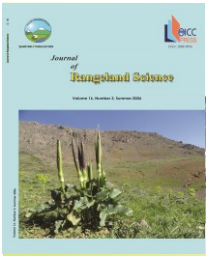

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Research Article

Prerequisites and Indicators for Sustainable Rangeland Management: A Governance Perspective from Ajisoo Watershed, Golestan Province, Iran

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Abstract

Sustainable rangeland management relies on governance systems that balance environmental conservation, economic resilience, and social equity. This study aimed to identify and evaluate the prerequisites (enabling conditions necessary for effective governance) and indicators (measurable attributes assessing governance performance) for sustainable rangeland management in the Ajisoo Watershed, Golestan Province, Iran. The watershed represents a typical region facing challenges such as overgrazing, climate variability, and socio-economic constraints. Data were collected from rangeland beneficiaries and stakeholders through a structured governance assessment and analyzed using descriptive statistics, Pearson correlation, and Structural Equation Modeling (SEM). The correlation results revealed significant associations between user characteristics and perceptions of governance indicators, particularly with age (r=0.40**), education level (r=−0.45**), and livestock number (r=0.22*). Path analysis results confirmed that all nine governance criteria had positive and significant effects on the feasibility of implementing good governance. The strongest standardized path coefficients were observed for Responsibility (β=0.48, p<0.001), Efficiency and Effectiveness (β=0.41, p<0.01), Law-centeredness (β=0.33, p<0.01), and Vision and Planning (β=0.35, p<0.01). Descriptive analysis further showed that participatory and law-centered criteria were ranked highest in importance (mean scores = 3.72 and 3.68, respectively). These findings highlight stakeholder trust, institutional capacity, and legal frameworks as essential governance prerequisites. The proposed framework integrates these elements into rangeland planning to enhance ecological outcomes, diversify local livelihoods, and promote inclusive decision-making. The policy recommendations emphasize embedding responsibility into management plans through clearly defined roles, performance monitoring, and stakeholder-led oversight, offering evidence-based strategies for sustaining rangeland ecosystems in Iran and other semi-arid regions.

Keywords: Livestock grazing, Governance, Environmental Policy, Stakeholder Participation

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1. Introduction

Effective management of natural resources is essential for ensuring human well-being and ecological sustainability. Developing nations face growing challenges in this regard, such as rapid population growth, urban expansion, and insufficient oversight of natural resources, which often leads to environmental degradation (Gedefaw et al., 2021; Kolahi et al., 2024a,b). Among these vital

resources, rangelands hold particular importance due to their role in maintaining ecological balance, biodiversity, and economic development (Mousavi et al., 2020; Kahrobaei et al., 2022).

Iran's rangelands, which cover approximately 51% of the country's land area, are valuable for their contributions to livestock farming, medicinal plant extraction, and economic development (Bagheri et al., 2021). However, these rangelands have suffered from severe degradation due to factors such as overgrazing, deforestation, and the impacts of climate change (Godde et al., 2020; Karimi and Saghalaini, 2021; Mohammadabadi and Kolahi, 2022). While traditional community management methods historically supported sustainable use of these lands, recent shifts toward governmental control have created management challenges (Khashtabeh et al., 2021; Kolahi et al., 2023; Heirany and Kolahi, 2023). Addressing these issues requires a deep understanding of the prerequisites and indicators that contribute to sustainable rangeland management. Good governance is increasingly recognized as essential in this context. Governance, which encompasses more than just government actions, involves collective decision-making and participatory approaches that engage various stakeholders from the public, private, and civil sectors (Sajasi Ghidari and Hajian, 2018; Paieste et al., 2022; Gholamhosein Ghoochani et al., 2023; Kolahi et al., 2024c). Transparency, accountability, and community involvement are vital indicators of governance that can support the long-term sustainability of rangelands (Herrera and Davies, 2014; Payeste et al., 2020). In this study, we distinguish between prerequisites—the foundational conditions that enable effective governance (e.g., legal frameworks, stakeholder capacity, and trust)—and indicators—the measurable attributes used to assess governance performance (e.g., responsiveness, accountability, collaboration). While closely related, prerequisites provide the enabling environment, whereas indicators reflect observable outcomes of governance in practice.

In this study, we distinguished between prerequisites (the foundational conditions that enable effective governance, such as legal frameworks, stakeholder capacity, and trust) and indicators (the measurable attributes that assess governance performance, including responsibility, responsiveness, accountability, efficiency, and collaboration). While closely related, prerequisites provide the enabling environment for governance effectiveness, whereas indicators reflect the observable outcomes of governance in practice.

This research aimed to identify the prerequisites and key indicators required for sustainable rangeland management, with a particular focus on governance-related factors. Good governance practices can help mitigate the environmental pressures facing rangelands by ensuring active stakeholder participation in decision-making, adherence to legal frameworks, and a balanced consideration of economic opportunities alongside ecological needs. Furthermore, recognizing the importance of participatory planning, transparency, and cross-sectoral coordination contributes to building a resilient system that supports both biodiversity and local livelihoods.

