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Exploring main drivers of ecological culture of stakeholders in semiarid ecosystems

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Abstract

Stakeholders' "hotspots" for conservation are critical for preserving remaining arid ecosystems and counteracting the projected trend of habitat loss. However, in the management of arid environments, the role of stakeholder culture in ecosystem conservation has received limited attention. This study aimed to assess ecological culture and its primary drivers within the context of dryland ecosystem conservation. We mapped ecological culture across the study region using cultural indicators and collected data through questionnaires. Results indicated that forests were among the most significant land-cover types in terms of ecological culture ($p < 0.05$). Principal component analysis (PCA) was used to identify the most influential drivers, and structural equation modeling (SEM) was subsequently applied to determine each driver's contribution to ecological culture. The findings revealed that, overall, urbanization exerted a negative direct and indirect effect ($p < 0.001$), and agriculture also had a negative effect ($p < 0.01$), while climate ($p < 0.01$), topography ($p < 0.01$), and income ($p < 0.01$) positively influenced ecological culture. These results can assist policymakers in identifying social hotspots where community-led landscape conservation may be feasible, particularly through the targeted management of key drivers.

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Introduction

The equilibrium between people and the natural world constitutes the foundation of sustainable development for both human societies and ecosystems (Houng and Houng, 2018). Numerous ancient civilizations and governing bodies encountered failures in ecosystem management due to their inability to establish a harmonious balance between anthropogenic activities and nature (Degroot et al., 2021). The interplay between social systems and ecosystems has emerged as a central concern in ecology and sustainability science in recent years (Steffen et al., 2020). Social responsibility toward natural ecosystems represents a relatively novel approach proposed to enhance ecosystem health (Liu et al., 2022). Environmental dilemmas invariably manifest as social challenges; should individuals and societies amend their current detrimental practices, the resolution of environmental issues becomes plausible (Kinzig et al., 2013). People conserve nature in accordance with the values they attribute to the environment. These values shape intrinsic motivations, which are themselves influenced by societal culture (Lillehammer, 2017). Ecological culture is conceptualized as an expression of material and spiritual values arising from human creativity, reflecting a state of harmony with nature (Houng & Houng, 2018).

Culture is further understood as the quintessence of human intellect, forged through arduous endeavors against the formidable forces of time and nature—a testament to humanity's resilience in overcoming challenges to achieve salvation and contentment (Sayago, 2023). According to Salehi (2022), among the components of ecological culture, awareness of the severity of risk had the greatest impact on the protective capacity of rural communities. Structural modeling has also confirmed the influence of ecological culture on environmental protection capacity at the village level. Goolmeer and Costello (2024) demonstrated that Indigenous peoples worldwide are actively seeking to better understand plants and animals of high cultural significance. Participatory management by cultural institutions plays an important role in biodiversity conservation, as well as in the health and well-being of Indigenous communities. Sima et al. (2024) examined the socio-cultural values of coastal ecosystems from tourists' perspectives, finding that visitors exhibited strong emotional attachment to coastal areas and concern for their preservation. Tourists proposed various management options to better protect coastal zones and promote sustainable tourism without compromising the uniqueness of these spaces.

Local knowledge and experiential wisdom are crucial for comprehending the intrinsic value of landscapes; neglecting to integrate local and Indigenous knowledge in landscape-related decision-making results in the erosion of the social, existential, and cultural significance of these landscapes (Chebus, 2018). The socio-cultural context, age, and the nature of local communities' interactions with surrounding natural resources significantly influence the accumulation of Indigenous knowledge (Alsaleh, 2024). Despite its critical importance in ecological conservation, as well as in the provision of food, medicine, and other resources, Indigenous knowledge is rarely acknowledged in ecosystem management efforts (Singh, 2007). Conservation policies and technologies are often devised without recognizing Indigenous knowledge or involving local populations and their traditional institutions (Tran et al., 2020). Consequently, management strategies seldom play a pivotal role in safeguarding and fostering local knowledge for ecosystem conservation—particularly among younger generations—or in enhancing local livelihoods (Li et al., 2024b).

