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Integrated SWOT and AHP Analysis for Participatory Forest Management – a case study in Qazvin Province, Iran

Integrierte SWOT- und AHP-Analyse für partizipatives Waldmanagement – eine Fallstudie in Provinz Qazvin, Iran

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Keywords: Decision-making, forest management, stakeholder engagement, sustainability, multi-criteria evaluation, resource conservation, participatory approach

Schlüsselbegriffe: Entscheidungsfindung, Waldmanagement, Beteiligung von Interessengruppen, Nachhaltigkeit, multikriterielle Bewertung, Ressourcenschutz, partizipativer Ansatz.

Abstract

Forest management, especially in regions with diverse socio-economic and environmental challenges, is crucial for promoting sustainable livelihoods. The absence of effective participatory forest management strategies has led to deficits in both forest resource conservation and the enhancement of local livelihoods. This research investigates participatory forest land management by identifying and prioritizing key factors and proposing strategic management approaches. Data were collected through interviews and questionnaires in Qazvin Province, Iran. The data was analyzed using an integrated SWOT-AHP model. The SWOT matrix underscored critical aspects of forest resource management in the study area: "soil conservation and erosion prevention" emerged as a key strength, while "economic stability, improvement

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and diversity of livelihood of dependent communities" were highlighted as significant opportunities. Conversely, "weak enforcement of laws, policies, and strategies" was identified as a notable weakness and "reduction of forests area" was a concerning threat. The prioritization of SWOT factors revealed that opportunities hold the highest priority. Specifically, "economic stability, improvement, and diversification of livelihoods for dependent communities" and "collaborative forestry" were assigned top priorities, with final weights of 0.1665 and 0.1095, respectively. Furthermore, the AHP method indicated that “program-oriented management with stakeholder participation” is the most crucial strategy, with a relative weight of 0.21. The study underscores this strategy as an effective approach to achieving sustainable forest management, emphasizing its potential to align stakeholder interests and enhance forest conservation efforts.

Zusammenfassung

Die Bewirtschaftung von Waldflächen, insbesondere in Regionen mit vielfältigen sozioökonomischen und ökologischen Herausforderungen, ist entscheidend für die Förderung nachhaltiger Lebensweisen. Das Fehlen effektiver partizipativer Waldmanagementstrategien hat zu Mängeln in der Walderhaltung und der Verbesserung der Lebensgrundlagen lokaler Gemeinschaften geführt. Diese Studie untersucht das partizipative Waldmanagement, indem zentrale Faktoren identifiziert und priorisiert sowie strategische Managementansätze vorgeschlagen werden. Die Daten wurden durch Interviews und Fragebögen in der Provinz Qazvin, Iran, erhoben und anschließend mit einem integrierten SWOT-AHP-Modell analysiert. Die SWOT-Matrix hob folgende wesentliche Aspekte des Waldmanagements im Untersuchungsgebiet hervor: "Bodenschutz und Erosionsverhütung" erwiesen sich als eine wichtige Stärke, während "wirtschaftliche Stabilität, Verbesserung und Diversifizierung der Lebensgrundlagen abhängiger Gemeinschaften" als bedeutende Chance identifiziert wurde. Im Gegensatz dazu wurde "schwache Durchsetzung von Gesetzen, Politiken und Strategien" als eine bemerkenswerte Schwäche und "Rückgang der Waldflächen" als eine besorgniserregende Bedrohung benannt. Die Priorisierung der SWOT-Faktoren zeigte, dass Chancen die höchste Priorität besitzen. Insbesondere "wirtschaftliche Stabilität, Verbesserung und Diversifizierung der Lebensgrundlagen für abhängige Gemeinschaften" sowie "kollaborative Forstwirtschaft" wurden mit den höchsten Prioritäten versehen, mit finalen Gewichtungen von 0.1665 bzw. 0.1095. Darüber hinaus zeigte die AHP-Methode, dass "programmorientiertes Management unter Beteiligung von Interessengruppen" die wichtigste Strategie darstellt, mit einem relativen Gewicht von 0.21. Die Studie hebt hervor, dass diese Strategie ein effektiver Ansatz zur Förderung nachhaltiger Waldbewirtschaftung sein kann und Potenzial zur Angleichung der Interessen von Interessengruppen und Verbesserungen in der Walderhaltung hat.

1 Introduction

Forest resources are vital for maintaining ecosystem balance, ensuring food security, and fostering a healthy environment for all living beings. Sustainable forest management is a key element in the broader context of natural resource utilization and environmental conservation. Traditionally, forest planning primarily aimed at economic objectives or enhancing environmental protection. However, the concept of forest management has evolved from focusing solely on sustainable product yields to adopting a more comprehensive approach that integrates ecology, economy, and society. Previously, less attention was given to multi-purpose goals due to their potential conflicts, which made achieving them simultaneously seem challenging (Mohammadi Limaei, 2022).

A more inclusive perspective on natural resource management recognizes the importance of a participatory approach that embraces diverse viewpoints, including local and potentially indigenous knowledge, history, and culture (Harris and Roach, 2022). This shift towards integrating varied perspectives is essential for developing effective and sustainable management strategies. Participatory forest management has gained significance as a way to improve the sustainability of forest resources while supporting local communities. Recent studies have highlighted the importance of local participation in forest management to address challenges such as deforestation and biodiversity loss (*e.g.*, Abedi Sarvestani & Ingram, 2020; Zandebasiri *et al.*, 2020).

According to the FAO (2015), "Participatory processes and mechanisms are meant at enabling those people who have a direct stake in forestry to be part of decision-making in all aspects of forest management, including forest policy formulation and management of forests. They are usually based on group-visual activities ("tools") and facilitation which intends to create mutual learning, and empowerment of the participants." Participatory approaches in forest management have been evolving globally due to the recognition of the limitations inherent in centralized and top-down decision-making in forestry. The adoption of national forest programs (NFPs) in many countries has integrated the principle of participation into planning, management, and monitoring within these frameworks, creating opportunities for stakeholders to negotiate agendas, policies, programs, roles, and partnerships (FAO, 2015). The increasing complexity and array of challenges in forest management necessitate the use of Decision Support Systems (DSS) to address multi-dimensional problems, supported by political and legislative backing (Başkent, 2018). Multipurpose goals along with the complexities of forest management requires the planning tools and the decision-making solution to enable optimal planning and sustainable management of forest resources more easily by creating more effective and comprehensive evaluation strategies

While numerous criteria and indicators have been developed internationally for sustainable forest management, the challenge lies in effectively localizing and operatio-

nalizing these frameworks at the national, regional, and local levels. In this context, participatory forest management plays a crucial role by integrating local knowledge and perspectives into decision-making processes. To support this, Multi-criteria decision-making (MCDM) methods have emerged as valuable tools for sustainable forest management, integrating diverse stakeholder perspectives and balancing conflicting objectives (Steiguer *et al.*, 2003). These approaches facilitate participatory decision-making processes, allowing for the inclusion of economic, environmental, social, and cultural factors in forest planning (Bertrand & Martel, 2002). MCDM techniques have evolved to address complex environmental issues and support stakeholder involvement in decision-making (Acosta & Corral, 2017). The integration of multiple criteria and group decision-making methods has become increasingly important in forestry, as it enables the consideration of various conflicting criteria evaluated by different stakeholders (Ortiz-Urbina *et al.*, 2019). By employing MCDM approaches, forest managers can develop socially acceptable and responsible management plans that address the growing complexity of forest management issues, including climate change and social protection (Acosta & Corral, 2017; Ortiz-Urbina *et al.*, 2019).

