



Ecotourism-led development and its socio-ecological impacts in Gaurishankar Conservation Area

Anju Bhandari¹, Shreehari Bhattarai¹, Prawesh Poudel², Manish Bhujel^{1*}

¹*Faculty of Forestry, Agriculture and Forestry University, Hetauda, Nepal*

²*National Trust for Nature Conservation - Gaurishankar Conservation Area Project, Singati, Nepal*

*Email: bhujelmanish110@gmail.com

Abstract

Ecotourism in Nepal emerged with a dual focus on conservation and socio-economic development. While its implementation across various regions has brought notable benefits, including improved livelihoods for stakeholders and increased economic opportunities, it also presents environmental and management challenges. This study evaluated the ecological and economic impacts of tourism exploring its necessity for sustainability. By assessing the perspectives of stakeholders, tourists, and local residents, it revealed that although tourism contributes significantly to local development, it also poses serious environmental challenges. These include increased solid waste, the spread of Invasive Alien Plant Species (IAPS), and reduced wildlife sightings. The findings highlight the need for improved sustainable management strategies to balance tourism growth with environmental preservation. This research serves as a valuable resource for policymakers, stakeholders, and communities to adopt practices that support both conservation and responsible tourism development.

Keywords: Biodiversity, Community livelihoods, Habitat degradation, Sustainable tourism

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Introduction

Ecotourism emerged in the late 1980s at the dawn of sustainable development (Stronza *et al.*, 2019). It was started with a theme of nature-based travel, support for conservation, socio-economic development, support and respect for local culture, environmental education, distribution of benefits, and local people's participation (Chandel and Mishra,

2016; Donohoe and Needham, 2006). The key tourism activities are skiing, fishing, hunting, boating, waterside recreation, hiking, etc. (Ceron and Dubois, 2003). Different studies have shown that the current tourism development is within the limit of sustainability, contributing to the sustainable development of rural livelihoods, creating various income opportunities such as tour

guides, organic product sales, homestay operators, boating, birding, etc. (Kuuder *et al.*, 2013; Ristić *et al.*, 2019). Also, a report published by the World Travel and Tourism Council [WTTC], 2023 shows that travel and tourism contributed \$7.7 trillion to global GDP and supported 295 million jobs globally in 2022. While in other hand, breeding disorders, change in migration patterns, greenhouse gas emissions, air pollution, water pollution, solid waste accumulation, rising consumption of ground (space), destruction of landscapes with creation of new infrastructures, alteration of ecosystems, introduction of exotic species, narcotic traffic and fluctuation in price of goods and services, etc. are the net negative impacts (Baloch *et al.*, 2023; Butarbutar, 2013; Ceron and Dubois, 2003; Kostić *et al.*, 2016).

Nepal's tourism is experiencing high flow with a total arrival of 1,014,882 in 2023, which is a 65.05% increment compared to 2022 (Ministry of Culture, Tourism and Civil Aviation, 2023). The World Tourism and Travel Council [WTTC], 2024 reports that travel and tourism contributed 6.1% to Nepal's GDP in 2023 (NPR 327.9 billion) including direct, indirect and induced impacts. Tourism had already been an alternative source of income generation in villages of Kaski, Tanahun, Syangja, Lamjung, and Gorkha districts of Nepal through rural tourism initiatives (Acharya and Halpenny, 2013). Community-based ecotourism in isolated and remote rural regions has improved livelihoods by providing tangible benefits to the people, and has also provided different opportunities to the national and international community for activities and exploring nature (Acharya and Halpenny, 2013; Nepal, 1997).

