

Sustainable Eco-Tourism Practices and Environmental Impact Analysis: A Case Study of Various Sites in Punjab, India

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Abstract

Eco-tourism is a type of conscientious tourism that occurs in natural areas and seeks to both preserve the environment and improve the welfare of local communities. This investigation explores the realm of eco-tourism in the Shivalik Hills of Punjab, India which was done through demographic analysis, GIS mapping, and in-depth flora and fauna investigations in the region, with a particular focus on water-dwelling invertebrates, species found in wetlands, and birds. The results show that the Shivalik Hills have a remarkable biodiversity, with over 420 plant species and a diversified fauna, including 200 aquatic invertebrates and 200 avian species. The study assesses the effectiveness of eco-tourism methods, focusing on strategic water management using dams, responsible construction approaches, and successful rewilding projects and demonstrates the effectiveness of sustainable rewilding strategies, namely in their role in maintaining ecological balance and biodiversity. Overall, the research promotes responsible travel behaviours that live peacefully with environmental well-being, establishing a precedent for future projects and the symbiotic interaction between visitors, local communities, and wildlife conservation.

Keywords: Eco-Tourism, Sustainable practices, Environmental impact, Shivalik Hills, Punjab

1. Introduction

Ecotourism, also known as Ecologically Sustainable Tourism, refers to a form of responsible tourism that takes place in natural regions and aims to both save the environment and enhance the well-being of local populations [1]. Recent years have witnessed the emergence of sustainable tourism and ecological conservation as a critical area of study and action [2]. To promote responsible travel practices and acknowledge the critical significance of conserving natural habitats, this research investigates the domain of eco-tourism in the Shivalik Hills of Punjab, India. Motivated by an increasing apprehension regarding the detrimental effects of traditional tourism on delicate ecosystems, the hypothesis is founded on the knowledge that eco-tourism, which prioritises sustainable practices and minimal environmental disruption, has the potential to serve as a catalyst for ecological rejuvenation.

The evaluation of ecotourism potential has emerged as a significant concern for governing bodies tasked with the strategic management of sustainable environments and ecotourism planning [3]. The primary objective of this study is to conduct a thorough evaluation of the ecological consequences of eco-tourism in the Shivalik Eco-region which was achieved through an in-depth examination of the region's flora and fauna, with an emphasis on aquatic invertebrates, wetland species, and avian species. Additionally, this research also assesses the efficacy of sustainable practices implemented in eco-tourism destinations, with

a particular focus on their contribution to the preservation of ecological equilibrium and biodiversity along with examining the socio-economic consequences of eco-tourism. To tackle this issue, the research combines demographic analysis, geographic information system (GIS) mapping, and a thorough investigation of the fauna in specific locations.

By means of results and analysis, this paper elucidates the wealth of the Shivalik Hills, highlighting the variety of flora, the efficacy of water management practices, and the favourable consequences of rewilding endeavours. The majority of well-liked eco-travel locations possess delicate ecological systems, therefore necessitating the maintenance of a meticulous equilibrium between preservation and promotion, commonly referred to as "sustainable development" [4]. The engagement of local communities in eco-tourism fosters the exchange of cultural wisdom and guarantees the responsible utilisation of resources so, by adopting this collaborative approach, a strong foundation is laid for long-term success. This approach is crucial for safeguarding the long-term well-being of both the ecological systems and the tourism economy. The research not only emphasises the achievements of eco-tourism but also recognises the limitations and emphasises the need for continuous monitoring, community engagement, and adaptable management.

