Is Drought a Driver of Renewable Energy Development in the United States?

WATER INSTITUTE SYMPOSIUM

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ABSTRACT

Drought is one of the costliest natural hazards in the United States and globally. Droughts devastate farmers, prompting some to diversify income through renewable energy. As droughts worsen and green energy demands rise, this study explores if droughts drive wind power development on farmlands. We analyze if drought-hit areas in the U.S. get more wind power installations, suggesting drought's role in shaping renewable energy landscapes.

Keywords:
Drought, United States, Renewable energy

INTRODUCTION

At present, electricity derived from wind farms powers about 20 million homes per year in the United States. Total annual U.S. electricity generation from wind energy increased from about 6 billion kWh 2000 to about 380 billion kWh in 2021. In 2022, wind turbines were the source of about 10.2% of total U.S. utility-scale electricity generation.

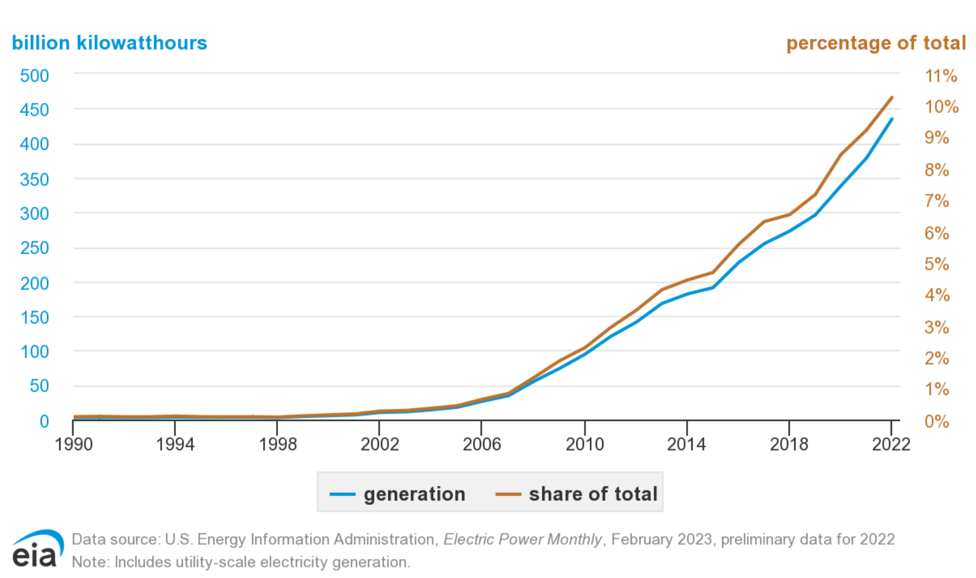


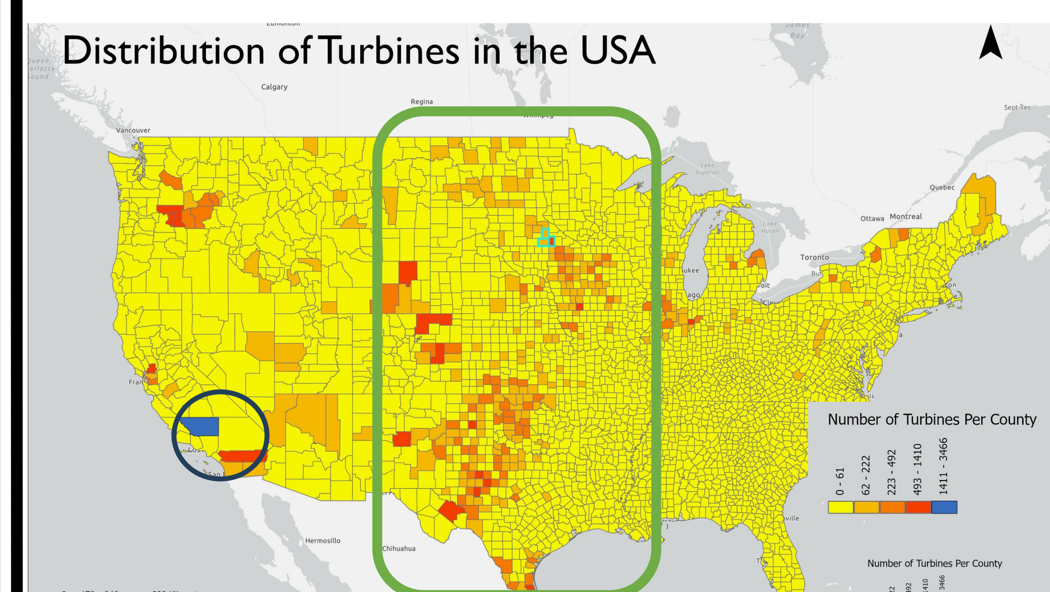
Figure 1: Graph of USA Utility-Scale Wind Electricity Generation

OBJECTIVES

To investigate the role of drought in renewable energy development.

