

## GEOGRAPHICAL INFORMATION SYSTEM APPLIED IN USING SOLAR ENERGY RESOURCE

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**Abstract:** *Due to industrial and human activities, in the last decades there has been a depletion of fossil fuels. Therefore, a general development regarding the use of renewable energies appeared. In Romania, different initiatives at national, regional and local level on the application of solar energy have started to be supported by photovoltaic systems. In this paper, Alba County of Romania is analysed from the solar energy point of view using a geographical information system model. The aim of the paper is to demonstrate the areas in which solar energy can contribute to a sustainable region.*

**Keywords:** *solar energy, photovoltaic system, sustainability, geographical information system, region*

### 1. Introduction

Current world scientific debates show that the use of renewable energy resources could contribute to an optimal strategy in order to ensure the sustainability of humanity. Therefore, taking into account the level of a technological development in a studied region, different application would allow to use renewable energy resources [1].

The European Union has set itself three targets that have to be achieved by 2020 for greenhouse gas emissions reductions (20%), the share of renewable energy (20%) and improvements in energy efficiency (20%) [2].

One aim of the Strategy for Competitive, Sustainable and Secure Energy is to promote renewable forms of energy. Increasing the use of energy from renewable sources, together with energy savings and efficiency, it leads to an important component in establishing the necessary measures to reduce greenhouse gas emissions [3].

The goal of this paper is to examine a study regarding the potential of the solar energy in Alba County and analyses the aspects needed to be taken into consideration in the field of photovoltaic panels systems.

### 2. Materials and Methods

A well-known tool used to facilitate complex geographic analysis is the Geographical Information System (GIS). GIS is a system which characterizes information by taking into account its localization and its spatial or geographical location in a territory, using the coordinates.

In order to analyse the solar radiation areas of the Alba County, it has been chosen the ArcMap application of GIS. ArcMap represents an essential component of the ArcGIS package and it is being used in order to:

- create geospatial database;
- modify, complete and update the GIS resources;
- create thematic maps;
- perform analyses and specific interrogations [4].

### 3. Results and Discussion

As a first phase of this study, a first solar radiation map has been created by using the Aspect function which is often applied to a digital elevation model (DEM) – figure 1, this DEM representing a raster of elevation values.