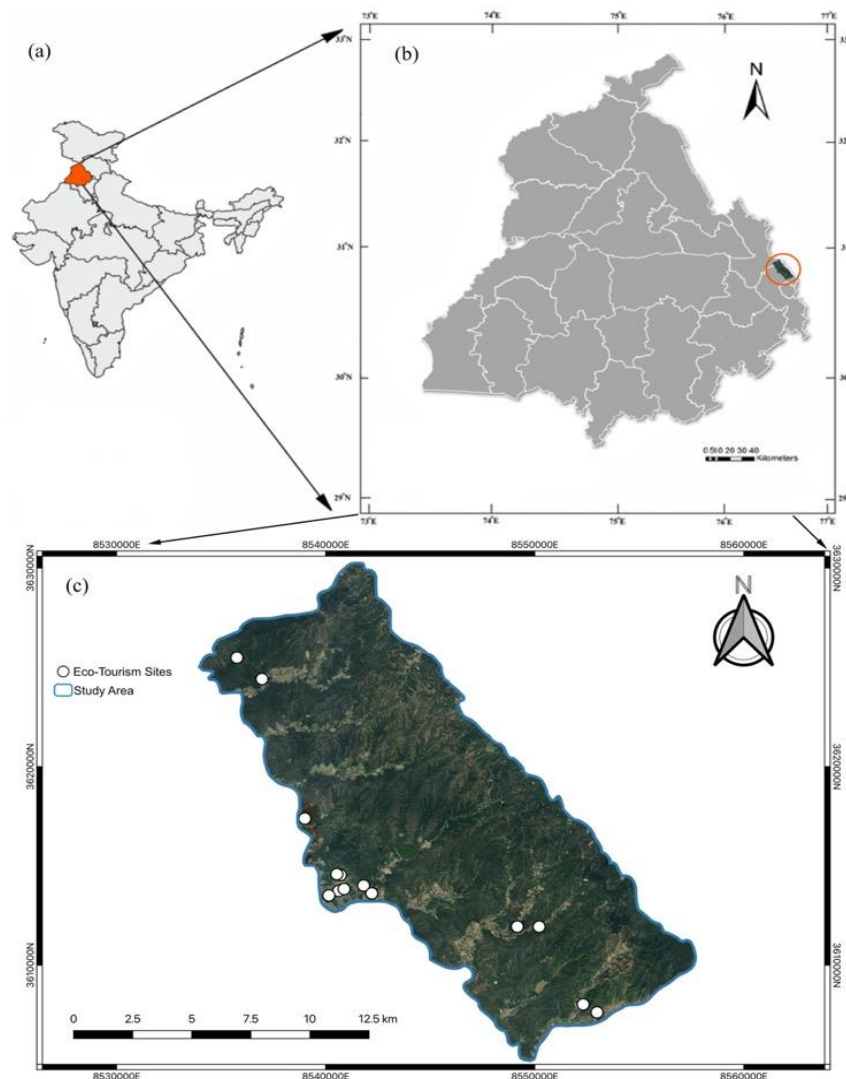


Figure 1. (a) Location of Punjab in India. (b) Study area within Punjab (c) Satellite image of Eco-Tourism sites in the study area.

