Site Suitability for Wind Farms in the United States

Mark Schmidt

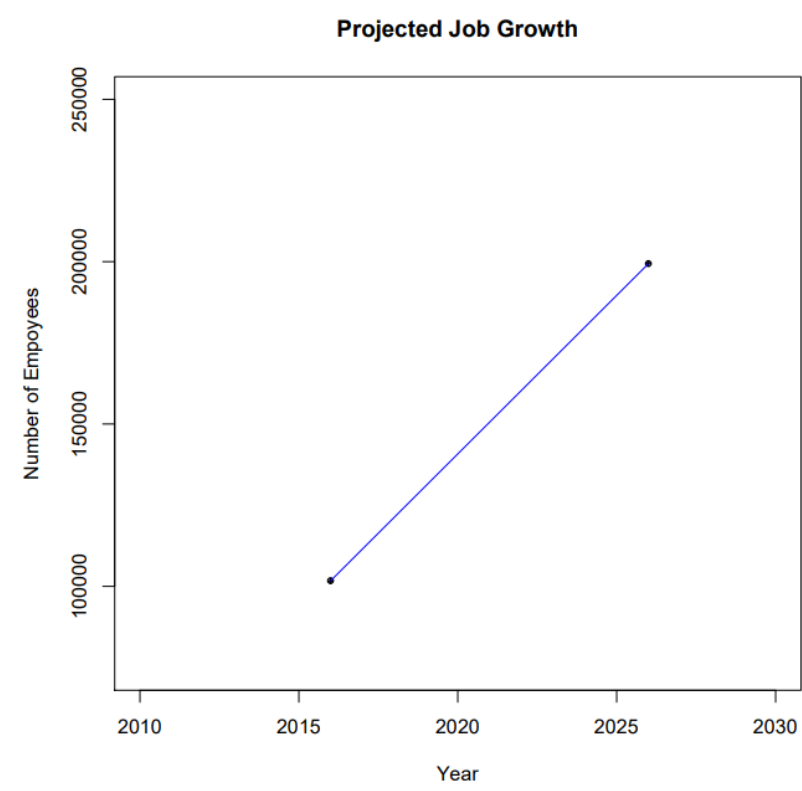University of Kansas, Department of Geography and Atmospheric Science
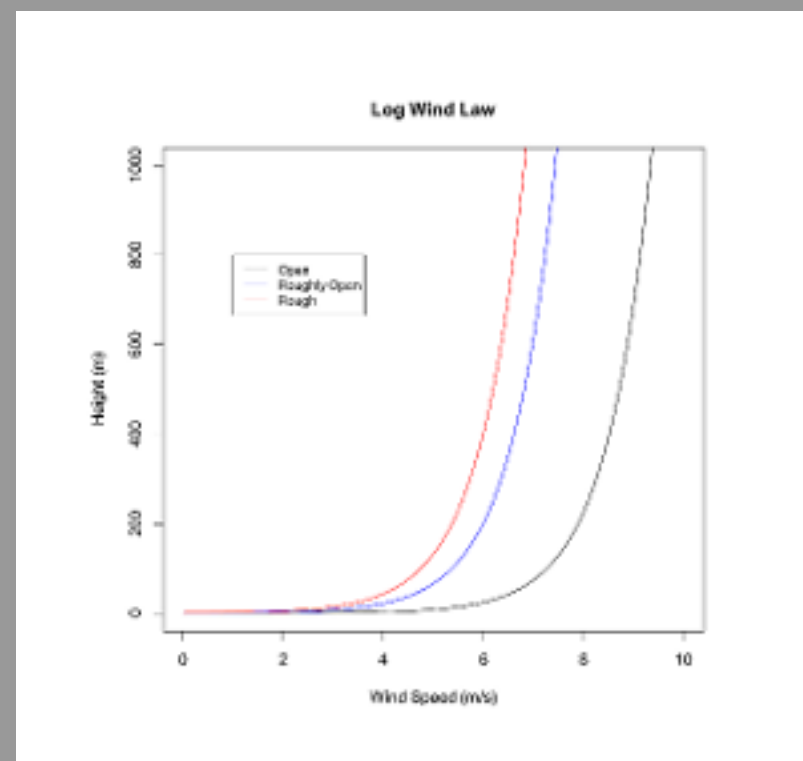
Background

- The earth is getting warmer and causing major changes in weather patterns.

