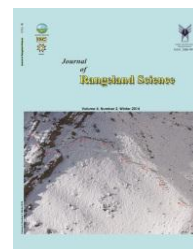


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**Full Length Article:**

## **Selection of Appropriate Estimation Methods of Range Conditions (Case Study: Kabirkooch Rangelands of Zagros, Iran)**

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**Abstract.** The range conditions explain its health as a management tool. Obviously, the implementation of this important assessment requires the most appropriate study method for each region. In order to select the most appropriate methods of range conditions in Kabirkooch grasslands of Zagros in Iran, five estimation methods (i.e. six-factor, four-factor, vegetation and soil combination, value of pasture and climax) were studied in three key and critical areas. In each area, five stations were selected using the randomized-systematic method. The differences between methods were analyzed using the factorial experiment by the help of the randomized complete blocks design with five replications. The results showed that there were significant differences ( $p < 0.01$ ) between both range conditions' determination methods and different areas. Regarding Kabirkooch rangelands in current circumstances, four-factor method for semi-arid region is more applicable for the range condition determination. Biomass production and range conditions had a close relationship using Pearson correlation test ( $p < 0.01$ ,  $r = 0.86$ ).

**Key words:** Range conditions, Climax, Value of pasture, Exclosure, Key and critical area, Zagros, Kabirkooch

## Introduction

Awareness value of the range conditions is that if the rangeland is in great or good conditions, the management practices will be continued and if the rangeland is in moderate or poor conditions, the management strategies need to be changed and new management policies should be selected (Pendelton, 1989). The range conditions explain its health as a management tool; of course, doing this important assessment needs to adopt the most appropriate studying method for each region (Sheidaei, 1994). Various classifications have been presented by researchers according to Pendelton (1989) which is the first condition classification carried out by Stoddart in 1975 based on the distance from climax plant societies. Goebel and Cook (1960) studied the effects of range conditions on vigor, production and quality of forage in southern Utah, USA. Their results expressed that the range conditions may be an effective parameter on production and quality. Poor rangelands produce less grass with lower quality in comparison with the good ones. Frost and Smith (1991) studied the relationships between biomass production and range conditions in southern Arizona. They concluded that the rangelands with higher conditions usually produce more forage for cattle as compared to lower condition classes in the same range. Nevertheless, it is not usually true that total biomass productivity in a low condition range is less than the same range in higher conditions. Tiedeman and Beck (1991) studied the relationships of vegetation consistency, stability and forage production with the changes in range conditions in New Mexico and showed that the status of vegetation and production depends on the range conditions. Barani (1996) compared several range conditions and concluded that the four-factor method was more suitable than the others. Safaeian and Shokri (2003) introduced the Value of

Pasture method in order to select the best condition assessment method and suggested it as a suitable method for northern Iran. This method considers major parameters such as canopy cover as an important factor in soil conservation as well as determination of grass values (regarding the palatability and nutritive value). In a research in Javaherdeh in Iran, Sabetpour (2003) has compared three methods of six-factor, value of pasture and four-factor based on diversity indicator and concluded that the value of pasture method was the best method to assess the rangelands of Javaherdeh. Similarly, Tamartash (2012) evaluated the same methods based on plant indices in Lasem, Iran. Their results showed that Shannon diversity index had a significant relationship with six-factor, four-factor and value of pasture methods but the rate of this relationship for six-factor was more than the other methods. For canopy cover index, the six-factor method had a high correlation with them. Gorgin (2004) in Saral of Kurdistan, Iran has compared two methods of four-factor and value of pasture and has concluded that the value of pasture method was more suitable in the assessment of range conditions. Akbarzadeh *et al.* (2007) studied the effects of 24-year grazing protection on vegetation dynamics of Kuhrang region, Iran by the use of four-factor method.

According to the importance of the rangelands in Zagros Mountains in the west of Iran and the necessity of implementation of scientific management in these ecosystems, the selection of the most appropriate method for range conditions' determination in consistency with climatic-ecologic conditions of this region has been considered in the present research.

## Materials and Methods

### Study area

Studied rangelands are located in Ilam province, Abdanan city. The study area is

located in 33°0' to 33°5' northern latitude and 47°15' to 47°25' eastern longitude. (Fig. 1), shows the location of study area. Annual average rainfall is 637 mm.

