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Changes in Vegetation and Soil Characteristics of Steppe and Semi-Steppe Rangelands under Impact of Solar Power Plant in Absard and Shahrerey, Iran

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Abstract. In recent years, Iran has begun to move towards the development of the use of renewable energy sources in line with global developments. In this study, Side effects of two solar power plants on rangeland condition were studied. These solar power plants have been constructed using mosaic panels for installation obliquely on 16 ha in Absard rangeland (semi-steppe) and 23 ha in Shahrerey rangeland (steppe), Iran in 2016. In this study, sampling was performed in both rangelands for solar power plant and adjacent control. Sampling was done in 2019, based on the use of 100 m transects with one and two square-meter plots for semi-steppe and steppe, respectively, with a distance of 10 m on transects, systematically. Soil samples were taken from a depth of 0-30 cm from the beginning, middle and end of each transect as a composite sample. The obtained data were compared using independent T-test by SPSS software. Results showed that in comparing of soil factors between solar power plant and adjacent control site in both rangelands, there were no significant differences between treatments. However, vegetation cover and total biomass between solar power plant and control in Absard were significantly different (P<0.01). In Absard site, the vegetation cover (39% vs. 51%) and total biomass with values of (254 vs. 312 kg/h) were obtained in solar power plant and control, respectively, so the panel significantly reduced the performance of the vegetation cover and biomass in semi-steppe rangeland. In contrast, In Shahrerey, the vegetation factors between the solar power plant and the control were not significantly different from each other. So, from the point of view of natural resources and according to the results of the present study, for electricity generation, the establishment of solar power plant in the steppe rangelands is recommended as compared to semi-steppe rangeland.
Key words: Renewable Energy, Steppe Rangelands, Semi-steppe Rangelands, Vegetation, Soil

Introduction

Renewable solar energy is a promising alternative to fossil fuel-based energy. Solar power generation is growing rapidly (Turney and Fthenakis, 2011). Iran is one of the suitable countries in the world with about 300 sunny days in a year and an average radiation of 9.4 kWh per square meter per day, which has the potential to build a solar power plant and use solar energy in the world (Mojahed, 2015). Solar energy is one of the best ways to supply electricity and energy in comparison with other models of energy transmission in the country in terms of cost, transportation, maintenance and similar factors (Mojahed, 2015). The favorable climatic conditions in Iran, due to having both tropical and cold natural regions, have high potential for the establishment of bioenergy energy systems using solar, wind and hydropower sources. The use of modern methods of electrical energy in order to meet part of the required energy will greatly contribute to Iran's economic growth. Solar energy as a renewable energy source is much cleaner than fossil fuels, but its use raises environmental concerns (Nurpour and Zaker, 2014). Installing solar energy equipment requires the destruction of plants and their roots. Photovoltaic panels are installed on steel or aluminum bases about one meter above ground level, or on concrete bases or by placing steel clamps into the ground. Shading of solar panels affects the soil and vegetation of the lower part. Panel shading changes the microclimate (Turney and Fthenakis, 2011). In many plants, shading affects the growth characteristics and yield of plants due to the reduction of light radiation (Nasrolzadeh *et al*., 2011). Hebert *et al.* (2001) found that different light diets had different and significant effects on the total biomass of plants. Ballare (2004) showed that the decrease in plant growth in the shade is related to the limitations due to the lack of light photons and low amount of light due to being in the shade. Islam *et al*. (2005) studied the effect of light intensity on the vegetative and reproductive growth of Lisianthus plant and concluded that shade and lack of light will reduce its yield. They concluded that with decreasing light intensity, vegetative growth decreased and the transition from vegetative to reproductive growth was prolonged. They have shown that plant growth in general, plant yield time, and plant quality are affected by light intensity and daylight.

Turney and Fthenakis (2011) identified and assessed the environmental impact of the installation and operation of US Solar power plant, under the themes of land use intensity, human health and welfare, plant and animal life, geological resources, and climate change. They concluded that the effects of solar power plant compared to fossil power plants are positive in terms of human health and the effect on climate change, but in terms of land use change and land occupation, they are the same as the effects of fossil power plants. Vladimir (2012) states that in order to obtain 10 MW of electricity, a large area about 10 ha will be occupied. Hernandez *et al.* (2015) stated that in order to reduce the negative environmental impact of solar power plant, it is better to build them in degraded areas.