- Extended dry spells and short intense bursts of intense storms causing major flooding are some weather patterns that are expected with an increase in global temperature.

- Wind power is a clean alternative to other power sources like fossil fuels.

- Not only is wind energy good for the environment, it is also good for the economy.

Objectives

1. Obtain wind data to find the areas with the strongest wind.

2. Find appropriate land cover to find open areas to place wind farms.

3. Overlay the wind data with the land cover data to find open areas with the strongest average wind.

Methods

2. Display .csv file as a grid of x and y points in ArcMap. Next convert that grid into a raster displaying longitude, latitude, and the annual average wind velocity.

1. Acquire wind data and turn convert it from a text file to a comma separated file. Acquire land cover data.

Wind: 10 year annual average velocity
eosweb.larc.nasa.gov/sse/

Land Cover: Data from USGS

3. Project the raster data to the USA Contiguous Albers Equal Area Conic projection. Next, interpolate the data using the Ordinary Kriging tool on ArcMap.

Comparison

This map displays the current locations of wind farms in the Great Plains region of the United States. Comparing this from the earlier analysis, it is clear that the Great Plains region of the United States is the best location for wind farms especially in Oklahoma and Texas.

Conclusion

- Wind power is a clean renewable energy source that will be available as long as the sun is shining.

- After learning how the wind works in different regions with different land cover types and how wind turbines produce energy, it was found that good locations for wind farms ranged from central Texas to North Dakota and the best locations for wind farms were in the panhandle region of Texas and Oklahoma.

- Using wind energy would not only help the environment by not emitting greenhouse gases into the atmosphere, it would also boost the economy by producing jobs creating and maintain wind farms. There are many benefits to wind energy that would make the world a better place.

Job Growth

- The wind energy sector provides the third largest share of electric power generation employment.

- A total of 101,738 people in 2016 worked in the national wind technology sector.

- By 2026 the number of wind turbine service technician jobs are expected to increase by 96 percent making it the second fastest growing occupation in the United States.

Wind Turbines

- Power starts to be generated by wind turbines when the wind reaches speeds of 4 to 5 m/s. The wind speed when maximum electrical output is produced is around 15 m/s.

- For safety reasons, wind turbines are designed to shut down when there are wind speeds of higher than 25 m/s.

