5SSG2061 Geographical Research Skills

Selection of solar energy farms in central-west Texas

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600 words

1 Context

Solar energy is a very promising renewable source of energy, essential for fighting climate change and creating a greener future. Although solar panels can be installed almost everywhere, solar farms in well situated sites can supply enough electricity to power surrounding cities. The aim of this report is to use GIS to select optimal sites for solar farms in Texas. The study area (Figure 1) is chosen to be in central-west Texas because there is a competing balance of cities, networks, and high solar radiation.

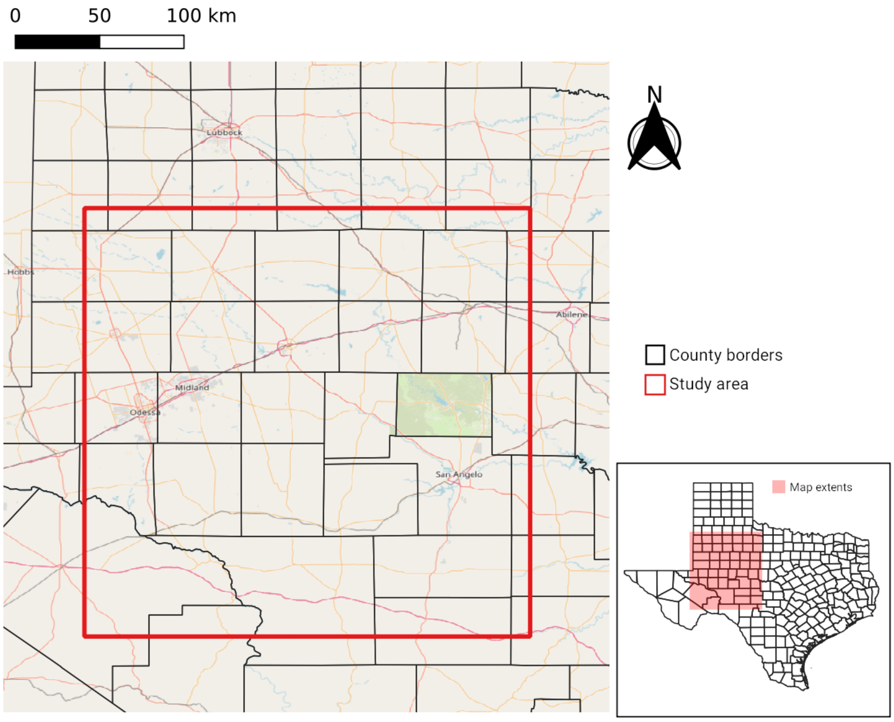

Figure 1: Map of study area

2 Methodology

The criteria used is justified by existing literature. For constraints, Watson et al. (2015) used a slope of less than 10°, away from residential and historically important areas, with a buffer of 500m and 1000m respectively. Uyan (2013) included protected areas as well, but using a buffer of 500m. Because there are only six protected areas within the study area, 500 m is chosen as the buffer. Both agree that solar farms should be 100 m away from major roads.

For factors, Unyan used distance from roads again (where closer is better) as a measure of transportation links. Watson included train networks, but it is a relatively rare mode in the United States, so only roads are used. Tahri et al. (2015) and Unyan also considered distance to transmission lines, while Watson included solar radiation. Both will be used here. Table 1 shows the dataset sources.

Data	Source
DEM	CGIAR (2018)
Major roads Residential areas	HOT (Humanitarian OpenStreetMap Team) (2020)
Protected areas	UNEP-WCMC et al. (2020)
Solar radiation	WorldClim (2020)
Transmission lines	HIFLD (2020)

Table 1: Datasets sources

The slope is calculated from a DEM and filtered to be $\leq 10^{\circ}$ shown in Figure 2a). The vector constraints (roads, protected and residential areas) are buffered and overlaid in Figure 2b). The constraints raster is created by subtracting the slope with the rasterized vector layer.