2. Materials and methods

2.1. Study area

The research was conducted in the Ajisoo watershed, a sub-basin of the Atrak River covering approximately 19,131 ha in northeastern Golestan Province, Iran. Located within the Koppedagh structural zone and bordering Turkmenistan to the north, the area is enclosed by the Koppedagh mountain range to the east and south (Fig 1). It spans coordinates of 36°10’31”–36°21’56” N and 37°56’23”–38°07’38” E, with elevations ranging from 113 m to 1,328 m above sea level. The watershed exhibits an average slope of 14.0% and features a varied climate—spanning semi-arid, semi-humid cold and semi-humid zones—which mirrors the climate variability faced by much of Iran’s rangelands.

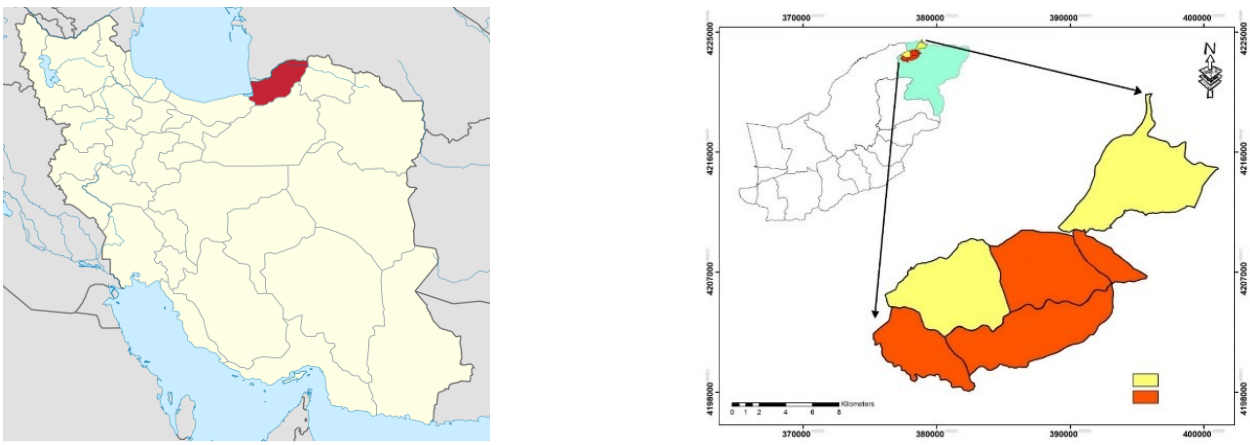

Figure 1. The spatial distribution of the surveyed landmarks in Golestan Province, Iran

These characteristics, such as topographic and climatic variety, rangeland conditions ranging from weak to moderate, and primary use for livestock grazing (sheep, goats, cattle), make Ajisoo a representative example of the environmental and management challenges faced in Iran's rangelands. The area also reflects socio-economic realities by supporting dispersed rural communities dealing with common issues like youth out-migration caused by limited education and job opportunities. This complex interaction of environmental factors (such as varying slopes, climate diversity, and fragile rangeland conditions) and socio-economic vulnerabilities made the Ajisoo watershed a small-scale reflection of broader rangeland management issues in Iran, especially regarding sustainable use, conservation, and the resilience of local livelihoods.

2.2. Research methodology

This study adopts a descriptive-analytical approach to evaluate the prerequisites and indicators for sustainable rangeland management from a governance perspective. A combination of documentary and survey-based methods was employed, involving both qualitative and quantitative data collection techniques. The statistical population consists of 304 rural and nomadic beneficiaries from six customary systems within the northern rangelands of Golestan province. Using stratified random sampling, a sample size of 172 respondents was determined, following the Yamane formula (1973). The data collection tool was a structured questionnaire designed in line with research objectives and hypotheses, covering two main sections: demographic characteristics (Table 1) and good governance indicators (Table 2). The Delphi method was employed to refine governance criteria and indicators, engaging a group of experts and beneficiaries to validate these measures through a series of consultations and interviews.

2.3. Questionnaire validity and reliability

The reliability and validity of the research instrument were rigorously tested. Content validity was ensured through feedback from rangeland management experts. Reliability was assessed using Cronbach's alpha, yielding satisfactory results (Table 2). Structural equation modeling (SEM) through Smart PLS3 software was applied to analyze the relationship between governance indicators and their perceived feasibility.

2.4. Statistical Analysis Methods

Descriptive and inferential statistical methods, including frequency distribution, Pearson correlation, and independent samples t-tests, were used to examine the data. The Interval of Standard Deviation from the Mean (ISDM) categorized governance indicators, while SEM assessed the influence of governance indicators on feasibility. The study achieved strong model fit based on Goodness of Fit (GOF) criteria, with a calculated GOF value of 0.439, indicating robust model validity.

In assessing discriminant validity using the Fornell and Larcker (1981) criterion, Table 3 presents the correlation matrix among latent constructs. Discriminant validity was considered adequate when the square root of the Average Variance Extracted (AVE) for each construct exceeded its highest correlation with other constructs. This criterion confirms that each latent variable shares more variance with its indicators than with other variables (Lin and Lee, 2017).

