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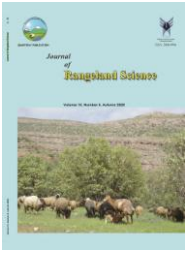

Research and Full Length Article:

Prioritization of Rangeland Species Functions with Emphasis on Indigenous Knowledge of Range Holders (Case study: Titoeieh Area in Baft Township, Kerman, Iran)

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Abstract. Prioritizing the rangeland plants for ecological functions is one of the main concerns in the operation of multifunctional rangelands. Considering that the use of various functions of plant species in rangelands can lead to higher renter's income and change single-livelihoods to multi-livelihoods. This research aims to prioritize the rangeland plants using Analytical Hierarchy Process (AHP) method and VIKOR software on the basis of indigenous knowledge of ranchers during 2017-2018 in Titoeieh rangelands of Baft Township, Kerman, Iran. The results, based on analyzing the hierarchical method of questionnaires on 29 plant species revealed that the coefficients of importance of plant species for kinds of functions including forage, medicinal, beauty, beekeeping and soil conservation were different. In this regard, there was no unique plant with similar coefficients of importance for all functions. Vikor scenario illustrated that scoring 0.25 coefficients to the forage production function (and giving remain one to others as equal coefficient) resulted in *Artemisia aucheri* species as the first priority species, priority even when the yield of forage functions scored by 0.25 and o.50 and 0.75 coefficients. Furthermore, by giving these coefficients to other functions, *Artemisia aucheri* was allocated as the first rank with the exception of scenarios 8 and 13 (scored respectively 0.5 and 0.75 to beauty function associated with the remains to other functions) that resulted in *Amygdalus scoparia* as the first one. According to indigenous knowledge, ground reality and scenario making results, it can be concluded that since *Artemisia aucheri* was ranked in the first priority species at almost all scenarios, it can be thinkable and manageable in the multiple use of rangeland. According to extensive habitats *of Artemisia aucheri* in mountainous rangelands of Iran, this research can be applicable for increasing the income of range holders with holistic view.

Key words: Scenario, Range plants, Priority

Introduction

Vegetative elements of rangeland ecosystems can have different functions in terms of forage production, miscellaneous products, production of mold pollen, preservation of water and soil resources, smoothness of the air and beauty for tourists (Fazilati and Hosseini Araghi, 1965). Different climatic conditions make diversity in medicinal plants in Iran. The need for comprehensive research and proper utilization of these plants for pharmaceutical and cosmetic industries, health and accelerating food is essential. A wide range of agricultural lands in dry lands has had a low efficiency and their production is low. The low efficiency pastures in large parts of Iran are lacking production capacity. At present, Iran with average annual precipitation of 240 mm is considered as arid regions among the countries worldwide. However, some regions go toward the dryness. Crops and cropping pattern in such areas should be revised (Pourmeidani *et al.*, 2017). Unfortunately, after the nationalization of rangeland ecosystems in Iran the ranchers had increased the number of livestock and targeted the maximum use of rangelands forage productions, so this action has had pressure equivalent as three times more than the permissible grazing pressure on these ecosystems in half last century (Bagheri *et al.*, 2010; Mesdaghi, 2008). A large amount of feedstuffs will be obtained from rangeland plants if the annual rainfall of Iran is optimum. There are a lot of rangeland plants whose nutritional value is still unknown to most ranchers. Many studies have evaluated the nutritional value of different rangeland or weed plants in Iran (Kazemi and Valizadeh, 2019. Kazemi *et al*., 2009; Towhidi *et al*., 2011; Kazemi *et al*., 2012; Naseri *et al*., 2017; Ezzat *et al*., 2018). Considering other functions of range species and increasing the income of rangelands through multipurpose use of rangelands have been used as a practical solution for natural resource executive agencies- as natural resources consultants - in order to conserve the rangelands in recent years. Knowledge of the relationships between biotic components of rangeland ecosystem i.e. herbivores and plants is important for range managers (Zeynivand *et al*., 2018). According to this importance, changing the interest of exploiters from the function of forage production and consequently the livelihood economy to other functions and the multi-livelihood economy in the range management plans of the country in recent years have been emphasized by the executive agencies (Technical office of rangelands, 2016). Exploitation of rangelands involves the use of more than one product and the use of several strategies in utilizing environmental resources while reducing the destruction of these resources will increase the income of the rancher. Proper time of entry and exit of livestock is one of the necessities of maintaining the cultivated cover and strengthening the existing cover is available (Borhani *et al*., 2017). Arzani (2015) found that the use of rangelands is not limited to grazing livestock, and the benefits of other aspects of rangeland use should be considered in the concept of rangeland suitability. Eskandari *et al.* (2008) argued that one of the functions of non-crop rotational vegetation cover is soil conservation and erosion prevention. So, paying attention to this science is very necessary. In this regard and in view of the expansion of demand for herbal medicine, investigation and research in this field are necessary. Research ethnobotany develops the characteristics of traditional information to value locally use of information as a logical use of resources and protection effective from biodiversity and cultural information (Hayat *et al*., 2008; Ibrar *et al*., 2007). Amiri *et al.* (2013) emphasized the development of beekeeping as an indigenous knowledge-

