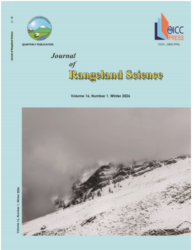

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# Exploring the Impact of Villages' Sustainability on Community Perceptions Towards Ecosystem Services

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**Abstract:**

Recently, while public perception has become a prominent scientific approach to valuing ecosystem services, less focus has been given to local communities' perspectives and the factors shaping their valuation of direct ecosystem benefits. This research aimed to evaluate the effects of residential sustainability, encompassing social, economic, and environmental dimensions, on how local communities perceive and assess ecosystem services. To achieve this, we studied 63 villages within a 20 km radius of Khabr National Park in Kerman Province, Iran. We examined seven environmental/ecological indicators, 15 social indicators, and seven economic indicators. We employed factor analysis to determine the factor loadings, which indicated the importance of each index. After identifying the influential factors and calculating their importance coefficients using the Varimax rotation method, we applied the VIKOR multi-criteria decision-making (MCDM) approach to prioritize the villages under various scenarios. The results indicated that a one-unit increase in sustainability led to significant changes in the provision of ecosystem services: a decrease of 24 times for fuel, an increase of 8.3 times for fodder, an increase of 21 times for medicinal resources, an increase of 4.8 times for food, and an increase of 21.2 times for pollination services. This research highlights a promising insight: by improving living conditions and enhancing sustainability, local communities' perspectives on the use of ecosystem services can be positively influenced.

**Keywords:** Multi-criteria decision-making; livelihood; Khabr National Park

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## 1. Introduction

Humans are inherently connected to ecosystems, a connection that the Millennium Ecosystem Assessment has highlighted through the concept of ecosystem services. Ecosystem services refer to the ecological characteristics, functions, or processes that contribute to human well-being, whether directly or indirectly (Millennium ecosystem assessment, 2005). The Millennium Ecosystem Assessment categorizes these services into four types: supporting, provisioning, regulating, and cultural ecosystem services. This classification has become a common starting point for understanding ecosystem services (Haines-Young & Potschin, 2018). The idea of final ecosystem services was developed to make the concept of ecosystem services more actionable for practitioners and decision-makers (Boyd & Banzhaf, 2007; Costanza et al., 2017; Finisdore et al., 2020). The Common International Classification of Ecosystem Services (CICES), created by the European Environment Agency, distinguishes between final and intermediate ecosystem services to prevent the double counting of some services in assessments (Haines-Young & Potschin, 2018; Newcomer-Johnson et al., 2020). While it is crucial to understand the indirect or intermediate ecosystem services that underlie final ecosystem services for effective evaluation and management, the focus on final ecosystem services emphasizes the distinct ways in which humans benefit from the environment. Final ecosystem services are defined as the benefits that society derives from ecosystems. Understanding the perspectives of local communities about these services is essential for recognizing how they contribute to societal well-being and regional development.

Recently, there has been a growing interest in using public perception as a scientific method to assess the value of ecosystem services (Chan et al., 2012; Collins et al., 2019; Hu et al., 2022; Lin et al., 2021; Purwestri et al., 2023; Sharafatmandrad & Khosravi Mashizi, 2021). However, too little attention has been given to incorporating the perspectives of local communities, who have valuable firsthand experience with ecosystem services. Their insights could lead to more effective management and decision-making practices (Targetti et al., 2020). Community understanding of ecosystem services can significantly influence their conservation behaviors towards the sustainability of these services (Erfanian et al., 2024; Maleknia, 2024).

Most researchers have identified demographic factors such as age, gender, and level of education as influencing people's views on the value of ecosystem services (Khosravi Mashizi & Sharafatmandrad, 2023; Lloyd-Smith et al., 2019). Other studies have highlighted the significance of the local environment and organizational or management factors in shaping the perspectives of local communities and Indigenous residents .(García-Llorente et al., 2020). The living conditions in various locations—considering aspects such as biophysical, cultural, traditional, local knowledge, institutional, and managerial factors—can significantly impact residents' experiences of nature and ecosystem services (Quintas-Soriano et al., 2018; Scholte et al., 2015; Sharafatmandrad & Khosravi Mashizi, 2021). Therefore, it is essential to develop a comprehensive and appropriate index to assess living conditions and their relationship with the viewpoints of local people.

Living environments significantly influence residents' perspectives on collective benefits due to their various environmental, social, and economic dimensions (Bernués et al., 2016; Diegues, 2014; Nabaloum et al., 2022). It is crucial to consider these environmental, social, and economic criteria when evaluating different settlements (Wang et al., 2018; Zhu et al., 2021). Furthermore, the concept of ecosystem services serves as an essential integrated framework in sustainability science (Geijzendorffer et al., 2017; Lloyd-Smith et al., 2019).

Khabr National Park, recognized as a national park by UNESCO in 1999, covers an area of 150,000 ha and has an elevation range from 1,000 to 3,845 m. It is one of Iran's most beautiful and diverse ecosystems, featuring various plant communities and natural landscapes. This unique ecosystem is significantly influenced by the local communities both within and near the park, playing an essential role in supporting their livelihoods and well-being (Bagheri et al., 2010; 2009; Borazjani et al., 2017). The mutual relationship that has developed in these protected areas enhances the resilience of the socio-ecological system (Cebrián-Piqueras et al., 2020; Liu et al., 2015; Martín-López et al., 2012). The importance of achieving three-dimensional socio-economic-environmental sustainability in local settlements is heightened by the perspectives of local communities regarding the ecosystem services surrounding their homes, which can be referred to as customary systems. However, there is a general lack of studies that explain how local communities perceive these ecosystem services. Therefore, this research aims to evaluate the role of sustainable living conditions, encompassing various social, economic, and environmental dimensions, in shaping local communities' perceptions of the ecosystem's services. Therefore, we aim to examine how sustainability in various settlements impacts local communities' perspectives on final ecosystem services.

## 2. Materials and Methods

### 2.1 Study area

Since coverage of various conditions in indices of three-dimensional criteria, including economic, social, and environmental ones, is required for assessing sustainability, this investigation was carried out for the living areas (e.g., nomadic and rural ones) located inside and around Khabr National Park and Rochoon Wildlife Refuge (KNP-RWR) as a vital influent ecosystem (Ansari et al., 2023). As shown in Figure 1, the studied area of 150,000 ha is situated in Baft and Orzoeieh townships of Kerman province, Iran, shaping different plant communities and natural landscapes due to its elevation variation between 1000 and 3845 m.

### 2.2 Research methodologies

The boundaries between rangelands and agricultural lands were first delineated to evaluate the ecological, economic, and socio-cultural criteria. Subsequently, vegetation elements and plant communities adjacent to the national park were identified through field surveys. In this process, the landscapes and plant communities of the national park and Rochoon refuge were shown in Table 1.

Villages within and surrounding the Khabr National Park were identified and located based on the statistical yearbook. A total of 63 villages within a 20-km radius of the national park were selected for this study. In this research, utilizing data from the statistical yearbook, 63 settlements were identified within and surrounding Khabar National Park, with their geographic locations mapped accordingly. The farthest settlements were located approximately 20 km from the park boundary. Despite this distance, community dependence on and utilization of the park's resources occurred predominantly within this 20-km radius.

Sustainability indicators were determined for the region based on social, economic, and environmental fac-

