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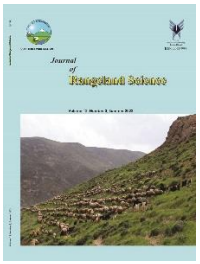

Research and Full Length Article:

Assessment of Land Use Changes in Miandoab Rangelands by GIS and AHP

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Abstract. Ecological capability assessment of a land as one of the most important steps in line with sustainable development was conducted based on identifying and pre-designed criteria, following assessment of the land's assets and its latent power. In the present study, which was conducted in 2019, in order to reveal the changes in the region during ten years, evaluateing the ecological potential of the regionwas done for rangeland use using the main criteria: soil science, lithology, topography, climate, vegetation, water level, road fault, flood zones and land use using AHP (Analytical Hierarchy Process) method and digitization of information in GIS environment. Then, in order to reveal the changes in the region, and the study of multi-time remote sensing images in 3.5 Envi software were done. Findings indicate that the highest potential of the region is for rangeland use (33.6%). The study of land use changes shows an increase of two uses of rangeland (+6.8%) and vegetation of trees and shrubs (+13.9%). Kappa coefficient and total accuracy of the classified images for 2009 are 0.98 and 98.66 and for 2019, they are 0.86 and 88.88. Therefore, considering the importance and priority of rangeland use in this region in order to achieve sustainable development, special attention should be paid to economicization of rangelands so that in addition to conserving water, soil and vegetation, we can see more grazing management.

Key words: Land use, Range management, Remote sensing, Analytical hierarchy process

Introduction

Optimal and principled utilization of natural resources of the land and organizing land use based on its natural (ecological) potential has an important role in environmental management, preventing environmental degradation in the direction of sustainable development. Ecological potential assessment is one of the methods to determine the optimal land use, in which first by preparing a map of environmental units obtained by combining maps of altitude, slope, slope direction, soil and vegetation, and then by analyzing a system of sustainable and unsustainable ecological factors of the land, the potential of various uses is evaluated. Using geographic information systems, the environmental units of the watersheds are mapped and after combining the necessary maps and updating them using a comparison of mathematical models, agricultural uses, rangeland, forestry, urban and rural development, Centralized recreation, extensive recreation, aquaculture and conservation with environmental units, the ecological potential of these units are evaluated and classified. After evaluating the ecological potential of the land uses in order to select the best options in the land unit and organize the land uses, the priority of the land uses is determined, and maps of different land use power categories are prepared. The issue of ecological capability assessment is of great importance in Iran (Maleknia *et al.,* 2017). Ecological capability assessment in Iran plays a key role in sustainable development and its biodiversity conservation.

However, during the recent decades, implementation of urban and rural development projects in the land zone without paying attention to the lands' ecological capability has resulted in the advent of various environmental, economic and social problems (Nadaf *et al.,* 2017). Taking this into account and for protecting the country's biological power, it is necessary to take all plans in line with national and regional development with consideration of the land's capabilities and potentials.

To achieve sustainable development, it is essential to have a plan based on a comprehensive assessment of the natural environment. Given that the natural environment has a limited ecological potential for human use, and the assessment of ecological potential as the core of environmental studies with the prevention of existing crises provides a good basis for environmental planning (Kargar *et al.,* 2018). AbdulRahman *et al.,* (2016) studied ecological capability of Karnataka area in India for agricultural use in order to find the most suitable lands for different plants. Hence, they combined physical parameters of the area with land use parameters and soil parameters in GIS software and finally, they could determine the best soil and the best plant for farming in each section of the area. Mishra *et al.,* (2015) proceeded on identification of appropriate sites for agricultural uses with the aid of AHP (Analytical Hierarchy Process) and GIS in Uttarakhand city of India. Considering that 64.6% of the region area has been located in Himalayan forest, so it enjoys the necessary requirements for agricultural development. This study indicates the effect of AHP (Analytical Hierarchy Process) on appropriate analysis of agricultural site in the study zone. Changes in the human needs, especially basic needs such as food, housing and clothing resulted in changes in the type of resource use whether gradually or rapidly (Jun *et al.,* 2017). Change in the lands uses has been noted widely since years ago. Change in the land use and coverage was considered as the key element of environmental world change and it is noted by scholars due to environmental health and socio-economic reasons (Herrmann *et al.,* 2015).

