


Challenges and prospects of sustainable tourism development in Jiuzhaigou, China



 Qiaoran Yang¹

 Asyirah Binti Abdul
Rahim²⁺

^{1,2}School of Humanities, Universiti Sains Malaysia, 11800 Minden, Penang, Malaysia.

¹Email: yangqiaoanyqa@gmail.com

²Email: Asyirah@usm.my



(+ Corresponding author)

ABSTRACT

Article History

Received: 24 July 2025

Revised: 21 August 2025

Accepted: 26 August 2025

Published: 29 August 2025

Keywords

Ecological environmental
Protection

Jiuzhaigou

Stakeholder collaboration

Sustainable tourism

World natural heritage

Tourism challenges.

Jiuzhaigou, China's first national nature reserve established for scenic landscape protection, was inscribed as a UNESCO World Natural Heritage Site in 1992. The aim of this study is to examine the key challenges to its sustainable tourism development under the pressure of rapid tourism growth and to propose effective solutions. Using a case study approach, the research reviews ecological and management issues that have emerged in recent years. Four major challenges are identified: environmental degradation, loss of aesthetic value, weak management systems, and limited stakeholder collaboration. In response, several strategies are proposed, including strengthening ecological protection and restoration, setting clear limits on visitor capacity, improving tourism products and service quality, enhancing environmental education and public participation, and establishing a more effective and collaborative management framework that engages multiple actors. The study also outlines directions for future research to ensure long-term sustainability, including conducting sustainable tourism evaluations, strengthening natural heritage conservation, broadening stakeholder participation and cross-sector collaboration, and applying smart technologies to improve scenic area management. The findings provide practical strategies to support the sustainable development of tourism in Jiuzhaigou and offer insights that may inform the management and conservation of other World Natural Heritage Sites facing similar pressures.

Contribution/ Originality: This study provides a systematic analysis of the challenges facing sustainable tourism in Jiuzhaigou. It proposes practical strategies and directions for future research, emphasizing the importance of stakeholder collaboration and the application of smart technologies in enhancing the management and conservation of World Natural Heritage Sites.

1. INTRODUCTION

Tourism is widely recognized as an important part of national economies around the world. It plays a key role in driving economic growth, creating employment opportunities, and promoting economic diversification (Olszewski-Strzyżowski, 2022). In developing countries in particular, tourism is not only a major source of foreign exchange but also an effective way to reduce unemployment (Wieckowski, 2021).

As environmental issues become more serious and public awareness of environmental protection continues to rise, the concept of sustainable development has gained global attention. Sustainable development is defined as meeting present needs without compromising the ability of future generations to meet their own needs (Mateoc-Sirb et al., 2022). It is considered an effective response to problems caused by overuse of resources and environmental degradation (Xu et al., 2020).

The United Nations' 2030 Agenda for Sustainable Development outlines 17 Sustainable Development Goals (SDGs), which are being implemented in different countries according to their specific economic and social contexts (Fu, Fu, Dávid, Zhong, & Zhu, 2024). Against this backdrop, the tourism industry has been shifting toward more sustainable practices. Many countries have realized that tourism policies must align with national environmental, cultural, and social conditions to promote economic growth while ensuring ecological protection (Kustos, Goodman, Jeffery, & Bastian, 2021).

Jiuzhaigou National Park, as China's first nature reserve focusing on scenic landscape protection, holds significant ecological and heritage value. Since being listed as a UNESCO World Natural Heritage Site in 1992, Jiuzhaigou has joined the World Network of Biosphere Reserves and the Green Globe 21 program, becoming an internationally recognized destination for ecological tourism. In recent years, as concerns about health and the environment have grown, sustainable tourism has attracted increasing academic interest (Ciolac, Iancu, Brad, Adamov, & Mateoc-Sîrb, 2021). Tourists' preferences for unspoiled natural environments have also encouraged destinations to adopt more eco-friendly development approaches (Ivasciuc & Ispas, 2023).

In this context, research on sustainable tourism in Jiuzhaigou is of great significance. It can help identify and address the environmental and social challenges caused by tourism activities, while protecting the area's unique natural resources and ecosystems. Moreover, such research provides theoretical support for improving the balance between tourism development and ecological conservation and contributes to the long-term sustainable development of Jiuzhaigou's tourism industry.

2. JIUZHAIGOU SCENIC AREA CURRENTLY FACING CHALLENGES

2.1. Ecological and Environmental Issues in Jiuzhaigou Scenic Area

The continuous increase in tourist numbers has boosted the development of related industries, promoted local economic growth, and improved employment opportunities for residents (Blancas & Lozano-Oyola, 2022). However, when the number of tourists exceeds the environmental carrying capacity, it threatens the sustainability of tourism resources (Falk & Hagsten, 2022; Valagussa et al., 2021). It also increases pressure on the environment, leading to ecosystem degradation, loss of biodiversity, and waste of natural resources (Hakim, Deoranto, Ayu, Pangestuti, & Natalia, 2023; Środa-Murawska, Grzelak-Kostulska, Biegańska, & Dąbrowski, 2021).

The economy of areas surrounding Jiuzhaigou is heavily dependent on tourism. Although tourism development has brought economic benefits, it has also increased the ecological burden on the region (Song & Li, 2021). Large numbers of tourists and the construction of tourism infrastructure have intensified human disturbance to the natural environment (Deng et al., 2020). These activities have damaged habitats of certain plant and animal species (Shi, Zhang, Song, & He, 2022) and led to a decline in the ecological security index (Liao, Xie, Liu, Zhu, & Wu, 2021).

In addition, frequent geological disasters have further damaged plant communities and reduced the living space for rare wildlife (Liu, Wang, Wang, Wang, & Deng, 2018; Pan et al., 2021), posing greater challenges for the protection of Jiuzhaigou's environmental authenticity (Chen, Zhao, & Wu, 2023).

Sustainable Development Goal 15 of the United Nations calls for the protection, restoration, and sustainable use of terrestrial ecosystems, sustainable forest management, and the prevention of land degradation and biodiversity loss (UNDESA, 2015). Under this global initiative and the national call for ecological protection, Jiuzhaigou is facing stricter standards for environmental management.

