

The Spatial Analysis of Insolation in Iran

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Abstract

This study aims at doing a spatial analysis of insolation in Iran. The statistical time span that has been investigated is the period between 1948 and 2009. After determining insolation, the spatial analysis maps are drawn as monthly, seasonal, and an annual map for the total statistical period. After the analysis of the annual map, Iran has been divided into 5 areas regarding the amount of insolation, including: areas with the least amount of insolation, areas with little amount of insolation, areas with average amount of insolation, areas with high amount of insolation and areas with the highest amount of insolation. The results of the study show that farthest area in north west of Iran with 185 kw/m^2 has the lowest amount of insolation and the farthest area in south east of Iran with 235 kw/m^2 has the most amount of insolation.

The results of this study are not in agreement with the results of previous studies, which have been done through experimental models. The former studies done through experimental models show that a huge part of center and some parts of north west of Iran receive the highest insolation and coasts of Caspian sea receives the lowest insolation. While the results of the present study show that southern coasts of Iran receive the highest insolation and the north west of Iran has the lowest insolation. These results are because of the low amount of cloudiness and high amount of radiation angle in the south coasts of Iran and the high amount of cloudiness and low amount of radiation angle in the north west of Iran.

Keywords: Insolation, Downward shortwave radiation, Downward longwave radiation, Solar radiation in Iran

1. Introduction

The increase of earth temperature, climate changes, and rising of sea level and etc. have motivated the politicians and researchers to establish rules and policies both to control the environment and to use clean and renewable resources. Therefore, using renewable energies that are compatible with the environment has turned into a necessity. Solar energy is one of the constant energies, which are compatible with the environment. This energy is the initial source of all physical and chemical energies on the earth. Solar radiation also affects the climatic procedures (Moradi, 2004). Iran is located between 25-40 northern latitude. Being located in this area put the country among those parts of the world that receive the highest amount of radiation (Satkin, 2001). With regard to the importance of solar energy, different empirical models are offered for determining the insolation in Iran as well as other parts of the world. In most of these empirical models due to the lack of exact radiation data, other climatic variables such as temperature, length of the day, sunny hours, etc. are used in order to calculate the insolation.

Bristo and Campbel have the temperature variable for measuring the amount of daily radiation (Bristo and Campbel, 1984). Samimi has calculated the insolation in Iran by using Minel-Minel model and by taking into account the height from the sea (Samimi, 1994). Khalili and Rezaeisadr have calculated the insolation in the horizontal surfaces in Iran and have divided Iran into 16 areas based on Angestrom Model and the exponential relationship between radiation and relative moisture (Khalili and Rezaeisadr, 1998). Almorex and Hontoria have measured the insolation in a city in Spain by the revised model of Angestrom-Priskat (Almorex and Hontoria, 2004). In another study, Darel *et al.* (2005) have used of cloudiness elements as well as maximum and minimum temperature to measure the insolation in Broking, Huron and Dakota areas (cited in Heidarbani, 2007). Rionigton *et al.* have used three models in measuring the insolation in 24 climatic stations in England, in order to investigate the effect of the used data. In two of these models temperature data and in one of them the solarium

data have been used (Rionigton, *et al.*, 2005). Sabziparvar and Shetaee have also investigated the solar radiation in dry and semidry weather of east and west of Iran through empirical models (Sabziparvar and Shetaee, 2007).