- Are drought-stricken farmlands more likely to be subject to new wind installations?
- What is the role of drought as a spatial driver of renewable energy development in the U.S?

MATERIALS & METHODS



The Central Plains was chosen as the study area based on the turbine distribution across the country.

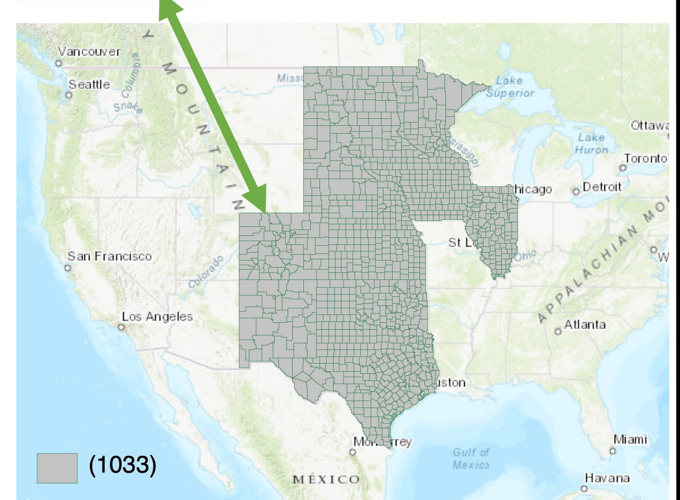


Figure 2: Case Study Map

Table 1: Data Used in the analysis

DATA	YEAR	DATA TYPE	SOURCE
# of Turbines/County within farmland	2000 - 2023	Points	USGS
Wind Speed	2008 - 2017	Raster	Global Wind Atlas
Farm Area	2008 - 2022	Raster	US Dept of Agriculture
Pop Density	2000 - 2020	Polygon	US Census
Annual Cumulative Drought Index (ACDI)	2000 - 2022	Raster	US Drought Monitor

Counties are grouped based on if they have wind turbines in agricultural areas or not. Figure 3 shows a representation of ACDI from 2011 to 2022 for different states using the with and without turbines groups of the counties and applied both descriptive and spatial statistical analysis.

