Ecotourism at High Altitudes: A Comparative Study of Yuzhu Peak and Muztagh Ata in Community Governance, Economic Growth, and Environmental Sustainability

Yifan Liu

Brighton College, Eastern Road, Brighton and Hove, BN2 0AL, United Kingdom

11kliu@brightoncollege.net

Abstract. This study focuses on three dimensions of ecology, economics, and community to compare two representative alpine tourism destinations in China, discussing the effects of ecotourism in promoting green transformation and environmental community co-governance at high altitudes. The study adopts the case study approach to assess tourist volume, income, environmental governance, and community participation using secondary data. Findings suggest that Muztagh Ata has relied on institutional policies and market mechanisms to implement a community-driven tourism framework. Though still in an early stage, Yuzhu Peak demonstrates growth potential and value in exploring community-level governance. This research shows that ecotourism may offer a pathway to achieve both ecological conservation and economic empowerment. However, its sustainability relies on a combination of strong institutional designs, community mobilization, and policy alignment. This paper serves as both theoretical reference and empirical evidence to institutional innovation and cross-regional collaboration in alpine ecotourism.

Keywords: Alpine ecotourism, Community governance, Sustainable tourism, Environmental policy, Comparative case study.

1. Introduction

1.1. Background

Following the rise of Green GDP, alpine areas have become vital platforms for the development of ecotourism due to their unique ecosystems and culture. In particular, Mount Everest in Nepal has undergone 40 years of development in this field, building community-led tourism governance systems and generating income for the local population [1]. In China, the regions of Qinghai-Tibet Plateau and Hengduan Mountains also began to transition to green growth. The development of tourist sites such as Mount Gongga in Sichuan and Mount Gangbala in Tibet has improved basic infrastructures, public services, and increased employment opportunities in high-altitude regions, making them important platforms for regional sustainable growth [2].

Overall, alpine ecotourism has gradually transitioned from a traditional "sight-seeing" approach to an "ecological preservation and community collaboration" development model. The United Nations World Tourism Organization has shown that ecotourism can reduce poverty and protect natural environments, promoting green development in rural areas [3].

1.2. Research Gap

The development of alpine ecotourism is not a linear process, but rather the combined outcome of ecological stability, tourism management, and community participation. From a global perspective, the United Nations Food and Agriculture Organization (FAO) highlighted in Mountains Matter that ecotourism can empower mountainous regions in economic development, cultural preservation, and ecological governance. Its success depends on the level of local agents' engagement in collective resource management [4].

As a representative case of mid-altitude alpine ecosystem, the Shennongjia National Park adopts a national park and community co-governance model [5]. Similarly, the study of Pudacuo, Shangri-La, Yunnan presents a development pathway involving environmental protection, tourism

development, and the income generation, providing valuable insights on institutional design and spatial transformation to other alpine regions [6].

While there is existing research on regions with relatively strong economic foundations, remote high-altitude areas with weaker ecosystem and infrastructure are often overlooked. To fill a critical gap in existing ecotourism literature, this study adopts the case study method to investigate the Yuzhu Peak and Muztagh Ata – two underdeveloped alpine regions. The dual case study on two typical alpine areas in China can strengthen existing understanding of high-altitude ecotourism development and provide empirical evidence to advance to an ecological-prioritizing approach.

1.3. Questions

This study centers its analysis around three key questions: (1) What are the differences between economic contributions of Yuzhu Peak and Muztagh Ata, and what are the underlying causes? (2) What are the approaches to environmental protectionism and managing the carrying capacity? (3) What is the depth of community participation in tourism, and do they demonstrate self-governance capabilities or a sense of agency? Addressing these questions can clarify the patterns in alpine ecotourism development and provide legislative and political references to similar regions in future.

In terms of methodology, this study adopts a qualitative research strategy. By collecting and analyzing secondary data including official statistics, academic literature, and media reports, it constructs a multi-dimensional indicator system that compares economic contributions, environmental governance, and community participation. Additionally, the case study method is used to analyze the development pathways of Yuzhu Peak and Muztagh Ata under different political backgrounds, showing a more concrete approach in practice.