based strategy for employment creation and compensation of asset revenues of livestock keeper. In their view, Mehrebani *et al.* (2013) acknowledged that in some areas, certain plant species are used as medicinal plants that have not yet been acquired by modern science and can be got using the experience of indigenous people. Mostafaei (2014) investigated the multipurpose use of natural habitats in a study and revealed that paying attention to all services of rangelands would increase income and decrease dependence on livelihood. Yeganeh *et al.* (2016a) also estimated the recreational value of rangelands of Tahm Zanjan in Iran. Despite the fact that several studies have emphasized the multiple use of rangelands in recent years, lack of determination of importance coefficients in terms of functions is one of the main concerns in the operation of multifunctional rangelands that hasn't got attention by researchers. With regard in this lack, making scenarios along with the determination of the importance coefficients of functions (prioritization) based on native knowledge can be considered as an effective and useful step. This will ensure the correct management of the budget and human resources and equipment in the customary systems in addition to making the advance planning of different scenarios for all users in different levels. Thus, indigenous knowledge can be used as a low cost method for transferring indigenous experiences, furthermore using multi-criteria decision-making methods such as AHP and VIKOR which are based on the validity and accuracy with limiting expert tendency (Mohammadi, 2018) to prioritize and make scenario functions.

Considering that the use of different functions of plant species in rangelands can lead to higher income of renegades and change economic life of single livelihoods to multiplicity, this research aims to prioritize and scenario the rangeland plants of the customary system of Titoeieh rangeland in Baft in Iran in terms of ecological functions performed based on the local knowledge of the exploiters using AHP and VIKOR methods.

Materials and Methods

Study area

Rangeland of Titoeieh is located between eastern longitude 55° 32′ 10″ and 56° 36′ 05″ and northern latitude 29° 15′ 30″ and 29° 19′ 10″. This area is located 10 km northwest of Baft city with a total area of 3241 ha. This rangeland has 8 land holders having 835 livestock. The area has semi-arid climate, with an average annual rainfall of 350 mm and an average annual temperature of 5.12°C.

Research Methodology

This study was carried during 2017-2018 in Titoeieh rangelands of Baft Township, Kerman, Iran, a customary system selected that was based on official documents of rangeland of study area. In order to compare and prioritize the species based on different functions including forage production, medicinal uses, beauty, beekeeping and soil conservation, a field survey was conducted to study vegetation types and vegetation components. Sampling was performed to investigate the production variables, canopy cover percent and species composition in the plant type of the system using a sampling unit under a randomized-systematic method. Production of species was estimated by clipping and weighing method. The number of plots was calculated by a graphical method based on variance of dominant species. The area of plots was determined using minimal area method. After harvesting ground facts including vegetation composition, production and canopy of species, a questionnaire was planned and developed to compare the species in terms of functions based on land holders knowledge using Analytical Hierarchy Process (AHP). Local studies from the interviews were conducted personally by observing male

users (aged 14 to 77 years old) in the study area. Questionnaires were used to determine the consumption coefficients for each function in terms of local knowledge of the area. The interviews and questions in this collaborative research continued to a point where repeated replies were proven to the researcher, and the continuation of the interviews did not add any new point to the notes. This quality is determined for researchers by similar replies from different interviewees (Alavi *et al*., 2011). In this regard, the species were split-two in a pair wise matrix with AHP method. Then, the production variables based on field operations and coefficients of significance of functions were determined based on native knowledge and hierarchical analysis method, a multi-criteria decision making method was used for prioritizing and scenario plan making. In this relation, the Vlse Kriterijumsk Optimizacija Kompromisno Resenje method (VIKOR) is one of the most widely used models in deciding and choosing the best option (Mohammadi, 2018). It is able to help decision makers to select a suitable decision among all ones. Here, the compromise solution is the closest justifiable answer to the ideal answer, which is the term "compromise" to be a reciprocal agreement. In fact, the VIKOR model prioritizes or ranks the options by evaluating options based on criteria. In this model, the criteria are not weighed, but the criteria are evaluated through other methods, and then, the options are evaluated and ranked based on criteria and combined in the value of the criteria. There are always several options in this model, which are independently evaluated on a multi-criteria basis, and finally, options are ranked based on value. The main difference between this model and the hierarchical or multi-criteria decision-making models is that unlike those models, this model does not make paired comparisons between criteria and options, and each option is independently measured by a criterion measured and evaluated.