2. Data and Procedures

The sun is the major energy source of earth and the life and climate control main factor on the ground. By controlling the surface temperature, solar radiation also determines place and time distribution, humidity and pressure. Therefore, the comprehensive study is necessary to better understand Earth's climate (Kaviani and Alijani, 2004). Solar radiation is measured in two ways, satellite and terrestrial. In terrestrial Radiation detection method, a Radiation detector is used to measure radiation. The main advantage of this method is careful measuring. Being Expensive and not covering the remote areas of the disadvantages in Radiation detection method. In satellite Radiation detection method, the amount of radiation in clear sky is measured in different places at certain times. Then the atmospheric variables affecting the amount of radiation, such as aerosols, cloud amounts are considered through satellite imagery and are considered in radiation amount. Fewer prices than terrestrial radiation detection and remote areas cover are of the advantages of this method are considered. Lower accuracy than terrestrial radiation detection is of satellite radiation detection disadvantages (Nezamivand, Bahar & Baxshi Sarabi, 2009). This study focuses on spatial analysis of radiation received in Iran. In 21 synoptic stations¹ in Iran, the received radiation is measured, but due to problems related to installation and maintenance of radiation detectors and systems quality control and records, measured data is not functional and must be controlled in terms of quality. Also, the radiation detectors medium are not that compact. Thus, the satellite data were used for spatial analysis of radiation received in Iran.

This study aims at doing a spatial analysis insolation in Iran by using radiation data. The radiation data have been taken from NCEP/NCAR data base (<http://www.esrl.noaa.gov/psd/data/reanalysis/reanalysis.shtml>). The statistical time span which has been investigated in the present study is the period between 1948 and 2009. The amount of insolation is the resulted from the sum of the downward longwave and downward shortwave radiation which receive the surface of the earth. The steps of the study are as follows:

- 1) The extraction of radiation data for downward longwave and downward shortwave radiations which receive the surface of the earth for 25-40 northern latitudes and 45-63 eastern longitudes.
- 2) Transforming raw data to w/m^2 and kw/m^2 considering determined ratios in NCEP/NCAR data base.
- 3) Summing up of downward longwave and downward shortwave radiations, which receive the surface of the earth.
- 4) Separation of radiation data for each month and season.
- 5) Drawing monthly and seasonal maps.
- 6) Drawing up an annual map for the total statistical period.
- 7) Analysis of annual, monthly and seasonal map.

The significance of the present in relation to the studies done by experimental models is related to applying radiation data instead of other climatic variables for determining the insolation, the long statistical period (62 years) without the missing data, and also the examined points (more than 50).

3. Conclusion

After examining the received insolation in Iran, the following results have been obtained:

The analysis of monthly maps shows that the least amount of insolation is received in January and September. The insolation in these months fluctuates between 350 w/m^2 in the north west and 510 w/m^2 in the south east of Iran (Figures 1 and 2). The main reason for this phenomenon is the existence of westerlies and emigrant Mediterranean systems that results in cloudiness and precipitation that had led to a decline in insolation in the abovementioned months. In July the highest amount of insolation is received. The main reason is the existence of subtropical high pressure (STHP) that results in barotropic atmosphere with no cloud. The insolation in these months fluctuates between 660 w/m^2 in north west and 760 w/m^2 in south west of the country (Figure 3).

The analysis of seasonal maps also shows that because of the existence of westerlies and cloudiness of the sky, least amount of insolation is received in winter. The insolation in this season fluctuates between 37 kw/m^2 in the north west and 51 kw/m^2 in the south east of Iran (Figure 4). In the summer, because of a complete existence of a subtropical high pressure and a cloudless sky, the highest insolation is received. In this season, the insolation fluctuates between 57 kw/m^2 in north west and 66 kw/m^2 in the south and south west of Iran (Figure 5).

After the analysis of the annual map, Iran has been divided into 5 areas according to the amount of insolation. These areas are as follows:

- 1) Areas with the least amount of insolation (from 185 to 195 kw/m^2) including north west of Iran.
- 2) Areas with little amount of insolation (from 195 to 205 kw/m^2) including some parts of north west, west, north east, northern coasts, and some parts in the center of Iran.
- 3) Areas with average amount of insolation (from 205 to 215 kw/m^2) including west, center and east of Iran.
- 4) Areas with high amount of insolation (from 215 to 225 kw/m^2) including areas in the south of Iran.
- 5) Areas with the highest amount of insolation (from 225 to 235 kw/m^2) including southern coasts of Iran (Figure 6).

