Analysis of solar radiation potential in arid and semiarid areas of Central Iran using remote sensing data

Abolfazl Ranjbar-Fordoei
Associate professor of desert engineering, Department of desert engineering, Faculty of natural resources, University of Kashan
Sayed Hojjat Mousavi
Assistant professor of geomorphology, Department of geography and ecotourism, Faculty of natural resources, University of Kashan, Kashan, Iran.
Vahid Vaisi *
MSc student of desert combating, Department of desert engineering, Faculty of natural resources, University of Kashan, Kashan, Iran

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Extended abstract

Introduction

Energy is one of the most important factors in the development of human societies and is one of the essential factors in economic, social development and quality of life.Population explosion and growing energy demand, increasing living standards, the risk of global warming due to the greenhouse phenomenon, falling of acid rains, environmental problems and threats to human health, and finally lack of fossil energy sources are among the issues that attract the attention of the world's nations to the use of renewable energies,so that, in their planning, they take the provision of a percentage of the energy needed by their country through wind turbines, solar energy, geothermal energy and other renewable energyinto considerations. Due to the limited resources of fossil fuels and savings for future generations, there should be a need to replace and use renewable energies such as solar energy. More than 85% of Iran's territory is covered by arid and semi-arid regions, where the energy share of solar radiation is high.Solar energy, as one of the sources of clean energy and free from environmental degradation, has long been used in many ways. Due to the limitation of fossil sources and their pollution, as well as the increasing demand for energy, it is necessary to take measures to optimize the use of the solar energy source in Iran.

Given that most of the work done in the field of estimating radiation energy has been made using weather or climatic data such as temperature, cloudiness, radiation, etc., and remote sensing data and satellite imagery have not been used generally, therefore, the purpose of this research is to investigate the radiation potential in a part of the central regions of Iran using remote sensing data and albedo, brightness, vegetation, moisture and land surface temperature indices.

Material and Methods

The study area is situated in central region of Iran in the geographical range 33º, 41,50-35º, 28, 30 northern latitudes and 50º, 41, 40-52º, 30, 27 eastern longitudes. The present research is an applied one, and its methodology is a combination of remote sensing and Geostatistical analysis. The data used in this research was obtained from the May 17, 2015 images of Landsat 8 satellite, with the course 164 and the row 36. In order to study the radiation

potential, indices such as albedo, brightness, NDVI, greenness, moisture, and ground surface temperature were used. To calculate each of the aforementioned indices, the equations and functions related to each index on the Landsat 8 image were used in ENVI 5.3 and GIS 10.3 software. In order to calculate the Earth's surface temperature index (LST), the thermal bands 10 and 11 of Landsat 8 must first be converted into the radiance, and then to the brightness temperature, and finally to the temperature of the satellite's brightness. Then, the map relating to each standardization index, and the potentiometric map were prepared by takingthe mean of all indicators. Finally, the potentiometric map was also classified into five classesaccording to the estimated amount of solar radiation, including very inappropriate, inappropriate, moderate, appropriate, and very appropriate.

Results and Discussion

The results obtained from Albedo, brightness, NDVI, greenness, moisture and land surface temperature indicators are shown from low to high. For Albedo index, the least amount (6668.87) was observed in the northwest of Qom, south ofGarmsar, southwest of Abu Zaidabad, Niasar, Golestan, northwest of Kashan, and the highest amount (61352.7) was observed in the northern parts of Garmsar, south and southeast of Qom, and West of Aran-o-Bidgol. For the brightness index, the lowest value (15441.9) was observed in the northwest of Qom, south ofGarmsar, southwest of Abu Zaidabad, Niasar, Galak, northwest of Kashan, West of Pishva, Gharchak, and the highest amount (129881)was observed in northern parts of Garmsar, Center and South and South West of Qom and West of Aran-o-Bidgol. For NDVI index, the lowest vegetation cover (-0.393175) was seen in the central and northwestern parts of Qom, south of Garmsar, Abu-zaidabad, north ofAran-Bidgol, northeast of Kashan, and the highest value (0.639655) was observed in the northeast of Garmsar, Qarchak, Pishva, Northwest of Javad-abad, south of the Kahak, west of Niasar, southeast of Kashan. For the greenness index, the lowest value (-43887.6) was observed in the northern parts of Garmsar, in the north of Hassanabad, south and southwest of Qom, south of Javad Abad, southwest andcenter ofKashan, west and southwest of Aran-o-Bidgol, and the highest value (-3385.181) was observed in the southern parts of Garmsar, Niasar, Kahak, Northwest of Kashan, Center and Southeast of Abu-zaidabad. For the humidity index, the lowest and highest values (-52599.1 and 11.56 respectively) were seen in the northwest of Qom, south of Garmsar, southwest of Abu-zaidabad, Niasar, and northwest of Kashan. For the LST index, the lowest value (19.585) was observed in Qarchak, Javadabad, southern Garmsar, southwest of Abu Zaidabad, Niasar, Kahak, north and northwest of Kashan and the highest value (577.557) was observed in Garmsar, central Qom, West of Aran-o-Bidgol, eastern and northeastern parts of Abu-zaidabad.

The results of the land suitability analysis showed that the solar radiation potential ranged from 0.13882 to 0.71867. These values show the regions with less radiation as it gets closer to 0.13882, and more radiation as it gets closer 0.741867. The regions were classified into 5 categories includingvery appropriate, appropriate, moderate, inappropriate, very inappropriate, on the proportionality analysis map according to the solar radiation potential.

Conclusion

Surface temperature and radiation are two important factors for the study of solar radiation. Based on these two factors, the best regions with the highest radiation potential and the highest albedo and the highest surface temperature were observed in Aran-Bidgol and Abouzid-Abad regions. The highest value (61352.72) of albedo was observed in the eastern part of Aran-o-Bidgol. However, the highest brightness value (129881) was found in this region. Based on Spatial Approach Analysis Map of solar radiation, the west of Aran-o-Bidgol region has the highest amount of radiation. Based on the results, it can be concluded that the places whereverthe Albedo and the brightness indices are higher, NDVI and greenness will decrease.

As a result, the albedo index has a direct correlation with the brightness index and an inverse correlation with NDVI index. Therefore, in the central regions of Iran, it is possible to determine the appropriate regions in terms of radiation potential through quantitative and qualitative calculation of suitable indicators such as albedo, temperature and brightness through remote sensing data and the relationships between each of these indices. Finally, it determines the best areas for acquiring solar energy and the construction of solar power plants. It is suggested that the remote sensing indices be combined with radiation models in order to obtain more accurate information in a shorter time and at a lower cost.

Keywords: Radiation power, Albedo, brightness, LST, Remote Sensing, Central Iran.