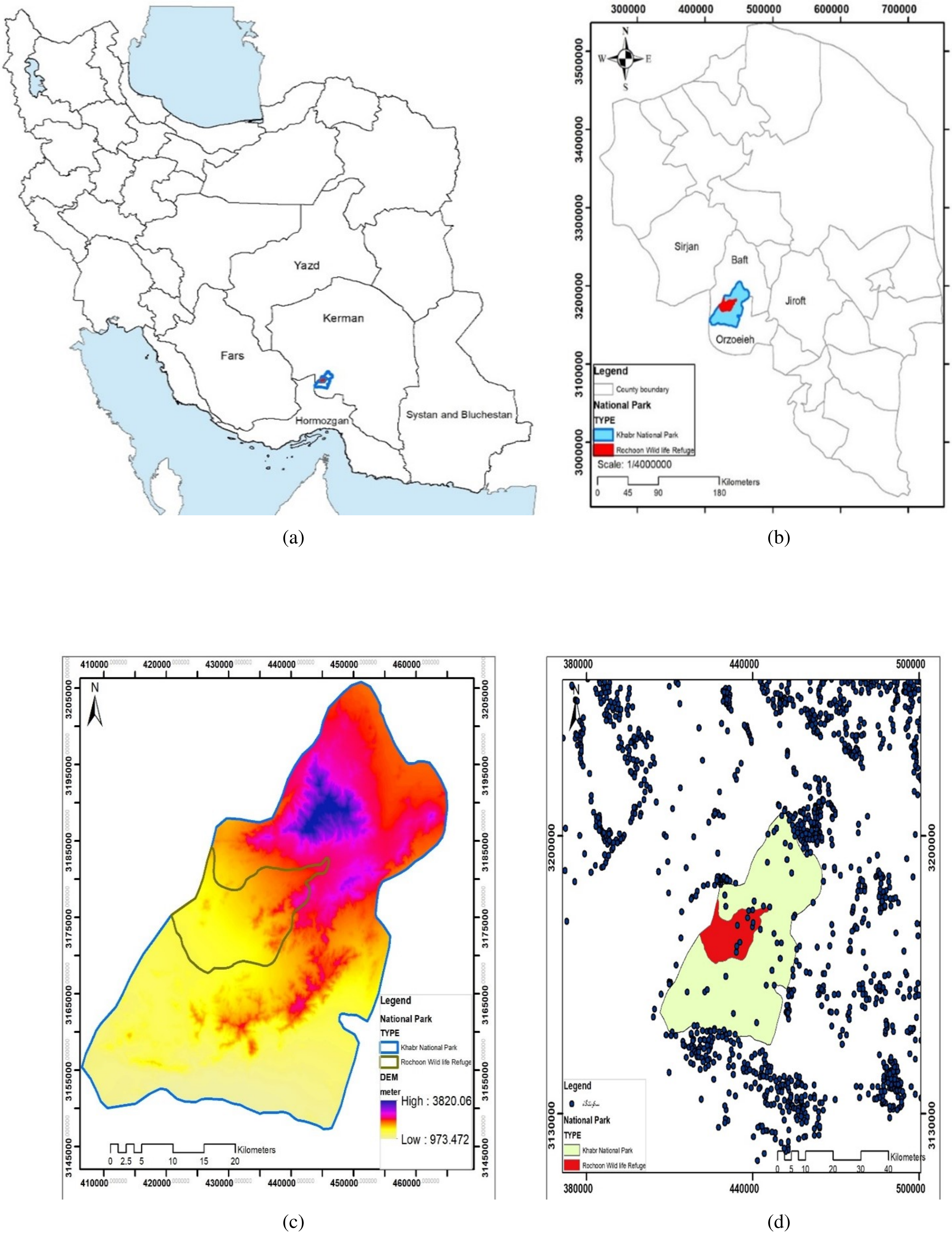


**Figure 1.** The location of Khabr National Park and Rochoon Wildlife Refuge (KNP-RWR) in Iran (a) and the townships of Kerman province (b) associated with Digital Elevation Map (c) and the location of villages inside and around the studied area (d)

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**Table 1.** Plant communities and landscapes formed in KNP-RWR

| Plant communities | Landscapes |
|---|---|
| Amygdalus scoparia Spach, Cousinia stocksii C.Winkl. - Ebenus stellata Boiss. - Amygdalus scoparia Spach | Lowland aphyllous woodland |
| Pistacia atlantica Desf. - Amygdalus L. - Acer monspessulanum L, Ebenus stellate Boiss- Amygdalus lycioides Spach- Pistacia atlantica Desf, Pistacia atlantica Desf | Deciduous broadleaved woodland |
| Artemisia aucheri Boiss- Pistacia atlantica Desf | Cushion-like bushes |
| Juniperus excels M.-Bieb. | Scale-leaved evergreen coniferous woodland |
| Convolvulus argyracanthus Rech. fil. - Ebenus stellate Bioss. - Artemisia sieberi Bioss.Cousinia stocksii C. Winkl. - Convolvulus argyracanthus Rech.fil., Artemisia sieberi Besser- Ephedra pachyclada Boiss.- Amygdalus lycioides Spach | Lowland xerophytic shrubs |
| Artemisia sieberi Besser | Mixed bush-grasses rangeland |
| Ziziphus spina- Christi (L) Desf Pteropyrum aucheri Jaub.& Spach- Hammada salicornica (Moq.) Iljin | Lowland evergreen broadleaved woodland |
| Platychaete aucheri (Boiss.) Boiss. - Gymnocarpos decander Forssk. - Hammada salicornica (Moq.) Iljin, Anvillea garcinii (Burm.) DC. - v- Hammada salicornica (Moq.) Iljin, Anvillea garcinii (Burm.) DC. - Gymnocarpos decander Forssk. - Zygophyllum eurypterum Boiss. & Buhse, Hammada salicornica (Moq.) Iljin | Lowland mixed halophyte shrubs, annual species |

tors (Table 2). Specifically, seven ecological indicators, 15 social indicators, and seven economic indicators were considered. (Table 2) provides a detailed methodological framework for all criteria and indicators, systematically outlining each indicator's assigned symbol, measurement unit, and its role in assessing settlement sustainability. The Table distinctly displays the multi-faceted aspects of settlement sustainability (economic, social, and ecological). Mean and standard deviation were computed from the studied villages with 63 replications. In this research, the criteria were selected based on the peer-reviewed scientific literature, and as outlined in Table 2, our methodology incorporates a comprehensive selection of the most critical economic (De Jonge et al., 2012; Ferran et al., 2018; Maleknia, 2024), social (De Jonge et al., 2012; Pretty & Bharucha, 2014), and ecological (Ferran et al., 2018; Gareiou et al., 2023) criteria and indicators.

In each allotment, the dominant plant community was first determined. Subsequently, indices related to 7 environmental criterion (Table 2) were assessed using sampling and field operations. The condition of each plant community was evaluated using the modified four-factor method (Jafari et al., 2017; Maleknia & Enescu, 2025).

The line intercept method using transects was employed to measure canopy cover percentage. Transect length was determined based on species diversity within each plant community. Four transects were established perpendicular to each community to eliminate the effects of slope and elevation. At the beginning and end of each transect, a plot was established to assess ecological indices such as forage production, species diversity, species dominance, and species richness (Bayat et al., 2021).

Soil samples were collected from a horizon at each transect location. Composite samples were prepared for each allotment and sent to the soil science laboratory for organic carbon analysis. This parameter was determined using the wet oxidation method.

Socioeconomic data for the villages were collected through questionnaires administered to village heads and local vital informants, supplemented by statistical yearbooks (Maleknia, 2025).

Following factor analysis to determine the importance coefficients of the indices, three criteria of economic, social, and ecologic aspects were considered. After identifying the influential factors and their importance coefficients using the varimax rotation, the Vikor multi-criteria decision-making method was employed for scenario planning to prioritize the villages (Bayat et al., 2023). In this regard, the scenarios were designed based on literature reviews (Hamzehnejad et al., 2020) as shown in Table 3. This study focused on how scenario planning empowers managers to choose a case aligned with their goals. Specifically, it examined the significance of environmental, social, and economic criteria across different situations of rating and giving importance, evaluated at 0%, 25%, 50%, 75%, and 100%.

The VIKOR method is one of the most widely used models in decision-making and optimal option selection. It can assist decision-makers in reaching a final decision. In this context, a compromise solution is the closest feasible solution to the ideal solution, where "compromise" refers to a mutual agreement (Mahmudah et al., 2024).

The VIKOR method prioritizes or ranks alternatives by evaluating them against various criteria. Unlike traditional methods, where criteria are assigned weights, VIKOR assesses criteria through alternative approaches. Subsequently, alternatives are evaluated based on these criteria and their combined value, leading to a final rank-

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**Table 2.** Studied Indicators and Criteria

| Criteria | Indicators | Units* | Symbol | Mean | Std |
|---|---|---|---|---|---|
| Environmental | Rangeland condition | Ordinal data | EN1 | 3.20 | 1.16 |
| | Soil Organic Carbon | % | EN2 | 5.46 | 1.63 |
| | Canopy cover | % | EN3 | 46.58 | 14.42 |
| | Forage | Kg/ha | EN4 | 342.34 | 134.47 |
| | Diversity index | - | EN5 | 2.56 | 1.06 |
| | Species number | number | EN6 | 11.95 | 5.86 |
| | Dominance index | - | EN7 | 0.39 | 0.31 |
| Social | Annual population growth | % | S1 | 8.75 | 1.51 |
| | Population density | $N/Km^2$ | S2 | 8.91 | 1.83 |
| | Household size | No/per/village | S3 | 82.13 | 146.43 |
| | Employment rate | % | S4 | 58.28 | 13.22 |
| | Unemployment rate | % | S5 | 11.11 | 8.41 |
| | Illiterate women's ratio of total population | % | S6 | 43.56 | 21.36 |
| | Illiterate women to illiterate men ratio | % | S7 | 1.58 | 0.29 |
| | Accessibility to official centers | Nominal data | S8 | 0.19 | 0.39 |
| | Accessibility to service centers | Nominal data | S9 | 0.38 | 0.48 |
| | Accessibility to recreation centers | Nominal data | S10 | 0.11 | 0.31 |
| | Accessibility to health centers | Nominal data | S11 | 0.65 | 0.48 |
| | Accessibility to educational centers | Nominal data | S12 | 0.60 | 0.49 |
| | Accessibility to masques | Nominal data | S13 | 0.58 | 0.49 |
| | Accessibility to suitable road centers | Nominal data | S14 | 0.55 | 0.50 |
| | Accessibility to infrastructures services (e.g., electricity, gas, and … ) services | Nominal data | S15 | 0.61 | 0.48 |
| Economic | Yield major crops | Ton/year | EC1 | 9.98 | 4.69 |
| | Annual net income of gardens | Milliard rial | EC2 | 0.23 | 0.55 |
| | Agricultural land per capita | ha | EC3 | 2.85 | 1.34 |
| | Number of livestock per capita | number | EC4 | 8.95 | 1.66 |
| | Livelihood reliance on agriculture | Ordinal data | EC5 | 3.30 | 1.44 |
| | Livelihood reliance on natural resources | Ordinal data | EC6 | 4.47 | 0.50 |
| | Livelihood reliance on fixed wage | Ordinal data | EC7 | 0.04 | 0.21 |

*-Ordinal data was assessed according to Likert scale

**Table 3.** Scenario building using the VIKOR method and scenario description

| Scenario | Description of the scenario | Coefficients of criteria | | |
|---|---|---|---|---|
| | | Environmental | Social | Economic |
| S (fa) | Factor analysis weights | 36.5 | 29.74 | 32.73 |
| S(equality) | Equal weights for all three criteria | 33.3 | 33.3 | 33.33 |
| S (25en) | 25% weight for the environmental criterion, with the remaining weight distributed equally between the other two criteria | 25 | 37.5 | 37.5 |
| S (25s) | 25% weight for the social criterion, with the remaining weight distributed equally between the other two criteria | 37.5 | 25 | 37.5 |
| S (25ec) | 25% weight for the economic criterion, with the remaining weight distributed equally between the other two criteria | 37.5 | 37.5 | 25 |
| S (50en) | 50% weight for the environmental criterion, with the remaining weight distributed equally between the other two criteria | 50 | 25 | 25 |
| S (50s) | 50% weight for the social criterion, with the remaining weight distributed equally between the other two criteria | 25 | 50 | 25 |
| S (50ec) | 50% weight for the economic criterion, with the remaining weight distributed equally between the other two criteria | 25 | 25 | 50 |
| S (75en) | 75% weight for the environmental criterion, with the remaining weight distributed equally between the other two criteria | 75 | 12.5 | 12.5 |
| S (75s) | 75% weight for the social criterion, with the remaining weight distributed equally between the other two criteria | 12.5 | 75 | 12.5 |
| S (75ec) | 75% weight for the economic criterion, with the remaining weight distributed equally between the other two criteria | 12.5 | 12.5 | 75 |

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ing. This model typically involves multiple options that are independently assessed against various criteria, with the final ranking determined by the overall value of each alternative (Kansal & Kumar, 2024).