Since land is one of the inputs of the production sector, it plays an important role

not only in the agricultural economy and natural resources but also in the economy of the whole country and it is necessary to pay attention to the land and the changes that have taken place in it. In recent decades, land use change due to environmental and human factors has caused serious effects on the environment, economy and society. Therefore, knowing the type of land use and its changes over time is one of the important issues in planning and policy-making in the country. Having information about changes in the land use for investigation of its reasons in a period might be noted by planners and managers (LY *et al.*, 2016). Paul *et al.*, (2014) proceeded on assessment of land use changes in TEKA river basin in Bangladesh using ERDAS software during 2000-2004.

It was identified that farming lands were increased for 4% and urban development was decreased by 16%, so annual monitoring should be conducted in the area considering its appropriate condition. The environmental effects assessment process is first designed to help appropriate planning of sustainable development and secondly, expanding the current available development projects (Naderi and Bahrami, 2014). In each country, there are different social, human, economic and natural capitals and the collection of these capitals is necessary to achieve sustainable development. In general, sustainable development can be divided into two categories; Weak sustainable development and strong sustainable development. Based on weak sustainable development, different capitals are somewhat interchangeable. In contrast, there is strong sustainable development, according to which different capitals have very limited interchangeability because in terms of strong sustainable development, different capitals are needed to increase the welfare of the present and future generations. Given the importance of different capitals (economic, social, natural and human), strong sustainable development is a more appropriate indicator. Currently, all developmental and civil engineering activities in Iran are implemented based on environmental observations in line with reaching sustainable development in the country and to prevent pollution and environmental destruction.

The present study proceeds on the two main objectives: 1-Assessment of the ecological capability of Miandoab county, Iran for rangeland use. 2- Studying land uses changes during 2009-2019.

Materials and methods

Study area

Miandoab County (Fig.1**)** has been located at 164 km southern of Uremia in province of West Azerbaijan province Iran. The county has been located at geographical longitude of eastern 46˚0ˈ and latitude of Northern 37˚10ˈ, at the south part of Uremia Lake, at 1314m sea level. The county with an area of 164 km^2 covers 4.18% of the province. Average rainfall of the area has been recorded as 289 mm. 33.11% of the county's area is covered with hills and remaining 67.88% is composed of plain and flowages. The area's climate is variable with relatively hot summers and relatively cold winters. The appropriate geographical condition of the area has resulted in relatively good development of agriculture and industry. Agricultural system is possible to increase the products output. According to the latest census, the city has population of about 240000 people (Manafiazar and Valaei, 2019).