The VIKOR method is explained by 5 steps (Opricovic and Tzeng, 2004):

Step 1: To formulate the decision matrix and normalize it: At this stage, the decision matrix or the matrix of scoring options is formed on the basis of the criteria, and its normalization is done from the same relation to the normalization of the VIKOR method.

Step 2: To weigh into a normalized matrix: At this stage, the weights (w) are multiplied in the normalized matrix (R).

Step 3: To determine the positive and negative ideal point: For each criterion, we assign the best and worst one among all options and call +f and -f, respectively. If the criteria get a suitable type:

+f=Max fij

–f =Min fij

Step Four: Determination of suitability: Opricovic and Tzeng have introduced two basic concepts of suitability (S) and Regretful (R) in the calculations of the VIKOR.

$$S_i = \sum_{j=1}^{n} w_j . \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \quad \text{(Equation 1)}$$

$$R_i = max\left[w_j . \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \right] \quad \text{(Equation 2)}$$

The suitability value (Si) represents the relative distance of the i-the option from the ideal point and the amount of regret (Ri) represents the maximum discomfort of the i-the in the distance from the ideal point and finally W_J (total weights in standardized matrix).

Step Five: Calculate the VIKOR **index:** The final step is to calculate the Qi index for each option:

$$Q_i = v\left[\frac{S_i - S^*}{S^- - S^*}\right] + (1 - v)\left[\frac{R_i - R^*}{R^- - R^*}\right] \qquad (2)$$

$S^*=MinS_i$; $S^-=MaxS_i$
$R^*=MinR_i$; $R^-=MaxR_i$
Multi-criteria decision-making method of VIKOR model was used for prioritizing and scenarios, and the scenarios made in this research are as follows:

Table 1. Introducing the scenarios used

Scenario	Anatomy of the scenario
1	scoring 0.25 coef.to the forage production function and giving remain one to other functions as equal coef. (0.1875)
2	scoring 0.25 coef.to medicinal value function and giving remain one to other functions as equal coef. (0.1875)
3	scoring 0.25 coef.to beauty function and giving remain one to other functions as equal coef. (0.1875)
4	scoring 0.25 coef.to beekeeping performance function and giving remain one to other functions as equal coef. (0.1875)
5	scoring 0.25 coef.to soil conservation function and giving remain one to other functions as equal coef. (0.1875)
6	scoring 0.5 coef.to the forage production function and giving remain one to other functions as equal coef. (0.125)
7	scoring 0.5 coef.to medicinal value function and giving remain one to other functions as equal coef. (0.125)
8	scoring 0.5 coef.to beauty function and giving remain one to other functions as equal coef. (0.125)
9	scoring 0.5 coef.to beekeeping performance function and giving remain one to other functions as equal coef. (0.125)
10	scoring 0.5 coef.to soil conservation function and giving remain one to other functions as equal coef. (0.125)
11	scoring 0.75 coef.to the forage production function and giving remain one to other functions as equal coef. (0.0625)
12	scoring 0.75 coef.to medicinal value function and giving remain one to other functions as equal coef. (0.0625)
13	scoring 0.75 coef.to beauty function and giving remain one to other functions as equal coef. (0.0625)
14	scoring 0.75 coef.to beekeeping performance function and giving remain one to other functions as equal coef. (0.0625)
15	scoring 0.75 coef.to soil conservation function and giving remain one to other functions as equal coef. (0.0625)

Results

According to the results (Fig.1), production of *Artemisia aucheri, Amygdalus eburnea* and *Hertia intermedia* species was more than other plant species. In this regard, results also showed that the main vegetation type was *Artemisia aucheri*. According to the results of the paired comparison, using the hierarchical analysis (AHP) method based on native knowledge and the function of the species (Fig.2), plant species including *Acanthophyllum bracteatum, Lactuca orietalis* and *Polygonam aviculare* have high coefficients and species such as *Peganum harmala, Daphne oleoide* and *Hertia intermedia* with low coefficients were the least important coefficients respectively in the forage function sector. According to these results, three species including *Bromus tecterum, Stipa barbata* species with significance coefficients were ranked in the lowest priority and *Zataria multiflora* Boiss, *Thymus kotschyanus* and *Ferula gummosa* species were ranked in the highest Priority in the medicinal value function.