The obtained results show that Maku in the farthest area in north west with 185 kw/m^2 has the lowest insolation and Chabahar in the farthest area in south east 235 kw/m^2 has the highest amount of insolation. The results of the present study are not in line with the former studies which have applied the experimental models. Based on the results from the previous studies, a wide part of the center of Iran and parts of north west of Iran have the highest insolation and coast of Caspian sea has the lowest insolation (Khalili and Rezaeasadr, 1998). While the results of the present study show that southern coasts of Iran receive the highest insolation and the north west of Iran has the lowest insolation. These results are because of the low amount of cloudiness and high amount of radiation angel in the south coasts of Iran and the high amount of cloudiness and low amount of radiation angel in the north west of Iran.

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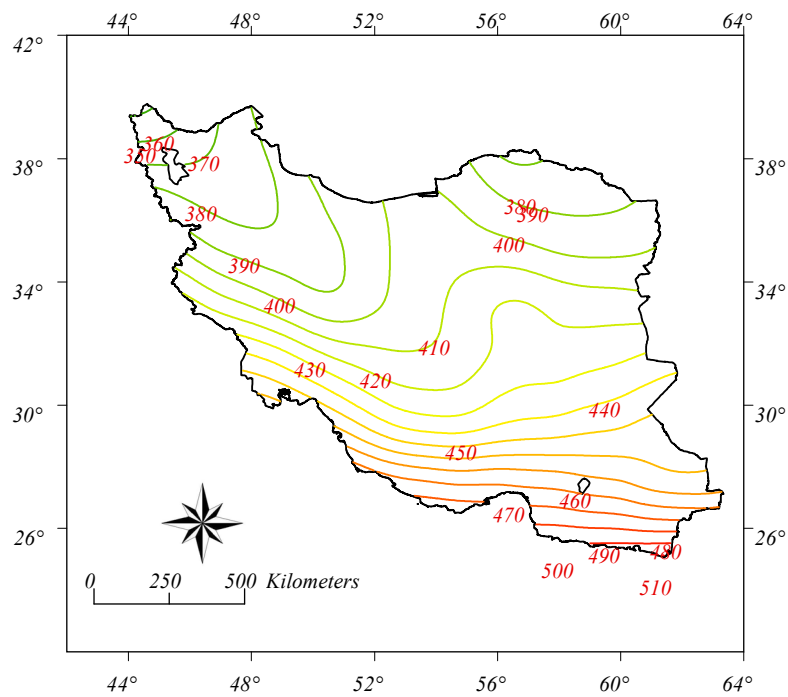


Figure 1. Insolation in January (w/m^2)