Burney *et al.* (2010) also do not consider suitable climatic lands and good agricultural and rangelands for the operation of solar power plant and recommend saline and degraded lands for the construction of solar power plant. Hernandez *et al.* (2014) studied the environmental effects of solar energy systems such as solar panels and provided a comprehensive list of environmental effects. They reported that the effects of solar technologies on the environment include positive effects on reducing greenhouse gas emissions, especially carbon dioxide, changes in surface temperature, changes in albedo coefficient, changes in microclimate and local hydrology, changes in participation regime, electromagnetic effects, erosion, dust production, fire, land use change and land cover, light and noise pollution, soil and water pollution, the effect on biodiversity through the lack of plant and animal species, especially birds. They stated that the adverse environmental impacts of solar energy technologies have not been assessed yet, but given the numerous advantages of this technology over fossil fuel energy technologies, especially in mitigating climate change, major challenges, there is still evidence of widespread deployment of these facilities.

Despite the use of renewable energy, extensive studies on the effects of this technology on vegetation in the area of solar panels have not been conducted. Assessing an environmental and ecological effect of using such new energies in order to properly manage their use is essential. If necessary, the policy structures in the field of renewable energy should be reviewed. Also, by removing the obstacles and possible problems, the way of developing the use of these energy sources in the country should be accelerated. Therefore, this study was conducted to determine the effects of solar power plant on vegetation parameters of steppe (Shahrerey) and semi-steppe rangeland (Absard) in Tehran province, Iran.

Materials and Methods

Sites information

Absard Sarbandan area is located in Absard plain in Damavand county in Tehran province. Its average altitude is 1972 m above sea level. Its mean participation is 333 mm and its mean annual temperature is 10 °C. Absard area is semi-steppe area. It is located in a geographical position of 35°42′ N and a longitude of 52°20′ E (Fig. 1).

HassanAbad Shahrerey area is located in south of Tehran. It is located in a geographical position of 35°22′ N and a longitude of 51°14′ E at distance of 10 km from Imam Khomeini Airport. Shahrerey area is a steppe area. The mean participation of the region is 158 mm and the mean annual temperature is 15 °C. This area has an average altitude of 965 m above sea level (Fig. 1).

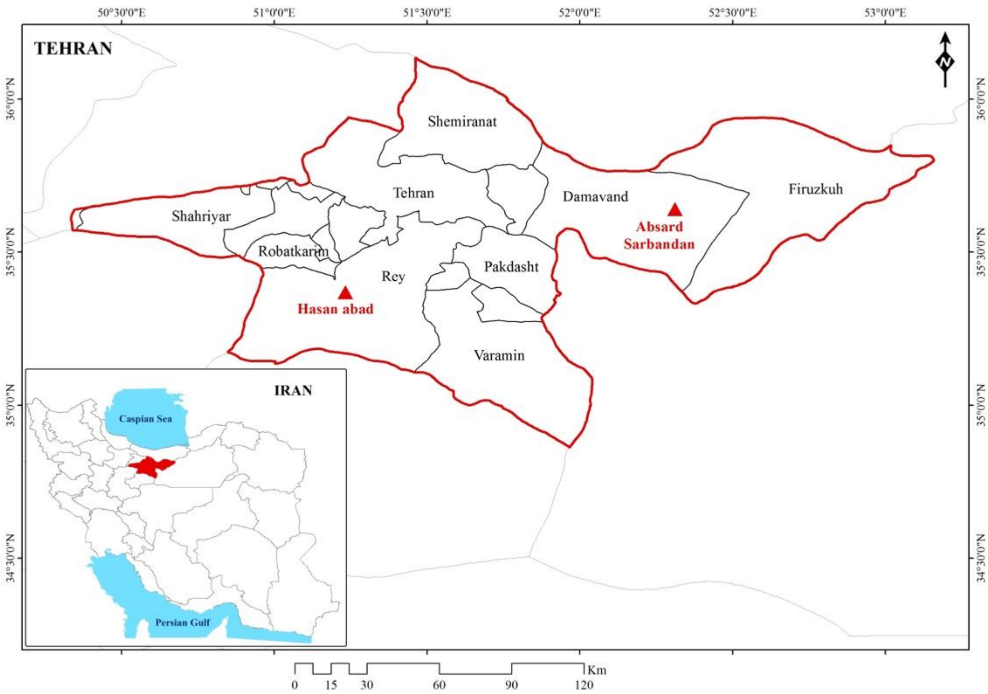

Fig. 1. Geographical location of Absard Sarbandan and HassanAbad Shahrerey in the province and Iran