The primary distinction between this model and hierarchical or network decision-making models lies in the absence of pairwise comparisons between criteria and alternatives. Instead, each alternative is independently evaluated against each criterion. Consequently, the steps involved in the VIKOR multi-criteria decision-making method can be summarized as follows:

Step 1: Decision Matrix Construction and Normalization. In this step, a decision matrix, or scoring matrix of alternatives based on criteria, is constructed. Subsequently, normalization is performed using the same normalization relationship as the TOPSIS method (Yazo-Cabuya et al., 2024).

Step 2: Weighting the Normalized Matrix. In this step, the set of weights (w) is multiplied by the normalized matrix (R).

Step 3: Determining the Positive Ideal and Negative Ideal Points

For each criterion, the best and worst values among all alternatives are identified and denoted as $f^+$ and $f^-$, respectively. If the criterion is of a benefit type, then:

$$f^+ = \max f_{ij} \qquad f^- = \min f_{ij}$$

Step 4: Assessing Utility: Opricovic (2015) introduced two fundamental concepts, utility ($S$) and regret ($R$), in VIKOR calculations. The utility value ($S_i$) represents the relative distance of the ith alternative from the ideal solution, while the regret value ($R_i$) signifies the maximum regret of the ith alternative due to its distance from the ideal solution (Yazo-Cabuya et al., 2024).

$$S_j = \sum_{j=1}^{n} = W_j \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \tag{1}$$

$$R_i = max \left[ W_j \frac{f_j^* - f_{ij}}{f_j^* - f_j^-} \right] \tag{2}$$

Where:

$f_{ij}$ denotes the performance of alternative $i$ for criterion $j$,

$j^*$ is the best value of $j$ criterion among all alternatives, and

$f_j^-$ shows the worst value of $j$ criterion among all alternatives.

$W_j$ is total weights in standardized matrix,

Step 5: Calculation of the VIKOR Index: The final step is the calculation of the VIKOR index ($Q_i$) for each alternative:

$$Q_i = V \left[ \frac{S_i - S^*}{S^- - S^*} \right] + (1 - v) \left[ \frac{R_i - R^*}{R^- - R^*} \right] \tag{3}$$

$$S^* = \min S_i; \quad S^- = \max S_i$$

$$R^* = \min R_i; \quad R^- = \max R_i$$

Where:

($S_i$) the suitability value represents the relative distance of the i-the option from the ideal point,

($R_i$) the amount of regret represents the maximum discomfort of the i in the distance from the ideal point, and finally $v$ is a weight ($0 \le v \le 1$) signifying the decision-maker's preference for utility versus regret.

It is worth noting that various scenarios can enhance the decision-making power of managers in both macro and micro policy-making. The categorization of local communities' sustainability was determined based on the VIKOR analysis and factor analysis results into five Likert-scale categories: very sustainable, sustainable, moderately sustainable, unsustainable, and very unsustainable. Following the scenario-building process, a questionnaire was developed to assess local communities' perceptions of the final services provided by park communities, including forage, medicinal plants, beekeeping, fuel, and food, in villages with different sustainability conditions (Guan et al., 2024).

For evaluation of ecosystem services, a panel of 10 natural resource and ecology experts from provincial universities assessed the questionnaire using Cronbach's alpha (1951) to ensure reliability. Following confirmation of the reliability of the indices ($\alpha > 0.7$), a snowball sampling technique was employed to identify interviewees in each class for an extensive field study assessing local communities' perceptions of direct and final ecosystem services. Our dataset includes 378 sample numbers ($n = 378$). As shown in Table 4, the descriptive statistics of the questionnaire responses were determined based on a Likert scale (ranging from 1: very low to 5: very high).

The effects of development level on perceptions of final ecosystem services in Khabr National Park and Rouchon Wildlife Refuge were analyzed using Kruskal-Wallis and Duncan's multiple range tests. A nonparametric method using Kruskal-Wallis test was employed due to its ability to rank multiple groups and assess the effects of different variables on the data. This statistical method is particularly useful when identifying significant differences between groups acquired from the selected indicators (such as social, economic, and environmental indicators). It allows for a precise and reliable evaluation of the impact of rural sustainability on the perception of local communities about ecosystem services (Montgomery, 2017).

The Spearman correlation test initially also examined the relationship between ecosystem services and the VIKOR sustainability index. Ultimately, an ordinal regression was employed in SPSS to examine the relationship between final ecosystem services and village development categories.

# 3. Results

## 3.1 Factor analysis of socio-economic-ecological indices

Rotated factor analysis using the principal component analysis method was employed to determine the importance coefficients of the socio-economic-ecological in-

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**Table 4.** Descriptive statistics of Ecosystem services using Likert-scale data collected from questionnaires

| Class | NO. | Ecosystem services | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Pollination | | Fuel | | Edible | | Medicinal | | Forage | |
| | | Mean | Std | Mean | Std | Mean | Std | Mean | Std | Mean | Std |
| Very low | 36 | 1.16 | 0.063 | 3.50 | 0.085 | 2.33 | 0.232 | 1.16 | 0.063 | 3.16 | 0.152 |
| Low | 234 | 1.97 | 0.028 | 2.10 | 0.020 | 3.41 | 0.082 | 2.05 | 0.033 | 3.51 | 0.057 |
| Medium | 84 | 2.78 | 0.045 | 1.42 | 0.068 | 3.85 | 0.109 | 2.92 | 0.050 | 4.07 | 0.121 |
| High | 12 | 5.00 | 0.000 | 1.00 | 0.000 | 5.00 | 0.000 | 4.00 | 0.000 | 4.00 | 0.000 |
| Very high | 12 | 5.00 | 0.000 | 1.00 | 0.000 | 5.00 | 0.000 | 5.00 | 0.000 | 4.00 | 0.000 |
| Total | 378 | 2.27 | 0.048 | 2.01 | 0.037 | 3.50 | 0.067 | 2.31 | 0.046 | 3.63 | 0.049 |

dicators. The results in Table 5 illustrate each factor's influential factors and factor loadings across seven axes. Based on this analysis, variables with factor loadings exceeding 0.70 were identified as significant factors. The contribution of each axis is displayed in Table 6. Accordingly, axes 1 to 7 account for explained variance percentages of 29.1%, 22.2%, 9.05%, 6.93%, 4.88%, 4.76%, and 4.63%.

The results of determining the importance weights of the effective indicators extracted from factor analysis are presented for each relevant criterion in Figure 3. Consistent with these findings, the environmental criterion (Figure 2a) allocated the highest weight to EN1 and the lowest weight to EN2. In this regard, among the importance weight indices for the social criterion (Figure 2b), the highest value was assigned to index S12 and the lowest to index S7. In addition, the highest and lowest importance weights for the economic criterion (Figure 2c) were assigned to EC1 and EC6, respectively.

Based on the importance coefficients of all influential factors and criteria (Figure 1), the indices of environmental, social, and economic criteria were calculated to have importance weights of 36.52%, 29.75%, and 32.74%, respectively. These findings suggest that the importance of the criteria in the studied area is prioritized as follows: environmental > economic > social.

### 3.2 Scenario building based on the VIKOR Multi-Criteria Decision-Making Method

The results of the data analysis based on the designed scenarios in Table 6 revealed that the first to tenth priorities varied across different scenarios. This finding could be attributed to the varying weights assigned to various criteria and their relative importance in other villages (Table 6).

Assessments presented in Figure 4 reveal that sustainable villages were consistently ranked last across all examined scenarios. Conversely, the top ten priorities, categorized as unsustainable settlements, exhibited more significant variability and shifts in ranking as scenarios changed. The prioritization results of the villages based on the importance coefficients derived from factor analysis and the VIKOR method (Figure 1a) indicated that the Qal'eh Now village ranked first due to its unstable environmental, social, and economic conditions. In contrast, the Khabr village with code 30 ranked last due to its stable ecological, social, and economic conditions.