MCDM approaches offer a promising framework for evaluating multidimensional and conflicting issues (Goleij *et al.*, 2016). Multi-criteria optimization can effectively aid in selecting appropriate forest management methods to fulfill various forest functions (Schreckenberg & Luttrell, 2019). Recent studies further support the utility of MCDM techniques in enhancing forest management practices by integrating scientific suitability, stakeholder engagement, and sustainability concepts (Başkent & Balci, 2024). Lacerda *et al.* (2023) explore these principles in the context of selective logging, a well-recognized practice in sustainable forest management. Their study integrates economic and ecological aspects through multi-objective functions and evolutionary algorithms, aiming to optimize stand diversity, merchantable logs, and logistical efficiency.

Currently, the issue of decision-making and evaluation of existing criteria and options has become one of the basic challenges in the field of management and attracted the attention of many managers and researchers. One of the most common methods that used in strategic planning and developing solutions for organization is the SWOT (Strengths, Weaknesses, Opportunities, and Threats) method. The purpose of SWOT is to formulate and adopt a strategy that aligns well with both internal and external factors. SWOT analysis is a participatory tool widely applied for analyzing both environments in order to attain a systematic approach and support decisions (Kurttila *et al.* 2000). In recent years, SWOT analysis has been adapted to the context of forest management methods due to its capability in providing a reasonable framework for developing solutions (*e.g.*, Baycheva-Merger & Wolfslehner, 2016; Falcone *et al.*, 2020; Nzunda and Manyanda, 2023; Limbong *et al.*, 2023).

Another important decision-making tool is the Analytical Hierarchy Process (AHP), developed by Saaty (1980), which can complement the SWOT analysis by providing a structured method for evaluating and prioritizing the identified factors. The AHP

is widely used in various fields, including forestry and forest management planning. It helps in structuring complex decision problems and evaluating multiple criteria. Its application in forestry and forest management is well-documented (e.g., Kangas, 1999; Mohammadi & Mohammadi Limaei, 2018; Chia *et al.*, 2020; Latterini *et al.*, 2022; Grošelj *et al.*, 2023; Zhu & Miao, 2024). Recently, it has also been applied to forest fire risk mapping and coppice forest management. For instance, Özcan *et al.* (2024) used AHP combined with other techniques like the Ordered Weighted Average (OWA) to map forest fire risks in southern Turkey, demonstrating its versatility in environmental hazard assessments. Similarly, Zandebasiri *et al.* (2024) employed AHP to optimize coppice forest management scenarios in Iran, illustrating its use in evaluating various management options based on social, ecological, and economic criteria.

Due to the limitations in ranking factors inherent in SWOT analysis, a combined AHP-SWOT analysis is often employed in decision-making to enhance the evaluation process (Görener *et al.*, 2012). Several studies have applied integrated AHP-SWOT methods in forest and land management to provide more comprehensive insights (*e.g.,* Yavuz & Baycan, 2013; Etongo *et al.,* 2018; Mackialeagha *et al.*, 2022; Fan *et al.*, 2023). This integrated approach facilitates a thorough examination of various scenarios, supporting more informed and sustainable forest land management strategies.

To formulate a suitable strategy for the sustainable management of forest resources, methods should not only present the strategy but also consider the potential involvement of all stakeholders influencing sustainable forest management. This includes assessing the impact of conflicts among stakeholders, as these conflicts can significantly affect the implementation and success of management strategies. By incorporating stakeholder perspectives and addressing conflicts, the combined AHP-SWOT approach ensures a more holistic and practical strategy, enhancing both the feasibility and acceptance of sustainable forest management initiatives.

2 Materials & Methods

2.1 Study area

This research was carried out in the Tarom Sofla region of Qazvin province, Iran, located between longitudes 49° 02′ 43″ E and 49° 19′ 30″ E, and latitudes 36° 42′ 53″ N and 36° 25′ 43″ N (Fig. 1). The forest area is 14212 ha. In addition, 72 ha are agricultural lands and gardens. The mean annual precipitation sum and mean annual temperature are 349.6 mm and 10.7 °C, respectively, and the mean elevation is approximately 1,850 m. This area has a semi-arid cold climate, based on the Emberger climate classification. The study area encompasses 17 residential settlements with a total population of 2,654 people, distributed across 1,078 households (Statistical Center of Iran, 2023). The social structure in the region is predominantly rural nomadic, with

the majority of residents primarily engaged in agriculture and animal husbandry as their main source of livelihood.

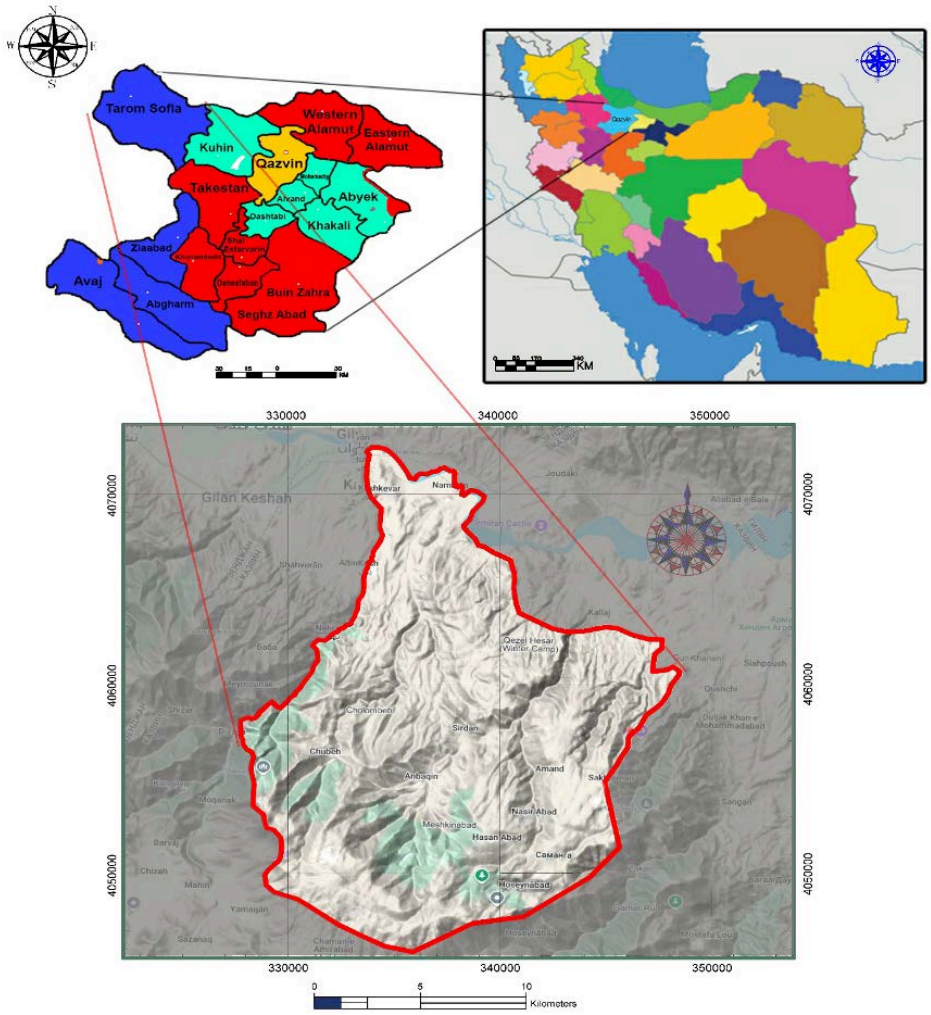

Figure 1: Location of study area.

Abbildung 1: Lage des Untersuchungsgebiets.

In the study area, the vegetation features a diverse range of major tree, shrub, and herb species. Prominent herbaceous plants include *Acantholimon flexuosum* (flexu-

ous spindleweed), *Achillea wilhelmsii* (Wilhelm's Yarrow), and *Agropyron intermedium* (intermediate wheatgrass) and *Agropyron trichophorum* (bearded wheatgrass), all from the Poaceae family. Other notable herbs are *Alyssum longistylum* (long-styled alyssum), *Astragalus citrinus* (lemon astragalus), and *Astragalus microcephalus* (small-headed astragalus), with *Alyssum* from the Brassicaceae family and *Astragalus* species from the Papilionaceae family. Among shrubs, *Lonicera hispidula* (trailing honeysuckle) is significant, along with *Cephalaria microcephala* (small-headed cephalaria) and *Cousinia calocephala* (beautiful-headed cousinia) and *Cousinia esfandiarii* (Esfandiari's cousinia).