Research Methods

In order to evaluate the uniformity between the solar power plant site and the control site, an adjacent rangeland similar to the conditions of the solar power plant rangeland was considered as the control, which in terms of general conditions (slope, direction, height, vegetation and soil), was similar to the solar power plant site. Then, vegetation and soil parameters in both solar power plant and control were measured.

Sampling was performed based on the use of 100-m transects with one-square-meter plots in the semi-steppe rangeland and two-square-meter plots in the steppe rangeland with a distance of 10 m on transects (10 plots per transect) and systematically in two areas (Arzani & Abedi, 2015). It should be noted that the area of solar power plant in Absard rangeland was 16 ha and in Shahrerey rangeland was 23 ha. These solar power plant sites were established in 2016. In this research, twelve 100-m transects were deployed (60 plots along 6 transects at the power plant site and 60 plots along 6 transects at the control site).

The following parameters were measured inside each plot according to (Moghadam, 2016):

Canopy cover percent: This parameter was based on the measurement of the vertical image of the canopy on the ground. This parameter was measured by dividing the amount of canopy cover for perennial species and annual species by vegetative form.

Arial biomass: Measurement of biomass was performed by cutting and weighing method in each plot. Plant species biomass was collected and weighed separately for perennial and annual species.

Range condition: it was evaluated using modified four-factor method as follows:

- The soil factor in five levels (depending on soil erosion and plant density) 0 to 20 points,
- Vegetation factor in four levels (depending on percentage of living canopy) 1 to 10 points,
- Vegetation factor in five levels 1 to 10 points and
- Plant vigor in four levels (depending on plant health, strength and age classes) was evaluated from 1 to 10 points, and finally
- Degree of rangeland condition was determined based on the sum of points.

Soil sampling under solar panels and control site: it was performed from both solar power plant and control. Soil samples were taken from a depth of 0-30 cm from the beginning; middle and end of each transect as a composite sample and transferred to the laboratory.

Soil analysis was made in the laboratory for the following parameters :

Soil texture was determined by hydrometric method (Jia *et al*., 2005).

Organic carbon: it was determined by walk-block method (Jia *et al*., 2005).

Soil electrical conductivity (EC) and acidity (pH) were determined by extraction method in saturated mud. For this purpose, the extracts obtained by EC (Jafari and Sarmadian, 2003) and pH device (Huang and Tsai, 2010) were read.

Nitrogen: it was measured by Kjeldahl method (Bremner *et al*., 1996) and

Phosphorus by Olsen method (Olsen & Sommers, 1982).

Data analysis: Due to the normality of the recorded vegetation and soil data obtained from control and solar panel installation sites and the assumption that the variances were the same, independent T-test by SPSS software was used for comparing data.

Results

Vegetation covers information

The list of plant species in the rangeland composition in Absard and Shahrerey areas is presented in Table 1. The composition of Absard rangeland vegetation includes: grasses species with palatability class I (*Poa bulbosa* belongs to Poaceae family, *Agropyron intermedium, Bromus tomentellus, Doctylis glomerata, Agropyron elongatum and Stipa barbata* belongs to Gramineae family) and shrubs with palatability class II (*Artemisia siberi*, *Achillea millefolium* belongs to Compositae family) as well as small number of forbes with palatability class III (*Gundelia tournefortii* belongs to Compositae family, *Launaea acanthodes* and *Echinops elbursensis* belongs to Asteraceae family, *Verbascum cheiranthifolium* belongs to Serophulariaceae family, *Cirsium echinus* belongs to Compositae family and *Peganum harmala* belongs to zygophyllacea family).