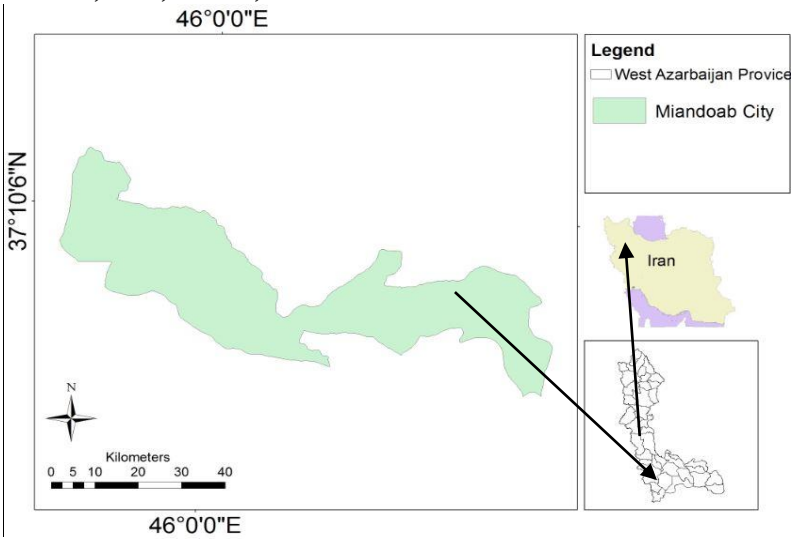

Fig. 1. Geographical location of Miandoab County in West Azerbaijan and Iran

In this research for assessment of ecological capability, the criteria and sub-criteria were first selected through assessment of different resources and obtaining the standards (Rastgar *et al.,* 2016). Then, using Delfi questioner, the criteria and sub-criteria were weighed and AHP (Analytical Hierarchy Process) was used in Expert Choice software to weigh the criteria. Finally, all layers were combined in Arc Map 10.2 using weighted linear combination methods and the final map of ecological capability of the area was obtained for three uses of urban development, recreation and agriculture- rangeland. Regarding agriculture- rangeland use, first three classes are related to agricultural use and the second classes are related to rangeland use. In each of these uses with qualitative increase of the classes, the capability of the underlying use was decreased accordingly. In Iran, the following table indicators are used in 4 categories to evaluate rangeland use (Makhdoum, 2014).

Table 1. Indicators for assessing the ecological potential of rangeland land use

Class name	Lithology	Slope	Climate	Vegetation	Water level	Land use	Soil pattern	Possibility of erosion
S1	Fine to medium grain size	8-15 %	Suitable for rainfed cultivation	> 70 %	3000 M^3.Hectare	Rangeland	Clay	Medium
S2	Granulation semi-medium to large	8-15 %	Sometimes suitable for rainfed cultivation	50-70 %	3000 M^3.Hectare	Rangeland-Livestock	Loamy Clay	Medium to high
S3	Medium to coarse grain size	15-30 %	Suitable for growing rangeland plants	20-70 %	1500 M^3.Hectare	Beekeeping	Loamy Sandy	Medium to high
N	It is a rocky land	>30 %	Not suitable for growing rangeland plants	< 20 %	<1000 M^3.Hectare	Protection	Soil in the form of thin sheets on the rock	Medium to high

Landset satellite images 8 related to 2009-2019 were used to study changes in land use and for classification of satellite images. These images were downloaded from https://earthexplorer.usgs.gov. After downloading the images, radiometric and spatial enhancement and coordination of the images (with the aid of the area's maps) were conducted in Envi 5.3 software (Jokar *et al.*, 2015). Implementation of radiometric corrections on multi-time data is necessary. Using such correction, the effect of difference in sun angle and height was solved in multi-time data and the effects of atmosphere, topography and the measurer's mistakes were solved with digital data. Spatial enhancement of the image was enhanced based on digital number values of each pixel along with the adjacent pixels. When employing the supervised classification, at first, those small regions in the satellite image were selected, which had steady state digits in terms of reflective values (Bunruamkaewa and Murayamaa, 2015). The underlying regions were referred to as training areas. After proving existence of each class through investigating and visiting the place, the interpreters using specific computer software classified remaining pixels of the image based on their compatibility with the digits of the supervised classes' pixels. Finally, using coordinates of the points which were sampled in field visits using GPS and also using Ermat guideline, error matrix was calculated and total kappa was obtained. The general steps of conducting research are as follows (Zoraghi *et al.*, 2019):

1- Preparing satellite images of the area
2- Preparing a band composition
3- Geometric and radiometric correction
4 – Preparing training samples and performing supervised classification
5 - Measuring land use changes through the method after comparison and image difference
6 - The final conclusion

The method and tools of data collection are shown in table 2.