This paper is structured as follows: Chapter 2 presents a literature review, highlighting existing theories and studies on ecotourism, green economy, community governance. Chapter 3 introduces the research methodology and data sources. Chapter 4 is a comparative analysis of the two regions on economic contributions, environmental governance, and community participation. Chapter 5 follows with a discussion and policy recommendations, providing specific suggestions to the development of Yuzhu Peak, and exploring the possibilities of cross-regional collaboration. Finally, chapter 6 ends with a conclusion, summarizing research findings and identifying areas for future research.

2. Literature review

2.1. Development model of ecotourism in mountainous regions

Mountain ecotourism is an important branch to ecotourism and has developed in diverse ways. Nepal [1] highlights how alpine ecotourism should balance environmental governance, economic development, and community participation to alleviate the pressure of poverty and pollution in remote mountainous regions. Ross and Wall [7] outlined five key measures to ecotourism, adding environmental education and local reinvestment to the three focus areas identified. Chowdhury and Dwyer [8] developed a new framework involving nature conservation, climate change, and economic development, offering insights to future policy actions.

To further understand the development of alpine ecotourism, some scholars have turned their attention to case studies in China's mountainous regions. Rana and Agrawal [9] explored tourism in the Himalayas, which gained popularity among adventurous tourists and pilgrims, providing employment and cultural exchange opportunities to the local population. Sharma et al. [10] conducted a study on Mount Everest, showing how the environment, culture, and indigenous communities may be unsustainable due to tourism, reiterating the importance of ecological preservation.

In addition to the environmental and social impacts, recent research has explored the practical implementation of ecotourism initiatives and their implications for sustainable development. Thomas [11] presented the impacts of ecotourism, including development of remote areas, agriculture, and community diversification, while stressing on the need to reduce environmental pollution. Rawlins et

al. [12] analyzed ecotourism in Cambodia, focusing on birdwatching, fishing, camping, hiking, kayaking, zip lining etc. Collectively, these studies will aid the transition from conservationism to sustainable development, providing evidence to guide the implementation of ecotourism on Yuzhu Peak and Muztagh Ata.

2.2. Economic Benefits of Green GDP and Ecotourism

The economic benefits to ecotourism have surpassed that of traditional sightseeing, becoming a leading driver to the growth of Green GDP. Bhaskar and Tripathi [13] showed how the concept of Green GDP can be used to weigh economic growth and ecological impacts, using which to construct a sustainable growth model. In the investigation of Nepal, Ghanshyam et al. [14] studied Rapti Peace Park to show how ecotourism can promote regional employment, carbon trading, and sustainable natural resource usage. Serio et al. [15] used the Spatial Durbin Error Model (SDEM) to investigate the effects of sustainability-driven policies on neighboring Italian provinces in promoting tourism flows. Green GDP can not only quantify the economic value generated but also provide means of assessing the degree of ecological preservation in alpine environments.

2.3. Community Participation and Sustainable Development Theory

The sustainability of ecotourism depends on multiple parties in collaborative governance, drawing on the theory "Governing the Commons" proposed by Elinor Ostrom. Ostrom [16] outlined eight principles to designing an effective policy framework for the collective allocation of regional public resources. Through the case study of Rio Limpio National Park, Borglund [17] found that clear, non-changing regulations can contribute to balancing tourism development with environmental protection. Sage [18] analyzed the effectiveness of self-governance of tourism in rural areas by the local community through implementing new regulations. Dangi et al. [19] focused on waste management in mountainous regions, emphasizing on the importance to involve different parties. The above studies show that mountain ecotourism must take a decentralized management approach to increase local community participation, finally transitioning from external source development to internal governance.

2.4. Review on Yuzhu Peak and Muztagh Ata

The studies on Yuzhu Peak and Muztagh Ata remain in an early stage, but their findings serve as important references to this article. Nepal's research [1] on the Pamier mountain area (which includes Muztagh Ata) demonstrates the crucial role the local community plays in building a comprehensive tourist network, involving transportation, hospitality, and alpine guides. Furthermore, Brouder's study [20] on Northern European mountains forms a standard model to combining green industries with ecotourism, diversifying the development of Xinjiang's mountainous regions. In contrast, there are currently no existing research on Yuzhu Peak. Overall, there are significant disparities in the level of community governance, market involvement, and policy support around the two peaks.