In the event that the vegetation composition of Shahrerey rangeland is often low-palatable species including: shrub with palatability class III (*Artemisia siberi, Lactuca orientalis, Onopordon acantitum, and Cousinia cylindracea* belongs to Compositae family, *Prosopis fracta* belongs to Mimosaceae family, *Stachys terinervis* belongs to Lamiaceae family) and also forbes with palatability class III (*Launaea acanthodes and Echinops elbursensis* belongs to Asteraceae family, *Peganum harmala* belongs to Zygophyllacea family).

Table 1. The list of plant species in the rangeland composition in Absard and Shahre rey

Areas	Site	Family	Species	Vegetative form	Palatability classes
	control	Poaceae	*Poa bulbosa*	grass	I
Absard		Compositae	*Artemisia siberi*	shrub	II
		Compositae	*Lactuca orientalis*	shrub	III
		Compositae	Cousinia cylindracea	shrub	III
		Asteraceae	*Onopordon acantitum*	shrub	III
		Gramineae	*Stipa barbata*	grass	II
		Gramineae	*Agropyron intermedium*	grass	I
		Papilionaceae	*Trigonella persica*	forb	I
		Gramineae	*Aegilops colomnaris*	grass	II
		Gramineae	*Bromus tomentellus*	grass	I
		Gramineae	*Doctylis glomerata*	grass	I
		Gramineae	*Agropyron elongatum*	grass	I
		Compositae	*Achillea millefolium*	shrub	II
	solar power plant	Compositae	*Gundelia tournefortii*	forb	III
		Compositae	*Artemisia siberi*	shrub	II
		Compositae	*Lactuca orientalis*	shrub	III
		Compositae	Cousinia cylindracea	shrub	III
		Asteraceae	*Launaea acanthodes*	forb	III
		Asteraceae	*Echinops elbursensis*	forb	III
		Gramineae	*Bromus tomentellus*	grass	I
		Gramineae	*Stipa barbata*	grass	I
		Serophulariaceae	*Verbascum cheiranthifolium*	forb	III
		Compositae	*Cirsium echinus*	forb	III
		zygophyllacea	*Peganum harmala*	forb	III
	control	Mimosaceae	*Prosopis fracta*	shrub	III
Shahrerey		Compositae	*Artemisia siberi*	shrub	III
		Compositae	*Lactuca orientalis*	shrub	III
		Compositae	*Cousinia cylindracea*	shrub	III
		Compositae	*Onopordon acantitum*	shrub	III
		Asteraceae	*Launaea acanthodes*	forb	III
		Asteraceae	*Echinops elbursensis*	forb	III
		Gramineae	*Aegilops colomnaris*	grass	II
	solar power plant	Mimosaceae	*Prosopis fracta*	shrub	III
		Compositae	*Artemisia siberi*	shrub	II
		Compositae	*Lactuca orientalis*	shrub	III
		Compositae	*Cousinia cylindracea*	shrub	III
		Asteraceae	*Launaea acanthodes*	forb	III
		Asteraceae	*Echinops elbursensis*	forb	III
		Lamiaceae	*Stachys terinervis*	shrub	III
		Zygophyllacea	*Peganum harmala*	forb	III

The results of measurement of canopy cover percent in Absard site showed a significant difference (P<0.01) in terms of palatability classes between the control and solar power plant.

In Absard site, the highest and lowest palatability rates in term of class I palatability with canopy cover percent of 14.4% and 4.2% were observed in control and solar power plant, respectively. In contrast, for palatability class III, the highest and lowest canopy cover percent of 9.2% and 4.3% was observed in solar power and control, respectively (Table 2). However, in Shahreri area, there was no significant difference in terms of palatability class between the control and the power plant sites (Table 2).

Table 2. Mean comparisons of canopy cover percentage based on palatability classes between control and solar power plant sites using independent T-test

Areas	Palatability classes	canopy cover percentage		T value	P value
		solar panels	Control		
Absard	I	4.20	14.48	8.238	0.000**
	II	4.30	8.30	4.167	0.000**
	III	9.21	4.31	-6.158	0.000**
Shahrerey	II	4.18	4.05	-0.243	0.808 ns
	III	14.78	13.76	-0.447	0.655 ns

ns, and **= Non significant and significant at 1% probability levels

According to the results of Table 3, there were significant differences in terms of vegetative forms between the treatments in Absard site (P<0.01). But there was no significant difference between treatments (control and the solar power plant) in Shahreri area (Table 3).