Table 2. Methods and tools for data collection study

Practical			Type of research
Examining the theoretical framework Understanding the current state of the research realm	Library	Library - Documentary	Data collection method
Prepare maps, images, data and statistics	Documentary		
Knowing the current situation and field survey of land uses	Field observations and evaluations	Field	
Envi and ARC GIS software Articles and books Preparation of statistics, data and maps from relevant organizations Satellite Images		Library - Documentary	Data collection tools
View Sampling		Field	
Miandoab rangelands		Spatial territory	Research area
2009-2019		Realm of time	

Results

The first and second degree parameters weights which will be multiplied according to AHP (Analytical Hierarchy Process) method to the related layers are obtained by distribution of Delfi questioner (Jouri, 2020) among 18 experts of environment and averaging their comments using Expert Choice software. Finally, with overlapping lower layers, the final map of rangeland use was produced. Fig. 2 shows the final map of rangeland use.

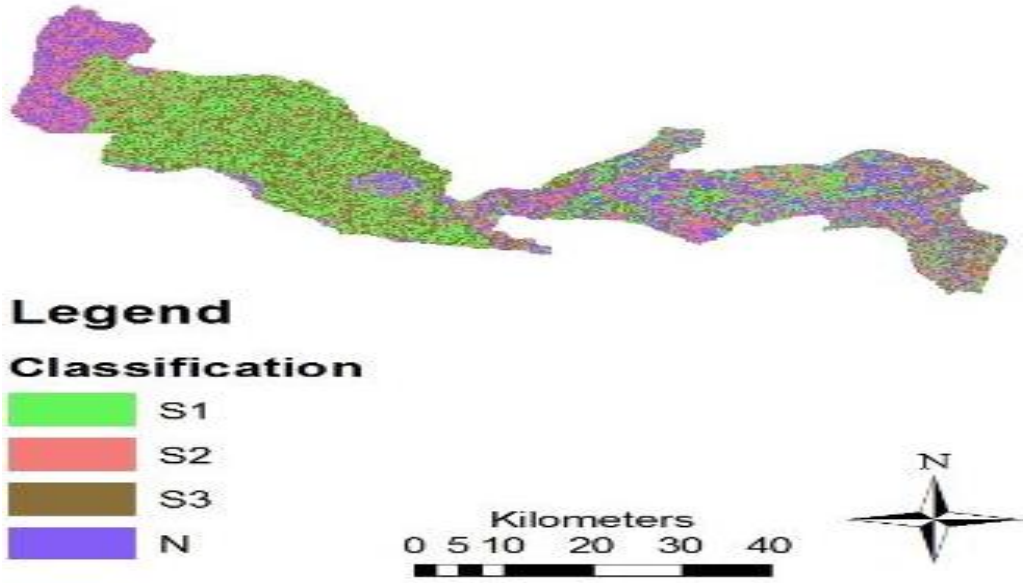

Fig 2. Final map of rangeland land use

Table 3 shows the final results for rangeland use. In rangeland uses, the first priority is with suitable 1 (S1) class with an area of 71451 hectares of the entire area (33.6 %) and the last priority is with unsuitable (N) class with an area of 44874.7 hectares of the entire area (21.1 %).

Table 3. Final classification of rangeland use

User name	Area(ha)	Percentage
S1	71451	33.6
S2	48792.5	22.97
S3	47114.2	22.2
N	44874.7	21.1

Two images of Landsat satellite related to 2009-2019 have been classified in the study area (Fig. 3). Results of the images indicate that lake and water areas without plant coverage and urban residence, salt lands and fish farming pool have been decreased and the areas with plant coverage and rangeland have been increased. Maximum Likelihood was used for supervised classification.

