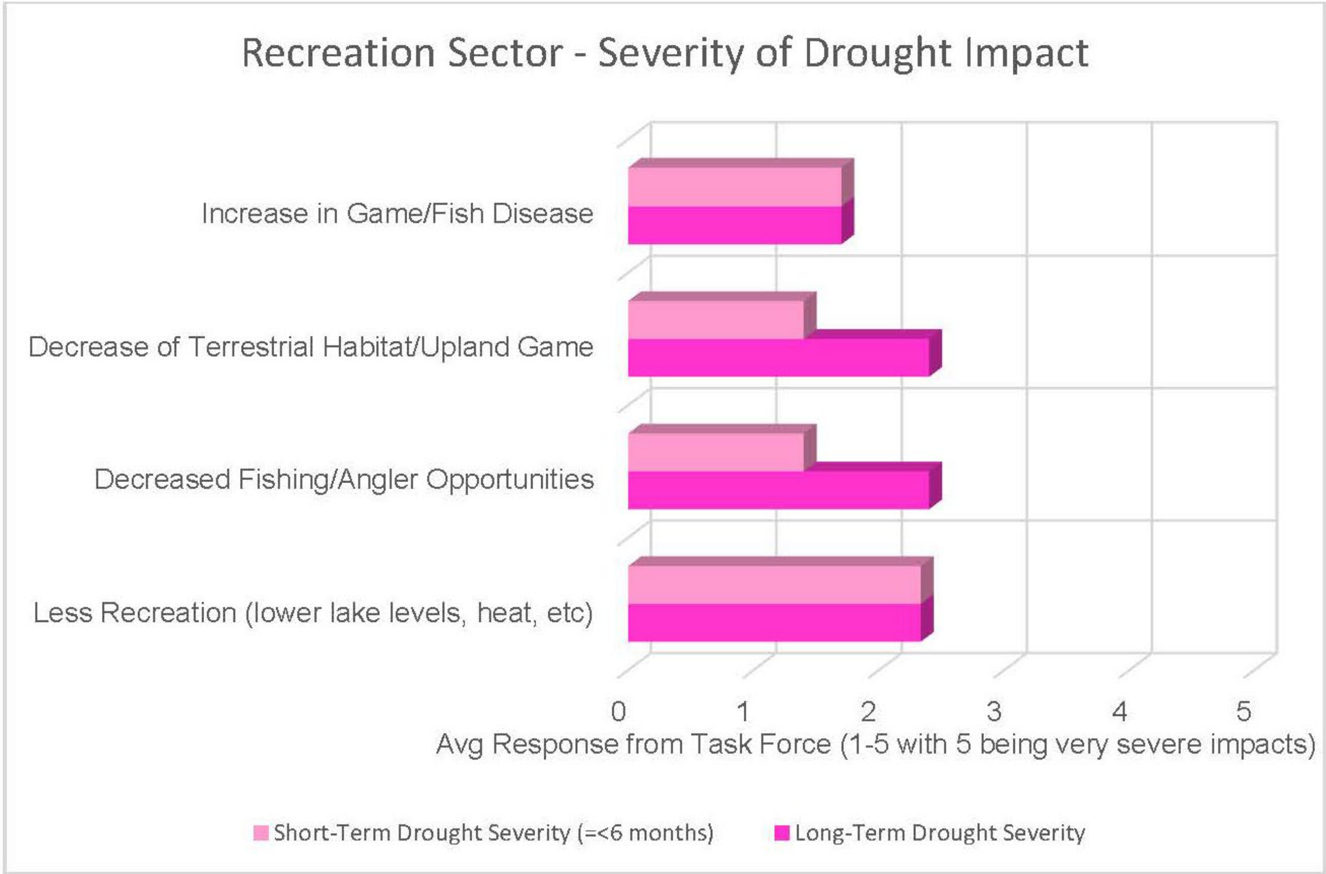
Vulnerabilities - Energy



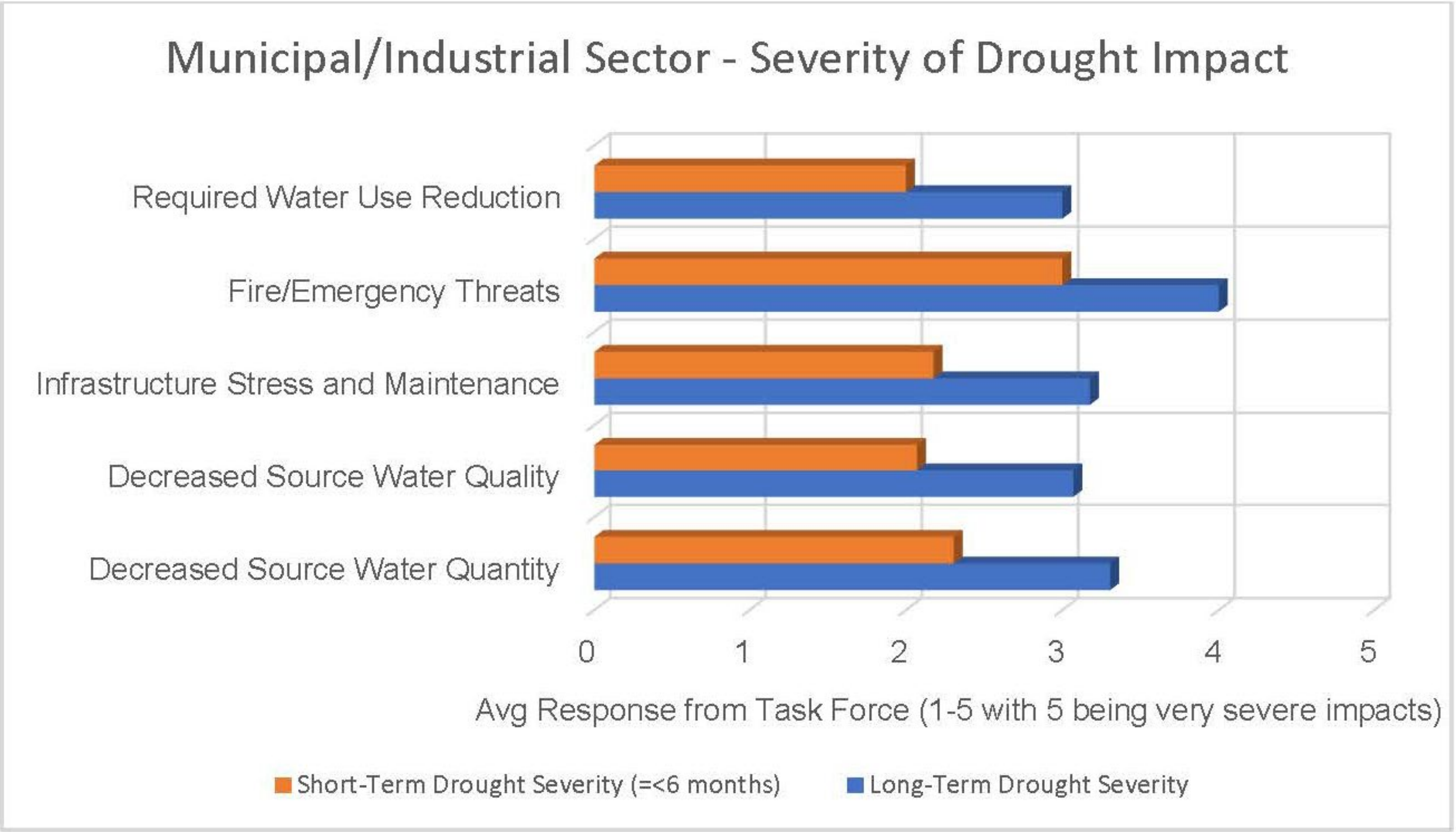
Vulnerabilities – Environmental



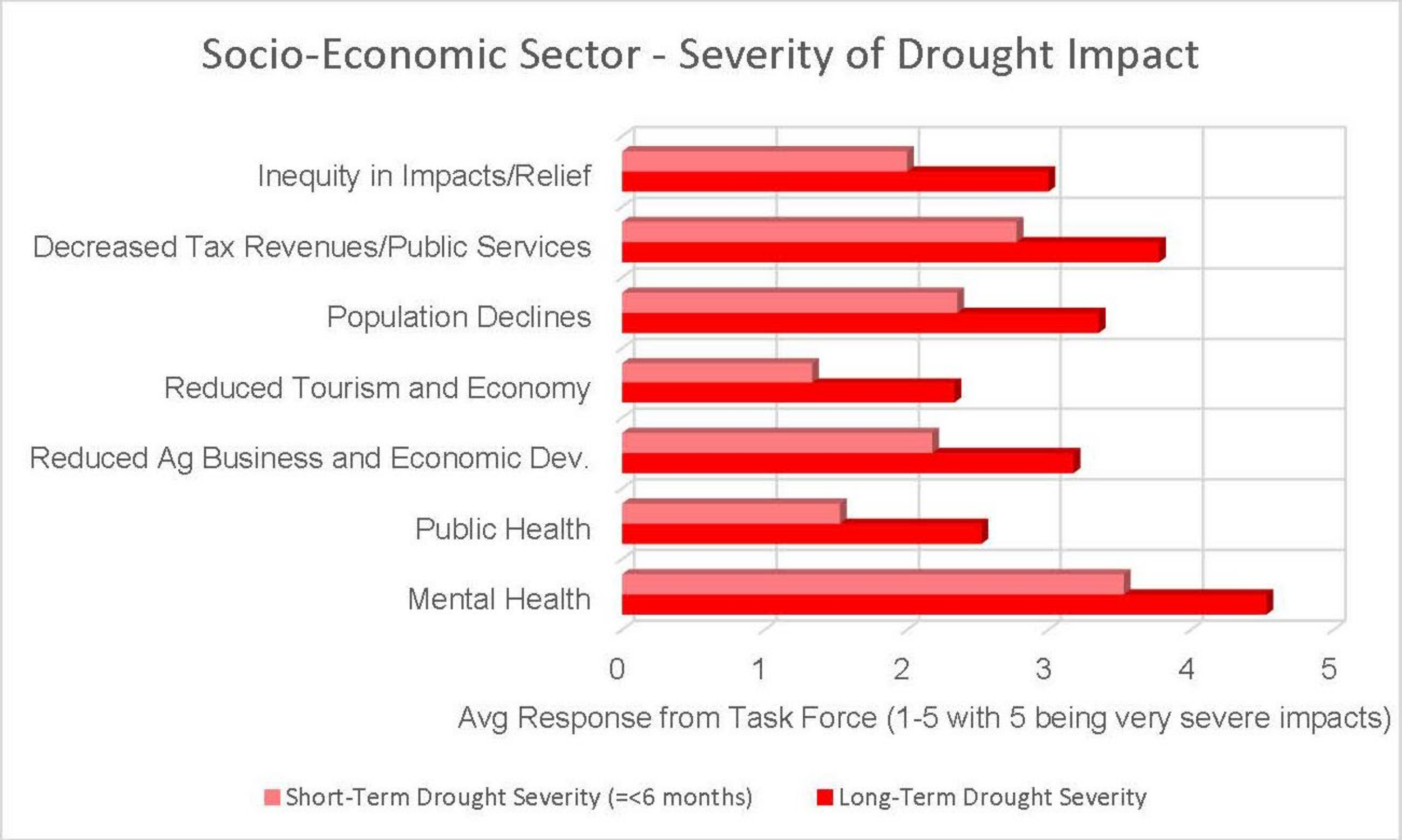
Vulnerabilities - Recreation



Vulnerabilities – Municipal / Industrial



Vulnerabilities - Socioeconomic



Drought Monitoring

Purpose

- Provide a framework to predict the probability of drought or to confirm existing drought
- Identify and define drought stages useful to stakeholders
- Collection and analysis of:
  - Water Availability
  - Precipitation
  - Other Data

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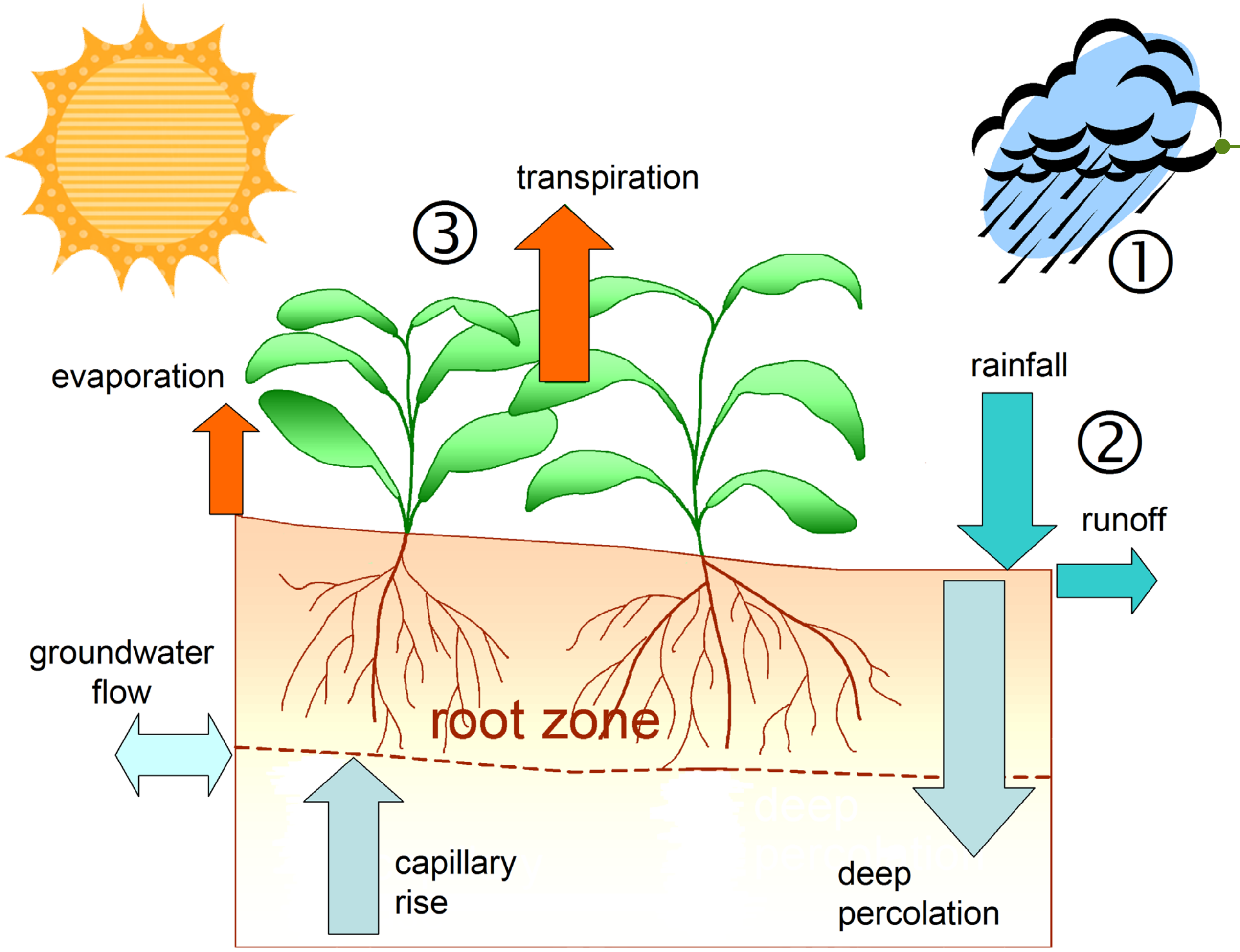
How is Drought Monitored?

