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Analysis of Natural Resource Governance in Iran Based on the NRGF Framework

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Abstract

This study assesses natural resource governance in Iran based on the IUCN standard. Iran, characterized by an arid and semi-arid climate, grapples with challenges such as unsustainable resource exploitation, environmental degradation, and social inequalities. This descriptive-survey research targeted natural resource experts from academic, research, governmental, and consulting sectors. Using snowball sampling, 89 electronic questionnaires, designed based on the Natural Resource Governance Framework (NRGF), were completed. The questionnaire's validity was confirmed through content validity, and its reliability was verified using Cronbach's alpha coefficient. Data were analyzed using the Partial Least Squares (PLS) method and Smart-PLS software. Findings indicate that the governance dimensions and items are reliable and valid, with items like "G12," "G16," and "G18" being particularly significant. The results suggest that Iran's natural resource governance, emphasizing alignment with national development plans, addressing environmental threats, continuous monitoring, sustainability principles, a robust legal framework, and stakeholder engagement, is on a positive trajectory. However, challenges such as limited resources, misalignment with local needs, and corruption require attention. To enhance governance, it is recommended to strengthen participatory frameworks, revise relevant laws, develop training programs to empower local communities, and implement adaptive governance models to ensure sustainable management of natural resources.

Keywords: Natural resource governance, IUCN, PLS, participation, sustainable development.

1. Introduction

Iran, located in the arid and semi-arid belt of the world, faces significant challenges in managing its natural resources, including unsustainable exploitation, environmental degradation, soil erosion, biodiversity loss, and socio-economic inequalities. These challenges are intensified by global climate change, which has driven the expansion of semi-arid regions, impacting ecosystems, agricultural productivity, and human well-being (Huang et al., 2016). Approximately 15% of the world's drylands are semi-arid, supporting 14.4% of the global population, many of whom rely on rain-fed agriculture for their livelihoods (Safriel and Adeel, 2005). Between 1990 and 2004, semi-arid areas expanded by 7% globally, particularly in the eastern hemisphere, transforming previously humid or semi-humid regions into drier climates (Rao et al., 2013). These climatic shifts have profound implications for biodiversity, agricultural practices, and water resource management, necessitating robust and cohesive governance frameworks to ensure sustainability (Prasad et al., 2008). Numerous studies in Iran and globally have explored the challenges of natural resource management in arid and semi-arid regions. In Iran, research has highlighted that overexploitation of groundwater resources and inefficient management practices, particularly in watershed management, have

led to declining water tables and ecosystem degradation (Madani, 2014). For instance, a study by Azizi et al. (2019) identified a lack of coordination among responsible institutions and limited community participation as key barriers to sustainable natural resource management in Iran.

Internationally, studies in arid regions such as the Sahara Desert and Central Asia have emphasized the importance of participatory governance and the integration of indigenous knowledge for sustainable resource management (Stringer et al., 2018). These studies underscore common challenges in developing countries with similar climates, including the lack of cohesive legal frameworks and insufficient financial resources for implementing sustainable policies. In recent years, research has further illuminated the complexities of natural resource governance in arid and semi-arid regions. For instance, Kolahi et al. (2024) highlighted the escalating impact of climate-induced drought on Iran's water resources, emphasizing the need for adaptive governance to mitigate groundwater depletion. Similarly, Tamassoki et al., (2024) underscored the role of participatory approaches in addressing socio-economic inequalities in Iran's watershed management. Globally, studies such as those by Akhtar et al. (2021) in Central Asia have stressed the integration of climate resilience into governance frameworks to ensure sustainable resource management. While previous studies in Iran have addressed specific aspects of natural resource management, such as groundwater depletion (Madani, 2014) or institutional coordination (Azizi et al., 2019), a comprehensive assessment of governance using a globally recognized framework like the NRGF remains absent.

This study fills this gap by systematically analyzing Iran's natural resource governance across multiple dimensions, including stakeholder participation, legal frameworks, and adaptive management. By leveraging the NRGF's structured indicators, this research provides novel insights into systemic governance challenges and offers tailored recommendations for aligning policies with Iran's unique socio-ecological context. Effective natural resource governance is a cornerstone of sustainable development, requiring a holistic approach that addresses environmental, social, and economic dimensions.

The Natural Resource Governance Framework (NRGF), developed by the International Union for Conservation of Nature (IUCN), provides a comprehensive tool for assessing governance systems, emphasizing key principles such as stakeholder participation, transparency, accountability, and alignment with sustainability goals (IUCN, 2020a). This framework offers specific indicators and sub-indicators to facilitate a detailed analysis of governance strengths and weaknesses. In Iran, studies such as Kamal et al. (2021) have shown that weak enforcement of regulations and insufficient attention to local capacities are major obstacles to effective natural resource governance. Similarly, global research, such as Ostrom's (1990) work on the management of common-pool resources, highlights the critical role of collaboration among governments, local communities, and other stakeholders in achieving successful governance outcomes.

For instance, successful participatory governance models from countries like Sweden (Ostrom, 1990) and Canada (Mitchell, 2013) can serve as a basis for adapting solutions to Iran's context. Furthermore, leveraging modern technologies such as Geographic Information Systems (GIS) and remote sensing (RS) can enhance monitoring and management of natural resources (Longley et al., 2015).

Good governance is frequently associated with principles such as transparency, participation, and accountability. Accordingly, good governance indicators consider governance as extending beyond the government, since decisions regarding natural resources are shaped by a wide range of both public and private actors (Mosaferi Zeyaaldine et al., 2025).

To assess the performance of a governance system, it is essential to understand and analyze governance structures and mechanisms. Governance is defined as a set of interdependent institutions, which constitutes a core feature of governance systems (Pahl-Wostl, 2009). In this regard, institutions are understood as the rules that govern the

behavior of actors (Tamassoki et al., 2021). Hence, their formal or informal nature depends on the development, codification, communication, and implementation processes (Tamassoki et al., 2022). Modes of governance refer to the various forms through which governance is realized. According to Thompson et al. (1991), these modes can be categorized into three types: hierarchies, networks, and markets.

As Tamassoki et al., (2022). points out, the difference between these modes lies in the degree of institutional formality and the relative roles of state versus non-state actors. In hierarchical governance, regulatory processes are primarily based on formal institutions, with dominant roles played by governmental actors. Markets are based on a combination of formal and informal institutions and are governed largely by non-governmental actors. Networks, in contrast, are mainly governed through informal institutions, involving the participation of both state and non-state actors (Gharechaei et al., 2015).

This study aims to analyze the state of natural resource governance in Iran using the NRGF framework. By assessing the strengths and weaknesses of Iran's governance system, this research seeks to identify gaps in policy and practice, particularly in stakeholder engagement, legal frameworks, and adaptive management. Additionally, it offers actionable recommendations to enhance governance effectiveness and promote sustainable resource management. Through an analysis of governance structures and insights from both domestic and international experiences, this research contributes to evidence-based policymaking, providing valuable insights for policymakers, managers, and stakeholders to advance sustainable development in Iran's unique ecological and socio-economic context.

This study aims to evaluate the strengths and weaknesses of Iran's natural resource governance using the IUCN's Natural Resource Governance Framework (NRGF), identifying critical gaps in policy implementation and proposing actionable recommendations to enhance sustainable resource management in Iran's arid and semi-arid context.

2. Materials and Methods

2.1. Study Area

Iran, a vast country situated in the arid and semi-arid belt of the world and in southwestern Asia (Middle East), lies between the Caspian Sea and the Persian Gulf, at geographical coordinates of 25° to 39° north latitude from the equator and 44° to 63° east longitude from the prime meridian, encompassing an area of 1,648,000 square kilometers. The country's average elevation above sea level is approximately 1,250 meters, with the Iranian Plateau having an average elevation of about 900 meters. Iran's average annual precipitation is 251 mm, which is one-third of the global average annual precipitation (732 mm) and one-third of the average precipitation across the Asian continent. The lowest precipitation is observed in Iran's central deserts, with less than 25 mm, while the highest, reaching 1,600 mm, occurs in the Caspian region. Approximately two-thirds of Iran's land area receives less than 250 mm of annual rainfall, with 50% of this precipitation occurring during winter. Iran accounts for about 1% of the global population. The country's share of freshwater resources is approximately 0.36%. The potential evapotranspiration, calculated using the Penman-Wright method, is 1,972 mm. The geographical location of Iran is illustrated in Figure 1 (Momeni Damaneh et al., 2024; Tajbakhsh Fakhrabadi and Momeny, 2023).

