Solar Grazing Suitability in Washington State

Cartographer: Tiffany Wu | UEP 232
Projection: Lambert Conformal Conic | Coordinate System: NAD83 State Plane WA (all maps)
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Introduction

In the realm of renewables, solar energy is rapidly expanding, with more than 2,500 utility-scale projects in the United States alone today. The utility of these large scale operations can be increased by having livestock graze on the land, allowing it to serve dual purposes. Since cropland that may otherwise need to be converted for grazing purposes can be kept in food production with the introduction of livestock to solar farms, this is beneficial to all parties involved — the solar farms themselves become pasture and receive basic maintenance in the form of mowing.

While Washington State has been a vanguard in the decarbonization sector, the majority of its efforts have been focused on hydroelectric power thus far. Growth in solar energy and indeed, solar grazing could be a novel way to strengthen the state's renewable energy efforts while providing livestock with healthy pasture. The purpose of this project is to identify sites within the state that may be good candidates for solar grazing.

Methodology

Spatial layers for slope, solar radiation, transmission line proximity and vegetation were processed for suitability with the raster calculator tool. Elevation was collected as individual digital elevation model (DEM) tiles and mosaicked using the Mosaic to New Raster tool to form one large raster for the entirety of the state. Slope was then obtained through calculating percent rise, and reclassified on a scale of 1 to 5, with 5 being the most optimal and 1 being the least. The elevation-to-slope layer was then clipped to the boundaries of the Washington polygon. The solar radiation raster, which originally included data for the entire planet, was first clipped to state boundaries before being reclassified on the same scale. Transmission line proximity was also clipped to the state before being calculated via Euclidean distance and then reclassified. Vegetation data was specifically for the state and did not need to be clipped, but did require significant reclassification as there were over a hundred vegetation categories that needed to be scored on the same 1 to 5 suitability scale.

Once the four layers were geo-processed, they were then combined using the raster calculator for a suitability map that would represent the whole state. A score close to 20 (5 + 5 + 5 + 5) would represent the best siting for solar grazing, whereas a score close to 4 (1 + 1 + 1 + 1) would mean the opposite. Layers were not weighted because each factor contributed equally to the success of a solar grazing operation, with flat landscapes, adequate sunlight levels, power line proximity and appropriate vegetation all being similarly important. A second, simplified suitability map was created by running the raster calculator for scores greater than or equal to 17. Zonal Statistics by Table was then used for this layer and mapped back to a vector layer of state counties. In the ensuing county attribute table, SUM was divided by COUNT using the field calculator to determine the five most suitable candidates for solar grazing by mean land suitability.

Map 6: Final Solar Grazing Suitability Analysis of Washington State

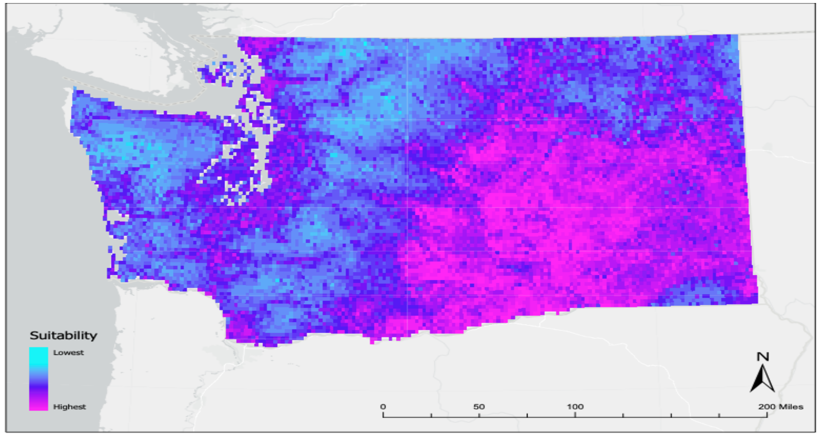


Table 1: Suitability Score Descriptions

Suitability	Slope (degrees)	Solar Radiation (kWh/m2/day)	Power Line Proximity (km)	Vegetation
1 (least)	> 40	< 2.5	> 50	Open water, wetlands, aquatic, highly developed
2	20 - 40	2.5 - 3.0	20 - 50	High montane, moderately developed
3	10 - 20	3 - 3.5	10 - 20	Forest, lightly developed
4	5 - 10	3.5 - 4.0	5 - 10	Shrubland, semi-arid, herbaceous cover
5 (most)	0 - 5	4 - 4.5	0 - 5	Grassland, barren, pasture, cropland

Results and Discussion

The results demonstrated that Central and Eastern Washington were the most ideal for solar grazing. Map 1 shows the slope is steepest in the western parts of the state — this is to be expected, as the Olympic Mountains on the peninsula and Cascades next to Puget Sound are prominent features and would make poor candidates for siting. Map 2 shows that solar radiation is highest in the south-central part of the state, followed by areas surrounding that region. Map 3 indicates the proximity of transmission lines, which is a necessary consideration of solar farming because they need to connect to the power grid. Transmission lines are distributed throughout the state, but the highest concentration is in Puget Sound and south-central Washington. Map 4 shows how this same region, also known as the Columbia Basin, contains the most vegetation that would be considered optimal, such as grasslands, prairies, and already established pastures.

When these four input layers were combined to form the final suitability analysis, it was clear that the flatter parts of Washington east of the Cascade Mountains, particularly in the Columbia Basin and Palouse region near the Idaho border, were optimal for solar grazing. They received lots of sunlight, were close to transmission lines, and contained appropriate vegetation. In fact, this area is currently an agricultural powerhouse for the state and produces wheat, barley, and legumes, among other crops. The results of this study demonstrate how solar grazing or agrivoltaic projects in this region – or converting existing operations to accommodate such initiatives – are a viable and potentially useful way for farmers to promote sustainability while generating additional revenue, without the need to fundamentally restructure present land use. These findings could also be useful for policymakers and utility companies in Washington as they find ways to adapt to rising energy demands and research renewable energy alternatives to hydroelectric or geothermal power.