2. Study Area

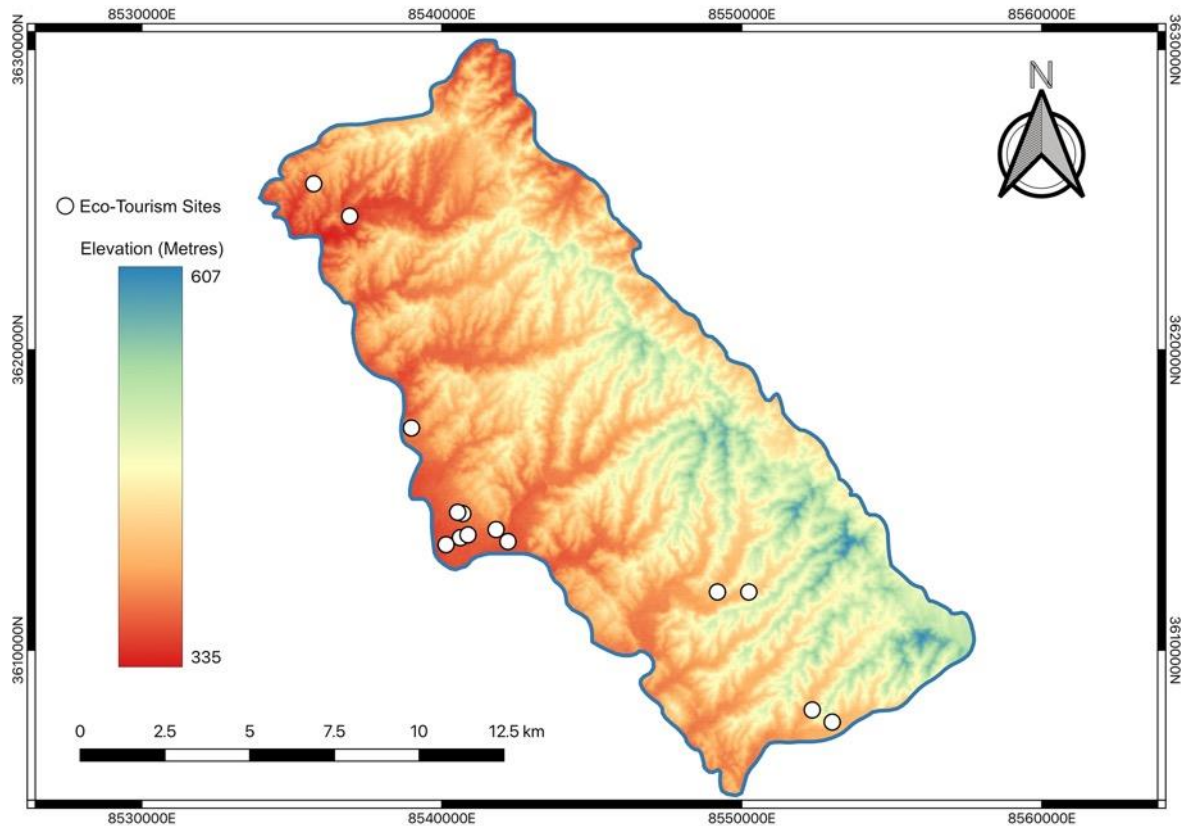


Figure 2. Topographic map of study area depicting the elevation (in metres) of the range.

The research area as seen in figure 1 is located in the scenic Shivalik Eco-region of Punjab spanning over 194.20 km² consists of several smaller regions namely, Village Bardar, Haripur, Siswan Community Reserve, Mirzapur, Majrian, Village Karoran, and the hills Chandiani Kalan. This eco-region encompasses the easternmost areas of Ropar and Nawanshahr districts and is characterised by a diverse range of geological formations, including conglomerates, clays, and silts. Located within the Shivalik Hills, it acts as a natural boundary separating the Himalayas from the lowlands [5]. It provides a range of altitudes, ranging from 300 to 600 metres above sea level. The region has an exceptional range of plant species, documenting over 420 floral species and is a crucial location for research because of the problems posed by rising urbanisation and industry. Significant differences in previous demarcations were resolved, with a focus on recognising the inherent unity of the Shivalik area rather than artificial divisions. The Shivalik Hills span almost 280 km, stretching from the northern region adjacent to the Ravi River, to the southern region near Chandigarh, along the Ghagghar River. This subdivision encompasses 2.6% of the entire state's territory, with a breadth that varies between 5 km and 12 km in different areas [6]. The affected districts encompass Gurdaspur, Pathankot, Hoshiarpur, Nawanshahr, and Rupnagar. The Shivalik Hills exhibit a steep ascent on their western side. The central ridge of the range boasts even higher elevations. They exhibit a wide range of geological formations, such as conglomerates, clays, and silts, which have been formed by rivers and streams providing the highest level of diversity in plant and animal life in the state of Punjab. The climate, classified as mild sub-tropical, has well-defined seasons with scorching summers, a substantial monsoon season, enjoyable autumn, and harsh winters [5].