RESULTS & ANALYSIS

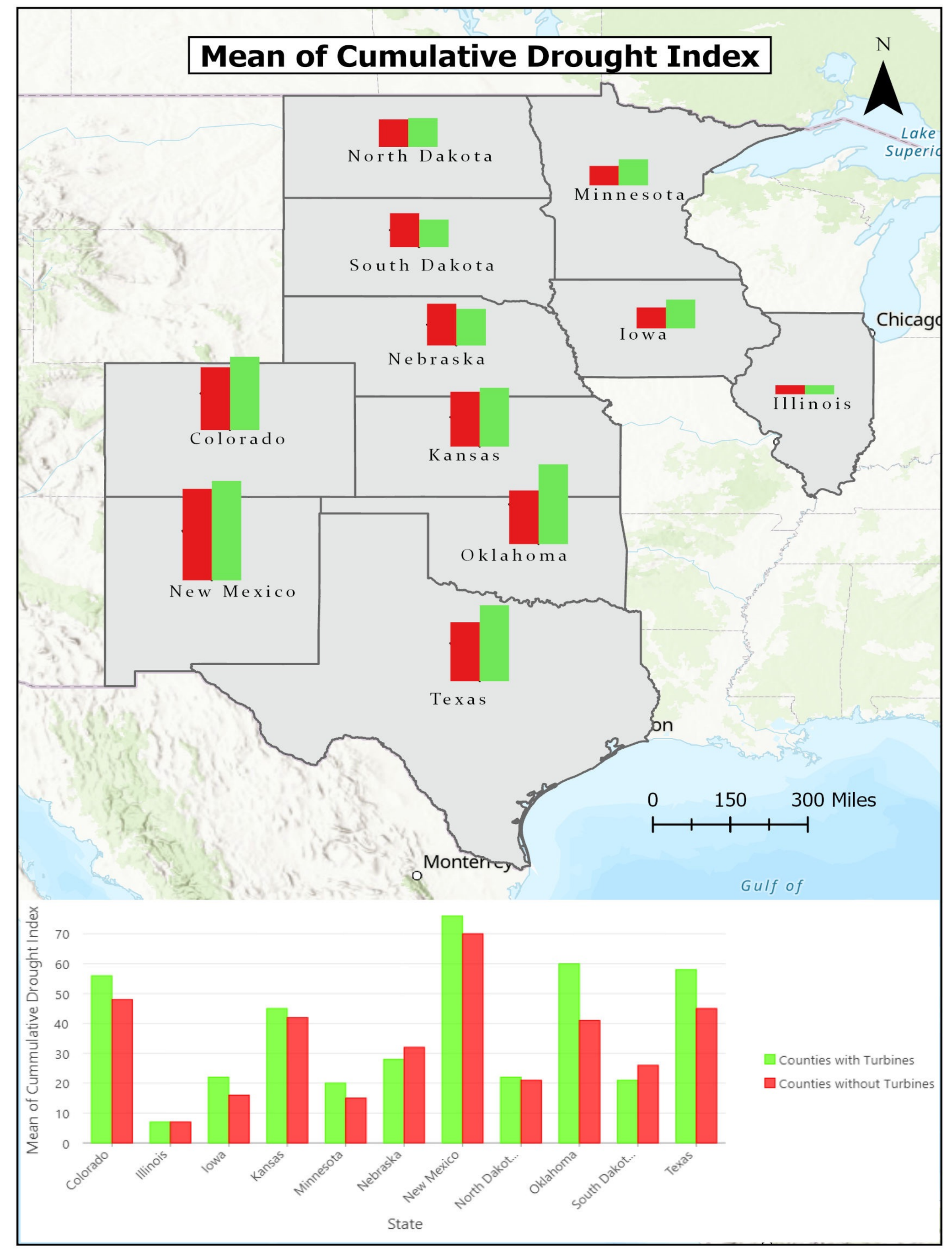


Figure 3: Mean Cumulative Drought Index for counties with and without wind turbines.

7 out of 11 states are dominated by counties that have wind turbines and that have experienced more severe droughts than counties without wind turbines.