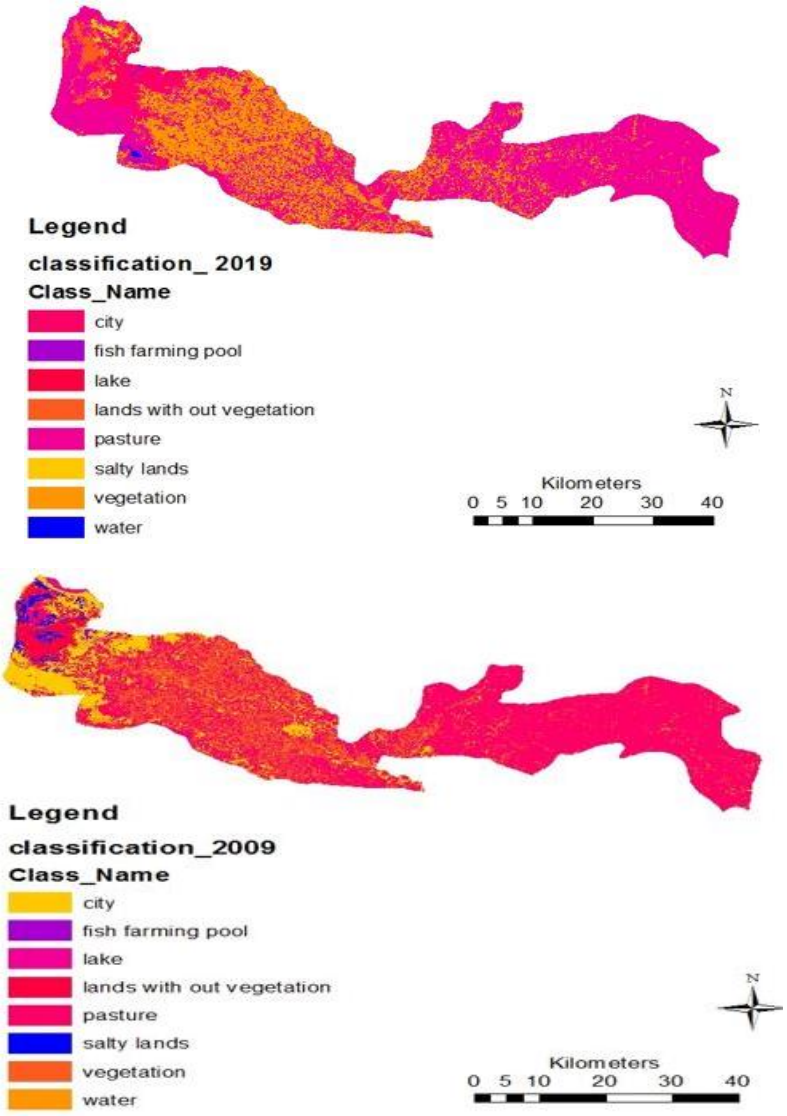

Fig. 3. Two classified images of 2009-2019

The area and change percent of each class in the time interval of 2009-2019 can be seen in Table 2. Results of the images indicate that lake and water areas without plant coverage and urban residence, salt lands and fish farming pool have been decreased. The highest decrease is observed in urban use (-5.19 %) and the lowest decrease is observed in the lake (-0.29 %). The areas with plant coverage and rangeland have been increased. The highest increase is observed in plant coverage (+13.94 %) and the lowest increase is observed in rangeland use (+6.89 %).The kappa coefficient, as another measure of the accuracy of the maps, is calculated for each matrix using diagonal and marginal elements and shows how much the classification agrees with the actual data. The overall agreement for each matrix is calculated based on the difference between the practical classification agreement (agreement between computer classification and terrestrial reality data represented by the diagonal elements of the table) and the chance agreement (obtained from pixel sub-values). Thus, the kappa coefficient indicates the agreement of general correctness with the state in nature. The efficiency of the classification method was evaluated by calculating two indicators of overall accuracy (Overall Accuracy) and

Kappa coefficient (Kappa Coefficient). Kappa coefficient and total accuracy of the classified images for 2009 are 0.98 and 98.66 and for 2019, 0.86 and 88.88.