3. Method

3.1. Research Methodology

This study uses a mixed-method approach that includes triangulation, Comparative Analysis Method, Case Study Method, and indicator-based measurement to compare the economic, ecological, and social dimensions in ecotourism developments between Yuzhu Peak and Muztagh Ata. First, Comparative Analysis Method is employed to assess the economic impacts of tourism, environmental governance, and community participation in the two regions. The aim is to explore the foundations of regional governance and development pathways. Second, Yuzhu Peak and Muztagh Ata are chosen as representative examples of alpine tourism to analyze their governance contexts and policy practice. The Case Study Method is applied to explain the logic behind each region's development, adopting

a contextualized approach. Additionally, secondary data are used to estimate economic and social development indicators, including tourist number, annual revenue, employment, and community participation.

3.2. Data Sources

All data in this study are drawn from authoritative and publicly accessible sources to ensure their reliability. These sources primarily fall into three categories: 1) Government's official reports, including tourism and poverty alleviation briefings from the People's Government of Qinghai Province, fiscal spending and management policies on alpine tourism issued by Xinjiang Akto County. 2) Literature study, including Nepal [1] on alpine tourism and community participation, Holzer et al. [21] on multi-source remote sensor of glacier changes on Muztagh Ata, and Li et al. [22] on the ecological pressure from tourism around Yuzhu Peak. 3) News reports and policy documents from international organizations, including Xinhua News Agency and People's Daily on tourism development, the United Nations Environment Program (UNEP) on sustainable ecotourism and policy frameworks, and the NGO Plateau Perspectives' "Yuzhu Destination Development" project.

3.3. Definition of variables and dimensions

This study selects six key variables including economic contributions, environmental governance, and community participation. Each variable is presented in a qualitative or semi-qualitative way. Quantitative indicators, such as tourist number and tourism revenue, are presented with specific numerical data for comparison, while semi-qualitative aspects, such as waste management mechanisms and the depth of community involvement, are assessed to provide logical foundation for later analysis.

Table 1. Indicators

Dimensions	Indicators	Definition
Economic contributions	Annual tourist number	Total number of mountaineers or tourists per year from official sources or media estimation (average tourist per day × number of days)
	Annual tourism revenue	Total tourism revenue disclosed by the government or estimates from news reports
	Employment generation	Employment of local population in tourism, such as alpine guides, caravan, hospitality
Environmental governance	Waste management	Whether "pack-in, pack-out" systems are established, whether local community or green organizations are involved
	Glacier / water conservation	Whether official parties are involved in studies on glacial retreat, whether relevant policies or legislation are in place
Community participation	Community involvement	Whether community participation is labor-based (e.g. transportation, hospitality) or extends to governance-level (e.g. forming legislations, sharing profits), reflecting the depth of engagement

4. Results and Discussion

4.1. Economic contributions comparison

Economic contribution is an important dimension in assessing the sustainability of ecotourism development. The comparison of Yuzhu Peak and Muztagh Ata reveal significant differences in the number of mountaineers, tourism revenue, job creation, and local fiscal spending.

As an important high-altitude mountaineering destination in the Kunlun Mountains of Qinghai Province in China, Yuzhu Peak has seen initial development in alpine tourism over recent years.

According to official numbers from Qinghai Province, there has been steady growth in the number of tourists from 1,078 in 2021 to around 2,000 in 2023 [23]. Alpine tourism revenue in the region reached ¥1.07 million in 2021. Specifically, 1,350 herders in Angla Village received community dividends, indicating that ecotourism is beginning to generate shared revenue in the area [24].

In contrast, Muztagh Ata in Aketao, Xinjiang has attracted significantly more tourists due to its international recognition and well-developed tourism infrastructure. Tianshannet reported daily tourist numbers of over 600 during peak mountaineering seasons. The estimated annual tourist number reached 18,000, far exceeding that of Yuzhu Peak [25]. Muztagh Ata has a more mature tourism industry that involves local Kyrgyz residents in jobs like alpine guides, pack animal transport, and logistical support. This has created large numbers of stable employment opportunities. In doing so, the mountaineering industry became more integrated into the domestic economy [1].