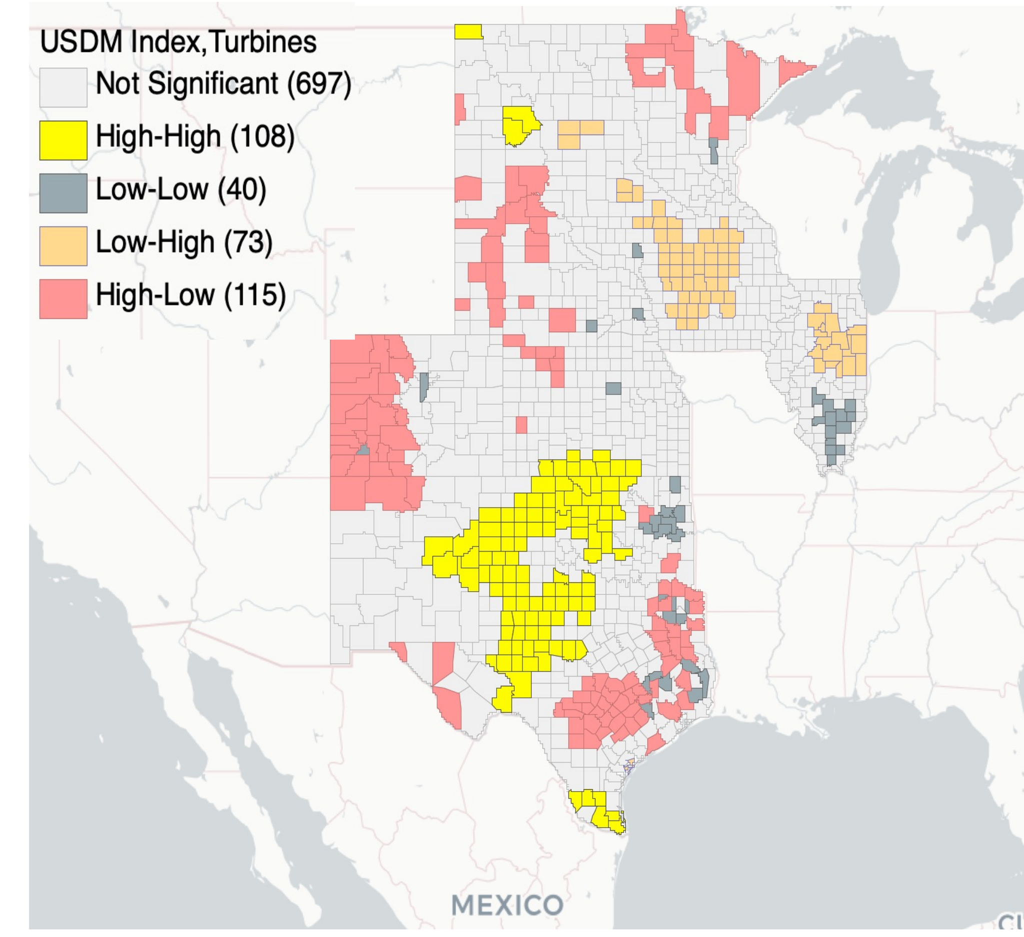


Figure 4: County level Bivariate Color Maps for high and low values between No. of Turbines, Drought index

108 out of 1033 counties are hotspots of both drought and turbines, as in Figure 4 . Figure 5 illustrate the spatial bivariate relationship between Agricultural Land, Population Density, Drought index and Turbines. There is high correlation between drought index and turbines for New Mexico and Texas, while Minnesota has both low drought index and turbine values.