Table 4. Area and percentage of land use change over ten years

User name	Area(ha) 2009	Area(ha) 2019	Percentage of change
City	33011.5	21646.62	-5.19
Fish farming pool	377.82	75.82	-0.82
Lake	676.08	43.11	-0.29
Lands without vegetation	8823.15	4876.2	-1.8
Rangeland	138247.38	147648.2	+6.89
Salty lands	3449.52	2376.27	-0.49
Vegetation	33999.66	64541.43	+13.94
Water	424.98	186.12	-0.11

Discussion

Land is a limited and vulnerable resource; however, if its capabilities are employed properly, it will be eternal and renewable. Jensen *et al.* (2001)synthesize our knowledge of ecological systems and commonly describe the biophysical and social limits of a system, the interrelations of its ecosystem components, the uncertainties and assumptions that underlie a given assessment effort. Ecological assessments facilitate understanding of an area's past, present, and future conditions through comprehensive description of ecosystem patterns, processes, and functions. Planning for optimal use of the lands not only causes its efficiency, but also it will be protected for the future users. Such a plan should be based on complete knowledge of nature and also different underlying uses. Land management and the correct and appropriate use of natural resources and data and environmental characteristics are important principles of sustainable development. The present study was conducted in this direction with the aim of finding suitable places for rangeland management in Miandoab city. After examining the possibility of doing this user, let's examine the level of change. Power assessment is an efficient step taken to obtain a plan for sustainable development and it is considered as the base and foundatvhion of land preparation or environmental planning in the countries, which try to reach a sustainable development along with protecting future generations. Considering the studies in Miandoab County, the major power of the area's land is for rangeland. One of the reasons for the increase in rangeland in Miandoab is that more than 400 hectares of rangelands in this city have been sprayed with the cooperation of villagers and farmers to increase the capacity and quality of plant growth. Also, protection and exclusion operations have been carried out in 5540 hectares of national lands and grazing control management plan has been applied in 105000 hectares of rangeland lands. With each millimeter of rainfall, forage production increases by one kilogram per hectare in rangelands. The distribution and amount of rainfall in recent months in the last half century in Miandoab is unprecedented and the existence of a suitable seed bank in rangeland soils has led to the growth of various species and increased forage production in these areas. In order to produce oxygen and remove dust, they planted trees and shrubs such as elm, burdock, mad willow, poplar, cypress and silver cypress in the city of Miandoab, which are protected by locusts. Another reason for planting these species is that the life of all kinds of insects, birds, mammals, fungi and lichens depends on the life of the trees in this area. If we add the organisms that live in the root environment of trees, we must say that the lives of thousands of species of small and large animals are tied to the life of each tree.

Hosseini *et al.* 2012) performed a study in Inche Shorezar site of Golestan province for nine years (1997-2005). Results showed that total canopy cover in 2005 was significantly higher than 1997 both inside and adjacent of exclosures, which has been mainly related to increased annual plant cover but the perennial canopy cover was decreased in these years. The reasons for the increase in rangeland vegetation in Miandoab city is that usually the cattle graze uniformly on the rangeland and the grazing season and grazing durability are considered and the rainfall is at a desirable level. The predominant vegetation in Miandoab city is rangeland cover and 13 % of the total area of the city is allocated to rangelands. The rangelands of this city, like other rangelands of the province, are apparently divided into good, medium and poor rangelands, which are used in summer and winter in the grazing season. Suneela and Mamatha (2016) proceeded on investigation of land use changes in Hyderabad state of India using satellite images Landsat 8 2013, Landsat 8 2016 and GIS.

They concluded that farming lands have been decreased by 2% and urban development has been increased by 8%. It seems that a three-year interval is not suitable for examining changes, so we considered ten-year changes in the Miandoab area, and in addition, we considered more land use changes. Animal husbandry is another profession of people in Miandoab County and its surrounding villages, who have found the only way of increasing livestock productions in using natural rangelands. Now, the more supply of new advancements in agriculture and its tools and techniques, the less will be production costs and exploitation of natural rangelands which are necessary and economical because cultivation of forage plants is not possible everywhere due to limited access to water and soil. Moreover, the people of the area cultivate sugar beet for soil protection and preventing more erosion of the soil.

