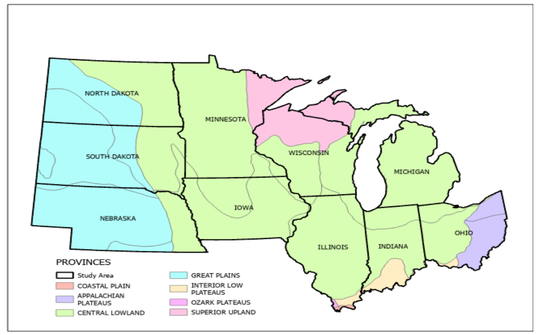
Spatial and temporal assessment of meteorological drought using the Standardized Precipitation Index (SPI) and its effect on crop yield over the Corn Belt Region of the United States from 2000 to 2023

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Introduction

Area of Interest - Corn Belt
Sections – Western & Eastern



Climate change and global warming have contributed to extreme weather events and patterns, including severe flooding, earthquakes, wildfires, and drought.

Drought happens to be the deadliest catastrophic event around the world.

Drought's impact on ecosystems and local communities has been rising in many parts of the world, including the United States and most importantly the corn belt, which also happens to be the country's food basket.

Research Question

What are the relationships between wet and dry periods of average precipitation below and above normal drought in the corn belt region?

Objective

The main objective for this research is to assess wet and dry conditions using SPI to examine the characteristics of spatial and temporal patterns of drought from 2000-2023.

Methods

Data

Standardized Precipitation Index (SPI) by using raster data to represent the pattern and trend of drought within the corn belt region from 2000-2023 derived from the Gamma Distribution – GridMET Drought – 4km

Blends spatial attribute data from PRISM and NLDAS-2

Provide inputs of ecological, hydrological and agricultural data

Source: Climate Engine

SPI Calculation

$$SPI = -(t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3}); t = \sqrt{\ln\left[\frac{1}{(H(x))^2}\right]};\ 0 < H(x) \leq 0.5$$

$$SPI = t - \frac{c_0 + c_1 t + c_2 t^2}{1 + d_1 t + d_2 t^2 + d_3 t^3};\ t = \sqrt{\ln\left[\frac{1}{(1 - H(x))^2}\right]};\ 0.5 < H(x) < 1$$

C_0=2.515517	C_1=0.802853	C_2=0.010328
d_1=1.432788	d_2=0.189269	d_3=0.001308

Analysis steps

Downloaded data and clipped out raster for area of interest. Classified a raster to represent the color scale and replicated all raster sets for all the years within the study to represent the pixels for the SPI criteria.

The three classes listed for drought conditions are presented from moderately dry (-1.0 to -1.49), very dry (-1.50 to -1.99) and extremely dry (-2.0 and below) conditions. Positive values represent wet conditions.

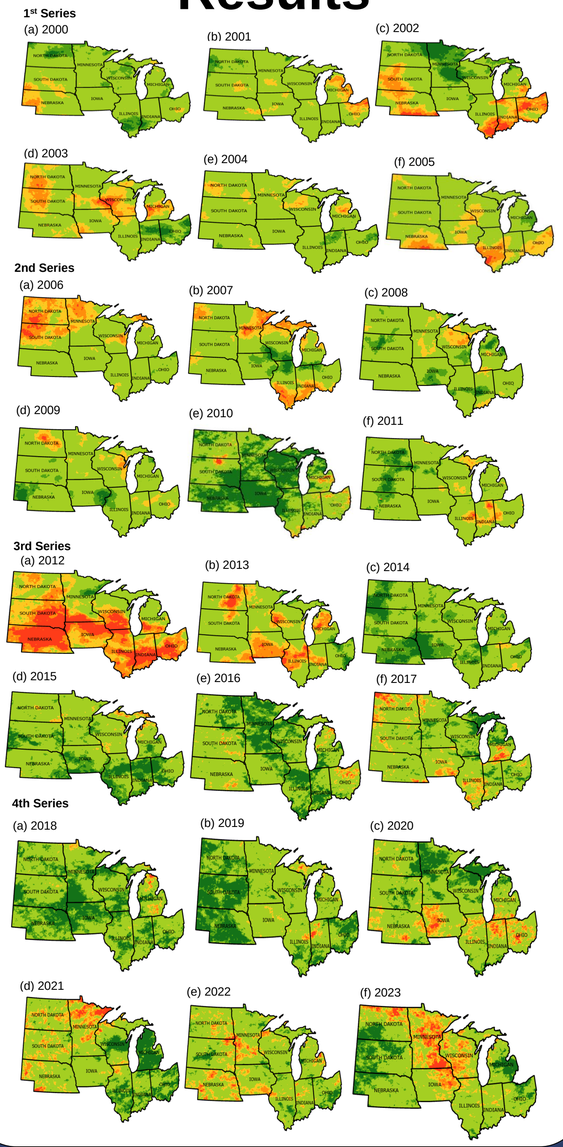
Results represent all years from 2000-2023 and were contained in a series of four sets representing six years for each set.

Formal Definition: SPI is an index that assesses precipitation calculated from a long term mean and is processed into standard deviation to discern between wet and dry conditions.

SPI

- +2.0 and above (extremely wet)
- +1.50 to +1.99 (very wet)
- +1.0 to 1.49 (moderately wet)
- -0.99 to +0.99 (near normal)
- -1.00 to -1.49 (moderately dry)
- -1.5 to -1.99 (very dry)
- -2.0 and below (extremely dry)

Results



Conclusions

Discussion

2002, 2006, 2012, 2013 represented the most coverage representing very dry to extreme conditions along portions of west and east corn belt.

2012 represented widespread coverage of extremely dry conditions along most sections of the region. Regions most impacted were along sections of the plains stretching into Indiana and Ohio and portions of Michigan.

2004, 2014, 2018 and 2019 showed little to no drought spread over the entire series. Despite some areas presenting some patches of drought, many areas were presenting wet conditions.

Summary

Extremely dry conditions showed the best correlations for the years 2002, 2006 and 2012.

Moderately to very dry conditions showed best correlations for 2002, 2006 and 2013.

Patterns of little to no drought conditions were observed for 2004, 2014, 2018 and 2019 with 2014 showing the smallest drought coverage of them all.

Drought patterns were observed mainly along portions of the Great Plains and eastern Corn Belt Plains while some years showed drought patterns along northern sections of the region.

Most drought correlations found in first three time series with third time series representing maximum correlations.

Wettest pattern observed mainly during fourth series within the study.

Acknowledgements

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