2.2. Methodology

This applied research adopted a descriptive-survey approach to evaluate natural resource governance in Iran, focusing on experts from academic, research, governmental, and consulting sectors. Data were collected using a researcher-developed questionnaire based on the Natural Resource Governance Framework (NRGF) by the IUCN. The NRGF, serving as the theoretical foundation for assessing natural resource governance, comprises 10 main indicators and 51 sub-indicators, each measuring distinct governance dimensions. To ensure the validity and reliability of the data collection tool, the questionnaire underwent rigorous evaluation.

Content validity was assessed by a panel of natural resource experts who reviewed the questions for clarity, relevance to NRGF, and

alignment with research objectives. Necessary revisions were made based on their feedback, ensuring the questionnaire accurately captured the intended constructs. Reliability was evaluated using Cronbach's alpha coefficient, which measures internal consistency.

The calculated Cronbach's alpha of 0.92 confirmed high reliability, indicating stable and consistent results across similar conditions. Due to the lack of a comprehensive list of natural resource experts nationwide, snowball sampling was employed. Initially, a group of recognized experts was identified, and questionnaires were distributed to them. These experts were asked to recommend other qualified professionals, continuing this chain-referral process until 89 questionnaires were completed, achieving theoretical saturation. The sample size of 89 questionnaires was determined through snowball sampling, a method suitable for accessing specialized populations where a comprehensive sampling frame is unavailable (Creswell, 2013).

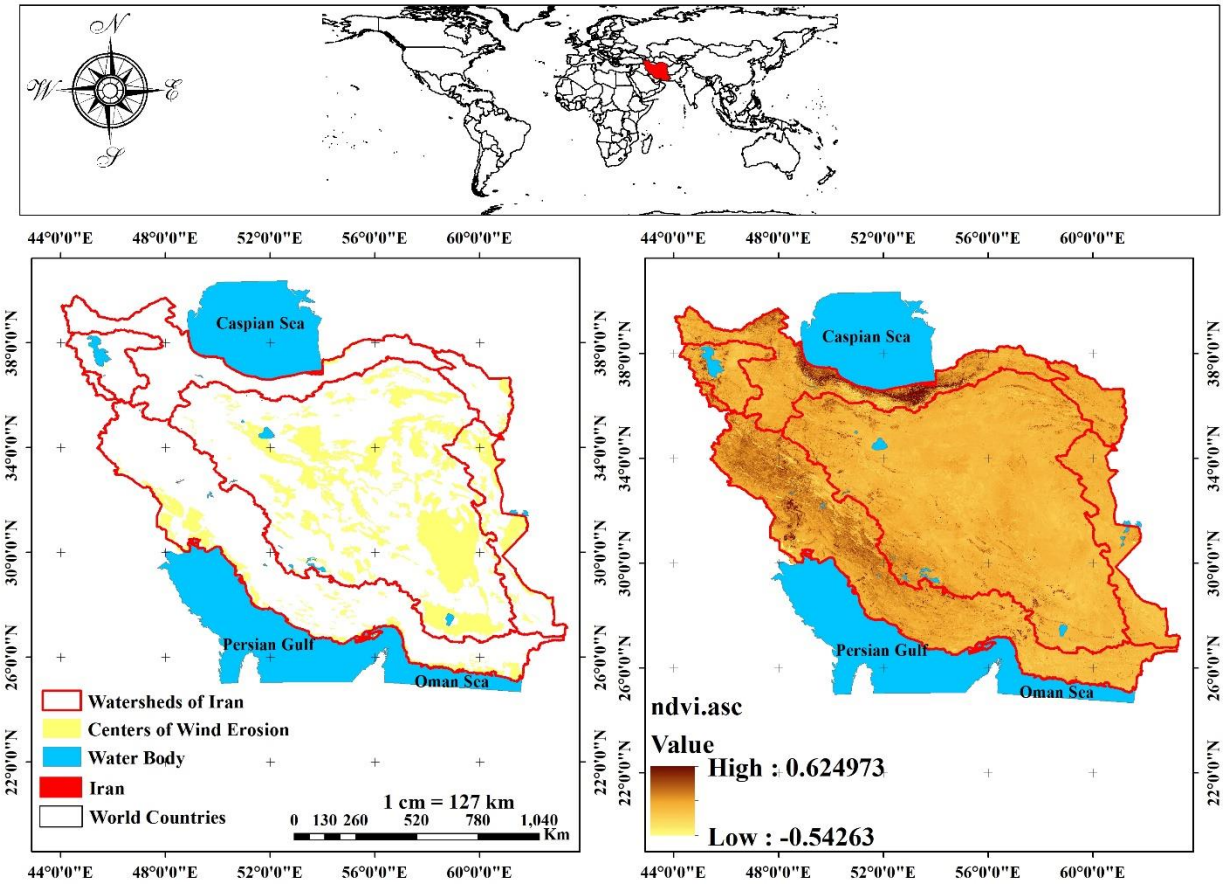

Fig. 1. Geographical map of Iran highlighting key ecological zones (Caspian region, central deserts, Iranian Plateau)

Initial participants were selected from recognized experts in academic, research, governmental, and consulting sectors. These experts recommended additional qualified professionals, continuing until theoretical saturation was achieved, where no new information emerged from additional responses (Saunders et al., 2018). This approach ensured a diverse and relevant sample, though its limitations in generalizability are acknowledged in the study. Despite potential limitations in generalizability, this method was deemed suitable given the specialized nature of the population and access constraints. A 5-point Likert scale, ranging from "very low" to "very high," was used to measure respondents' agreement with each question, enabling precise quantitative assessment of attitudes and facilitating advanced statistical analysis. Data analysis utilized the Partial Least Squares (PLS) method, implemented via Smart-PLS software. PLS, a multivariate statistical technique, is ideal for analyzing complex relationships between latent (constructs) and observed (indicators) variables, particularly

when data do not follow a normal distribution or sample sizes are limited. In this study, PLS was chosen to examine the structural relationships between NRGF's main indicators (latent variables) and sub-indicators (observed variables). The method allowed simultaneous evaluation of the measurement model (relationships between observed and latent variables) and the structural model (relationships among latent variables). Smart-PLS, with its robust analytical capabilities and user-friendly interface, ensured accurate execution of the PLS model, yielding reliable results for assessing governance dimensions.

2.3. Questionnaire Validity and Reliability

To ensure the accuracy and credibility of the researcher-developed questionnaire, both validity and reliability were rigorously assessed. Content validity was evaluated to confirm that the questions aligned with the research objectives and comprehensively covered NRGF dimensions. A panel of distinguished natural resource experts reviewed the questionnaire, assessing the clarity, relevance, and alignment of questions with the NRGF framework. Their constructive feedback led to revisions, including rephrasing ambiguous questions and removing those misaligned with the study's goals. This consensus-based process ensured that the final questionnaire possessed strong content validity, capable of accurately measuring the intended governance constructs. Reliability was assessed using Cronbach's alpha to evaluate the internal consistency of the questionnaire items. The analysis yielded a Cronbach's alpha of 0.92, indicating excellent reliability. This high value demonstrates strong correlations among questions, ensuring that the questionnaire would produce consistent results if administered under similar conditions. The robust validity and reliability of the questionnaire significantly enhance the credibility and precision of the study's findings.

2.4. Data Analysis Method

Data analysis was conducted using the Partial Least Squares (PLS) method, implemented through Smart-PLS software, to explore the complex relationships between NRGF's main indicators and sub-indicators. PLS, a multivariate statistical approach, is well-suited for analyzing relationships between latent and observed variables, particularly in studies with non-normal data distributions or smaller sample sizes. In this research, PLS was selected to evaluate the structural relationships between NRGF's sub-indicators (observed variables) and main indicators (latent variables), enabling a comprehensive analysis of governance dimensions. The method facilitated simultaneous assessment of the measurement model (linking observed and latent variables) and the structural model (examining causal relationships among latent variables). Smart-PLS provided a powerful platform for executing the PLS model, delivering reliable and precise results. The analysis outcomes were thoroughly presented and discussed, leading to practical recommendations for improving natural resource governance. The sample of 89 experts was selected via snowball sampling, achieving theoretical saturation (Saunders et al., 2018). While this ensures a specialized sample, potential biases (e.g., institutional homogeneity) are acknowledged as a limitation. Sub-indicators with lower factor loadings (e.g., G3=0.568, G4=0.509) were retained due to their conceptual relevance to the NRGF framework, as recommended by Hair et al. (2009). Sensitivity analysis confirmed that excluding these items did not significantly alter model fit. Low AVE values for Inclusive Decision-Making (0.444) and Accountability (0.508) suggest potential measurement weaknesses. Future studies could refine these constructs by adding context-specific indicators or re-specifying the model to enhance convergent validity.This systematic, evidence-based approach aimed to deepen the understanding of factors influencing governance and propose actionable strategies for enhancement.