- Need a means of measuring drought
  - when does a drought start / end
  - how severe is it
- Indicators (e.g., precipitation) or climate-based index
- Indices are measures of anomalies, ideally comparable across a large area and long (30-yr) period of norms
- Drought indices / indicators ***are not forecasts***
- Can show the impacts of past droughts
- Provides guidance when combined with soil moisture, reservoir levels, and weather forecasts

Example Drought Index
Standardize Precipitation Index (SPI)



Focus: Rainfall

Evaluates if rainfall is above or below normal

Timescales:

Monthly -> runoff/infiltration impacts

Multiple months -> Soil moisture

Annual -> Groundwater impacts

Uses:

Flexible and widely used

Calculated by Drought Mitigation Center

Scale:

– = Dry/Drought Conditions

0 = Normal/Average

\+ = Wet Conditions

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Drought Index/Indicator Types Considered

Indicator	Description	Timeframe	Data Source
Standardize Precipitation Index (**SPI**)	Precipitation anomaly	1 to 96 months	National Drought Mitigation Center (UNL)
Standard Precipitation Evapotranspiration Index (**SPEI**)	Precipitation minus evaporation anomaly	1 to 96 months	National Drought Mitigation Center (UNL)
Evaporative Demand Drought Index (**EDDI**)	Evaporation anomaly	1 to 12 months	NOAA Physical Scenarios Laboratory
Palmer Drought Severity Index (**PDSI**)	Precipitation minus evaporation including soil moisture capacity	Varies depending on soil	National Drought Mitigation Center (UNL)
Snow Depth and Content (**SWE**)	Maximum and average snowpack depth (NE) and SWE (WY and CO)	Monthly	NOAA National Centers for Environmental Information

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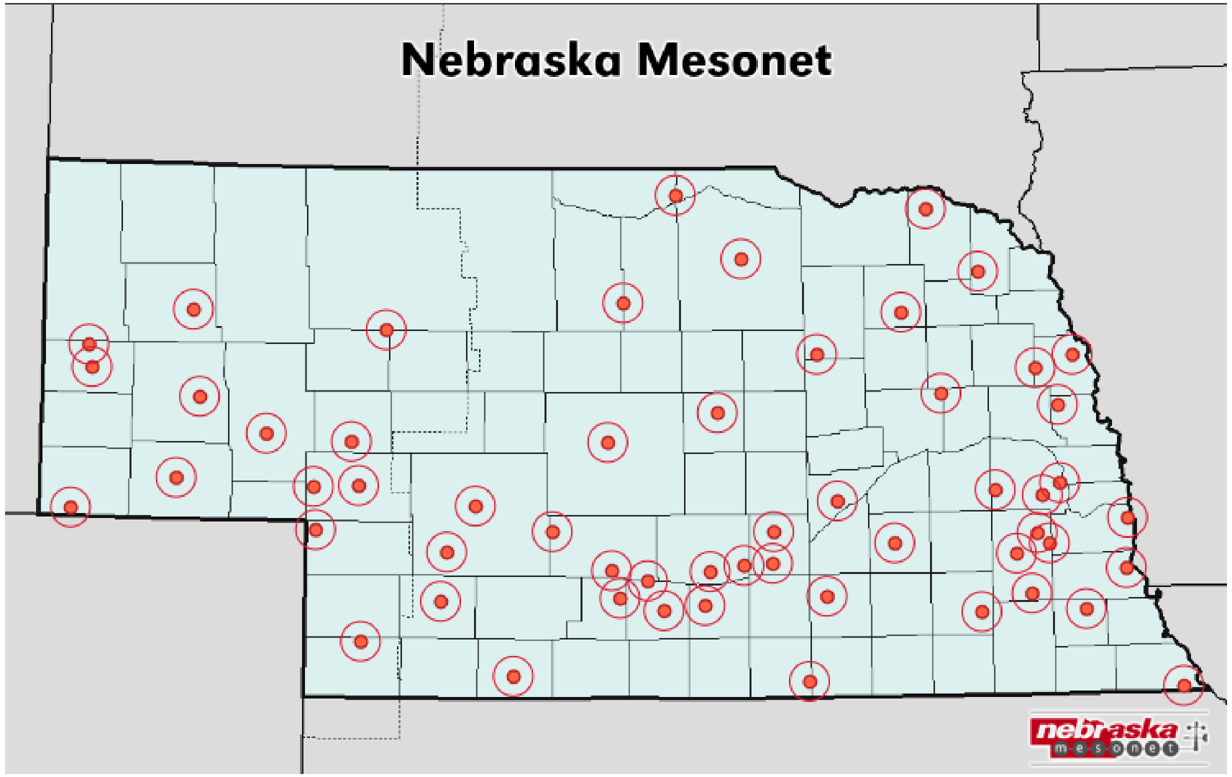
Drought Indicator Types Not Considered

- Soil Moisture
    - NRCS SCAN network has two stations in Upper Platte
    - Unclear what continued Mesonet operation looks like
    - Mesonet data is “real-time” and may need access to past months.



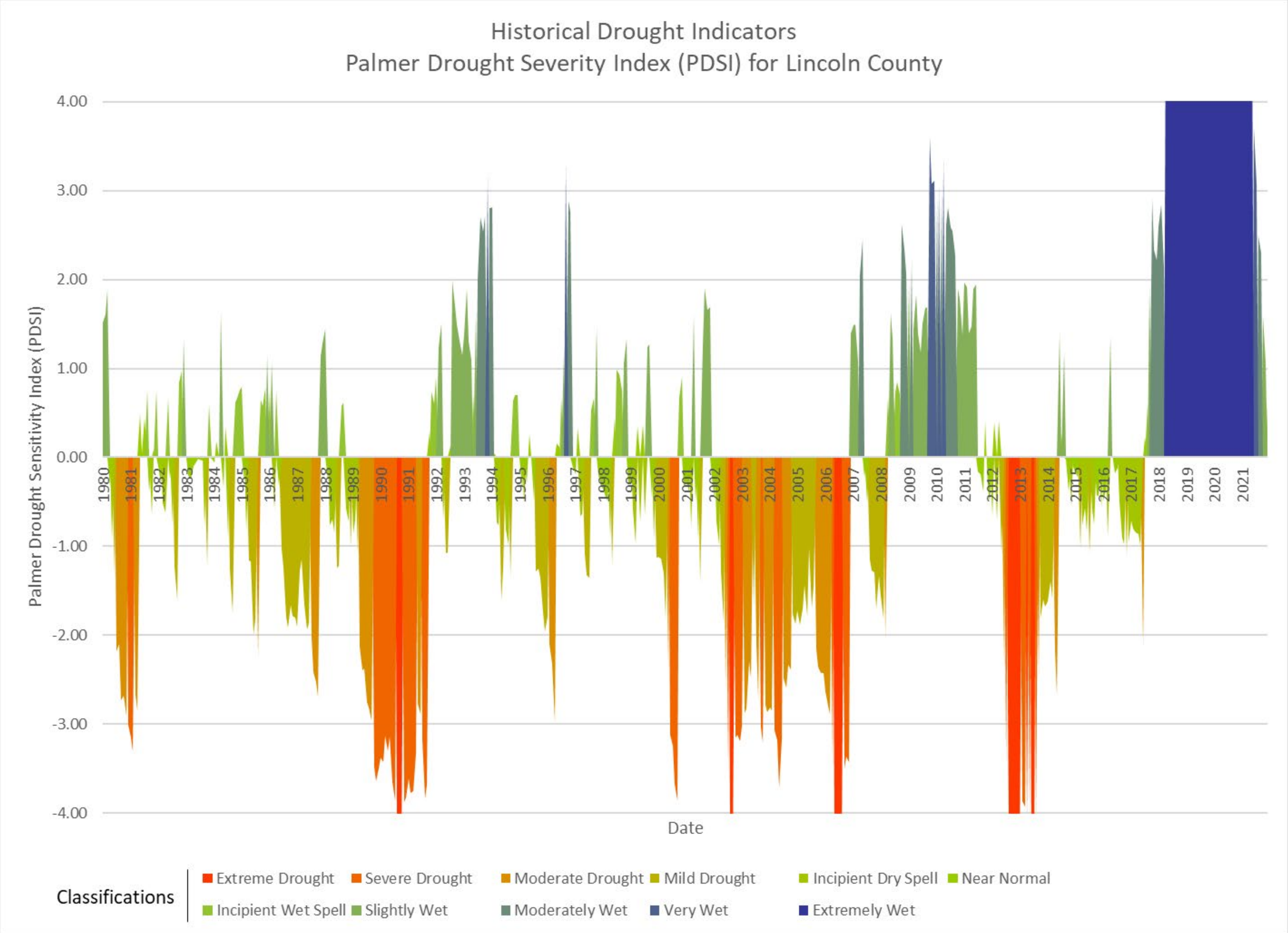
Drought Indicator Types Not Considered

- Remote Sensing
  - Comparison to past historical droughts limited
  - Could be useful for more precision, linked to other indices
  - Examples:
    - GRACE (Gravity Recovery and Climate Experiment) – Shallow and deep groundwater
    - NDVI (Normalized Difference Vegetation Index) – Vegetation health (chlorophyll)
    - NDWI (Normalized Difference Water Index) – Water extents, vegetation health (humidity)
    - NDSI (Normalized Difference Snow Index) – Snowpack extents
    - FEWS (Famine Early Warning System) – NDVI anomalies

Approach

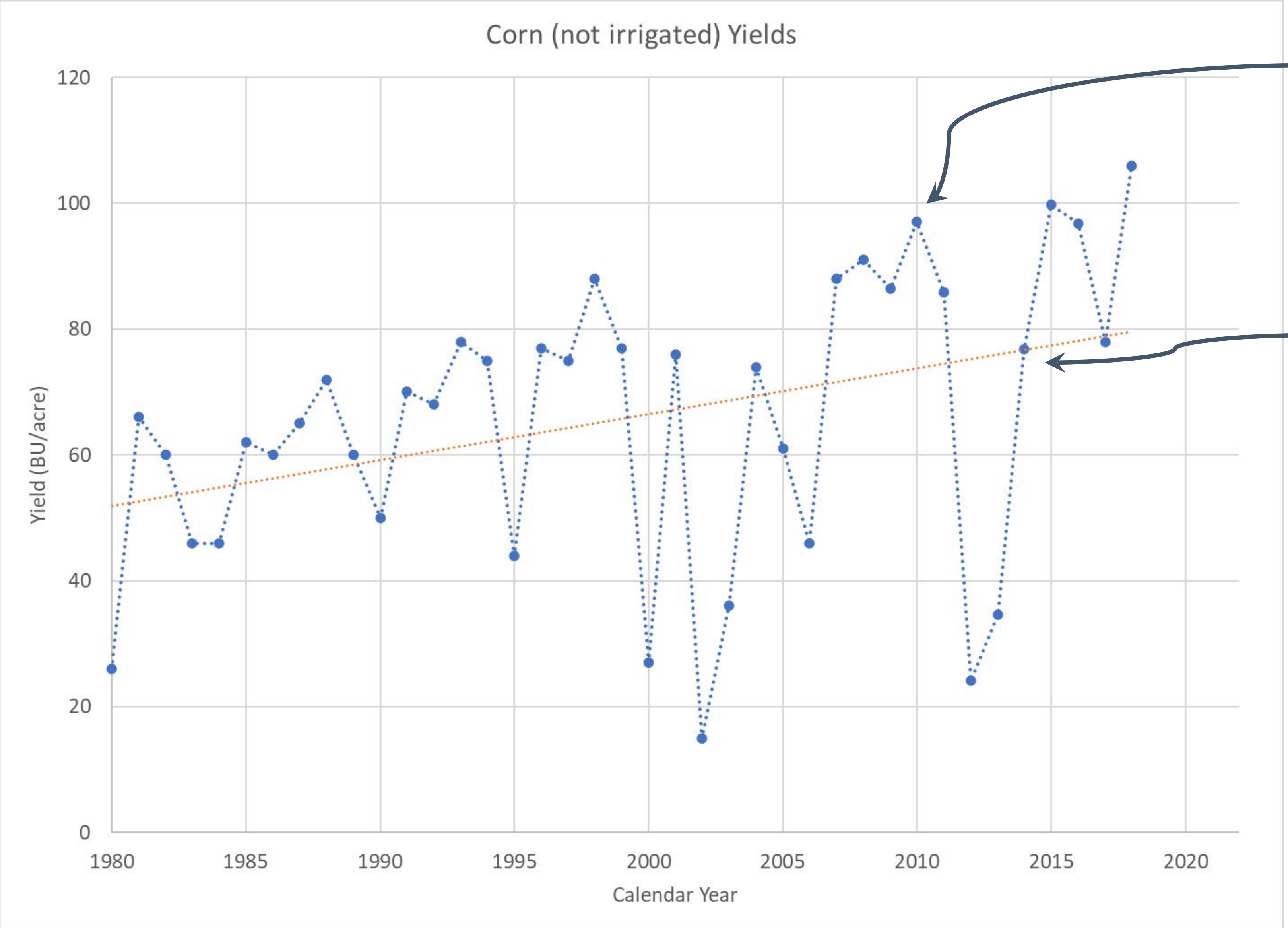
- Compare a Drought Impact to a Drought Indicator
- Time period: 1980 to 2020 (40 years)
- Key Droughts:
  - 1989 to 1992
  - 2002 to 2006
  - 2012 to 2014
- Find drought indicators that more accurately predict impacts

Example – PDSI for Lincoln County



Source: National Drought Mitigation Center calculation using North Platte Regional Airport data