Tree species include *Cotoneaster kotschyi* (Cotoneaster) and various *Quercus* spp. (oaks). Associated species are *Sorbus torminalis* (Wild service tree), *Berberis vulgaris* (barberry), *Acer* spp. (maple), *Juniperus excelsa* (Greek juniper), *Fraxinus excelsior* (European ash), *Prunus cerasifera* (Cherry plum) and *Crataegus monogyna* (hawthorn). This rich variety underscores the ecological complexity and biodiversity of the region.

Based on species dominance and canopy cover percentages, two distinct forest types were identified according to Mozaffari Sahneh Saraei (2024):

1. **Oak-Cotoneaster forest:** Dominated by *Cotoneaster kotschyi* and *Quercus* spp., with associated species including *Sorbus torminalis*, *Berberis vulgaris*, maple, *Juniperus excelsa*, *Lonicera nummularifolia*, and *Fraxinus excelsior*.
2. **Cotoneaster-Oak forest:** Characterized by *Cotoneaster kotschyi* and *Quercus* spp., with associated species such as *Juniperus excelsa*, *Acer* spp., *Crataegus monogyna*, and *Prunus cerasifera*.

In 2007, a conservation and protection plan for the Hosseinabad region of Tarom Sofla was approved, with funding allocated beginning in 2009. The project included afforestation efforts over 50 ha, utilizing *Juniperus excelsa* as the primary species. In addition, the land was compartmentalized. From 2009 to 2014, additional measures such as grazing control and irrigation were implemented.

2.2 Methods

This study presents a novel approach to forest land management in Qazvin Province, Iran, by integrating the SWOT analysis and AHP methods. These methodologies, individually well-established in forest management, are used here in combination to provide a comprehensive framework for addressing complex management challenges. The integration of AHP and SWOT facilitates the identification, evaluation, and prioritization of key factors influencing forest management, offering a more effective decision-making process. This method not only advances forest management practices but also contributes to sustainable development principles by considering a wide range of social, economic, and environmental factors in decision-making.

Our comprehensive approach tackles critical social, economic, and environmental issues, providing a holistic framework for decision-making. This method ensures that various principles, criteria, and indicators are considered, which is essential for achieving sustainable forest development. Analyzing current conditions through this model is crucial for shaping effective future strategies. Moreover, the application of MCDM methods in this study facilitated expedited data collection and result processing. This not only streamlined the research process but also enhanced local community engagement in forest resource management. By emphasizing the role of stakeholder participation and presenting a robust strategy for sustainable management, this study offers valuable insights and practical solutions that are likely to resonate with international audiences and contribute significantly to the global discourse on forest management.

To achieve the research objective of proposing effective solutions for forest land management, an integrated approach utilizing both SWOT and AHP methods was employed. The study began with the formation of a core group of qualified experts in natural resource management, which included experienced forestry officials and key regional stakeholders. This group was established using the Delphi method to ensure a structured, consensus-driven selection process. Hence, forest experts and academics were consulted to determine the factors influencing participation in forest management using the Delphi method through interviews in 2022.

The Delphi method was used to refine and validate the SWOT factors through input from experts in forestry, environmental management, and socio-economics. The process included three rounds:

1. **Round 1:** Experts reviewed an initial list of factors derived from field data and literature, providing feedback and suggesting modifications. This resulted in a more context-specific set of factors.
2. **Round 2:** Experts rated the revised factors on a Likert scale (1–5), enabling prioritization and identification of areas of disagreement.
3. **Round 3:** Experts re-evaluated factors based on anonymized feedback, achieving consensus on the final factors and their importance for the AHP analysis.

Changes Across Rounds: The number of factors was refined with shifts in priority, such as "collaborative forestry" gaining prominence. This process ensured that SWOT components were robust, relevant, and actionable. Following the initial expert consultation, a problem-solving workshop was organized to clarify the research objectives and thoroughly review all relevant records, documents, and data sources. The workshop provided an opportunity for stakeholders to engage in collaborative discussions and exchange insights on the challenges and opportunities in forest land management. Utilizing the SWOT analysis framework, participants systematically identified and evaluated the internal strengths and weaknesses, as well as external opportunities and threats, that impact the effectiveness of forest management practices (Rauch, 2017; Grošelj *et al.*, 2023).

In addition to the expert consultations, participatory rural assessment (PRA) workshops were held at four locations within Qazvin Province to engage local communities, including villagers and nomadic populations, in identifying relevant strengths, weaknesses, opportunities, and threats related to forest management. These workshops facilitated collaborative discussions, enabling participants to share their knowledge and experiences regarding the challenges and opportunities in forest management. To complement the PRA workshops, 50 questionnaires were distributed to a diverse group of participants, including local residents, forestry experts, university academics, and representatives from NGOs and industries. The data were collected in 2022, with respondents comprising 15 females and 35 males, representing a range of professions: 5 forest dwellers, 15 experts from the General Office of Natural Resources of Qazvin Province, 10 academic members, 10 representatives from NGOs, and 5 individuals from the wood and tourism industries. The questionnaires gathered information on local perceptions of forest management issues and potential solutions.

The data from the PRA workshops were integrated with the questionnaire responses, providing a comprehensive understanding of the community's views. Expert responses, in particular, helped refine the SWOT analysis framework, ensuring that the factors identified through the workshops were accurately captured and prioritized. The combined data were subsequently used for further analysis, including the application of the AHP method to prioritize the SWOT factors. The highest-scoring factors from the SWOT analysis were then included in pairwise comparison questionnaires, referred to as expert questionnaires, which were distributed to specialists. The responses from these questionnaires were analyzed to develop strategic programs for managing forest resources. This approach ensured that the strategic programs were based on expert evaluations and insights.

Unlike several previous studies that relied solely on the SWOT method for prioritizing sustainable solutions for forest lands, this study adopted a more comprehensive approach. It incorporated the quantification of various factors through the AHP, utilizing paired comparisons. AHP is a structured decision-making method that enables the prioritization of factors by considering their relative importance based on expert judgment.

Scale used: AHP employs a scale of 1 to 9 for pairwise comparisons, where:

1 indicates equal importance between two factors,
3 indicates that one factor is slightly more important than the other,
5 indicates a strong preference for one factor over another,
7 indicates a very strong preference,
9 indicates an extreme preference. Intermediate values (2, 4, 6, 8) can represent intermediate degrees of importance. This scale was used by experts to compare each pair of factors at each level of the hierarchy.

Designing the questionnaire: For this study, a paired comparison scale questionnaire was designed and completed by 50 experts. The experts evaluated the SWOT fac-

tors—strengths, weaknesses, opportunities, and threats—relative to each other within the entire group. Each expert made pairwise comparisons, assessing how much more important one factor was over another. The questionnaire provided the structure for entering these comparisons into Expert Choice software, which was used for further analysis.

Calculation of the priority vector: After the pairwise comparisons were entered into the Expert Choice software, a hierarchical structure was created, and the data were processed to calculate the priority vector. This vector reflects the relative importance of each factor based on the aggregated judgments from the experts. First, the pairwise comparison matrix was normalized by dividing each element in a column by the sum of the elements in that column. The normalized values were then averaged row-wise to derive the priority vector.

Consistency Ratio (CR): An important feature of AHP is the calculation of the CR, which measures the reliability of the pairwise comparisons. A high inconsistency rate suggests that the judgments made by the experts may be contradictory.