According to the Domartan method, the climate is semi-arid to humid (Parsab Consultant Engineering, 1999).

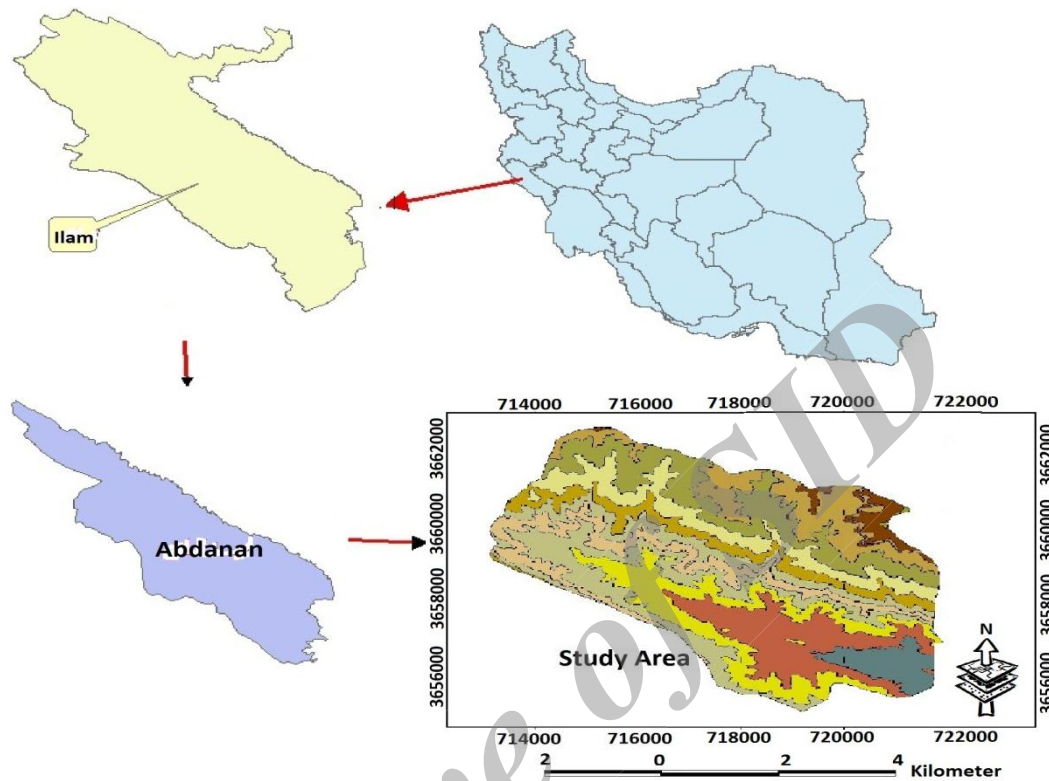


Fig. 1. Location of study area

### Methodology and data collection

At first, three areas at three different levels of utilization including enclosure (no grazing), key (average grazing intensity) and critical (high grazing intensity) areas were separated from each other. Sampling was carried out by the randomized-systematic method (Mesdaghi, 2008) so that five random transects were established in each vegetation type; then, 10 plots of 1-m<sup>2</sup> were systematically selected along each transect (Cox, 2002; Krebs, 1999). The production was estimated by clipping and weighing, estimation and double sampling and comparative yield methods (Mesdaghi, 2008) in late May and early June during full growth stage.

#### a) Six-factor method

In the six-factor method, canopy cover, plant composition, soil conservation,

forage production, plant vigor and amount of litter were studied and scored as 20, 20, 20, 15, 15 and 10 scores, respectively into the classes of excellent (88-100 scores), good (70-87 scores), fair (50-69 scores), poor (30-49 scores), very poor (11-29 scores) and unavailable use (0-10 scores). Then, based on total scores, the range conditions were determined (Mesdaghi, 2008; Moghadam, 1994).