3. Results and Discussion

This research investigates the dimensions and items of natural resource governance using the Partial Least Squares (PLS) method. The PLS method, developed by Wold in 1974 and extended by Lohmöller in 1989 (Wold, 1974 and Lohmöller, 2013), is suitable for inferential data analysis in conditions of small

sample sizes and unknown data distribution. In this study, due to the unknown size of the statistical population and the importance of accuracy in responding to questions, purposive sampling with 100 participants was used. PLS analysis includes examining model fit and the analysis algorithm. Prior to estimating model relationships, manifest variables (questions) related to each construct (latent variable) were determined. The research questionnaire included 51 questions across 10 constructs related to natural resource governance: Comprehensive Decision-Making (G1-G7), Tenure Rights (G8-G12), Cultures (G13-G16), Devolution (G17-G20), Strategic Vision (G21-G26), Coordination (G27-G30), Shared Resources (G31-G36), Accountability (G37-G42), Rule of Law (G43-G47), and Access to Justice (G48-G51). Structural equation modeling consists of two parts: the measurement model (relationship of questions with constructs) and the structural model (relationship of constructs with each other) (Henseler et al., 2009). In this research, the overall model was analyzed by representing constructs as circles, questions as rectangles, and the relationships between them with directed arrows.

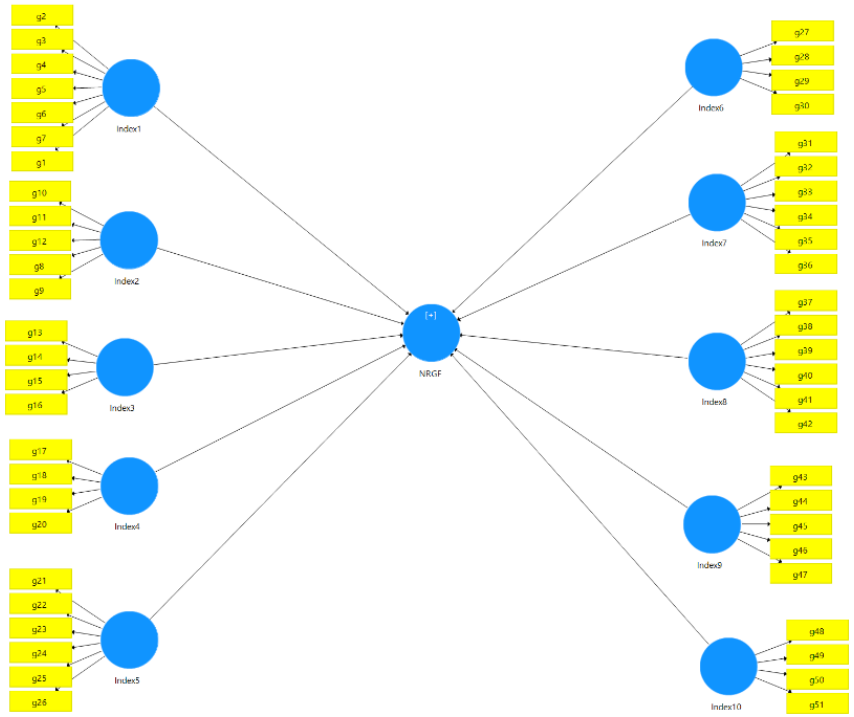

Fig. 2. Graphical Representation of Measurement Models, Structural Model, and Overall Research Model in the PLS Environment

3.1. Model Fit Assessment

The measurement models of the questionnaire were evaluated by assessing the validity and reliability of the constructs. Validity was examined through content validity, face validity, and factor analysis. Convergent and discriminant validity were assessed using the Average Variance Extracted (AVE) index. According to the criteria proposed by Hair et al. (2009), a Composite Reliability (CR) value greater than 0.8 and an AVE value of at least 0.5 were established as prerequisites for convergent validity. Discriminant validity was confirmed by ensuring that the square root of the AVE for each construct exceeded its correlation coefficients with other constructs. To assess construct reliability, both CR and Cronbach's alpha were utilized. Factor loadings greater than 0.4, as recommended by Fornell and Larcker (1981), were considered statistically significant. Ultimately, the fit of the measurement models was evaluated based on three criteria: reliability, convergent validity, and discriminant validity.

3.2. Fitting Measurement Models for a Inclusive decision-making Index

The questionnaire's reliability and validity were assessed using the Partial Least Squares (PLS) method. Results showed that Cronbach's Alpha (0.789) and Composite Reliability

(0.847) for the comprehensive decision-making dimension were above the standard test values, indicating appropriate reliability of the questions. However, the Average Variance Extracted (0.444) was slightly below the desired threshold.

Table 1. Measurement Model Fit Results

Indicator	Index	Sub-Indicator	Factor Loading	Validity Result	AVE	CR	Rho	Cronbach's Alpha
Inclusive decision-making	G1	Relevant legal and policy frameworks include robust provisions on the inclusion of rights-holders and stakeholders in decision making.	0.702	Adequate	0.444	0.847	0.804	0.789
	G2	Platforms and processes are in place to enable full and effective participation in decision making.	**0.694**	Inadequate				
	G3	Processes for inclusive decision-making engage diverse groups, are socially and culturally appropriate and take into account power dynamics within and between groups.	**0.568**	Inadequate				
	G4	Rights-holders and stakeholders have access to information on the environment and natural resources.	**0.509**	Inadequate				
	G5	Rights-holders and stakeholders have the capacities and support they need to participate in decision making, including through appropriate representation.	0.752	Adequate				
	G6	Natural resource decisions take into account the views expressed through participatory processes.	0.709	Adequate				
	G7	Free, prior and informed consent is required, secured and maintained for decisions concerning Indigenous peoples and other customary rights-holders and their lands and resources.	**0.683**	Inadequate				
Recognition and respect for tenure rights	G8	Relevant laws, policies and rules mandate recognition and respect for all tenure rights, with particular attention to the customary (including collective) rights of Indigenous peoples and local communities, and women's rights.	0.800	Adequate	0.583	0.874	0.823	0.832
	G9	Tenure rights are robust – enabling rights-holders to sustainably access, use, benefit from, manage and protect lands and other natural resources from threats.	0.760	Adequate				
	G10	Accessible and effective processes and capacities are in place to recognise and respect land and resource rights, including for the purposes of formal recognition.	0.754	Adequate				
	G11	Effective processes and capacities are in place to protect and enforce tenure rights.	**0.660**	Inadequate				
	G12	Overlapping tenure rights and claims are clarified in law and resolved in practice.	0.833	Adequate				
Recognition of and respect for diverse cultures, knowledge and institutions	G13	Governance strategies and actions are informed by sound, diverse forms of knowledge, including Indigenous and local knowledge.	0.707	Adequate	0.623	0.868	0.811	0.797
	G14	The diverse cultural values and practices that sustain natural resources are respected and protected.	0.802	Adequate				
	G15	Governance institutions foster learning and adaptive management, valuing insights from diverse cultures and knowledge systems.	0.772	Adequate				
	G16	Indigenous and local knowledge are integrated into natural resource governance in respectful, appropriate and meaningful ways, including through appropriate free, prior and informed consent.	0.867	Adequate				