A future analysis could take into account additional factors, such as the risk of flooding or soil quality, for a more robust approach. (While the latter was originally intended to be an input layer for this study, the WA DNR site no longer had the data available for download). A source of spatial error may be from the mosaicking of detailed DEM tiles as over twenty of them were joined to make the elevation and slope rasters, leading to some data ambiguity. Another possible limitation is that the vegetation data was collected over five years ago and may not account for wildfires or climate change-induced differences in land cover. Lastly, there may be some ecological fallacy because this analysis covers the scale of an entire state, so this feasibility study should be viewed as guidance on where best to look and not necessarily a set of specific recommendations.

Table 2: Five Most Suitable Counties for Solar Grazing in Washington

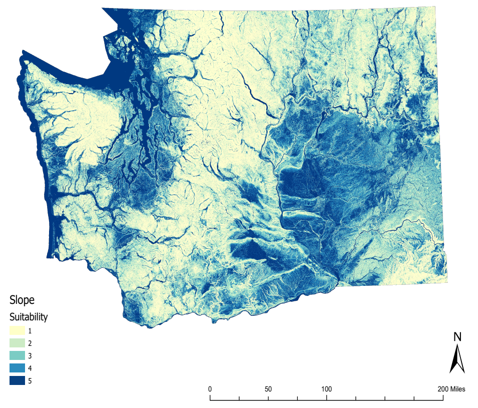
Rank	County Name	Location within State	Mean Land Suitability
1st	Franklin	SE Wash.	89.9%
2nd	Adams	SE Wash.	89.1%
3rd	Grant	SE Central Wash.	87.4%
4th	Benton	SE Central Wash.	80.5%
5th	Lincoln	SE Wash.	77.6%


Solar grazing in New York. Source: American Solar Grazing Association (2020)

References:

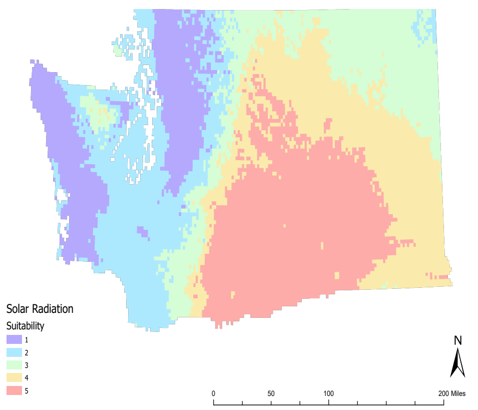
1. Mey, Alex. 2019. *Today in Energy.*
2. Dinesh, H. and Pearce, J. 2016. The Potential of Agrivoltaic Systems. *Renewable and Sustainable Energy Reviews.*
3. Waltson, et al. 2021. Modeling the ecosystem services of native vegetation management practices. *Ecosystem Services.*
4. Sharpe, et al. 2021. Evaluation of solar photovoltaic systems to shade cows in a pasture-based dairy herd. *Journal of Dairy Science.*
5. Washington State Department of Commerce. 2019. *Clean Energy Transformation Act*

Map 1: Slope



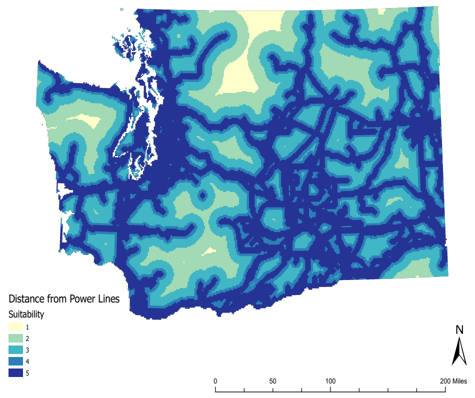
Data Source: USGS (2021)

Map 2: Solar Radiation



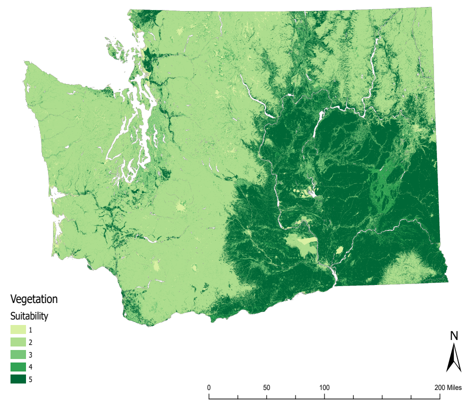
Data Source: NREL (2018)

Map 3: Transmission Line Proximity



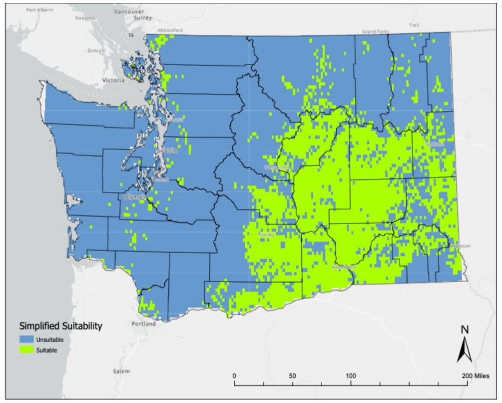
Data Source: Oak Ridge National Laboratory (2022)

Map 4: Vegetation



Data Source: NatureServe (2017)

Map 5: Simplified Suitability Map of Washington State



Data Source: U.S. Census Bureau (2020)