Studies investigating the motivation of Indigenous peoples to protect ecosystems in Iran remain very limited. Given the urgent and ongoing need for biodiversity conservation and the recognition of local roles in ecosystem stewardship, this study aims to delineate the spatial distribution of stakeholders' ecological culture and to identify its principal drivers.

Materials and Methods

Study area

The study area is Jiroft basin located in Kerman Province in southeastern Iran (56˚ 50′ to 58˚ 20′ E and 28˚ 10′ to 29˚ 15′ N). The area of this region is about 864,428 ha and includes diverse landscapes from mountains in the north to flat plains in the south. The region receives an average annual rainfall of 290 mm, most of which falls in winter. The study region is situated at the convergence of the Irano- Turanian and Indus- Saharan phytocoria, resulting in a rich flora composed of multiple plant communities and diverse vegetation types. The dominant land covers include rangelands, forests, and agricultural lands (Figure 1). The Jiroft basin boasts a long and significant cultural history. Archaeologically, the so- called "Jiroft civilization" or "Halilrud civilization" refers to a complex cultural entity that flourished during the third millennium BCE in the southern part of Kerman province (Madjidzadeh & Pittman, 2008; Eskandari et al., 2019).

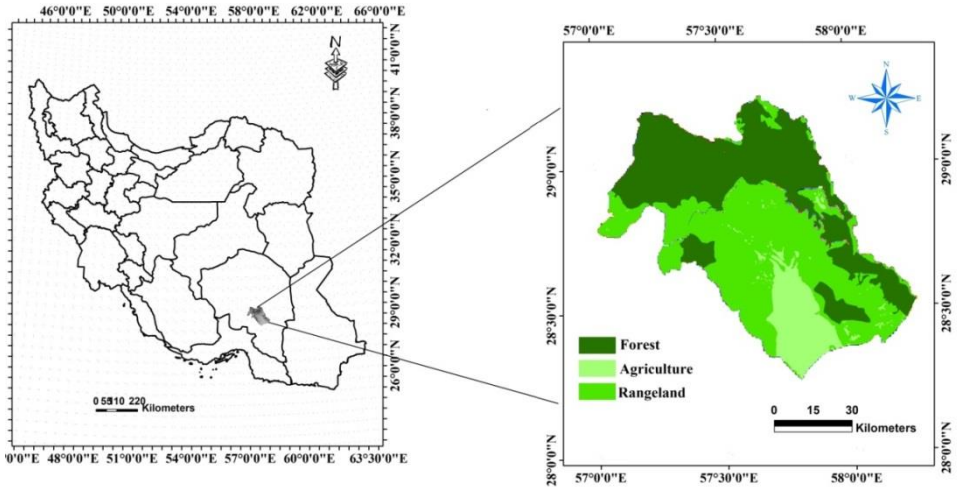

Figure 1. Map of land covers of the study region

Data Collection

Ecological culture

Local stakeholders in the Jiroft Basin settlements made up our research population. Based on Cochran's method (1997), a sample size of 185 individuals was selected from 15 villages using non-proportional quota sampling (Tashakkori and Teddlie, 2003). A conventional questionnaire and in-person interviews were used to gather data. To make sure that respondents' views of the questions were the same, the reliability of the questionnaire was assessed using the Cronbach's alpha coefficient. There were two primary sections of the questionnaire. Questions about the respondents' age, gender, experience of exploitation, and educational attainment were included in the first section. Questions about ecological cultural variables were added in the second section. A five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), was used to evaluate each variable in the second section. Abedi-Sarvestani and Shahvali (2008), Karimi and Amir Saghaleini (2021), Hossain and Lamb (2020), Huong and Huong (2018), and other prior research were consulted while determining the indicators for each criterion (Table 1). Ecological culture was measured as the average of standardized indicators (ranging from 0 to 1). Using ArcGIS (Hernandez-Stefanoni and Ponce-Hernandez, 2006) and GS+ (Gamma design software Version 5.1.1, 2001), the spatial distribution of ecological culture in the basin was mapped using ordinary kriging interpolation.