According to the results in Absard site, the highest canopy cover percent of forb vegetation form with values of 19.3% and 3.7% was obtained n solar power plant and control, respectively. In contrast, for grasses, the highest and lowest values of 24% and 3.9% were obtained in control and solar power plant, respectively (Table 3). In Shahreri area, there was no significant difference in terms of vegetation form cover percent between the control and the power plant sites (Table 3).

Table 3. Mean comparisons of cover percentage based on vegetation forms between control and solar power plant sites using independent T-test

Areas	Vegetation forms	cover percentage		T value	P value
		Solar panels	Control		
Absard	Grasses	3.98	24.30	10.926	0.000**
	Forb	19.35	3.78	-9.124	0.000**
	Shrub	16.06	22.50	2.967	0.004**
Shahrerey	Grasses	4.30	4.10	-0.388	0.699 ns
	Forb	5.03	4.81	-0.381	0.704 ns
	Shrub	10.11	9.95	-0.107	0.915 ns

ns, and **= Non significant and significant at 1% probability levels

For rangeland condition, according to the sum of the scores of the four-factor method (Table 4), In Absard site, the highest and lowest values of total score of rangeland condition with values of 29 and 40 were obtained in control and solar power plant sites treatments, respectively. This result Indicated the negative effect of Solar panels on rangeland condition in semi step area. Result indicated a higher class of rangeland condition in Absard site than that for Shahreri site. According to Table 4, in Shahreri site, the rangeland conditions for both treatments were in a weak class.

Table 4. Scores of rangeland condition factors based on the four-factor method at the control site and the solar power plant

Rangeland condition factors	Absard		Shahrerey	
	Solar panels	control	Solar panels	control
Soil factor (relying on soil erosion and crop residues)	12	14	12	12
Vegetation factor (percentage of live canopy)	8	9	5	6
Plant composition factor and age classes	5	9	2	2
Factor of plant vigor and vitality (plant health and strength)	4	8	5	5
Total Score	29	40	24	25

Means comparisons were made between treatments for total canopy cover and total biomass using independent T-test (Table 5). In Absard site, there were significant differences between the treatments for both traits (P<0.01). In Absard site, the lowest and highest values of total canopy cover (39.5 and 51.3%) and total biomass (247 and 313 kg/h) were obtained at the power plant and the control treatments, respectively while Indicating the negative effect of Solar panels on rangeland production in semi step area. In Shahrerey, there was no significant difference between treatments for both total canopy cover and total biomass (Table 5). Total canopy cover and total biomass of Absard were more than Shahrerey rangeland Because Absard rangeland is a semi-steppe rangeland and its participation is more and its temperature is lower compared to Shahrerey which is a steppe rangeland.

Table 5. Mean comparisons of total canopy cover and total biomass beteeween control and solar power plant sites using independent T-test

Areas	Traits	Mean values		T value	P value
		Solar panels	Control		
Absard	Percentage of Total Canopy Cover	39.51	51.35	-3.840	0.000**
	Total Biomass (kg/h)	254.75	312.95	-2.932	0.004**
Shahrerey	Percentage of Total Canopy Cover	19.45	19.45	0.001	1.000 ^{ns}
	Total Biomass (kg/h)	109.66	119.71	-1.051	0.295 ^{ns}

ns, and **= Non significant and significant at 1% probability levels

The results of comparing different soil factors between the power plant site and the control showed that there were no significant differences in either of the two areas for any of the studied soil factors. Comparison of soil between two rangelands shows that the values of all soil factors are different between two regions. Thus, the values of soil fertility factors such as carbon content, nitrogen content and phosphorus content soil of Absard semi-steppe rangeland are higher than Shahreray steppe rangeland. However, the destructive factor of soil electrical conductivity in Absard semi-steppe rangeland was less than Shahreray steppe rangeland:

The average soil carbon content of Absard rangeland and Shahrerey rangeland is 1.6% and 0.3%, respectively. The average soil nitrogen content of Absard rangeland and Shahreray rangeland is 0.15% and 0.03%, respectively. The average soil phosphorus content of Absard rangeland and Shahreray rangeland is 14.2 and 7.3 ppm, respectively. The average soil electrical conductivity of Absard rangeland and Shahreray rangeland is 0.47 and 2.11, respectively (Table 6). This is due to the fact that the amounts of participation and temperature of two regions are different from each other. This means that these climatic parameters have been better in Absard semi-steppe rangeland and therefore, in terms of vegetation factors, Absard semi-steppe rangeland was in a more favorable situation. Therefore, in terms of soil fertility factors, it has better conditions.

Table 6. Comparison of the mean of different soil factors in the control site and solar power plant site based on independent T-test

Areas	Traits	Site	Mean	T value	P value
Absard	%Sand	Control	26.0500	.043	.966 ns
		Solar panels	25.9833		
	%Silt	Control	44.0000	-.370	.719 ns
		Solar panels	44.6667		
	%Clay	Control	29.6333	-.273	.790 ns
		Solar panels	29.0667		
	P(PPM)	Control	14.1667	-.083	.935 ns
		Solar panels	14.3333		
	%C	Control	1.7550	2.197	.053 ns
		Solar panels	1.6400		
	%N	Control	0.1683	1.872	.091 ns
		Solar panels	0.1517		
	EC	Control	0.5500	1.400	.192 ns
		Solar panels	0.4333		
	PH	Control	7.5833	-.325	.752 ns
		Solar panels	7.6500		
Shahrerey	%Sand	Control	64.0333	-.006	.995 ns
		Solar panels	64.0500		
	%Silt	Control	17.0333	-.061	.952 ns
		Solar panels	17.4167		
	%Clay	Control	18.6167	.015	.989 ns
		Solar panels	18.0917		
	P(PPM)	Control	7.6667	-.500	.628 ns
		Solar panels	7.0000		
	%C	Control	0.3267	.288	.779 ns
		Solar panels	0.3533		
	%N	Control	0.0300	.277	.787 ns
		Solar panels	0.0367		
	EC	Control	2.2667	-.034	.974 ns
		Solar panels	2.1000		
	PH	Control	8.1833	.483	.640 ns
		Solar panels	8.1583		

ns: there is no significant difference between treatments

Discussion

The issue of climate change and its relationship with the consumption of fossil fuels and the increase in greenhouse gases resulting from the use of fossil fuels has given the use of renewable energy a global dimension. On the other hand, the escalation of the energy crisis in different countries of the world has led many of these countries to change the energy consumption basket in their country by moving to the use of alternative and renewable energy sources and by making changes in the pre-program. In this regard, they provide the ground for the development of more use of these resources in their country. Given the high potential of renewable energy sources, in recent years, Iran has begun to move towards the development of the use of these energies in line with global developments. Iran is located on the solar belt of the world and is one of the countries that enjoys sunlight with the desired power and is one of the most prone areas to use this energy (Mojahed, 2015). Solar power plants are built in a wide variety of locations and ecosystems, from forests in the UK, California deserts, near-tropical locations in Florida and elsewhere. The environmental impact of a solar power plant varies depending on their place of construction (Turney and Fthenakis, 2011). Pazuki (2001) emphasizes the need to pay attention to natural resources and their proper and scientific use in order to maximize their sustainable use. One of the main effects of solar power plant is on vegetation characteristics in the region of their construction. Based on the results of our research, it was found that the percentage of total vegetation cover at the power plant site

