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SITE SELECTION FOR CONSTRUCTING SOLAR AND WIND PLANTS USING METEOROLOGICAL PARAMETERS IN IRAN

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Abstract:-
Due to the increasing environmental pollutions and reducing fossil energy sources, using new energy in the world is of utmost importance including the solar and wind energy that used in the world. In this context and to identify areas with high potential for solar and wind plants in Semnan province, the average relative humidity data, the number of days with thunderstorms, number of days with dust, the number of cloudy days, horizontal visibility below 2,000 meters, sunshine hours and average wind speed in a 20-year period for five synoptic stations in the province was used. After the analysis made on the province's meteorological parameters, point data was changed into the zone by Arc GIS software. To achieve this goal first of multiple regression methods were used and the correlation between latitude and altitude parameters obtained. Results showed that in most cases, the correlation coefficient was more than 0.9 and determination coefficient was more than 0.8 in most cases. Studies showed that lowland areas of the province have enormous potential and highlands has less potential for constructing solar and wind power plants.

Keywords:-
Solar, wind, meteorological parameters, Semnan, Iran.

1. INTRODUCTION

Although, renewable energies remain unknown, the rapidly are expanding and influence and neglect that, will be irreversible. Solar, wind, hydro, biomass, biogas and geothermal energy are from clean energy sources. Three issues in 1995 were caused milestone for renewable energies [1]:

1. Climate changes due to greenhouse gas accumulation of atmosphere.
2. Increase the consumption of electricity energy around the world.
3. The opening of vision promising about renewable energy technologies that frankly was announced by the experts.

It should be considered that forevery Kw hour of electricity produced of renewable energies instead of coal, it will avoid the release of approximately one Kg of Co2. So, for example, for every %1 of conventional energy replaced by wind power will reduce about 13 percent of carbon dioxide emissions. Renewable energies are basically compatible with nature and not pollution and are endless because of are renewable. The other properties such as scattering and dispersion of the resources in the whole world, especially for developing countries have more attractions. Thus, in international programs and policies in line with the global sustainable development, has been assigned a special role to renewable energy sources, but adapting renewable resources with the current system is still problematic, that solved them is dedicated a large volume of scientific research the world in recent decades [2].

Mortality fossil fuels, diversification to the energy resources, sustainable development and energy security, environmental problems caused by the consumption of fossil fuels on the one hand and being renewable of new energies sources such as solar and wind on the other hand, cause to the serious attention of world and to develop and expand the use of this resource and increasing the share of these sources in the global energy mix. Today we are witnessing a significant increase in activities and governments and companies budget in the research, development, and supply of renewable energy systems and these experiences and spend the funds ultimately reduce the cost of renewable energies and competitiveness with traditional energy systems. With a glance at the statistics obtained in 2007 can be seen, which more than 100 billion dollars have been invested to increase capacities, plants construction and research and development of new-energy in the world. Currently, wind energy, with the average annual growth of more than 26 percent since 1990, had the highest growth rate among the various sources of energy. The global production capacity of wind energy has been over 59 GW by the end of 2005 [3]. However, global wind energy potential still has not been fully utilized. Historically, the wind energy market has been controlled by five countries, mainly Germany, Spain, United States of America, India and Denmark. According to the International Energy Agency, wind power will consider second renewable large source after large water electricity until 2030 and, according to the World Wind Energy Council (GWEC) by 2040, wind power industry has an annual turnover ability of 67$ billion. Also, about 94 GW of wind capacity installed worldwide in 2007 will increase to 1,000 GW by 2020 and will account for 12 percent of the world's electricity supply [4]. The sun as an endless source of energy solves the problems in the energy and environment. Energy without the risk that shines on the earth is a thousand times more than what we need and we consume. Even a little light through the window into the room, have more energy than electric wire, which is drawn into the room. Solar energy can be used very useful, as a clean and accessible energy everywhere. But the sun can’t be directly used instead of fossil fuels, but must be constructed devices, which can convert solar energy into usable energy such as mechanical energy, electricity thermal etc.

1.1. History of wind energy

According to the magazine (the UN World Meteorological Organization), the oldest known turbine has been detected in Iran. About 20 years before B.C this turbine as windmill has been common in Iran, especially on the eastern border of the winds of 120 days. The mills mainly are used to flour wheat and draw water from well. In the 14th century, people of Indian tried to reform the windmills to dry marshes. In 1586, the first windmill established in order to make the paper in the Netherlands. By the mid-19th century, more than 6 million windmills were built with less power than Hp in America and then in Denmark and in 1931 by the Russians, an advanced turbine with the power of 100 kW was constructed and was installed by the Black Sea [5].