Regarding the beauty function, three species of *Amygdalus scoparia, Stipa barbata* and *Amygdalus eburnean* had the most importance. In terms of beekeeping function, *Artemisia aucheri, Astragalus parrowiana* and *Astragalus glaucacanthus* species were among the three priority species, respectively. Also, studies on species in terms of soil conservation function showed that *Acanthophyllum bracteatum, Astragalus parrowiana* and *Astragalus glaucacanthus* species had the most importance coefficient, respectively.

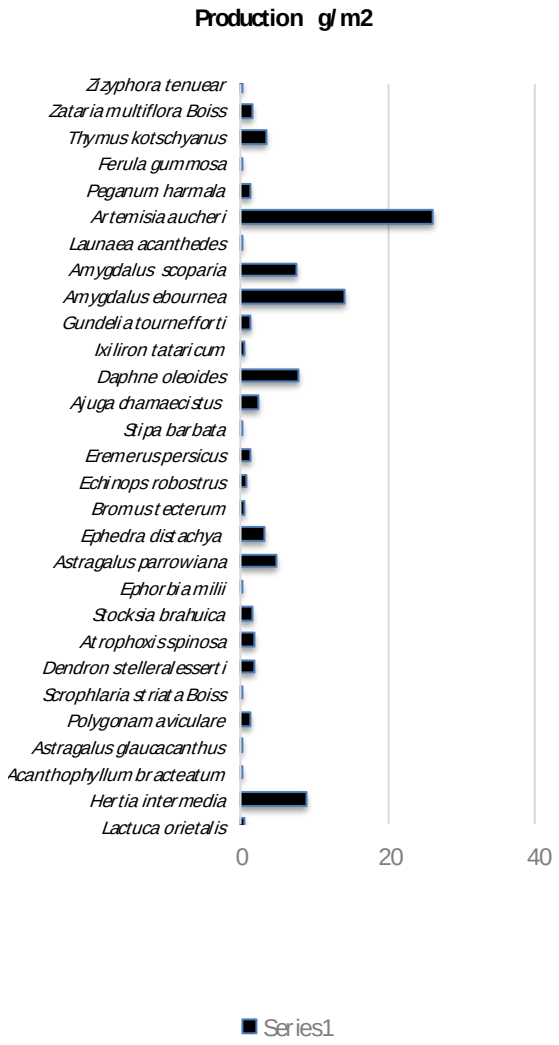

Fig.1. Results of vegetation sampling

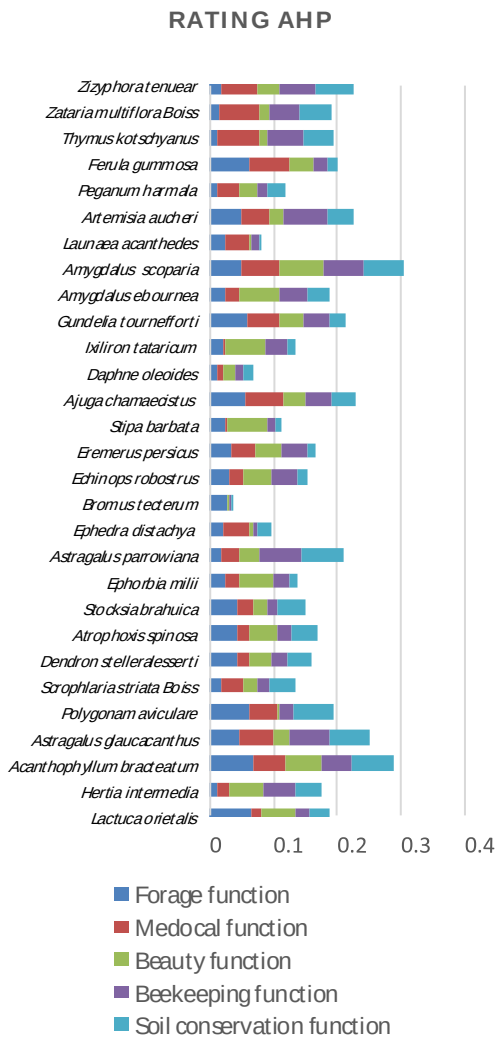

Fig.2. Results of Analytical Hierarchy process

The results of scenario making with the help of the VIKOR method (Fig. 3), which included scoring 0.25 with every function and other functions with equal coefficients (0.1875), revealed that when the forage function had a score of 0.25, the species *Artemisia aucheri*, *Amygdalus scoparia* and *Amygdalus eburnean* were considered as priority species. When other functions including medicinal, beauty, beekeeping and soil conservation scored as 0.25, these three species again earned the priority ones, respectively.