3. Result

3.1. Descriptive statistics

The descriptive statistics provide a comprehensive overview of the socioeconomic and managerial characteristics of rangeland beneficiaries as follows:

- In terms of grazing system status, 42.4% of the participants were rural beneficiaries, while 57.6% were nomadic beneficiaries.
- Regarding rangeland management, 75% of respondents reported possessing a management plan, including approximately 80% of rural and 77% of nomadic households.
- Demographically, 81.4% of respondents were married, with marital rates exceeding 90% among nomadic beneficiaries compared to 67% among rural beneficiaries.
- The average age of participants was 51.68 years, with most falling within the 41–50 years old.
- The mean household size was about seven people.
- Employment data revealed that 42.4% were primarily engaged in animal husbandry, and livestock ownership averaged around 194 head per household. Beneficiaries also reported extensive experience in animal husbandry, averaging approximately 30 years, although 9.52% were engaged in non-livestock-related occupations. More than 50% of the respondents owned agricultural land.
- The annual net income from animal husbandry ranges between 500 and 700 US$.
- Educationally, most participants had elementary to intermediate literacy levels.
- Regarding institutional engagement, 74.4% were members of rural organizations or pastoral cooperatives, and more than 50% had participated in training and promotional courses on rangeland management.

Access to financial resources was varied, with 64.5% not receiving credit or loan services, while 35.5% benefited from bank facilities, with pastoralists generally accessing more financial services compared to rural farmers.

Table 1. Indicators for Assessing Demographic Characteristics

Indicator	Spectrum of Assessment	Scale
System of exploitation	Rural (1), Nomadic (2)	Nominal
Marital Status	Married (1), Single (2)	Nominal
Employment other than animal husbandry	Yes (1), No (0)	Nominal
Ownership of agricultural land	Yes (1), No (0)	Nominal
Participation in training and extension courses	Yes (1), No (0)	Nominal
Membership in pastoral cooperatives and rural and nomadic organizations	Yes (1), No (0)	Nominal
Receiving loans and banking facilities	Yes (1), No (0)	Nominal
Ownership of rangeland projects	Yes (1), No (0)	Nominal
Household size	-	Interval
Number of people employed in animal husbandry	-	Interval
Number of livestock	-	Interval
Age	-	Ratio
Livestock farming experience	-	Relative
Literacy level	Illiterate (0), Primary (1), Secondary (2), Diploma and higher education (4)	Ordinal
Annual income from animal husbandry	Less than 300 US$(1) 300 to 500 US$ (2) 500 to 700 US$ (3) 700 to 900 US$ (4) more than 900 US$ (5)	Ordinal

Table 2. Operational Definitions and Measurement Scales of 74 Good Rangeland Governance Indicators

Criteria	Indicator	Cronbach alpha	Scale
Participatory	1. Importance given to the programs and opinions of pastoralists by managers. 2. Creating a spirit and motivation for participation of pastoralists in rangeland restoration and improvement activities 3. Managers' willingness to cooperate with pastoralists in implementing rangeland projects 4. Attention to the opinions of local leaders and influential figures in rangeland programs 5. Establishment and strengthening of grassroots organizations and natural resource NGOs 6. Development and improvement of cooperative activities of pastoral cooperatives 7. Active participation in workshops and training classes related to livestock and rangeland 8. Participation in cooperative rangeland management decision-making meetings.	0.877	Ordinal
Consensus-based agreement	1. Group decisions related to the timing of livestock entry and exit in rangelands 2. Collective agreement on decisions made in cooperative meetings 3. Collective agreement on communal grazing by pastoralists 4. Dissemination of important topics by cooperatives and local opinion leaders 5. Pastoralists' belief in and commitment to collective action 6. Harmony and cooperation of officials with pastoralists in decision-making and implementation of projects 7. Holding meetings and group sessions among pastoralists to reduce violations and conflicts 8. Election of cooperative boards by the collective decision of pastoralists 9. Collective agreement of pastoralists on the location of water storage and its distribution 10. Protection and maintenance of rangelands by pastoralists in collaboration with each other.	0.901	Ordinal
Responsibility	1. Regular participation in cooperative rangeland management meetings 2. Continuous participation in organizing classes and training courses 3. Willingness to contribute to the customary organization of rangelands 4. Positive attitude towards conservation and proper utilization of rangelands 5. Willingness to participate in restoration and improvement operations and enhance rangeland vegetation cover 6. Timely provision of water tanks and watering troughs to address water scarcity 7. Timely renewal of grazing permits in rangelands 8. Prevention of surplus livestock entry into rangelands 9. Timely exit of livestock from rangelands 10. Informing executive officials about land use changes in rangelands 11. Distributing and dispersing livestock across the rangeland surface to prevent rangeland degradation.	0.908	Ordinal

