Cooperating Tec: Wind and Solar

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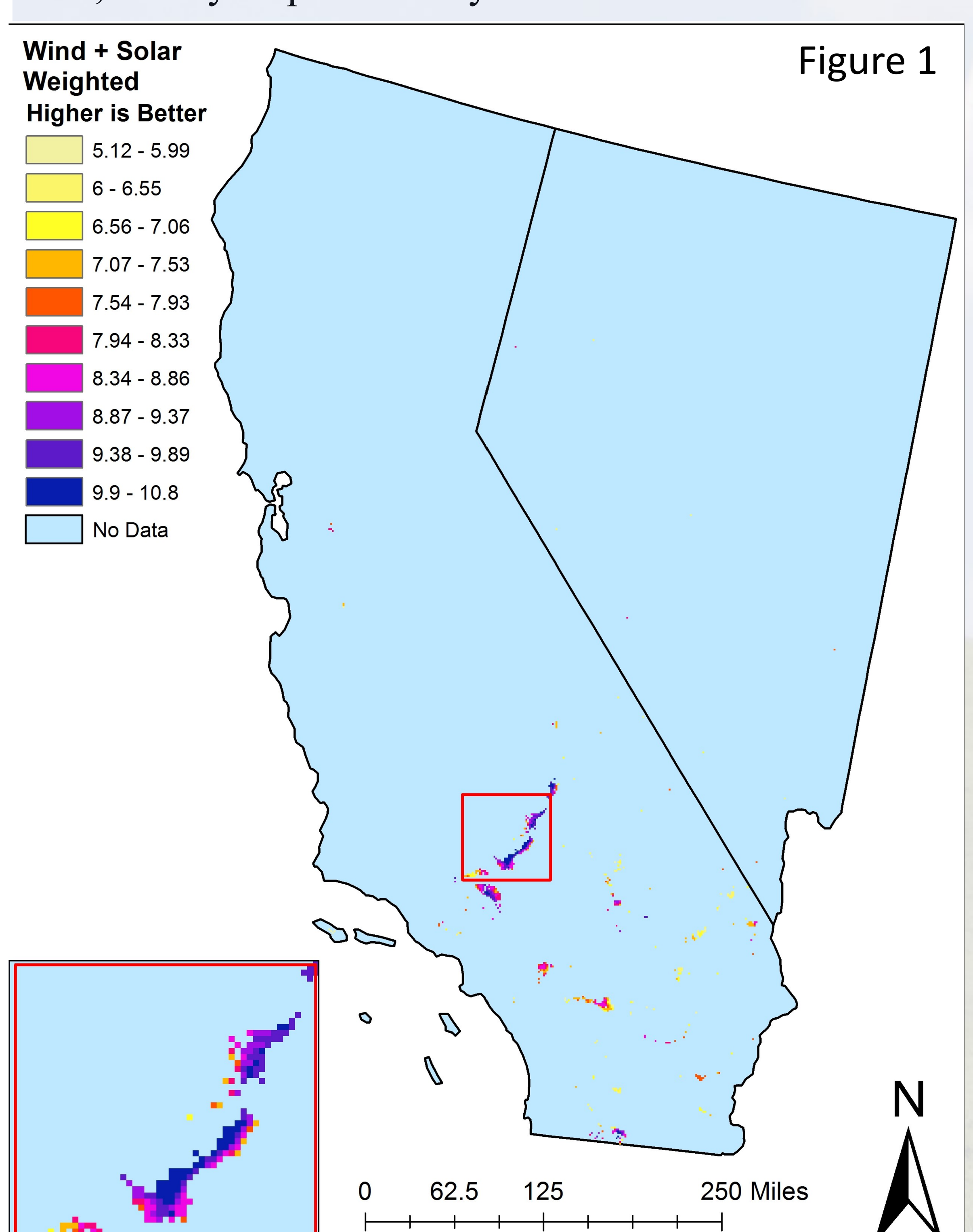
Research Question