The consistency index (CI) is calculated using the formula (Eq. 1):

$$CI = \frac{\lambda_{max} - n}{n-1} \qquad (1)$$

where λ_{max} is the largest eigenvalue of the comparison matrix and n is the number of factors being compared. The random index (RI) is then used to calculate the consistency ratio:

$$CR = \frac{CI}{RI} \qquad (2)$$

If the CR exceeds 0.1, it indicates that the judgments may not be reliable, and the questionnaire would either be discarded or revised. In this study, the inconsistency rate was checked individually for each expert's responses. If any questionnaire had a CR greater than 0.1, it was returned to the expert for revision, in accordance with Saaty's (2004) guidelines.

1. Aggregation of individual assessments into group assessments: The individual assessments from each expert were aggregated to form a group assessment. The average priority vector of all experts was used to compute the final priority rankings for the SWOT factors. This aggregation process ensures that the results reflect the consensus of all experts, minimizing individual biases.

2. Final scoring and strategy development: The scores of the elements within each SWOT category were then analyzed comprehensively. The final score for each factor was calculated by multiplying its individual score (derived from the priority vector) by the overall score of its respective SWOT category. Based on these final scores and the collective judgment of experts, strategies for sustainable forest management were developed. These strategies were informed not only by the AHP results but also by the insights of participants, results from previous research, and inferred relationships between the factors in the SWOT matrix.

By combining both qualitative insights and quantitative analysis through AHP, this study provides a robust framework for addressing the challenges of sustainable forest management and offers actionable recommendations for stakeholders and policymakers. To address the challenge of conducting pairwise comparisons with a large number of factors in the SWOT-AHP approach, we first prioritized the most significant factors identified through the SWOT analysis, informed by the inputs from both the PRA workshops and questionnaires. This allowed us to reduce the number of factors for pairwise comparisons, ensuring a more manageable process for the experts. Clear guidelines were also provided to facilitate the experts' assessments and maintain consistency throughout the evaluation process. This approach ensured that the AHP method was effectively applied without overwhelming the participants.

Results

The results of the SWOT analysis, derived from expert evaluations, are summarized in Table 1. This analysis categorizes factors into strengths, weaknesses, opportunities, and threats. Strengths and opportunities represent positive attributes and potential advantages, while weaknesses and threats highlight challenges and risks. Strengths include aspects like valuable non-wood products, rich biodiversity, and effective carbon sequestration. These are areas where the forest management can build upon. Opportunities such as expanding the production of non-wood products and enhancing supply chain management provide avenues for growth and improvement. Conversely, weaknesses such as inadequate cooperation and wood smuggling represent internal challenges that need to be addressed. Threats, including climate change and construction activities, pose external risks that could undermine management efforts.

This structured approach not only identifies current conditions but also provides actionable insights to enhance forest management strategies, aiming to maximize benefits while mitigating risks.

Table1: Results of SWOT analysis.

Tabelle 1: Ergebnisse der SWOT-Analyse.

Weaknesses	Strengths
W_1: Lack of cooperation between interest groups	S_1: By-products or non-wood products
W_2: Wood smuggling	S_2: Natural, tourist and cultural attractions
W_3: Livestock grazing	S_3: Wood production
W_4: Undesired economic status of society	S_4: Carbon sequestration
W_5: Lack of technical and scientific management	S_5: Biodiversity
W_6: Weak enforcement of laws, policies and strategies	S_6: Soil conservation and erosion prevention
Threats	**Opportunities**
T_1: Climate change and natural disasters	O_1: Production of non-wood products or by-products
T_2: Lack of desire to cooperate in the supply chain	O_2: Supply chain management
T_3: Construction operations	O_3: Availability of resources and investment
T_4: Low efficiency of natural resource plans	O_4: Increasing the contribution of forests to the economy of the region
T_5: Lack of financial resources for investment	O_5: Teaching and promoting the culture of natural resources in society
T_6: Failure to use expertise in decisions	O_6: Collaborative forestry
T_7: Reduction in the area of forests	O_7: Economic stability, improvement and diversity of livelihood of dependent communities

3.1 The weighting of SWOT groups and factors based on the AHP

The results obtained from the pairwise comparisons (relative weights) of SWOT groups indicated that opportunities have the highest preferences compared to the other groups (Fig. 2).

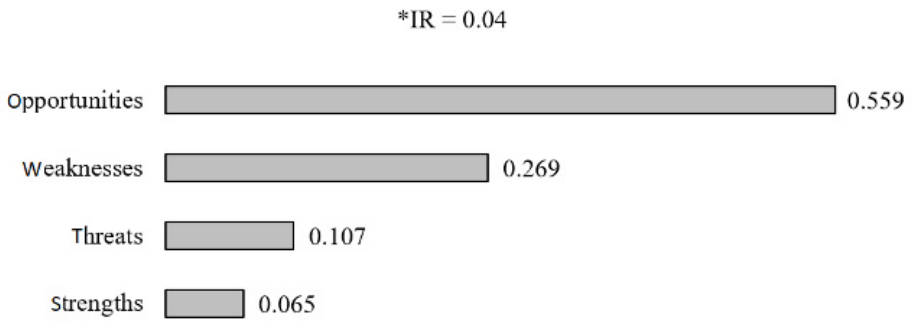

Figure 2: Prioritization of SWOT groups. IR is inconsistency rate. The IR in Figures represents the overall inconsistency of the pairwise comparisons made during the AHP process.

Abbildung 2: Priorisierung der SWOT-Gruppen. IR ist der Inkonsistenzgrad. Der IR in den Abbildungen stellt die Gesamtinkonsistenz der Paarvergleichsanalysen dar, die während des AHP-Prozesses durchgeführt wurden.

The prioritization of strengths in the SWOT model, based on the AHP, revealed that the highest priority was attributed to soil conservation and erosion prevention, while the lowest priority was associated with non-wood products (Fig. 3).

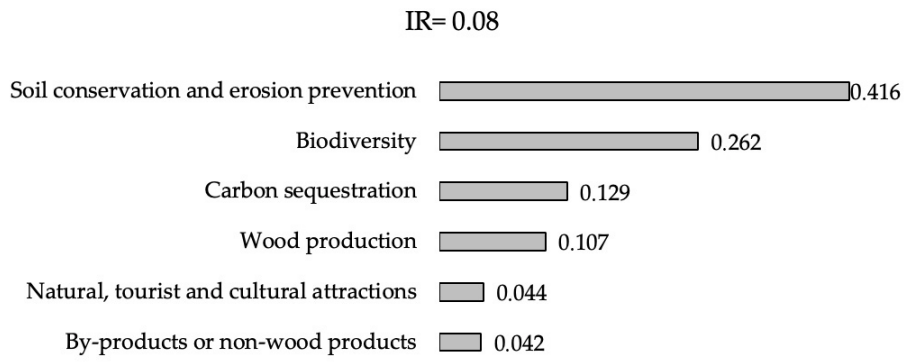

Figure 3: Prioritization of strengths in SWOT.

Abbildung 3: Priorisierung der Stärken in der SWOT-Analyse.

The prioritization of weaknesses in the SWOT analysis, based on the AHP, indicated that the highest priority was assigned to the "weak enforcement of laws, politics, and strategies," while the least priority was associated with the "lack of cooperation between interest groups" (Fig. 4.).

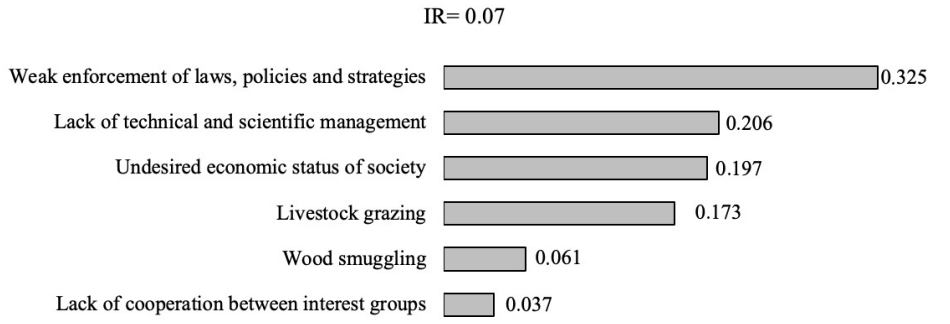

Figure 4: Prioritization of weaknesses in SWOT.