Therefore, it is critical to find a balance between economic growth and environmental authenticity. At the same time, it is necessary to resolve the conflict between peak tourist seasons and the carrying capacity of the scenic area.

2.2. Aesthetic Value of Landscape Resources in Jiuzhaigou Scenic Area

Jiuzhaigou is named after nine Tibetan villages and is widely known for its unique karst water formations, primitive forest landscapes, and rich ethnic cultural scenery. These natural and cultural elements together form the

core of Jiuzhaigou's tourism resources (Chen et al., 2023). However, strict ecological protection measures, frequent natural disasters, and the rapid growth of tourism activities are placing increasing pressure on these valuable landscape resources (Li et al., 2020). In mountainous and economically underdeveloped areas, tourism is often regarded as a key driver of local development. Overdependence on tourism makes such regions more vulnerable to economic collapse and significant material losses during sudden crises, and the sharp decline in tourist demand can further weaken local economic resilience (Fountain & Cradock-Henry, 2020; Hu, Hu, Tang, You, & Wu, 2019).

According to the World Heritage Convention proposed by UNESCO in 1972, the concept of “Outstanding Universal Value” (OUV) is the core standard for world heritage designation. It emphasizes that a site must possess unique and globally significant natural or cultural value (Khalaf, 2021). As a World Natural Heritage Site, Jiuzhaigou holds important scientific and aesthetic value. Among these, aesthetic value Criterion (vii) in the UNESCO assessment system is one of the key indicators used to evaluate OUV (Zhang, Xiong, & Huang, 2023). Jiuzhaigou's unique scenic beauty is not only central to its tourism appeal but also provides a strong economic foundation for local tourism development. (Luo & Chiou, 2021). However, while tourism development brings economic benefits, it can also degrade the landscape's aesthetic quality and ecological integrity, creating a tension between conservation and development (Zhang, Kangning, Liu, & Lixiang, 2022).

As a special type of tourism destination, natural heritage sites hold irreplaceable scientific and aesthetic value. However, improper use of tourism resources, frequent natural disasters, and human disturbances pose serious threats to the integrity and sustainability of OUV in many World Natural Heritage Sites (Bian et al., 2022; Hu, Hu, Zhang, Wei, & Tang, 2019; Streimikiene, Svagzdiene, Jasinskas, & Simanavicius, 2021; Wang & Yuan, 2020; Zhao et al., 2023; Zheng et al., 2022). For this reason, how to strike a balance between protecting OUV and guiding responsible tourism development has become a key issue of growing interest in academic research (Xiong, Zhang, Fei, Jin, & Zhang, 2023; Zhang et al., 2022).

Currently, most studies on OUV focus on theoretical discussions and qualitative descriptions. There is a lack of a precise understanding of aesthetic value, unclear definitions of protection boundaries, and insufficiently targeted management strategies (Xu, Yang, & Xu, 2022). Moreover, research on monitoring, evaluation, technical solutions, and model development remains limited (Zhang et al., 2023). Therefore, exploring the relationship between aesthetic value protection and tourism development is essential for mitigating conflicts between conservation and development. It also plays a critical role in protecting Jiuzhaigou's natural scenery and promoting the long-term sustainability of tourism in the region.

2.3. Research on Sustainable Tourism in Jiuzhaigou Scenic Area

Ecological protection and socio-economic development in nature reserves are often interdependent and simultaneously influenced by surrounding ecological conditions (Hatta & Tuwo, 2023; Robinson, Martins, Solnet, & Baum, 2019). As tourism continues to evolve, new forms of tourism are constantly emerging. Therefore, how to adjust and expand existing sustainable tourism strategies to meet changing demands has become a key research issue (Roblek, Drpić, Meško, & Milojica, 2021). Although sustainable tourism has gained increasing attention in recent years, many studies still focus too heavily on environmental aspects while overlooking critical social and economic factors. This leads to an incomplete and fragmented understanding of tourism sustainability (Chen et al., 2023).

In Jiuzhaigou, existing research mainly concentrates on disaster prevention and ecological protection, while systematic studies on sustainable tourism remain limited. There is a lack of comprehensive assessment frameworks for evaluating tourism development (Guo, Yang, Fan, & Zang, 2023; Wungo, Nurini, Ardian, & Franestia, 2023). Insufficient attention has been paid to the region's local characteristics and socio-cultural values. The unique cultural, historical, and social context of Jiuzhaigou as a tourism destination has not been fully considered (Stojanović et al., 2024). As a result, existing evaluation systems fail to capture the full impact of tourism on the area's sustainable development (Vuksanović, Petrović, & Jovanović, 2024).

In addition, sustainable tourism evaluation frameworks are diverse in terms of indicator selection and methodological application, lacking standardized approaches (Gordan et al., 2024). The variation in indicators across studies and practices makes comparisons difficult and hinders the consistent implementation of sustainability goals (Guo, Yang, Fan, & Lu, 2022; Sobhani, Esmaeilzadeh, Sadeghi, Marcu, & Wolf, 2022). In response to the United Nations 2030 Agenda for Sustainable Development and the UNWTO's initiative on developing a "statistical framework for measuring sustainable tourism" (MST) (UNWTO, 2022), it is necessary to construct a comprehensive and context-specific evaluation system for Jiuzhaigou to assess its level of tourism sustainability scientifically.

Currently, many assessments of tourism sustainability rely on expert-driven approaches, which are often subjective and fail to reflect the perspectives of tourism enterprises, local communities, and other key stakeholders (Ordóñez-Martínez, Seguí-Pons, & Ruiz-Pérez, 2024; Spadaro et al., 2023). Most existing studies focus on residents' attitudes toward tourism development, while the involvement of communities and tourism businesses in policymaking and planning is largely overlooked (Abuhay, Teshome, & Mulu, 2023; Jumiya & Frimawaty, 2023; Zulvianti, Akmal, & Putra, 2023). Moreover, the collaborative role of multiple stakeholders in promoting sustainable tourism is often neglected (Birendra, Dhungana, & Dangi, 2021; Lievens & Blažević, 2021; Masouras, Papademetriou, Belias, & Anastasiadou, 2023).