### 3.3 Exploring the impact of villages sustainability on community perceptions

A Kruskal Wallis test was employed to investigate the effects of five categories of Vikor test results on the importance coefficients extracted from factor analysis regarding the final ecosystem services of natural ecosystems (in Khabr National Park and adjacent areas). The results of this test are presented in Table 7. Based on these results, the residential (environmental, social, and economic) sustainability effect on the local communities' perceptions of using all the final ecosystem services, including fodder, medicinal plants, food, fuel, and beekeeping, is significant at the 99% confidence level. Given the significance of the village sustainability factor, Duncan's multiple range test was employed to compare the means across the different groups. The results are presented in Table 8. According to this analysis, pollination services and their use in beekeeping increased significantly with increasing sustainability levels. In this regard, no significant difference was observed between the very high and high sustainability groups. Conversely, the belief in the use of fuel services increased significantly with decreasing sustainability, with the highest level belonging to the very unsustainable group. While the use of medicinal plants increased significantly with increasing sustainability levels, results also revealed a significant increase in the use of edible plants with increasing sustainability levels. Furthermore, findings indicated that the perception of using forage services differed significantly only between the highly unsustainable group and other groups, with the highly unsustainable group exhibiting the lowest level of forage service utilization.

### 3.4 Relationship between village sustainability and the utilization of final ecosystem services

The results are presented in Table 9. According to these results, the independent variable was significantly correlated with all the final services examined. The findings showed a significant negative correlation between fuel use services and other final services and the sustainability index. In contrast, a significant positive correlation was observed between forage, medicinal, food, and pollination services and each other and the sustainability

**Table 5.** Factor loadings of the rotated axes along the direction of maximum variance

| Indicators Abbrev. | Indicators | Component | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 |
| EN1 | Rangeland condition | -0.26 | 0.90 | -0.14 | -0.01 | 0.05 | 0.09 | -0.03 |
| EN2 | Soil Organic Carbon | -0.46 | 0.82 | -0.07 | 0.14 | 0.12 | 0.02 | -0.09 |
| EN3 | Canopy cover | -0.41 | 0.85 | -0.08 | 0.14 | 0.11 | 0.03 | -0.10 |
| EN4 | Forage | -0.17 | 0.88 | -0.16 | 0.14 | -0.05 | 0.18 | -0.12 |
| EN5 | Diversity index | -0.30 | 0.87 | -0.05 | -0.03 | 0.18 | 0.09 | 0.00 |
| EN6 | Species number | -0.32 | 0.86 | 0.01 | -0.02 | 0.04 | -0.03 | -0.01 |
| EN 7 | Dominance index | 0.00 | -0.62 | -0.09 | -0.09 | 0.55 | 0.26 | 0.12 |
| S1 | Annual population growth | -0.59 | 0.31 | -0.09 | 0.57 | -0.10 | 0.05 | 0.03 |
| S2 | Population density | -0.65 | 0.28 | 0.05 | 0.39 | 0.10 | -0.03 | 0.11 |
| S3 | Household size | 0.30 | -0.05 | 0.79 | 0.15 | 0.05 | 0.11 | -0.05 |
| S4 | Employment rate | 0.79 | -0.38 | 0.26 | -0.29 | -0.04 | 0.04 | -0.02 |
| S5 | Unemployment rate | 0.69 | -0.33 | 0.30 | -0.35 | -0.11 | -0.08 | 0.13 |
| S6 | Illiterate women's ratio of tota. | -0.74 | 0.45 | -0.24 | 0.28 | 0.02 | 0.18 | 0.04 |
| S7 | Illiterate women to men ratio | -0.18 | 0.11 | 0.10 | 0.04 | 0.07 | 0.85 | 0.01 |
| S8 | Accessibility to official centers | 0.09 | 0.04 | 0.74 | -0.27 | -0.13 | -0.11 | 0.20 |
| S9 | Accessibility to service centers | 0.41 | -0.24 | 0.49 | -0.27 | -0.25 | -0.29 | -0.19 |
| S10 | Accessibility to recreation centers | 0.14 | -0.22 | 0.76 | -0.02 | 0.23 | 0.16 | -0.16 |
| S11 | Accessibility to health centers | 0.69 | -0.33 | 0.19 | 0.09 | -0.15 | -0.08 | 0.09 |
| S12 | Accessibility to educational centers | 0.84 | -0.32 | 0.15 | -0.13 | -0.09 | -0.02 | 0.08 |
| S13 | Accessibility to masques | 0.09 | -0.11 | 0.06 | -0.19 | -0.15 | 0.02 | 0.24 |
| S14 | Accessibility to suitable road centers | 0.68 | 0.00 | 0.15 | -0.30 | 0.07 | 0.16 | 0.35 |
| S15 | Accessibility to infrastructure services | 0.03 | -0.07 | 0.45 | 0.10 | 0.30 | -0.39 | 0.52 |
| EC1 | Yield major crops | 0.88 | -0.33 | 0.10 | 0.09 | 0.10 | -0.16 | 0.01 |
| EC2 | Annual net income of gardens | -0.07 | 0.27 | 0.10 | -0.01 | 0.79 | 0.00 | -0.05 |
| EC3 | Agricultural land per capita | 0.88 | -0.33 | 0.10 | 0.09 | 0.10 | -0.16 | 0.01 |
| EC4 | Number of livestock per capita | -0.25 | 0.02 | -0.05 | 0.88 | -0.02 | 0.03 | 0.01 |
| EC5 | Livelihood reliance on agriculture | 0.76 | -0.11 | 0.15 | -0.12 | 0.12 | -0.34 | -0.24 |
| EC6 | Livelihood reliance on natural resources | -0.77 | 0.54 | -0.04 | 0.21 | 0.26 | 0.01 | -0.01 |
| EC7 | Livelihood reliance on fixed wage | 0.11 | -0.17 | -0.09 | 0.01 | -0.07 | 0.06 | 0.80 |
| Eigenvalues | | 8.44 | 6.44 | 2.62 | 2.01 | 1.42 | 1.38 | 1.34 |
| % of Variance | | 29.11 | 22.19 | 9.05 | 6.93 | 4.88 | 4.76 | 4.64 |
| % Com. Var | | 29.11 | 51.30 | 60.34 | 67.27 | 72.15 | 76.91 | 81.55 |

Extraction Method: Principal Component Analysis.


**Figure 2.** Importance coefficients of effective indicators in studied criteria including environmental (a), social (b), and economic (c) ones

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**Table 6.** Scenario- building for various villages of the studied area by Vikor method