Abbildung 4: Priorisierung der Schwächen in der SWOT-Analyse.

The prioritization of opportunities in the SWOT analysis, conducted using the AHP method, revealed a clear ranking of priorities. The analysis determined that the hig-

hest priority was given to "economic stability, improvement, and diversification of livelihoods for dependent communities." This reflects the significant potential impact of enhancing economic stability and expanding livelihood options on sustainable forest management and community well-being.

In contrast, the "production of non-wood products or by-products" was assigned the lowest priority. While still valuable, this opportunity was deemed less critical compared to other factors in addressing immediate needs and long-term sustainability goals.

Fig. 5 illustrates this prioritization, highlighting the relative importance of each opportunity. By focusing on the top-priority areas, stakeholders and policymakers can more effectively allocate resources and design interventions that maximize benefits for both forest ecosystems and local communities.

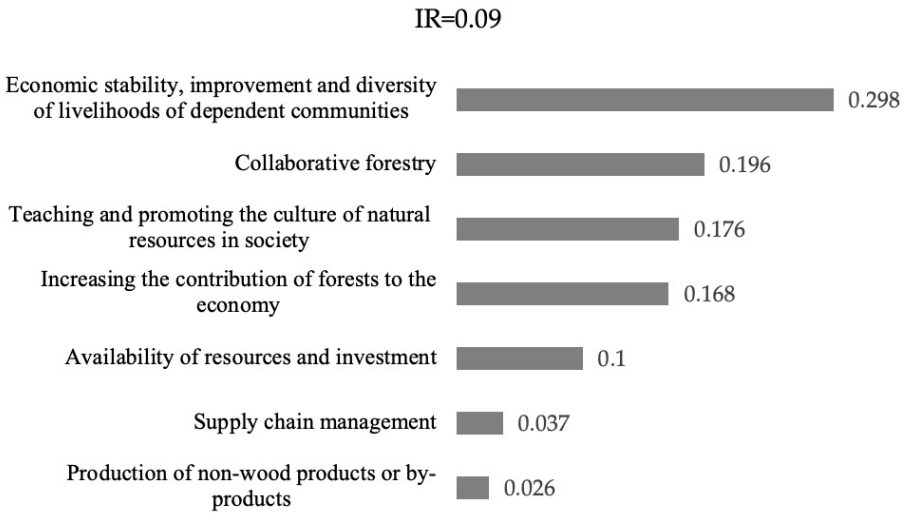

Figure 5: The prioritization of opportunities in SWOT.

Abbildung 5: Priorisierung der Chancen in der SWOT-Analyse.

The prioritization of threats in the SWOT model, as determined by the AHP method, revealed that the highest priority threat was the "reduction of forests area." This indicates that the loss of forest cover is considered the most critical issue impacting forest management. On the other hand, "climate change and natural hazards" were assigned the lowest priority among the identified threats.

Fig. 6 illustrates this prioritization, showing the relative importance of each threat. Addressing the primary concern—forest area reduction—allows for targeted strategies to prevent further deforestation and mitigate its impacts. Additionally, incorporating measures to manage and mitigate the effects of other threats, such as inadequate use of expertise in decision-making, climate change, and natural hazards, will contribute to a more comprehensive approach to forest management. Addressing these additional threats alongside the primary concern of forest area reduction will help enhance overall sustainability and resilience in the region.

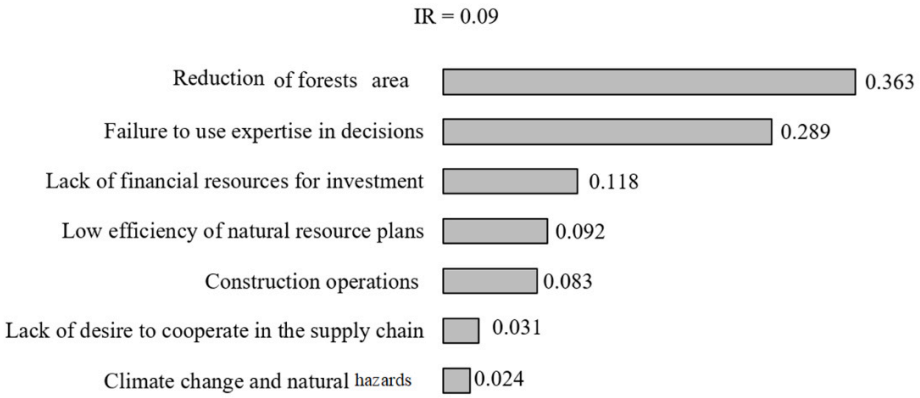

Figure 6: The prioritization of threats in SWOT.

Abbildung 6: Priorisierung der Bedrohungen in der SWOT-Analyse.

3.2 Determining the final priority of each factor in SWOT groups

Table 2 presents the final priorities (weights) assigned to each factor, calculated by multiplying the respective factor's priority within its group. As shown in Table 2, the AHP analysis has determined the following SWOT factors to have the highest overall weights, highlighting the most significant aspects that should guide forest management efforts:

1. **Economic stability, improvement, and diversification of livelihoods for dependent communities** (final Weight: 0.1665)
   – This factor stands as the most critical overall, emphasizing the importance of improving economic stability and livelihood diversification for communities that depend on forest resources. This factor was identified as having the highest priority across all SWOT groups.

2. Cooperative forestry (Final Weight: 0.1095)
   – Ranked second, cooperative forestry represents a vital opportunity for enhancing community involvement in forest management, improving sustainability through collaborative efforts.

3. Increasing the contribution of forests to the economy of the region (Final Weight: 0.0939)
   – This factor highlights the potential economic benefits of forests and their increasing role in the regional economy, making it a high-priority opportunity for future management strategies.

4. Weak enforcement of laws, policies, and strategies (Final Weight: 0.0874)
   – Identified as the most pressing weakness, the inadequate enforcement of forest management laws and policies poses a significant barrier to achieving effective governance and sustainability in forest resources.

5. Reduction of forests area (Final Weight: 0.0388)
   – As a major threat, the ongoing reduction of forests area is considered the most critical external risk, necessitating immediate action to prevent further loss of forest cover and ensure long-term forest health.

6. Soil conservation and erosion prevention (Final Weight: 0.0270)
   – Soil conservation and erosion prevention is the most highly prioritized strength, underscoring the importance of maintaining soil quality and preventing land degradation within forested areas.

These findings, derived from the AHP model presented in Table 2, underscore the relative importance of each factor and serve as a guide for prioritizing forest management strategies. By focusing on these key factors, stakeholders can better allocate resources and design interventions to address the most critical issues in the region.

Table 2: Final priority of factors in SWOT.

Tabelle 2: Endgültige Priorisierung der Faktoren in der SWOT-Analyse.

SWOT group	Group priority	SWOT factors	Final priority
Strength	0.065	By-products or non-wood products	0.0027
		Natural, tourist, and cultural attractions	0.0028
		Wood production	0.0069
		Carbon sequestration	0.0083
		Biodiversity	0.0170
		Soil conservation and erosion prevention	0.0270
Weakness	0.269	Lack of cooperation between interest groups	0.0099
		Wood smuggling	0.0164
		Livestock grazing	0.0465
		Undesired economic status of society	0.0529
		Lack of technical and scientific management	0.0554
		Weak enforcement of laws, policies, and strategies	0.0874
Opportunity	0.559	Production of non-wood products or by-products	0.0145
		Supply chain management	0.0206
		Availability of resources and investment	0.0559
		Increasing the contribution of forests to the economy of the region	0.0939
		Teaching and promoting the culture of natural resources in society	0.0983
		Cooperative forestry	0.1095
		Economic stability, improvement, and diversification of livelihoods of dependent communities	0.1665
Threats	0.107	Climate change and natural disasters	0.0025
		Lack of desire to cooperate in the supply chain	0.0033
		Construction operations	0.0088
		Low efficiency of natural resource plans	0.0098
		Lack of financial resources for investment	0.0126
		Failure to use expertise in decisions	0.0309
		Reduction of forests area	0.0388

3.3 Formulating strategies

A comprehensive review of various strategies has been conducted with the goal of sustainable forest land management in mind.