California and Nevada are two geographically connected states that have both shared and unique resources enabling a mutually beneficial relationship. Harnessing the wind provided by California's peaks and coastline coupled with the enormous solar potential of the states' shared deserts, would foster sustainable growth for these two rapidly expanding urban areas.
Nationally wind and solar are two industries that have seen unparalleled investment, expansion and potential. Today solar and wind account for about 5% of national electricity production, 25% and 39% of new energy growth respectively and 64% of federal subsides amounting to over $10 billion. Through policy, these two states, particularly California, have set themselves on the forefront of this movement.
Data used in this project includes information on powerlines, roads, national parks, state boundaries, critical habitats, urban areas, water sources and of course regional solar and wind resources.

Methodology

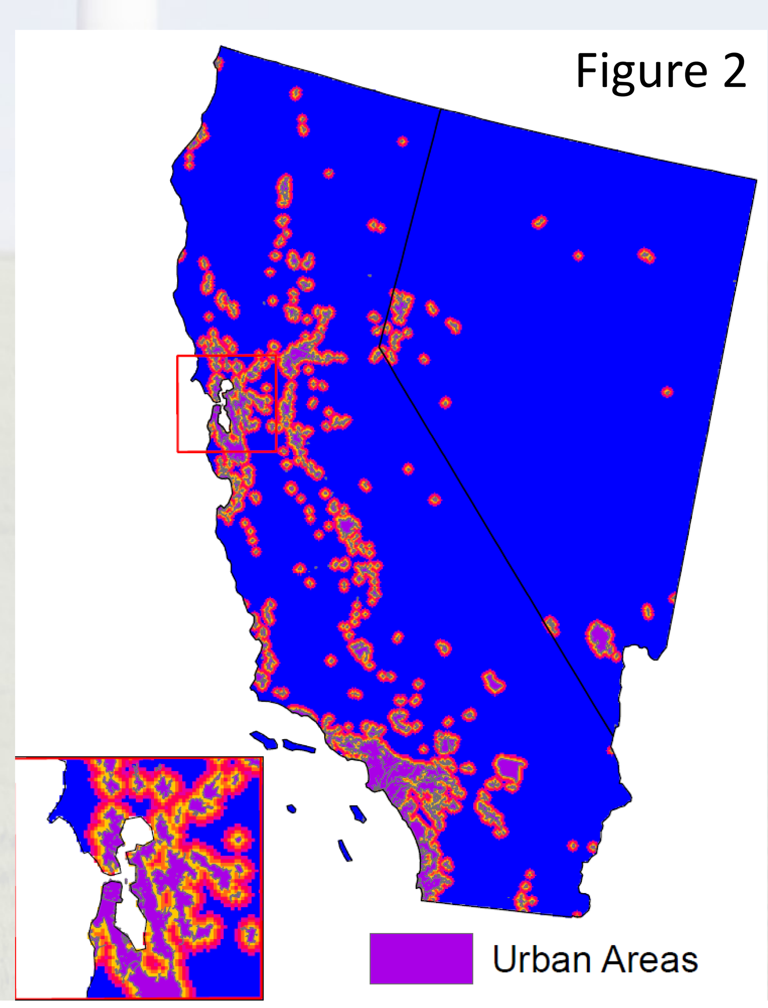
Finding the data and preparing it for processing were the first steps. National shapefiles needed to be clipped to the extent of the two states and a common projection -North America Albers Equal Area Conic- assigned to all layers to ensure commonality and measurability in meters. After that, all separate state data was merged into single layers.
Next, the layers provided by the National Renewable Energy Laboratory gave wind strength classes so I filtered the data for areas considered good, excellent, outstanding or superb measured in potential watts per square meter. I used the same criteria groups for solar though these were measured in Global Horizontal Irradiance, an industry standard.
With this processed data, Euclidean distance was used to create rasters surrounding features at classes of 2000, 4000, 6000, 8000 and max range meters. Suitability criteria were split into proximity avoided and proximity sought features. Avoidance criteria included: critical wildlife habitat, urban areas, national parks and water sources . Proximity to existing power lines, roads and obviously high wind and solar resources were considered positive criteria. Based on these positive or negative criteria, the distances were reclassified with simple integers of 1-5 or 5-1 depending on whether the features were sought after or to be avoided. These efforts created suitability maps by factor such as those in figures 2, 3 and 4 below.
In the final step, raster calculations were used to create composite maps such as those in figures 1, 5 and 6 showing most preferred areas overall. In order of importance factors were wind/solar resources, proximity to powerlines, roads, critical habitat, national parks, water bodies, urban areas.