| N0 | Villages/Settlements | S (FA) | S (equality) | S (25EN) | S (25S) | S (25EC) | S (50EN) | S (50S) | S (50EC) | S (75EN) | S (75S) | S (75EC) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Gazm | 0.535 | 0.488 | 0.481 | 0.490 | 0.490 | 0.502 | 0.483 | 0.477 | 0.574 | 0.474 | 0.489 |
| 2 | Kaht | 0.667 | 0.567 | 0.524 | 0.598 | 0.555 | 0.630 | 0.502 | 0.548 | 0.754 | 0.401 | 0.563 |
| 3 | Rochoon | 0.711 | 0.651 | 0.631 | 0.666 | 0.645 | 0.681 | 0.621 | 0.644 | 0.755 | 0.573 | 0.659 |
| 4 | Madan | 0.511 | 0.424 | 0.397 | 0.446 | 0.412 | 0.460 | 0.379 | 0.420 | 0.569 | 0.308 | 0.457 |
| 5 | Chahziba | 0.379 | 0.393 | 0.318 | 0.414 | 0.431 | 0.559 | 0.350 | 0.248 | 0.796 | 0.282 | 0.095 |
| 6 | Chahkenar | 0.422 | 0.437 | 0.362 | 0.456 | 0.480 | 0.607 | 0.400 | 0.284 | 0.840 | 0.341 | 0.116 |
| 7 | Chahsiah | 0.383 | 0.408 | 0.333 | 0.430 | 0.443 | 0.569 | 0.363 | 0.269 | 0.799 | 0.292 | 0.125 |
| 8 | Giho | 0.473 | 0.540 | 0.470 | 0.583 | 0.536 | 0.658 | 0.453 | 0.481 | 0.842 | 0.315 | 0.449 |
| 9 | Chahsorkh | 0.439 | 0.444 | 0.371 | 0.474 | 0.461 | 0.585 | 0.380 | 0.340 | 0.796 | 0.281 | 0.247 |
| 10 | Cheshmeh hosein | 0.317 | 0.326 | 0.299 | 0.338 | 0.331 | 0.378 | 0.301 | 0.289 | 0.510 | 0.262 | 0.280 |
| 11 | Bagh kenar | 0.379 | 0.445 | 0.422 | 0.461 | 0.441 | 0.483 | 0.413 | 0.430 | 0.588 | 0.363 | 0.447 |
| 12 | Mazar | 0.548 | 0.560 | 0.506 | 0.580 | 0.579 | 0.671 | 0.520 | 0.473 | 0.835 | 0.456 | 0.389 |
| 13 | Sohandar | 0.496 | 0.488 | 0.425 | 0.516 | 0.500 | 0.609 | 0.429 | 0.403 | 0.795 | 0.336 | 0.332 |
| 14 | Darnian | 0.297 | 0.369 | 0.350 | 0.362 | 0.399 | 0.430 | 0.383 | 0.293 | 0.555 | 0.405 | 0.219 |
| 15 | Zargarha (tiroft) | 0.289 | 0.339 | 0.392 | 0.310 | 0.336 | 0.246 | 0.399 | 0.395 | 0.217 | 0.492 | 0.485 |
| 16 | Samizadeh | 0.474 | 0.495 | 0.422 | 0.532 | 0.502 | 0.627 | 0.418 | 0.412 | 0.827 | 0.297 | 0.348 |
| 17 | Hamzelu | 0.382 | 0.444 | 0.375 | 0.470 | 0.466 | 0.584 | 0.390 | 0.336 | 0.792 | 0.304 | 0.234 |
| 18 | Motor taheri | 0.508 | 0.566 | 0.507 | 0.603 | 0.560 | 0.663 | 0.490 | 0.520 | 0.821 | 0.370 | 0.503 |
| 19 | Motor razinefahimi | 0.356 | 0.408 | 0.376 | 0.429 | 0.404 | 0.460 | 0.365 | 0.386 | 0.586 | 0.297 | 0.399 |
| 20 | Motor Amiri | 0.347 | 0.398 | 0.364 | 0.421 | 0.393 | 0.454 | 0.352 | 0.376 | 0.584 | 0.278 | 0.388 |
| 21 | Jalalu | 0.231 | 0.301 | 0.261 | 0.310 | 0.324 | 0.391 | 0.283 | 0.218 | 0.560 | 0.254 | 0.147 |
| 22 | Ghadamgah | 0.323 | 0.378 | 0.342 | 0.401 | 0.376 | 0.441 | 0.332 | 0.348 | 0.580 | 0.259 | 0.351 |
| 23 | Abkorku | 0.356 | 0.413 | 0.376 | 0.439 | 0.404 | 0.470 | 0.359 | 0.394 | 0.601 | 0.275 | 0.414 |
| 24 | Shekarab | 0.319 | 0.371 | 0.340 | 0.392 | 0.365 | 0.420 | 0.327 | 0.353 | 0.546 | 0.258 | 0.373 |
| 25 | Ghorbangholi | 0.193 | 0.269 | 0.237 | 0.275 | 0.290 | 0.345 | 0.256 | 0.198 | 0.502 | 0.236 | 0.142 |
| 26 | Motor seieda | 0.314 | 0.413 | 0.388 | 0.441 | 0.390 | 0.437 | 0.355 | 0.433 | 0.539 | 0.264 | 0.506 |
| 27 | Chadyvar (chadar) | 0.308 | 0.368 | 0.344 | 0.385 | 0.363 | 0.407 | 0.334 | 0.354 | 0.522 | 0.280 | 0.376 |
| 28 | Jiji | 0.297 | 0.351 | 0.326 | 0.370 | 0.344 | 0.389 | 0.313 | 0.342 | 0.505 | 0.253 | 0.372 |
| 29 | Zargarha (motorhashmar) | 0.300 | 0.300 | 0.346 | 0.267 | 0.312 | 0.234 | 0.369 | 0.320 | 0.233 | 0.476 | 0.362 |
| 30 | Khabr | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 31 | Vakilabad | 0.551 | 0.612 | 0.671 | 0.551 | 0.660 | 0.555 | 0.739 | 0.576 | 0.515 | 0.938 | 0.510 |
| 32 | Ghalehnu | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.002 | 0.000 | 0.000 | 0.115 | 0.000 | 0.049 |
| 33 | Tolombeh roknadini | 0.121 | 0.108 | 0.117 | 0.119 | 0.080 | 0.068 | 0.085 | 0.170 | 0.135 | 0.048 | 0.305 |
| 34 | Mohamadabad | 0.276 | 0.321 | 0.401 | 0.249 | 0.365 | 0.223 | 0.468 | 0.314 | 0.173 | 0.700 | 0.295 |
| 35 | Motor alahabadsal | 0.383 | 0.310 | 0.312 | 0.310 | 0.306 | 0.303 | 0.308 | 0.319 | 0.375 | 0.306 | 0.366 |
| 36 | Gijueih | 0.313 | 0.246 | 0.244 | 0.241 | 0.255 | 0.258 | 0.255 | 0.226 | 0.353 | 0.269 | 0.234 |
| 37 | Golestan | 0.325 | 0.296 | 0.313 | 0.271 | 0.322 | 0.292 | 0.348 | 0.261 | 0.355 | 0.430 | 0.234 |
| 38 | Khosroabad | 0.350 | 0.343 | 0.369 | 0.309 | 0.376 | 0.329 | 0.413 | 0.305 | 0.373 | 0.524 | 0.265 |
| 39 | Jouan | 0.356 | 0.302 | 0.308 | 0.291 | 0.313 | 0.302 | 0.323 | 0.285 | 0.376 | 0.357 | 0.291 |
| 40 | Petkan | 0.325 | 0.331 | 0.357 | 0.290 | 0.374 | 0.326 | 0.415 | 0.271 | 0.377 | 0.548 | 0.200 |
| 41 | Aliabad | 0.334 | 0.333 | 0.362 | 0.297 | 0.365 | 0.312 | 0.407 | 0.298 | 0.351 | 0.524 | 0.263 |
| 42 | Eslamabad | 0.292 | 0.223 | 0.228 | 0.213 | 0.237 | 0.230 | 0.245 | 0.200 | 0.318 | 0.280 | 0.201 |
| 43 | Jarub | 0.357 | 0.325 | 0.342 | 0.301 | 0.351 | 0.321 | 0.375 | 0.292 | 0.381 | 0.454 | 0.267 |
| 44 | Vakilabad2 | 0.321 | 0.262 | 0.268 | 0.250 | 0.278 | 0.268 | 0.288 | 0.238 | 0.349 | 0.328 | 0.235 |
| 45 | Baghpishgah | 0.461 | 0.373 | 0.375 | 0.370 | 0.378 | 0.376 | 0.380 | 0.365 | 0.447 | 0.392 | 0.384 |
| 46 | Meydan | 0.449 | 0.365 | 0.364 | 0.365 | 0.364 | 0.366 | 0.364 | 0.365 | 0.438 | 0.363 | 0.397 |
| 47 | Khardan | 0.462 | 0.404 | 0.417 | 0.390 | 0.415 | 0.394 | 0.432 | 0.394 | 0.444 | 0.477 | 0.403 |
| 48 | Abyade ghahramni | 0.424 | 0.340 | 0.342 | 0.339 | 0.341 | 0.339 | 0.343 | 0.342 | 0.410 | 0.347 | 0.375 |
| 49 | Dikhoueieh | 0.407 | 0.402 | 0.427 | 0.365 | 0.439 | 0.393 | 0.477 | 0.353 | 0.435 | 0.596 | 0.296 |
| 50 | Hoseinabad | 0.216 | 0.172 | 0.221 | 0.147 | 0.166 | 0.083 | 0.223 | 0.229 | 0.079 | 0.304 | 0.333 |
| 51 | Heydarabad | 0.255 | 0.232 | 0.260 | 0.209 | 0.243 | 0.194 | 0.279 | 0.237 | 0.233 | 0.354 | 0.269 |
| 52 | Mahmodabad | 0.272 | 0.273 | 0.317 | 0.234 | 0.298 | 0.222 | 0.355 | 0.267 | 0.236 | 0.483 | 0.270 |
| 53 | Aliabad takhtekhaj | 0.274 | 0.228 | 0.255 | 0.215 | 0.226 | 0.182 | 0.257 | 0.258 | 0.217 | 0.301 | 0.329 |
| 54 | Aliabad shamshirbor | 0.245 | 0.231 | 0.261 | 0.207 | 0.243 | 0.191 | 0.281 | 0.238 | 0.227 | 0.358 | 0.271 |
| 55 | Eslamabd2 | 0.345 | 0.276 | 0.289 | 0.272 | 0.270 | 0.249 | 0.284 | 0.301 | 0.303 | 0.296 | 0.367 |
| 56 | Hoseinabad khani | 0.306 | 0.284 | 0.311 | 0.258 | 0.301 | 0.254 | 0.337 | 0.276 | 0.294 | 0.420 | 0.285 |
| 57 | Kashkoeieh | 0.391 | 0.384 | 0.430 | 0.349 | 0.400 | 0.321 | 0.457 | 0.397 | 0.313 | 0.572 | 0.424 |
| 58 | Beridoeieh | 0.250 | 0.204 | 0.219 | 0.190 | 0.215 | 0.189 | 0.235 | 0.199 | 0.256 | 0.282 | 0.222 |
| 59 | Dehuj | 0.268 | 0.254 | 0.281 | 0.230 | 0.267 | 0.220 | 0.302 | 0.254 | 0.261 | 0.377 | 0.278 |
| 60 | Gorgin | 0.081 | 0.079 | 0.135 | 0.036 | 0.097 | 0.000 | 0.167 | 0.098 | 0.007 | 0.306 | 0.143 |
| 61 | Ghalehno | 0.042 | 0.097 | 0.171 | 0.021 | 0.155 | 0.023 | 0.254 | 0.056 | 0.019 | 0.501 | 0.000 |
| 62 | Abkar ashayer25 | 0.117 | 0.101 | 0.162 | 0.059 | 0.112 | 0.008 | 0.186 | 0.137 | 0.000 | 0.321 | 0.204 |
| 63 | Soltanabd | 0.206 | 0.259 | 0.355 | 0.180 | 0.299 | 0.131 | 0.420 | 0.273 | 0.055 | 0.674 | 0.283 |

**Table 7.** Nonparametric variance analysis (Kruskal-Wallis test) to examine the effect of residential (environmental, social, and economic) sustainability on local communities' perceptions of ecosystem service utilization

| Indicators | Pollination value | Fuel production | Edible plants | Medicinal plants | Fodder production |
|---|---|---|---|---|---|
| Very stable | 50.00 | 353.00 | 104.50 | 46.00 | 132.50 |
| Unstable | 160.19 | 209.96 | 180.04 | 160.04 | 177.65 |
| Moderate stability | 280.36 | 105.29 | 216.29 | 283.36 | 231.50 |
| Stable | 366.50 | 39.50 | 315.50 | 354.50 | 243.50 |
| Very stable | 366.50 | 39.50 | 315.50 | 372.50 | 243.50 |
| Kruskal Wallis test | 245.9** | 244.6** | 64.6** | 247.9** | 35.2** |

*, **= significant at 5 and 1% probability level.