SO Strategies: In the section focusing on Strengths and Opportunities (SO) strategies, the emphasis is on leveraging strengths and external opportunities. This includes strategies such as forestry and wood cultivation, rural ecotourism, and empowerment of local communities through education. These strategies are based on internal capabilities in forestry, rural economics, and community education to systematically enhance the sustainable utilization of forest resources.

WO Strategies: In another section, strategies addressing Weaknesses and capitalizing on Opportunities (WO) have been identified. These strategies prioritize program-based management with stakeholder participation, social forestry with community empowerment, and securing funding from governmental sources. They are centered around addressing weaknesses in program management, forest degradation, and financial constraints through positive changes to capitalize on available opportunities.

ST Strategies: Strategies resulting from Strengths and Threats (ST) combinations are presented with the goal of strengthening defenses against external threats. These strategies partially focus on actions such as developing multi-purpose plans, internally economically focused plans, and implementing climate change-related initiatives. The objective of these strategies is to enhance responsiveness to environmental challenges and climate change.

WT Strategies: Strategies emerging from Weaknesses and Threats (WT) aim to improve law-based management and utilize innovative technologies to empower operational entities. These strategies aim to enhance management efficiency, eliminate legal deficiencies, and leverage innovative technologies to improve environmental and economic conditions.

Utilizing these strategies in sustainable forest land management, through a precise combination of strengths, opportunities, weaknesses, and threats, enhances the optimal utilization of forest resources and achieves the ultimate goal of sustainable forest land management. These strategies not only contribute to improving current conditions but also provide effective, scientifically and empirically based solutions to address various challenges in forest management (Table 3).

Table 3: Strategies resulting from the SWOT matrix.

Tabelle 3: Strategien aus der SWOT-Matrix.

1: W1, W5, O2, O5, O6 *Program-oriented management with the participation of stakeholders 2: W3, W4, O1, O6, *Social forestry by empowering local communities by eliminating destructive factors 3: W4, O1, O3, O4, O7 *Government finance	1: S3, S4, O4, O5 *Reforestation and wood farming 2: S2, O5, O7 *Rural ecotourism 3: S1, O1, O5 *Education and empowerment of local communities for basic exploitation of by-products
WO strategies	SO strategies
1: W1, W5, W6, T4, T5, T6 *Management based on rules, science, expertise and executive experience 2: W5, T2, T3 *Utilization and capability of executive bodies in using new technologies 3: W1, W4, T3, T4, T5 *Economic revenues based on natural resources	1: S1, S2, S3, S6, T4, T5 *Preparation and development of multi-purpose plans 2: S1, S3, S5, T3, T4 *Preparation and development of natural resource plans by an endogenous economic approach that has knowledge-based components. 3: S4, S5, S6, T1, T7 *Measures related to climate change (use of new energies, development and reforestation)
WT strategies	ST strategies

The strategies for sustainable forest management are developed based on a thorough SWOT analysis, which evaluates both internal factors (strengths and weaknesses) and external factors (opportunities and threats). Here are the proposed strategies, along with their scientific rationale:

SO strategies (leveraging strengths and opportunities)

1. Reforestation and wood farming Strategy (S3, S4, O4, O5)

- Internal Strengths: This strategy leverages strengths in wood production (S3) and carbon sequestration (S4). These factors are crucial for enhancing both the economic and environmental benefits of forest resources.
- External Opportunities: It also incorporates opportunities for increasing the forest's economic contribution (O4) and diversifying into non-timber forest products (O5).
- Rationale: The objective is to maximize the utilization of forest resources, thereby optimizing economic benefits while contributing to regional economic development. By integrating these strengths and opportunities, the strategy aims to improve forest sustainability and economic viability.

2. Rural ecotourism strategy (S2, O5, O7)

- Internal Strengths: This strategy capitalizes on natural and cultural attractions (S2) that can drive tourism.
- External Opportunities: It aligns with opportunities for promoting education about natural resources (O5) and enhancing economic stability and livelihood diversity (O7).
- Rationale: The strategy seeks to boost local economic conditions and community well-being through the development of ecotourism. By leveraging the region's inherent attractions and educational opportunities, it aims to foster sustainable tourism and strengthen community engagement.

3. Education and empowerment of local communities for basic exploitation of by-products (S1, O1, O5)

- Internal Strengths: This strategy focuses on strengths related to the production of non-timber forest products (S1).
- External Opportunities: It utilizes opportunities for increasing the production of these products (O1) and advancing educational initiatives about natural resources (O5).
- Rationale: The goal is to empower local communities by enhancing their knowledge and capacity to utilize non-timber forest products effectively. This approach aims to boost local income and support sustainable forest management practices through targeted education and community engagement.

WO strategies (addressing weaknesses and capitalizing on opportunities)

1. Program-oriented management with the participation of stakeholders (W1, W5, O2, O5, O6)

- Internal weaknesses: This strategy addresses the lack of cooperation between interest groups (W1) and the lack of technical and scientific management (W5).
- External opportunities: It capitalizes on opportunities for improving supply chain management (O2), advancing the education about natural resources (O5), and fostering collaborative forestry (O6).
- Rationale: This strategy seeks to improve forest management through enhanced cooperation among stakeholders, incorporating scientific expertise and supply chain management to promote better decision-making and effective planning.

2. Social forestry by empowering local communities by eliminating destructive factors (W3, W4, O1, O6, O7)

- Internal weaknesses: This strategy addresses issues related to livestock grazing (W3) and the undesired economic status of society (W4).
- External opportunities: It uses opportunities for increasing the production of non-wood products (O1), fostering collaborative forestry (O6), and promoting economic stability and diverse livelihoods (O7).
- Rationale: This strategy promotes social forestry to address land degradation caused by livestock grazing while improving local economic stability by diversifying into non-timber forest products. It also empowers communities, enhancing their resilience and long-term sustainability.

3. Government finance (W4, O1, O3, O4, O7)

- Internal weaknesses: This strategy seeks to address the undesired economic status of society (W4).
- External opportunities: It aligns with opportunities for promoting the production of non-wood products (O1), securing investment resources (O3), increasing the forest's economic contribution (O4), and improving the livelihoods of dependent communities (O7).
- Rationale: This strategy focuses on securing government finance to support forest management programs that promote non-timber product industries, contribute to regional economic development, and ensure the sustainable use of forest resources.

ST strategies (leveraging strengths to mitigate threats)

1. Preparation and development of multi-purpose plans (S1, S2, S3, S6, T4, T5)

- Internal strengths: This strategy integrates strengths in non-wood products (S1), natural and cultural attractions (S2), wood production (S3), and soil conservation (S6).
- External threats: It aims to address the low efficiency of natural resource plans (T4) and the lack of financial resources for investment (T5).
- Rationale: The strategy seeks to improve forest resource utilization by developing multi-purpose forest management plans. These plans aim to increase efficiency, prevent soil erosion, and optimize both timber and non-timber product

outputs, thus addressing external threats while enhancing internal strengths.

2. *Preparation and development of natural resource plans by an endogenous economic approach that has knowledge-based components (S1, S3, S5, T3, T4)*
   - Internal strengths: This strategy leverages strengths in non-wood products (S1), wood production (S3), and biodiversity (S5).
   - External threats: It aims to mitigate threats related to construction operations (T3) and the inefficiency of natural resource plans (T4).
   - Rationale: By promoting local, knowledge-based approaches to forest management, this strategy focuses on protecting biodiversity and enhancing the sustainable use of non-timber products. It works to reduce the impact of construction on forests and improve overall resource management efficiency.