Example – Historical Corn Yields

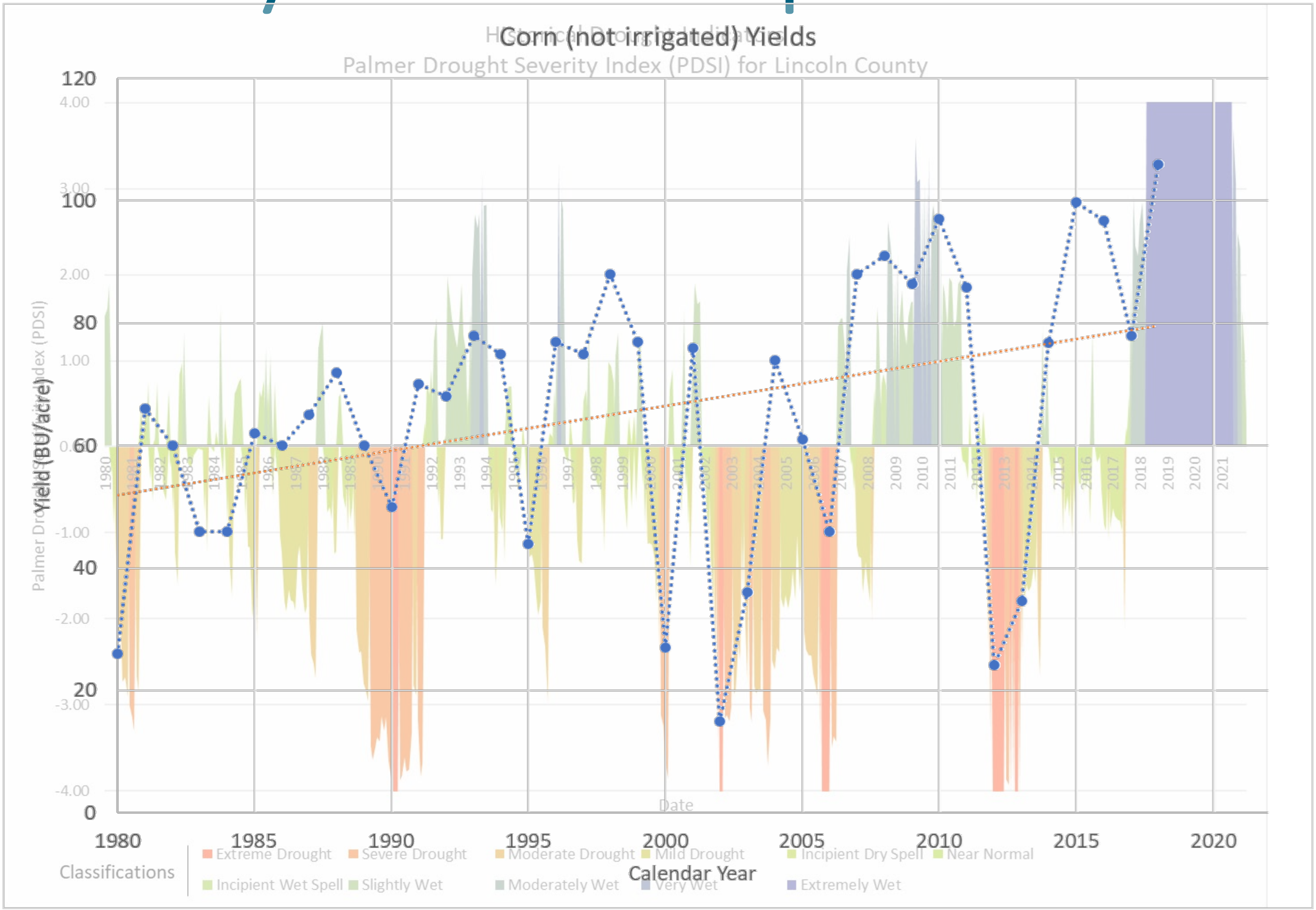


Yields have changed over time
Due to:
GMOs, mechanization efficiency, land management changes

Long-term average yield

Source: National Agriculture Statistics Service (USDA)

Overlay Index and Impact



Wet Conditions have greater potential for above-average yields

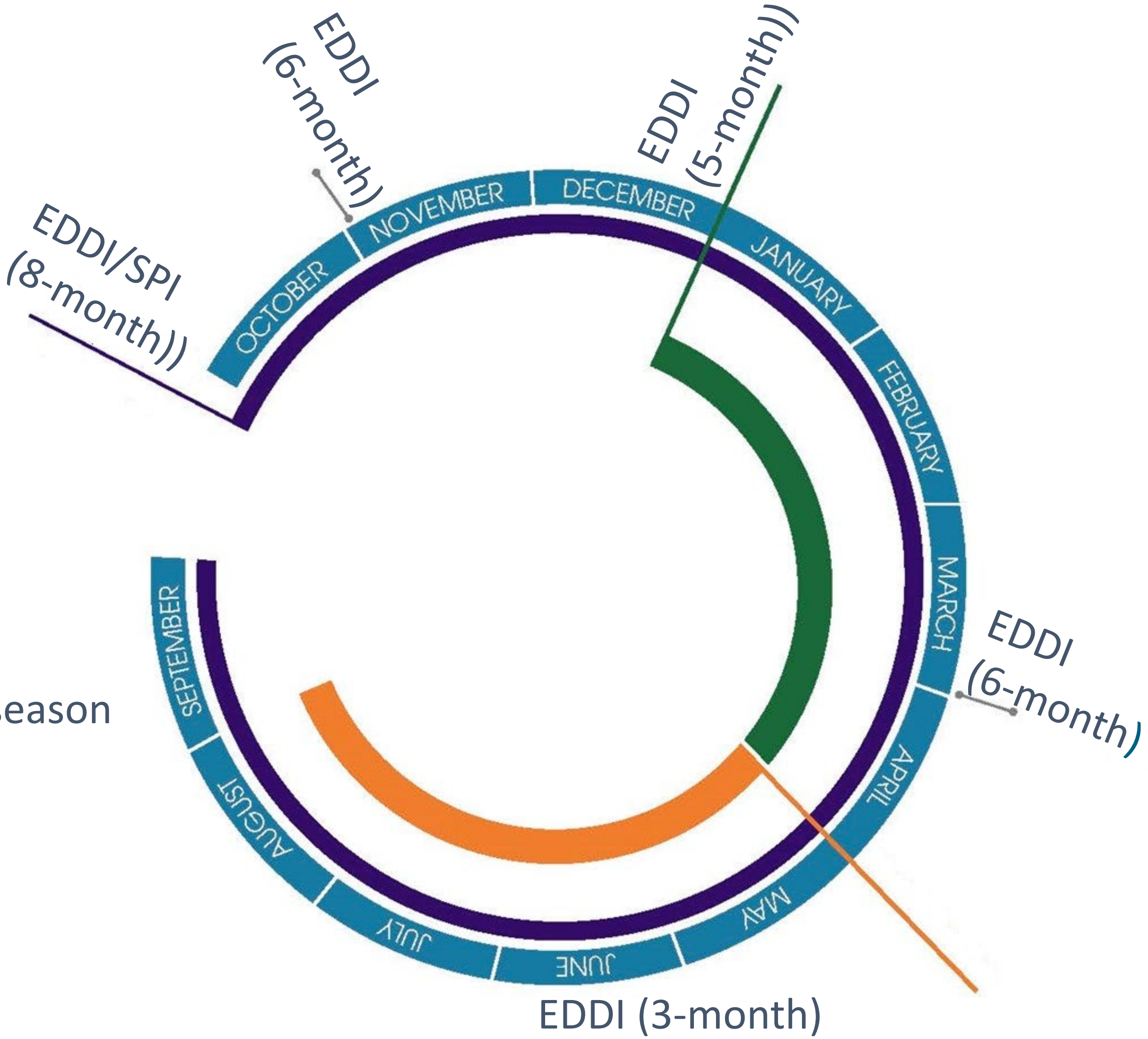
Dry Conditions have greater potential for below-average yields

Selected Drought Impacts

Sector	Impact	Description	Data Source
Agriculture	Crop Yields	Change in crop yields from average	USDA National Agriculture Statistic Service
Energy (Demand)	Cooling Degree Days	Number of days and excess air temperature where air temperature > 65° F	NOAA National Centers for Environmental Information
Energy (Production)	Annual River Flow Volume	Hydropower potential as daily flows	USGS/DNR
Environmental	Fire Risk: Number of Wildfires	Number of non-prescriptive fires	National Interagency Fire Center
Reservoir Levels	River Flow Volumes	Winter flows – Refill potential Summer flows – Demand potential	USGS/DNR
Water Quality	Summer River Flow Volume	River flows between April and September	USGS/DNR

Drought Indicators – Non-Irrigation Yields

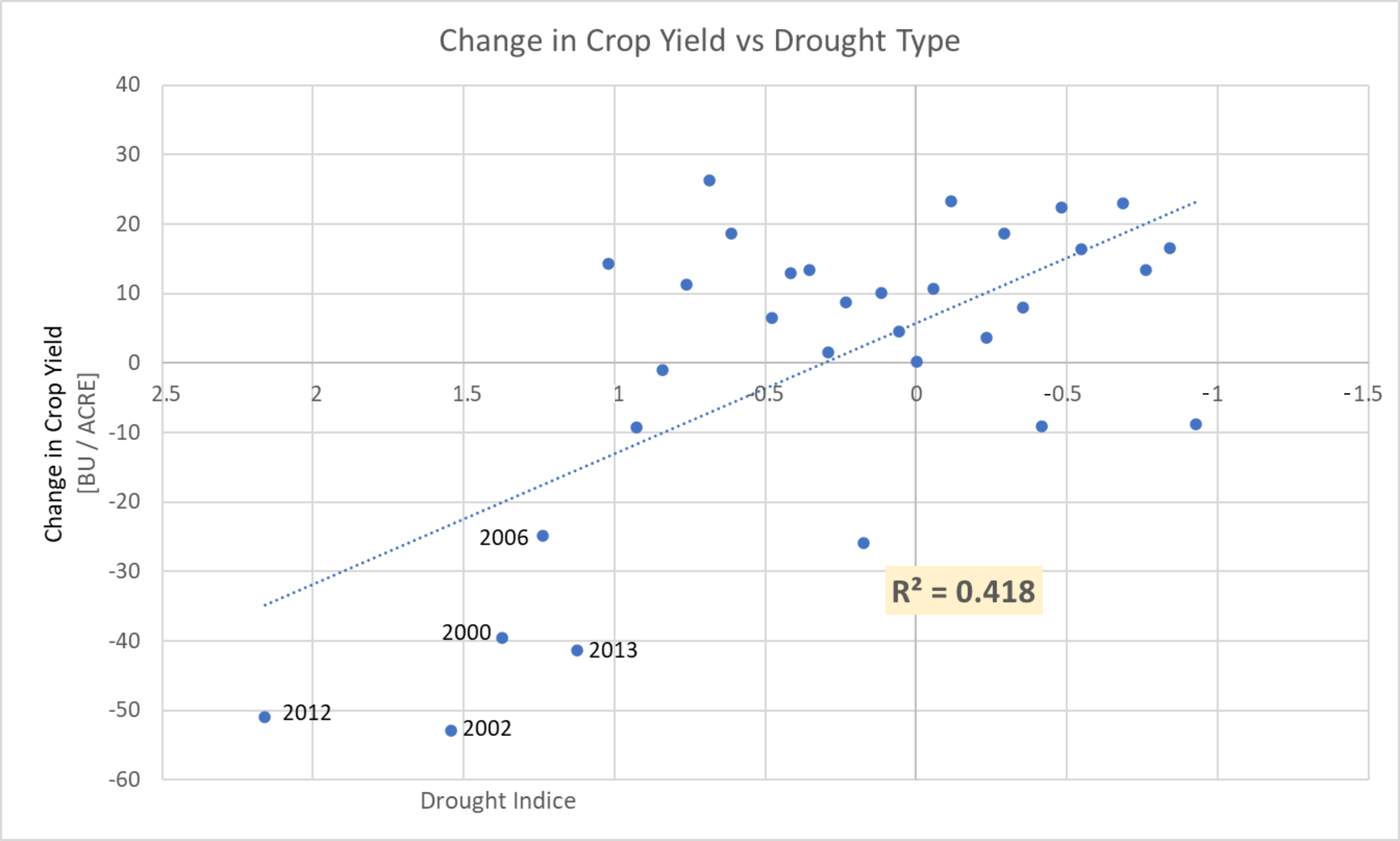
<u>Crop Types:</u>
- Corn, Non-Irrigated
- Sorghum, Non-Irrigated
- Wheat, Non-Irrigated
- Winter Wheat, Non-Irrigated
- Hay