Despite this, tourism has resulted in several hazards in Sagarmatha National Park (Jefferies and Sherpa, 1989; McConnell, 1991; Nepal and Nepal, 2004). Similarly, the Annapurna circuit trek is seriously endangered due to massive road construction along Marsyangdi, Kaligandaki in the western, and

to Mukthinath in the northern interrupting the pristine natural environment through mechanized mobility, inducing CO₂ emissions, noise, and dust pollution (Upadhayaya, 2015). The Annapurna region is experiencing heightened human pressures resulting in a decrease of forest cover by 8% from 1911 to 2011 (Chaplin and Brabyn, 2013). Similarly, concentration of tourism in one sector, concessionaire hotels in prime wildlife habitat areas, impacts from vehicular and jungle drive, elephant safaris, canoeing and river pollution, exotic plants, development of prostitution, gambling and drug abuse, etc. are the major impacts by tourism in Chitwan National Park (Shrestha, 2003; Subedi, 1999).

Gaurishankar Conservation Area (GCA) was declared by the government of Nepal to conserve the mountain ecosystem and to maintain a biological corridor between Langtang and Sagarmatha National Park. Due to high biodiversity, the tourism number has risen to 2764 in 2017 from 141 in 2010 serving as a major source of income, contributing about half (45%) of total income but despite, gambling, alcoholism, changes in behavior of the wild animals, price hike, etc. are the key negative impacts (Sharma *et al.*, 2018). Despite all this, there remains a gap to address the impacts of tourism to take both the ecology and economy, and biodiversity and tourism towards a sustainable management practice. So, this study focuses on evaluating the direct and indirect impacts on biodiversity and economy, along with the identification of key factors influencing the balance between biodiversity conservation and economic development for sustainable tourism.

Materials and Methods

Study area

This study was conducted in GCA (Figure 1) that extends between 85°46.8' to 86°34.8' East longitude and 27°34.2' to 28°10' North latitude with an area of 2179 sq.km. GCA has three physiographic zones of High Himalaya, High

Mountain and Middle Mountain. It includes three districts, viz. Sindhupalchowk, Dolakha and Ramechhap. Forest and bushes cover 44.5%, while cultivation land covers 8.8%, grasslands accounts 8.6%, glaciers accounts for 2.8% and barren land and other covers 35.3% of the total area. It harbors 565 species of plants, 35 species of mammals, 16 species of fishes, 9 species of amphibians, 22 species of reptiles and 235 species of birds (National Trust for Nature Conservation [NTNC], 2017). Inside GCA, the study was conducted in three sites: Rolwaling valley, Lapchi and Ramechhap area in which Rolwaling valley is situated in Nepal just South of its border with the Tibetan region of China. Located approximately 50-km west of Mt. Everest, it lies in the Southern slopes of the 7,146 m peak known as Gaurishankar in Nepalese and Tseringma in Tibetan. It has been known in Tibetan culture as a holy place for at least a thousand years (Sacherer, 2011). Also, Tsho-Rolpa glacial lake (27°51'N, 86°29'E) lies in Rolwaling valley at an altitude of 4555 m (Shrestha and Nakagawa, 2014) while, Lapchi valley is located at the foot of the Lapchi Khang mountain range. It lies between 86°10'32.53"E to 86°29'9.45"E and 28°20'13.9"N to 28°21'54.55"N with an elevation range 2600 m to 4950 m, surrounded by China border at East, West and North. It is an important pilgrimage destination for Tibetan Buddhists and is known for meditation caves of famous Tibetan saint and poet, Jetsun Milarepa (Gosai *et al.*, 2024; Koju *et al.*, 2021). Ramechhap area lying under GCA offers a unique blend of natural beauty and cultural experiences, attracting tourists interested in trekking, nature and local traditions. The major trekking sites are; Numbur Cheese Circuit, Jatapokhari, Panchpokhari and Thulo Sailung.