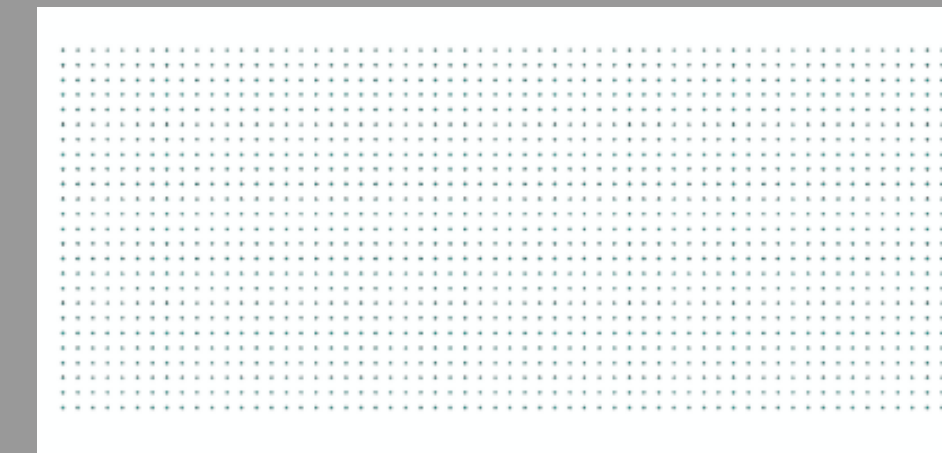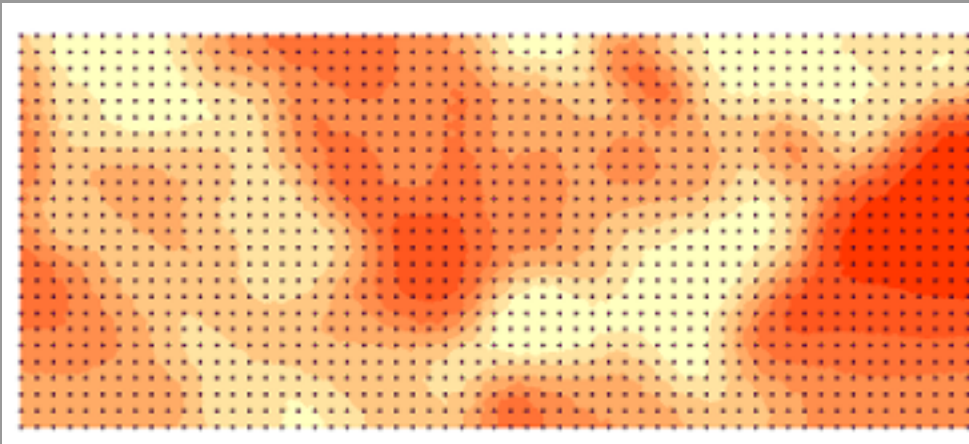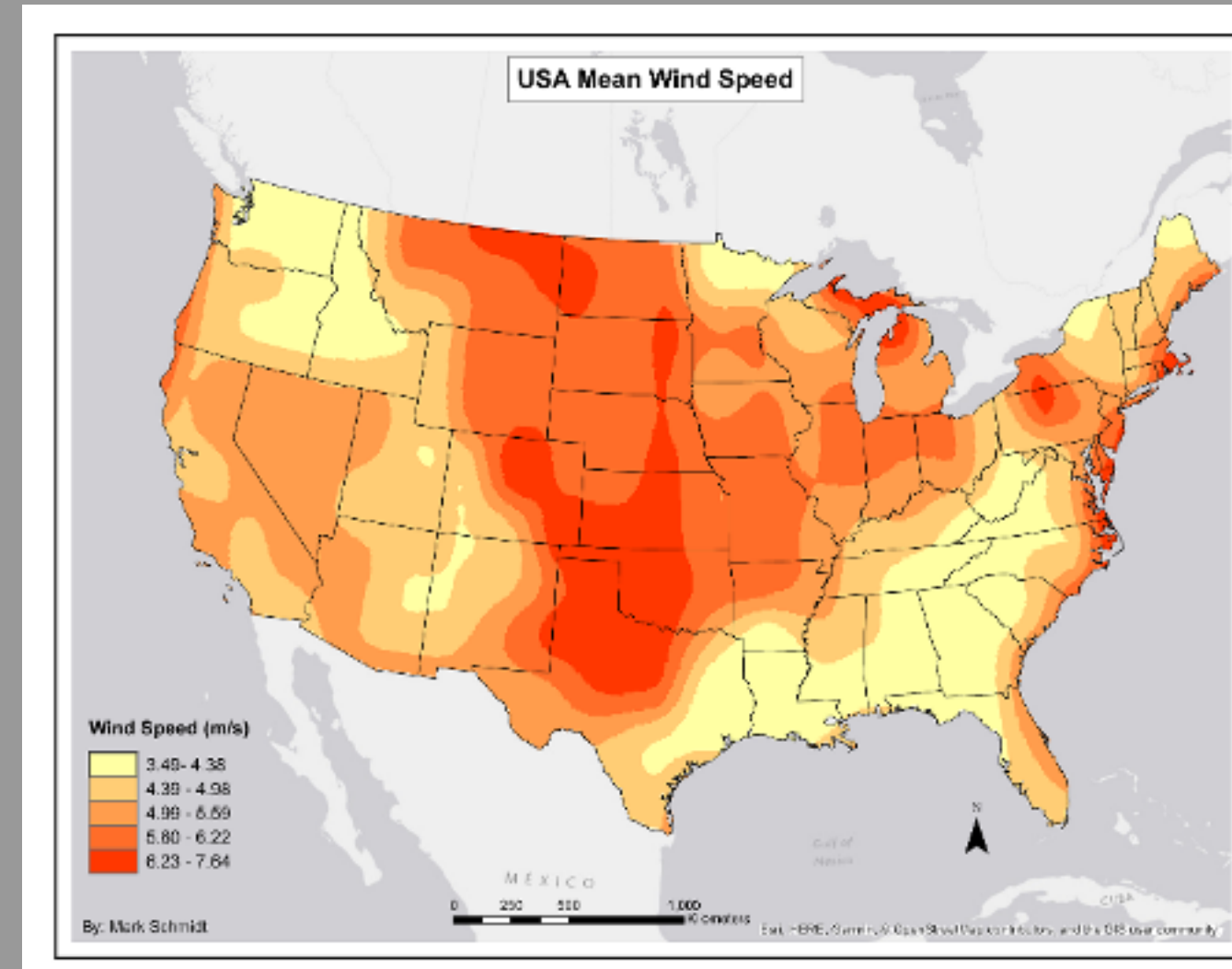- Modern wind turbines produce electricity 70-80 percent of the time