The average solar radiation is calculated using an average of 12 months shown in Figure 2c). The distance to transmission lines and major roads are calculated from their vector layers using the GDAL Proximity function, producing Figures 2d) and e). The three rasters are converted into relative percentages. Because closer to transmission lines and roads are better, radiation is multiplied with the other two subtracted from 100%.

The raster constraints and factors are multiplied to produce the suitability map in Figure 3. Ideally the solar farm should be big enough (large area) and has a regular shape (approximately small perimeter). Sites are better in the north-west corner because the solar radiation is higher, so the most suitable areas there are vectorized. The area-perimeter ratio for each potential site is shown in Figure 4.

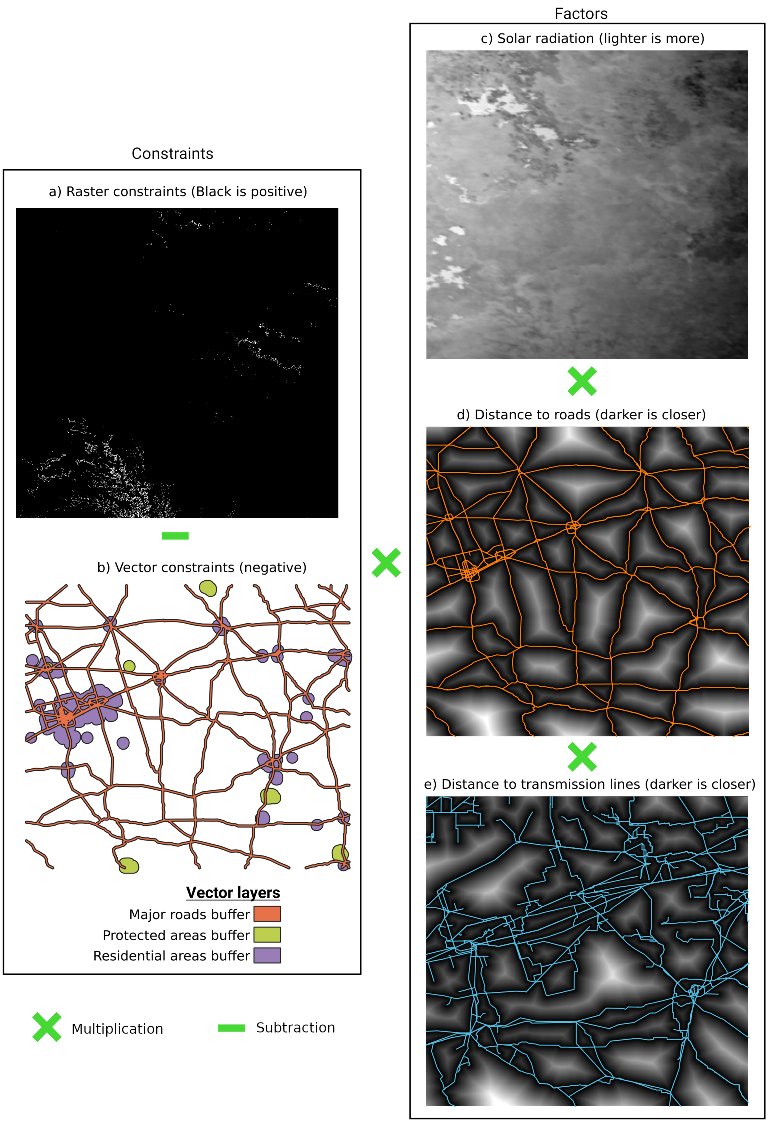

Figure 2: Flowchart illustrating the calculation of constraints and factors

3 Interpretation

According to Figure 4, the best site for a solar farm is just west of Lamesa. It is not too far away from residential areas (where consumers are), is close to two major roads (easier maintenance), and many panels can conveniently fit. Alternative sites that are accessible and has good capacity are next to the roads from Andrews and in the north-west from Odessa.