3. *Measures related to climate change (use of new energies, development and reforestation) (S4, S5, S6, T1, T7)*
   - Internal strengths: This strategy capitalizes on strengths in carbon sequestration (S4), biodiversity (S5), and soil conservation (S6).
   - External threats: It aims to mitigate the impacts of climate change and natural disasters (T1) and the reduction in forest area (T7).
   - Rationale: The strategy focuses on enhancing the resilience of forest ecosystems to climate change by strengthening carbon sequestration, protecting biodiversity, and implementing soil conservation measures, thus addressing climate-related threats.

WT strategies (addressing weaknesses to defend against Threats)

1. *Management based on rules, science, expertise and executive experience (W1, W5, W6, T4, T5, T6)*
   - Internal weaknesses: This strategy addresses the lack of cooperation between interest groups (W1), lack of technical and scientific management (W5), and weak enforcement of laws and policies (W6).
   - External threats: It aims to mitigate the low efficiency of natural resource plans (T4), lack of financial resources for investment (T5), and the failure to use expertise in decision-making (T6).
   - Rationale: This strategy seeks to strengthen governance and law enforcement by improving cooperation between stakeholders, enhancing technical and scientific management, and ensuring effective implementation of forest policies, which will help defend against external threats.

2. *Utilization and capability of executive bodies in using new technologies (W5, T2, T3)*
   - Internal weaknesses: This strategy focuses on addressing the lack of technical and scientific management (W5).
   - External threats: It aims to overcome resistance to cooperation in the supply chain (T2) and mitigate the impact of construction operations on forests (T3).
   - Rationale: This strategy emphasizes building technical capacity to implement new technologies in forest management, helping overcome barriers to collaboration and reduce the negative effects of construction activities.

3. Economic revenues based on natural resources (W1, W4, T3, T4, T5)

- Internal weaknesses: This strategy tackles the lack of cooperation between interest groups (W1) and the undesired economic status of society (W4).
- External threats: It aims to address the impacts of construction operations (T3), low efficiency of natural resource plans (T4), and lack of financial resources for investment (T5).
- Rationale: This strategy focuses on developing sustainable revenue streams from natural resources, aiming to address financial constraints, enhance forest management efficiency, and reduce the negative impacts of construction on forest ecosystems

These strategies, developed from the SWOT analysis, provide a comprehensive approach to sustainable forest management by leveraging strengths, addressing weaknesses, and mitigating external threats while capitalizing on available opportunities. This holistic approach ensures that forest management practices are both effective and sustainable, promoting ecological health, economic stability, and community resilience.

3.4 The prioritization of strategies

Fig. 7 illustrates the prioritization of strategies using the AHP model. In Figure 7, the weights for the criteria or strategies were calculated using the eigenvalue method by first constructing the pairwise comparison matrix, normalizing it, and then finding the dominant eigenvalue and the corresponding eigenvector. This method produces a set of normalized weights that sum to 1, representing the relative importance of each criterion or strategy.

Key Findings from the Analysis:

1. Top Priority: "Program-oriented management with the participation of stakeholders" was identified as the most important strategy, with a relative weight of 0.21. This suggests that involving stakeholders in decision-making processes is crucial for effective natural resource management.
2. Other important strategies:
   - Management based on rules, science, expertise, and executive experience: This strategy also received a significant weight, indicating the importance of evidence-based and expert-driven approaches.
   - Social forestry by empowering local communities by eliminating destructive factors: This strategy likely to promote sustainable practices.

Implications for natural resource management:

Based on these findings, the following recommendations can be made:

- Stakeholder involvement: Prioritize involving local communities, businesses, and other stakeholders in decision-making processes related to natural resource management.
- Evidence-based approach: Ensure that management decisions are based on scientific evidence, expert knowledge, and best practices.
- Social forestry: Promote social forestry initiatives that empower local communities and help protect natural resources.
- Multi-purpose planning: Develop comprehensive plans that address various aspects of natural resource management, including conservation, economic development, and social well-being.

Additional considerations:

- Context-specific factors: The relative importance of these strategies may vary depending on specific local conditions, cultural factors, and environmental challenges.
- Implementation challenges: Implementing these strategies effectively may require overcoming various obstacles, such as limited resources, institutional barriers, and conflicting interests.

By carefully considering these factors and implementing the prioritized strategies, it is possible to achieve more sustainable and equitable natural resource management.

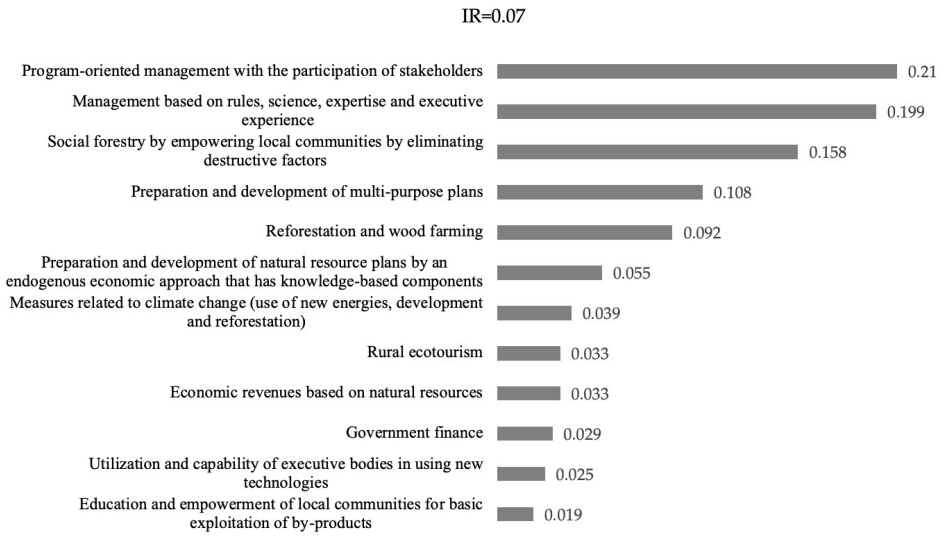

Figure 7: Prioritization of strategies (IR=0.07).

Abbildung 7: Priorisierung der Strategien (IR=0.07).

4 Discussion

This study assessed influential factors affecting forest land management in Qazvin Province, Iran, and led to the selection and prioritization of a suitable management approach. The prioritization of SWOT groups revealed that opportunities, with a relative weight of 0.559, were the highest priority. In contrast, weaknesses, threats, and strengths had relative weights of 0.269, 0.107, and 0.065, respectively. Within the strengths category, "soil conservation and erosion prevention" and "biodiversity" emerged as the top priorities, with relative weights of 0.416 and 0.262, respectively. This indicates that environmental and protective functions, such as soil conservation and erosion control, are prioritized over production functions like wood and by-product production. Consequently, the study emphasizes the importance of focusing on management solutions that prioritize the protection of forest lands.

The region's forest lands are rich in plant species, hosting approximately 35 species of trees and shrubs. However, forest biodiversity is increasingly threatened by activities such as deforestation, climate change, and other human-induced factors. These activities significantly contribute to soil erosion and the decline of forest biodiversity. Therefore, management strategies should focus on mitigating these human-induced impacts to preserve soil integrity and biodiversity. Maintaining these ecological functions is crucial for ensuring the stability and health of the forest ecosystem.

The prioritization of weaknesses showed that the "weak enforcement of laws, policies, and strategies" with a relative weight of 0.325 had the highest priority compared to other weaknesses. Instances of poor regulations include inadequacies in the forest protection plan, insufficient control over domestic animal grazing, and the lack of organization among forest dwellers. These are the examples of weak implementation of laws, policies, and strategies. Goushehgir *et al*. (2022) found similar challenges in the Hyrcanian forests of Iran, including inconsistent forest policy and outdated scientific approaches, which hinder effective forest management. These findings underscore the critical need for improved enforcement and more up-to-date management practices to address these deficiencies effectively. Omidi et al. (2020) showed that the lack of supervision, lack of a proper evaluation and monitoring system on the applied operations and the lack of a control process for the implementation of natural resources plans are the weaknesses of the performance system in Hyrcanian forests of Iran.