So far, many studies have been carried out on the feasibility of using wind energy potential for different geographical areas using wind data from meteorological stations at a height of 10 meters above ground level and obtained worthwhile results, the among them we can mention to the below cases. To examined specifications and characteristics of wind speed in 7 meteorology stations in Turkey and height of 10 m above ground level and he is estimated mean annual speeds in 4 to 6.5 meters per second [6]. He also examined the region's wind energy power. To obtain the energy to study the daily, monthly and yearly trend of wind speeds of a study area, and wind speed of 4 to 25 m/s are considered appropriate for energy [7]. They were used of Weibull & Rayleigh distribution functions to power survey the energy density and coefficients x and y of Weibull function have earned using the least squares method and the equivalent of two unknowns. Another research entitled wind energy potential and real possibilities processing in the event of wind have been carried out by Bromand Salehi using Weibull probability density distribution function in synoptic stations of Ardabil in 2001. According to studies conducted, wind power density in Ardabil station is 342 w/ m2and due to the number of hours, winds greater than 4 m/s in Ardabil station is a good place for wind energy. Another study in this field in order to use of the energy calculated the density and wind power in Ardabil, which have been carried out by Salahiand et al. (2004), of the total hours of the year, 3652 wind turbine hours could produce the energy in the station. Theoretical and practical wind turbine power in the station with a diameter of blade 4 meters is 1757 and 456 w/m2, respectively. Another study has been made by [8] that examined the economic evaluation of wind turbine plants installation and construction compared to fossil plants in Iran and found which is wind turbines produced energy economically are fully competitive with fossil plants and from the standpoint of technology, environmental and consumption of fossil fuels, wind turbines are better than fossil plants. [9] has provided Windrose Atlas the country to estimate and evaluate wind energy in the country, using sstatistics 5 years of wind around 60 synoptic stations, and has determined average winds speed and direction, and energy from them annually. [10], is examined wind regime using data the three-hour synoptic stations in the period of ten years. He stated that direction and wind speed data in a geographic area are a function of height, season and time of measurement and generally measure wind speed and directions competence for a full year [11]. [12],examined the local potential and the potential of wind energy in the rural areas of Iran and studied the wind speed using weather data and have been introduced cities and provinces with good potential of wind speed at a height of 10 m and 40 m. To determine the suitable location of the wind speed for installation of wind turbines, it isneed to investigate the wind speed, wind blast time and continuing coefficient of wind turbines installation and accessible energy from the wind in the day, months and years in each area and then the turbine has designed according to the circumstances.[14], has studied the predicted wind speeds of 120 days of Sistan, using neural networks and assess the continuity and the ability to produce electricity at four stations of Zabul which determined the area has the condition for the installation of wind turbines. Since 1994, operation and maintenance of wind turbines in the country has begun intensity (Atomic Energy Organization of Iran, 2010). As well as extensive research on wind plant in Dizbad plain located in 45 km from the city of Mashhad in has been carried out that has been one of the most susceptible areas for construction of wind plant. There is a wind tunnel with a length of over 70 km and a width of 5 km and average wind speed of 9 m/s which it creates wind farm with a minimum capacity of 200 MW. Construction of the plant started in 2002 and ended in 2007 by the New Energy Organization of Iran (SUNA) [15]. Wind energy technology used in Iran is based on the latest technology available of Denmark. Iran until early 2008, 37 wind turbine purchased from company Vestas of Denmark, and imported into the country and has installed [16]. In order to endemic wind turbines technology in the country, Sabaniro company, dependent on the Sadid industrial group and with collaboration the Danish company Vestas established for the production of wind turbines of 300 kW, 550 kW and 660 kW in 2000.

1.2. History use of solar energy

Extensive and impressive studies about the amount of solar radiation reaching to the Earth's surface and its estimate took place all over the world of the 1970s and suitable models were offered according to the geographical and climatic condition of different areas. For example, Eskiker in Syria Damascus studied 13 models from one to seven variables for calculating solar radiation using seven different climatic and geographical parameters. In this study, despite acceptability of all models, the model provided by seven variables statistically selected as the best model. Yang et al. also suggested the global model estimate the hourly and daily radiation per month. The important point in this new model, in addition to taking the sunshine hours, is to use of theair surface pressure parameters, the global distribution of ozone layer, precipitation and global distribution of cloudiness coefficient. [17], offered the multivariate linear regression model to estimate the radiation using six parameters: air temperature, solar radiation, sunshine hours, air pressure, cloudiness and soil temperature in the region ofElazig, Turkey. In research presented by [18], reduction models (based on cloudiness) and Angstrom-Prescott, Garj, and Siyokaf(based on sunshine duration) were examined. This study was conducted in two mountainous area Feldberg and Bremgartenflat area, the model of Angstrom-Prescott, and Garj to estimate solar radiation in these areas were selected as the best models. In Iran,Sabziparvar and Shataei to estimate radiation in arid and semi-arid areas of West and East Iran used of six models, Paltridge, Sabbagh, Daneshyar, modified Paltridge, modified Sabbagh and modified Daneshyar.[19],studied seven models of solar radiation estimation model and Angstrom-Prescott model suggested by FAO as the most suitable model in a semi-arid climate were introduced.As noted above, most studies have been talked about solar radiation estimation and modeling of these parameters and researches on the identification of areas with minimal cloudiness to optimal use of solar radiation as an energy supplier are very few in the world and in this field can only be noted to researches conducted by Ramachandra and et al in India. [20],in Saudi Arabia and Sozan using recorded data of cloudiness amount in Turkey. In Iran fortunately, studies have been conducted, which we can point to study Khalili which used of sunshine hour’s statistics and cloudiness 8 synoptic stations in the period 1991 to 1966. He concluded from his research, which Iran is favorable for solar energy receives. Samimi in a study entitled solar radiation estimation based on height and its application in solar climate emphasized the importance of solar energy in meeting energy deficit of the present and future. Binesh with study South Khorasan and Sistan-Baluchestan cloudiness stated that solar energy could be used in various fields such as solarwater hatters, technologies related to sweetensalt waters, power plants, solar cells, solar-driven refrigerators, heat plants etc. in these areas.To locate solar plants have been conducted studies in Iran, including can be pointed out the studies [21], that studied the feasibility establishment ofsolar plants in arid areas using GIS and analyzed the climatic parameters in GIS and to locate the best area in Iran for the solar plant.