3. Methodology

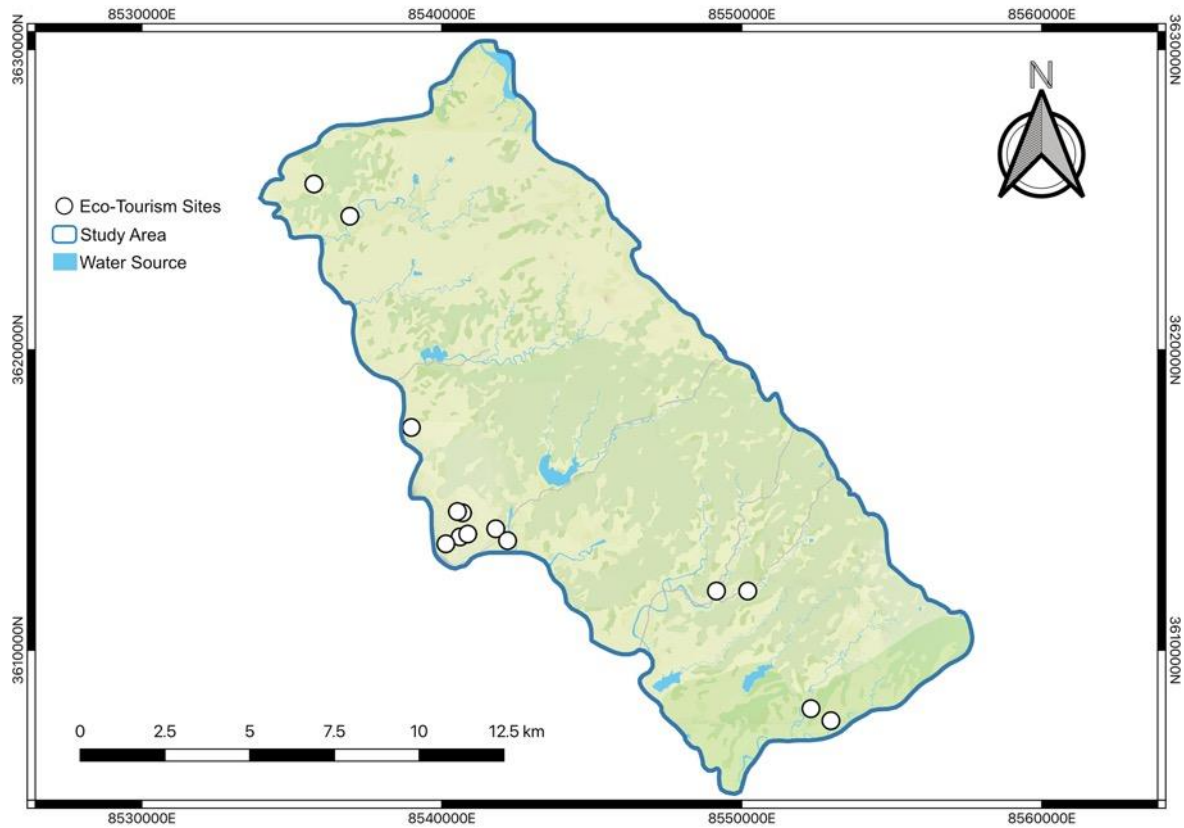


Figure 3. Hydrological map of the study area depicting the water sources of the range.