Field survey, data collection and analysis

We conducted three field visits: the first in Rolwaling valley, second in Lapchi area and

the third in Ramechhap district. On average, each visit lasted for 7 days and was conducted between November 2024 and March 2025, as this period was allocated and funded by GCA under Darwin Initiative Project to align with optimal field condition and logistical feasibility. This timeframe coincides with the dry season in Nepal, characterized by clear weather, minimal precipitation and accessible trekking routes, which facilitated safe and effective data collection in the mountainous terrain (Gosai *et al.*, 2024). We carried out the environmental, social and economic impacts, ensuring more precise understanding using some criteria and indicators (Table 1). For assessment of Invasive Alien Plant Species (IAPS), we collected data from influenced and controlled sites. Trekking routes were used as influenced sites while controlled sites were placed at least 100m away, beyond the tourism influence to compare the impacts. Sites were chosen based on feasibility since topography significantly influences impact assessment in mountainous tourism (Geneletti and Dawa, 2009) and adaptive sampling is required in such environments (Baral *et al.*, 2023; Monz *et al.*, 2010) because site specific methods in protected areas ensure realistic and reliable evaluation (Canteiro *et al.*, 2018). Fifteen 25m * 4m line transects were established to assess coverage and species frequency and visual estimation was carried out by 2 observers, with coverage recorded in percentage basis as this design aligns with the FIREMON Density (DE) Method (Caratti, 2006), which supports flexible transects dimensions suited to vegetation type and field conditions. Semi-structured interview was conducted with 103 respondents including tourists, local people, stakeholders, guides and porters. Also, one Focus Group Discussion (FGD) and two Key Informant Interview (KII) was conducted during survey. To analyze the tourism influence on IAPS, T-test was used to evaluate the status between influenced and controlled sites. Pearson correlation was calculated to

identify the relationship between tourism and economic contribution and ANOVA was used to identify the impact of COVID-19. All analyses were carried out in R studio in version 2024.04.0. Thematic analysis was used to interpret qualitative data obtained from interviews and FGD.

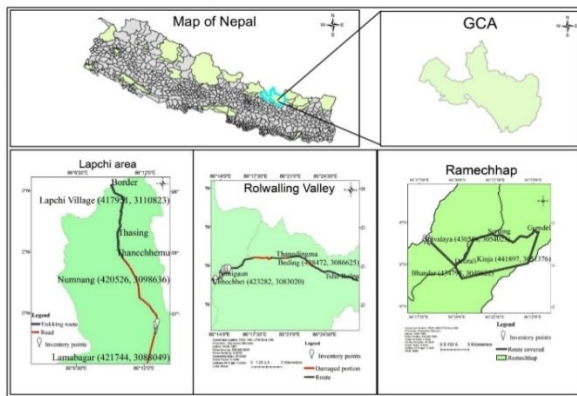


Figure 1. Map of study area showing walking trails and sampling sites

Table 1. Tourism impacts and its indicators

Category (Impacts)	Indicators
Environmental	Trail structure, width (Any unauthorized paths or shortcut made)
	Vegetation trampled near trails
	Invasive species present at tourism and non-tourism sites
	Solid waste accumulation
Economic	Number of new homestays and hotels built in past few years
	Total revenue generated
	Average annual income before and after tourism
Social	Community involvement in biodiversity conservation
	Community attitudes towards tourism

Results

Visitor's trend at GCA

The visitors trend highlights the impact of COVID-19 on tourism. Non-SAARC international visitors have consistently been the highest group, showing a pandemic induced decline ($p = 0.044$) followed by

recovery. Domestic tourism was initially low but has notably increased after 2022 ($p = 0.032$). In contrast, SAARC visitor numbers remained extremely low before 2022 and have continued to show minimal growth ($p = 0.594$).

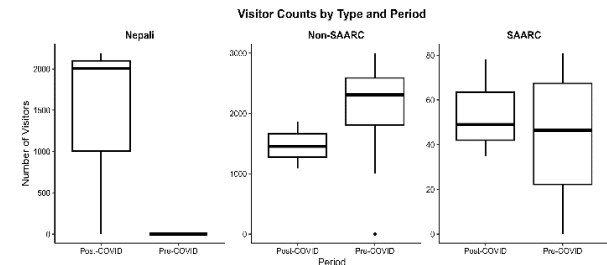


Figure 2. Visitors type and their flow pattern

Annual visitors number at GCA

The visitors count has showed a notable peak in 2017, reaching 2764 which was significantly higher than most year prior to it ($p < 0.0001$) but after 2017, the number got fluctuated with a statistically significant decline from 2018 to 2019 ($p < 0.0001$). The decline continued sharply in 2020 and 2021 ($p < 0.0001$), highlights COVID-19 impact. Since 2022, the visitors count has significantly increased, surpassing 4000 in 2024 ($p < 0.0001$) indicating strong post-pandemic recovery.