2. Materials and method

In this study were used the data of synoptic stations in Semnan province. The average relative humidity data, the number of days with thunderstorms, number of days with dust, the number of cloudy days, horizontal visibility below 2,000 meters, sunshine hours and mean wind speed over a period of 20 years were selected and analyzed. The station's location according to their geographical coordinates added to the digital map the area in the Arc GIS software and was made a relevant database. For mapping of climatic parameters, the layers of each parameter were prepared using interpolation method and then was defined a weight within the layer. So that each layer classified into multiple classes, and each class were weighted according to its importance and the corresponding map was prepared. Then, to obtain the final map, indicating potential zones, an interlayer weight was applied according to the importance and effectiveness of each layer. Then, maps of areas with an equal potential obtained using integration the weighted layers that represent high potential areas to construct plants (Table 1).

Table1.Weight applied to the data layers

Wight applied	Thunder storm	Horizontal viewing	altitude (m)	Relative humidity	Dust	The number of cloudy days	Sunshine hours
1	16- 19	6- 8	500- 800	56- 75	16- 32	48- 62	755- 2117
2	14- 16	5- 6	800- 900	49- 56	9- 16	42- 48	2118- 2682
3	12- 14	4- 5	900- 1100	44- 49	5- 9	39- 42	2683- 3081
4	10- 12	3- 4	1100- 1200	40 -44	2- 5	35- 38	3082- 3369
5	5- 9	2- 3	1200- 1400	37- 40	1-2	32- 35	3370- 3579

To calculate the wind to construct the wind powerhouse was used the average wind speed in each month. Near Earth's surface, wind speed increases with height. According to international standards, measuring wind speed at 10 m height was done. To install wind turbines at higher altitudes, it is necessary to calculate the wind speed at the heights. For this reason, several studies have been carried out based on theories fluids and statistical techniques to calculate the wind speed, which can be cited, for example, Johnson (2006),Jowder(2009) and Montgomerie(2000). According to the findings, in general, can be calculatedwind speed at different altitudes using the following equation.
To calculate the wind speed at a height above the ground is used of the following logarithmic formula:
Equation (1):

$$V = V_{ref} \frac{In\left(\frac{Z}{Z}\right)}{In\left(\frac{Z_{ref}}{Z}\right)}$$

Where:
V= wind speed at a height z above the ground
Vref= reference speed or wind speed measured at a height Z and is clear.
Z= surface roughness height in the direction of wind flow.
The surface rough amount is provided in the following table, which can be used in the above formula.

Table2.The roughness of the regions to assess wind speed

Type roughness	Z
Unknown	0.1
Urban	0,7
Agricultural Lands	0.04
Plain	0.02
Forest	0.4
Water and lake	0.0005
Wetlands	0.04
Arid and bare lands	0.008
Treeless plains covered with lichen	0.02
Surfaces covered with snow or ice	0.0001

It should be mentioned, that are needed for the installation of wind turbines, to be calculated the winds at a higher altitude. According to the above equation is shown, at an altitude of 40 meters above the ground wind speed increases approximately 2 m/s in Semnan province. Because the installation of turbine is possible only in rural areas and there are some risks (such as ice throw, the possibility of falling, noise, etc.) and considering that much of it is the plain, a value of 0.02 was considered to Z,which is calculated at an altitude of 40 meters above the ground. We were used of multivariate regression method to represent better and height impact in the distribution of meteorological parameters which in these relationship meteorological parameters were used as the dependent variable and the length, width, and height as independent variables. Finally, prone zones were identified by modeling in Arc GIS software and the composition of the layers based on their weights.

3. Results and discussion

Variables were entered into regression model by Enter method, including the average relative humidity, number of days with thunderstorms, number of days with dust, the number of cloudy days, horizontal visibility below 2,000 meters, sunshine hours, altitude, latitude, which is the model, six variables and their coefficients in the model is shown in table 3. In this table is shown the regression model summary, where R is the correlation coefficient and R square is the coefficient of determination.