Indicator	Index	Sub-Indicator	Factor Loading	Validity Result	AVE	CR	Rho	Cronbach's Alpha
Devolution	G17	Legal and policy frameworks devolve natural resource management to capable institutions closest to the natural resources concerned.	0.800	Adequate	0.630	0.867	0.797	0.795
	G18	Legal and policy frameworks for devolved — including Indigenous and community-led — natural resource governance are widely implemented.	0.825	Adequate				
	G19	Local institutions (including customary institutions) have the capacities and support they need for effective and equitable natural resource governance.	0.796	Adequate				
	G20	Appropriate recognition is given to the roles and authority of Indigenous peoples and local communities in natural resource governance.	0.726	Adequate				
Strategic vision, direction and learning	G21	Relevant legal, policy and management frameworks establish strategic vision and direction for natural resource governance.	0.771	Adequate	0.626	0.909	0.889	0.881
	G22	The strategic vision and direction are set through inclusive processes that take into account the diverse values and forms of knowledge of rights-holders and stakeholders.	0.762	Adequate				
	G23	The strategic vision and direction incorporate key principles of environmental sustainability, such as the precautionary principle against risks of environmental and social harm.	0.786	Adequate				
	G24	The strategic vision and direction effectively and equitably address present threats and anticipate future challenges.	0.805	Adequate				
	G25	Natural resource governance and management activities are consistent with the strategies articulated in the vision.	0.828	Adequate				
	G26	Governance institutions have processes in place for ongoing monitoring, reflection and learning, thereby enabling responsiveness to changing conditions and needs.	0.792	Adequate				
Coordination and coherence	G27	Legal and policy frameworks across sectors responsible for or affecting natural resource governance are aligned.	0.874	Adequate	0.795	0.939	0.916	0.914
	G28	Coordination mechanisms are in place to enable horizontal collaboration and coherence among multiple actors and sectors operating in the same geographical space or thematic area.	0.895	Adequate				
	G29	Mechanisms are in place to enable vertical coordination across multiple levels of actors with roles in the governance of an ecosystem or resource.	0.897	Adequate				
	G30	Institutions collaborate and overlap functions in ways that increase resilience.	0.901	Adequate				
Sustainable and equitably shared resources	G31	People responsible for natural resource governance have access to revenues and/or livelihoods that enable them to carry out resource management activities.	**0.697**	Inadequate	0.571	0.888	0.855	0.849
	G32	Available revenues and other resources provide sufficient economic sustainability for the people and actions required to sustainably manage the natural resource.	0.720	Adequate				
	G33	Benefits arising from the use of natural resources are shared equitably.	0.739	Adequate				
	G34	The sharing of revenues and other benefits provides sufficient incentive for the sustainable management of natural resources.	0.757	Adequate				

Indicator	Index	Sub-Indicator	Factor Loading	Validity Result	AVE	CR	Rho	Cronbach's Alpha
	G35	Losses borne by Indigenous peoples, local communities and all vulnerable, marginalised and/or minority peoples due to conservation — including restrictions on resource use to ensure sustainability — are prevented or, where unavoidable, are compensated.	0.829	Adequate				
	G36	Natural resources are managed sustainably so that the following generations have equitable access to the benefits those resources provide.	0.782	Adequate				
Accountability	G37	The institutions responsible for natural resource governance have clearly defined roles and responsibilities.	**0.639**	Inadequate	0.508	0.860	0.814	0.805
	G38	The actors responsible for or affecting natural resource governance operate transparently and share relevant information on their actions openly and accessibly.	0.809	Adequate				
	G39	Appropriate capacities and mechanisms are in place to hold authorities involved in natural resource governance responsible for their actions (and inactions).	**0.656**	Inadequate				
	G40	Social and environmental safeguards are adopted and implemented that explicitly take into account the situation of vulnerable groups and environments.	0.712	Adequate				
	G41	The potential impacts of governance decisions on vulnerable people and environments are understood in advance and avoided or minimised to the fullest extent possible.	0.754	Adequate				
	G42	Accountability mechanisms effectively rein in corruption.	**0.693**	Inadequate				
Fair and effective rule of law	G43	A clear system of natural resource norms and sanctions is defined in laws, policies or rules and is widely shared.	0.780	Adequate	0.532	0.849	0.785	0.775
	G44	Natural resource-related laws, policies and rules are consistent with human rights and take into account the situation of Indigenous peoples, local communities, women and all vulnerable, marginalised and/or minority groups.	0.760	Adequate				
	G45	Natural resource-related, laws, policies and rules incorporate principles of environmental sustainability.	0.754	Adequate				
	G46	Enforcement bodies have the capacity and commitment to uphold the norms and sanctions established to protect rights and the environment.	**0.660**	Inadequate				
	G47	Natural resource-related laws, policies and rules are carried out equitably, effectively and humanely.	0.833	Adequate				
Access to justice and conflict resolution	G48	Formal or informal mechanisms are in place to resolve conflicts and grievances regarding land and natural resources.	0.750	Adequate	0.625	0.869	0.805	0.779
	G49	People are aware of their natural resource-related rights and the avenues available to them for resolving conflicts or seeking redress.	0.820	Adequate				
	G50	Grievance- or dispute-resolution mechanisms are accessible to rights-holders and stakeholders, including vulnerable, marginalised and/or minority groups.	0.750	Adequate				
	G51	Mechanisms operate impartially and effectively to resolve disputes and redress rights violations.	0.829	Adequate				

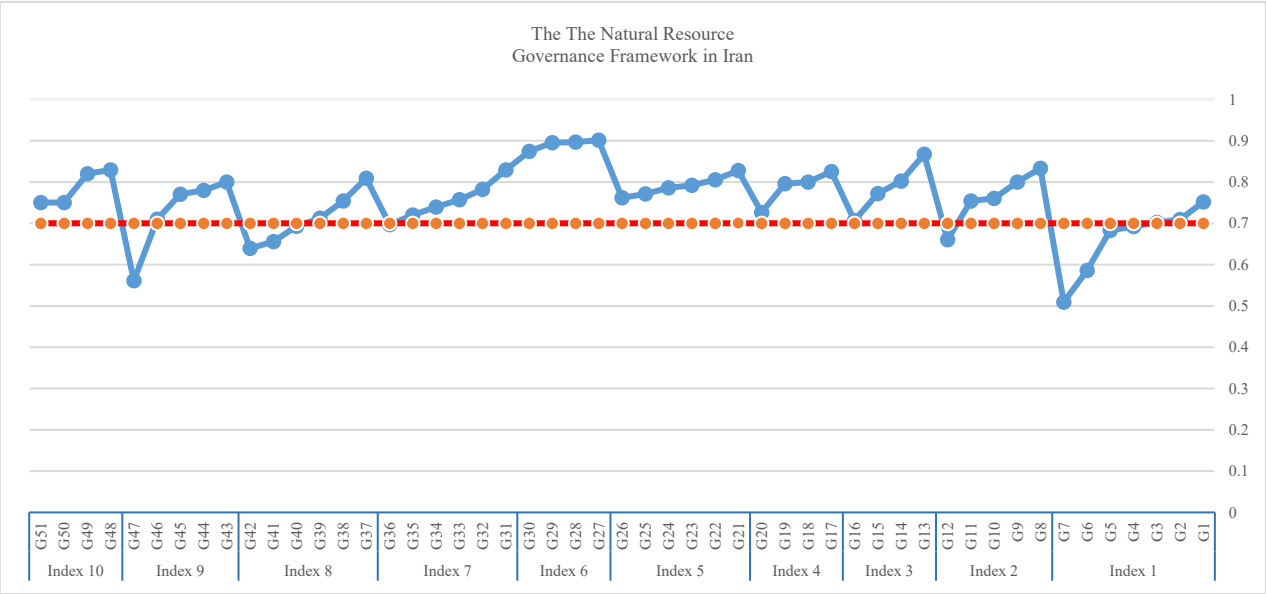

Fig. 3. Factor Loading Coefficients of Sub-Indicators for the Natural Resource Governance Framework in Iran

An examination of the item factor loadings revealed that three items: "Rights-holders and stakeholders have the capacities and support they need to participate in decision-making" (0.752) 1, "Views expressed through participatory processes are taken into account in natural resource decisions" (0.709) 2, and "All rights-holders and stakeholders participate in legal and policy decision-making concerning natural resources" (0.687) 3 had factor loadings above the standard value. These results indicate that active participation of rights-holders and stakeholders, consideration of local community views, and broad participation in natural resource decisions are of high importance in natural resource governance. In contrast, four other items, including "Platforms and processes are in place to enable full and effective participation" 4 and "Access to information on the environment and natural resources"5, did not show a desirable status. These findings emphasize that strengthening participatory platforms and processes and improving access to information are essential for enhancing natural resource governance.