The research findings revealed that, following the issue of weak enforcement of laws, policies, and strategies, the "lack of technical and scientific management" emerged as the second priority, with a relative weight of 0.206. This deficiency in technical and scientific management can be attributed to factors such as misalignment between responsibilities and educational qualifications within organizational roles, insufficient awareness, and reliance on outdated methods rather than modern technologies. Poudyal *et al.* (2020) highlight similar challenges in their study on forest management in Nepal, where stakeholders' varied understanding and application of scientific management practices resulted in inefficiencies and conflict. Addressing these challenges requires improving technical expertise, aligning responsibilities with qualifications, and updating management practices to ensure more effective and sustainable outcomes.

The prioritization of opportunities indicated that "economic stability, improvement and diversity of livelihood of dependent communities", with a relative weight of 0.298, was the highest priority. Thus, decision-making processes should place a stronger emphasis on enhancing the livelihoods of these communities. Providing alternative, suitable, and diverse employment opportunities is essential to ensuring that obstacles in natural resource management do not impede the achievement of goals (FAO, 2022). By addressing these needs, planners and policymakers can better support community development and effective resource management.

Collaborative or participatory forestry and "teaching and promoting the culture of natural resources in society", respectively with relative weights of 0.196 and 0.176, were allocated as the second and third priorities within the opportunities group. The results indicate a mutual correlation among most factors. Therefore, by employing one of the opportunities, conditions for utilizing other opportunities also become available. The implementation of participatory forestry is feasible in tandem with educating and promoting a culture of natural resource preservation within society. This approach establishes the foundation for economic stability, improvement, and the diversification of dependent communities. Consequently, an increase in the fo-

rest's contribution to the regional economy becomes apparent. Nybakk *et al.* (2009) introduced a conceptual model proposing that social networking, entrepreneurial climate, and a learning orientation individually exert a direct, positive influence on landowner innovativeness. They further postulated that innovativeness directly contributes positively to economic performance within Norway's non-timber forest products and services sector. The results of this study revealed that among the identified threats, the foremost priority, with a relative weight of 0.363, was attributed to the reduction of forests area. Given the widespread decline of natural forests globally, Iran grapple with the challenge of preventing further degradation and loss of forested areas. These findings align with the results of the other research such as (*e.g.* Amiri-Lemar and Moradmand Jalali, 2015; Cozma and Achim, 2023).

The process of forest resource degradation, particularly deforestation, involving the reduction in forest density, elimination of valuable species, substitution with inferior species, and the decline in biodiversity, has emerged as a serious concern for achieving sustainable development. Consequently, it becomes imperative to identify the factors contributing to forest depletion in decision-making processes and to propose solution-based approaches aimed at mitigating or eliminating these existing threats. In a SWOT analysis, one can either explore all components comprehensively or focus on specific strategies to propose managerial solutions. Prioritization using the AHP revealed that program-oriented management with stakeholder participation (0.21), management based on rules, science, expertise and executive experience (0.199), and social forestry by empowering local communities by eliminating addressing destructive agents (0.158) are the highest priorities. These results highlight the importance of a social approach for sustainable forest management, aligning with findings from Yavuz and Baykan (2013) and Razaghpour (2017).

Effective forest management requires collaborative decision-making involving both experts and local communities. Wolfslehner (2007) demonstrated that integrating ecological, economic, and social aspects at the executive level enhances the sustainability of forest management. Furthermore, Gutiérrez-Zamora *et al.* (2022) illustrate that community forestry in Oaxaca at Mexico improves forest values and collective capabilities through deliberation and social accountability, although the exclusion of women from decision-making processes remains a significant limitation.

This study underscores the need for a holistic and inclusive approach to forest management that balances environmental protection, community involvement, and effective policy enforcement. By prioritizing stakeholder engagement, addressing technical and scientific deficiencies, and fostering economic stability, forest management strategies can more effectively tackle the complex challenges of conservation and sustainable development.

The role of various stakeholders in forest management is critical to the success of these strategies. In Iran, stakeholders include local communities, forest management

agencies, environmental organizations, research and educational institutions, and policymakers. The involvement of these stakeholders ensures that forest management is comprehensive, inclusive, and sustainable.

In particular, the Natural Resources Departments play a central role in enforcing forest protection policies and regulations. These agencies are responsible for forest monitoring, resource allocation, and oversight of logging activities. However, the research by Keshavarz *et al.* (2023) highlights the challenges faced by natural resource departments in Iran, particularly the conflicts arising from halting industrial exploitation. This has led to debates about whether such policies can truly restore forest health, with some stakeholders advocating for continued forestry projects as a tool for forest management rather than complete cessation of activities. The effectiveness of such measures depends heavily on collaboration with local communities, whose livelihoods often rely on forest resources. The study by Keshavarz *et al.* (2023) points to a gap between environmental goals and the economic realities faced by forest dwellers, who may resist restrictions on logging and other forest activities.

Environmental organizations are another significant stakeholder in Iran's forest management. They advocate for the preservation and restoration of forests, particularly the endangered Hyrcanian forests, and often push for policies that reduce exploitation and promote conservation. Their influence is crucial in shaping public opinion and advocating for sustainable forest management practices. However, there are often tensions between environmentalists and other stakeholders who prioritize economic development and resource utilization.

Research and educational institutions also play a pivotal role in scientific research and policy development. They provide the data and expertise needed to formulate evidence-based strategies for forest conservation and restoration. However, the lack of technical and scientific management, as identified in this study, underscores the gap between theoretical research and its practical application in the field. Aligning the roles and responsibilities of forest management agencies with scientific advancements is essential for improving the effectiveness of forest management practices.

Moreover, the study by Zandebasiri *et al.* (2022), which models stakeholder roles using Shapley value calculations, offers valuable insights into the distribution of power and influence among key stakeholders in Iranian forests. The research highlights the importance of local communities in forest management, with local stakeholders receiving the highest Shapley value (0.41) in comparison to forest management agencies (0.37) and research/education institutions (0.22). This indicates that local communities hold a more significant role in determining the success of forest management strategies, as their involvement is essential for achieving sustainable forest conservation. These findings are consistent with the broader trend in forest management literature, where local communities are often at the center of efforts for participatory management and resource sustainability.

Globally, stakeholder analysis in forest management has shown similar patterns, with local communities often playing a pivotal role. For example, in Ukraine, Pelyukh *et al.* (2021) identified ecological and economic coalitions in forest management, highlighting the need for balanced participation from all stakeholders to ensure sustainability. In Romania, Nichiforel *et al.* (2024) found that stakeholder engagement in forest certification processes, though limited, contributed to positive feedback and improved forest management practices. The global trend emphasizes the importance of inclusivity and participatory decision-making in achieving sustainable forest management.

5 Conclusions

The objective of this research was to identify sustainable management and developmental solutions for forest ecosystems in the study area. The sustainability and resilience of these ecosystems depend on preserving and enhancing their diverse ecological, social, economic, and cultural dimensions. Achieving this goal requires effective forest resource management that addresses the full spectrum of surrounding challenges.

The study employed a combined SWOT-AHP model to offer insights for refining and advancing forest management practices. The findings emphasize the importance of utilizing strengths and opportunities while addressing weaknesses and threats. Effective forest resource utilization, through appropriate methodologies and preservation efforts, is vital for fostering holistic development and sustainability. The results provide a framework for decision-makers to develop robust and sustainable strategies for forest management. By integrating these insights, policymakers can enhance the long-term health and resilience of forest ecosystems, ensuring their preservation for future generations.

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