Continue of **Table 2.**

Criteria	Indicator	Cronbach alpha	Scale
Law-centered	1. Close monitoring by project supervisors 2. Observance of the timing of livestock entry and exit based on the dates specified in the grazing permits 3. Observance of livestock capacity based on the number specified in the grazing permits 4. No change in residence and tent pitching location in rangelands 5. Implementation of restoration and improvement activities according to rangeland project resolutions 6. Grazing of livestock within the specified grazing boundary and not crossing it 7. Timely payment of forage fees 8. Non-conversion of rangeland to other land uses 9. Non-entry of non-native livestock into various forms 10. Non-transfer of rangeland to non-family members 11. No fencing in rangelands to determine grazing boundaries.	0.851	Ordinal
Justice and equality	1. Non-granting of privileges in rangelands by government officials 2. Equality in providing services to all pastoralists (treating all pastoralists equally under the law) 3. Equal participation of all members in decision-making meetings and training classes 4. Fairness of the type of rangeland and grazing hours for all pastoralists within a customary system 5. Providing opportunities for women's involvement in various activities and their entry into rangeland management affairs 6. Fair allocation of resources among pastoralists.	0.819	Ordinal
Accountability	1. Managers' accountability for their performance 2. Pastoralists' accountability to executive programs in rangelands 3. Resolving social disputes and challenges in rangelands with the presence of executive agencies (accountability to pastoralists' complaints) 4. Pastoralists' easy access to cooperative managers and project supervisors 5. Pastoralists' timely referral to natural resource authorities for grazing permit renewal 6. Informing pastoralists on time about the dates of livestock entry and exit in rangelands 7. Informing and communicating decisions made in rangelands to pastoralists in person and virtually.	0.85	Ordinal
Transparency	1. Transparent disclosure of issues related to decisions made in rangelands in various areas 2. Honesty in the words and actions of managers with pastoralists 3. Transparency in the process of pastoralists' participation in decision-making 4. Transparency in implementing resolutions approved in rangeland projects 5. Transparent utilization of natural resources in budget and credit management 7. Transparency in natural resource laws and their strict enforcement in rangelands.	0.86	Ordinal
Efficiency and Effectiveness	1. The impact of building drinking water collection channels for livestock 2. The impact of restoration and improvement operations in strengthening vegetation cover 3. Optimal water consumption due to the construction of water tanks and covered watering troughs 4. Adequate water supply and timely meeting of livestock water needs 5. Increased ability of pastoralists to store and conserve water resources 6. Increased forage fee for rangeland vegetation improvement operations 7. Empowerment of pastoralists in resolving disputes and incompatibilities in rangelands 8. Availability of agricultural tools and machinery for restoration and improvement activities in rangelands 9. Effectiveness of training and workshops held to improve rangeland management success.	0.882	Ordinal
Vision and Planning	1. Planning for sustainable rangeland management 2. Planning for rangeland restoration and improvement with various methods 3. Planning for balanced livestock and rangeland 4. Planning to reduce pastoralists' dependence on rangelands by creating alternative livelihoods 5. Planning for multifunctional use of rangelands by identifying other rangeland capacities 6. Compatibility between development plans and participatory capacities of pastoralists.	0.733	Ordinal
Implementing Good Governance	1. Participatory 2. Consensus-based agreement 3. Responsibility 4. Law-centered 5. Justice and equality 6. Accountability 7. Transparency 8. Efficiency and Effectiveness 9. Vision and Planning	0.817	Ordinal
Total		0.817	

Table 3. Discriminant Validity Assessment Matrix Using the Fornell-Larcker Method for Good Governance Indicators

Indices	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. Participatory	0.76									
2. Consensus-based agreement	0.65	0.79								
3. Responsibility	0.55	0.46	0.80							
4. Law-centered	0.57	0.54	0.73	0.76						
5. Justice and equality	0.61	0.41	0.43	0.68	0.73					
6. Accountability	0.56	0.36	0.47	0.53	0.69	0.76				
7. Transparency	0.53	0.43	0.61	0.65	0.47	0.66	0.80			
8. Efficiency and Effectiveness	0.54	0.48	0.34	0.49	0.60	0.41	0.56	0.70		
9. Vision and Planning	0.45	0.43	0.37	0.45	0.49	0.29	0.47	0.54	0.70	
10.Implementing Good Governance	0.48	0.48	0.39	0.37	0.28	0.36	0.26	0.20	0.26	0.67

Table 4. Comparison of the Importance and Feasibility of Good Governance Criteria in Rangeland Management

Criteria	The Importance			The Feasibility of Implementing		
	Unweighted Linear Combination	SD#	Priority	Unweighted Linear Combination	SD	Priority
Participatory	3.691	0.544	2	2.990	0.568	1
Consensus-based Agreement	3.720	0.565	1	2.602	0.588	5
Responsibility	3.639	0.574	6	2.544	0.462	7
Law-centered	3.678	0.531	4	2.802	0.550	2
Justice and Equality	3.640	0.540	5	2.028	0.293	9
Accountability	3.680	0.516	3	2.663	0.528	3
Transparency	3.588	0.563	7	2.555	0.543	6
Efficiency and Effectiveness	3.483	0.543	9	2.634	0.592	4
Vision and Planning	3.525	0.635	8	2.486	0.500	8

SD, Standard deviation

Table 5. Impact of Good Governance Indicators on Feasibility in Rangeland Management Based on Path Coefficients and t-values