#### b) Value of pasture method

In the value of pasture method (Safaeian and Shokri, 2003), the range conditions were determined on the basis of the relative importance of species, rangeland value class of the plants and canopy cover via following (Equation 1):

(Equation 1)

$$V.P.S = \frac{1}{K} \left\{ \left[ n_{i/N} \times \dots \right] IS \right\} \times R.V$$

Where

*V.P* = the value of pasture or condition class

*S* = the site or studied station (ecologic unit)

*K* = the maximum score given to the plants which is suggested to be 10

*n<sub>i</sub>* = the importance of each plant species

*N* = the importance of all plant species

*IS* = the index of species

*RV* = the percentage of vegetation in the site

In this method, the length of each transect based on the conjunction of the bar and the plant and the area covered by plants, total number of contacts with vegetation and percentage of vegetation (*R.V*), importance of each species (*n<sub>i</sub>*), total importance (*N*) and relative importance (*n<sub>i</sub>/N*) were measured.

The value of the rangeland (*IS*) was determined after doing floristic studies and identifying the nutritive value of plants (Tiedman and Beck, 1991). This coefficient (*IS*) was measured from zero to ten for the sheep and key plants at first step regarding the growth rate, nutritive value and palatability as excellent and good (9-10 scores), relatively good (6-8 scores), fair (3-5 scores), poor (1-2 scores), toxic plants and unavailable use (0 score).

After determining *V.P.S* for each station, the range conditions were determined as 1=excellent (more than 51 scores), 2=good (39-50), 3=fair (26-38), 4=poor (13-25) and 5=very poor (0-12).

### c) Four-factor method

Considering four-factor method, the studied elements include soil conditions (20 scores), vegetation (10 scores), plant combination, age levels (10 scores) and vigor (10 scores) and condition levels involve excellent (46-50 scores), good (38-45 scores), fair (31-37 scores), poor (20-30 scores) and very poor (0-20

scores). Scores of each element had been determined; then, based on total scores, the range conditions were determined (Moghaddam, 1994).

### d) Soil and vegetation combination method

Considering soil and vegetation combination method, the studied elements include two factors of vegetation such as vegetation combination (60 scores) and biomass production (40 scores) and two factors related to the soil involve soil surface cover (50 scores) and soil erosion (50 scores). Also, range conditions' classes are excellent (161-200 scores), good (121-160 scores), fair (81-120 scores), poor (41-80 scores) and very poor (0-40 scores). After assigning the score of each element, the range conditions were determined on the basis of total scores (Stoddart *et al.*, 1975).

### e) Climax method

Considering climax method by comparing present composition and climax, the range conditions were classified into four classes of excellent (75-100 scores), good (50-75 scores), fair (25-50 scores) and poor (0-25 scores). Since the climax of the area was unknown, the plants of area were first divided into three ecological classes involving reducer, increaser and invader based on their reactions to grazing. Then, the percentages of reducer and increaser plants were accepted while the invader one was rejected (Mesdaghi, 2008).

### Statistical analysis

Due to various range scores in each method, scores resulting from each method were transferred into a common scale. Because of different numbers of levels in each method, the decimal basic of zero to hundred was selected and scores of methods have been linearly changed to this scale. Then, the range scores may be excellent (81-100 scores), good (61-80 scores), fair (41-60 scores), poor (21-40 scores) and very poor (1-20 scores).

After normalizing data, five methods of range conditions' determination as factor A and three utilization intensities as factor B were analyzed using the factorial experiment at the randomized complete blocks design by the means of SAS software. The correlation test was used to find the relationship between the production and range conditions.

### Results

Results of analysis of variance (Table 1) and means comparison (Tables 2 and 3) showed that there was a significant difference between five methods of range conditions' determination and three areas of utilization intensity ( $P < 0.01$ ). According to Table 2, soil and vegetation combination with the average value of 3.89 and value of pasture calculated as 2.17 had higher and lower scores of range conditions' estimation methods, respectively. However, there were no

significant differences between two methods of four-factor and soil and vegetation combination (Table 2).

Comparing three areas, results showed that enclosure area with the average value of 4.028 and critical area with the average value of 2.803 had higher and lower scores of range conditions' estimation methods, respectively (Table 3). The results of interactions between range conditions in three areas of utilization intensity and key and critical areas are presented in Table 4. Results indicate that in enclosure area, higher scores were obtained for soil and vegetation combination method followed by climax, four factor, six factor and value of pasture estimations' methods, respectively. In key and critical areas, the order of methods' scores relatively was the same as enclosure area.

