The analysis of suitable area for solar plant construction in Nišava district: a GIS-MCDM approach

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OBJECTIVE

Building on previous studies, the objective of this paper is to analyze the suitable location for solar plants construction in Nišava district, Serbia (Fig. 1), in this way contributing to the objectives stated in Energy Strategy 2030 that are among others based on the activities that include more intense use of RES and its inclusion in energy plans of cities and local communities as part of local energy strategies.

METHODOLOGY

The analysis in this research employs GIS multi criteria decision making approach (GIS-MCDM). In this modeling exercise we focus on climatic, spatial and environmental parameters, primarily relying on open data for creation of a GIS data set: global horizontal irradiation (GHI) is derived form Global Solar Atlas (www.globalsolaratlas.info), for protected area we used data from the Institute for Nature Conservation of Serbia, settlements, railways, roads, and waterbodies are generated form Open Street Map (OSM) (the OSM data timeframe is 2018.), Corine Land Cover European seamless vector database (RELEASE v18_5) was used for the land cover data, the geomorphological variables slope, aspect, and elevation gradient maps are calculated based on the - shuttle radar topography mission (SRTM) digital elevation model with a resolution of 30 km. Applying the 25% rule each parameter is reclassified on the on the scale from 0 to 1, where the value $p_j=0$ is considered as the least favorable and value $p_j=1$ as the most favorable location for the given parameter (Table 1). The relative weights (w_j) of the parameters are assigned by expert form the energy industry applying Analytical Hierarchy Process. Finally, to generate of solar plant suitability map the arithmetically weighted overlay approach is used to integrate all parameters using following equitation:

$$SUI_i = \sum_{j=1-n}^{i=1-n} w_j p_{ij} \quad .$$

Where SUI_i is the suitability index of the *i-th* cell, w_j is the relative weight of the *j-th* parameter, and p_{ij} is the value of the *j-th* parameter in the *i-th* cell.