Table3. Summary of regression model on meteorological parameters

parameter	Each parameter regression equation	Std. Error of the Estimate	Adjusted R Square	R Square	R
Relative humidity	Y=4.871+.924-.707+.012	3.08211	-0.145	0.714	0.845
Thunderstorms	Y=-113.638+5.009-3.954-.002	3.37932	0.499	0.875	0.935
Dust	Y=100.334+2.094-6.185+.011	3.43602	-1.203	0.449	0.670
Cloudiness	Y=-261.931-3.868+13.964+.008	7.13167	-0.603	0.599	0.774[a]
Horizontal visibility	Y=-22.525+2.010-2.298+.001	2.04169	-0.040	0.740	0.860[a]
Sunshine hours	Y=-1457.913+47.907+84.311-.908	26.97756	0.933	0.983	0.992[a]

Results showed that the highest coefficient of determination of the model related to sunshine hours and thunderstorms and cloudiness are the lowest, respectively. The results this model show that the selective parameters are correlated with the model and to perform later stages of research can be emphasized more authoritatively on them. Accordingly, the maps related to any of the parameters in the model were produced. According to Figure 1 can be seen, the minimum and maximum relative humidity in the year are according to the lowlands and highlands in the province respectively. The southern areas of the province are considered very dry areas of the province due to proximity to the central deserts of Iran and lack of the necessary moisture to the area. In contrast, the northern regions of the province and Biarjomand, has more height, low temperature, and consequently higher relative humidity. By examining the days with thunderstorms in the province wasdeterminedthe highest the occurrence of this phenomenonwas in Biarjomand area and East of the province which is reduced to the West. The lowest is in Garmsar region between 5 to 9 days per year (Figure 2). The number of days with dust in the uplands of the province is more than the plain areas, so that among the selected stations, Biarjomand with an average of 13 days per year and Garmsar with an average one day per year were maximum and minimum, respectively (Figure 3). The cloudiness situation of the provincewasthus that, heights with more than 50 cloudy days per year and lowlands with an average of 32 days per year have been the most and least from the point of view frequency. The stations Semnan and Garmsar have lowest and Biarjomand, Damghan, and Shahroud have cloudiest days per year (Figure 4).