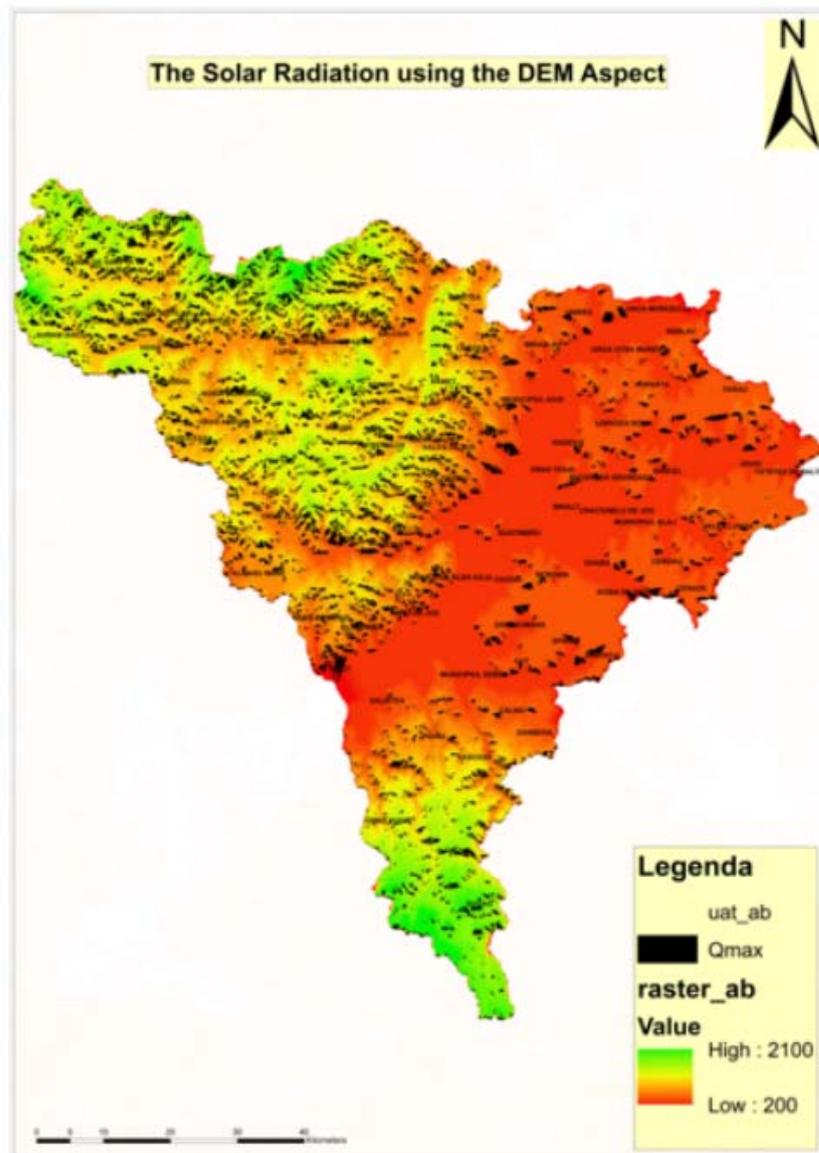


Figure 1. The Solar Radiation in [Wh/ m<sup>2</sup>] Map using the DEM Aspect

In order to obtain a more detailed map, the solar radiation values of the Alba County’s cities have been determined (Wh/ m<sup>2</sup>) – figure 2. This aspect has been made taking into account the azimuth angle and the online Sun calculator [5].