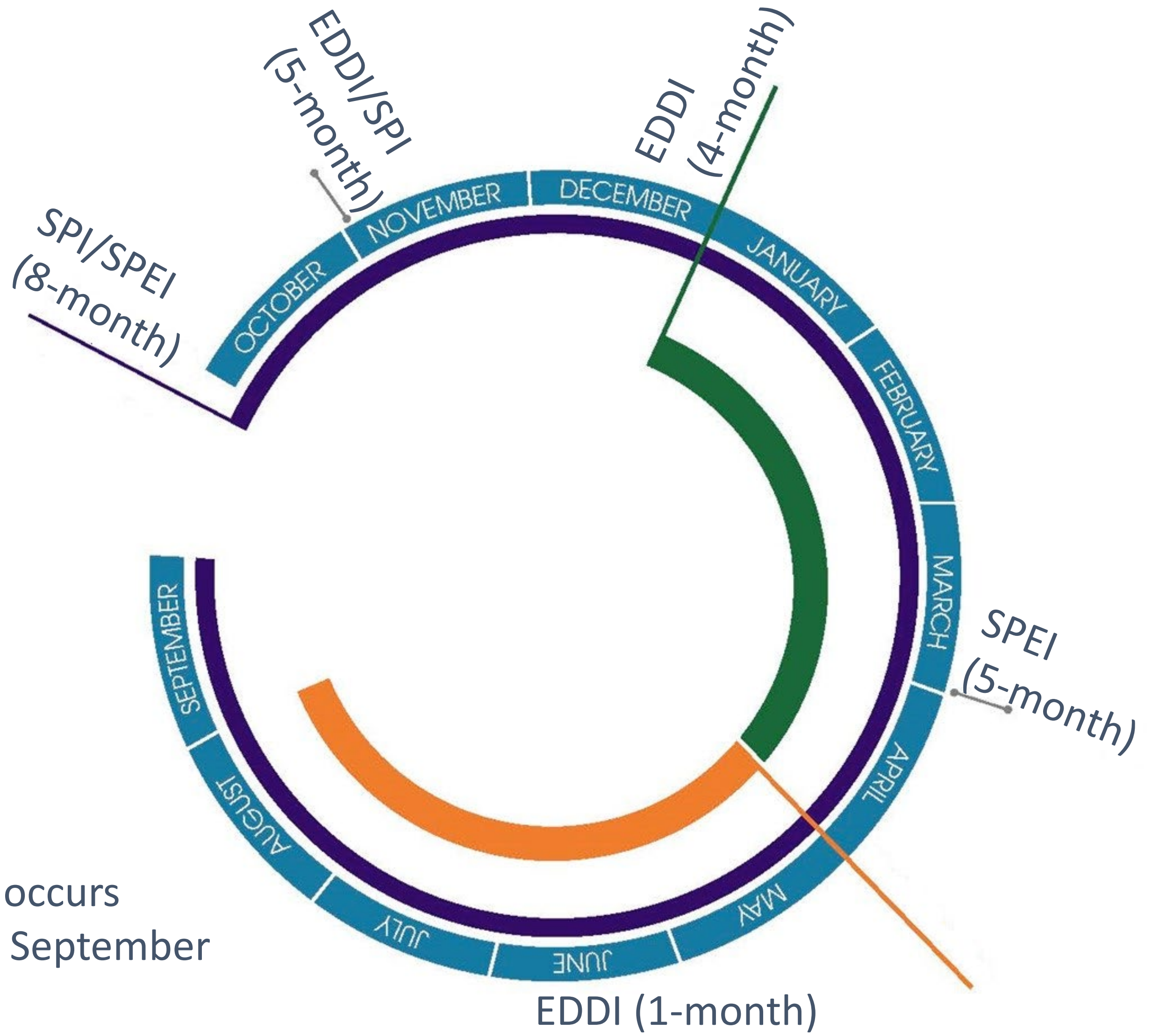
Impact occurs:
End of growing season

Agriculture Yield Example

- Corn (Non-Irrigated) Yield for Lincoln County using June EDDI



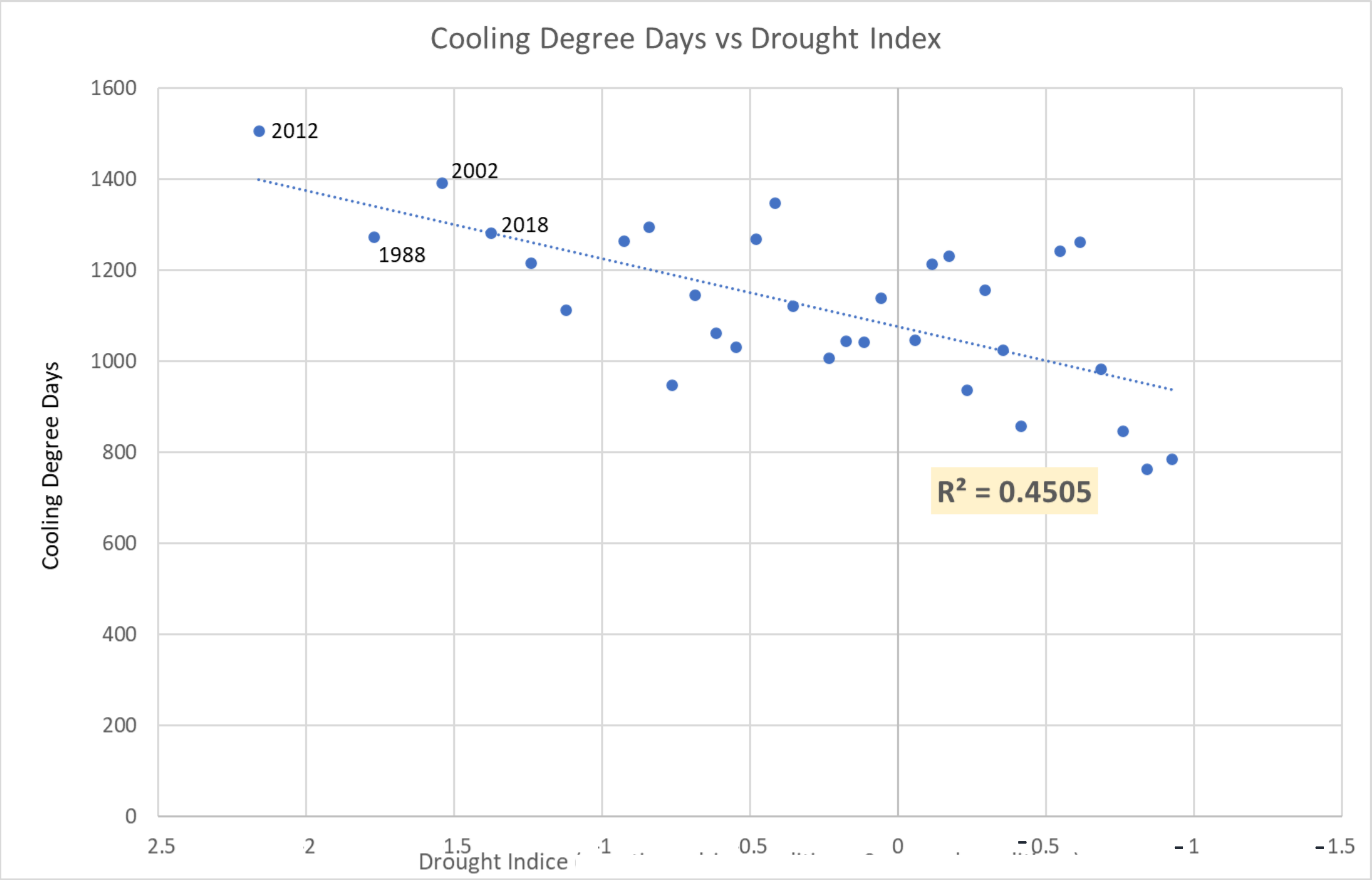
Drought Indicators – Energy Demand



Impact occurs
June to September

Energy Demand Examples

- Annual Cooling Degree Days for Hall County using June EDDI



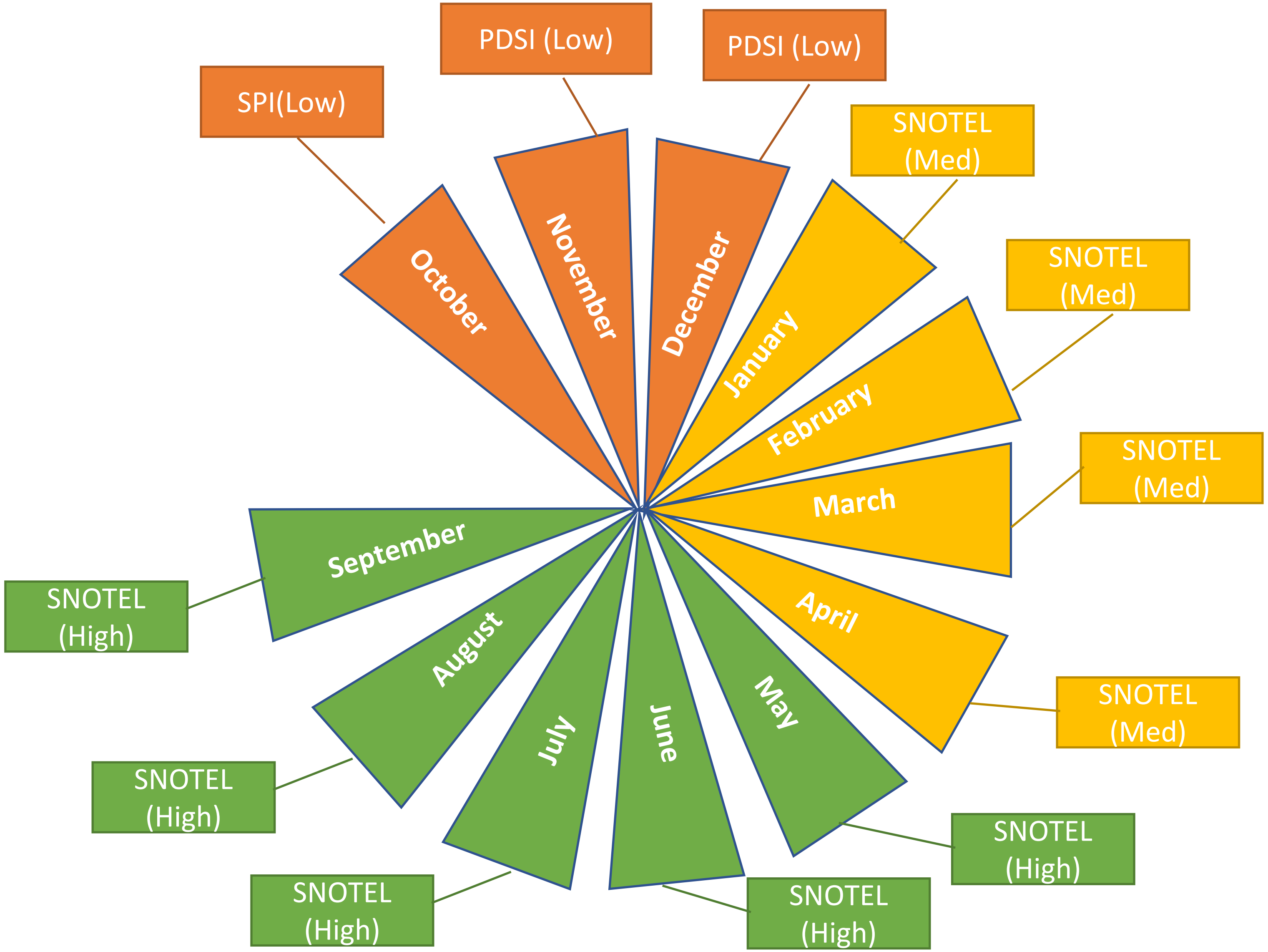
North Platte Summer Volume at WY-NE State Line

Correlation

Low (<50%)

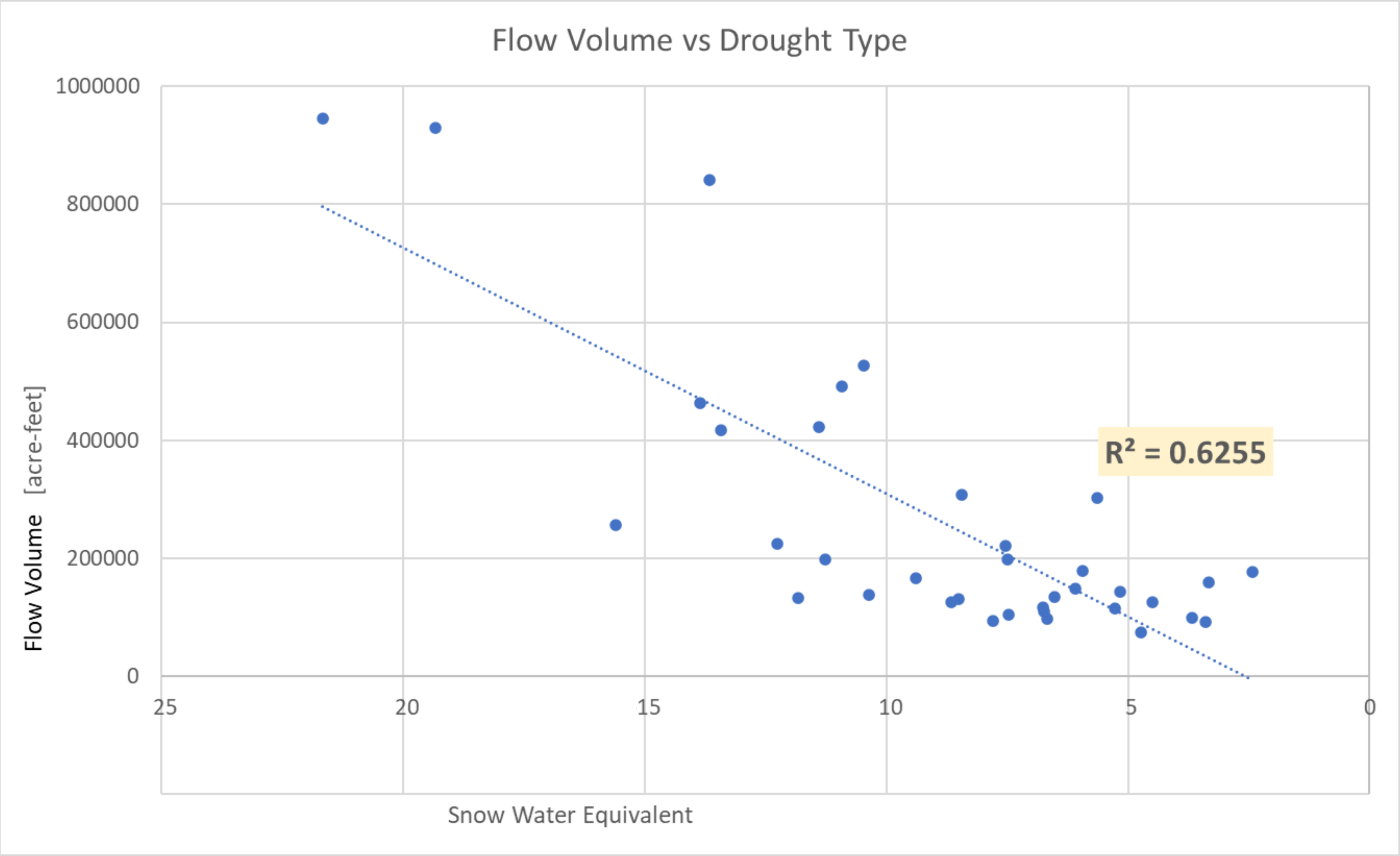
Medium (50-70%)

High (>70%)

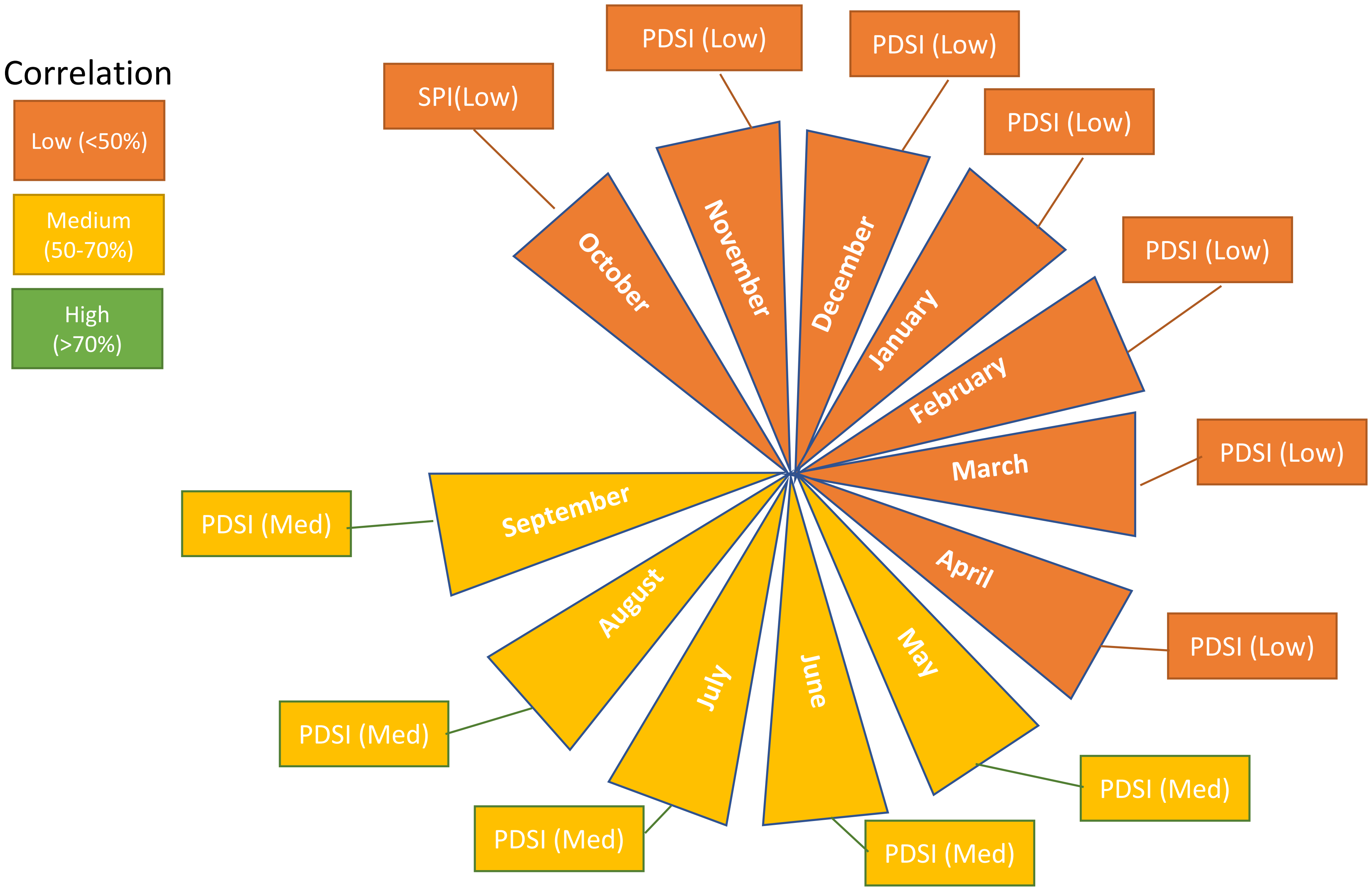


Flow/Drought Indicator Correlation

- Summer Flows at WY-NE Border Correlation with SNOTEL (snow-water equivalent) In North Platte Basin (79% correlation in July)