**Table 1.** Results of variance analysis (ANOVA) for range conditions' methods and areas

| S.O.V.   | DF | SS    | MS    | F                   |
|----------|----|-------|-------|---------------------|
| Block    | 4  | 0.816 | 0.204 | 1.29 <sup>ns</sup>  |
| Factor A | 4  | 31.42 | 7.855 | 49.53 <sup>**</sup> |
| Factor B | 2  | 19.66 | 9.832 | 62.0 <sup>**</sup>  |
| A×B      | 8  | 3.33  | 0.416 | 2.62 <sup>*</sup>   |
| Error    | 56 | 8.88  | 0.158 |                     |
| Total    | 74 | 64.11 |       |                     |

\*and\*\*: significant at 1 and 5% levels, respectively and ns: non-significant

**Table 2.** Comparison of means for factor A (range conditions' methods)

| Range Conditions' Methods       | Score             |
|---------------------------------|-------------------|
| Soil and vegetation combination | 3.89 <sup>A</sup> |
| Four-factor                     | 3.85 <sup>A</sup> |
| Six-factor                      | 3.48 <sup>B</sup> |
| Climax                          | 3.11 <sup>C</sup> |
| Value of pasture                | 2.17 <sup>D</sup> |

The means with the different letters were significantly different based on Duncan ( $p < 0.05$ )

**Table 3.** Comparison of means for factor B (areas)

| Utilization Intensity | Score              |
|-----------------------|--------------------|
| Enclosure area        | 4.028 <sup>A</sup> |
| Key area              | 3.180 <sup>B</sup> |
| Critical area         | 2.803 <sup>C</sup> |

The means with the different letters were significantly different based on Duncan ( $p < 0.05$ )



**Table 4.** Results of range conditions' class in key and critical areas

| Utilization Intensity | Stations | Range Conditions' Estimation Methods |                                 |             |                |           |
|-----------------------|----------|--------------------------------------|---------------------------------|-------------|----------------|-----------|
|                       |          | Six-Factor                           | Soil and Vegetation Combination | Four-Factor | Pastoral Value | Climax    |
| Exclosure area        | 1        | fair                                 | good                            | fair        | fair           | good      |
|                       | 2        | poor                                 | good                            | fair        | poor           | fair      |
|                       | 3        | fair                                 | excellent                       | fair        | poor           | good      |
|                       | 4        | fair                                 | good                            | fair        | fair           | good      |
|                       | 5        | good                                 | excellent                       | excellent   | good           | excellent |
| Key area              | 1        | poor                                 | fair                            | poor        | very poor      | poor      |
|                       | 2        | poor                                 | fair                            | poor        | very poor      | poor      |
|                       | 3        | fair                                 | fair                            | fair        | very poor      | good      |
|                       | 4        | poor                                 | fair                            | fair        | very poor      | poor      |
|                       | 5        | very poor                            | fair                            | poor        | very poor      | poor      |
| Critical area         | 1        | very poor                            | poor                            | very poor   | very poor      | poor      |
|                       | 2        | very poor                            | poor                            | very poor   | very poor      | poor      |
|                       | 3        | very poor                            | poor                            | very poor   | very poor      | poor      |
|                       | 4        | very poor                            | poor                            | very poor   | very poor      | poor      |
|                       | 5        | very poor                            | poor                            | very poor   | very poor      | poor      |

Correlation between biomass production and range conditions' methods is shown in Table 5. Results showed a positive and significant correlation between biomass production and range conditions' methods in three methods involving the clipping

and weighting, double sampling and comparing ones. It means that the biomass production will increase with the improvement of range conditions (Table 5).