Log Wind Law

$$u = (u*/k)\ln(z/z0)$$

In the above equation u is the mean wind speed, u* is the friction velocity, k is the von Karman constant (approximately 0.4), z is the height above the surface, and z0 is the roughness length.
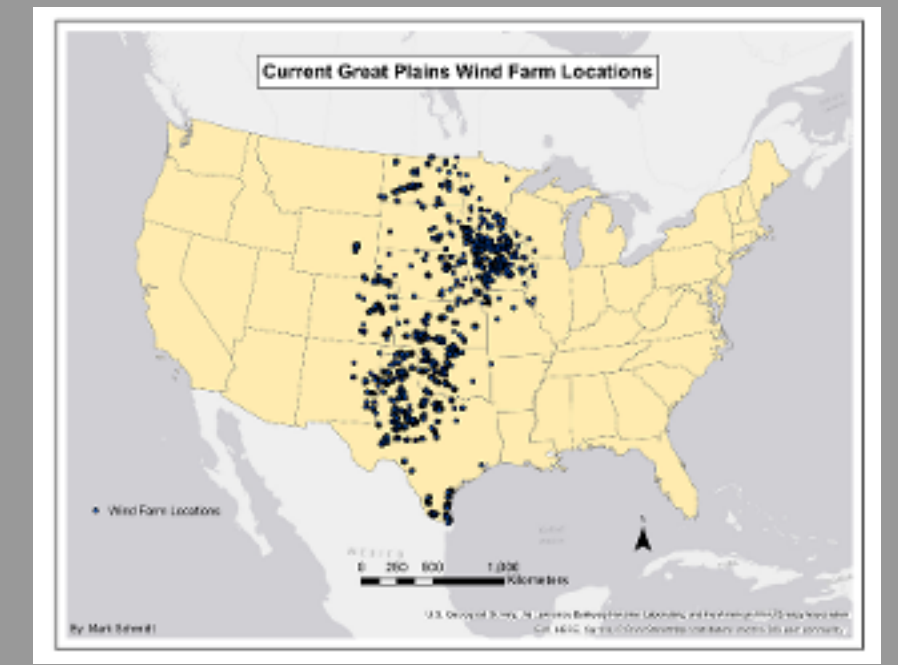
Final Maps and Discussion