Therefore, it is essential to explore the roles and mechanisms of stakeholder participation in Jiuzhaigou's sustainable tourism development. Strengthening stakeholder engagement from planning to management and policy formulation will help address existing research gaps. It will also provide theoretical support and practical pathways for promoting comprehensive, coordinated, and sustainable tourism development in the Jiuzhaigou scenic area.

2.4. Stakeholder Collaboration Mechanisms in Jiuzhaigou Scenic Area

China faces various challenges in promoting a balance between nature reserve conservation and socio-economic development. However, it has also continuously explored and proposed relevant solutions (He & Cliquet, 2020; H. Zheng et al., 2019). In the Jiuzhaigou region, the local government's efforts in resource development have been constrained by technical limitations, economic capacity, and environmental conditions, which have led to varying degrees of resource waste and ecological damage (Liao et al., 2021). Due to a lack of advanced tourism planning and professional management expertise, Jiuzhaigou still lags behind world-class tourism destinations in terms of service quality, resource utilization, and overall management performance (Reindrawati, 2023).

At present, the management model of Jiuzhaigou Scenic Area is mainly top-down. The planning and governance processes rarely incorporate the views of tourism stakeholders, and the lack of collaborative mechanisms among various actors has limited progress toward sustainable development goals (Rule et al., 2022). In addition, imbalanced resource allocation and uneven management investment have led to inconsistencies in service quality across the scenic area, which further restricts the effectiveness of sustainability initiatives (Zhang et al., 2022).

Moreover, tourists today not only expect quality products and services but also place increasing importance on overall experience and personal well-being (Bagheri, Guerreiro, Pinto, & Ghaderi, 2024). Poorly designed planning and management strategies often reduce visitor satisfaction and decrease the perceived suitability of the destination (Chang & Watanabe, 2021). Therefore, it is necessary to reassess and integrate Jiuzhaigou's tourism development strategies and address existing vulnerabilities and potential threats with effective management responses.

By building a scientifically grounded planning system and sustainable development framework, Jiuzhaigou can improve its governance capacity and address current weaknesses. This would not only provide practical guidance for the scenic area's management but also help unlock its tourism development potential and enhance its overall competitiveness in the long term.

3. POLICY RECOMMENDATIONS

3.1. Strengthening Environmental Protection and Ecological Restoration

3.1.1. Develop and Implement Environmental Protection Policies

Strict environmental protection policies should be formulated to clearly define prohibited or restricted behaviors in tourism activities (Javeed et al., 2024). At the same time, enforcement mechanisms must be strengthened and regulatory efficiency improved to ensure the effective implementation of these policies in practice (López-Arquillo, Oliveira, Serrano González, & Durán Sánchez, 2023).

3.1.2. Launch Ecological Restoration Projects

To address ecological damage caused by tourism development and natural disasters, comprehensive ecological restoration programs should be established. These efforts can include a combination of natural vegetation recovery and human-assisted ecological restoration to promote long-term stability and recovery of local ecosystems (Jurjonas et al., 2024).

3.1.3. Establish Biodiversity Conservation Zones and Habitat Restoration Mechanisms

Biodiversity conservation areas should be designated both inside and around the scenic area, especially in habitats of rare and endangered species. Human activity in these areas should be restricted or prohibited to improve living conditions for protected species. Habitat restoration, regular ecological monitoring, and scientific management practices should be implemented to ensure effective conservation outcomes (Ocampo-Melgar et al., 2024; Robinson et al., 2024).

3.1.4. Protect Environmental Authenticity

Efforts should be made to preserve the authenticity of Jiuzhaigou's natural heritage landscapes. Infrastructure development and tourism expansion must not compromise the area's unique natural and cultural features. Particular attention should be given to the protection and regular maintenance of karst water landscapes, forest ecosystems, religious structures, and ethnic cultural heritage sites, to safeguard their ecological and cultural value (Zuo, Lan, Liu, & Zeng, 2024).

3.2. Controlling Tourist Capacity and Strengthening Visitor Management

3.2.1. Establish A Visitor Capacity Control System

A scientifically based maximum visitor capacity should be set according to Jiuzhaigou's environmental carrying capacity and resource limits. Management tools such as online reservation systems, timed entry, and digital ticketing can be used to control visitor numbers effectively and reduce the environmental pressure caused by overcrowding (Kang, 2023; Lu & Chen, 2023).

3.2.2. Implement Differentiated Management Strategies

Visitor management strategies should be adapted based on seasonal variations and specific zones within the scenic area. During peak tourism periods, reservation and quota systems should be enforced to distribute visitor flow more evenly and mitigate environmental risks caused by crowding. In ecologically sensitive areas, stricter control should be implemented to limit the frequency of tourist access and minimize human disturbance (Majdak & De Almeida, 2022).

3.2.3. Enhance Visitor Management Through Smart Technologies

Technologies such as video surveillance, intelligent sensors, and behavior monitoring systems should be used to manage visitor activities in real time. These tools can guide tourists to follow park rules, regulate inappropriate

behavior, improve management efficiency, and reduce the environmental impact of human activities (Pan, Zhao, & Sun, 2024).

3.3. Optimizing Ecotourism Products and Improving Service Quality

3.3.1. Develop Ecotourism and Cultural Tourism Products

Tourism development in Jiuzhaigou should integrate its unique natural landscapes and ethnic culture to create locally distinctive ecotourism and cultural tourism products. Activities such as ecological hiking, wildlife observation, cultural immersion, and educational tours can help visitors better appreciate the region's natural beauty and cultural richness (Ji, Chen, Wu, & Zhang, 2025). At the same time, environmental protection concepts should be embedded into tourism experiences to raise environmental awareness and encourage responsible behavior among tourists (Rizaldi, Rumanti, & Andrawina, 2024).