**Table 5.** Pearson correlation between biomass production and range conditions in three methods of clipping and weighting, double sampling and comparing

| Methods                         | Comparing | Double Sampling | Clipping and Weighting |
|---------------------------------|-----------|-----------------|------------------------|
| Six-factor                      | 0.922**   | 0.940**         | 0.947**                |
| Soil and vegetation combination | 0.832**   | 0.871**         | 0.862**                |
| Four-factor                     | 0.908**   | 0.908**         | 0.914**                |
| Value of pasture                | 0.863**   | 0.912**         | 0.900**                |
| Climax                          | 0.863**   | 0.892**         | 0.896**                |

\*\* : significant at 1% level

### Discussion and Conclusion

Since there were non-significant differences between two methods of four-factor and soil and vegetation combination in all three areas (Table 2); therefore, these two methods could be replaced with each other. Nevertheless, the four-factor method is more preferred because the production potentials of the areas around the country are unknown for the soil and vegetation combination method and high quality species might not be recognized. Besides, six-factor method did not show lots of differences for inside and outside the exclosure areas due to lack of information about biomass production potentials of the area (Table 4); thus, it might not be a proper method.

The climax method was not a proper method at least for rangelands of Iran because it only considers the decreasing plants or class I and increasing plants or class II. Since there is not any calibrated model in Iran for different climates, it is better to use a specific model for each one. Considering four-factor method, the maximum score for vegetation will be achieved in 50% coverage and since in humid areas, the ecologic potential of the area is able to provide 50% and even 80 to 90% coverage, the canopy cover score in humid areas will be more than real situations. On the other hand, in this method, the plant combination factor is more focused on high quality grass. Regarding these two factors of vegetation

and plant composition, this method is more applicable for semi-arid areas and might have been developed based on the conditions of these areas (arid and semi-arid). Consequently, this research approves the results reported by Moghadam (1994) and Barani (1996) (applicability of four-factor method for semi-arid areas).

Correlation between the production and range conditions is positively high and significant. It means that the increase in biomass production is related with range conditions degrees (Table 5) while range conditions may be a more effective factor on forage production. Therefore, poor rangelands produce less forage than good ones and our findings are in agreement with the results expressed by Goebel and Cook (1960), Frost and Smith (1991) and Tiedman and Beck (1991).

It has been concluded that the difference between the assessment methods of range conditions was obvious and significant. Most methods in this research had an article or articles where the ideas, experiences, education or thoughts of experts affect the scores and different experts might estimate different scores for range conditions in one fixed time and location. According to the above mentioned reasons, it is necessary to develop a new model or improve the previous models for the assessment of range conditions. Regarding the conclusions concerning Kabirkooch rangelands in current circumstances, four-factor method for semi-arid regions is more applicable for range conditions' determination.

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## انتخاب روش‌های مناسب تخمین وضعیت مرتع (مطالعه موردی: مراتع کبیرکوه زاگرس، ایران)

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**چکیده.** وضعیت مرتع از چگونگی سلامتی آن خبر می‌دهد، به طور حتم انجام این ارزیابی مهم، مستلزم اتخاذ مناسب‌ترین روش مطالعه در هر منطقه است. به منظور معرفی مناسب‌ترین روش تعیین وضعیت مرتع برای علفزارهای کبیرکوه زاگرس پنج روش شش فاکتوری، چهار فاکتوری، ترکیب خاک و پوشش، ارزش مرتع و روش کلیماکس در سه منطقه مرجع، کلید و بحرانی بررسی شد. در هر منطقه پنج ایستگاه جهت نمونه برداری به روش سیستماتیک تصادفی انتخاب گردید. روش‌های تعیین وضعیت با استفاده از آزمایش فاکتوریل در قالب طرح بلوک‌های کامل تصادفی مورد آزمون و مقایسه میانگین‌ها توسط آزمون دانکن صورت گرفت. نتایج نشان داد که بین روش‌های تعیین وضعیت مرتع و همچنین بین سه منطقه قرق، کلید و بحرانی، در سطح یک درصد اختلاف معنی‌داری وجود داشت. با توجه به نتایج بدست آمده، در شرایط فعلی روش چهار فاکتوری برای تعیین وضعیت مناطق نیمه خشک مراتع کبیرکوه زاگرس روش مناسب‌تری می‌باشد. رابطه تولید با وضعیت مرتع با استفاده از آزمون همبستگی پیرسون ارتباط نزدیکی داشت ( $r=0/86$ ,  $p < 0/01$ ).

**کلمات کلیدی:** وضعیت مرتع، کلیماکس، ارزش مرتع، مناطق قرق، کلید و بحرانی، زاگرس، کبیرکوه