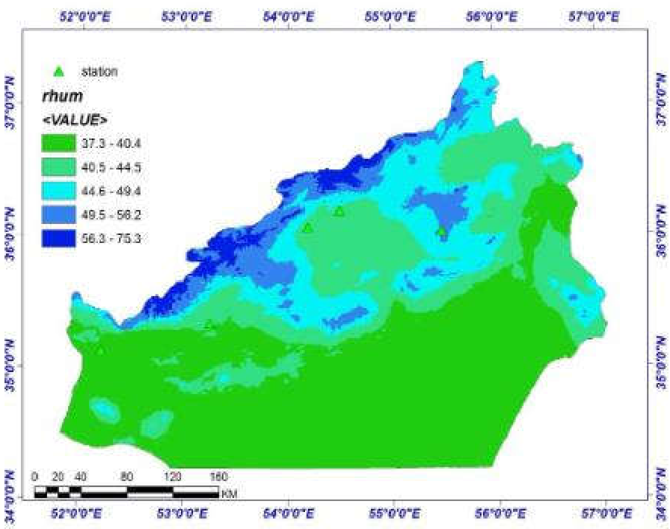


Figure 1. Relative humidity zoning map

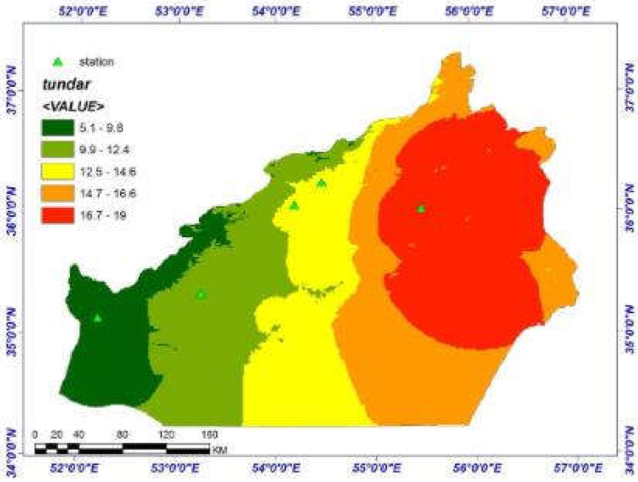


Figure2.Map of the zoning number of days with thunderstorms

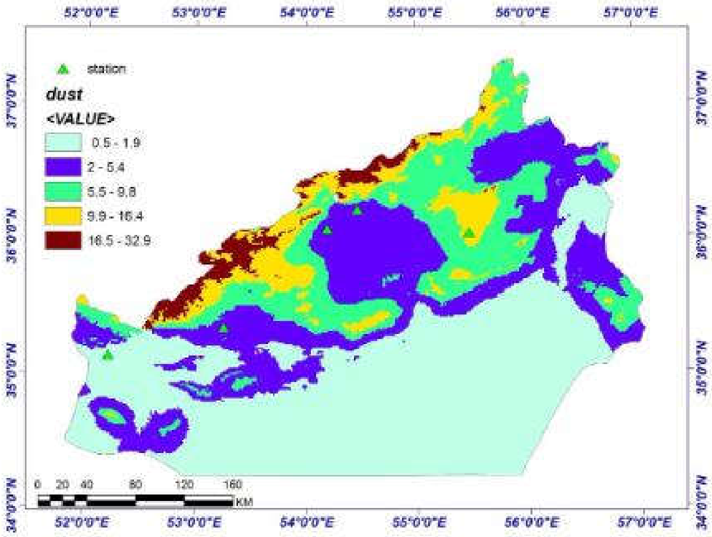


Figure3.Map of the zoning number of days of dust

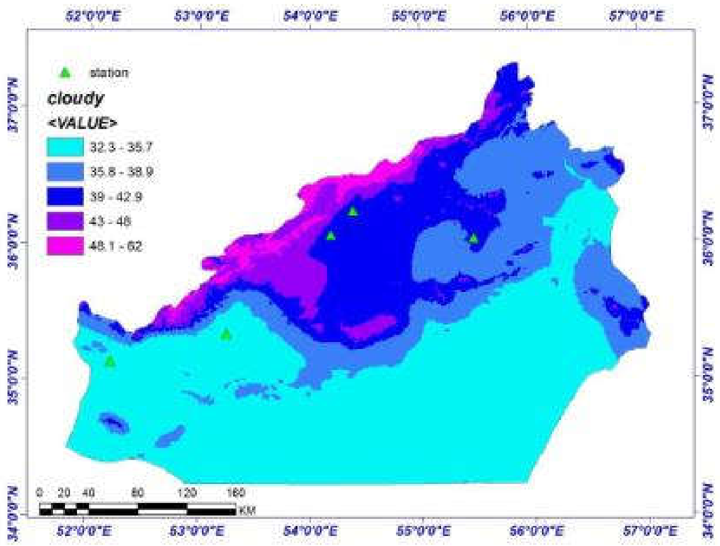


Figure4.Zoning map completely cloudy days

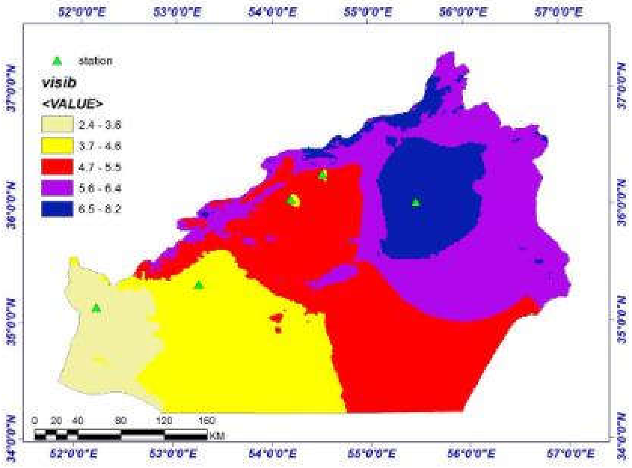


Figure5.Map the number of days with horizontal visibility below 2,000 meters

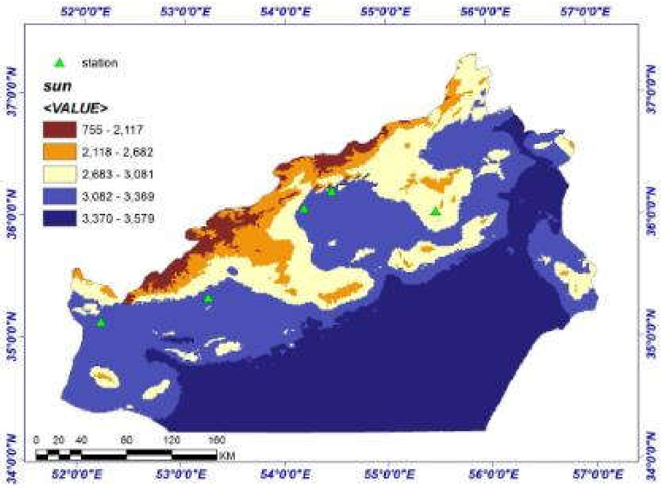


Figure6. Map the average number of sunny hours

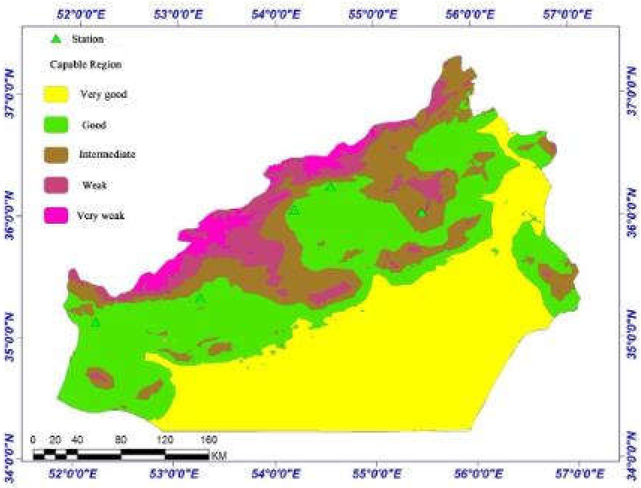


Figure7.Zoning of suitable sites for construction of solar power plants in Semnan province