3.3. Fitting Measurement Models for the Index of Recognition and Respect for Tenure Rights

Data analysis using the Partial Least Squares (PLS) method revealed that the dimensions and items related to natural resource governance possess appropriate reliability and validity. Examination of the reliability of the "Recognition and Respect for Tenure Rights" dimension showed that Cronbach's Alpha (0.832) and Composite Reliability (0.874) were above standard values, and the Average Variance Extracted (0.583) was also at an acceptable level. Analysis of item factor loadings indicated that item "G12" with a factor loading of 0.833, is the most important factor in this dimension. This finding emphasizes that the existence of clear laws and procedures for conflict resolution plays a vital role in natural resource governance. The items "Relevant laws, policies and rules mandate recognition and respect for all tenure rights, with particular attention to the customary (including collective) rights of Indigenous peoples and local communities, and women's rights." (0.800), "Tenure rights are robust – enabling rights-holders to sustainably access, use, benefit from, manage and protect lands and other natural resources from threats." (0.789), and "Accessible and effective processes and capacities are in place to recognise and respect land and resource rights, including for the purposes of formal recognition." (0.754) are also of high importance, indicating attention to customary rights, tenure, and protective processes in natural resource governance. However, the item "Effective processes and capacities are in place to protect and enforce tenure rights." (0.660) had a lower factor loading, which indicates challenges in the

effective implementation of tenure rights. These findings suggest that although appropriate laws and frameworks exist for natural resource governance, their effective implementation requires more attention to local processes and capacities.

3.4. Fitting Measurement Models for the Index of Recognition and Respect for Diverse Cultures, Knowledge, and Institutions.

The results of data analysis using the Partial Least Squares (PLS) method, and the reliability and validity analysis of the research instrument, indicate the appropriate credibility of the questionnaire items in measuring the intended concepts. The Cronbach's Alpha, Composite Reliability, and Average Variance Extracted for the construct "Recognition of and respect for diverse cultures, knowledge and institutions" were 0.797, 0.868, and 0.623, respectively, all of which are above standard values.An examination of the factor loadings for the items of the construct "Recognition and respect for tenure rights" also showed that all four items had factor loadings above the standard threshold. Item "G16" with a factor loading of 0.867, had the highest factor loading, indicating the importance of integrating local knowledge into natural resource governance decision-making processes.

The item "The diverse cultural values and practices that sustain natural resources are respected and protected" with a factor loading of 0.802, demonstrates the importance of interaction between natural resource conservation and cultural values. The item "Governance institutions foster learning and adaptive management, valuing insights from diverse cultures and knowledge systems" with a factor loading of 0.772, specifies the role of governance institutions in strengthening community capacities and promoting cultural values.

The item "Governance strategies and actions are informed by sound, diverse forms of knowledge, including Indigenous and local knowledge" with a factor loading of 0.707, emphasizes the importance of utilizing local knowledge in formulating and implementing governance strategies and actions. Overall, the results of this research indicate that the research instrument possesses appropriate reliability and validity and effectively measures various dimensions of natural resource governance.

3.5. Fitting Measurement Models for the Devolution Index

The results of data analysis using the Partial Least Squares (PLS) method revealed that the items related to the "Devolution" dimension in natural resource governance possess acceptable reliability and validity. Cronbach's Alpha (0.795), Composite Reliability (0.867), and Average Variance Extracted (0.630) values were all above standard thresholds, indicating high consistency and validity of the questionnaire items in measuring this dimension. An examination of the factor loadings also showed that all four statements related to devolution had factor loadings above the standard threshold. Among these, statement "G18" with a factor loading of 0.825, held the highest importance in explaining this dimension.

This finding emphasizes that the implementation of legal and policy frameworks supporting community-led natural resource management, especially in watershed management, plays a vital role in achieving effective and equitable governance. Furthermore, the statements "Legal and policy frameworks devolve natural resource management to capable institutions closest to the natural resources concerned." (factor loading 0.800), "Local institutions (including customary institutions) have the capacities and support they need for effective and equitable natural resource governance." (factor loading 0.796), and "Appropriate recognition is given to the roles and authority of Indigenous peoples and local communities in natural resource governance" (factor loading 0.726) were ranked next in importance, respectively.

These results indicate that establishing appropriate laws and policies, delegating responsibilities to capable institutions, supporting local institutions, and recognizing the role of Indigenous peoples are key factors in achieving devolution and improving natural resource governance in the studied region.

3.6. Fitting Measurement Models for the Strategic Vision Index.

The results of structural equation modeling analysis with the Partial Least Squares (PLS) approach showed that all questionnaire constructs, including strategic vision and comprehensive decision-making, possess appropriate reliability and validity. Cronbach's Alpha (0.881) and Composite Reliability (0.909) for strategic vision were above the standard threshold, and the Average Variance Extracted (0.626) also indicated a good model fit. In the comprehensive decision-making dimension, all statements had factor loadings above the standard threshold, indicating their high power in measuring the intended concept. Statements such as "Natural resource governance and management activities are consistent with the strategies articulated in the vision.", "The strategic vision and direction effectively and equitably address present threats and anticipate future challenges.", "Governance institutions have processes in place for ongoing monitoring, reflection and learning, thereby enabling responsiveness to changing conditions and needs.", "The strategic vision and direction incorporate key principles of environmental sustainability, such as the precautionary principle against risks of environmental and social harm.", "Relevant legal, policy and management frameworks establish strategic vision and direction for natural resource governance." and "The strategic vision and direction are set through inclusive processes that take into account the diverse values and forms of knowledge of rights-holders and stakeholders." had high factor loadings. These findings indicate that natural resource governance in the studied region is on the right track, with an emphasis on alignment with the development document, attention to environmental threats, continuous monitoring and evaluation, adherence to sustainability principles, the existence of appropriate legal and policy frameworks, and stakeholder participation.

3.7. Fitting Measurement Models for the Coordination and Coherence Index.

The results of statistical analyses showed that the coordination and coherence index within the framework of natural resource governance possesses acceptable reliability and validity. According to Table 1, the Cronbach's Alpha value for this index is 0.914, and its Composite Reliability value is 0.939, both of which are higher than the standard test values. Furthermore, the Average Variance Extracted (AVE) for this index is 0.795, indicating its appropriate convergent validity. Examination of the factor loadings of the items for this index showed that all four statements had factor loadings higher than the standard research value.

The statement "Institutions collaborate and overlap functions in ways that increase resilience" ranks first with a factor loading of 0.901, indicating the importance of cooperation between institutions and local communities in improving regional resilience. The statement "Mechanisms are in place to enable vertical coordination across multiple levels of actors with roles in the governance of an ecosystem or resource" is ranked second with a factor loading of 0.897, emphasizing the importance of inter-organizational cooperation in integrated natural resource management. The third statement, with a factor loading of 0.895, indicates the importance of coordination between different institutions and organizations at the watershed level.

The statement "Legal and policy frameworks across sectors responsible for or affecting natural resource governance are aligned" is ranked fourth with a factor loading of 0.874, emphasizing the importance of aligning legal and policy frameworks in effective natural resource governance. These findings indicate that the coordination and coherence index is well capable of measuring the concept under investigation and can be used as a valid tool in evaluating natural resource governance.

3.8. Fitting Measurement Models for the Sustainable and Equitably Shared Resources Index.

The results of Partial Least Squares (PLS) analysis indicate that the research questionnaire possesses appropriate reliability and validity, such that the examined indices are well capable of measuring the intended concepts. In the dimension of sustainable and equitably shared resources, Cronbach's Alpha (0.849), Composite Reliability (0.888), and

Average Variance Extracted (0.571) are all above standard values.In examining the reliability of the items in the comprehensive decision-making dimension, 5 out of 6 statements had factor loadings above the standard threshold, indicating the importance of prevention and compensation principles in natural resource governance. These principles, which are emphasized within the legal and policy framework, address the protection of the rights of Indigenous peoples and local communities and the compensation for incurred losses. Statements related to equitable access of future generations to natural resources (factor loading 0.782), creating incentives through shared revenues (factor loading 0.757), equitable sharing of benefits (factor loading 0.739), economic sustainability (factor loading 0.720), and access of responsible parties to financial resources (factor loading 0.697) are all of high importance within the framework of natural resource governance in the studied region. These results indicate that comprehensive and sustainable management of natural resources requires attention to various economic, social, and environmental dimensions and necessitates appropriate mechanisms to ensure the rights of stakeholders and create incentives for their active participation.