Paths/ Relationships	Path Coefficient	T value	P value
Participation	0.175	2.223*	0.035
Consensus-based agreement	0.259	3.803**	0.002
Responsibility	0.480	9.494**	0.000
Law-centered	0.326	6.137**	0.000
Justice and Equality	0.127	1.998*	0.046
Accountability	0.209	3.444*	0.028
Transparency	0.229	3.385*	0.021
Efficiency and Effectiveness	0.412	8.968	0.412
Vision and Planning	0.349	8.368**	0.000

*, **, significant at 5 and 1% probability levels, respectively

3.2. Comparison between the importance and feasibility of good governance criteria

The comparison of governance criteria uses an Unweighted Linear Combination method to calculate the score of each criterion based on respondents' feedback presented in Table 4. Among the governance criteria, Consensus-based Agreement and Participatory elements rank highest in importance. In contrast, Vision and Planning and Efficiency and Effectiveness are deemed the least important, placing eighth and ninth, respectively, for sustainable rangeland management (Table 4). Impact of Good Governance Indicators on Feasibility in Rangeland Management is presented in Table 5. Indicators with factor loadings lower than 0.50 were excluded from the analysis, demonstrating strong convergent validity, as the Average Variance Extracted (AVE) values for all indicators exceed the 0.50 threshold.

The classification of the Good Governance indicators that are critical for sustainable rangeland management is presented in Fig 2 and Table 6. The analysis reveals that Participation and Consensus-based decision-making are central indicators of good governance in rangeland management (Table 6).

The correlation between respondents' personal and professional characteristics and their perceptions of governance importance is presented in Table 7. The results highlight several significant relationships, including those between age, literacy level, and the number of people employed in animal husbandry and the perceived importance of good governance in rangeland management.

These findings suggest that respondents with higher literacy levels and greater experience in animal husbandry tend to view good governance as more important. Additionally, Fig 3 illustrates the model representing the impact of the importance of Good Governance indicators on their implementation capability in rangeland management based on path coefficient values.

4. Discussion

Our findings showed that good governance in rangeland management was relatively stable, with notable levels of importance and feasibility for implementation. This observation aligns with the studies by Noori et al. (2021) and Zand Razavi et al. (2018), which highlighted the importance of communication and participatory practices among stakeholders. High levels of participation, particularly in revitalization projects, collective work, and shared decision-making, contribute to this stability. This indicated that despite the lack of a predetermined program, governance practices in the study area were functioning in a way that supports rangeland conservation and local communities. Participation plays a crucial role in good governance, especially in promoting consensus and collective decision-making, as supported by Emami and Shakeri (2015). Our results confirm this trend, with high levels of participation facilitating efficient rangeland management and promoting the sustainable feasibility of good governance. Furthermore, the study found that "responsiveness" and "participation" were the indicators with the highest sustainability rates, contributing to the stable governance structure in the rangelands. This was aligned with Paieste et al. (2022), who identified low stakeholder participation as a contributing factor to weak governance.The consensus-oriented indicator emerged as the most important in the rangeland's governance structure. This was in agreement with Mohammad Ebrahimi and Oshnooei Nooshabadi (2023), who suggested that consensus and cooperation could significantly reduce conflicts and disputes. The activation of rangeland cooperatives and consensus-oriented decision-making between governmental and local stakeholders are key elements in this stability. The facilitation of collective planning and the effective management of resource utilization, like livestock entry and exit, contributes to reducing conflicts and enhancing good governance, as seen in studies by Lockwood et al. (2010). Our findings here also align with Lockwood et al. (2010), who identified legitimacy, transparency, accountability, inclusion, fairness, capability, integration, and adaptability as core governance principles in natural resource management. The high accountability, responsiveness, participatory practices, and adherence to legal frameworks in Ajisoo correspond closely with these principles. The role of rangeland cooperatives illustrated functional integration and capacity building, while knowledge-sharing practices reflect adaptability with principles that were effective in Australian rangeland governance.