Figure 5 represents the number of days with horizontal visibility less than 2000 meters. According to the map prepared it can be seen that the eastern regions of the province with the average frequency 8 days per year than west of the province with an average of 3 days per year are attributed to the atmosphere feature. As a result, the increase in the air concentration in maximum areas can be prevented by direct radiation and reached energy to the surface. In Figure 6, one of the most important parameters in locating solar power plant is shown. By examining the actual radiation, we can plan better and more suitable. The excess amount of sunshine hours is the main factor in the net radiation. The results of this study show that in the southern half of the province, total sunshine hours were between 3370 to 3579 hours, while in the uplands reduce in the amount of 755 to 2117 hours per year. It can be concluded that the maximum amount of sunshine hours in the province is in lowlands and sharply decreased with increasing the height. After the maps were prepared, prone areas with high potential were identified based on the weight of each layer in Arc GIS software. As can be seen in Figure 7, lowlands of the province have great potential for the construction of solar power plants due to excess sunshine hours, the low number of cloudy day and phenomena related to vision. On the other hand, there are adverse conditions in the uplands. Also, because of low population densities in desert areas south of the province, it is recommended that it would be done in cities which are located adjacent these areas. For those purposes, cities such as Garmsar and Semnan have great potential and Biarjomand has the lowest potential.

Wind power as other renewable energy sources is extensive geographically and it is dispersed and decentralized, which is almost always available. Hence, we need to examine the overall behavior of the phenomenon in different months, to achieve a general pattern of blast and power this phenomenon in the region. For this purpose, in the province was used of wind speed daily. It Is required for the construction of wind turbines to measure the average wind speed in height 40 meters, which on the basis of Equation 1 was used. After calculating the monthly, average wind speed was identified in the province and zoning. Hence, it was necessary, as the previous section, modeling donebetween latitude and altitude. Therefore, by modeling with the regression model Enter, the wind speed at a height of 40 m was entered intothe model. It should be noted, that the unit of wind measurement was knotted, and convert it to meters per was neglected. The results of the regression model are shown in Table 4. The results show that there is the coefficient of determination and the high correlation between wind speed at a height of 40 meters with latitude and altitude, so in most months the correlation coefficient was more 0.9 and coefficients of determination is not never less than 0.75 except October. This show, which implemented model has high accuracy and can be used to zoning the province. The results of equation (1) on wind speed data at 10 m height showed that the maximum wind speed has been between 7 and 8 knots in January, which is based on the lowlands. This amount reaches to 8to 11 knots in February, 10 to 13 in March, between 11 and 14.5 in April, between 13 and 17 in May, 15 to 21 in June, July similar to June, 13 to 17 in August, September between 9 and 11, 8 to 8.5 in October, 5 to 8.7 knots in November and 4.7 to 6 knots in December (Fig. 8). According to this figure, the lowest wind speed matches the high altitude, which never reaches more than 2 knots. So it can be concluded that the lowlands have the high potential wind speed than other areas. Results showed that maximum wind speeds in areas prone that it was necessary for operating the turbines -an average of more than 5 meters per second (10 knots), started in March and will continue until September. This would be suitable conditions for the construction of wind turbines. 7-month continuation wind over 5 m/s confirms this theme.

Table4.Summarizes the regression model implemented on the average wind speed in 12 months

Regression equation between the average wind speed in each of the months	Std. Error of the Estimate	Adjusted R Square	R Square	R	month
Y=-154.089-1.644+7.141-.008	0.21414	0.971	0.993	0.996a	January
Y=-200.037-1.931+9.060-.013	0.64413	0.846	0.962	0.981a	February
Y=-261.448-2.631+11.952-.016	2.00902	0.252	0.813	0.902a	March
Y=-254.745-2.337+11.360-.017	2.24718	0.063	0.766	0.875a	April
Y=-313.355-2.126+12.841-.021	3.00213	-0.074	0.732	0.855a	May
Y=-375.017-1.278+13.432-.025	2.80954	0.328	0.832	0.912a	June
Y=-314.380+.063+9.683-.024	0.65649	0.952	0.988	0.994a	July
Y=-278.160-.190+8.880-.019	0.57635	0.949	0.987	0.994a	August
Y=-196.143-.251+6.394-.012	1.54762	0.363	0.841	0.917a	September
Y=-145.010-.717+5.511-.008	1.61620	-0.261	0.685	0.827a	October
Y=-138.676-1.261+6.091-.007	0.77370	0.571	0.893	0.945a	November
Y=-145.801-1.445+6.531-.006	0.56333	0.794	0.948	0.974a	December

After analysis made in different months, prone zones in the region were identified by Arc GIS software. The eastern areas and the southern half of the province were identified as perfect areas and the northern highlands ending in the Alborz Mountain as weak areas. In this area, the station is different from the surrounding areas which are representative of a Shahroud and were designated as suitable areas for construction of the wind farm. Also in Figure 10, the average wind speed at ground level and a height of 40 meters and the coefficient of variation of wind data recorded and calculated are shown.