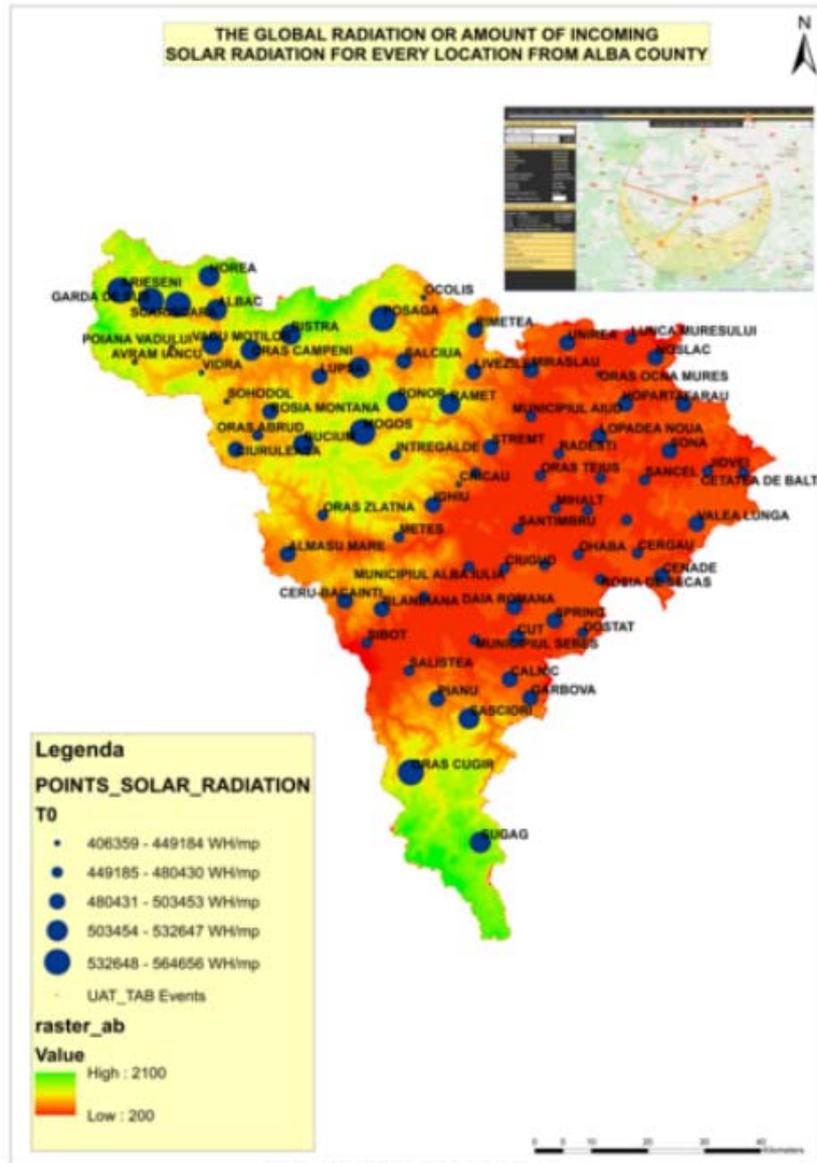


Figure 2. The amount of solar radiation of each location of Alba County

In the North – West and South regions, there is a more prominent potential of solar energy. Its value ranges between 533 kWh/ m<sup>2</sup> and 565 kWh/ m<sup>2</sup>. In what concerns the Central region and the East one, the solar energy potential has an average value of 520 kWh/ m<sup>2</sup>.

Solar radiation reaching the surface is made up of two components, namely direct and diffuse radiations. Direct radiation is the part which travels unimpeded through space and the atmosphere to the surface. Diffuse radiation is the part scattered by atmospheric constituents such as aerosols and clouds.

The map of global radiation for the Alba County has been elaborated using ArcMap program – figure 3.