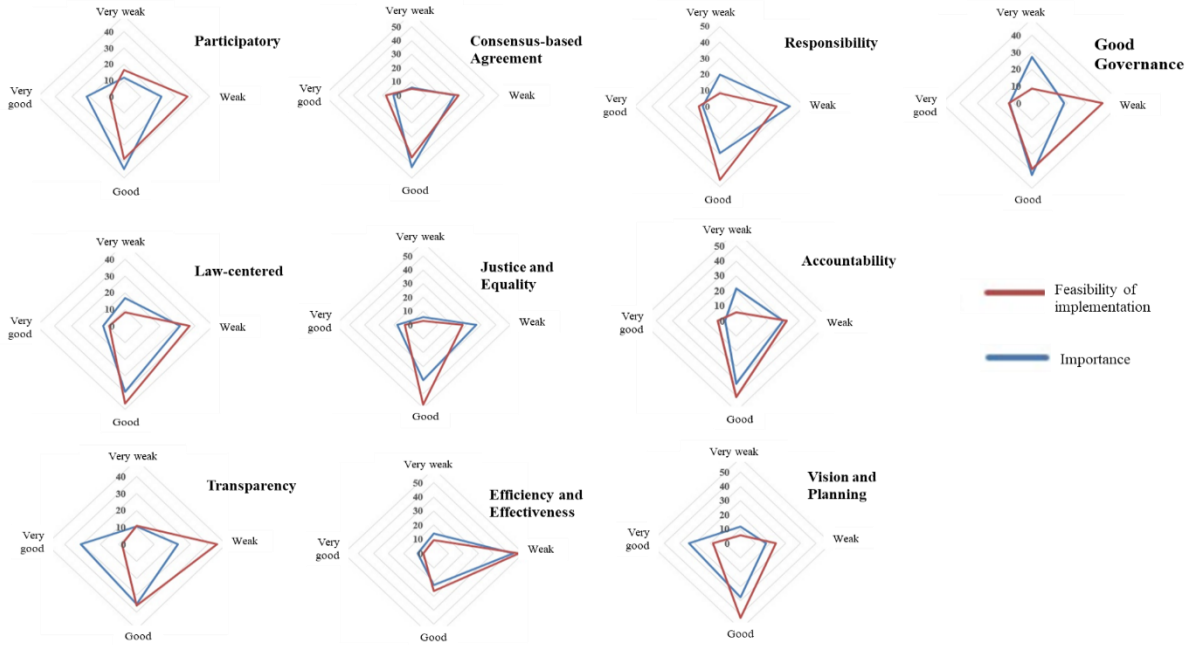

Figure 2. Classification of Good Governance Indicators in Rangeland Management

Table 6. Classification of Good Governance Indicators in Rangeland Management

Indicator	Category	Score	Importance		Feasibility	
			Frequency	%	Frequency	%
Participatory	Unstable	Very Weak	10	5.8	8	4.7
	Moderate Stability	Somewhat Weak	51	29.7	56	32.6
	Relatively Stable	Good	90	52.3	78	45.3
	Stable	Very Good	21	12.2	30	17.4
Consensus-based Agreement	Unstable	Very Weak	20	11.6	28	16.3
	Moderate Stability	Somewhat Weak	38	22.1	64	37.2
	Relatively Stable	Good	77	44.8	66	38.4
	Stable	Very Good	37	21.5	14	8.1
Responsibility	Unstable	Very Weak	29	17.9	14	8.1
	Moderate Stability	Somewhat Weak	54	31.4	63	36.6
	Relatively Stable	Good	68	39.5	80	46.5
	Stable	Very Good	21	12.2	15	8.7
Law-centered	Unstable	Very Weak	34	19.8	14	8.1
	Moderate Stability	Somewhat Weak	71	41.3	58	33.7
	Relatively Stable	Good	50	29.1	79	45.9
	Stable	Very Good	17	9.9	21	12.2
Justice and Equality	Unstable	Very Weak	37	21.5	10	5.8
	Moderate Stability	Somewhat Weak	51	29.7	55	32.0
	Relatively Stable	Good	72	41.9	87	50.6
	Stable	Very Good	12	7.0	20	11.6
Accountability	Unstable	Very Weak	10	5.8	5	2.9
	Moderate Stability	Somewhat Weak	63	36.6	47	27.3
	Relatively Stable	Good	69	40.1	99	57.6
	Stable	Very Good	30	17.4	21	12.2
Transparency	Unstable	Very Weak	24	14.0	16	9.3
	Moderate Stability	Somewhat Weak	92	53.5	98	57.0
	Relatively Stable	Good	38	22.1	46	26.7
	Stable	Very Good	18	10.5	12	7.0
Efficiency and Effectiveness	Unstable	Very Weak	18	10.5	19	11.0
	Moderate Stability	Somewhat Weak	40	23.3	77	44.8
	Relatively Stable	Good	61	35.5	62	36.0
	Stable	Very Good	53	30.8	14	8.1
Vision and Planning	Unstable	Very Weak	47	27.3	15	8.7
	Moderate Stability	Somewhat Weak	31	18.0	68	39.5
	Relatively Stable	Good	73	42.4	67	39.0
	Stable	Very Good	21	12.2	22	12.8
Good Governance	Unstable	Very Weak	20	11.6	10	5.8
	Moderate Stability	Somewhat Weak	29	17.9	41	23.8
	Relatively Stable	Good	65	37.8	90	52.3
	Stable	Very Good	58	33.7	31	18.0