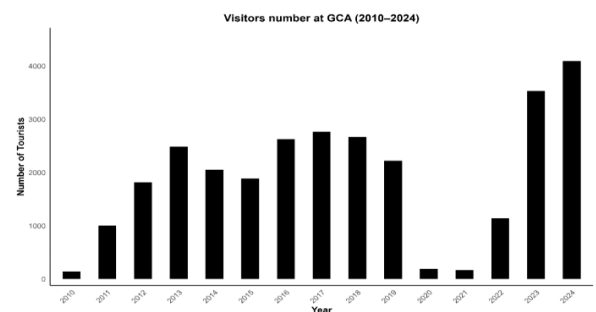


Figure 3. Visitors number at GCA

Average economic contribution by tourism

The economic condition of stakeholders, porters and guides have evolved over time, demonstrating a strong correlation between tourism growth and livelihood improvement. Statistical analysis confirms extremely strong

positive relationships i.e. stakeholders ($r = 0.997$, $p = 0.00293$), guides ($r = 0.997$, $p = 0.00279$), and porters ($r = 0.9999$, $p = 0.0000658$) highlighting tourism's direct impact on income generation.

Between 2010 and 2024, permit revenue surged from NRS. 2,82,000 to NRS. 58,64,300 paralleling an increase in visitors from 147 to 4,098 confirming a strong correlation between tourism flow and economic gains. The steady rise in earnings until 2017, when visitor numbers reached 2,764 indicates a critical threshold for local benefits. The downturn in 2020 (194 visitors) illustrates the pandemic's disruption, while the 2024 recovery reaffirms tourism as a key driver of revenue and employment.

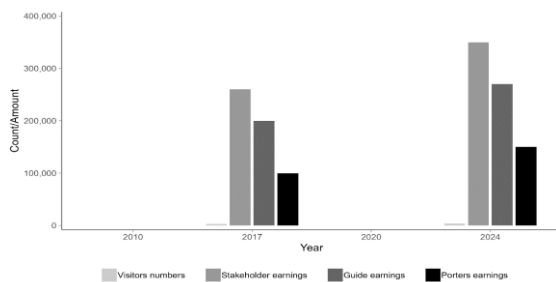


Figure 4. Economic contribution by tourism

IAPS status in tourism influenced and controlled site

Statistically significant difference ($p = 0.02$) in abundance of IAPS in tourism influenced and controlled sites along with the difference ($p = 0.006$) in coverage was found. Both coverage and abundance were higher in tourism influenced sites (Figure 5) than in controlled sites indicating tourism's influence on IAPS.

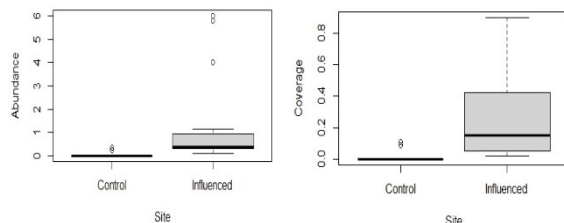


Figure 5. Comparison of IAPS between influenced and controlled site

Implication for conservation

Among the total respondents, 77.6% profoundly appreciated nature and its beauty and 74.75% were satisfied with the expenses they spent (Figure 6). Similarly, 17.47% highlighted the improvement in livelihood and 11.6% expressed the place as budget friendly. 2.91% encountered wildlife followed by 0.9% hearing the sound of Red Panda, one of the rare and endangered species. Also, 8.7% expressed the high religious tourist influx since the place is religiously important.