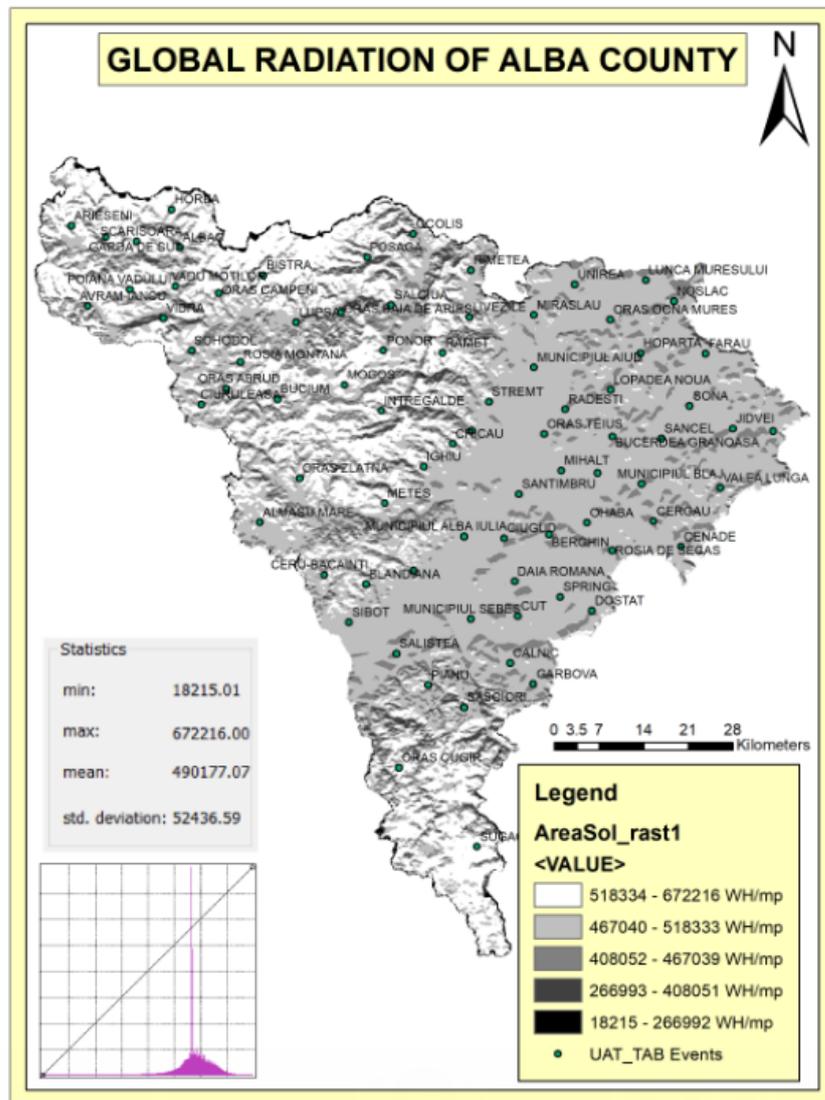


Figure 3. Global radiation of Alba County

The average solar radiation in Romania ranges from 1300 to 1500 kWh/ m<sup>2</sup> per year [6]. Normally, the central region of Romania is recognised by its natural gas and hydro energy resources, but in the last years, many photovoltaic projects have started to appear.

Therefore, before using a type of land, it is important to consider the following aspects:

- solar panels have to be at a predetermined distance one from each other in order to avoid shading and for maximum capture of solar radiation;
- the ideal orientation of the photovoltaic structure is the southern part;
- the tilting of the panels have to be made according to the slope of the ground on which they will be positioned so that they can maximize the amount of radiation captured over a year;
- the ideal angle of inclination is 35° [7].

Moreover, the design process of a photovoltaic panel needs to be carefully analysed, to take into account all aspects in order to get those better features based on available resources and to consider possible losses in the system in order to maximize profitability.

Another important element is shading, which produces a strong impact on the performance of a photovoltaic system. Even a small degree of shading on one side of the installation can have a significant impact on the energy production generated by the entire array. For this reason, shading is considered an element of system performance. It must be specially addressed in the design phase of the system a careful selection of location – figure 4.

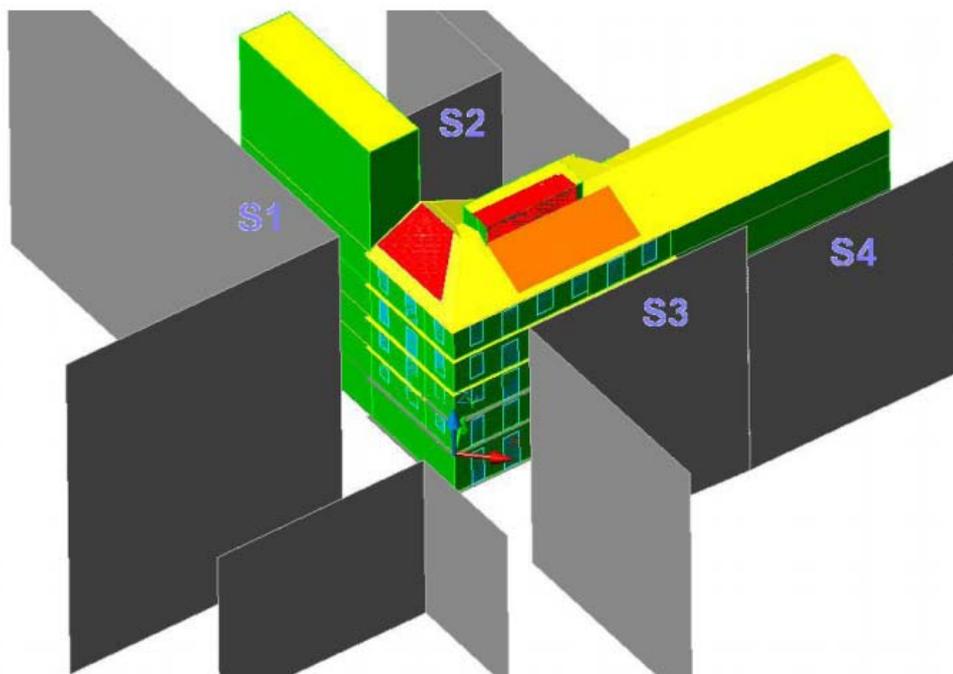


Figure 4. Obstacles (S1, S2, S3, S4) location which has to be considered [8]

Giving the case from the figure 4, there are two hypothetical location options (case A and B), each one with its solar radiation diagram and shading losses.