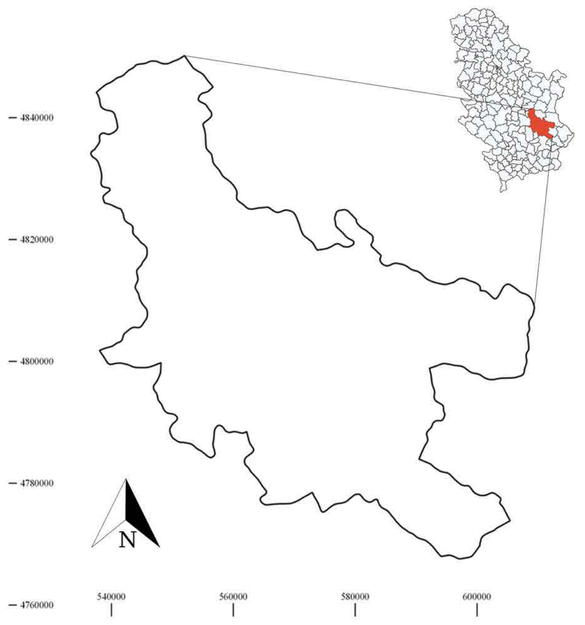

Figure 1. Study area

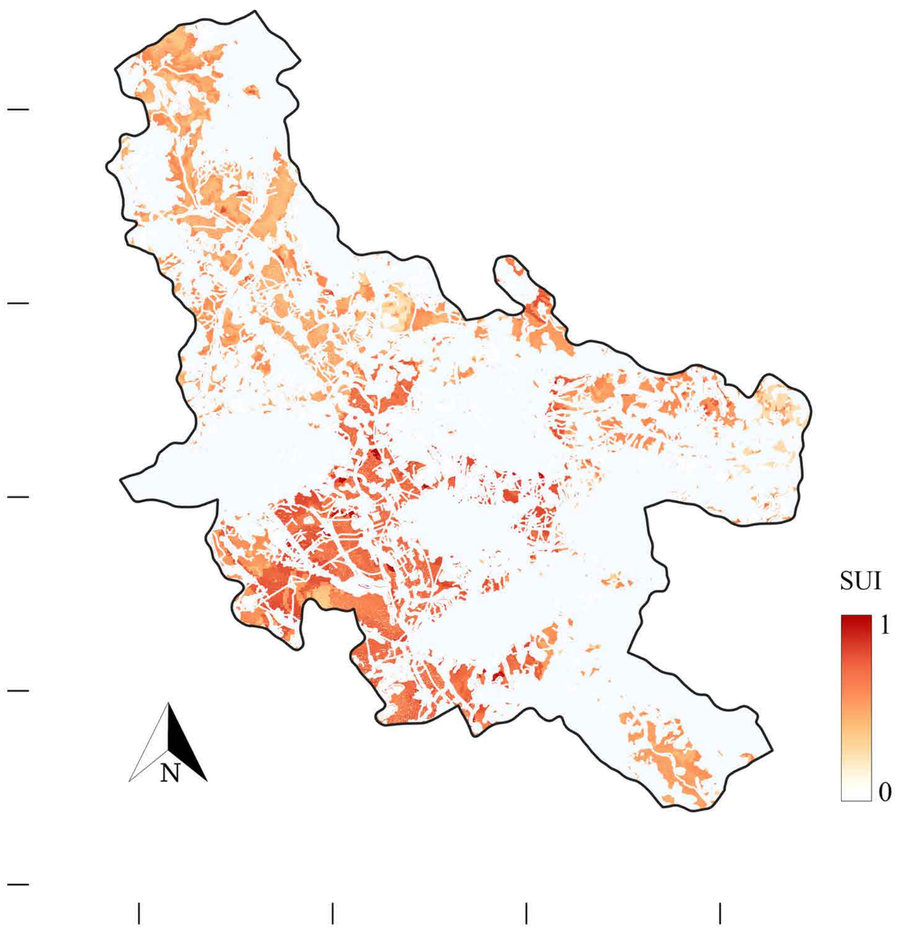

Figure 3. Suitability map for solar plant installation; 1 – highly suitable, 0.75 - moderately suitable, 0.5- suitable, 0.25 – marginally suitable, 0 – unsuitable

TABLE I. QM REQUIREMENTS TO SEEDLINGS.

Criteria (w)	Sub-Criteria (w)	Values	Reclassified value (p_j)
Spatial (0.1718)	Distance to settlements (0.5736)	0-1000m	1
		1000-5000m	0.75
		5000-10000m	0.5
		10000-20000m	0.25
		>20000m	0
	Distance to roads (0.3614)	0-750m	1
		750-1500m	0.75
		1500-2250m	0.5
		2250-3000m	0.25
		>3000m	0
	Distance to railway (0.0650)	0-5000m	1
		5000-10000m	0.75
		10000-15000m	0.5
		15000-20000m	0.25
		>20000m	0
Environmental (0.2425)	Land Cover (0.2425)	Pastures and natural grasslands	1
		Sparsely vegetated areas	0.75
		Heterogeneous agricultural areas	0.5
		Arable land	0.25
		Other	0
Geomorphological (0.0838)	Slope (0.6267)	<25%	1
		>25%	0
	Orientation (0.2797)	South	1
		East, West	0.5
		North	0
	Elevation (0.0936)	<300masl	1
		300-450masl	0.75
		450-650masl	0.5
		>650masl	0
Climate (0.5019)	GHI (0.5019)	>1387kWh/m²	1
		1314-1387kWh/m²	0.75
		<1314 kWh/m²	0.5