Although this county enjoys higher potential for urban development, its development has been decreased because of the villagers' immigration to Miandoab and marginalization caused by economic, social, cultural and educational factors. Such immigrations, over the time, confront rural communities with lack of human power specially young work force and this causes the country to confront with major difficulties and barriers on its progress path. Society needs rural work force in the village environment. When the immigration rate of villagers increases, so rapidly in the country, then in the close future, such immigrations will affect biological, economic and social conditions of both immigrant sender and immigrant receiver areas. As a result of the recent draughts and decreased level of surface and ground waters, most of the drinking water wells in villages of Miandoab County have changed into salinity. Draught phenomenon is inevitable and it is impossible to stop it, however, taking proper management methods can minimize damage and its resulting stresses. In a study conducted by Fakhraei and Abdi in 2010, it was found that the main factors of migration of people from Miandoab city and the shrinking of the city in this region can be considered by the following factors: income difference in the center of the province (Urmia) and Miandoab, age of Immigrants, marital status, welfare, health, recreational and educational facilities in the center of the province. The suggestions of this research according to the mentioned cases are as follows:

Creating facilities and creating employment in Miandoab city due to reducing migration

Establishment of health facilities and hospitals in Miandoab city due to reducing migration.

Preventing the conversion of land to other uses that will ultimately lead to the destruction of nature.

Organizing livestock farmers living in forest and rangeland areas in order to reduce livestock reliance on rangeland and forest.

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ارزیابی تغییرات کاربری اراضی مراتع میاندوآب با استفاده از سامانه اطلاعات جغرافیایی و آنالیز تحلیل سلسله مراتبی

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چکیده. ارزیابی توان اکولوژیک سرزمین به عنوان یکی از ابزارهای حرکت در راستای توسعه پایدار، به دنبال سنجش موجودی و توان نهفته سرزمین با ملاک‌ها و معیارهای مشخص و از پیش طرح‌ریزی شده است. در پژوهش حاضر که در سال ۱۳۹۸ به انجام رسید، به جهت آشکار ساختن تغییرات منطقه در طی ده سال ابتدا ارزیابی توان اکولوژیک منطقه برای کاربری مرتعداری با استفاده از معیارهای اصلی: خاکشناسی، سنگ شناسی، توپوگرافی، اقلیم، پوشش گیاهی، میزان آب، جاده، گسل، پهنه‌های سیلاب و کاربری اراضی و با استفاده از روش AHP (Analytical Hierarchy Process) و رقومی سازی اطلاعات در محیط GIS انجام گردید. سپس جهت آشکارساختن تغییرات منطقه از بررسی تصاویر چند زمانه سنجش از دور در نرم افزار Envi 3.5 استفاده شد. یافته‌ها حاکی از آن است که بیشترین توان منطقه برای کاربری مرتعداری (۳۳/۶ %) می باشد و بررسی تغییرات کاربری‌ها نشان دهنده افزایش دو کاربری مرتعداری(۶/۸+ %) و پوشش گیاهی درختی و درختچه ای (۱۳/۹+ %) است. ضریب کاپا و صحت کلی تصاویر طبقه بندی شده برای سال ۱۳۸۸ به ترتیب: ۰/۹۸ و ۹۸/۶۶ و برای سال ۱۳۹۸ به ترتیب ۰/۸۶ و ۸۸/۸۸ می باشد. بنابراین با توجه به اهمیت و اولویت کاربری مرتعداری در این منطقه به جهت رسیدن به توسعه پایدار، می بایست توجه ویژه‌ای به اقتصادی کردن مراتع نمود تا علاوه بر حفظ آب و خاک و پوشش گیاهی مدیریت بهتری برای چرای دام اتفاق بیافتد.

کلمات کلیدی: کاربری اراضی، مرتعداری، سنجش از دور، روش تحلیل سلسله مراتبی