3.3.2. Improve Tourism Infrastructure and Service Quality

Tourism infrastructure and service management within the scenic area should be enhanced to provide an eco-friendly, safe, and convenient travel environment. Facilities such as eco-toilets, waste-sorting stations, and barrier-free access paths should be installed to improve the overall visitor experience and increase tourist satisfaction and sense of belonging (Wu & Wang, 2024).

3.3.3. Implement Landscape Protection Planning and Minimize Human Disturbance

A comprehensive landscape protection plan should be formulated and strictly enforced. Key areas such as karst water landscapes, forests, and wildlife habitats must be clearly identified for priority conservation. During tourism development, expansion of infrastructure should be strictly limited to avoid destructive construction. All new projects should be planned and designed in harmony with the natural environment to preserve both ecological integrity and aesthetic value (D. He, Chen, & Zhang, 2024).

3.4. Enhancing Environmental Education and Public Participation

3.4.1. Implement Environmental Education Programs

Diverse environmental education activities should be carried out both within and around Jiuzhaigou Scenic Area. These may include exhibitions, public lectures, and nature-based experiential programs aimed at improving visitors' and local residents' understanding of ecological issues and strengthening their environmental awareness and responsible behavior (Wang et al., 2024).

3.4.2. Expand Environmental Awareness Through New Media Platforms

New media platforms such as social media, official websites, and mobile apps should be used to disseminate environmental knowledge, policies, and opportunities for public participation. These tools improve accessibility to information and increase outreach. By leveraging the speed and broad coverage of digital communication, the effectiveness of public engagement campaigns can be amplified, raising awareness and encouraging public involvement in Jiuzhaigou's ecological protection efforts (Firman et al., 2023; Wang et al., 2024).

3.4.3. Promote Community Participation in Ecological Protection

Environmental education and awareness campaigns should be integrated with efforts to increase local community involvement in biodiversity conservation and sustainable development. Incentive mechanisms and participatory initiatives can be introduced to encourage residents to take part in conservation actions. This helps build a sense of environmental responsibility and belonging and supports a collaborative governance model for sustainable tourism development (Li, Zhang, & Wang, 2024).

3.5. Improving Management Systems and Promoting Multi-Stakeholder Collaboration

3.5.1. Establish A Scientific and Efficient Management System

Jiuzhaigou should develop an integrated and effective management framework by optimizing the use of its natural, cultural, and service resources. Management processes should be streamlined to improve operational efficiency. Smart technologies and digital tools should be introduced to enable real-time monitoring of tourist flow, environmental quality, and facility operation. This approach will support fine-grained management and ensure the effective implementation of conservation and administrative measures (Qin & Pan, 2023).

3.5.2. Promote Multi-Stakeholder Participation and Community Collaboration

The active participation of local residents, tourists, tourism enterprises, and related institutions should be encouraged in the governance and protection of the scenic area. Environmental awareness campaigns, volunteer activities, and community-based projects can be used to enhance the sense of responsibility and willingness to participate among the public. A collaborative governance model led by the government, supported by the community, and backed by the public can help build a shared commitment to the sustainable protection of Jiuzhaigou (Samal & Dash, 2024).

4. FUTURE RESEARCH DIRECTION

4.1. Strengthening Heritage Conservation and Promoting Diversified and Sustainable Tourism Development

Future research should explore Jiuzhaigou's aesthetic landscape characteristics through the lens of environmental aesthetics and visual culture. This includes identifying strategies to balance tourism development with cultural heritage preservation and formulating systematic plans for landscape protection and restoration. Such efforts would contribute to the long-term conservation and transmission of both natural and cultural heritage.

At the same time, the integration of ecotourism and cultural tourism should be further examined. Research can focus on developing locally distinctive tourism products such as eco-hiking, nature photography, educational travel, and cultural experience activities. By enriching the tourism content and improving the visitor experience, it is possible to promote diversified and sustainable tourism development while preserving the scenic and cultural values of Jiuzhaigou.

4.2. Developing an Integrated Sustainability Assessment Model to Enhance Scientific Decision-Making

Future studies should focus on developing a comprehensive sustainability assessment model that incorporates environmental, economic, and social dimensions. This model would enable a holistic evaluation of the impacts of tourism activities on Jiuzhaigou's ecosystem and help predict future environmental changes. Based on these insights, more forward-looking strategies for ecological protection and restoration can be formulated.

In addition, research should explore diversified economic development pathways to reduce reliance on a single tourism income source. The assessment model should also integrate mechanisms for stakeholder participation to support real-time monitoring and enhance the scientific basis of decision-making related to sustainable tourism management.

4.3. Promoting Stakeholder Engagement and Cross-Sector Research Collaboration

Future research should explore the roles and responsibilities of various tourism stakeholders in promoting sustainable development within the scenic area. A systematic participation mechanism and benefit-sharing framework should be developed to ensure that communities, businesses, and tourists are actively involved in destination governance. Policy incentives, public awareness campaigns, and capacity-building initiatives can be used to increase stakeholder engagement and encourage collaboration.

In addition, a cross-sector research platform should be established to promote cooperation among government agencies, research institutions, universities, and private enterprises. Joint empirical studies on ecological conservation, management improvement, and sustainability innovation will help integrate resources and foster collaborative solutions, contributing to the long-term sustainability of Jiuzhaigou.

4.4. Integrating Emerging Technologies to Advance Smart Scenic Area Management

Future research should focus on applying modern information technologies to improve scenic area management. Technologies such as the Internet of Things (IoT), cloud computing, big data, and artificial intelligence (AI) can be used to build a smart tourism management system. This system would enable real-time monitoring of visitor flow, environmental quality, emergency response, and service operations, contributing to more efficient and intelligent management.

Additionally, the use of virtual reality (VR) and augmented reality (AR) technologies in tourism should be explored. Applications such as immersive interactive experiences and digital exhibitions can enhance the visitor experience while helping to disperse tourist traffic and reduce direct interference with natural resources. These innovations can support the balance between ecological conservation and tourism development in Jiuzhaigou.