Table 1. Indicators of ecological culture

Indicators	References
Waste from households is not discharged into the environment.	(Barr, 2003)
Save maximum resources in building and use energy source in nature	(Huong and Huong, 2018)
Put more effort on sustainable environment demand in the future	(Huong and Huong, 2018)
People are responsible only toward some live beings.	(Abedi-Sarvestani and Shahvali, 2008)
There are sufficient resources and time to conserve ecosystems.	(Karimi and Amir Saghaleini, 2021)
People are responsible toward s what God has created.	(Abedi-Sarvestani and Shahvali, 2008)

Data Analysis

Kolmogorov–Smirnov normality test was used to check data for normal distribution. Principal Component Analysis (PCA) was used to reveal the most important drivers of ecological culture. The most important variables can be selected based on the significant loading factors of each PC axis (Curz-Cardenas ´ et al., 2014).The Structural Equation Model (SEM) was utilized to evaluate both the direct and indirect determinants influencing habitat quality and ecological culture. SEM represents a statistical approach that integrates regression analysis with confirmatory factor analysis and has progressively become a favored method for elucidating the intricate relationships among components of ecosystems (Awang et al., 2015). Composite reliability (CR) and average variance extracted (AVE) were employed to assess the reliability and validity of the SEM, utilizing SmartPLS v2 (Bido et al., 2014). Furthermore, Analysis of Variance (ANOVA) and the Least Significant Difference (LSD) tests were applied to compare land cover characteristics in relation to ecological culture.

Results

Of the total respondents, 55% were male and 59% were adults. Regarding socioeconomic characteristics, 29% had low incomes, 65% had resided in the area for more than ten years, 15% reported low-income dependence on ecosystems, and 51% exhibited moderate levels of social activity (Table 2). The ecological culture index in the Jiroft basin ranged from a minimum of 0.13 to a maximum of 0.83. Least Significant Difference (LSD) analysis revealed that forests exhibited the highest ecological culture value, with a mean of 0.516 ± 0.125, followed by rangelands (0.439 ± 0.113), while agricultural lands recorded the lowest value (0.324 ± 0.107) (Table 3). Finally, significant drivers of ecological culture were identified using principal component analysis (PCA) (Table 4).

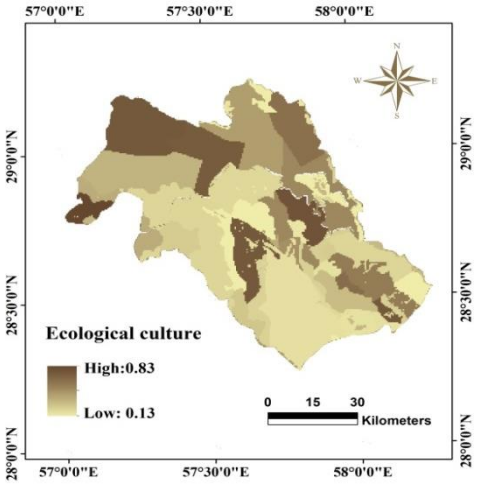

Figure 2. Map of ecological culture in the study area

Table 2. Socio-economic characteristics of respondents

Characteristics		Frequency	Percent
Gender	Female	83	45
	Male	102	55
Age (year)	Young	76	41
	Adult	109	59
Education	Less than high school	43	23
	High school	49	27
	Bachelor	56	30
	Master or doctorate	37	20
Annual income	Low	53	29
	Middle	87	47
	High	45	24
Land tenure	Private	79	43
	Public	106	57
Duration of residence (year)	<1	23	12
	1-10	43	23
	10-30	84	45
	30<	35	20
Income dependency on ecosystems	Low	27	15
	Middle	75	40
	High	83	45
Social activity	Low	42	23
	Middle	96	51
	High	47	26

Table 3. Analysis of Variance results and Least Significant Difference test results among land covers in terms of ecological culture

Land covers	**Cultural diversity**	
	Average	**SD**
Rangeland	0.439b	0.113
Forest	0.516c	0.125
Agriculture	0.324a	0.107
F	5.12**	

Table 4. The contribution of ecological culture's drivers using the first two axes of PCA