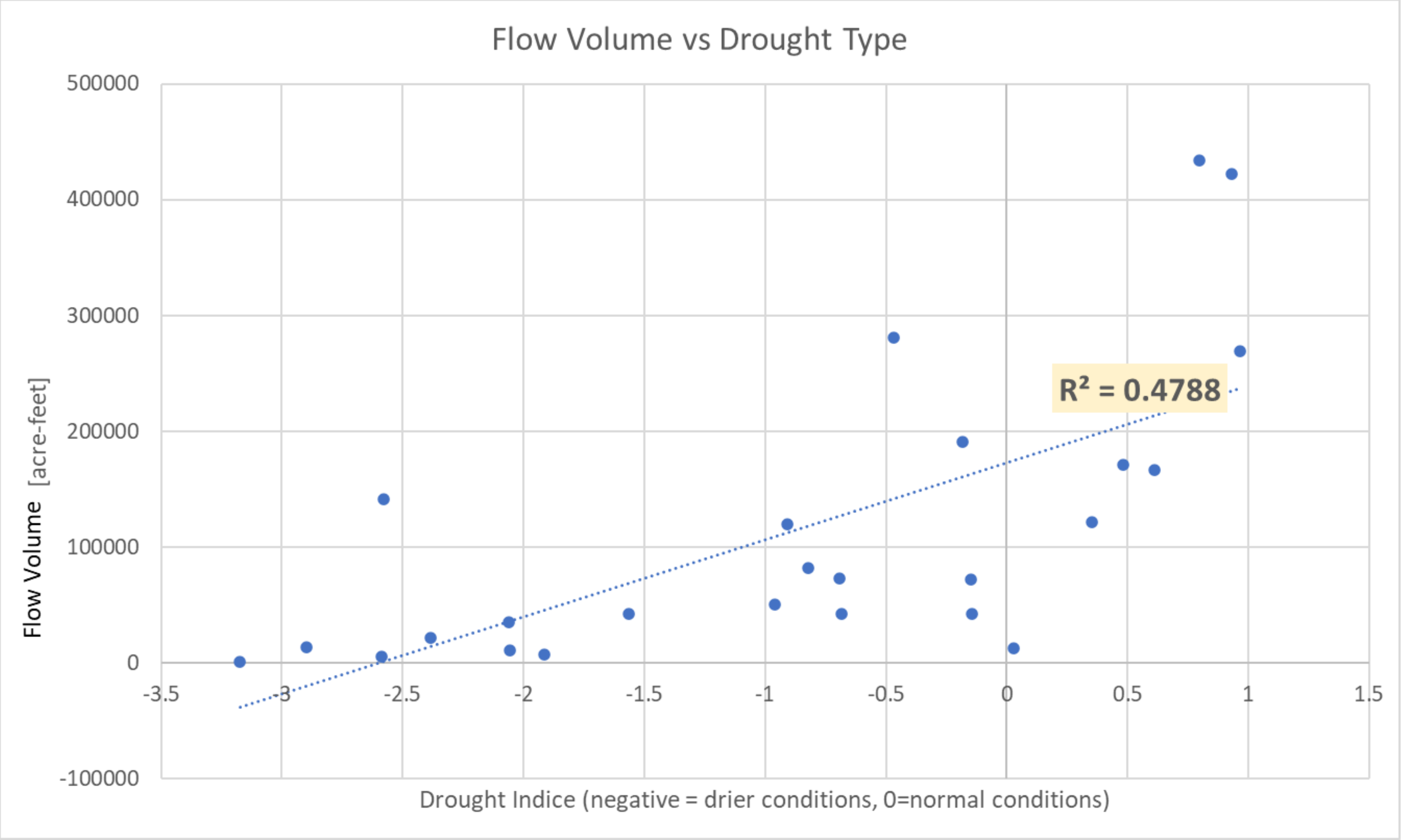


South Platte Summer Volume at Roscoe

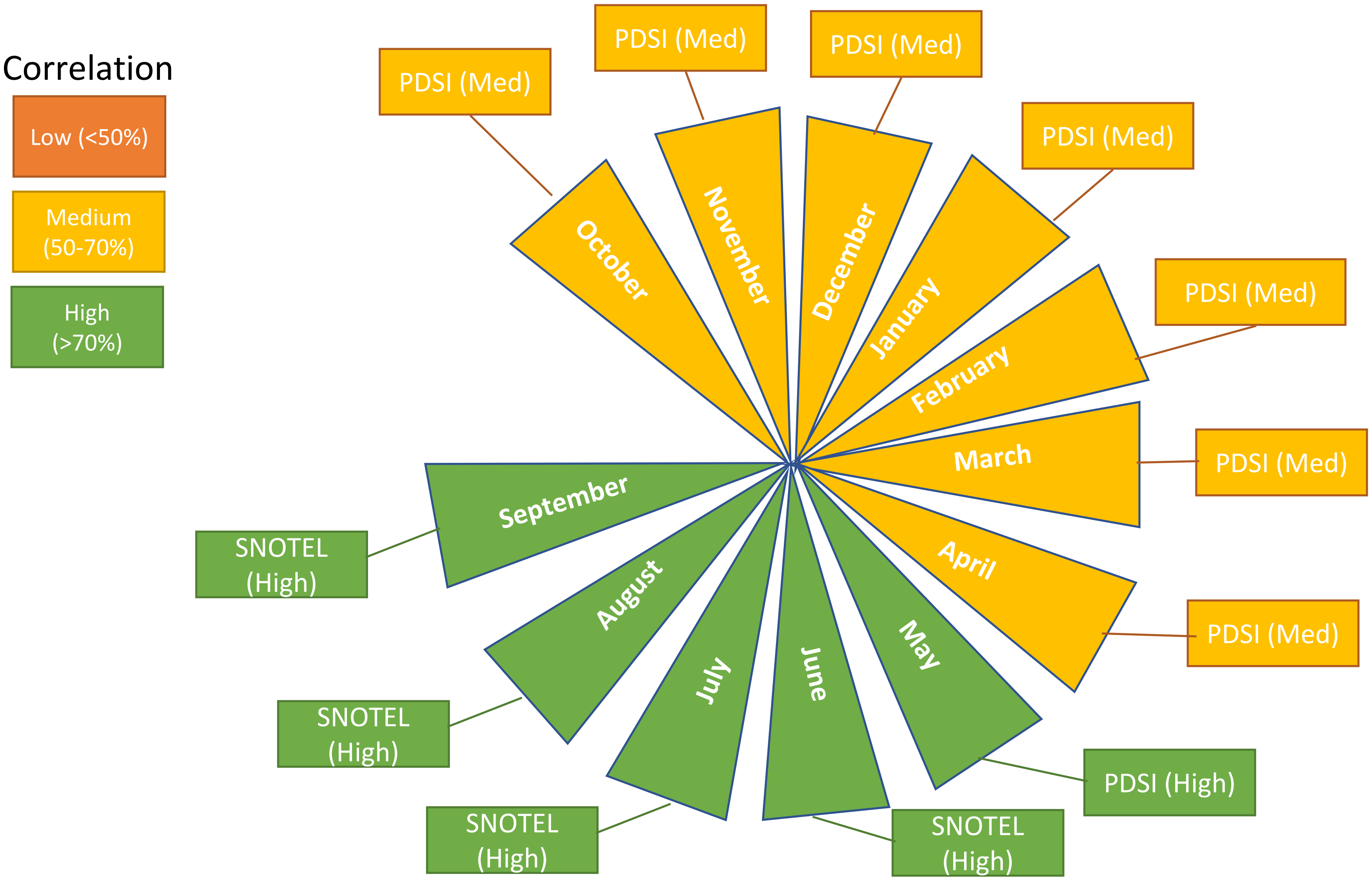


Flow/Drought Indicator Correlation

- Summer Flows at Roscoe Gage Correlation with PDSI (69% correlation in June)

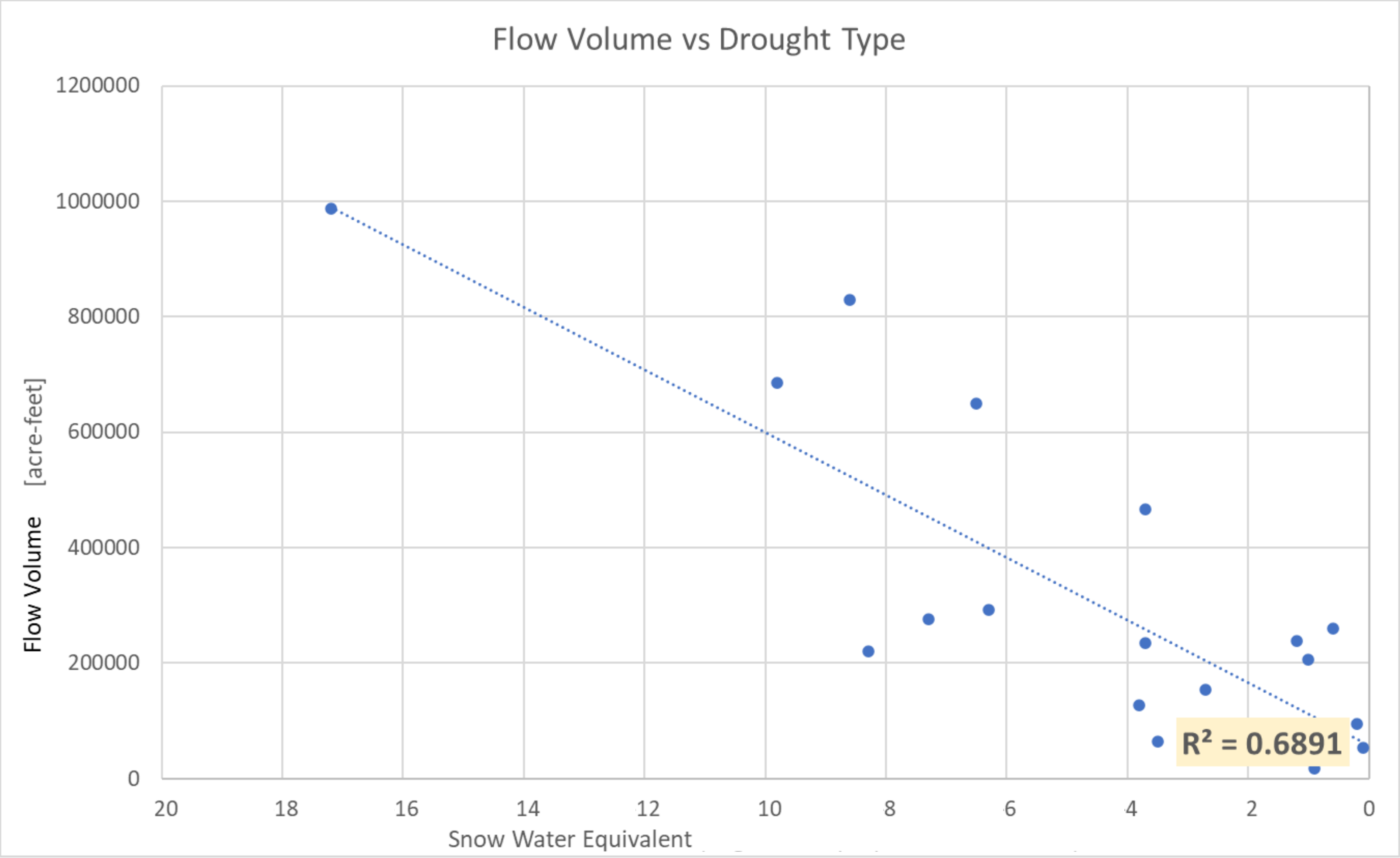


Platte River at Grand Island Summer Volume



Flow/Drought Indicator Correlation

- Summer Flows at Grand Island Gage Correlation with SNOTEL (snow-water equivalent) In South Platte Basin (82% correlation in June)



Next Steps

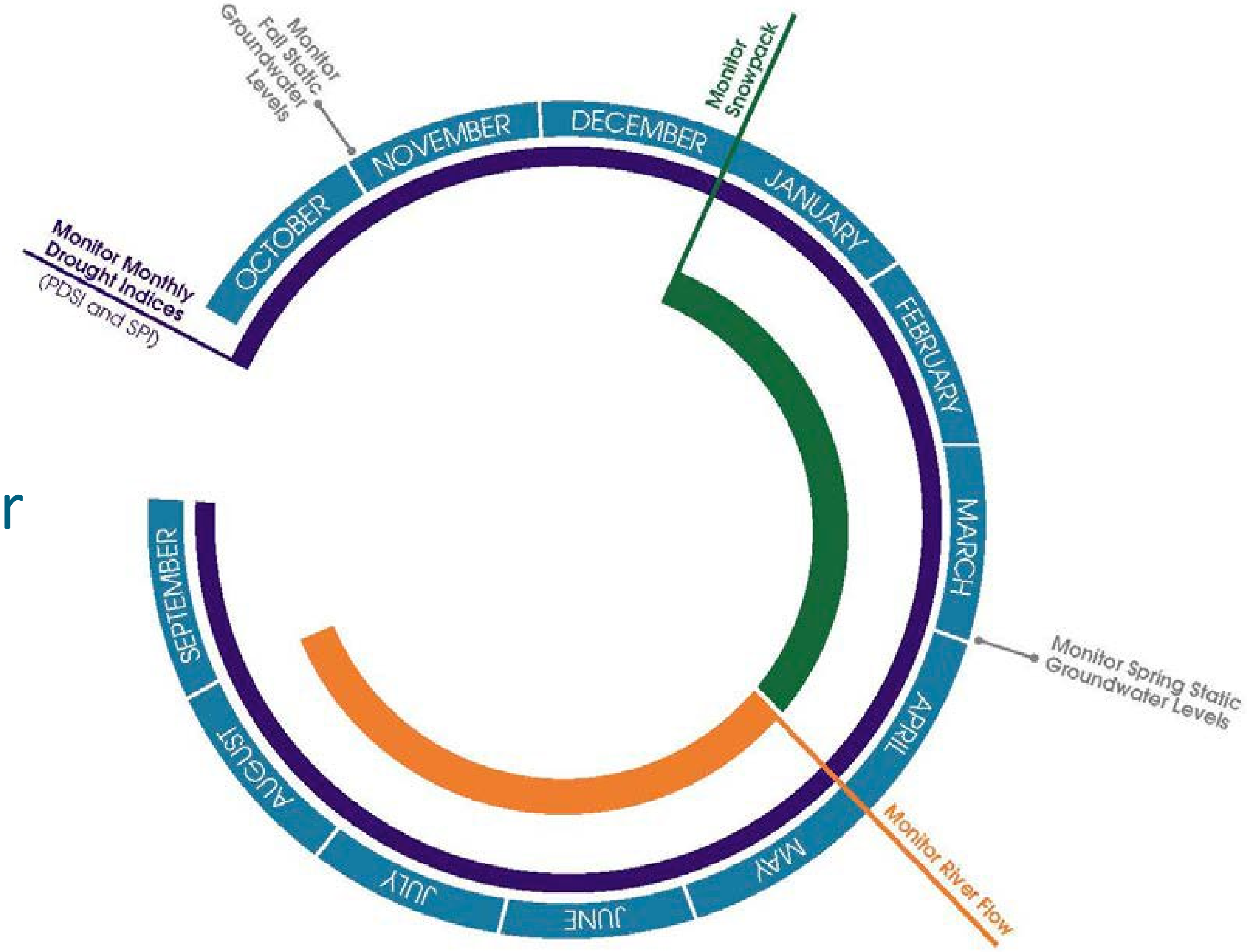
- Are there other drought impacts to consider?
  - Groundwater data
  - Lake/Reservoir data
- Other drought indicators or indices to consider?
- How could monitoring fit into your existing operations and planning?
  - Desired advanced notice of drought
- Examine Dual and Hybrid Indicators

Next Steps

- Ultimate Goal is continuum of monitoring

(example from Lower Platte River DCP)

[Lower Platte Drought Monitor Landing Page (ne.gov)]



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BREAK

We’ll see you back here in about 15 minutes!