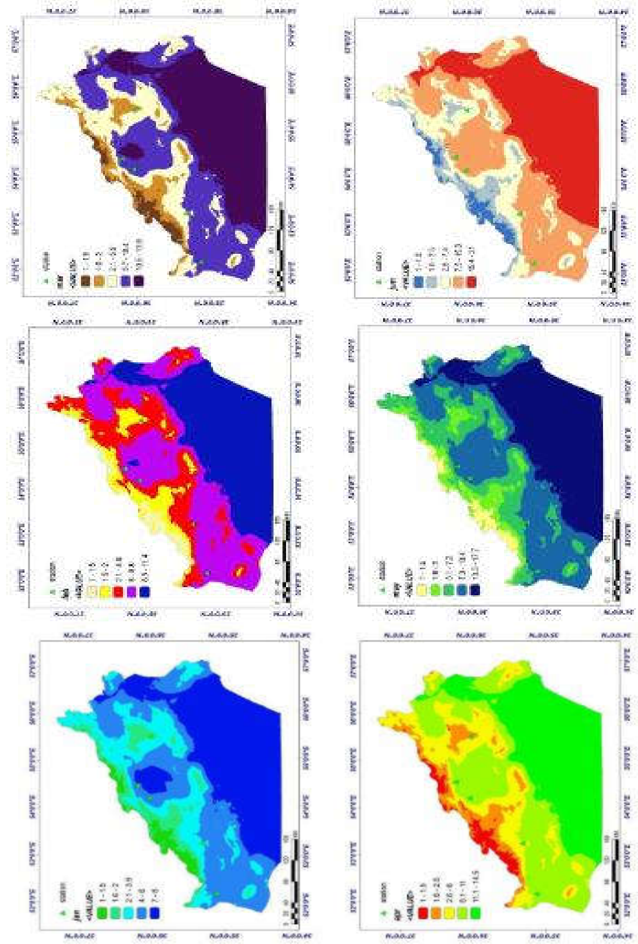
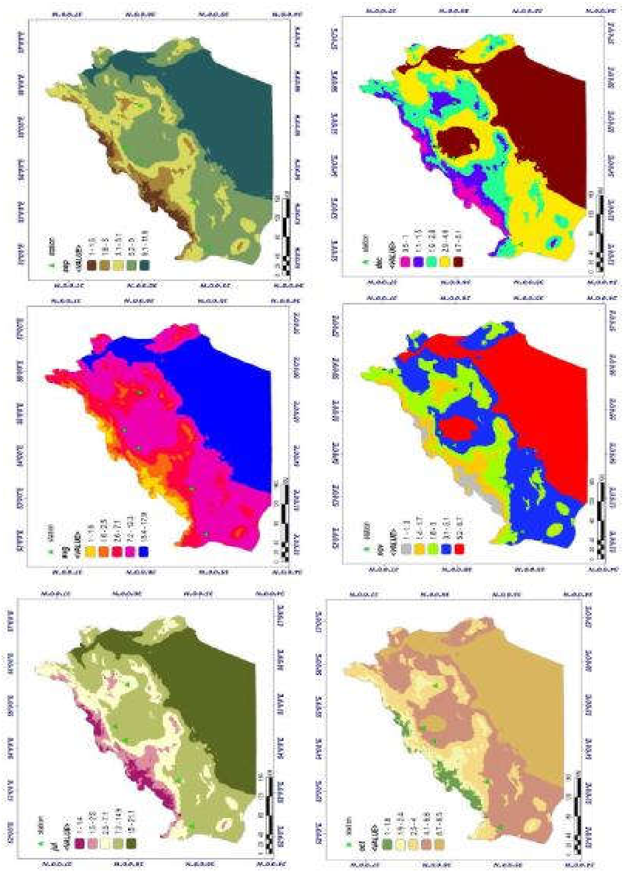


Figure8.Average wind speed at a height of 40 meters for 12 months (speed in knots). In order left to right, from January to December.



Continue Figure8. Average wind speed at a height of 40 meters for 12 months (speed in knots). In order left to right, from January to December.

This coefficient is expressed as a percentage and also called the chaos intensity define as the standard deviation divided by the average. The results show, that in the cold period, wind speed reaches the lowest at selected stations, which can be noted months of November, December, and January. On the other hand, in this period, the coefficient of variation is high and has great fluctuations in the stations of the province. The lowest CV was related to July to November, February, and April is not excluded from this rule.