3.9. Fitting Measurement Models for the Accountability Index.

The results of structural equation modeling analysis using the Partial Least Squares (PLS) method showed that the dimensions and items related to accountability in natural resource governance possess acceptable reliability and validity. According to Table 1, Cronbach's Alpha (0.805), Composite Reliability (0.860), and Average Variance Extracted (0.508) for the accountability dimension were above the standard research values, indicating the construct's internal consistency and validity. Examination of the factor loadings for accountability items revealed that three items: "The actors responsible for or affecting natural resource governance operate transparently and share relevant information on their actions openly and accessibly.", "The potential impacts of governance decisions on vulnerable people and environments are understood in advance and avoided or minimised to the fullest extent possible.", and "Social and environmental safeguards are adopted and implemented that explicitly take into account the situation of vulnerable groups and environments." had factor loadings above the standard value. These findings emphasize that transparency, attention to the impacts of decisions on vulnerable groups, and comprehensive oversight are key components of accountability in natural resource governance. However, three other items in this dimension, with lower factor loadings, indicate challenges in terms of resource scarcity, non-compliance with local needs, and corruption, which require attention and correction.

3.10. Fitting Measurement Models for the Fair and Effective Rule of Law Index.

The reliability and validity analysis of the items related to the "Fair and effective rule of law" dimension, using the Partial Least Squares (PLS) method, showed that all indicators possess appropriate reliability and validity (Table 1). Cronbach's Alpha (0.775), Composite Reliability (0.785), and Average Variance Extracted (0.532) were all above standard values, indicating the high capability of the questions in measuring the intended concept. Among the 5 statements examined, 4 statements had factor loadings above the standard value. The statement "Natural resource-related, laws, policies and rules incorporate principles of environmental sustainability." one ranked first with a factor loading of 0.800, indicating the importance of environmental sustainability principles in sustainable natural resource governance in Iran.

The statements "A clear system of natural resource norms and sanctions is defined in laws, policies or rules and is widely shared.", "equity in resource distribution" (0.770), and "Enforcement bodies have the capacity and commitment to uphold the norms and sanctions established to protect rights and the environment. (0.710) were also of high importance. However, the statement "Natural resource-related laws, policies and rules are consistent with human rights and take into account the situation of Indigenous peoples, local communities, women and all vulnerable, marginalised and/or minority groups." These findings suggest that although laws and

regulations in the natural resource sector are acceptable in terms of reliability and validity, in practice, they do not fully align with the living conditions of Indigenous and local people and require review and amendment.

3.11. Fitting Measurement Models for the Access to Justice and Conflict Resolution Index.

The results of data analysis using the Partial Least Squares (PLS) method showed that the items of the Access to Justice and Conflict Resolution index possess appropriate reliability and validity. Cronbach's Alpha (0.779), Composite Reliability (0.869), and Average Variance Extracted (0.625) values were all above standard thresholds, indicating the high capability of the questions in measuring the intended concept. Examination of factor loadings also indicated a significant relationship between the items and the access to justice index; such that the statements "Mechanisms operate impartially and effectively to resolve disputes and redress rights violations." (0.829), "People are aware of their natural resource-related rights and the avenues available to them for resolving conflicts or seeking redress." (0.82), "Formal or informal mechanisms are in place to resolve conflicts and grievances regarding land and natural resources." (0.750), and "Grievance- or dispute-resolution mechanisms are accessible to rights-holders and stakeholders, including vulnerable, marginalised and/or minority groups." (0.750) all had acceptable factor loadings. These findings indicate a favorable status of natural resource governance in the studied watershed and the existence of effective and accessible mechanisms for conflict resolution and ensuring justice in this domain.

3.12. Summary and Final Model Presentation

Analysis of the natural resource governance questionnaire results in the studied region revealed the relative importance of various indices in sustainable natural resource management. Based on the findings, the Strategic Vision index was identified as the most crucial factor in natural resource governance, achieving the highest score (8.42), which indicates the necessity of formulating long-term and strategic plans and policies in this domain. Subsequently, the Coordination and Coherence index ranked second with a score of 7.63, emphasizing the importance of establishing effective interaction and cooperation among various institutions and stakeholders.

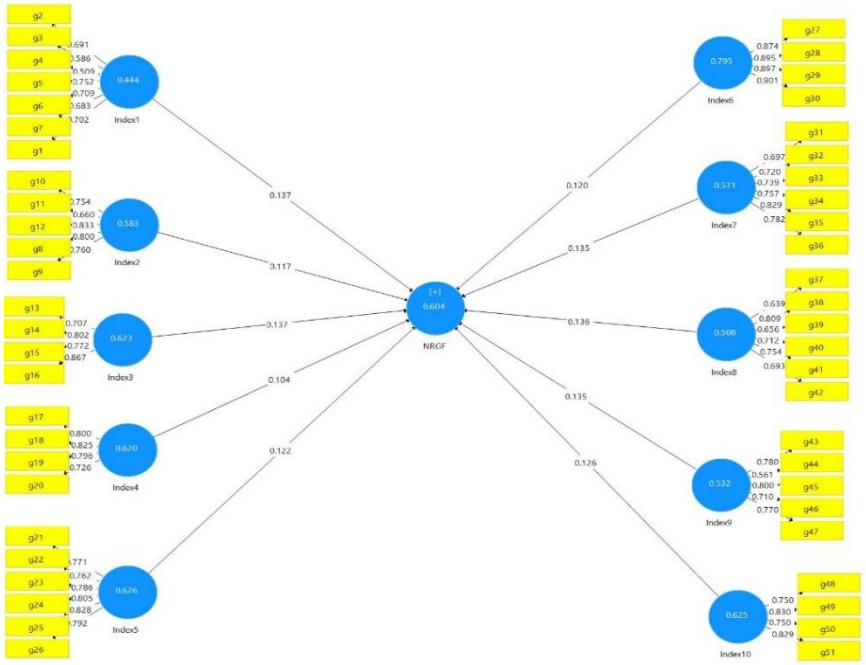

Fig. 4. Results of model fit for AVE

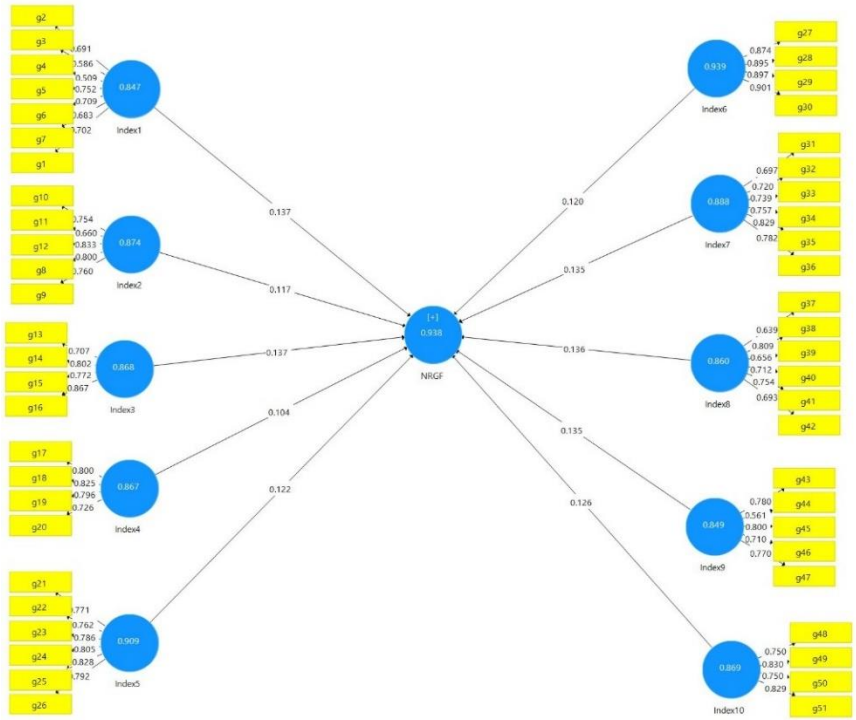

Fig. 5. Results of model fit for Composite Reliability (CR)

The Devolution (7.153), Fair and Effective Rule of Law (7.15), and Comprehensive Decision-Making (7.04) indices were also identified as important factors in natural resource governance, highlighting the need for broad stakeholder participation in decision-making processes and program implementation. The study reveals a significant implementation gap despite robust formal frameworks, particularly in Devolution (CR=0.867) and Coordination (CR=0.939). Weak execution is evident in sub-indicators like Access to Information (G4, FL=0.509) and Anti-Corruption Mechanisms (G42, FL=0.693).