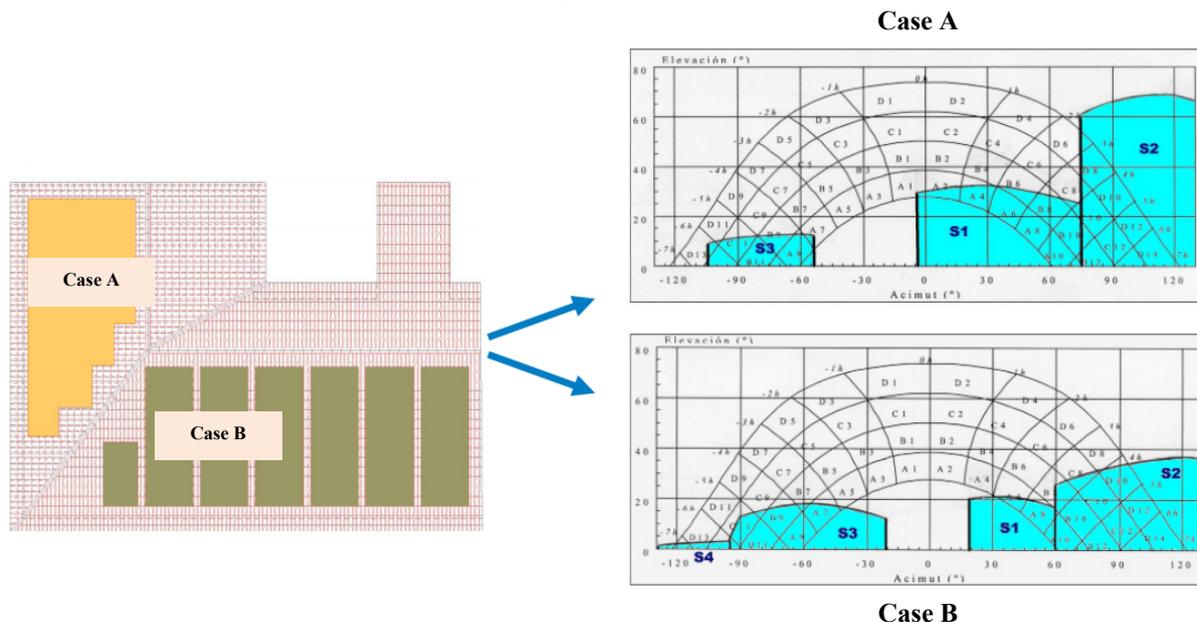


Figure 5. PV location alternatives and their solar radiation diagram and shading losses [8]

#### 4. Conclusions

Among the advantages of placing photovoltaic panels, it is important to mention that Sun is an inexhaustible source of energy and one of the most important for mankind. Moreover, solar energy is a free energy source and the depreciation of investments in a photovoltaic panel installation can take place over a certain period of time depending on the solar radiation and the geographic location of the considered area.

Considering Alba County, there have been identified areas where photovoltaic power plants or parks could be constructed from the solar radiation perspective, considering the amount of solar radiation but also a set of construction aspects. In the North – West and South regions, there is a more prominent potential of solar energy. Its value ranges between 533 kWh/ m<sup>2</sup> and 565 kWh/ m<sup>2</sup>. In what concerns the Central region and the East one, the solar energy potential has an average value of 520 kWh/ m<sup>2</sup>.

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