5. CONCLUSION

As a UNESCO World Natural Heritage Site, Jiuzhaigou faces increasingly stringent requirements from international organizations and national policies regarding sustainable development. These expectations have necessitated the adoption of stricter measures in site management and conservation, while also posing significant challenges. Against the backdrop of growing tourism activities and mounting ecological pressures, promoting the sustainable development of Jiuzhaigou has become a pressing issue.

To address these challenges, this study proposes a series of strategic recommendations. These include strengthening ecological protection and restoration, scientifically managing the site's environmental carrying capacity, optimizing tourism products and service quality, enhancing environmental education, and encouraging participation and collaboration among communities and stakeholders. Moreover, this paper highlights the importance of using new media and intelligent technologies to improve management efficiency and raise public awareness, thereby fostering a society-wide model of sustainable governance.

Looking ahead, future research should focus on balancing tourism development with the protection of natural landscapes, promoting diversification and green transformation of the tourism economy, and improving the system for evaluating sustainable development. It is also essential to establish long-term, multi-stakeholder cooperation mechanisms and to integrate technological innovation with smart management. These efforts will strengthen Jiuzhaigou's capacity to achieve sustainable development under ecological constraints and provide both practical guidance and theoretical insights for the management of World Natural Heritage Sites.

Funding: This study received no specific financial support

Institutional Review Board Statement: Not applicable.

Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: Both authors contributed equally to the conception and design of the study. Both authors have read and agreed to the published version of the manuscript.

REFERENCES

- Abuhay, T., Teshome, E., & Mulu, G. (2023). Community knowledge and support of ecotourism in the world heritages sites of Simien Mountain National Park. *Global Business & Finance Review*, 28(4), 62-76.
<https://doi.org/10.17549/gbfr.2023.28.4.62>

- Bagheri, F., Guerreiro, M., Pinto, P., & Ghaderi, Z. (2024). From tourist experience to satisfaction and loyalty: Exploring the role of a sense of well-being. *Journal of Travel Research*, 63(8), 1989–2004. <https://doi.org/10.1177/00472875231201509>
- Bian, Z., Zhang, D., Xu, J., Tang, H., Bai, Z., & Li, Y. (2022). Study on the evolution law of surface landscape pattern in earthquake-stricken areas by remote sensing: A case study of Jiuzhaigou County, Sichuan Province. *Sustainability*, 14(20), 13032. <https://doi.org/10.3390/su142013032>
- Birendra, K., Dhungana, A., & Dangi, T. B. (2021). Tourism and the sustainable development goals: Stakeholders' perspectives from Nepal. *Tourism Management Perspectives*, 38, 100822. <https://doi.org/10.1016/j.tmp.2021.100822>
- Blancas, F. J., & Lozano-Oyola, M. (2022). Sustainable tourism evaluation using a composite indicator with different compensatory levels. *Environmental Impact Assessment Review*, 93, 106733. <https://doi.org/10.1016/j.eiar.2021.106733>
- Chang, L., & Watanabe, T. (2021). Dilemma faced by management staff in China's protected areas. *Land*, 10(12), 1299. <https://doi.org/10.3390/land10121299>
- Chen, Z., Zhao, S., & Wu, M. (2023). Coupling coordination and spatial evolution of sustainable tourism-innovation-environment system: Evidence in China. *SAGE Open*, 13(4), 21582440231196353. <https://doi.org/10.1177/21582440231196353>
- Ciolac, R., Iancu, T., Brad, I., Adamov, T., & Mateoc-Sîrb, N. (2021). Agritourism—A business reality of the moment for Romanian rural area's sustainability. *Sustainability*, 13(11), 6313. <https://doi.org/10.3390/su13116313>
- Deng, G., Wang, L., Tang, Y., Pan, Y., Cao, Y., Zhu, Z., . . . Pang, W. (2020). Understanding human and nature interaction outcomes for sustaining tourist destinations: An example of Jiuzhaigou Nature Reserve, China. *Aquatic Ecosystem Health & Management*, 23(3), 373–384. <https://doi.org/10.1080/14634988.2020.1776498>
- Falk, M. T., & Hagsten, E. (2022). Digital indicators of interest in natural world heritage sites. *Journal of Environmental Management*, 324, 116250. <https://doi.org/10.1016/j.jenvman.2022.116250>
- Firman, A., Moslehpour, M., Qiu, R., Lin, P.-K., Ismail, T., & Rahman, F. F. (2023). The impact of eco-innovation, ecotourism policy and social media on sustainable tourism development: Evidence from the tourism sector of Indonesia. *Economic Research-Ekonomska Ostraživanja*, 36(2). <https://doi.org/10.1080/1331677X.2022.2143847>
- Fountain, J., & Cradock-Henry, N. A. (2020). Recovery, risk and resilience: Post-disaster tourism experiences in Kaikōura, New Zealand. *Tourism Management Perspectives*, 35, 100695. <https://doi.org/10.1016/j.tmp.2020.100695>
- Fu, H., Fu, L., Dávid, L. D., Zhong, Q., & Zhu, K. (2024). Bridging gaps towards the 2030 agenda: A data-driven comparative analysis of government and public engagement in China towards achieving sustainable development goals. *Land*, 13(6), 818. <https://doi.org/10.3390/land13060818>
- Gordan, M.-I., Popescu, C. A., Călina, J., Adamov, T. C., Mănescu, C. M., & Iancu, T. (2024). Spatial analysis of seasonal and trend patterns in romanian agritourism arrivals using seasonal-trend decomposition using loess. *Agriculture*, 14(2), 229. <https://doi.org/10.3390/agriculture14020229>
- Guo, B., Yang, F., Fan, J., & Lu, Y. (2022). The changes of spatiotemporal pattern of rocky desertification and its dominant driving factors in typical karst mountainous areas under the background of global change. *Remote Sensing*, 14(10), 2351. <https://doi.org/10.3390/rs14102351>
- Guo, B., Yang, F., Fan, Y., & Zang, W. (2023). The dominant driving factors of rocky desertification and their variations in typical mountainous karst areas of Southwest China in the context of global change. *Catena*, 220, 106674. <https://doi.org/10.1016/j.catena.2022.106674>
- Hakim, L., Deoranto, P., Ayu, T., Pangestuti, E., & Natalia, D. C. (2023). Mangrove biodiversity and conservations: foundation toward ecotourism implementation in Bintan Island, Indonesia. *International Journal of Conservation Science*, 14(3), 1139–1150. <https://doi.org/10.36868/ijcs.2023.03.23>
- Hatta, M., & Tuwo, A. (2023). *Evaluating coastal area suitability and ecological carrying capacity in topejava village, South Sulawesi*. Paper presented at the IOP Conference Series: Earth and Environmental Science. <https://doi.org/10.1088/1755-1315/1272/1/012034>.
- He, D., Chen, W., & Zhang, J. (2024). Integrating heritage and environment: Characterization of cultural landscape in Beijing great wall heritage area. *Land*, 13(4), 536. <https://doi.org/10.3390/land13040536>