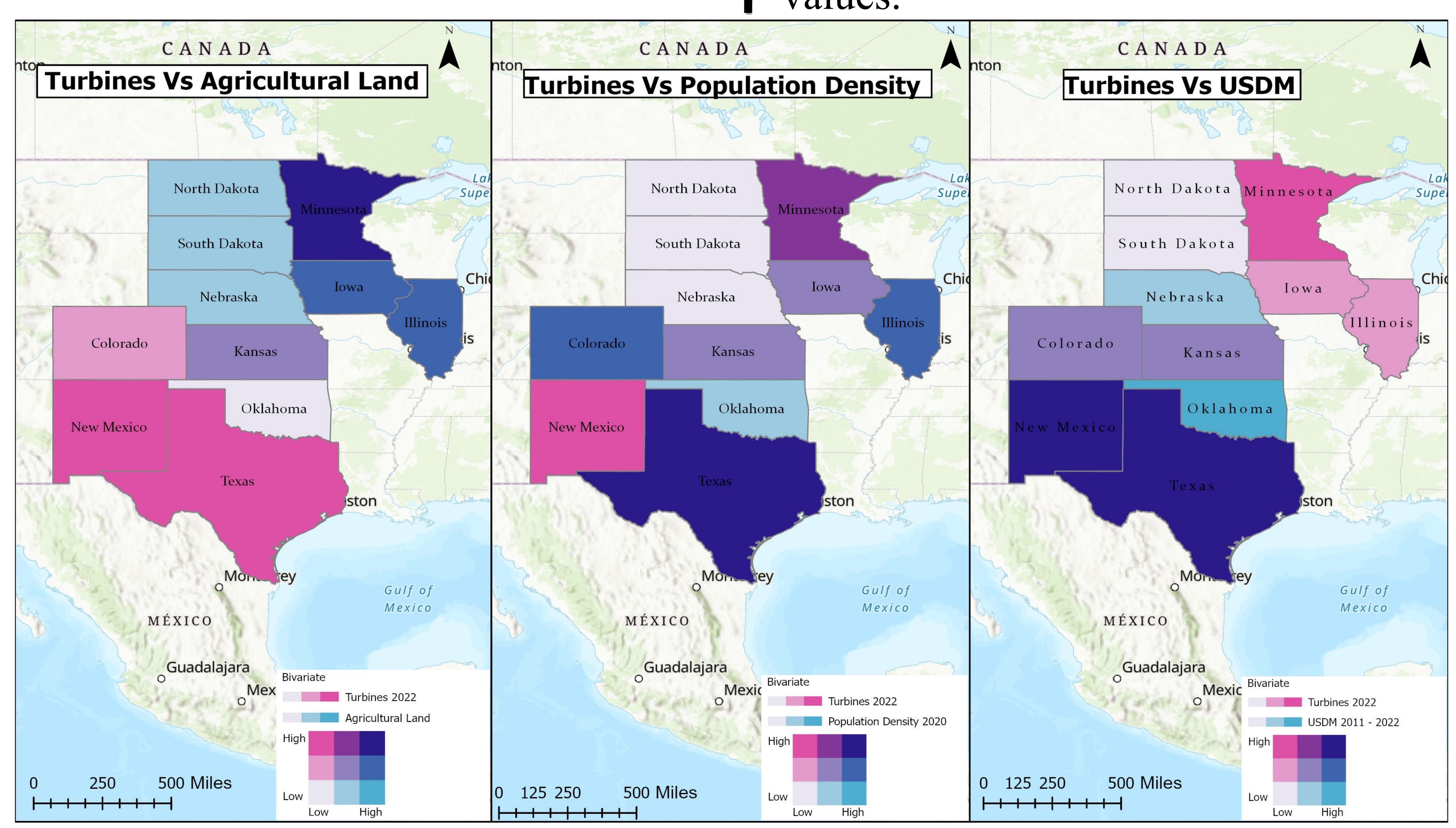


Figure 5: Local Bivariate Color Maps for high and low values between Turbines and Agricultural Land, Population Density, and Drought index

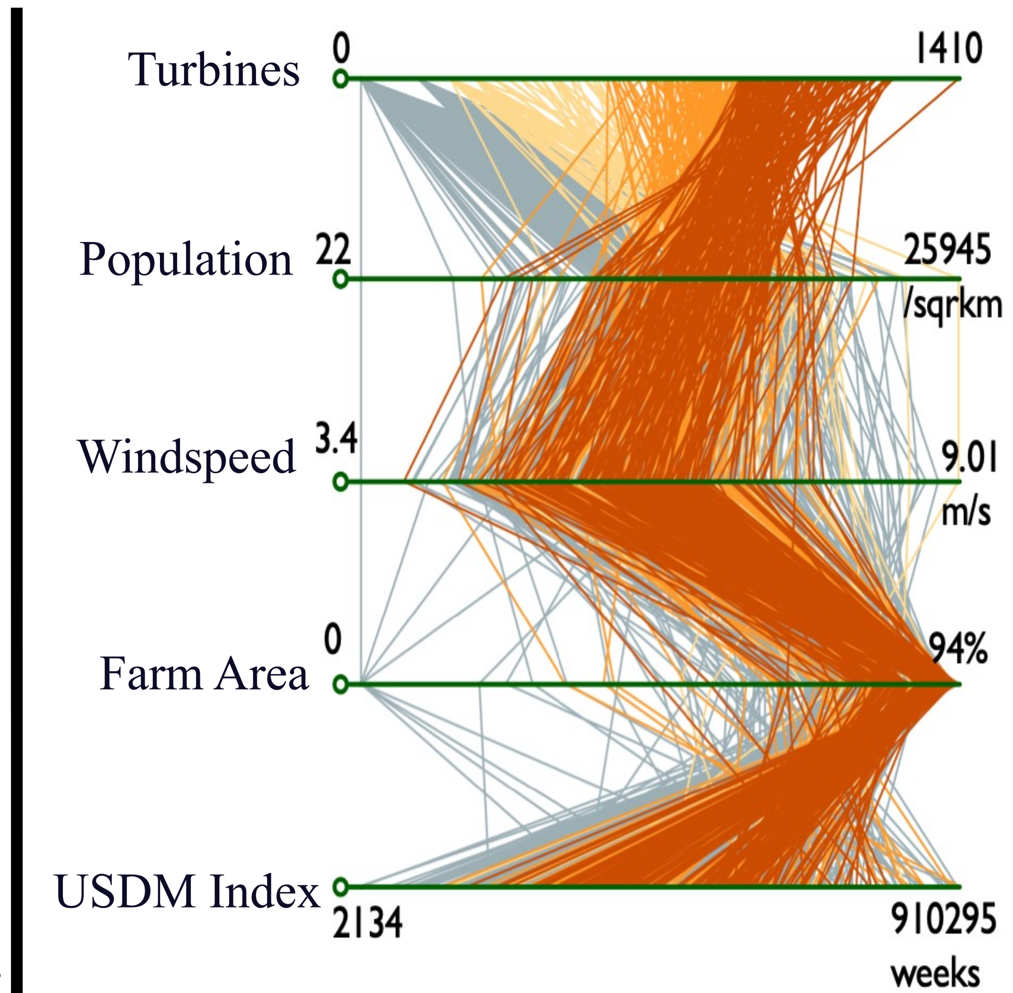


Figure 6: The parallel coordinate plot

The parallel coordinate plot in Figure 6 further depicts the connection between the number of turbines and the four variables.

CONCLUSION

The results of this study suggest that utility-scale wind power installations are more common in the agricultural areas of the Great Plains that have repeatedly been impacted by drought since 2000-present.

Next steps include a time-series analysis to determine the timing of major drought events vs installations of wind turbines in that region, as well as including solar power installations, which might be a viable option in regions that are less favorable for wind power.

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