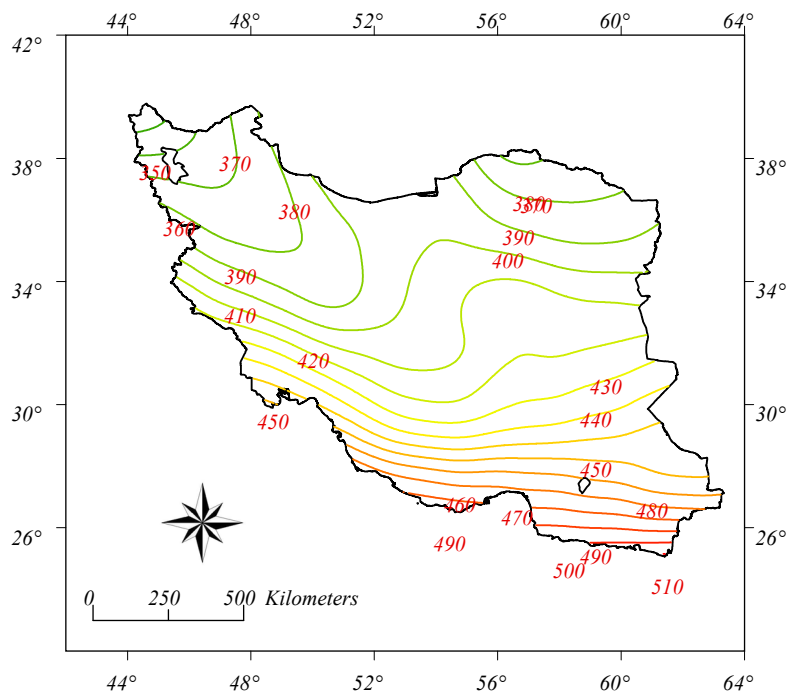
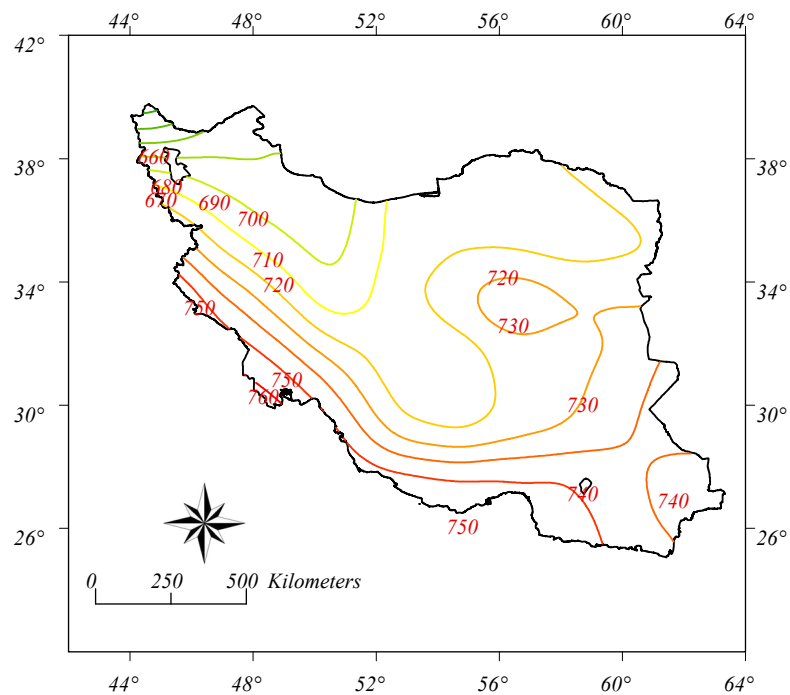
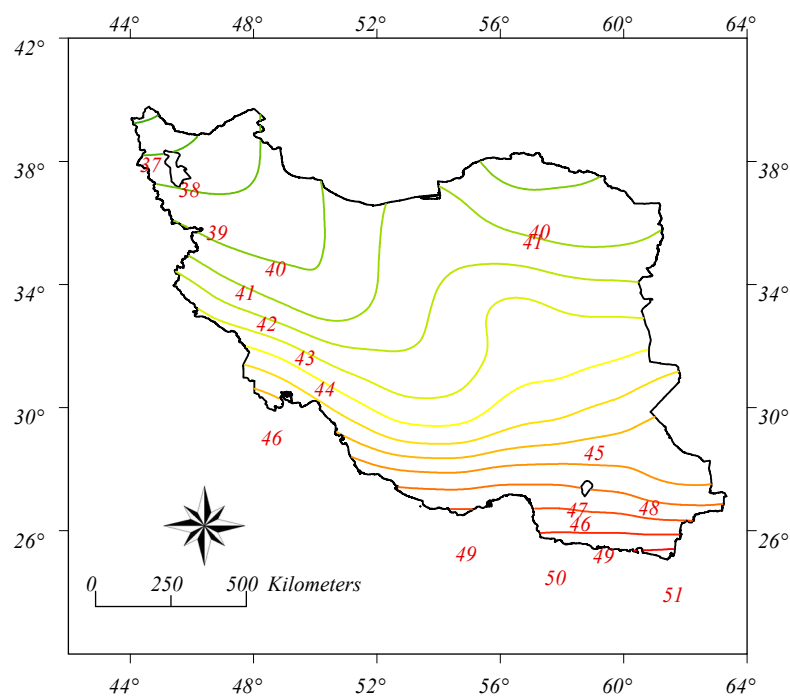