Results of the scenarios with the VICOR method (Fig. 4) indicate separately scoring 0.5 to every function contemporary with giving equal coefficients (0.125) to others, it was determined that only when beauty function scored 0.50, the *Amygdalus scoparia* ranked in the first priority and once the other functions were scored 0.50, priority pattern fallowed *Artemisia aucheri*, *Amygdalus scoparia* and *Amygdalus eburnea*, respectively.

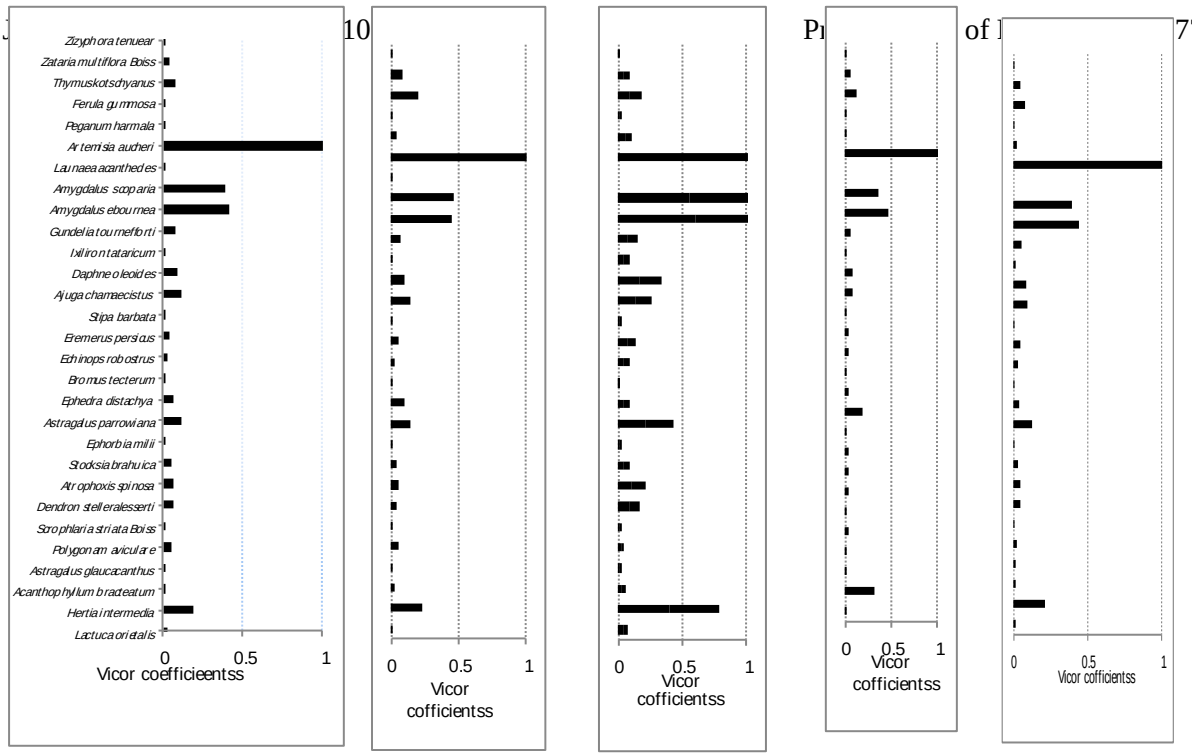

Fig.3. Scenarios based on separately scoring 0.25 coefficient to all functions contemporary with giving equal coefficients (0.1875) to others