Vulnerability & Mitigation Actions by Sector

Small Group Discussions & Ranking Activity

Vulnerabilities: We Want to Know…

- Should any additional vulnerabilities be added to your list?
- Should any vulnerabilities be removed from your list?
- What are your top three vulnerabilities in short-term droughts?
- What are you top three vulnerabilities in long-term droughts?

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Mitigation Actions: We Want to Know…

- Are there any existing mitigation and response actions in place that would benefit the sector’s top vulnerabilities?
- What would be the most beneficial mitigation and response actions for the sector?

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Socio-Economic Sector: Vulnerabilities & Mitigation Actions

Large Group Discussions

Next Steps

Next Steps

Upcoming Drought Task Force Meetings:

- April/May 2023
- May/June 2023

Draft Plan anticipated Summer 2023

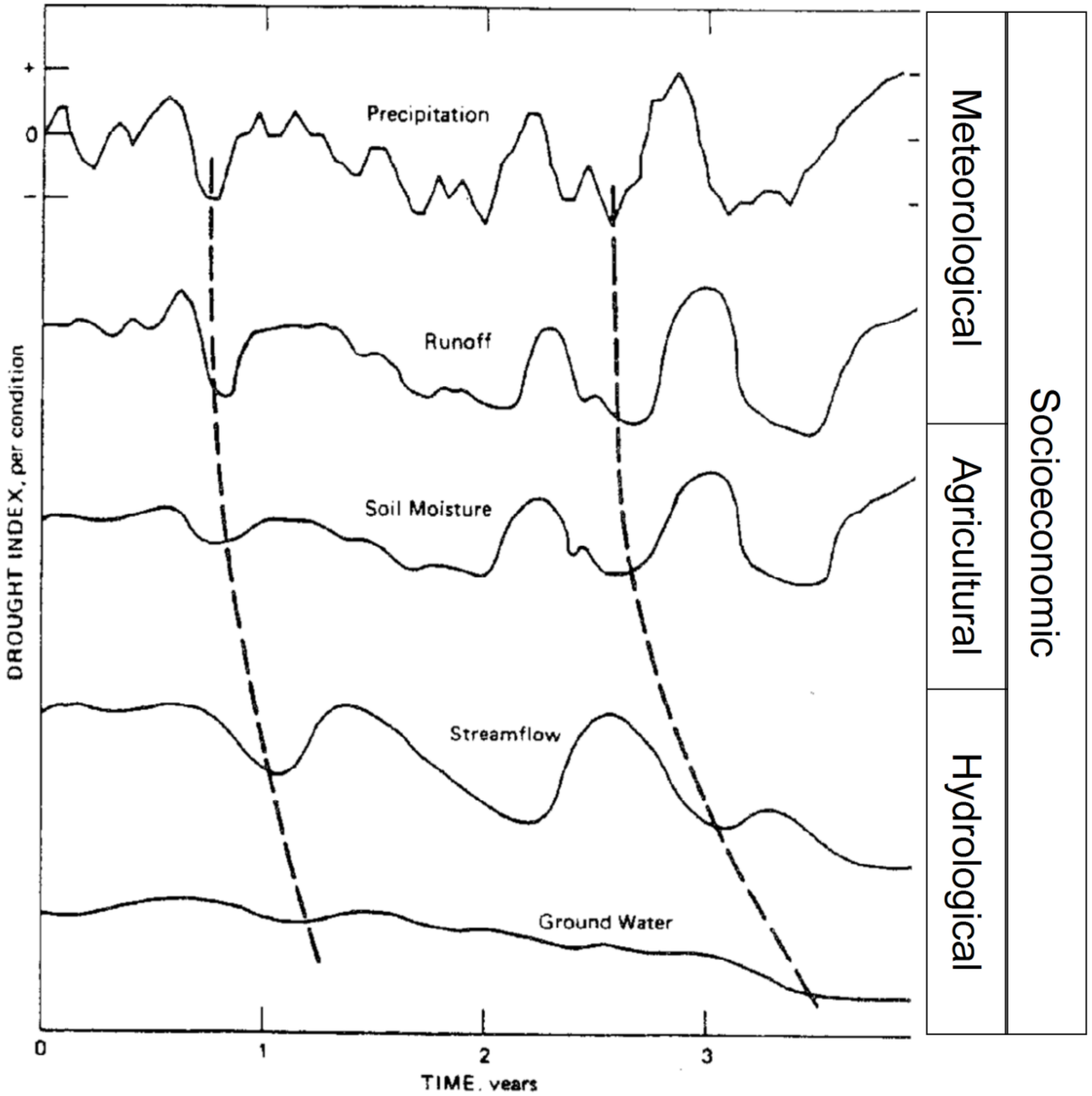
Any Questions?

THANK YOU!

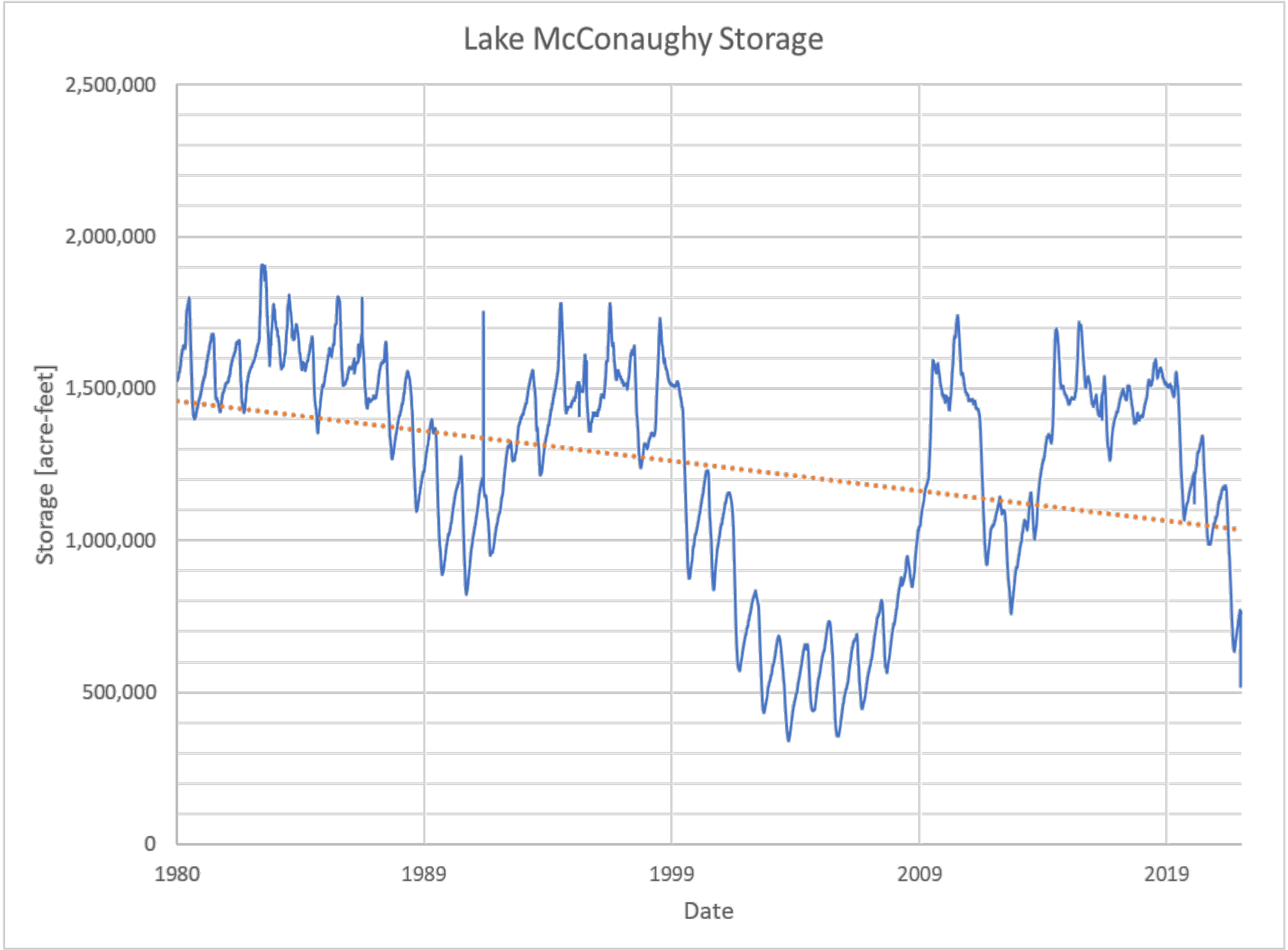
Monitoring Protocols

Additional Information

Drought Scales



McConaughy Storage and Snowpack



Drought Indices Scales

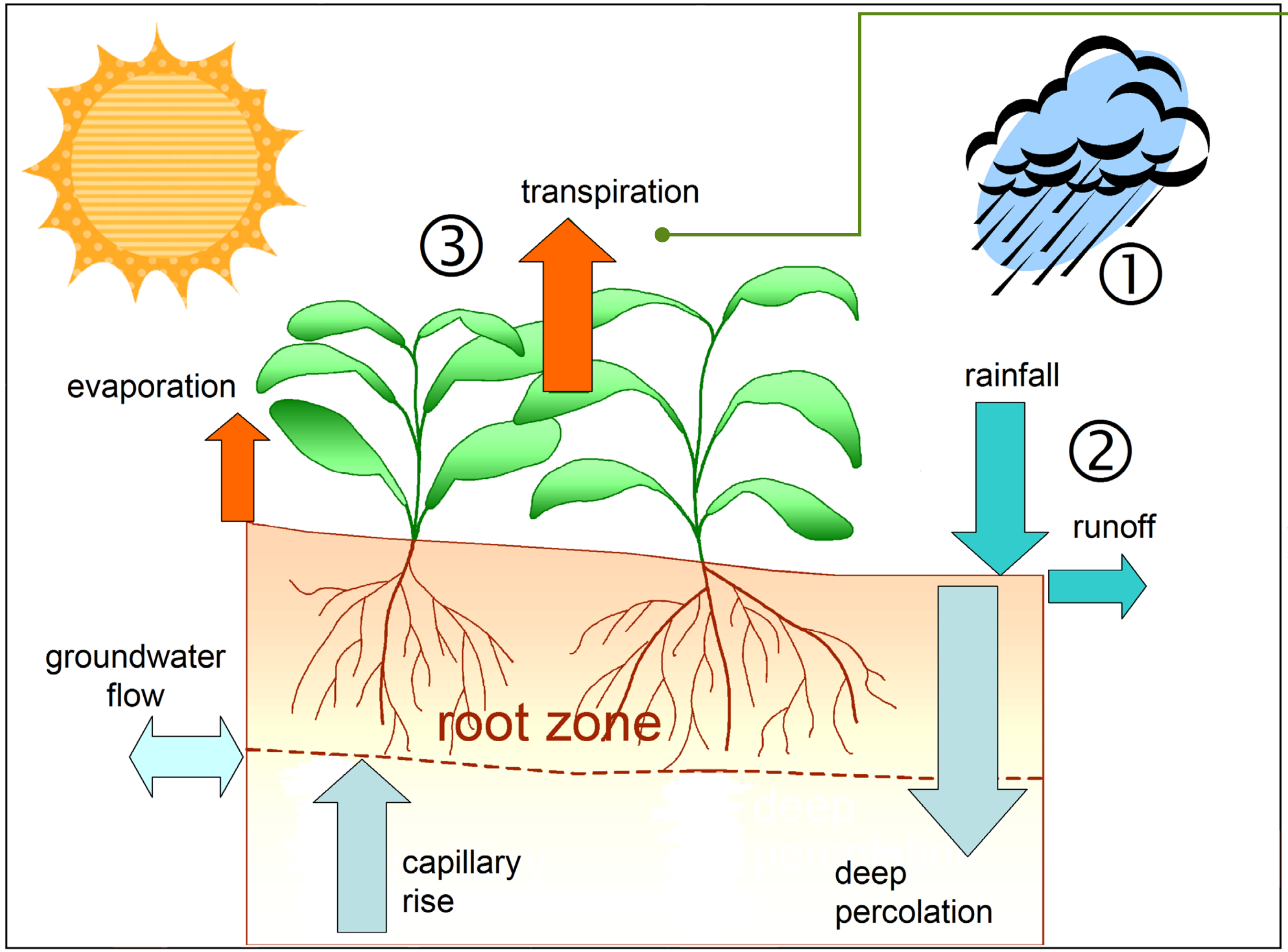
PDSI

-4.0 or less Extreme drought	-3.0 to -3.9 Severe drought	-2.0 to -2.9 Moderate drought	-1.0 to -1.9 Mild drought	-0.5 to -0.9 Incipient dry spell	-0.49 to +0.49 Near normal	0.5 to 0.9 Incipient wet spell	1.0 to 1.9 Slightly wet	2.0 to 2.9 Moderately wet	3.0 to 3.9 Very wet	4.0 or more Extremely wet

SPI

-2.00 or less Extremely dry	-1.50 to -1.99 Severely dry	-1.00 to -1.49 Moderately dry	-0.99 to +0.99 Near normal	1.00 to 1.49 Moderately wet	1.50 to 1.90 Very wet	2.00 or more Extremely wet

Example Drought Indicator
Evaporative Demand Drought Index (EDDI)