Figure 2. Insolation in December (w/m^2)

Figure 3. Insolation in July (w/m^2)Figure 4. Insolation in winter (kw/m^2)

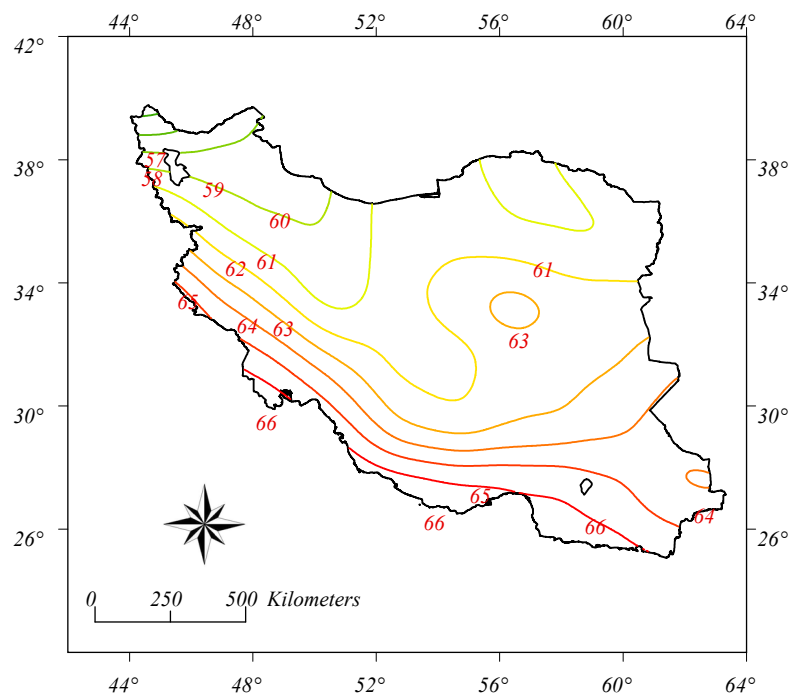


Figure 5. Insolation in Summer (kw/m²)

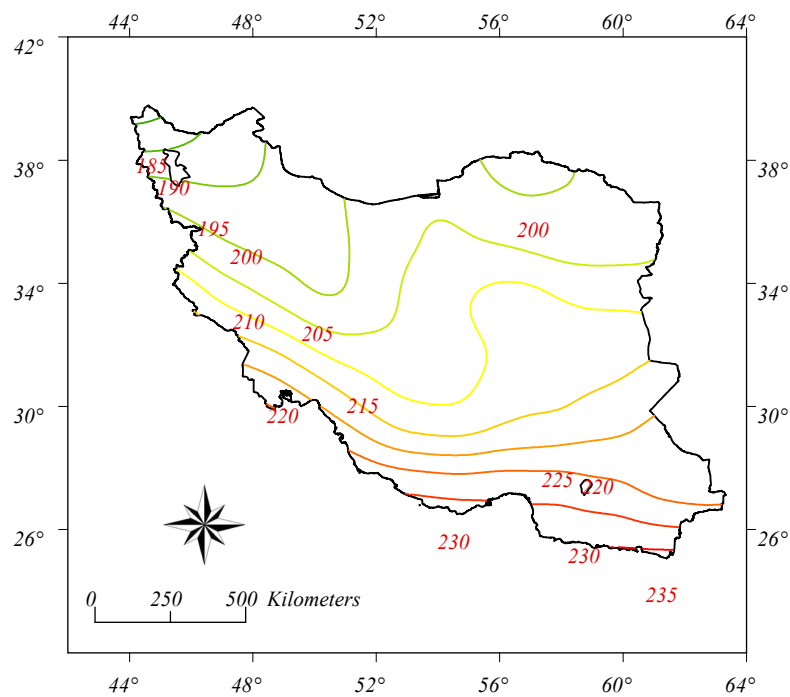


Figure 6. Annual Insolation (kw/m²)