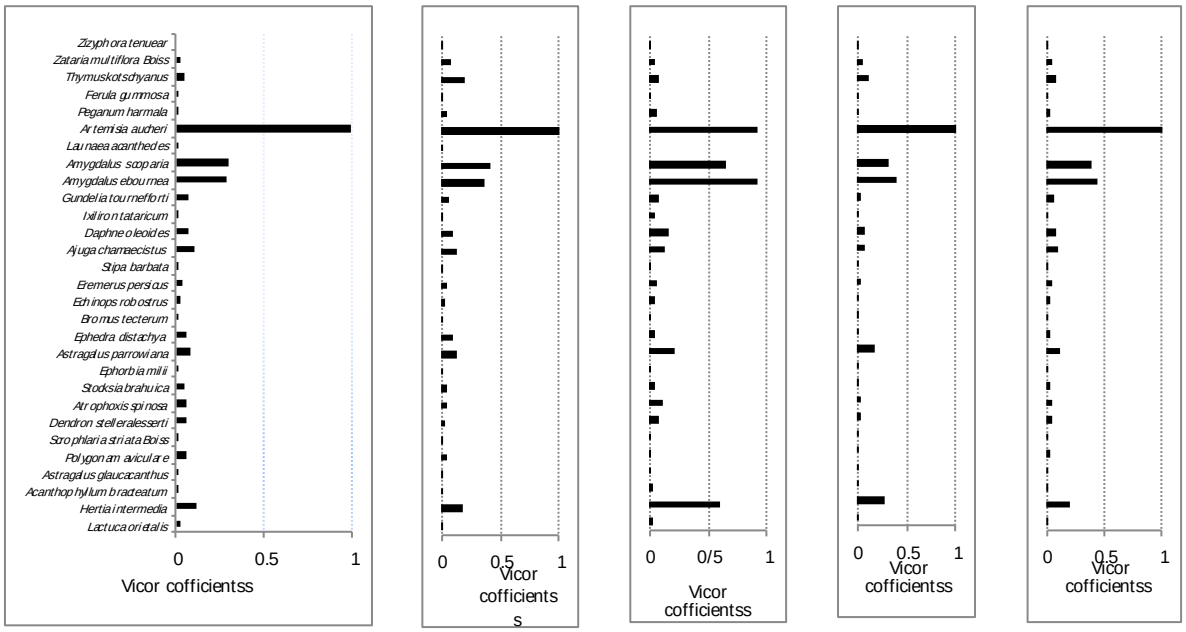

Fig.4. Scenarios based on separately scoring 0.5 coefficient to all functions contemporary with giving equal coefficients (0.125) to others

According to the results of the scenario scenarios with the VIKOR method (Fig.5) indicate separately scoring 0.75 to every function contemporary with giving equal coefficients (0.0625) to others, it was found that when the forage, medicinal, beekeeping and soil protection function had a score of 0.75, the species of *Artemisia aucheri*, *Amygdalus scoparia* and *Amygdalus eburnea* were considered as priority species, respectively. But when the beauty function is scored at 0.75, the priority species fallowed *Amygdalus scoparia*, *Artemisia aucheri* and *Amygdalus eburnea*.

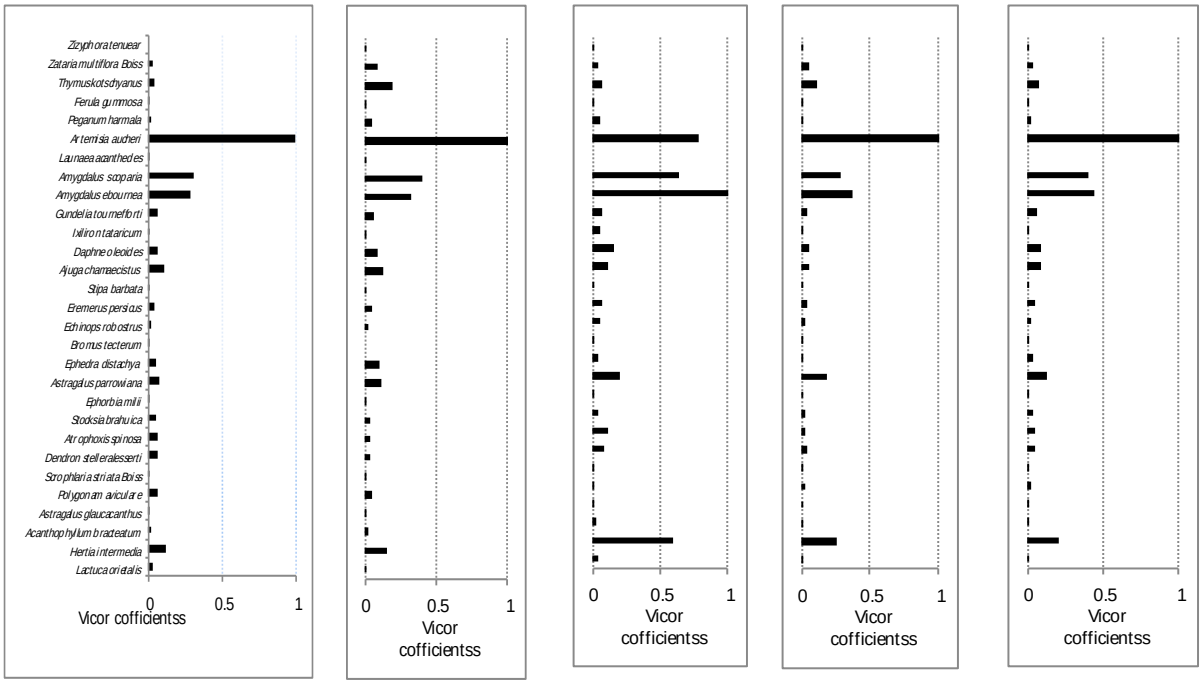

Fig.5. Scenarios based on separately scoring 0.75 coefficients to all functions contemporary with giving equal coefficients (0.0625) to others