- He, M., & Cliquet, A. (2020). Challenges for protected areas management in China. *Sustainability*, 12(15), 5879. <https://doi.org/10.3390/su12155879>
- Hu, X.-d., Hu, K.-h., Zhang, X.-p., Wei, L., & Tang, J.-b. (2019). Quantitative assessment of the impact of earthquake-induced geohazards on natural landscapes in Jiuzhaigou Valley. *Journal of Mountain Science*, 16(2), 441-452. <https://doi.org/10.1007/s11629-018-5240-7>
- Hu, X., Hu, K., Tang, J., You, Y., & Wu, C. (2019). Assessment of debris-flow potential dangers in the Jiuzhaigou Valley following the August 8, 2017, Jiuzhaigou earthquake, western China. *Engineering Geology*, 256, 57-66. <https://doi.org/10.1016/j.enggeo.2019.05.004>
- Ivasciuc, I.-S., & Ispas, A. (2023). Exploring the motivations, abilities and opportunities of young entrepreneurs to engage in sustainable tourism business in the mountain area. *Sustainability*, 15(3), 1956. <https://doi.org/10.3390/su15031956>
- Javeed, B., Huang, D., Shangguan, D., Ahsan Mukhtar, M., Sajjad, W., Banerjee, A., . . . Butt, A. Q. (2024). Assessing the effectiveness of national park's policies and laws in promoting biodiversity conservation and ecological development in Pakistan. *Frontiers in Environmental Science*, 11, 1333650. <https://doi.org/10.3389/fenvs.2023.1333650>
- Ji, Q., Chen, Y., Wu, F., & Zhang, D. (2025). International tourism and global biodiversity risks. *Annals of Tourism Research*, 113, 103982. <https://doi.org/10.1016/j.annals.2025.103982>
- Jumiyati, S., & Frimawaty, E. (2023). *The development of an edu-agrotourism concept in the buffer zone of conservation area based on education and local community empowerment*. Paper presented at the IOP Conference Series: Earth and Environmental Science (Vol. 1275, No. 1, p. 012027). IOP Publishing. <https://doi.org/10.1088/1755-1315/1275/1/012027>.
- Jurjonas, M., May, C. A., Cardinale, B., Kyriakakis, S., Pearsall, D. R., & Doran, P. J. (2024). The perceived ecological and human well-being benefits of ecosystem restoration. *People and Nature*, 6(1), 4-19. <https://doi.org/10.1002/pan3.10558>
- Kang, N. (2023). Assessing tourism carrying capacity based on visitors' experience utility: A case study of Xian-Ren-Tai National Forest Park, China. *Forests*, 14(9), 1694. <https://doi.org/10.3390/f14091694>
- Khalaf, R. W. (2021). Continuity: A fundamental yet overlooked concept in World Heritage policy and practice. *International Journal of Cultural Policy*, 27(1), 102-116. <https://doi.org/10.1080/10286632.2019.1696782>
- Kustos, M., Goodman, S., Jeffery, D. W., & Bastian, S. E. (2021). Appropriate food and wine pairings and wine provenance information: Potential tools for developing memorable dining experiences. *Food Quality and Preference*, 94, 104297. <https://doi.org/10.1016/j.foodqual.2021.104297>
- Li, Q., Zhang, L., & Wang, H. (2024). Participatory initiatives in rural tourism: Enhancing conservation and community engagement. *Journal of Sustainable Tourism*, 32(4), 567-589.
- Li, X., Zhang, M., Xiao, W., Du, J., Sheng, M., Zhu, D., . . . Sun, G. (2020). The color formation mechanism of the blue karst lakes in Jiuzhaigou Nature Reserve, Sichuan, China. *Water*, 12(3), 771. <https://doi.org/10.3390/w12030771>
- Liao, Y., Xie, Y., Liu, J., Zhu, Z., & Wu, Y. (2021). Ecological security dynamic assessment and obstacle factors analysis in Jiuzhaigou National Nature Reserve. *Acta Ecologica Sinica*, 41(15), 5950-5960.
- Lievens, A., & Blažević, V. (2021). A service design perspective on the stakeholder engagement journey during B2B innovation: Challenges and future research agenda. *Industrial Marketing Management*, 95, 128-141. <https://doi.org/10.1016/j.indmarman.2021.04.007>
- Liu, J., Wang, J., Wang, S., Wang, J., & Deng, G. (2018). Analysis and simulation of the spatiotemporal evolution pattern of tourism lands at the Natural World Heritage Site Jiuzhaigou, China. *Habitat International*, 79, 74-88. <https://doi.org/10.1016/j.habitatint.2018.07.005>
- López-Arquillo, J. D., Oliveira, C., Serrano González, J., & Durán Sánchez, A. (2023). Interdependence in coastal tourist territories between marine litter and immediate tourist zoning density: Methodological approach for urban sustainable development. *Land*, 13(1), 50. <https://doi.org/10.3390/land13010050>
- Lu, J., & Chen, H. (2023). Dynamic evaluation and forecasting analysis of touristic ecological carrying capacity of Forest Parks in China. *Forests*, 15(1), 38. <https://doi.org/10.3390/f15010038>