Focus: Evaporation

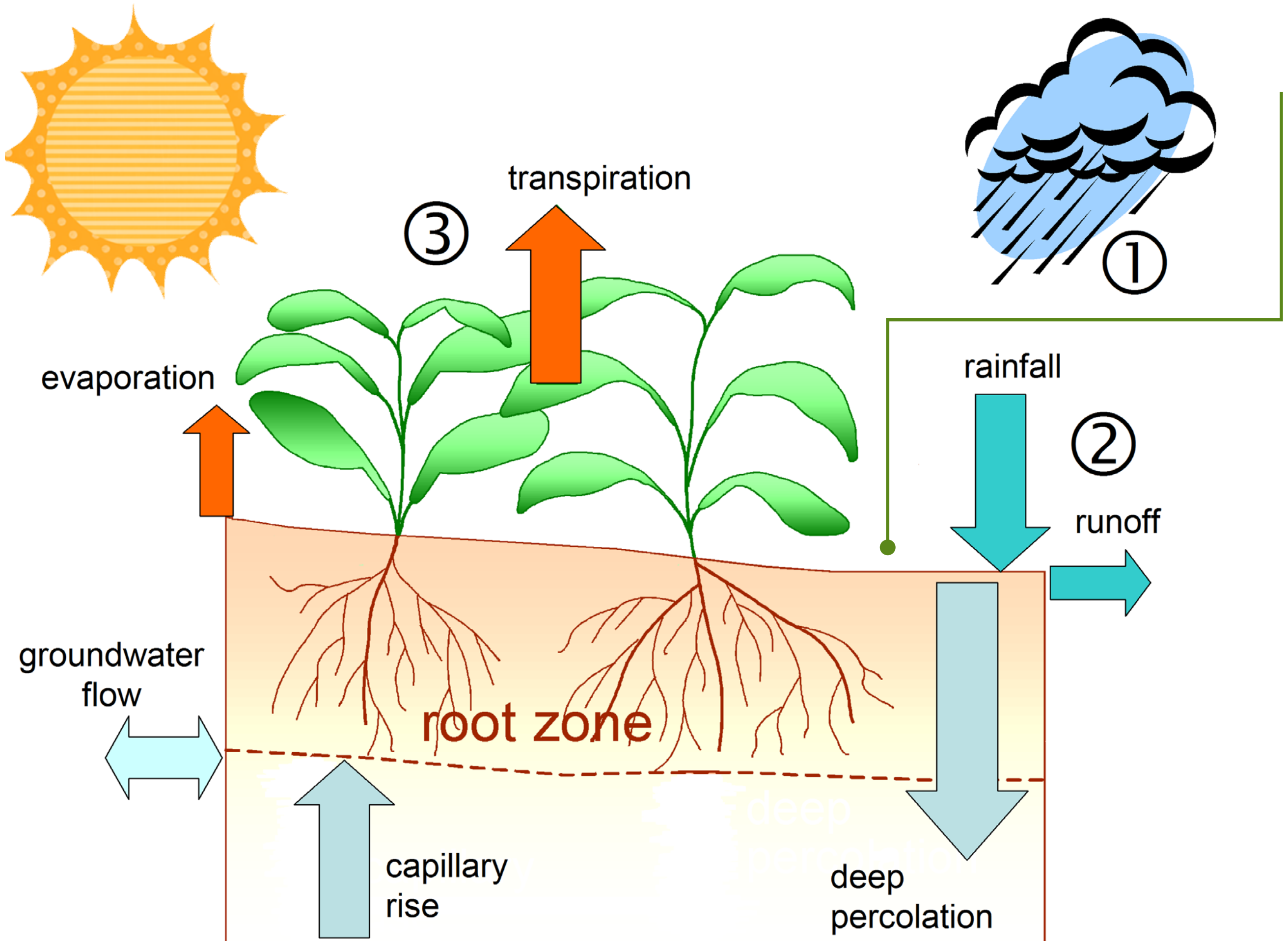
Evaluates if evaporation is above or below normal

Timescales:
- Monthly -> Soil moisture impacts
- Multiple months -> Yield impacts
- Annual -> Wildfire impacts

Uses:
- Identify vegetation water stress
- Calculated by NOAA

Scale:
- < 0 = Cooler conditions
- 0 = Normal/Average
- > 0 = Hotter conditions

Example Drought Indicator
Palmer Drought Severity Index (PDSI)



Focus: Soil moisture

Evaluates precipitation, evaporation and the moisture holding capacity of soil

Timescales:
- Depends on local soils
- Sand -> PDSI can change rapidly
- Loams -> PDSI changes gradually

Uses:
- Widely used
- Calculated by Drought Mitigation Center

Scale:
- < 0 = Dry/Drought Conditions
- 0 = Normal/Average
- > 0 = Wet Conditions

Other Indices

Meteorology	Page	Ease of use	Input parameters	Additional information
Aridity Anomaly Index (AAI)	11	Green	P, T, PET, ET	Operationally available for India
Deciles	11	Green	P	Easy to calculate; examples from Australia are useful
Keetch–Byram Drought Index (KBDI)	12	Green	P, T	Calculations are based upon the climate of the area of interest
Percent of Normal Precipitation	12	Green	P	Simple calculations
Standardized Precipitation Index (SPI)	13	Green	P	Highlighted by the World Meteorological Organization as a starting point for meteorological drought monitoring
Weighted Anomaly Standardized Precipitation (WASP)	15	Green	P, T	Uses gridded data for monitoring drought in tropical regions
Aridity Index (AI)	15	Yellow	P, T	Can also be used in climate classifications
China Z Index (CZI)	16	Yellow	P	Intended to improve upon SPI data
Crop Moisture Index (CMI)	16	Yellow	P, T	Weekly values are required
Drought Area Index (DAI)	17	Yellow	P	Gives an indication of monsoon season performance
Drought Reconnaissance Index (DRI)	17	Yellow	P, T	Monthly temperature and precipitation are required
Effective Drought Index (EDI)	18	Yellow	P	Program available through direct contact with originator
Hydro-thermal Coefficient of Selyaninov (HTC)	19	Yellow	P, T	Easy calculations and several examples in the Russian Federation
NOAA Drought Index (NDI)	19	Yellow	P	Best used in agricultural applications
Palmer Drought Severity Index (PDSI)	20	Yellow	P, T, AWC	Not green due to complexity of calculations and the need for serially complete data
Palmer Z Index	20	Yellow	P, T, AWC	One of the many outputs of PDSI calculations
Rainfall Anomaly Index (RAI)	21	Yellow	P	Serially complete data required
Self-Calibrated Palmer Drought Severity Index (sc-PDSI)	22	Yellow	P, T, AWC	Not green due to complexity of calculations and serially complete data required
Standardized Anomaly Index (SAI)	22	Yellow	P	Point data used to describe regional conditions
Standardized Precipitation Evapotranspiration Index (SPEI)	23	Yellow	P, T	Serially complete data required; output similar to SPI but with a temperature component
Agricultural Reference Index for Drought (ARID)	23	Red	P, T, Mod	Produced in south-eastern United States of America and not tested widely outside the region
Crop-specific Drought Index (CSDI)	24	Red	P, T, Td, W, Rad, AWC, Mod, CD	Quality data of many variables needed, making it challenging to use
Reclamation Drought Index (RDI)	25	Red	P, T, S, RD, SF	Similar to the Surface Water Supply Index, but contains a temperature component

Soil moisture	Page	Ease of use	Input parameters	Additional information
Soil Moisture Anomaly (SMA)	25	Yellow	P, T, AWC	Intended to improve upon the water balance of PDSI
Evapotranspiration Deficit Index (ETDI)	26	Red	Mod	Complex calculations with multiple inputs required
Soil Moisture Deficit Index (SMDI)	26	Red	Mod	Weekly calculations at different soil depths; complicated to calculate
Soil Water Storage (SWS)	27	Red	AWC, RD, ST, SWD	Owing to variations in both soil and crop types, interpolation over large areas is challenging

Hydrology	Page	Ease of use	Input parameters	Additional information
Palmer Hydrological Drought Severity Index (PHDI)	27	Yellow	P, T, AWC	Serially complete data required
Standardized Reservoir Supply Index (SRSI)	28	Yellow	RD	Similar calculations to SPI using reservoir data
Standardized Streamflow Index (SSFI)	29	Yellow	SF	Uses the SPI program along with streamflow data
Standardized Water-level Index (SWI)	29	Yellow	GW	Similar calculations to SPI, but using groundwater or well-level data instead of precipitation
Streamflow Drought Index (SDI)	30	Yellow	SF	Similar calculations to SPI, but using streamflow data instead of precipitation
Surface Water Supply Index (SWSI)	30	Yellow	P, RD, SF, S	Many methodologies and derivative products are available, but comparisons between basins are subject to the method chosen
Aggregate Dryness Index (ADI)	31	Red	P, ET, SF, RD, AWC, S	No code, but mathematics explained in the literature
Standardized Snowmelt and Rain Index (SMRI)	32	Red	P, T, SF, Mod	Can be used with or without snowpack information

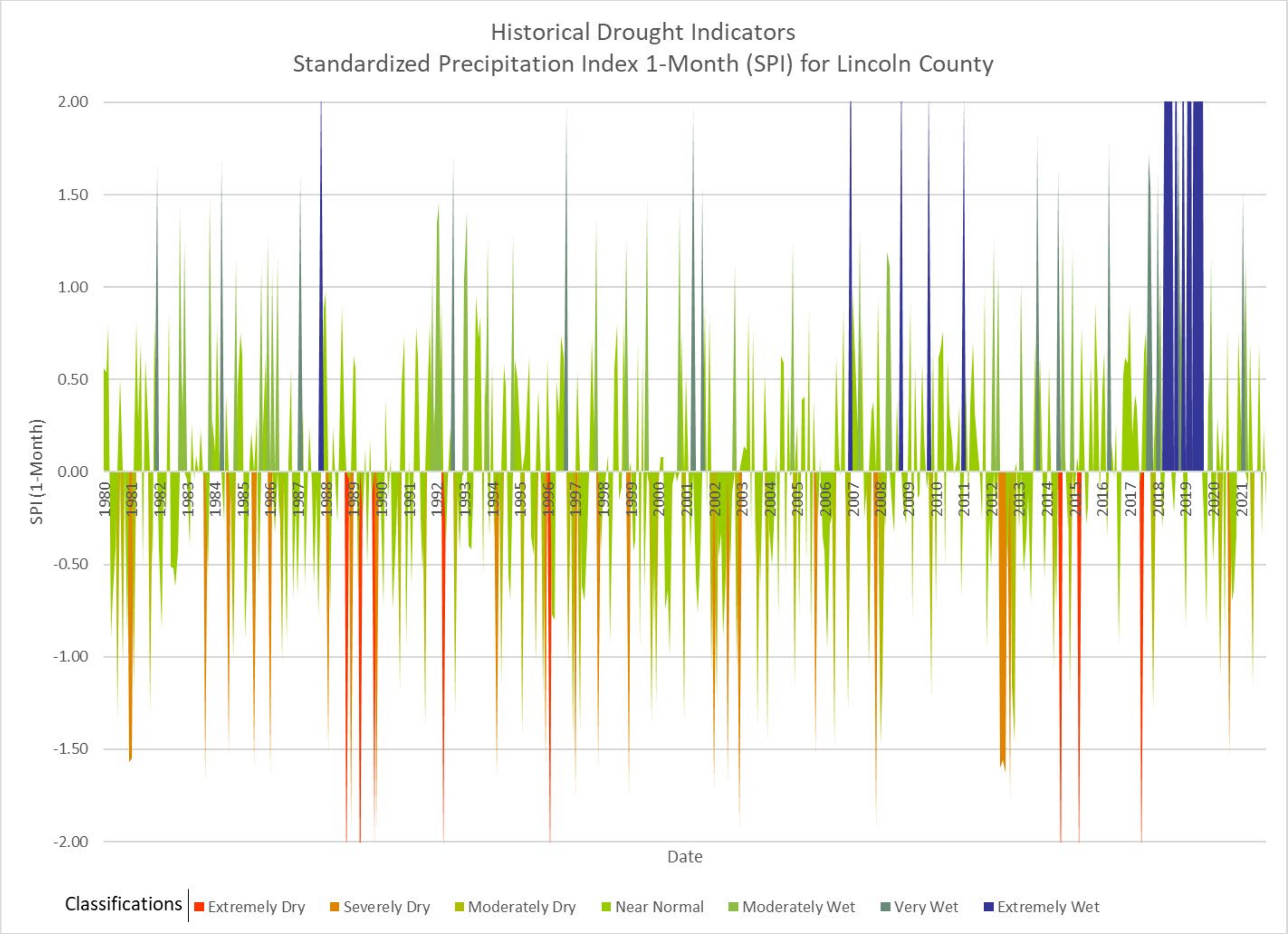
Remote sensing	Page	Ease of use	Input parameters	Additional information
Enhanced Vegetation Index (EVI)	32	Green	Sat	Does not separate drought stress from other stress
Evaporative Stress Index (ESI)	33	Green	Sat, PET	Does not have a long history as an operational product
Normalized Difference Vegetation Index (NDVI)	33	Green	Sat	Calculated for most locations
Temperature Condition Index (TCI)	34	Green	Sat	Usually found along with NDVI calculations
Vegetation Condition Index (VCI)	34	Green	Sat	Usually found along with NDVI calculations
Vegetation Drought Response Index (VegDRI)	35	Green	Sat, P, T, AWC, LC, ER	Takes into account many variables to separate drought stress from other vegetation stress
Vegetation Health Index (VHI)	35	Green	Sat	One of the first attempts to monitor drought using remotely sensed data
Water Requirement Satisfaction Index (WRSI and Geo-spatial WRSI)	36	Green	Sat, Mod, CC	Operational for many locations
Normalized Difference Water Index (NDWI) and Land Surface Water Index (LSWI)	37	Green	Sat	Produced operationally using Moderate Resolution Imaging Spectroradiometer data
Soil Adjusted Vegetation Index (SAVI)	37	Red	Sat	Not produced operationally

Composite or modelled	Page	Ease of use	Input parameters	Additional information
Combined Drought Indicator (CDI)	38	Green	Mod, P, Sat	Uses both surface and remotely sensed data
Global Integrated Drought Monitoring and Prediction System (GIDMaPS)	38	Green	Multiple, Mod	An operational product with global output for three drought indices: Standardized Soil Moisture Index, SPI and Multivariate Standardized Drought Index
Global Land Data Assimilation System (GLDAS)	39	Green	Multiple, Mod, Sat	Useful in data-poor regions due to global extent
Multivariate Standardized Drought Index (MSDI)	40	Green	Multiple, Mod	Available but interpretation is needed
United States Drought Monitor (USDM)	41	Green	Multiple	Available but interpretation is needed