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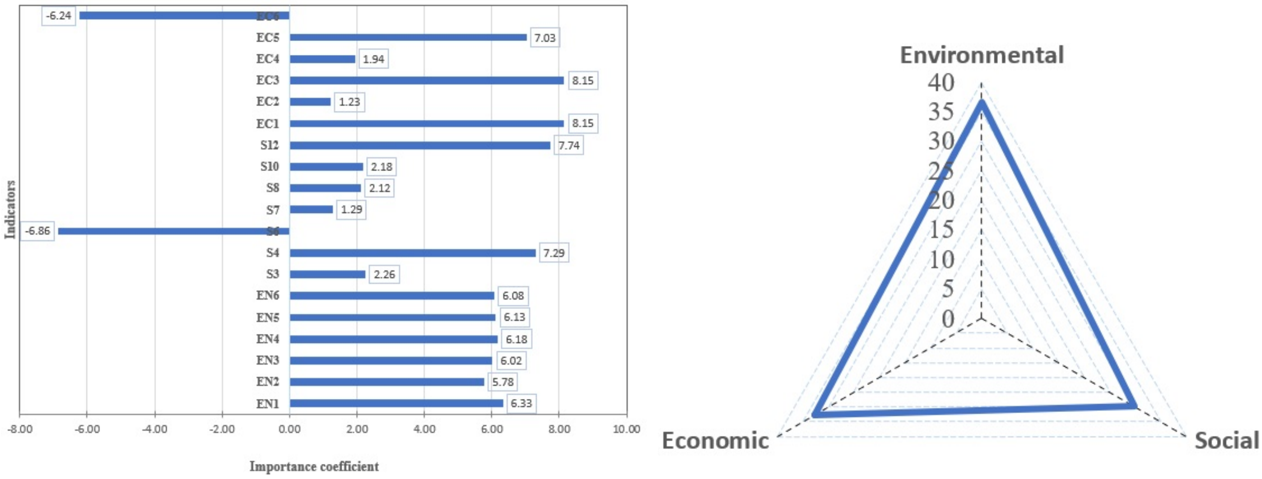


**Figure 3.** Importance coefficients for all effective indicators (a) and criteria (b)

**Table 8.** Comparison of Mean Values of Sustainability Groups for the Use of Final Ecosystem Services

| Likert's category | Pollination value | Fuel production | Edible plants | Medicinal plants | Fodder production |
|---|---|---|---|---|---|
| Very stable | 1.67 d±0.06 | 3.50 a±0.08 | 2.03 c±0.23 | 1.16 e±0.06 | 3.16 b±0.15 |
| Unstable | 1.97 c±0.02 | 2.10 b±0.02 | 3.40 b±0.08 | 2.05 d±0.03 | 3.5 1ab±0.05 |
| Moderate stability | 2.78 b±0.04 | 1.67 c±0.07 | 3.85 b±0.11 | 2.92 c±0.05 | 4.07 a±0.12 |
| Stable | 5.00 a±0.00 | 1.00 d±0.060 | 5.00 a±0.00 | 4.00 b±0.00 | 4.00 a±0.01 |
| Very stable | 5.00 a±0.00 | 1.00 d±0.00 | 5.00 a±0.00 | 5.00 a±0.01 | 4.00 a±0.02 |

Means of column followed by the same letter" indicates not significantly different from each other.

index.

Ordinal regression models were employed to examine the relationship between the degree of sustainability and final ecosystem services. The results are presented in Table 10. According to these findings, a one-unit increase in the degree of sustainability resulted in a 24-fold decrease in fuel services. Furthermore, the results showed that a one-unit increase in the degree of sustainability led to an 8.3-fold, 21-fold, 8.4-fold, and 21.2-fold increase in fodder, medicinal, food, and pollination services, respectively.

### 3.5 Discussion

The research results indicated that the greatest importance was assigned to rangeland condition (EN1), accessibility to educational facilities (S12), and the production of major crops (EC1). The assessment revealed that the environmental, social, and economic criteria accounted for 36.52%, 29.75%, and 32.74%, respectively. While the ecological criterion was deemed the most significant in this study, the interplay between the economic and social criteria showed that the combined importance of socioeconomic factors (related to human well-being) surpassed that of environmental factors (ecosystem) in the study area. Given these findings, it is crucial for planners to focus on the role of humans in conserving and preserving areas like Khabr National Park. The research aimed to evaluate and prioritize villages based on various socioeconomic and environmental factors, employing the VIKOR multi-criteria decision-making method to assess local communities' perceptions of final ecosystem services. The results highlighted significant differences among the studied settlements concerning these socioeconomic and environmental dimensions. As a result, Qal'eh Now village was prioritized first due to its unstable environmental, social, and economic conditions. In contrast, Khabr village, which has stable ecological, social, and economic conditions, was given the lowest priority. While no research has specifically prioritized villages based on these criteria in relation to settlements located within or near hotspot areas (such as national parks), this study underscores the importance of using a multi-criteria sustainability index to prioritize villages within and around the Khabr National Park hotspot area. Therefore, it is recommended that assessments of various environmental, social, and economic indicators in settlements surrounding hotspot areas can be taken into account for prioritization in any government initiatives. This comprehensive and systematic approach can help minimize the risk of program failure and avoid one-dimensional, sectoral planning. Empirical investigations have established a significant correlation between public perception of forest-derived ecosystem services and the manifestation of pro-environmental behaviors, alongside the formulation of conservation intentions. For example: (Maleknia, 2024) documented a positive relationship between enhanced awareness of urban forest ecosystem services and an increased individual willingness to pay for ecosystem services (Erfanian et al., 2024) also sub-

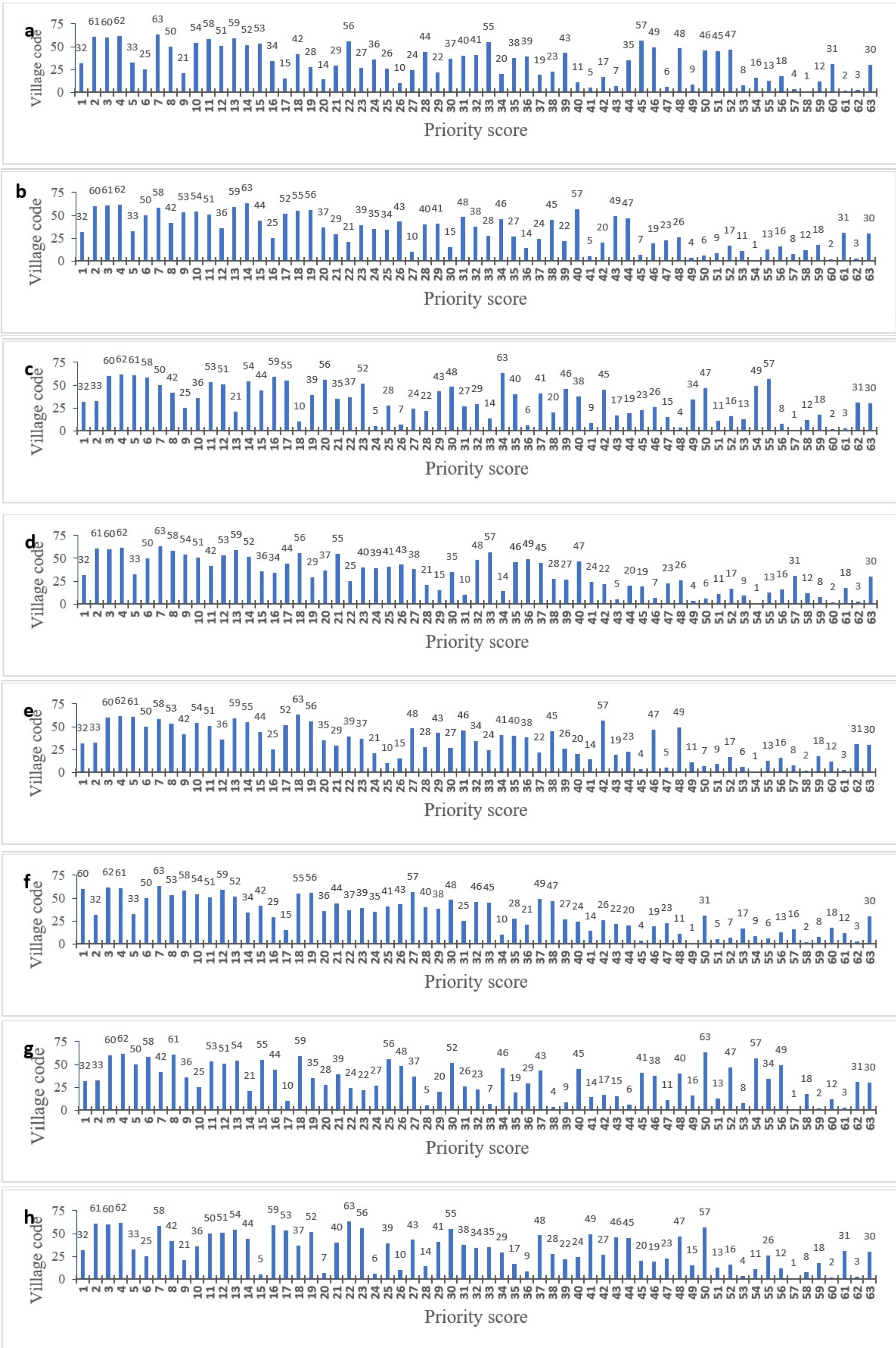


**Figure 4.** Prioritizing of village based on various scenarios including a: S (FA), b: S (equality), c: S (25EN), d: S (25S), e: S (25EC), f: S (50EN), g: S (50S), h: S (50EC)