In terms of fiscal spending, Qumalai County allocated over ¥30 million to develop "Yuzhu Peak International Mountaineering Village", where Yuzhu Peak is located. The aim is to improve transportation, accommodation, and medical facilities to build a mountaineering hub [24]. Though there are no exact figures to show this, the mountaineering industry has evolved into a self-sustaining financial cycle through market mechanisms.

In general, Yuzhu Peak is still in the early stage of ecotourism development with limited economic contribution. However, it displays a stabilizing growth trend and strong policy support. In comparison, Muztagh Ata exhibits a more mature market-governed development model. Its economic contribution not only consists of tourism revenue, but also the high level of community participation and income distribution. The contrasting mechanisms of economic contribution offer valuable insights for the sustainable development of high-altitude alpine ecotourism.

4.2. Environmental protection and ecological governance

Both mountain regions adopted a range of environmental protection practices. Yuzhu Peak introduced a waste disposal system involving the community and government, where forest rangers and local villagers take turns to remove wastes. Moreover, climbers are required to pack out their waste, creating a closed-loop system for alpine waste management [26]. Volunteers and environmental organizations also engage in promoting the "zero waste policy".

In comparison, the focus of ecological governance in Muztagh Ata is shifting to glacier retreat and legal protection. Holzer et al. [21] used remote sensing research to identify zones of rapid glacier retreat and prompted relevant authorities to incorporate these areas into environmental impact assessment frameworks and to develop targeted protection measures. The research by Beard and Clason [27] suggests that micro-plastics, heavy metals, and other artificial pollution have accumulated in glacial environments. As the glaciers melted, these pollutants were released into the ecosystem, reinforcing the role which glaciers play as a risk accumulation node. This science and policy-led approach demonstrates the systematic and structural nature of ecological governance in the area.

For sustainability, Yuzhu Peak predominantly relies on community-led waste removal and limiting the number of tourists to manage waste, whereas Muztagh Ata uses scientific monitoring and legislation for glacier protection. The two case studies represent different approaches to ecological governance, offering valuable insights to understanding green economic development in mountainous regions.

4.3. Community participation analysis

4.3.1 Participants and level of engagement

The depth of community involvement in ecotourism not only determines its revenue but also its sustainability and governance effectiveness. There exist significant differences to the width and depth of community participation in the regions of Yuzhu Peak and Muztagh Ata, revealing contrasting development pathways of governance frameworks and culture.

In the region where Yuzhu Peak is located, most local herders in tourism train to become alpine guides or provide other forms of logistical support to climbers (such as waste collection and supply transport). According to Qinghai Province People's Government [23], there are currently around 20 local villagers receiving alpine guides training. Over 1,350 herders from Angla Village have received indirect dividends through tourism. However, most forms of community participation that occur are labor-intensive. Community involvement in decision-making is not yet achieved, such as designing tourism activities, profit distribution, or environmental management. Most core aspects including mountaineering management, setting service standards, and marketing are still led by external corporations or government institutions, restricting the community's agency and its capacity for institutional development.

In comparison, the Kyrgyz community around Muztagh Ata have played a more diverse and proactive role in tourism. The locals are involved in pack animal transport, logistical support, and campsite management [1]. Others work in the hospitality sector or partner with mountaineering corporations. Some even engage in discussions on tourist site management and environmental resource allocations. This system relies on strong community collaboration, building the foundations of regulations on tourism revenue localization and ecological conservation.

4.3.2 Assessing the applicability of Ostrom's Collective Action Theory

Based on theory, Ostrom's eight principles [16] for the allocation of common-pool resources offer an analysis framework to assessing community collective action capacity in ecotourism. These contrasting patterns highlight the institutional differences in local governance. The development of Yuzhu Peak resembles an externally-led governance approach. While there are early forms of community mobilization, there are no clear boundaries to resource allocations, regulation-setting, and internal incentive mechanisms. On the contrary, Muztagh Ata aligns more closely with a community governance model. There are high levels of community participation and stability in resource management, profits distribution, and environmental conservation. Iqbal et al. [28] proposed that tourism competition and development sustainability depend on the integration of local population into planning, operations, and oversight, which is relatively well-established at Muztagh Ata.