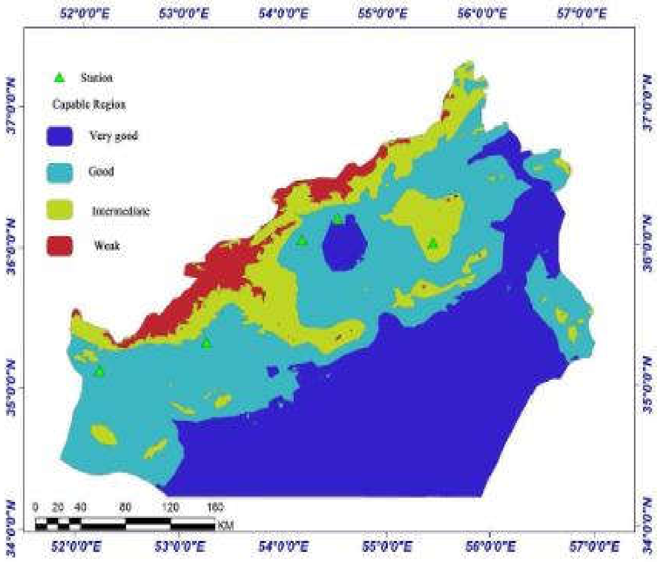


Figure9.Zoning map of suitable areas for construction of wind turbines

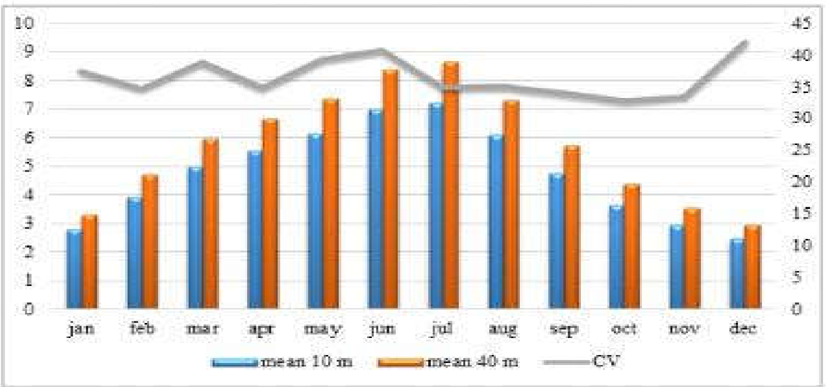


Figure10.Average wind speed at ground level and a height of 40 meters and the coefficient of Variation of the data recorded and calculated.

4. Conclusion

In order to identify prone areas to use wind and solar energy was used parameters of average relative humidity, number of days with thunderstorms, number of days with dust, the number of cloudy days, horizontal visibility below 2,000 meters, sunshine hours and average speed wind on a 20-year period for five synoptic stations in the province. For this purpose, the Enter multiple regression methods was used. The regression equation was entered into Arc GIS and zoning maps were prepared for each parameter. According to the final map, suitable areas for solar and wind plants were identified at the provincial. Results showed that the highlands have the lowest potential for construction solar and wind plants and lowlands of the province have the highest potential. These areas have been determined by taking into account a series of factors, spatial differences in the different layers of information in the model were analyzed. The accuracy of the information greatly affects the accuracy of basic information and selection criteria, which were used invarious tages of research. The findings of this research show capability in modeling geographic information systems also contribute to environmental planning and combining qualitative and quantitative criteria with different scales. Depending on the capabilities that these systems compared with research conducted in space modeling data show, they have the generalizability of data, build new models and test different methods.

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References

[1]. Abdoli, H., Sari Sarraf, B., Hosseini Shamchi, A., "A feasibility study of wind energy potential and its application in the development plans of the province of eastern Azerbaijan", Journal of geographical space, (2009), Vol. 9, No. 28.
[2]. Akpinar, S., Akpinar, E. K., "Estimation of wind energy potential using finite mixture distribution models", Energy Conversion and Management; (2009), 50; 877–884.
[3]. Baizzi, A.M., "GIS-based wind farm siteselection in Lebanon", 2008, ICEE explores.
[4]. Bennui, A., Rattanamanee P., Puetpaiboon U.,Phukpattaranont P. & Chetpattananondh, K., "SITE SELECTION FOR LARGE WINDTURBINE USING GIS. PSU-UNS" International Conference on Engineering and Environment, (2007), Thailand.
[5]. Shams Abadi, Ali Hussein, "Exploring the possibility of using wind energy in the climatic conditions in various parts of Iran", The fourth the throughout village and energy conference, (2000), Chah Bahar.
[6]. Sidki, U., T. Molly, J., 1998. Wind energy in Turkey.
[7]. Manuel, U., Nelson, L., "Analysis of time series data on wind turbine loads", (2002).
[8]. Fakhr Mazlomi, M, "Economic assessment of the installation and construction of wind turbine power plants compared to fossil power plants in Iran", (2001), Energy economics and marketing MSc thesis, Islamic Azad University (Tehran center).
[9]. Kaviyani, M. R., "Wind turbines and assessment of wind energy potential in Iran", Journal of Geographical Research.(1995), No. 36.
[10]. Jahangiri, Z., Rahim Zadeh, F., Kamali, Gh. A., "Calculation of wind energy using the two-parameter Weibull distribution", Journal of Geographical Research, (2005), 20 Years. No. 76.