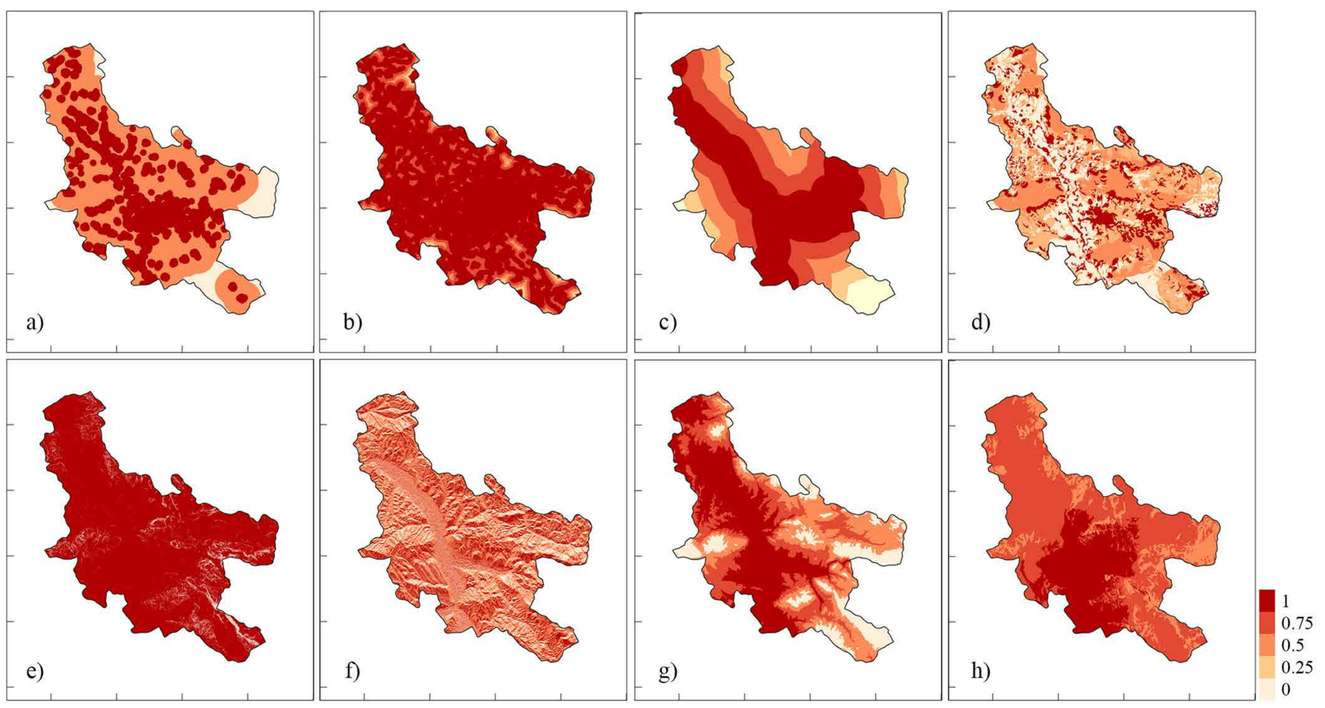

Figure 2. Reclassified values for the criteria: a) distance to settlements, b) distance to roads, c) distance to railway, d) land cover, e) slope, f) orientation, g) elevation, and h) GHI

RESULTS

Fig. 2 shows a spatial distribution of each selected criteria. Based on expert evaluation, applying AHP, we assigned local weights to the reclassified raster's, and by summing them up calculated solar plant construction suitability index for the territory of Nišava district. As indicated in Table 1, climate (GHI) is perceived as the single most dominant criteria, followed by environmental and spatial criteria. The resulting suitability index reveals the distribution of the area for solar plant construction categorized on a scale from 0, meaning unsuitable, to 1 meaning highly suitable (Fig. 3). The available land for solar plant construction is 20% of the district. As the resulting map indicates, all the remaining territories fall in the categories of the index values between 0.5 (moderately suitable) and 1 (highly suitable).

REMARSKS

The obtain results stand true for the selected criteria and expert evaluation. In further studies the agricultural land can be categorized according to land quality classes where the least productive lands can be allocated for energy production purposes. Distance to electricity infrastructure is frequently considered as one of the criteria, however, it is insufficient criteria by itself, since the connection of solar power plant to network often requires reconstruction of the network itself, where related costs might out-weight the proximity to the network. Further research might consider these criteria. Finally, the higher resolution of official data can result in the accuracy of the result.

ACKNOWLEDGMENT

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