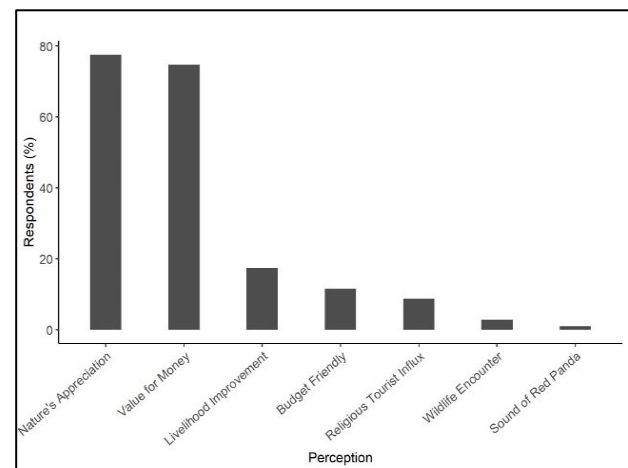


Figure 6. Respondent's perceptions towards nature conservation

Key challenges and improvements need:

The most argued challenges and improvements needed is navigation by 72.8% reporting the issue of being lost on the route followed by solid waste accumulation (68%) and trail improvement by 68% since it is highly damaged by flood and landslide. Similarly, 53.4% asked for proper route establishment of Dudhkunda, 41.7% reported the issue of insufficient accommodation facility and 32% argued for exclusionary practice from stakeholders. Also, wildlife sightings have reportedly declined as 26.2% of respondents highlighted reduced encounters with wildlife, 25.2% demanded to improve security at trails and 24.3% argued for proper drinking water facility. 22.3% stated the bad hospitality by stakeholders followed by inadequate rest spots

(20.4%) and 16.5% asked for year-round inspection. Likewise, 15.5% argued for conservation to fulfill its responsibility on maintaining trails, 12.6% mentioned the gap of promotion, 10.7% argued unregulated behavior by national tourists, 4.9% asked for ban in weed and music systems, 2.9 % for updated information at websites and pages and demanded for price variation between national and international tourists. The least cited need was the helipad by 1% particularly for safety.

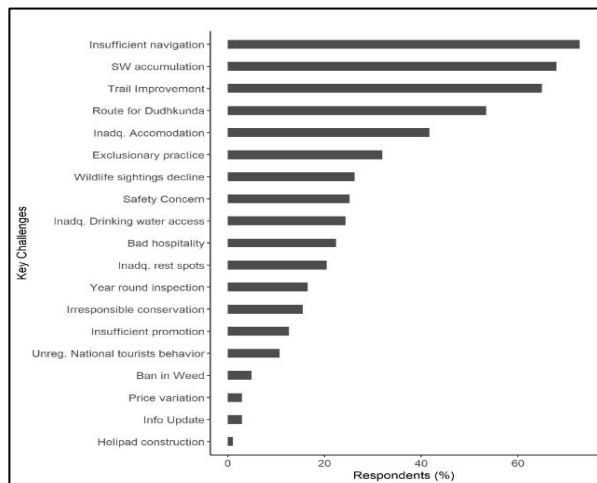


Figure 7. Key challenges and improvement need

Discussion

This study explored impacts of tourism on socio-economic and environmental aspects. The major tourism activities at high mountains of Nepal are exploring natural scenery, trekking and adventure, wildlife and bird watching, culture and nature photography (Khanal and Gosai, 2024). Livelihood improvement was the major positive impact reported by 17.47% respondents, especially by porters, stakeholders and guides highlighting their dependency on tourism, similar to the study by Gurung and Seland, 2011 in Bhutan. 77.6% profoundly appreciated the natural environment and its beauty expressing deep and strong connection with nature for mental peace and 74.5% were satisfied with the price

mechanism because trekkers tend to rate more highly the importance of natural attributes than comfort and are willing to pay eco-fee (Nepal, 2007).