Discussion

Based on analyzing the hierarchical method of questionnaires related to 29 plant species, the results showed that the coefficients of importance of plant species for different functions including forage, production, medicinal uses, beauty, beekeeping and soil conservation were different. Therefore, one species can be found with similar coefficient of importance in terms of functions. In this regard, the finding of the beekeeping, function based on native knowledge by hierarchical method revealed that the species including *Artemisia aucheri*, *Astragalus parrowiana* and *Astragalus glaucacanthus* had the highest coefficients of the importance, respectively. Findings of Amiri *et al.* (2013) in Ghareh Aghach watershed, Esfahan, Iran indicated Asteraceae family ranked as the first priority among other ones for beekeeping. Therefore, the results of this research were consistent with their findings. The species including *Acanthophyllum bracteatum*, *Lactuca orietalis* and *Polygonum aviculare* were prioritized respectively in terms of forage function importance in the area. The results from the perspective of medicinal functions showed *Zataria multiflora* Boiss, *Thymus kotschyanus* and *Ferula gummosa* as higher priority ones among other species, respectively. *Thymus caramanicus* was reported to be a native and valuable species of Kerman in Iran province (Bagheri and Arjomand, 2012). Moreover, findings of Mostafaei (2014) indicated the importance of *Thymus*

kotschyanus as a rich species in carvacrol in mountainous regions of Baft in Kerman for harvesting and selling in other provinces such as Hormozgan in Iran. Our results are corresponded to their findings. This present result was also consistent with the studies of Alavi *et al*. (2011), Saeedi Gharaghani *et al*. (2011) introduced *Thymus kotschyanus*, *Cichorium intybus*, and *Zizyphora teniur* as a medicinal indicator in the northern rangelands of the country. Regarding AHP analysis, three species of *Amygdalus scoparia*, *Stipa barbata* and *Amygdalus eburnea* were important in terms of amenity. Also, studies on species in terms of soil conservation function showed that *Acanthophyllum bracteatum*, *Astragalus parrowiana* and *Astragalus glaucacathus* species gained the importance coefficient, respectively. Asgari *et al*. (2018) found in their study that plant types with the highest percentage of cover such as *Medicago sativa* and *Acanthophyllum microcephalum* had the highest impact on soil erosion control and soil conservation according to soil conservation criterion. Mousavi *et al*. (2014) in a study demonstrated that vegetation type of *Astragalus gossypinus*, and *Artemisia aucheri* has the highest erosion control. The results of present research were consistent with their findings. Yeganeh *et al*. (2016b) in estimating the economic value of soil conservation function in Tahm of Zanjan in Iran found that plant species prevented to waste of nitrogen as 4.4 kg/ha, phosphorus as 0.09 kg/ha and potassium as 1.51 kg/ha in soil played the most role. These results are consistent with the findings of these researchers, which indicate the importance of cushion like species in mountainous areas to maintain soil and water penetration in the soil. Considering the importance of plant species in terms of indigenous knowledge, it is suggested to preserve this value in other parts of the country for different ecological functions in order to be able to use indigenous knowledge for alleviating the problem of management of rangelands of the country in the multipurpose use framework. Since indigenous knowledge has been involved in the minds of local people for many years and it may not have operational aspects due to the elimination of some species under the pressure exerted on pastures in recent years, it is suggested that future researches focus on all the important factors alongside the reality of the ground in order to manage rangelands and make the scenarios. In this regard, in the present study, the results of production evaluation based on the statistics indicate that the *Artemisia aucheri* had the highest production among other plant species, and a suitable grazing plan must be set each year to provide forage with sufficient quality for livestock and augment the animal production (Naseri *et al*., 2017).