(39%) and control (51%) in Absard area had a significant difference (P<0.01) so that it was higher in the control site. Similarly, the mean of biomass was significantly different (P<0.01) between two treatments of Absard so that in power plant site (254 kg/ha), it was lower than control (312 kg/ha). These significant differences between the power plant and the control site in Absard area can be attributed to the limited radiation input due to the presence of solar panels and their shading because shading causes a change in the wavelength of the received light. In many plants, shading affects the growth characteristics and yield of plants due to the reduction of light radiation (Nasrolzadeh *et al*., 2011). Hebert *et al.* (2001) found that different light diets had significant effects on the total biomass of plants. The reduction in plant growth in the shade is related to the limitations of light photons in the shade (Ballare, 2004). Reduced amount of plant species and their products occurs under environmental stresses such as shading and reduced amount of light passing through the shade of plants and reduced amount of photosynthetic active radiation absorbed by the plant. Also, biomass produced by plant decreases due to limited radiation of light in ordinary conditions (Nasrolzadeh *et al*., 2011). In shade treatment, the growth of plants is decreased and the aerial part and the total biomass are significantly reduced. There is a close relationship between energy received from the sun and the presence and height of the plant. Light intensity is one of the factors affecting the growth and development of plants. Shading also changes the wavelength of light, which can affect plant growth (Kayhanpour *et al*., 2018). Islam *et al*. (2005) studied the effect of light intensity on the vegetative and reproductive growth of Lisianthus plant and concluded that shade and lack of light will reduce its yield. They concluded that with decreasing light intensity, vegetative growth decreases and the transition from vegetative to reproductive growth is prolonged. They had shown that plant growth and plant quality are affected by light intensity during the day. Lugassi-Ben-Hamo *et al*. (2010) investigated the effect of shade on the stage of transition from vegetative to reproductive growth, plant growth and development, yield and flower quality. The results of their research showed that in shady conditions, plant yield decreases. This poor performance may be due to poor nutrient storage, which results from insufficient absorption of light required for photosynthesis in the early stages of growth. It has also been reported that the reduction in light intensity by shade causes a delay in flowering and reduced plant yield (Dai *et al*., 2009). Cemy *et al*. (2003) stated that the amount and intensity of light often affect the flowering mechanism in the early stages of plant development. Dai *et al*. (2009) stated that the amount of photosynthesis decreases rapidly in ornamental plants with decreasing light intensity. Miralles *et al.* (2011) reported that excessive shade reduced the rate of photosynthesis, increased the concentration of carbon dioxide in the chamber under the stomata, and reduced the efficiency of water consumption by the plant. They stated that due to the direct relationship between the intensity of light reaching the leaves and the amount of photosynthesis, as the intensity of light decreases, the light reactions of photosystems 1 and 2 are disrupted and fewer hydrocarbons are produced in the plant. Decreased performance at lower light intensities can be attributed to reduced energy and less dry matter production. Also, based on research by Tsoutsos *et al*. (2005), excess heat from installing solar cells may kill a number of species in this type of environment and reduce vegetative parameters such as biodiversity.

Based on the results, it was found that in Shahreri area, there was no significant difference in terms of vegetative forms between the solar panel and control. The results also showed that the percentage of total vegetation cover and biomass at the site of the power plant and the control site of Shahrerey were not significantly different from each other.

Based on the above, it can be concluded that the establishment of solar power plant does not have a significant impact on vegetation in the steppe area, so solar power plant in the steppe area can be used in electricity generation without significant negative effects on vegetation and soil proties. Also, the results show that there were no significant differences in comparing different soil factors between the power plant and control in both areas. Kashki *et al*. (2015) in their research show that changes in soil materials and elements have a slower trend than changes in vegetation. Amigh *et al*. (2015) stated that nowadays, due to the limited fossil fuel resources and the consequences of environmental pollution and global climate change, the process of electricity using solar energy should be considered. However, in semi-steppe areas, the construction of power plants caused significant negative effects on the vegetation of the region, which should be considered by managers and planners. In this regard, Hernandez *et al*. (2014) stated that in order to reduce the negative environmental impact of solar power plant, it is better to build these power plants in degraded areas. Burney *et al*. (2010) also do not consider suitable climatic lands and good agricultural and rangeland for the operation of solar power plant and recommend saline and degraded lands for the construction of solar power plant because the vegetation cover is not affected. Also, Turney and Fthenakis (2011) state that desert areas have very little precipitation consequently low biodiversity and biomass, so these areas are the most suitable place for the construction of Solar power plant. However, according to research of Gunerhan *et al*. (2008), Turney and Fthenakis (2011), Hosseini *et al*. (2012) and Hernandez *et al*. (2015), solar power plants are environmentally friendly systems. But solar power plant must be exposed to an environmental assessment process such as vegetation and soil assessments to minimize potential negative impacts on the environment.