The statistical analysis (T-test) showed that abundance ($p = 0.02$) and coverage ($p = 0.006$) of invasive species varied significantly in tourism influenced and controlled sites as tourism development is one of the main determinants of non-native plants abundant in terrestrial sites with recreational activities than in control sites since introduction of alien species exclusively depends on human activities such as building footpaths, lodges and plantation of non-native species in hotel gardens (Anderson *et al.*, 2015; Shrestha, 2016). *Ageratina adenophora* is a highly reported species during the study since it has already reached the northern border crossing through low mountains (Shrestha, 2016). However, due to the lack of baseline data on historical IAPS distribution, we couldn't directly correlate link it with tourism intensity, limiting our ability to quantify the relationship between visitor numbers and IAPS proliferation. The invasive species poses significant challenge in ecotourism as they are human-induced detrimental changes in nature that reduces the aesthetics and is correlated with number of visitors and kilometers from backcountry trail (Allen *et al.*, 2009; Kueffer and Kull, 2017; Selge *et al.*, 2011). These non-native invasive plant inhibits native species establishment and growth as native plants are strongly suppressed in densely invaded areas and also, the non-native species are weakly or non-dependent on arbuscular mycorrhizal fungi (AMF) for growth which reduces AMF network leading to habitat degradation posing significant challenge to land manager and conservation biologists (Flory and Clay, 2010; Stohlgren *et al.*, 1999; Tanner and Gange, 2013) but such study lacks in GCA. So, long-term monitoring of IAPS distribution and tourism intensity is highly recommended.

The major evident impact in GCA is accumulation of solid waste reported by 68% visitors. It is estimated that an average trekking group of 15 generates 15 kg of non-biodegradable, non-burnable garbage in 10 trekking days, primarily due to the lack of monitoring, management strategies, local institutions and government policies (Nepal, 1997). In response, waste management workshop and coordination meeting for promotion of tourist was organized in Shivalaya in 2019 gathering 48 participants, including representatives from rural municipalities, Community Anti-Mining Committees (CAMCs), Community Forest Management Sub-Committees (CFMSCs), Nepal Police, Youth clubs, women's groups and hotel entrepreneurs (NTNC, 2019). Also, Wildlife sightings have reportedly declined, as 26.2% of respondents indicated reduced encounters. While GCA harbors 35 species of mammals, 22 birds, 16 fishes and 9 amphibians (NTNC, 2017) but the lack of baseline data limits assessment of actual impact. Several improvements were highlighted such as insufficient navigation (72.8%), trail improvement (65%), bad hospitality (22.3%), inadequate accommodation facility (41.7%), safety (25.2%), exclusionary practice (32%), lack of proper route to Dudhkunda (53.4%) and this attribute results in negative tourism experiences (Kim *et al.*, 2021). Similarly, 10.7 % argued for unregulated behavior by national tourists and 4.9% asked to ban weed and music system as these behaviors can harm natural environment and biodiversity, so it can be managed by moral persuasion by guides and the force of group or have travel companion remind each other to make improvements (Tsaur *et al.*, 2019).

The present study will provide a baseline information for effective tourism management practices that emphasizes community participation, sustainability, and strong policy frameworks to protect

biodiversity while supporting local economies. Managing visitors within carrying capacity, introducing eco-fees, enforcing community-based waste management models and integrating local communities into tourism planning and benefit sharing is highly recommended.

Conclusion

The findings highlight the dual nature of tourism in High Mountain regions of Nepal, bringing both socio-economic benefits and environmental challenges. While tourism has significantly contributed to livelihood improvement and enhanced appreciation of natural beauty, it has also accelerated ecological degradation through invasive species proliferation, waste accumulation, and wildlife disturbances. The statistical evidence of increased IAPS in tourism-affected areas and the widespread concerns regarding solid waste and infrastructure highlights the urgent need for sustainable tourism practices. To ensure long-term ecological integrity and community well-being, tourism development must be guided by inclusive and evidence-based planning, along with solid waste management policies, community-led IAPS removal programs, implementation of carrying capacity limits, eco-fees for conservation funding, widespread environmental education campaigns, inclusive planning, stringent regulation, environmental education, and active local participation. These measures are vital to strike a balance between economic benefits and conservation priorities, thereby fostering responsible ecotourism in Nepal's fragile mountain ecosystems.

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