1. This map displays where the strongest average annual wind occurs in the United States. It is occurring in the Great Plains region. From the Log Wind Law along with land cover analysis, this is expected because this part of the United States is mainly covered by grasslands or dry brush. This type of land cover has a roughness length of 0.3m and from the Log Wind Law the estimated wind speed 50m above the ground is between 6 and 8 m/s which is what the obvserved data shows on this map.
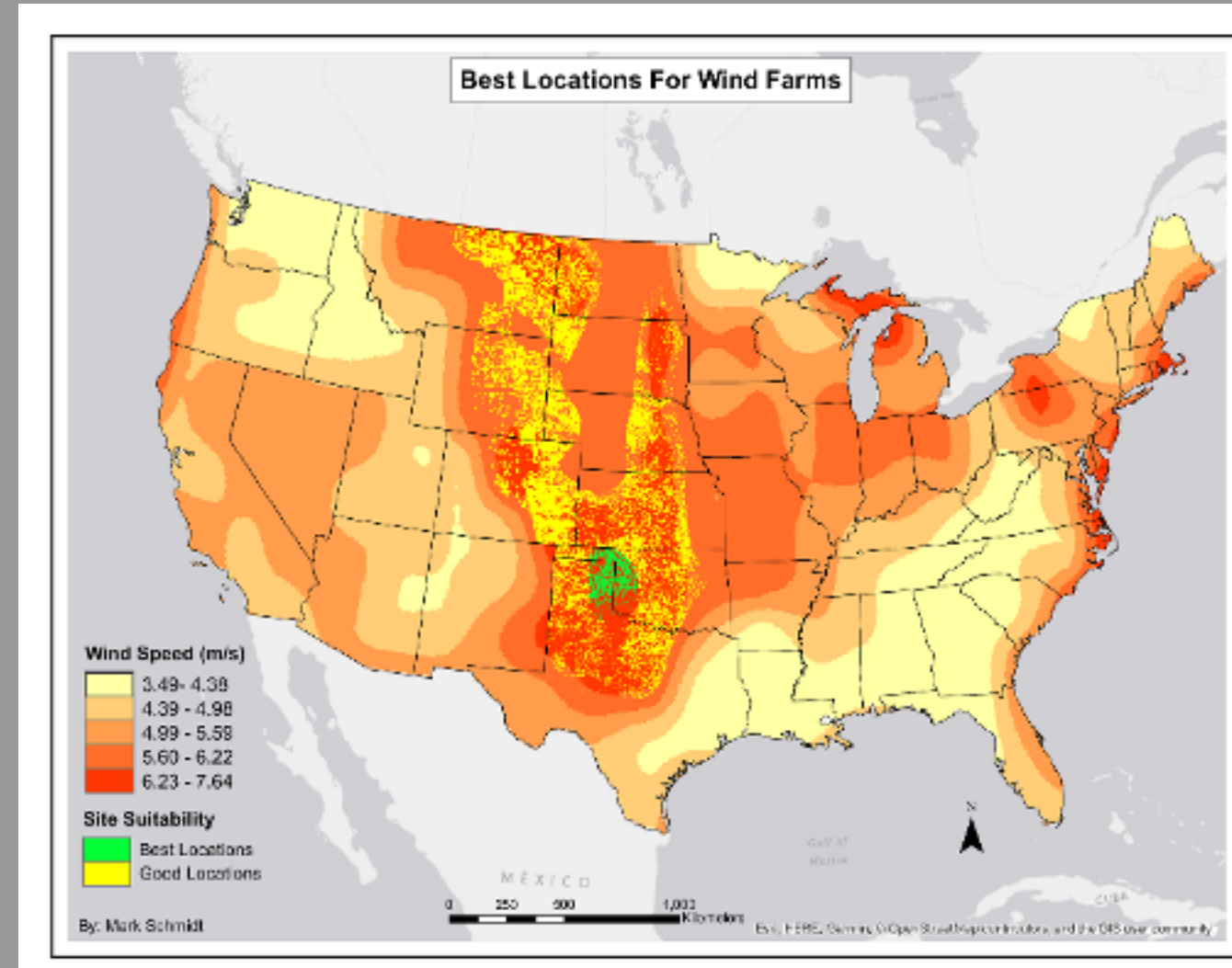
2. This map displays the best locations for wind farms in the United States. The final product was obtained by overlaying the land cover data on the average wind speed map. Then the land cover data was cut down to only display open grasslands and brush. After that the land cover data was clipped down to show the grasslands and brush lands that are located in areas with an average annual wind speed of over 6 m/s. Further classification was done to display the best locations. The best locations for wind farms are in areas with open grasslands and an average annual wind speed of over 7 m/s. Good locations for wind farms are displayed in yellow while the best locations are displayed in green. From this analysis the best locations for wind farms are located in the panhandle region of Oklahoma and Texas. Most of the central United States have enough wind and the right land cover to make them good locations for wind farms also.

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