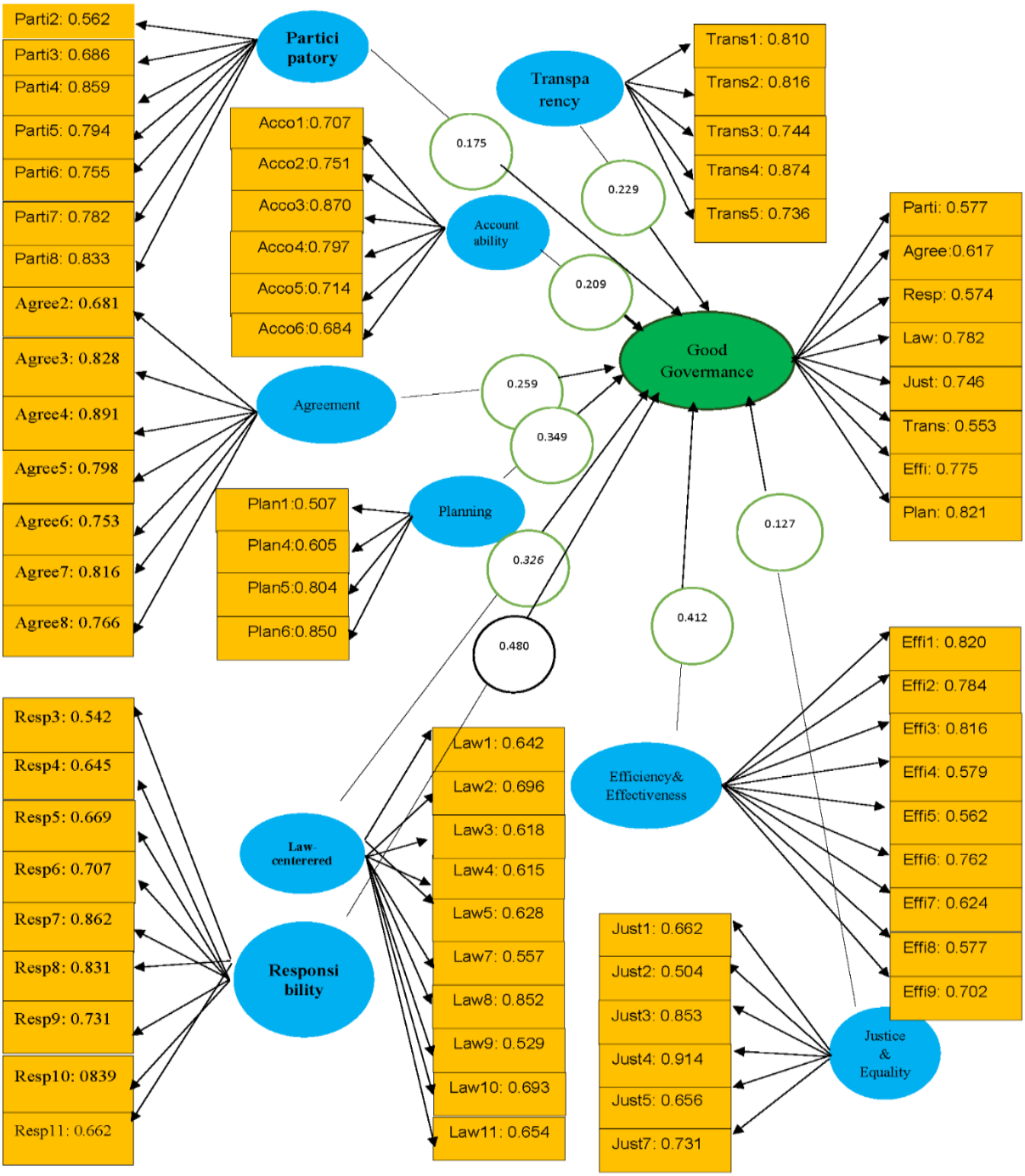

Figure 3. Model of the importance of desirable governance indicators on its executability in rangeland management based on path coefficient values

Table 7. Pearson correlation between individual-professional characteristics of the beneficiaries and their perspective on the importance of the good governance index in rangeland management

Variable	Correlation Coefficient
Age (years)	0.40 **
Literacy (Educational Level)	-0.45**
Household Size (members)	0.28*
Number of Individuals Employed in Animal Husbandry (members)	0.43**
Number of Livestock (heads)	0.22*
Years of Experience in Animal Husbandry (years)	0.18*
Income Level (US$)	-0.01

*, **, significant at 5 and 1% probability levels, respectively

Accountability, another key indicator, has a high executive capability in rangeland governance. This supports the findings of Ghafarzadeh et al. (2021) and Einloo et al. (2022), emphasizing the importance of stakeholder accountability. Managerial responsiveness, information dissemination, and addressing complaints are critical criteria contributing to effective governance. This accountability fosters trust among stakeholders, reducing social disputes and ensuring better governance practices.

The lawfulness indicator also shows high executive capability, consistent with the results of Sasanpour et al. (2022). This stability is partly due to the legal frameworks that regulate rangeland use, such as grazing permits, which govern livestock entry and exit, capacity, and settlement locations. Proper implementation of rangeland management plans and compliance with legal frameworks play a crucial role in ensuring good governance, as noted by Tarmohammadi Ghorchi et al. (2020) and Moradi et al. (2022). These governance attributes also agree with the global pastoralist governance insights presented by Herrera and Davies (2014), who document case studies from Africa, Asia, and the Middle East, such as the Hima system in Jordan and cooperative systems in Morocco. In these cases, consensus-based decision-making and community empowerment improved conflict resolution and resource management, echoing the patterns observed in Ajisoo. Similarly, in Tanzania's ngitili system (Eilola et al., 2021), governance benefits from a mix of formal legal arrangements and traditional practices that mirror the combination of grazing permits and local participatory customs in our study area.