According to using the VIKOR method, the scoring coefficient of 0.25 for the production of forage resulted in *Artemisia aucheri* species as the first priority species, and with a score of 0.25 to other functions, the priority species did not change. In the scoring of coefficients of 0.50 and 0.75 for the production of forage, the *Artemisia aucheri* species obtained the first priority and by rating this coefficient to other functions (except for the beauty that *Amygdalus scoparia* resulted as the first priority), the *Artemisia aucheri* species still remained as the first priority for most scenarios. Regarding the evaluation of the results of the review of native knowledge, ground reality and scenario, it can be concluded that for ranchers in Titoeieh, *Artemisia aucheri* species is a priority species in almost all scenarios (except scenario 8 and 13) which can be considered in planning and management. Owing to the multidimensional nature of the services of this dominant species, paying attention to this one can be recommended in rangeland management with a multifunctional approach. Even though 29 species were

present in terrestrial sampling, some species did not have significant differences because of the disappearance of plant diversity in addition to the intervention of the ground-based matrix in the results of the hierarchical analysis matrix. The results find roughly similarity to show the first priority species in prioritizing with different scenarios by VIKOR. In this regard, consideration of other functions of the *Artemisia aucheri* species in addition to its forage value and the provision of an integral grazing system are recommended and emphasized to executive devices. In addition, the scenarios derived from this research can be used to manage the functioning of other species in the area. In this regard, due to the special attention to endemic species such as *Thymus kotschyanus* and considering it in the management of grazing and seasonal regulation can increase the income of ranchers in the region. Therefore, consideration of the function of this valuable species in accordance with the target scenario is recommended to managers to maintain valuable and endangered species.

Conclusions:

Our results revealed that *Artemisia aucheri* was ranked in the first priority species at almost all scenarios (except scenario 8 and 13). Due to the fact that this species can be applied for different uses especially medical ones, therefore, considering the other services of this species in grazing systems will increase income of range holder by application of the multiple uses of rangelands in mountain ecosystems.

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اولویت‌بندی گیاهان مرتعی از منظر کارکرد اکولوژیک بر اساس دانش بومی مرتعداران (مطالعه موردی: منطقه طیطوئیه در شهرستان بافت)

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چکیده. اولویت‌بندی گیاهان مرتعی از نظر کارکردهای اکولوژیک از دغدغه‌های اصلی در عملیاتی کردن استفاده چندمنظوره مراتع می‌باشد. با توجه به اینکه استفاده از کارکردهای مختلف گونه‌های گیاهی در مراتع می‌تواند به افزایش درآمد مرتعداران و تغییر از اقتصاد تک‌معیشتی به چندمعیشتی منجر گردد، لذا این تحقیق با هدف اولویت‌بندی گیاهان‌مرتعی طی سالهای ۱۳۹۶الی۱۳۹۷ در سامانه عرفی طیطوئیه شهرستان بافت، کرمان، ایران بر اساس دانش‌بومی بهره‌برداران با استفاده از روشهای روند سلسله مراتبی تحلیلی (AHP) و نرم افزار VIKOR انجام شد. نتایج ، بر اساس تحلیل روش سلسله مراتبی پرسشنامه‌ها برروی ۲۹ گونه گیاهی، نشان داد که ضرایب اهمیت گونه‌های گیاهی برای انواع عملکردها از جمله تولید علوفه، دارویی، زیبایی، زنبورداری و حفظ خاک متفاوت است. در این راستا، یک گیاه با ضریب اهمیت مشابه برای همه عملکردها وجود ندارد. ساخت سناریو VIKOR نشان داد که، نمره‌گذاری ۰/۲۵ ضرایب به عملکرد تولید علوفه (و همچنین دادن یک به‌عنوان ضریب مساوی برابر باقی‌مانده) باعث شد گونه‌های *Artemisia aucheri* حتی وقتی که عملکرد توابع علوفه‌ای با ضریب ۰/۲۵، ۰/۵۰ و ۰/۷۵ به‌دست آمد، در اولویت اول قرار گرفت، علاوه براین، با دادن این ضرایب به سایر کارکردها (به جز سناریو ۸ و ۱۳ که در آن ها به ترتیب ضرایب ۰/۵ و ۰/۷۵ به کارکرد زیبایی و بقیه به سایر کارکردها امتیازدهی می‌شوند و نتیجه آن *Amygdalus scoparia* به‌عنوان اولویت اول بود) *Artemisia aucheri* جایگاه اولویت اول را به خود اختصاص داد. اولین مورد با توجه به دانش‌بومی، واقعیت زمینی و نتیجه‌گیری سناریو، می‌توان نتیجه گرفت که از آنجا که *Artemisi aucheri* تقریباً در تمام سناریوها بعنوان گونه اولویت‌دار اول در برنامه‌ریزی و مدیریت قابل استفاده است. بنابراین می‌توان در استفاده چندگانه از مراتع اندیشمند وکنترل‌پذیر بود. باتوجه به زیستگاه‌های گسترده *Artemisia aucheri* در مراتع کوهستانی ایران، این تحقیق می‌تواند برای افزایش درآمد دارندگان دامنه با دید کل‌نگر باشد.

کلمات کلیدی: سناریو، گیاهان مراتع، اولویت