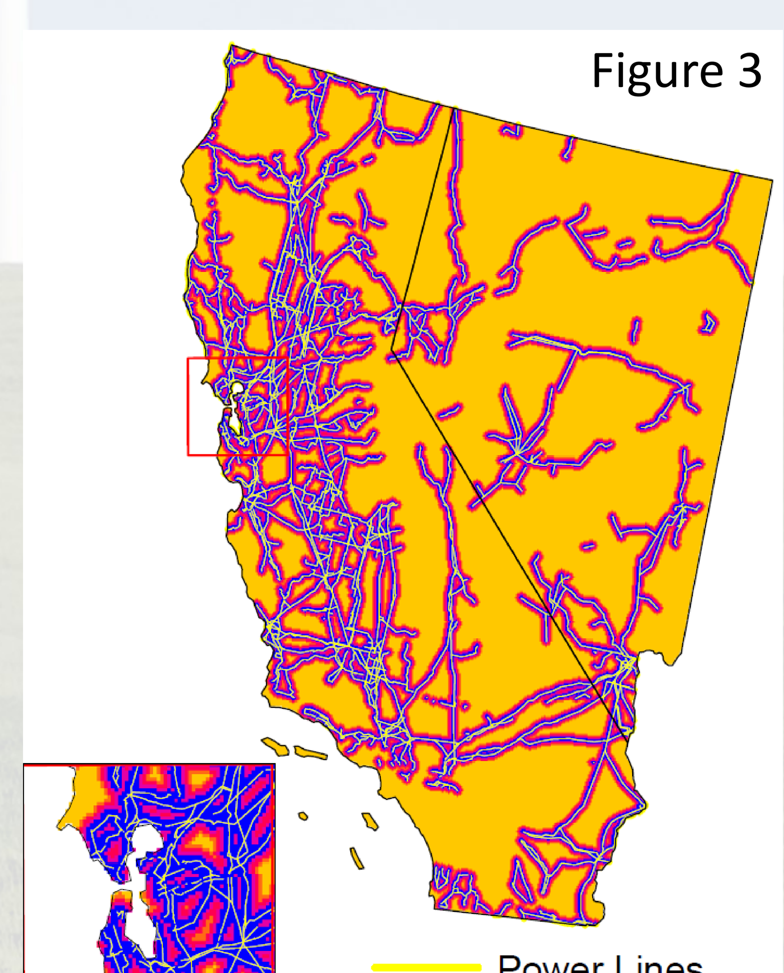


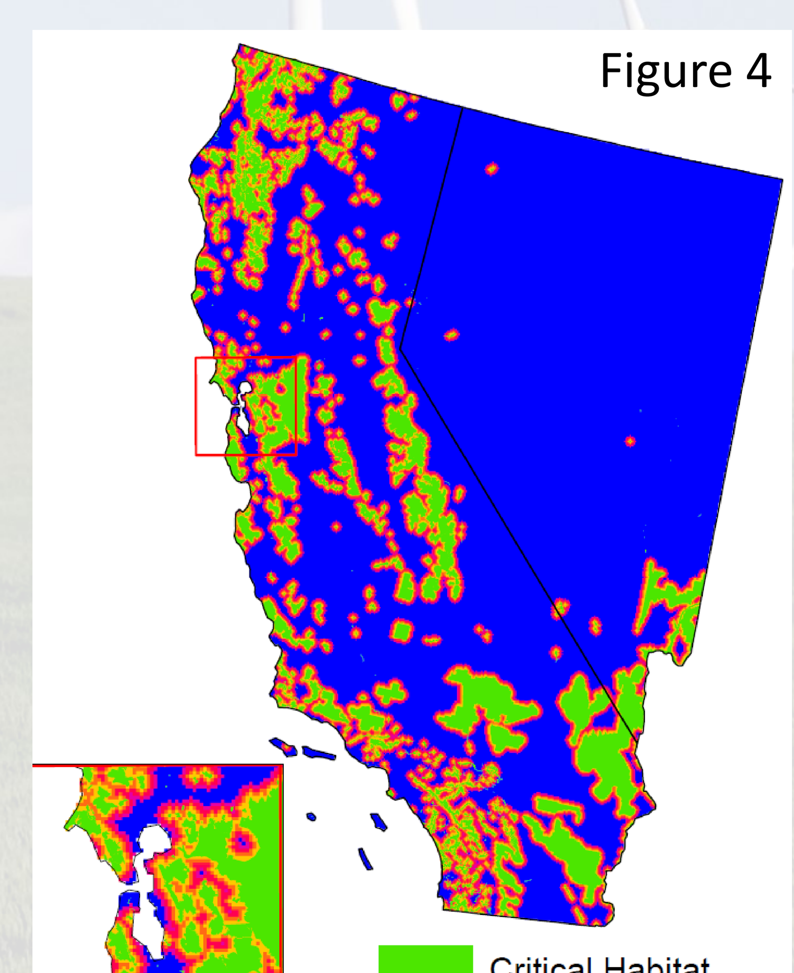
Findings

Unsurprisingly, the most suitable areas for solar production are found in the arid desert regions in the southeast of these two states (figure 6). Wind prospects are also best towards the southern part of the states but are much nearer to the Pacific Coast, likely due to the stronger currents there and wind off the more mountainous east (figure 5). The suitability maps share a linearity in some areas likely due to the high importance attributed to both power line and road proximities in the raster calculations. The box within figure 1, shows a combined weighted raster of best solar and wind prospects pointing to the ideal location for a large cluster of joint solar and wind renewable energy facilities.
Of further interest, counting the pixels within different layer classes and multiplying them by the pixel size (2000 meters) can yield estimates of total available land for energy production. Multiplying the number of pixels classified as having the highest global horizontal irradiance (5.13 to 6.00GHI in W/m²) by 2000 meters² yields 41,847,816,000 square kilometers of prime land for solar production. The same calculations show 17,380,808,000 km² of good, excellent, outstanding or superb areas for power generation by wind turbine.