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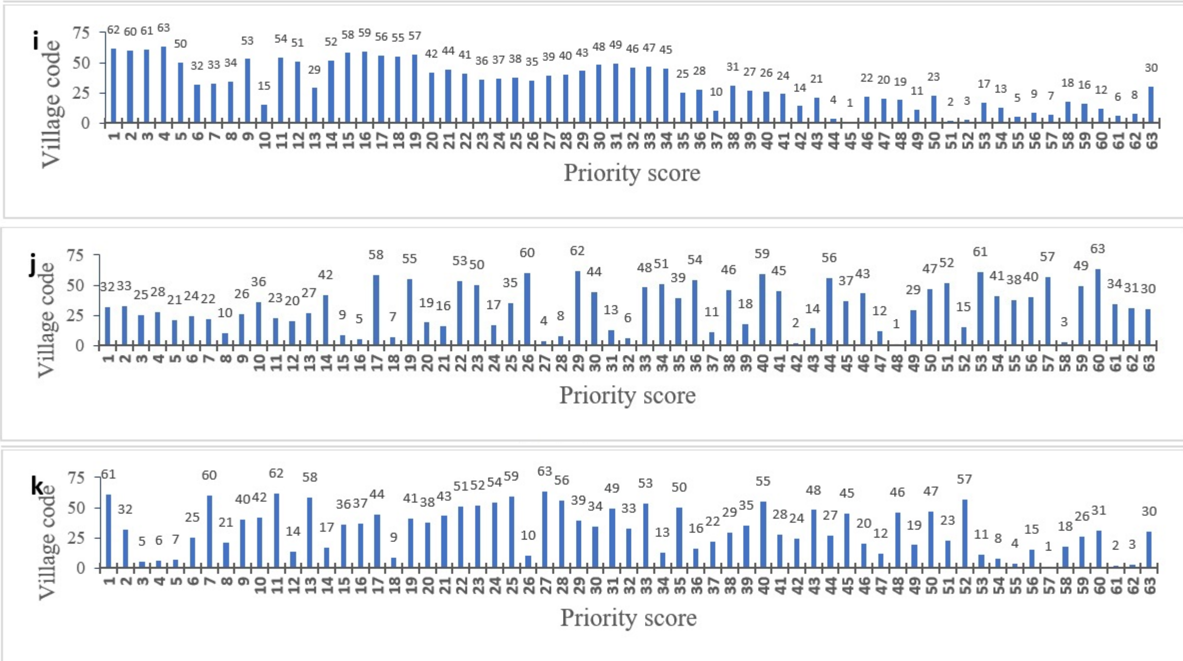


**Figure. 4 (continue).** Prioritizing of village based on various scenarios including i: S (75EN), j: S (75S), k: S (75EC)

**Table 9.** Correlation between variables by the Spearman method

| Factors | Pollination | Fuel | Edible | Medicinal | Forage |
|---|---|---|---|---|---|
| Fuel | -0.674** | | | | |
| Edible | 0.426** | -0.394** | | | |
| Medicinal | 0.697** | -0.695** | 0.443** | | |
| Forage | 0.357** | -0.312** | 0.826** | 0.322** | |
| Sustainability degree | 0.711** | -0.732** | 0.465** | 0.729** | 0.358** |

*, **= significant at 5 and 1% probability level.

**Table 10.** Ordinal Regression (OR) model for final ecosystem services' proxies using Vikor procedure score as independent

| Ecosystem services | Likert classes' thresholds | | | | B value | Chi-square | R-square |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | | | |
| Pollination value | 4.06 | 9.00 | 12.83 | | 21.2 | 372.27** | 0.70 |
| Fuel production | -11.17 | -5.39 | -1.97 | | -24.33 | 375.22** | 0.72 |
| Edible plants | -0.13 | 1.79 | 3.07 | 3.84 | 8.42 | 109.25** | 0.26 |
| Medicinal plants | 3.76 | 8.74 | 11.77 | 14.97 | 21.04 | 385.75** | 0.70 |
| Fodder production | -2.93 | -1.48 | 1.48 | 2.64 | 3.85 | 40.55** | 0.11 |

*, **= significant at 5 and 1% probability level.

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stantiated that an elevated understanding of ecosystem service provision acts as a catalyst for the reinforcement of environmentally responsible behavior. Specifically, the recognition of the functional importance of these services fosters a heightened sense of ecological stewardship. The cultivation of a comprehensive understanding of the diverse ecosystem services such as climate change mitigation (Maleknia & Enescu, 2025) and the provision of human health benefits (Maleknia, 2025), is posited to facilitate a societal shift towards sustainable natural resource utilization paradigms. In essence, the cognitive internalization of the instrumental and intrinsic values associated with ecosystem services precipitates a greater proclivity for their conservation.

The findings indicate a strong correlation between the residential sustainability of local communities and their use of final ecosystem services. Specifically, for each one-unit increase in sustainability, there was a 24-fold decrease in the consumption of fuel services. Additionally, the results showed that a one-unit increase in sustainability corresponded to increases of 3.8, 21, 8.4, and 21.2 times in fodder, medicinal, food, and pollination services, respectively. Furthermore, the study found that both pollination services and the use of ecosystems for beekeeping significantly increased with higher levels of sustainability. However, no significant difference was noted in pollination services or the use of ecosystems for beekeeping between the ”very high” and ”high” sustainability groups. On the other hand, the consumption of fuel services notably increased as sustainability decreased, with the ”very unsustainable” group exhibiting the highest levels of fuel service use. These results align with other studies (e.g., (Mace et al., 2012)) showing that more sustainable communities tend to rely more on ecosystem services for their livelihoods and well-being, while the increased fuel consumption observed among the least sustainable groups is consistent with research indicating that unsustainable practices often result in higher dependence on fuelwood and other ecosystem products (Wunder et al., 2014).

## 4. Conclusions

The results indicated that as the level of sustainability increased, the use of both medicinal and edible plants also significantly increased. Additionally, the findings revealed that perceptions of fodder services varied significantly, particularly between the very unsustainable group and the other groups; the very unsustainable group exhibited the lowest level of fodder use. Furthermore, the results showed a significant negative correlation between fuelwood services and other final services, as well as with the sustainability level. In contrast, the use of fodder, medicinal, edible, and pollination services was positively correlated with each other and with the sustainability level.

**Authors contributions**
M.S.N. conceived and designed the experiments; M.S.N, and R.B. performed the experiments and analyzed the data; H.A. a contributed rea-gents /materials/analysis tools; M.S.N and S.A.J. wrote the paper. All authors have read and agreed to the published version of the manuscript.
**Availability of data and materials**
The data that support the findings of this study are available from the corresponding author, upon reasonable request.

**Conflict of interests**
The authors have no relevant financial or non-financial interests to disclose.
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### References

Ansari, A., Ghorbanpour, M., & Kazemi, A. (2023). Ecological assessment of iran’s terrestrial biomes for wildlife conservation. *Scientific Reports*, *13*, 17761. https://doi.org/10.1038/s41598-023-45120-4

Bagheri, R., Chaichi, M., & Mohseni Saravi, M. (2010). Effect of grazing intensity on soil moisture and vegetation (case study: Khabr national park and near rangelands) [In Persian]. *Iranian Journal of Range and Desert Research*, *17*(2), 301–316.

Bagheri, R., Mohseni, S., & Chaeichi, M. (2009). Effect of grazing intensity on some soil chemical properties in a semi-arid region (case study: Khabr national park and near rangelands) [In Persian]. *Journal of Rangeland*, *3*(3), 398–412.

Bayat, M., Bettinger, P., Masteali, S., Hamidi, S., Masood Awan, H., & Abolhasani, A. (2023). Recreation potential assessment at tamarix forest reserves: A method based on multicriteria evaluation approach and landscape metrics. *Forests*, *14*(4), 705.

Bayat, M., Burkhart, H., Namiranian, M., Hamidi, S., Heidari, S., & Hassani, M. (2021). Assessing biotic and abiotic effects on biodiversity index using machine learning. *Forests*, *12*(4), 461. https://doi.org/10.3390/f12040461

Bernués, A., Tello-García, E., Rodríguez-Ortega, T., Ripoll-Bosch, R., & Casasús, I. (2016). Agricultural practices, ecosystem services and sustainability in high nature value farmland: Unraveling the perceptions of farmers and nonfarmers. *Land Use Policy*, *59*, 130–142.

Borazjani, A., Mosapour, S., Keykha, A. A., & Sasouli, M. (2017). Willingness to participate of local communities in the conservation of national parks. *International Journal of Human Capital in Urban Management*, *2*(1), 69–76.

Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? the need for standardized environmental accounting units. *Ecological Economics*, *63*(2-3), 616–626.

Cebrián-Piqueras, M., Filyushkina, A., Johnson, D., Lo, V., López-Rodríguez, M., March, H., Oteros-Rozas, E., Peppler-Lisbach, C., Quintas-Soriano, C., Raymond, C., & Ruiz-Mallén, I. (2020). Scientific and local ecological knowledge, shaping perceptions towards protected areas and related ecosystem services. *Landscape Ecology*, *35*(11), 2549–2567.

Chan, K., Satterfeld, T., & Goldstein, J. (2012). Rethinking ecosystem services to better address and navigate cultural values. *Ecological Economics*, *74*, 8–18.

Collins, C., Cook-Monie, I., & Raum, S. (2019). What do people know? ecosystem services, public perception and sustainable management of urban park trees in london, uk. *Urban Forestry and Urban Greening*, *43*, 126362.