Our results showed that factors such as age, literacy levels, household size, and the number of livestock could significantly influence the importance and executability of good governance in rangeland management. For instance, older individuals tend to value good governance more due to their experience, aligning with the studies of Heidari Sareban (2019). Likewise, lower literacy rates correlate with higher perceived importance of good governance, indicating that empirical knowledge gained through years of experience is valued in these settings. These findings align with Ziaee and Asadian Ardakani (2021), suggesting that a sense of responsibility and experience in collective activities significantly contribute to good governance.

Global research supports this linkage between local experience and governance quality. In African pastoral systems, indigenous ecological knowledge often plays a central role in grazing management decisions and ecological assessments (Coppock et al., 2022). Similarly, the long-term experience of Ajisoo beneficiaries (>30 years) served a comparable function, compensating for low levels of formal literacy through deep practical expertise. Furthermore, the positive correlation between household size, livestock count, and the attitude toward good governance in rangeland management highlights the significance of participatory practices. Studies by Mairomi and Kimengsi (2021) in Cameroon and Coppock et al. (2022) in Namibia supported the idea that collective agreements in group meetings can reduce violations and conflicts in rangelands, paving the way for participatory and joint cooperation through rangeland cooperatives.

Additionally, our research emphasizes the importance of structural equation modeling in identifying influential indicators for good governance. The impact of "responsibility" on the executability of good governance aligns with findings by Ziaee and Asadian Ardakani (2021) and Soroushan et al. (2023), who believed responsibility should be a central focus for managers when implementing good governance practices. This highlights the need for effective training programs to empower stakeholders in rangeland management, providing the necessary tools to handle various challenges such as water supply and grazing practices. In summary, the results confirmed that good governance in rangelands relies heavily on participation, consensus-building, accountability, and lawful practices. By situating these findings within a broader global framework—from Australia's governance principles to Africa's indigenous knowledge systems and the Middle East's cooperative traditions—our study demonstrated that Ajisoo's governance challenges and successes reflect patterns common to rangelands worldwide. Our study underscores the importance of fostering a participatory culture and engaging stakeholders in collective decision-making, reinforcing the need for sustainable governance practices to address the challenges faced by rangeland management.

5. Conclusion

This study highlights the crucial role of governance prerequisites and indicators in ensuring sustainable rangeland management. Effective governance serves as the backbone for balancing ecological conservation, socio-economic stability, and equitable resource use in rangeland areas. The findings of this research have illuminated key factors that influence the successful implementation of governance mechanisms in these landscapes. Central to this discussion is the importance of well-coordinated policy-making and management. Effective governance in rangeland management is achievable through cohesive collaboration between government authorities and stakeholders, especially rangeland users. Integrating the knowledge and perspectives of local users in decision-making processes significantly enhances the effectiveness of governance frameworks, ensuring that policies are both contextually relevant and practical.

Based on the findings, several actionable policy recommendations emerge:

1. Operationalizing "Responsibility" in Rangeland Plans – Define clear roles and obligations for each stakeholder group in formal management plans, including timelines, monitoring responsibilities, and compliance mechanisms. Assign community rangeland committees a formal role in tracking grazing schedules, enforcing agreed limits, and reporting violations.
2. Strengthening Accountability Mechanisms – Establish transparent feedback channels (e.g., public reporting boards, periodic stakeholder meetings) to ensure decisions are reviewed and adapted when needed. Link performance evaluations of local managers to measurable governance indicators.
3. Investing in Livelihood Diversification – Provide targeted subsidies and microfinance schemes to support non-livestock economic activities, such as eco-tourism, beekeeping, or drought-resilient crops, reducing overdependence on grazing.
4. Enhancing Knowledge Sharing and Communication – Develop mobile-based platforms or local radio programs to share weather forecasts, grazing capacity updates, and training materials, ensuring timely access to information for both nomadic and rural users.
5. Improving Legal Compliance – Strengthen enforcement of grazing permits through community monitoring teams supported by government agencies, while ensuring regulations are adjusted to reflect ecological capacity and local needs.
6. Expanding Capacity Building Programs – Institutionalize regular training on sustainable grazing, water management, and conflict resolution, prioritizing inclusion of youth and women to address generational gaps.

Participatory governance remains pivotal in driving inclusivity and ownership in the management of rangelands. By involving rangeland users and other stakeholders in decision-making processes, governance structures can better reflect the needs and aspirations of the community, thereby improving implementation outcomes and ensuring long-term success.

Ultimately, enhancing users' satisfaction with services and facilities, while adhering to legal frameworks, will strengthen governance systems and promote sustainable resource management. Addressing the key prerequisites and indicators for good governance in rangeland management—particularly responsibility, accountability, and participation—will be essential for safeguarding these ecosystems for future generations.

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Authors Contribution

KB conceptualized the study, collected and analyzed the data, and drafted the manuscript. SKM supervised the research process and guided the study. MM and GA contributed to the study design, provided critical feedback on the analysis, and revised the manuscript for intellectual content. All authors approved the final version of the manuscript for submission.

Availability of data and materials

on reasonable request, the corresponding author may provide data.

Conflict of interests

The authors declare no conflict of interest.

Ethical permissions:

All participants were informed about the study's purpose, voluntary participation, confidentiality, and anonymity before providing consent. The study followed institutional ethical standards and the principles of the 1964 Helsinki Declaration and its later amendments.

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