- Luo, H., & Chiou, B.-S. (2021). Framing the hierarchy of cultural tourism attractiveness of Chinese historic districts under the premise of landscape conservation. *Land*, 10(2), 216. <https://doi.org/10.3390/land10020216>
- Majdak, P., & De Almeida, A. M. M. (2022). Pre-emptively managing overtourism by promoting rural tourism in low-density areas: Lessons from Madeira. *Sustainability*, 14(2), 757. <https://doi.org/10.3390/su14020757>
- Masouras, A., Papademetriou, C., Belias, D., & Anastasiadou, S. (2023). *Sustainable growth strategies for entrepreneurial venture tourism and regional development*. Hershey, PA: IGI Global.
- Mateoc-Sîrb, N., Albu, S., Rujescu, C., Ciolac, R., Tigan, E., Brînzan, O., . . . Milin, I. A. (2022). Sustainable tourism development in the protected areas of Maramureş, Romania: Destinations with high authenticity. *Sustainability*, 14(3), 1763. <https://doi.org/10.3390/su14031763>
- Ocampo-Melgar, A., Barría, P., Cerda, C., Venegas-González, A., Fernández, J., Díaz-Vasconcellos, R., & Zamora, J. (2024). Payment for Ecosystem Services: Institutional arrangements for a changing climate in the Chilean Mediterranean Region. *npj Climate Action*, 3(1), 52. <https://doi.org/10.1038/s44168-024-00132-2>
- Olszewski-Strzyżowski, D. J. (2022). Promotional activities of selected national tourism organizations (NTOs) in the light of sustainable tourism (including sustainable transport). *Sustainability*, 14(5), 2561. <https://doi.org/10.3390/su14052561>
- Ordóñez-Martínez, D., Seguí-Pons, J. M., & Ruiz-Pérez, M. (2024). Toward establishing a tourism data space: Innovative geo-dashboard development for tourism research and management. *Smart Cities*, 7(1), 633-661. <https://doi.org/10.3390/smartcities7010026>
- Pan, C., Zhao, H., & Sun, M. (2024). Real-time target detection system in scenic landscape based on improved YOLOv4 algorithm. *Informatica*, 48(8), 35-48. <https://doi.org/10.31449/inf.v48i8.5700>
- Pan, H. L., Meng, C. L., Diao, Y. B., Liu, Y. P., Yang, X. M., & Deng, D. Z. (2021). Study on restoration of food source plants in damaged habitats of rare animals in Jiuzhaigou earthquake stricken areas. *Journal of Sichuan Forestry Science and Technology*, 42(5), 48-52.
- Qin, Z., & Pan, Y. (2023). Design of a smart tourism management system through multisource data visualization-based knowledge discovery. *Electronics*, 12(3), 642. <https://doi.org/10.3390/electronics12030642>
- Reindrawati, D. Y. (2023). Challenges of community participation in tourism planning in developing countries. *Cogent Social Sciences*, 9(1), 2164240. <https://doi.org/10.1080/23311886.2022.2164240>
- Rizaldi, A. S., Rumanti, A. A., & Andrawina, L. (2024). Sustainable tourism industry in Indonesia through mapping natural tourism potential: Taxonomy approach. *Sustainability*, 16(10), 4201. <https://doi.org/10.3390/su16104201>
- Robinson, J. G., LaBruna, D., O'Brien, T., Clyne, P. J., Dudley, N., Andelman, S. J., . . . Grantham, H. (2024). Scaling up area-based conservation to implement the Global Biodiversity Framework's 30x30 target: The role of Nature's Strongholds. *PLoS Biology*, 22(5), e3002613. <https://doi.org/10.1371/journal.pbio.3002613>
- Robinson, R. N., Martins, A., Solnet, D., & Baum, T. (2019). Sustaining precarity: critically examining tourism and employment. *Journal of Sustainable Tourism*, 27(7), 1008-1025. <https://doi.org/10.1080/09669582.2018.1538230>
- Roblek, V., Drpić, D., Meško, M., & Milojica, V. (2021). Evolution of sustainable tourism concepts. *Sustainability*, 13(22), 12829. <https://doi.org/10.3390/su132212829>
- Rule, A., Dill, S.-E., Sun, G., Chen, A., Khawaja, S., Li, I., . . . Rozelle, S. (2022). Challenges and opportunities in aligning conservation with development in China's national parks: A narrative literature review. *International Journal of Environmental Research and Public Health*, 19(19), 12778. <https://doi.org/10.3390/ijerph191912778>
- Samal, R., & Dash, M. (2024). Stakeholder engagement in advancing sustainable ecotourism: an exploratory case study of Chilika Wetland. *Discover Sustainability*, 5(1), 50. <https://doi.org/10.1007/s43621-024-00233-2>
- Shi, H., Zhang, L., Song, B., & He, C. (2022). The impact of ecotourism on local rural households' livelihood around Wolong Nature Reserve. *Forestry Economics Review*, 4(1), 2-18. <https://doi.org/10.1108/FER-06-2021-0013>
- Sobhani, P., Esmaeilzadeh, H., Sadeghi, S. M. M., Marcu, M. V., & Wolf, I. D. (2022). Evaluating ecotourism sustainability indicators for protected areas in Tehran, Iran. *Forests*, 13(5), 740. <https://doi.org/10.3390/f13050740>