Costanza, R., De Groot, R., Braat, L., Kubiszewski, I., Fioramonti, L., Sutton, P., et al. (2017). Twenty years of ecosystem services: How far have we come and how far do we still need to go? *Ecosystem Services*, *28*, 1–16. https://doi.org/10.1016/j.ecoser.2017.09.008

De Jonge, V., Pinto, R., & Turner, R. (2012). Integrating ecological, economic and social aspects to generate useful management information under the eu directives' ecosystem approach. *Ocean and Coastal Management*, *68*, 169–188.

Diegues, A. (2014). The role of ethnoscience in the build-up of ethnoconservation as a new approach to nature conservation in the tropics. the case of brazil. *Revue d'ethnoécologie*, *6*. https://doi.org/10.4000/ethnoecologie

Erfanian, S., Maleknia, R., & Azizi, R. (2024). Environmental responsibility in urban forests: A cognitive analysis of visitors' behavior. *Forests*, *15*(10), 1773. https://doi.org/10.3390/f15101773

Ferran, P., Heijungs, R., & Vogtländer, J. (2018). Critical analysis of methods for integrating economic and environmental indicators. *Ecological Economics*, *146*, 549–559.

Finisdore, J., Rhodes, C., Haines-Young, R., Maynard, S., Wielgus, J., Dvarskas, A., Houdet, J., Quétier, F., Lamothe, K., Ding, H., & Soulard, F. (2020). The 18 benefits of using ecosystem services classification systems. *Ecosystem Services*, *45*, 101160.

García-Llorente, M., Castro, A., Quintas-Soriano, C., Oteros-Rozas, E., Iniesta-Arandia, I., González, J., García del Amo, D., Hernández-Arroyo, M., Casado-Arzuaga, I., Palomo, I., & Gómez-Baggethun, E. (2020). Local perceptions of ecosystem services across multiple ecosystem types in spain. *Land*, *9*(9), 330.

Gareiou, Z., Gizani, N., Laskari, I., Mavromati, I., & Zervas, E. Review of specific environmental indicators. In: In *E3s web of conferences*. *436*. EDP Sciences, 2023, 07001.

Geijzendorffer, I., Cohen-Shacham, E., Cord, A., Cramer, W., Guerra, C., & Martín-López, B. (2017). Ecosystem services in global sustainability policies. *Environmental Science and Policy*, *74*, 40–48.

Guan, J., Liu, J., Chen, H., & Bi, W. (2024). A multi-criteria decision-making approach for equipment evaluation based on cloud model and vikor method. *International Journal of Advanced Computer Science and Applications*, *15*(7), 60–74.

Haines-Young, R., & Potschin, M. (2018). Cices v5.1: Guidance on the application of the revised structure [Available online].

Hamzehnejad, N., Arzani, H., Bagheri, R., & Javad, S. (2020). Prioritization of rangeland species functions with emphasis on indigenous knowledge of range holders (case study: Titoeieh area in baft township, kerman, iran). *Journal of Rangeland Science*, *10*(4), 370–383.

Hu, C., Wright, A., & He, S. (2022). Public perception and willingness to pay for urban wetland ecosystem services: Evidence from china. *Wetlands*, *42*(2), 19.

Jafari, R., Bashari, H., & Tarkesh, M. (2017). Discriminating and monitoring rangeland condition classes with modis ndvi and evi indices in iranian arid and semi-arid lands. *Arid Land Research and Management*, *31*(1), 94–110. https://doi.org/10.1080/15324982.2016.1224955

Jaganyi, D., Njunwa, K., Nzayirambaho, M., Rutayisire, P. C., Manirakiza, V., Nsabimana, A., & Nduwayezu, G. (2018). Rwanda: National urban policies and city profiles for kigali and huye. *79. glasgow: The GCRF centre for sustainable, healthy and learning cities and neighbourhoods (SHLC)*.

Kansal, D., & Kumar, S. (2024). Multi-criteria decision-making based on intuitionistic fuzzy exponential knowledge and similarity measures, as well as an improved vikor method. *Granular Computing*, *9*(2), 26–48.

Khosravi Mashizi, A., & Sharafatmandrad, M. (2023). Cultural services in arid landscapes: A comparative study based on people's perception, southeast of iran. *Arid Land Research and Management*, *37*(4), 619–636.

Lin, J., Chiou, C., Chan, W., & Wu, M. (2021). Public perception of forest ecosystem services in taiwan. *Journal of Forest Research*, *26*(5), 344–350.

Liu, J., Mooney, H., Hull, V., Davis, S., Gaskell, J., Hertel, T., Lubchenco, J., Seto, K., Gleick, P., Kremen, C., & Li, S. (2015). Systems integration for global sustainability. *Science*, *347*, 1258832–1258832.

https://doi.org/10.57647/jrs-2026-1601.04

Lloyd-Smith, P., Abbott, J., Adamowicz, W., & Willard, D. (2019). Decoupling the value of leisure time from labor market returns in travel cost models. *Journal of the Association of Environmental and Resource Economists*, *6*(2), 215–242. https://doi.org/10.1086/701760

Mace, G., Norris, K., & Fitter, A. (2012). Biodiversity and ecosystem services: A multilayered relationship. *Trends in Ecology & Evolution*, *27*(1), 19–26.

Mahmudah, R. S., Putri, D. I., Abdullah, A. G., Shafii, M. A., Hakim, D. L., & Setiadipura, T. (2024). Developing a multi-criteria decision-making model for nuclear power plant location selection using fuzzy analytic hierarchy process and fuzzy vikor methods focused on socio-economic factors. *Cleaner Engineering and Technology*, *19*, 100737.

Maleknia, R. (2024). Psychological determinants of citizens' willingness to pay for ecosystem services in urban forests. *Global Ecology and Conservation*, *54*, e03052.

Maleknia, R. (2025). Urban forests and public health: Analyzing the role of citizen perceptions in their conservation intentions. *City and Environment Interactions*, 100189.

Maleknia, R., & Enescu, R. (2025). Does climate change stimulate citizens' responses to conserving urban forest? insights from stimulus-organism-response theory. *Ecological Modelling*, *501*, 111000.

Martín-López, B., Iniesta-Arandia, I., García-Llorente, M., Palomo, I., Casado-Arzuaga, I., Amo, D. G. D., Gómez-Baggethun, E., Oteros-Rozas, E., Palacios-Agundez, I., Willaarts, B., et al. (2012). Uncovering ecosystem service bundles through social preferences. *PLoS one*, *7*(6), e38970.

Millennium ecosystem assessment, M. (2005). *Ecosystems and human well-being* (Vol. 5). Island press Washington, DC.

Montgomery, D. C. (2017). *Design and analysis of experiments*. John wiley & sons.

Nabaloum, A., Goetze, D., Ouédraogo, A., Porembski, S., & Thiombiano, A. (2022). Local perception of ecosystem services and their conservation in sudanian savannas of burkina faso (west africa). *Journal of Ethnobiology and Ethnomedicine*, *18*(1), 1–25.

Newcomer-Johnson, T., Andrews, F., Corona, J., DeWitt, T., Harwell, M., Rhodes, C., Ringold, P., Russell, M., Sinha, P., & Van Houtven, G. (2020). *National ecosystem services classification system (nescs plus)* (tech. rep. No. EPA/600/R-20/267). U.S. Environmental Protection Agency. Washington, DC.

Opricovic, M. Vikor method with application to borrowing terms selection. In: In *Multiple criteria decision making in finance, insurance and investment*. 2015, pp. 205–227.

Pretty, J., & Bharucha, Z. (2014). Sustainable intensification in agricultural systems. *Annals of Botany*, *114*(8), 1571–1596.

Purwestri, R., Palátová, P., Hájek, M., Dudík, R., Jarský, V., & Riedl, M. (2023). Public perception of the performance of czech forest ecosystem services. *Environmental Sciences Europe*, *35*(1), 89.

Quintas-Soriano, C., Brandt, J., Running, K., Baxter, C., Gibson, D., Narducci, J., & Castro, A. (2018). Social-ecological systems influence ecosystem service perception. *Ecology and Society*, *23*(3).

Scholte, S., Van Teeffelen, A., & Verburg, P. (2015). Integrating socio-cultural perspectives into ecosystem service valuation: A review of concepts and methods. *Ecological Economics*, *114*, 67–78. https://doi.org/10.1016/j.ecolecon.2015.03.007

Sharafatmandrad, M., & Khosravi Mashizi, A. (2021). Linking ecosystem services to social well-being: An approach to assess land degradation. *Frontiers in Ecology and Evolution*, *9*, 654560.

Targetti, S., Raggi, M., & Viaggi, D. (2020). Benefits for the local society attached to rural landscape: An analysis of residents' perception of ecosystem services. *Bio-based and Applied Economics*, *9*(2), 155–170.

Wang, S., Fu, B., Zhao, W., Liu, Y., & Wei, F. (2018). Structure, function, and dynamic mechanisms of coupled human–natural systems. *Current Opinion in Environmental Sustainability*, *33*, 87–91. https://doi.org/10.1016/j.cosust.2018.05.002

Wunder, S., Angelsen, A., & Belcher, B. (2014). Forests, livelihoods, and conservation: Broadening the empirical base. *World Development*, *64*, 1–11.

Yazo-Cabuya, E. J., Ibeas, A., & Herrera-Cuartas, J. A. (2024). Integration of sustainability in risk management and operational excellence through the vikor method considering comparisons between multi-criteria decision-making methods. *Sustainability*, *16*(11), 4585.

Zhu, J., Yuan, X., Yuan, X., Liu, S., Guan, B., Sun, J., & Chen, H. (2021). Evaluating the sustainability of rural complex ecosystems during the development of traditional farming villages into tourism destinations: A diachronic emergy approach. *Journal of Rural Studies*, *86*, 473–484.