Overall, the comparison of the two regions highlight the significance of community participation in ecotourism. It affects not only the economic outcomes but also the sustainability of the environment and the regulations. Going forward, the development of Yuzhu Peak would benefit from exploring self-governance mechanisms grounded in Ostrom's framework. The community should be more deeply involved in planning and decision-making in order to advance to a human-centered ecotourism model.

5. Discussion and Implications

5.1. Regional Policy Impacts: Xinjiang vs Qinghai

The divergence in the two regions' development trajectories reflect the critical role of policy orientation. With strong national support, Akto County, Xinjiang implemented glacier protection legislation and ethnic tourism support regimes, building the foundations to a structured development model for the Muztagh Ata region. Contrarily, Yuzhu Peak has relied more on local government initiatives and the community's self-organization, taking a "bottom-up" experimental approach [29]. The difference in policy implementation has impacted tourism governance capacity and growth rate in the two areas.

5.2. Suggestions for Yuzhu Peak

Three suggestions are proposed for the future advancement of Yuzhu Peak. Firstly, there should be reinforced systematized community training beyond that of alpine guides, expanding to general skills such as ecological management, hospitality, and emergency response to strengthen the community's agency and bargaining power in the industry. Secondly, an environmental monitoring

and feedback mechanism should be introduced to regularly assess tourist capacity and set up ecological compensation mechanisms. This will reduce the potential pressure imposed on the environment due to tourism activities. Lastly, promoting Yuzhu Peak as an ecotourism brand by integrating Qinghai's unique culture, ethnic diversity, and natural resources can increase its market influence and environmental awareness.

5.3. Promoting Cross-region Collaboration and Expertise Exchange

From a macro perspective, a potential strategy is to establish an "Alpine Ecotourism Development Alliance" which combines the expertise and resources in Yuzhu Peak, Muztagh Ata, and other touristic snow peaks. This promotes inter-regional regulation standardization, environmental figures sharing, and joint talent development. Universities, NGOs, and local government can communicate and co-construct mechanisms to support alpine ecotourism governance and branding [29].

Overall, the differing development pathways of Yuzhu Peak and Muztagh Ata reflect the dynamics of eco-economic models. Moving forward, strengthening institutional design and community participation will be central to the sustainable development of Yuzhu Peak.

6. Conclusion

This study conducted a comparative analysis of Yuzhu Peak and Muztagh Ata around ecotourism's economic contribution, ecological governance, and community participation, systematically analyzing their development pathways and suggesting potential policies.

Findings indicate the two regions differ significantly in institutional design, community governance capacity, and resource integration strategies despite both being ecologically vulnerable plateaus in western China. These are reflected not only in tourism figures (such as tourist number, tourism revenue), but also in the level of environmental governance and breadth of community participation.

Economically, Muztagh Ata has advanced into a relatively mature market-driven system with some policy support. Kyrgyz and Tajik communities dominate the tertiary sector with diversified and stable income. While Yuzhu Peak is still in an early stage of development, it demonstrates growth potentials and possibility in transforming to a more structured model. In terms of environmental governance, Yuzhu Peak has implemented a village-based rotation and waste-backpacking system through community-government collaboration, which is a form of replicable micro-governance. In contrast, Muztagh Ata has adopted a more structured approach that involves glacier legislation, remote sensing technologies, and pollutant monitoring, integrating technological foresight with policy responsiveness. Regarding community participation, the two regions differ significantly in their ability to manage common-pool resources according to Ostrom's theory. Muztagh Ata has successfully transitioned from labor-based "execution" to decision-making "co-governance" in tourism, whereas Yuzhu Peak remains externally driven with limited community participation. This suggests a need for further institutional developments to improve community agency.

Despite offering a comparative case-based analysis, this study is subjected to several limitations. First, the results rely on second-hand data and lacks ethnographic fieldwork and primary quantitative datasets. Second, dynamic variables of ecotourism — such as cultural identity, tourist perceptions — are not discussed in depth. Future research would benefit from a greater range of data sources and quantitative modeling techniques.

In summary, alpine ecotourism integrates green growth and remote region development. Its sustainability relies not only on natural resources, but also on adaptive governance structures, high levels of community participation, and compatible policy regimes. The divergent development pathways of Yuzhu Peak and Muztagh Ata provide empirical models for understanding the synergy between the ecosystem, economy, and community.

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