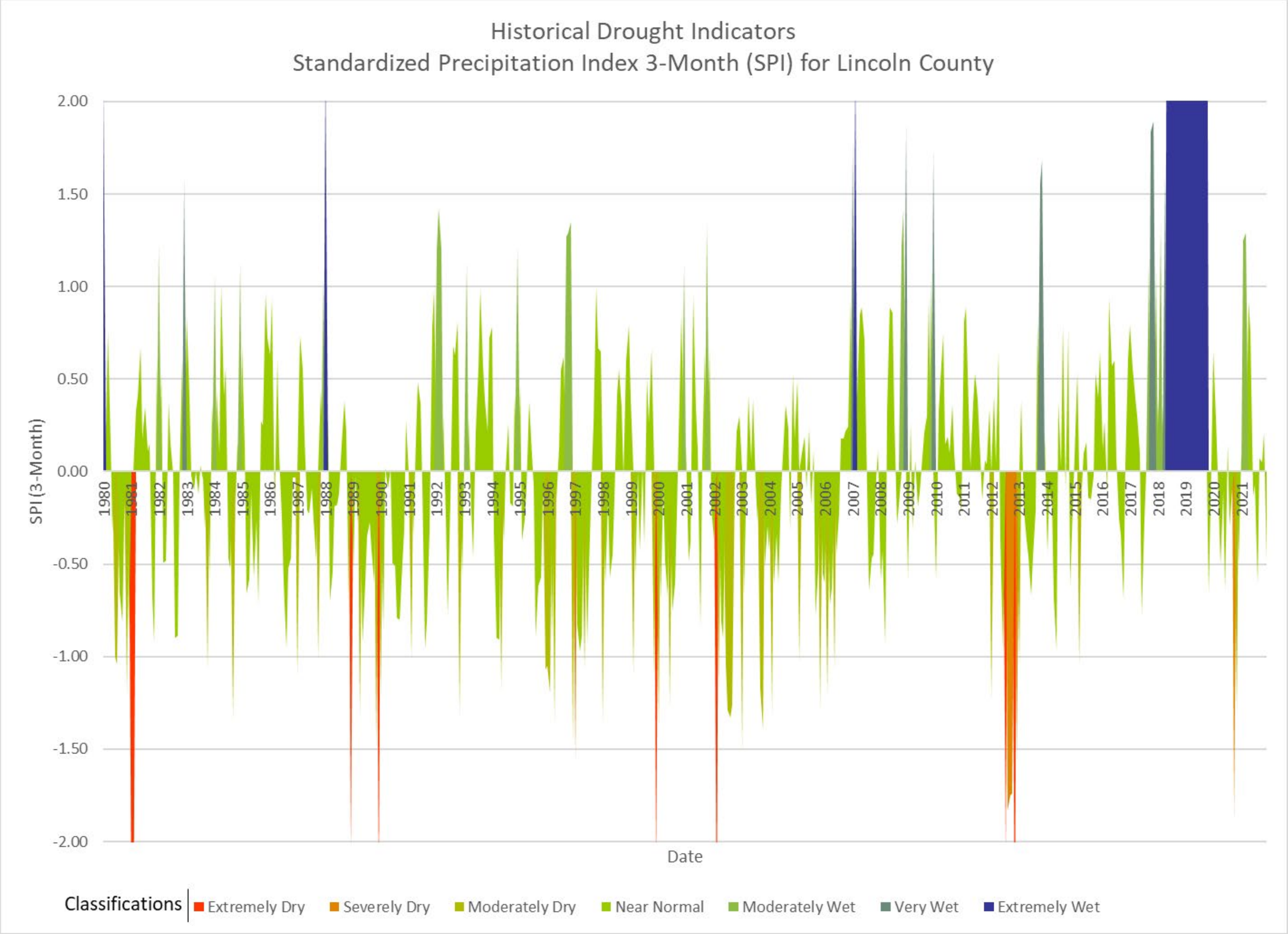
Note: Indicators and indices are sorted by 'ease of use' and then alphabetically within each 'ease of use' category.

Source: WHO. 2016. Handbook of Drought Indicators and Indices.

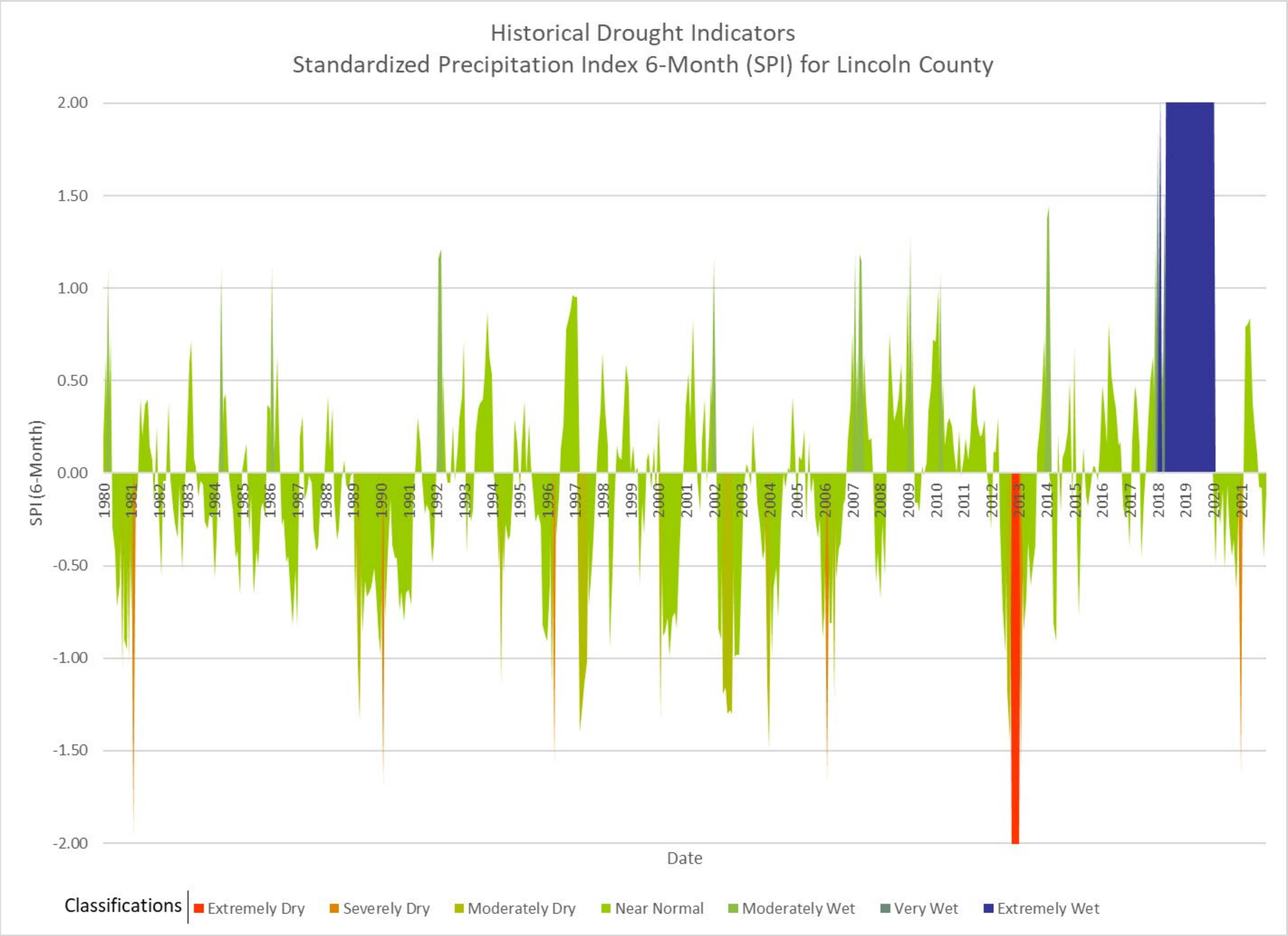
Standardized Precipitation Index (1-Month)



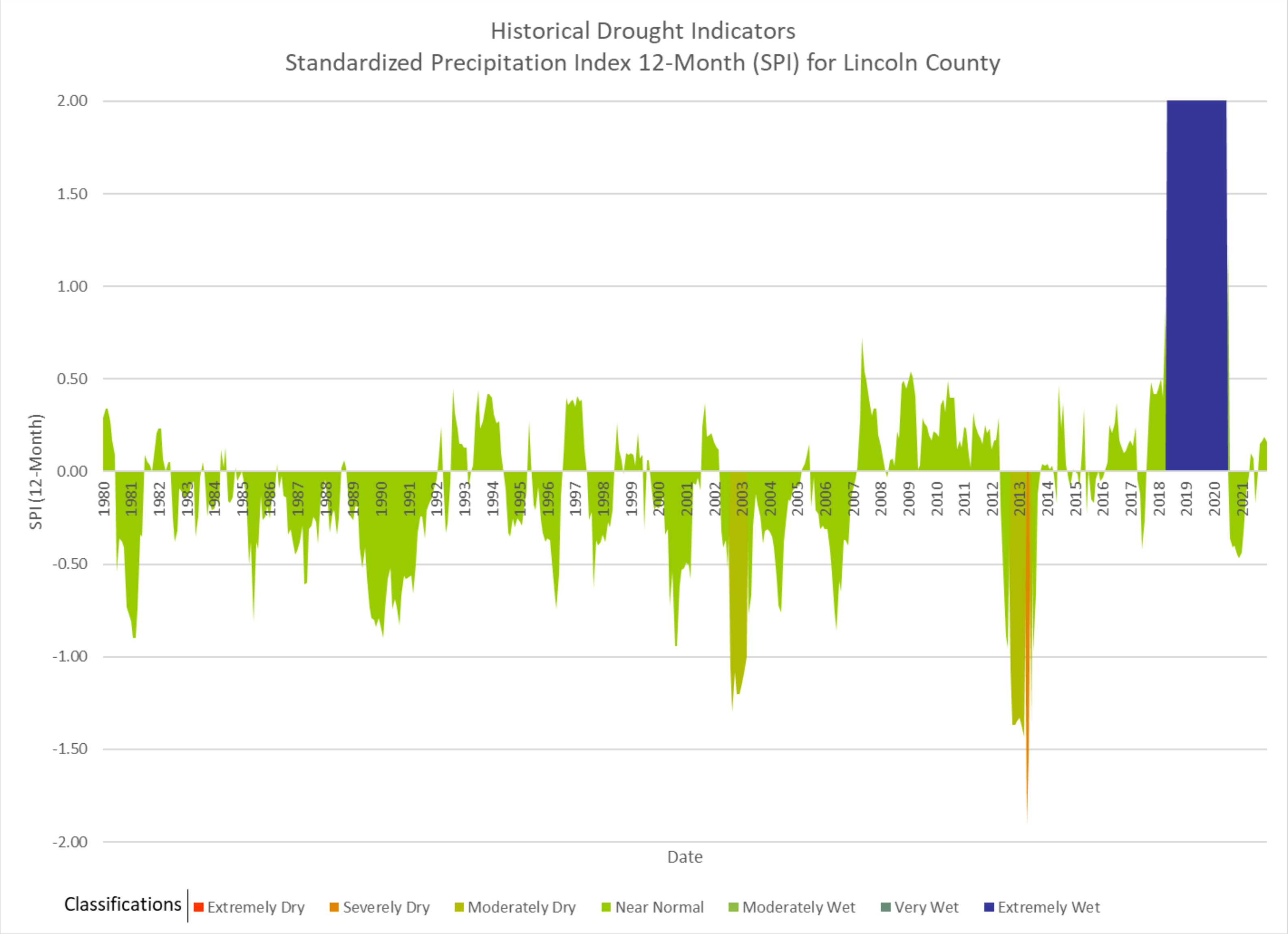
Standardized Precipitation Index (3-Month)



Standardized Precipitation Index (6-Month)

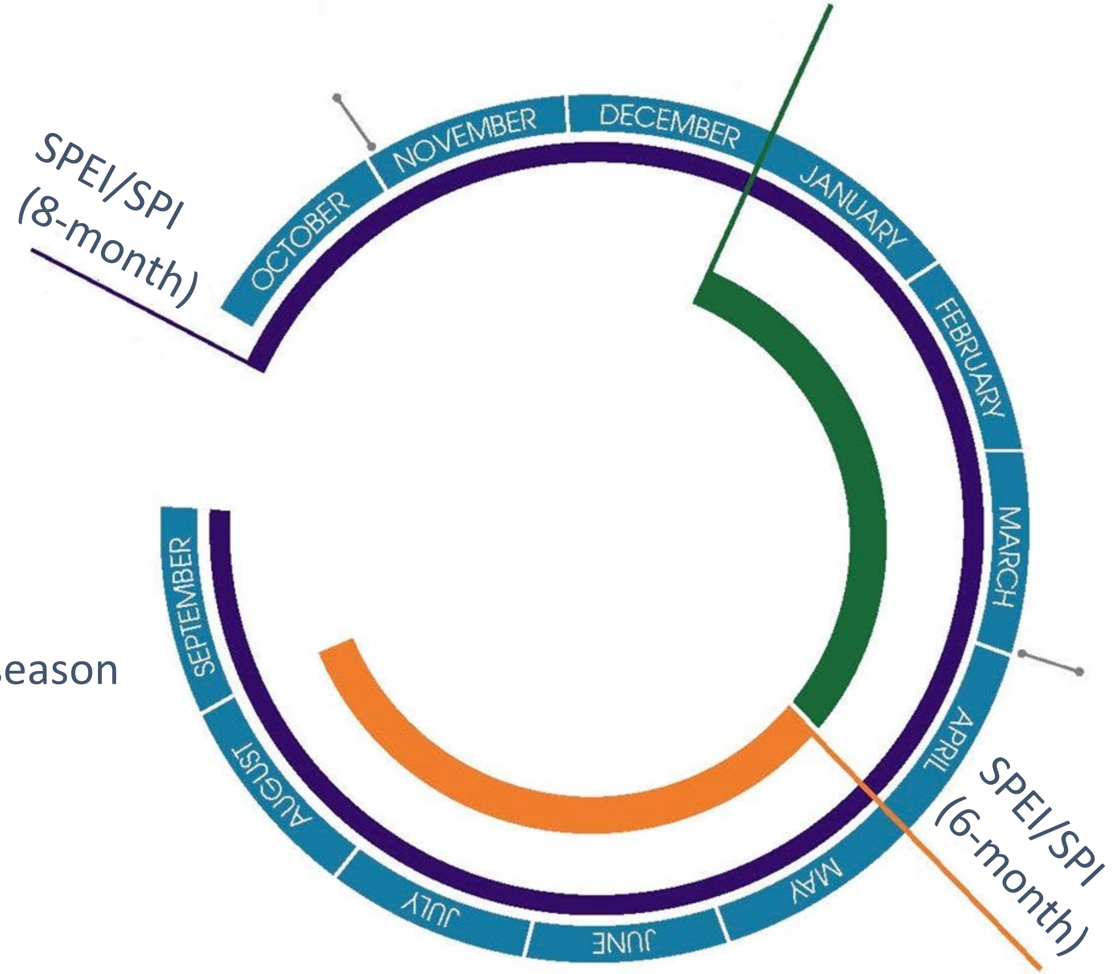


Standardized Precipitation Index (12-Month)



Drought Indicators Shortlist – Irrigation Yields

Crop Types:
Alfalfa
Corn,Irrigated
Sorghum,Irrigated
Soybeans,Irrigated
Wheat,Irrigated



Impact occurs:
End of growing season