The high Strategic Vision score (8.42) contrasts with poor performance in inclusive processes (G3, FL=0.568), reflecting a disconnect between long-term planning and stakeholder engagement. This discrepancy arises from centralized decision-making, limiting local input. Additionally, the Recognition and Respect for Diverse Cultures, Knowledge, and Institutions (7.16) and Accountability (6.67) indices also held significant importance, emphasizing the necessity of attention to cultural diversity and commitment to fulfilling responsibilities related to natural resource management. In summary, the results of this research indicate that effective natural resource governance requires attention to various dimensions, including strategic planning, stakeholder cooperation and participation, rule of law, and respect for cultural diversity.

This study has several limitations. First, the use of snowball sampling may introduce selection bias, as it relies on expert networks, potentially leading to institutional or regional homogeneity (Saunders et al., 2018). Second, the sample size of 89 experts, while sufficient for theoretical saturation, may not fully represent Iran's diverse governance landscape. Third, the study's focus on the NRGF framework limits its scope to predefined governance dimensions, potentially overlooking context-specific factors unique to Iran. Future research could employ mixed-method approaches to enhance generalizability. The NRGF, developed by the IUCN, is a globally applicable framework designed to assess natural resource governance across diverse ecological and socio-political contexts (IUCN, 2020b).

Its structured indicators and sub-indicators allow for adaptation to various regions, including arid and semi-arid environments similar to Iran. The use of PLS analysis further enhances its applicability by accommodating small sample sizes and non-normal data distributions, making it suitable for case studies in developing countries with limited data availability (Henseler et al., 2009). This study's methodology can thus be replicated in

other semi-arid regions, such as Central Asia or the Sahel, with adjustments for local governance structures. Iran's socio-political context, characterized by centralized governance and international sanctions, exacerbates governance gaps such as corruption (G42, FL=0.693) and limited devolution (G18, FL=0.825). Sanctions constrain funding for local institutions (G31, FL=0.697), while centralization limits participatory processes (G3, FL=0.568). Findings vary across Iran's ecosystems: the Caspian region's high precipitation (1,600 mm) supports different governance needs compared to the central deserts (<25 mm). Figure 1illustrates these ecological variations.

In this regard, successful experiences from other countries in natural resource governance can be utilized, and suitable models can be localized considering Iran's specific conditions and characteristics. For example, the participatory governance approach in Scandinavian countries (Ostrom, 1990) and ecosystem-based natural resource management models in Canada (Mitchell, 2013) can serve as appropriate models for Iran. This study's findings align with global research on natural resource governance in arid and semi-arid regions.

For instance, Stringer et al. (2018) emphasized the importance of resilience-focused governance in semi-arid regions like the Sahel, highlighting stakeholder collaboration, similar to the high-ranking Coordination and Coherence index (score=7.63) in this study. However, unlike Stringer et al.'s focus on resilience, this study uniquely identifies Strategic Vision (score=8.42) as the most critical governance factor in Iran, reflecting the need for long-term planning in a centralized governance system. Similarly, Akhtar et al. (2021) noted weak implementation as a barrier in Central Asia, corroborating this study's findings on enforcement gaps (e.g., G46, FL=0.660). Furthermore, the use of modern technologies such as Geographic Information Systems (GIS) and Remote Sensing (RS) can help improve natural resource monitoring and management (Longley et al., 2015).

Table 2. Inadequate Sub-Indicators

Sub-Indicator	Description	Factor Loading	Issue
G3	Inclusive stakeholder participation	0.568	Limited local engagement
G4	Access to information	0.509	Inadequate transparency
G42	Anti-corruption mechanisms	0.693	Weak enforcement
G46	Enforcement capacity	0.660	Resource constraints

3.13. Policy Suggestions and Recommendations

Despite ongoing efforts, the governance of natural resources in Iran continues to face numerous structural and functional challenges. The following recommendations and executive suggestions are presented considering these complexities and with the aim of promoting effective and sustainable environmental management.

3.13.1. Policy Recommendations

A: Strengthening Stakeholder Engagement: Policies should be formulated to ensure the active and meaningful participation of all relevant stakeholders (local communities, NGOs, private sector, experts, and academia) in decision-making processes concerning natural resources. However, it is important to note that achieving genuine and effective participation can be challenging and requires precise mechanisms to ensure the voices of marginalized groups are heard and to prevent the dominance of particular interests.

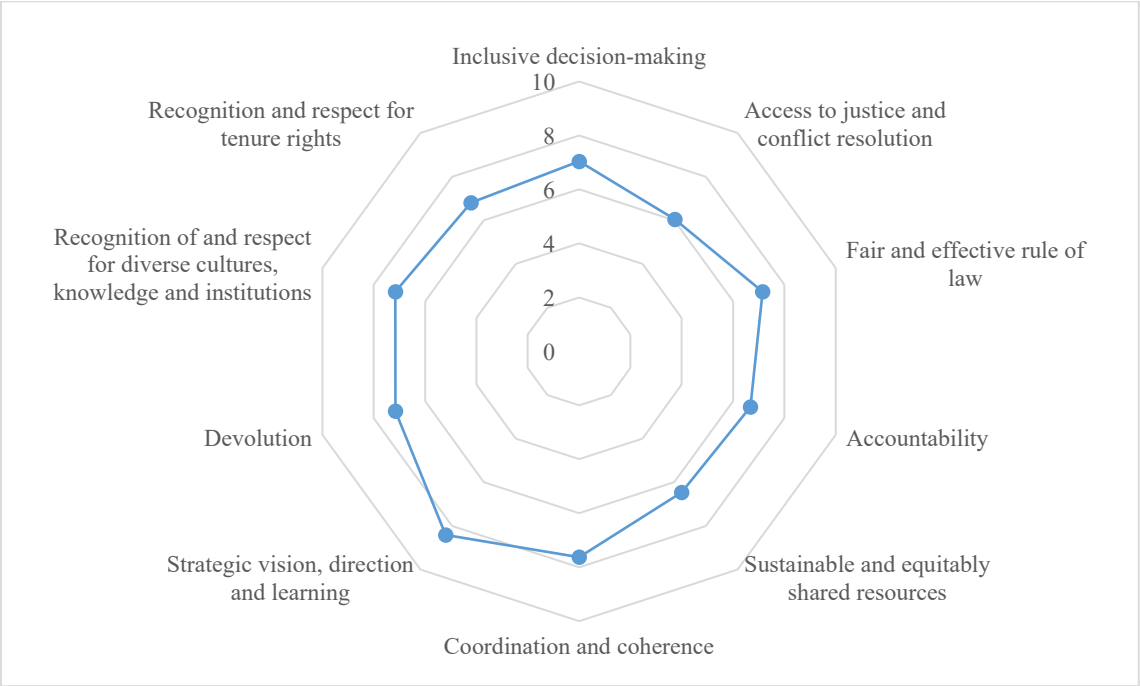

Fig. 6. Ranking of Influential Indicators in Iran's Natural Resource Governance

B: Legislative and Regulatory Reforms: Existing laws and regulations in the field of natural resources should be reviewed and reformed to resolve ambiguities, increase efficiency, and improve alignment with local conditions and needs. Additionally, the development of new laws to address emerging environmental challenges is necessary. However, special attention should be paid to the potential resistance of influential stakeholders to changes, as well as ensuring the scientific and expert basis of the reforms.

C: Capacity Building and Awareness Raising: Policies should emphasize the importance of education and capacity building at various levels, including local communities, government officials, and resource users. These programs should focus on promoting sustainable resource management practices, environmental awareness, and the principles of good governance. Of course, the effectiveness of these programs requires continuous evaluation and adaptation of content to the real needs of the audience to prevent merely increasing knowledge without changing behavior.

D: Adopting Adaptive Governance Approaches: Policymakers should promote and adopt adaptive governance models that provide flexibility, continuous learning, and responsiveness to changing environmental and social dynamics in natural resource management. However, the implementation of these approaches requires changes in organizational structures and management mindsets and may face resistance.

D: Alignment with National Development Goals: Ensuring the complete alignment and integration of natural resource governance policies with the goals, strategies, and priorities outlined in the country's national development plan is essential to prevent conflicts and strengthen synergy. However, it should also be noted whether the national development goals adequately prioritize environmental considerations, and how the alignment process can ensure genuine integration.

E: Proactive Management of Environmental Threats: Policies should adopt a proactive and preventative approach to identify, assess, and develop effective strategies to reduce major environmental threats facing Iran. However, the accuracy and reliability of scientific data used in threat assessment, as well as the potential influence of political and economic pressures on the decision-making process, should be critically considered.