Master Legend
Factor Proximity
Higher is Better
1 2 3 4 5

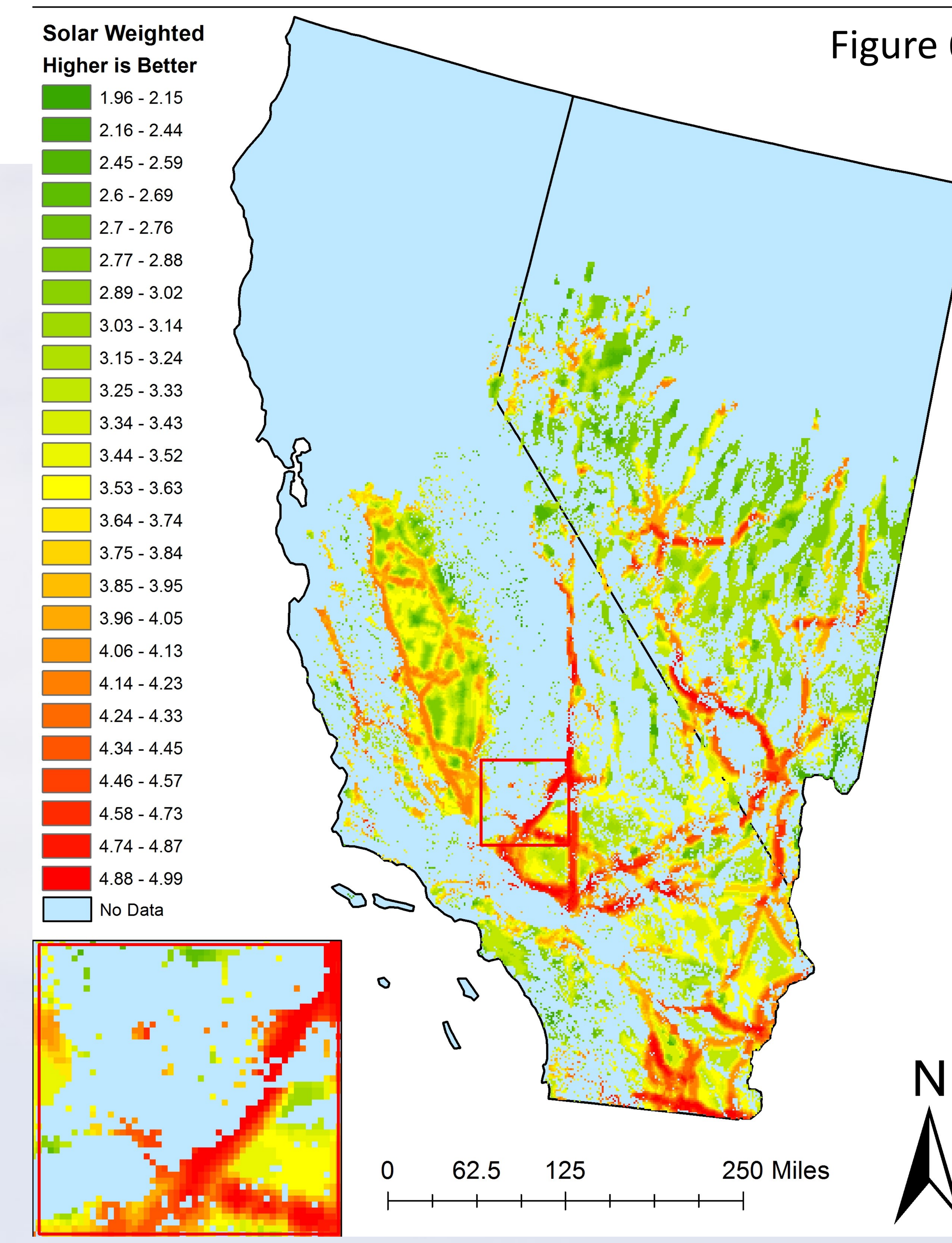


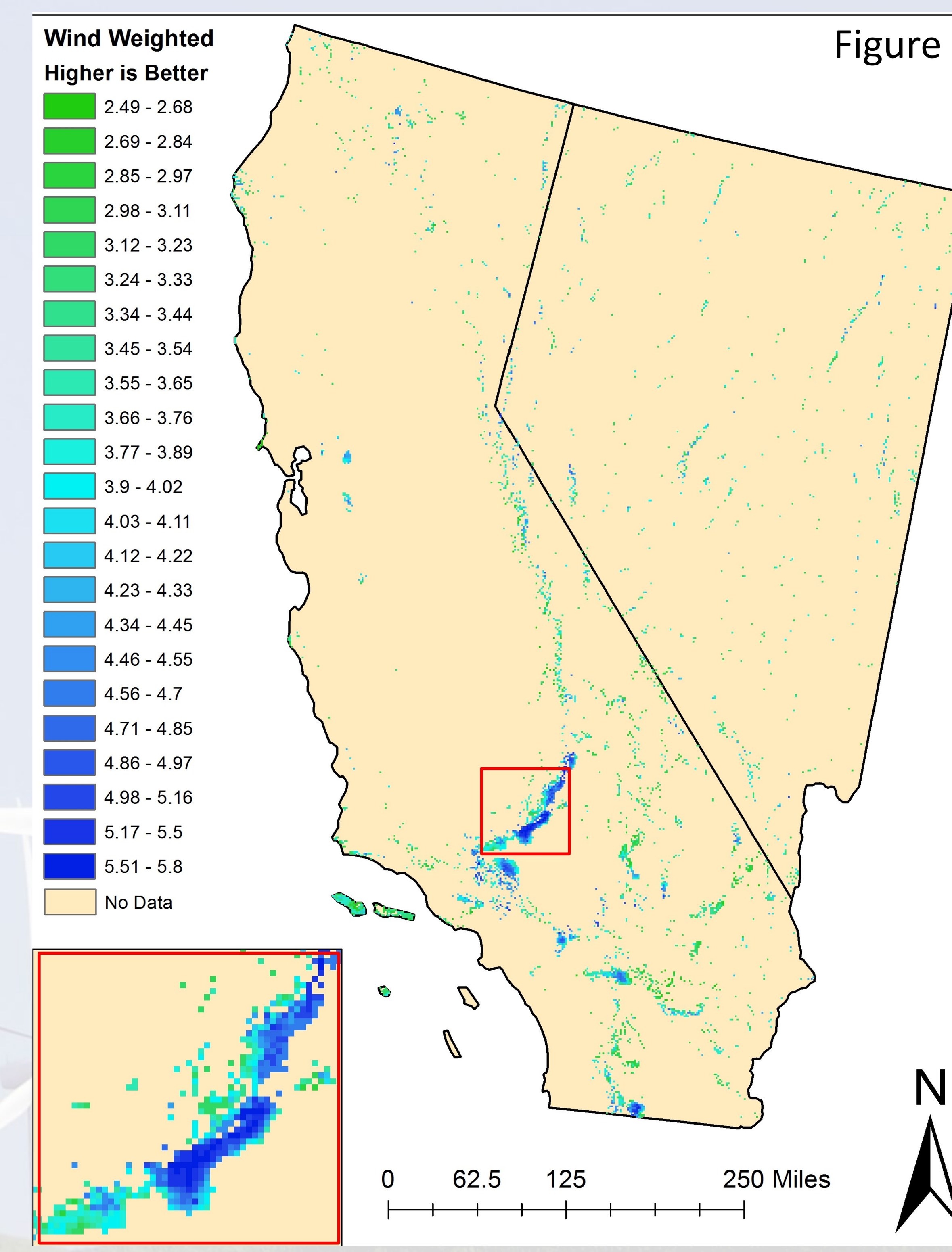




Conclusion

A major limitation of this project is the cell size used to make these very calculations. Since the cells were classified with an area of 2000 square meters, any features smaller than this, even if suitable for renewable energy production were not included in this study. Some promising areas indicated in this study could also be discredited due to factors not accounted for. However, the large cell size used in this project's process indicates there could actually be far more area suitable for even smaller industrial scale renewable energy production.
In policy terms, with the huge amount of resources and interest behind solar and wind power's implementation, maps such as these can direct these efforts towards areas that will yield the most power at the lowest relative cost to both the electric industry but also American taxpayers and consumers. With additional research into implementation costs of utility scale solar and wind farms and energy produced per unit area, spatial maps such as these could be used to calculate overall potential. Calculations such as these are especially important within the context of lofty renewable energy targets that have been set at the state, federal and even international levels.





Data Sources

GeoData@tufts.edu, National Parks Service, Census.gov, U.S. Fish and Wildlife Service, National Renewable Energy Laboratory
Projection System: North America Albers Equal Area Conic
Coordinate System: GCS North American 1983