Conclusion

The fact is that the environmental impact of solar power plants depends on the place of their construction. It should be noted that suitable lands that had good capability for agricultural and pasture are not considered for the establishment of solar power plant. Instead, degraded and unsuitable lands and rangelands are recommended for the construction of solar power plant. Based on the results, it can be concluded that the establishment of solar power plant had no significant impact on vegetation and soil of the steppe rangelands (Shahrerey). While, in semi-steppe rangelands (Absard), the construction of solar power plants caused significant negative effects on the vegetation of the rangelands, which should be considered by managers and planners. So, from the point of view of natural resources and according to the results of the present study, for electricity generation without significant effects on vegetation and soil, the establishment of solar power plant in the steppe rangelands is preferable than to semi-steppe rangeland. Due to the fact that very little research has been done in the field of environmental and ecological impacts of solar power plant, more extensive and comprehensive studies in this field are recommended.

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تغییرات ویژگی‌های پوشش گیاهی مراتع استپی و نیمه استپی تحت تاثیر نیروگاه‌های خورشیدی (سربندان آبسرد و حسن آباد شهرری)

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چکیده. کشور ایران در چند سال اخیر، حرکت خود را به سمت توسعه کاربرد انرژی‌های تجدیدپذیر، متناسب با تحولات جهانی آغاز نموده است. انرژی خورشیدی به عنوان یکی از این منابع تجدیدپذیر هرچند بسیار پاک‌تر از انرژی سوخت‌های فسیلی است، اما با این وجود، استفاده از آن نگرانی‌های محیط زیستی و اکولوژیکی را به دنبال دارد. لذا هدف این تحقیق، ارزیابی تاثیرات احداث نیروگاه های خورشیدی بر پارامترهای پوشش گیاهی و خاک مراتع مناطق استپی و نیمه استپی می‌باشد. بدین منظور، تاثیرات احداث دو نیروگاه خورشیدی که در سال ۱۳۹۶، با استفاده از پنل‌های موزاییک در سطح ۱۶ هکتار در مراتع سربندان آبسرد (نیمه‌استپی) و ۲۳ هکتار در مراتع حسن آباد شهرری (استپی) ایجاد شده بودند، بر پارامترهای پوشش گیاهی و خاک مورد بررسی قرار گرفت. در این پژوهش، از مراتع نیروگاه‌های خورشیدی و مراتع شاهد مجاورشان نمونه‌برداری انجام شد. نمونه‌برداری با استفاده از ترانسکت‌های ۱۰۰ متری و با پلات‌های دو متر مربعی (مراتع استپی) و یک متر مربعی (مراتع نیمه استپی) با فاصله ده متری بر روی ترانسکت‌ها و به روش سیستماتیک انجام شد. سپس، داده‌های ثبت شـــده پوشش گیاهی و خاک مراتع نیروگاه خورشیدی و شاهد، با آزمون T مستقل و با استفاده از نرم افزارSPSS با یکدیگر مقایسه شدند. بر اساس نتایج حاصل از این تحقیق مشخص گردید که درصد پوشش گیاهی و زیتوده دو سایت نیروگاه و شاهد مراتع سربندان آبسرد (نیمه‌استپی) اختلاف معنی‌داری با یکدیگر داشتند به طوری که میزان درصد پوشش (۵۱٪ و ۳۹٪) و میزان تولید (۲۵۴ و ۳۱۲ کیلوگرم بر هکتار) به ترتیب برای دو سایت شاهد و نیروگاه مراتع آبسرد به دست آمد، ولی از لحاظ فاکتورهای خاکی تفت بین دو منطقه در مراتع نیروگاه و شاهد، اختلاف معنی‌داری با یکدیگر نداشتند. بنابراین، با توجه به به اثرات سوء پنل‌ها بر پوشش گیاهی و تولید مرتع زیر اشکوب پنل‌ها، از دیدگاه مدیریت منابع طبیعی، احداث نیروگاه خورشیدی در مراتع استپی نسبت به مراتع نیمه استپی ارجحیت دارد.

کلمات کلیدی: انرژی تجدیدپذیر، مراتع استپی، مراتع نیمه استپی، پوشش گیاهی، خاک