Variable	**PCA1**	**PCA2**
Age	0.123	0.052
Agriculture	0.215*	-0.123
Climate	-0.352**	-0.162
Duration of residence	0.132	0.211*
Education	0.261	0.128
Gender	0.135	0.281*
Grazing	0.052	-0.265*
Health	-0.144	0.032
Immigration	0.132	-0.035
Income	-0.038	0.356**
Income dependency to ecosystems	0.156	0.112
Land covers	0.274*	0.112
Landscape	-0.025	0.135
Language	0.218*	-0.145
Land tenure	0.205*	0.025
Occupation	0.103	-0.215*
Ownership	-0.112	0.169
Population	0.137	0.033
Migration	-0.023	-0.237*
Social network	0.018	0.163
Topography	0.265*	-0.041
Urbanization	-0.368**	0.155

Table 5. Composite reliability (CR) and convergent validity (AVE) of impacts of ecological and social characters on ecological culture (AVE >0.5, CR>0.7)

Criteria	Ecological culture	
	AVE	**CR**
Climate	0.745	0.827
Land cover	0.718	0.835
Agriculture	0.792	0.837
Language	0.825	0.844
Land tenure	0.784	0.912
Topography	0.738	0.927
Urbanization	0.685	0.927
Grazing	0.812	0.933
Gender	0.745	0.957
Income	0.812	0.957
Education	0.892	0.958
Duration of residence	0.782	0.961
Ecological culture	0.827	0.967
Migration	0.628	0.974
Occupation	0.795	0.987

For the reliability and validity of the SEM model, two CR and AVE indices were used (Table 5). For both habitat quality and ecological culture models, all model variables had AVE greater than 0.5 and CR greater than 0.7. Also, the CR value was higher than the AVE value, which indicates the validity of the two models of habitat quality and ecological culture. Figure 6 shows the direct and indirect relationships of ecological and social variables on ecological culture, which in total, the direct and indirect relationships of urbanization ($p<0.001$) and agriculture ($p<0.01$) negatively and climate ($p<0.01$), topography ($p<0.01$) and income ($p<0.01$) positively affected ecological culture (Figure 3).

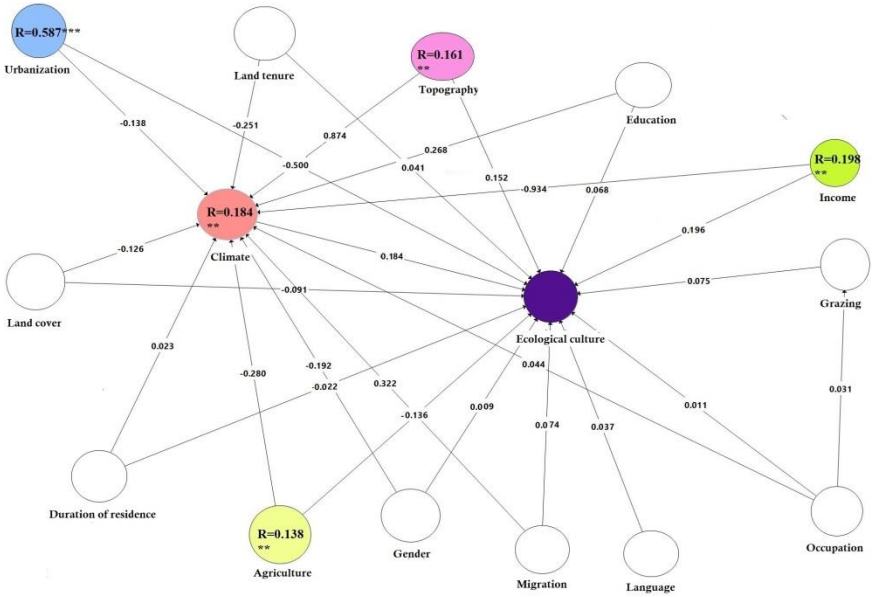

Figure 3. Structural equation modeling (SEM) examining impacts of ecological and social characters on ecological culture

Discussion

Mapping Ecological Culture

The distribution of ecological culture was not uniform across the study area. The highest values were concentrated in the northern and western parts of the Jiroft basin. Consistent with previous research, culture is rarely evenly distributed; for instance, the distribution of cultural heritage in southwest China was most strongly influenced by

natural factors such as the percentage of mountainous terrain, river density, and average annual sunshine, as well as human factors including urbanization rates (Li et al., 2024a). In our region, 15% of the area exhibited high ecological culture, primarily located in highlands and forests—areas of significant social importance, as ecological culture can enhance the resilience of social systems (Harmon, 2002). Preserving ecological culture and indigenous knowledge will, in the future, strengthen the capacity of social systems to adapt to environmental and management changes (Ingelbrecht, 2024). Conversely, 50% of the area displayed low ecological culture, indicating a clear need for targeted promotion and intervention.