Those sites are selected primarily because of more solar radiation in the north-west. All the factors are weighted equally, but there is no evidence to support this. If solar radiation was weighted less than the optimal sites would not be concentrated there. If the buffer sizes were larger, the Odessa site will no longer be suitable, and the buffer sizes are quite rough. The analysis is fixed on current technology, so technological innovation, such as floating solar farms on water or panels above existing land was not considered.

References

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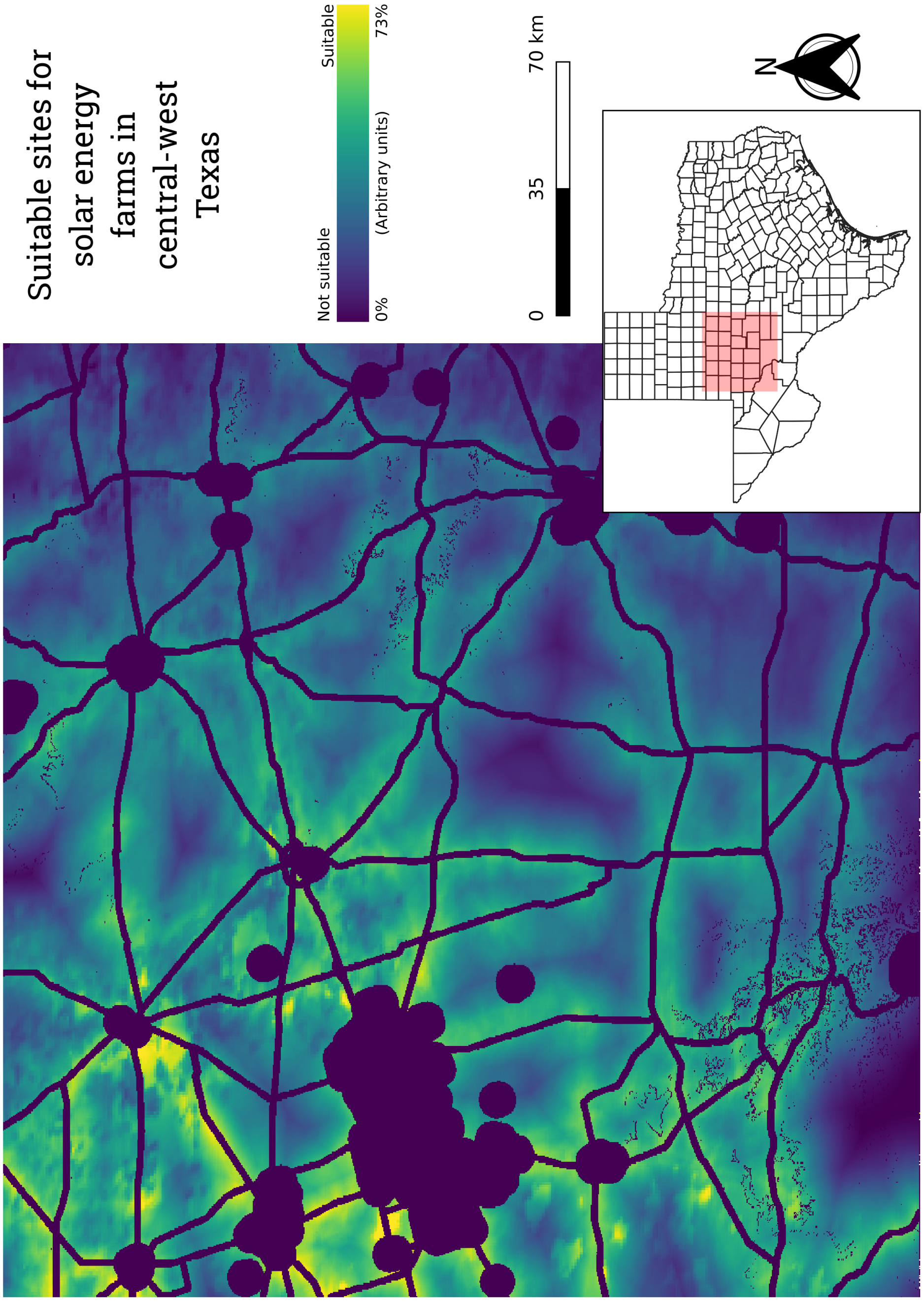

