Analyzing Potential Solar Farm Sitting for Montgomery County, PA Using GIS

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Abstract

I used Esri ArcGIS Pro in conjunction with the analytic hierarchy process (AHP) to identify and rank the suitability for solar panel sitting in Montgomery County PA. I accounted for factors of slope, aspect, distance from roads, distance from power lines, protected areas, water bodies, and distance from development. For solar panel site selection, I considered only non-developed landscapes. The best locations for solar panels had South facing slopes, were close to existing infrastructure, and away from natural protected areas.

Introduction

Figure 1 Montgomery County's (Orange) location in Pennsylvania (Blue), USA

With the growth of renewable energy, communities face a growing need to assess how they can integrate renewable energy infrastructure, such as solar panels. I chose Montgomery County PA (Fig. 1) to map out potential solar farm sitting because Montgomery County was already beginning to plan solar panel infrastructure development [1].

Methodology

I accounted for slope [2,3], aspect [3,4], distance from roads [2], distance from power lines [2], environmental protected areas [2,5,6], historical locations [7], water bodies [2], and buildings [4] to map potential solar farm sitting in Montgomery County. I used Environmental protected areas, historical locations, water bodies, and buildings to exclude areas from analysis. Each of these excluded factors, except for buildings, had a protection buffer placed around them. Historical sites had a buffer of 500 m [7] and the remaining factors had a buffer of 100 m [2,5,6]. I then used the analytical hierarchy process (AHP)[8] for factors of slope, aspect, distance from roads, and distance from power lines to access the suitability of the remaining land in Montgomery County for solar farm sitting (Table 2). Areas would be suitable if they had a slope less than 25% [2,3], aspect facing the Southern direction [3,4], was within 3 km within roads [2], and was within 10 km of powerlines [2].

Table 1 Source Material for Analysis

Layer	*Use*	*Provider*
Digital Elevation Models (DEMs)	Slope and Aspect	United States Geological Survey (USGS)
TIGER/Line Linear Water and Areawater	Water Layer	U.S. Census Bureau
TIGER/Line Roads	Roads	U.S. Census Bureau
Transmission Lines	-	Homeland Infrastructure Foundation-Level Data (HIFLD)
DVRPC 2015 Land Use	Buildings Layer	Delaware Valley Regional Planning Commission (DVRPC)
Montgomery County Historical Attractions	-	Montgomery County GIS
Protected Open Space	Environmental Exclusion Layer	DVRPC
Montgomery County Parks	-	Montgomery County GIS
Montgomery County Natural Areas Inventory	Environmental Exclusion Layer	Montgomery County Planning Commission
Montgomery County Wetlands	Environmental Exclusion Layer	U.S. Fish and Wildlife Service
Montgomery County Boundary	-	Montgomery County GIS
World Administrative Divisions	Location Map for Montgomery County	ESRI

Table 2 Criteria and Associated Priorities for AHP

	Slope	Aspect/ Orientation	Distance from Roads	Distance from Power Lines	Distance from Cities	TOTAL	PRIORITY
Slope	1	2	3	4	5	15	0.41189931
Aspect/Orientation	0.5	1	2	3	4	10.5	0.28832952
Distance from Roads	0.33333333	0.5	1	2	3	6.83333333	0.18764302
Distance from Power Lines	0.25	0.333333333	0.5	1	2	4.08333333	0.11212815

Results

Figures 2a (slope), 2b (aspect), 2c (roads), and 2d (electric power lines) indicate which areas based on the factor are suitable and unsuitable land for solar farm sitting. Figure 2e shows all the area that is excluded from being suitable land based on the factors of historical attractions, water bodies, protected environmental areas, and buildings. Figure 3 ranks the suitability of solar farm sitting locations in Montgomery county by synthesizing all the factors that are identified in Figure 2.

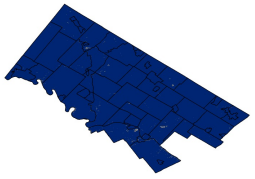


Figure 2a Suitable slopes for solar farm sitting in Montgomery County

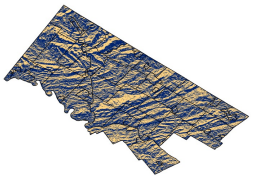


Figure 2b Southern facing slopes for solar farm sitting in Montgomery County

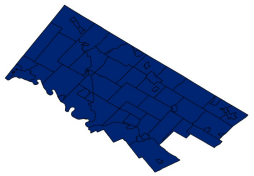


Figure 2c Areas within 3 km of roads for suitable solar farm sitting in Montgomery County

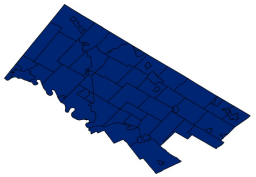


Figure 2d Areas within 10 km of electric power lines for suitable solar farm sitting in Montgomery County

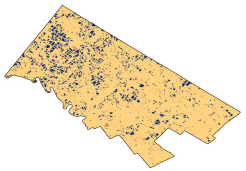
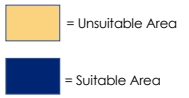


Figure 2e Areas excluded for solar farm sitting in Montgomery County



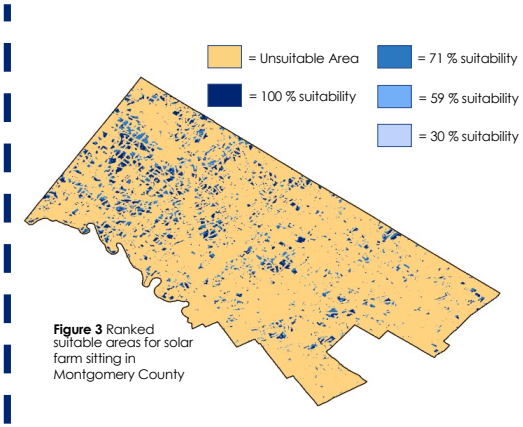


Figure 3 Ranked suitable areas for solar farm sitting in Montgomery County

Discussion

Aspect is the most important factor when determining solar farm placement in Montgomery County because slope, distance to roads, and distance to powerlines do not significantly reduce the amount of suitable land available for solar farms. There are a variety of ways to measure the criteria I used to identify suitable solar farm locations, so my parameters reflect a subset of the possible ways to map out solar farm sitting. Therefore, future mapping of solar farm sitting in Montgomery County could use tighter or looser constraints based on economic, social, and environmental factors.

Conclusion

I mapped suitable locations for solar panel sitting in Montgomery County based on slope, aspect, distance from roads, distance from power lines, environmental protected areas, historical locations, water bodies, and buildings. Aspect is the most important factor in determining solar panel location, and Figure 3 identifies the most suitable locations for solar farms once all the factors have been accounted for.

Acknowledgements

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