F: Enhancing Transparency and Accountability: Strengthening transparency in decision-making processes, resource allocation, and environmental monitoring, along with strong accountability mechanisms, is essential for building trust and improving governance effectiveness. However,

establishing genuine transparency and effective accountability requires the existence of independent regulatory bodies and strong laws for access to information and punishment of violations.

3.13.2. Executive Suggestions:

A: Establish Multi-Stakeholder Platforms for Dialogue and Collaboration: Create formal platforms at various levels (local, regional, national) that bring together diverse stakeholders to facilitate dialogue, knowledge sharing, and collaborative decision-making in natural resource management. However, it must be ensured that these platforms become venues for genuine negotiation and not merely formal exchanges, and that decision-making power is distributed proportionally.

B: Develop Accessible Information Management Systems: Implement user-friendly and publicly accessible information systems that provide comprehensive data on the state of natural resources, environmental regulations, and governance processes. However, merely providing information is not sufficient, and it must be ensured that this information is understandable and relevant to different stakeholders, with mechanisms for its active dissemination.

C: Implement Targeted Training and Extension Programs: Design and deliver tailored training programs and extension services for local communities, resource users, and government personnel to enhance their understanding of sustainable practices and governance principles. However, the effectiveness of these programs should be continuously evaluated, and the content and delivery methods should be adjusted based on the actual needs and different cultural contexts.

D: Support Pilot Projects in Adaptive Management: Initiate and support pilot projects that utilize adaptive management approaches in different ecological and socio-economic contexts to test and refine governance strategies. However, transferring the findings of these projects to the national level and ensuring their sustainability requires attention to the challenges of scalability and the allocation of sufficient resources.

E: Strengthen Environmental Monitoring and Enforcement Agencies: Increase the capacity and resources of environmental monitoring and enforcement agencies to ensure effective implementation of regulations and address environmental violations. However, the independence and immunity of these organizations from political and economic pressures to perform their duties effectively are essential.

F: Promote the Integration of Traditional and Local Knowledge: Develop mechanisms to identify, value, and integrate indigenous and local ecological knowledge into natural resource management planning and implementation. However, this process should be carried out with respect for the rights of local communities and their active participation, avoiding the mere extraction of knowledge without benefiting these communities.

G: Conduct Regular Audits and Assessments of Governance Effectiveness: Implement periodic audits and assessments of the effectiveness of environmental governance frameworks and practices, using established indicators and involving independent experts. Feasibility: Implementation barriers include political resistance to devolution (G18) and funding constraints (G31). Phased strategies, such as pilot projects followed by national scaling, can mitigate these challenges. Stakeholder Prioritization: Targeted capacity-building programs should prioritize marginalized groups, including women and Indigenous communities, to enhance inclusive decision-making (G3, G5). Technology Integration: GIS and RS technologies can address monitoring gaps (G26) by providing real-time data on resource use, improving enforcement (G46) (Longley et al., 2015).

H: Establish Clear Grievance Mechanisms and Conflict Resolution Processes: Develop accessible and fair mechanisms for addressing grievances and resolving conflicts related to natural resource management and environmental issues. However, it must be ensured that these mechanisms are independent, impartial, and efficient, and that access to them is easily possible for all stakeholders.

I: Promote Corporate Social Responsibility in Resource Extraction: Encourage and incentivize companies involved in natural resource extraction to adopt strong corporate social responsibility practices to minimize

environmental and social impacts. However, relying solely on corporate social responsibility is not sufficient, and there is a need for binding regulations and strong oversight to ensure their responsible behavior.

4. Conclusion

This research aimed to analyze natural resource governance in Iran based on the Natural Resource Governance Framework (NRGF) and investigate its impacts on ecological, social, and economic sustainability in the studied region. The results indicate that effective governance necessitates multi-dimensional interaction among governmental institutions, local communities, and non-governmental organizations. However, the findings point to challenges such as weak public participation, lack of transparency in decision-making, and inequality in benefit distribution. Based on data analysis, increasing local community participation in the decision-making and policy-making processes is the most effective component for improving natural resource governance. The absence of efficient participatory structures has led to top-down decisions and the disregard of local communities' voices.

Therefore, a revision of the governance model towards adaptive and participatory governance is suggested. Economic dimension analysis shows that unsustainable exploitation and the lack of transparent regulatory mechanisms have led to environmental degradation and reduced productivity. Adopting policies based on intergenerational equity and sustainable development, and reforming the legal and regulatory system, are essential.

In the social sphere, disregard for local communities' rights and inattention to indigenous knowledge are obstacles to achieving desirable governance. It is suggested that planning and policymaking should incorporate the perspectives and experiences of local communities. The findings of this research, which aimed to investigate and analyze the status of natural resource governance in Iran, indicate that improving this domain requires adopting multi-faceted and integrated strategies.

First, strengthening participatory frameworks and creating appropriate platforms for the active presence of local communities in decision-making processes is essential. Second, reforming laws and regulations related to natural resource exploitation, with the aim of increasing transparency and accountability, should be prioritized. These reforms must be designed to facilitate administrative processes while preventing misuse and destruction of natural resources. Third, developing training programs for empowering local communities and enhancing environmental awareness plays a key role in achieving sustainable governance. These programs should be designed and implemented considering local needs and conditions, and include technical, managerial, and environmental training.

Fourth, adopting adaptive governance models that offer flexibility in facing environmental and social changes is essential. These models should be designed to adapt to changing conditions and utilize innovative, evidence-based approaches. Finally, achieving sustainable natural resource governance requires continuous and constructive cooperation among the government, local communities, the private sector, and other stakeholders.

This cooperation must be based on principles of transparency, accountability, justice, and participation to maintain a balance between economic exploitation and environmental protection Ultimately, establishing a continuous monitoring and evaluation system to assess natural resource governance performance and identify strengths and weaknesses is essential. The NRGF framework, combined with PLS analysis, offers a robust methodology for future studies on natural resource governance, particularly in arid and semi-arid regions. Its adaptability allows application in diverse contexts, such as Central Asia or North Africa, by tailoring indicators to local conditions (IUCN, 2020a).

To enhance this study, future research could integrate mixed-method approaches, combining qualitative interviews with quantitative surveys to capture nuanced governance dynamics. Expanding the sample size and incorporating stratified sampling could improve representativeness, addressing limitations of snowball sampling (Saunders et al., 2018). Additionally, incorporating climate resilience as a distinct NRGF dimension could

strengthen its applicability to regions facing intensifying environmental challenges.

This study reveals a profound structural dichotomy in Iran's natural resource governance system: While legal frameworks in domains such as Devolution (AVE=0.63, CR=0.867) and Coordination (AVE=0.795, CR=0.939) demonstrate robust design—exemplified by sub-indicator G27 (sectoral policy alignment, FL=0.874)—critical implementation gaps persist. Four key sub-indicators, including Access to Information (G4, FL=0.509), Anti-Corruption Mechanisms (G42, FL=0.693), Enforcement Capacity (G46, FL=0.660), and Inclusion of Diverse Groups (G3, FL=0.568), are rated "Inadequate."

This governance gap stems from three systemic failures: (1) Ineffective monitoring mechanisms bridging law and practice (evidenced by low accountability reliability, CR=0.860), (2) Inequitable capacity-building distribution (32.4 %disparity between G5/FL=0.752 and G3/FL=0.568), and (3) Chronic underfunding of local institutions (G31, FL=0.697).

To address this, three transformative solutions are proposed: First, establishing a National Natural Resource Monitoring Platform to enhance transparency (G4); second, creating a High Council for Natural Resource Oversight with judicial inspection authority to strengthen G42/G46; third, launching a National Resource Restoration Fund, sourcing 30 %of capital from industrial pollution fees to resolve G31.

Reform sustainability requires institutionalizing governance metrics in ministerial performance evaluations and forming joint think tanks with local communities. Crucially, the core impediment is not legislative deficiency but institutional reluctance to operationalize accountability—a challenge necessitating redefining the state's role from "operator" to "effective regulator".

This study refines the NRGF for arid regions by suggesting the inclusion of a "climate resilience" dimension, addressing the unique challenges of water scarcity and ecosystem degradation (Kolahi et al., 2024). Compared to Stringer et al. (2018), which focused on resilience in the Sahel, this study emphasizes strategic vision (score=8.42) as a priority for Iran's centralized governance system, offering a unique perspective on aligning national policies with local needs.

5. Conflict of Interest

No potential conflict of interest was reported by the authors.

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