Figure 3: Suitability map

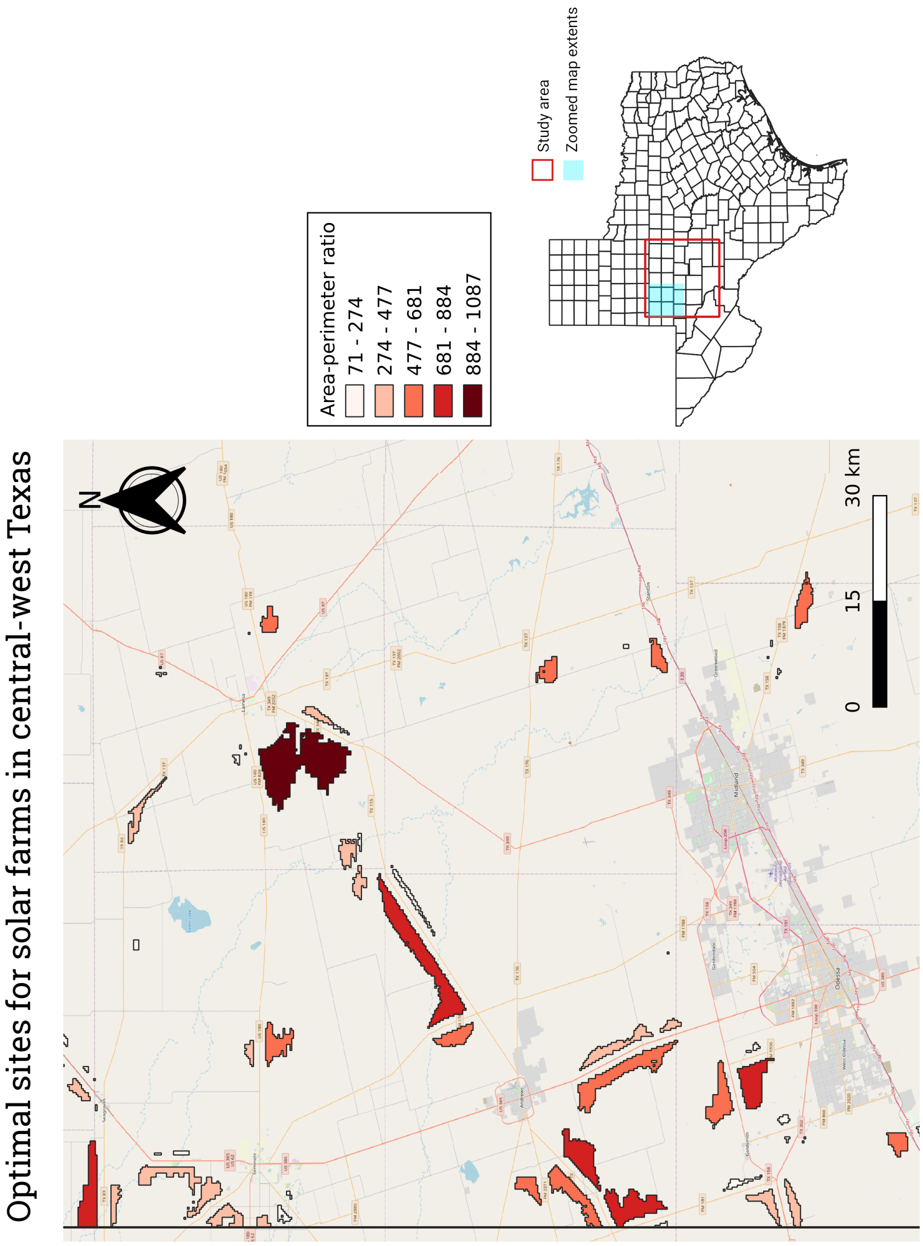

Figure 4: Area-perimeter ratio of very suitable sites