- Song, Z., & Li, Y. (2021). Quantifying ecological performance of giant panda conservation: Evidence from Sichuan province. *Forests*, 12(12), 1701. <https://doi.org/10.3390/f12121701>
- Spadaro, I., Pirlone, F., Bruno, F., Saba, G., Poggio, B., & Bruzzone, S. (2023). Stakeholder participation in planning of a sustainable and competitive tourism destination: The Genoa integrated action plan. *Sustainability*, 15(6), 5005. <https://doi.org/10.3390/su15065005>
- Środa-Murawska, S., Grzelak-Kostulska, E., Biegańska, J., & Dąbrowski, L. S. (2021). Culture and sustainable tourism: Does the pair pay in medium-sized cities? *Sustainability*, 13(16), 9072. <https://doi.org/10.3390/su13169072>
- Stojanović, T., Nechita, F., Igor, T., Eldin, B., Snežana, Š., & Adina, N. C. (2024). Natural and sociocultural values of a tourism destination in the function of sustainable tourism development—An example of a protected area. *Sustainability*, 16(2), 759. <https://doi.org/10.3390/su16020759>
- Streimikiene, D., Svagzdiene, B., Jasinskas, E., & Simanavicius, A. (2021). Sustainable tourism development and competitiveness: The systematic literature review. *Sustainable Development*, 29(1), 259–271. <https://doi.org/10.1002/sd.2133>
- UNDESA. (2015). *Transforming our world: The 2030 agenda for sustainable development*. Rome, Italy: United Nations Department of Economic and Social Affairs.
- UNWTO. (2022). *Statistical framework for measuring the sustainability of tourism (SF-MST)*. Retrieved from https://webunwto.s3.eu-west-1.amazonaws.com/s3fs-public/2023-04/SF_MST_draft.pdf
- Valagussa, A., Frattini, P., Crosta, G., Spizzichino, D., Leoni, G., & Margottini, C. (2021). Multi-risk analysis on European cultural and natural UNESCO heritage sites. *Natural Hazards*, 105(3), 2659–2676. <https://doi.org/10.1007/s11069-020-04417-7>
- Vuksanović, A., Petrović, B., & Jovanović, C. (2024). *Advances in urban development*. Belgrade, Serbia: Academic Press.
- Wang, J., Dai, J., Gao, W., Yao, X., Dewancker, B. J., Gao, J., . . . Zeng, J. (2024). Achieving sustainable tourism: Analysis of the impact of environmental education on tourists' responsible behavior. *Sustainability*, 16(2), 552. <https://doi.org/10.3390/su16020552>
- Wang, P., Zhou, J., Jin, X., Shi, J., Chan, N. W., Tan, M. L., . . . Zheng, K. (2024). The impact of offshore photovoltaic utilization on resources and environment using spatial information technology. *Journal of Marine Science and Engineering*, 12(5), 837. <https://doi.org/10.3390/jmse12050837>
- Wang, Z., & Yuan, B. (2020). Harmonizing the branding strategy of world natural heritage in China: Visitors' awareness of the multiple brands of Wulingyuan, Zhangjiajie. *Geoheritage*, 12(2), 41. <https://doi.org/10.1007/s12371-020-00462-7>
- Wieckowski, M. (2021). The border as a resource—new places for tourism development, Evidence from two Carpathian tripoints. *Baltic Journal of Health and Physical Activity*, 13(6), 17. <https://doi.org/10.29359/bjhp.13.spec.iss1.17>
- Wu, Y., & Wang, Y. (2024). An empirical study on the tourist cognitive evaluations of tourism public services in Xinjiang province, China. *Sustainability*, 16(5), 1712. <https://doi.org/10.3390/su16051712>
- Wungo, G. L., Nurini, N., Ardian, R., & Franestia, F. (2023). Enhancing decision-making for sustainable agriculture and tourism development through system dynamics and GIS Integration: A Study of Jenawi District. *IOP Conference Series Earth and Environmental Science*, 1264(1), 012030. <https://doi.org/10.1088/1755-1315/1264/1/012030>
- Xiong, K., Zhang, S., Fei, G., Jin, A., & Zhang, H. (2023). Conservation and sustainable tourism development of the natural world heritage site based on aesthetic value identification: A case study of the Libo Karst. *Forests*, 14(4), 755. <https://doi.org/10.3390/f14040755>
- Xu, R., Yang, Z., & Xu, X. (2022). OUV analysis and global comparative study of karakoram-pamir world natural heritage potential area. *Sustainability*, 14(19), 12546. <https://doi.org/10.3390/su141912546>
- Xu, Z., Chau, S. N., Chen, X., Zhang, J., Li, Y., Dietz, T., . . . Huang, B. (2020). Assessing progress towards sustainable development over space and time. *Nature*, 577(7788), 74–78. <https://doi.org/10.1038/s41586-019-1846-3>
- Zhang, J., Kangning, X., Liu, Z., & Lixiang, H. (2022). Research progress and knowledge system of world heritage tourism: A bibliometric analysis. *Heritage Science*, 10(1), 42. <https://doi.org/10.1186/s40494-022-00654-0>

- Zhang, Z., Xiong, K., & Huang, D. (2023). Natural world heritage conservation and tourism: A review. *Heritage Science*, 11(1), 55. <https://doi.org/10.1186/s40494-023-00896-6>
- Zhao, L., Xu, G., Cui, Y., Kong, F., Gao, H., & Zhou, X. (2023). Post-disaster restoration and reconstruction assessment of the Jiuzhaigou Lake landscape and a resilience development pathway. *International Journal of Environmental Research and Public Health*, 20(5), 3957. <https://doi.org/10.3390/ijerph20053957>
- Zheng, H., Wang, L., Peng, W., Zhang, C., Li, C., Robinson, B. E., . . . Xiao, Y. (2019). Realizing the values of natural capital for inclusive, sustainable development: Informing China's new ecological development strategy. *Proceedings of the National Academy of Sciences*, 116(17), 8623-8628. <https://doi.org/10.1073/pnas.1819501116>
- Zheng, X., Du, J., Schmidt, A. H., Qiao, X., Power, A., Grosvenor, M. J., & Tang, Y. (2022). Response of lake water nutrient condition to anthropogenic activities from 1871 to 2013 in the Jiuzhaigou World Natural Heritage Site, China. *Journal of Paleolimnology*, 68(4), 345-360. <https://doi.org/10.1007/s10933-022-00248-7>
- Zulvianti, N., Akmal, H., & Putra, M. (2023). The role of pro-environmental behavior in the development of sustainable tourism. *Global Journal of Environmental Science and Management*, 9, 319-330. <https://doi.org/10.22034/GJESM.2023.09.SI.18>
- Zuo, Y., Lan, T., Liu, S., & Zeng, H. (2024). The post-effects of the authenticity of rural intangible cultural heritage and tourists' engagement. *Behavioral Sciences*, 14(4), 302. <https://doi.org/10.3390/bs14040302>