The context in which cultural traits emerge significantly influences their development. Climate is one such factor, as environmental conditions affect population dynamics, migration patterns, and cultural transmission (Hsiang et al., 2013). Additionally, 41% of the study area suffers from poor habitat quality. Overall, our findings suggest that ecological culture loss is more vulnerable to threats than is habitat quality. According to Oliveira et al. (2019), ecological culture is dynamic and subject to change. Contemporary cultural sociology views culture as an ongoing, evolving process rather than a static entity. To preserve and enhance the distinctiveness and sustainability of ecosystem use, future management strategies must give greater consideration to the utilization of cultural resources (Ingelbrecht, 2024).

Maintaining ecological culture requires the adaptive improvement of human systems in response to environmental changes. Integrated social–environmental management is essential for enhancing cultural development plans and initiatives in rural areas. New approaches to cultural planning demand a fresh perspective on rural social challenges, including combating social injustice, preventing habitat degradation, fostering local identity, promoting traditional culture, empowering villagers through active participation, ensuring democratic support for cultural policies, and deepening public understanding of cultural issues.

Threats to Ecological Culture

Our findings elucidate the detrimental effects of urbanization on ecological culture. Numerous studies have demonstrated that urbanization negatively affects Indigenous epistemologies and cultural aspects (Gaoue et al., 2017; Ferreira-Júnior et al., 2016; Rangel et al., 2024). In contrast, our results showed that economic status was a favorable factor influencing ecological culture. Rural populations, which are more dependent on habitat quality for food security and income generation (Cordero et al., 2020), tend to maintain substantial ecological knowledge and possess a deeper understanding of their surroundings. Rural residents associate higher habitat quality with better quality of life (Rangel et al., 2024); consequently, these areas exhibited the strongest ecological awareness and cultural ties.

In urban settings, people are more likely to interact with gardens and green spaces (Peroni et al., 2016; Ávila et al., 2017), yet prior studies have shown that city dwellers—particularly younger populations—have less engagement with nature (da Cunha Ávila et al., 2015; Arjona-García et al., 2021; Sousa et al., 2022). By eliminating ecosystem-based livelihoods and the Indigenous knowledge that underpins them, urbanization—through the commercialization of resources and diversification of livelihoods—poses a significant threat to ecological culture (Fu et al., 2023). These changes may be driven by the adoption of new commercial resources or the aspiration toward consumer lifestyles (Wang & Zhang, 2024). Therefore, urbanization policies that hinder cultural integration should be avoided (Shao et al., 2024). Instead, government policy frameworks and incentives can play a crucial role by promoting the incorporation of cultural elements into urban development (Wang & Zhang, 2024). This may include funding for research into sustainable practices that respect cultural traditions, regulations protecting historic sites, and financial incentives for developers who integrate traditional design elements into their projects.

Conclusions

One of the fundamental challenges facing sustainable landscape conservation is the trade- off between multiple ecological and socio- economic factors. Urbanization, as a particularly detrimental human activity, posed the greatest threat to the conservation goal of preserving human–nature interactions. Given that cities in developing nations are expected to continue expanding, new socio- economic circumstances must be carefully considered in accordance with the needs of local populations. Landscape conservation programs should therefore incorporate a nuanced adjustment of cultural values in relation to habitat quality, adapting them to emerging socio- economic realities. It is essential that local communities, managers, and conservationists be made aware of the linkages between natural environment loss and cultural practices, as well as of the potential for innovative conservation approaches to integrate people's cultural identities. The findings of this study can assist policymakers in identifying social hotspots where community- led landscape conservation may be feasible, particularly through the targeted management of key drivers.

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