To elucidate the factors underlying the resurgence of eco-tourism in the Shivalik Hills, an all-encompassing and varied approach was necessary which encompassed exhaustive field investigations, informative stakeholder discussions, engagement with the local community and meticulous data scrutiny in order to furnish an all-encompassing comprehension of sustainable practices and their ecological ramifications. Demographic analysis considered factors such as land usage, and infrastructure development. The study utilised geographic information system (GIS) mapping to delineate the area's extent, identify key features, and assess the impact of human activities on the landscape [7]. The survey focused on fauna, evaluating the presence of wildlife in selected sites which involved systematic field visits, employing standard observational and recording methods with special attention given to indigenous species and their habitats. Simultaneously, an assessment of the eco-tourism potential of each site was conducted, considering factors like accessibility, infrastructure, and the overall environmental impact [8]. To gauge the environmental impact of eco-tourism activities, an in-depth analysis was undertaken which encompassed studying the potential disruptions caused by human presence, infrastructure development, and tourism-related activities [9]. Emphasis was placed on identifying both positive and negative impacts on the local ecosystems, with a keen focus on maintaining the delicate balance between eco-tourism and environmental conservation.

4. Results

The study area boasts a diverse array of fauna, including a wide variety of invertebrates, often overlooked in conservation policies, play crucial roles in ecosystem dynamics. It was found that the water bodies hold over 200 species of aquatic invertebrates contributing significantly to the nutrient cycle and acting as a

food source for almost half of the birds and all the fish and frog's species of the area. Additionally, the survey unveiled the existence of numerous families of aquatic invertebrates that function as dependable indicators of the condition of the water. Caddisfly larvae (Trichoptera), stonefly larvae (Plecoptera), and mayfly larvae (Ephemeroptera) are noteworthy examples. The aforementioned taxa are widely acknowledged as bio-indicators of pure water environments on account of their susceptibility to contamination. The region's network of seasonal and perennial streams supports life from Protozoa to mammals. The hills harbour over 200 species of birds, both resident and migratory, some sites had higher diversity than others with Bardar region having the highest closely followed by Majrian region and Siswan having the lowest. The topography depicted in figure 2 provides valuable insights into the suitability of the research region for eco-tourism sites. Elevation, being a crucial factor, has a detrimental impact on the development of eco-tourism sites, as indicated by a negative correlation [10]. The regions with lower height are more favourable for the development of ecotourism sites, while the ability for such development declines with rising elevation [11].

There is a also favourable correlation between water availability and the presence of an ecotourism location and the presence of water is vital for the survival of human beings [11]. The study area consists of three distinct watersheds, as depicted in figure 3. These watersheds are supplied by seasonal streams and freshwater dams located in the Siswan, Mirzapur, and Majrian regions. Additionally, several smaller dams have been constructed by the landowners of the eco-tourism sites. These dams serve the purpose of re-charging groundwater and controlling the flow of silt.



Figure 4. Nesting Site of Baya Weaver

Water management plays a crucial role in these sustainability efforts. Strategically constructed dams serve multiple purposes, acting as vital habitats for wildlife like Muntjacs and Sambar deer and attracting diverse birdlife with their thriving aquatic ecosystems. Moreover, these dams function as silt reserves and control water flow, effectively preventing soil erosion, a major threat to the Shivalik Hills, and contributing to the overall ecological health of the land. The dams also function as breeding grounds for Baya Weavers, with

each site supporting a robust population of 25-30 nests. The presence of Baya Weavers underscores the success in creating a conducive environment for nesting and breeding (Fig. 4).

In stark contrast to conventional tourism's often detrimental approach, the eco-tourism sites in the Shivalik Hills prioritise minimal environmental disturbance. Buildings are strategically positioned outside protected areas, ensuring wildlife habitats remain untouched and secure. Responsible construction techniques, adhering to green building principles, minimise the impact on sewage, water supplies, and roads, reducing pollution and ensuring long-term sustainability. A SWOT analysis of the region revealed the results as stated in in table 1.

Table 1. SWOT analysis of the study area.

Factor	Strengths	Weaknesses	Opportunities	Threats
Biodiversity & Landscape	Rich flora & fauna.	Limited accessibility in some areas	Expand sustainable practices to other sites	Unsustainable tourism practices (mass tourism, habitat degradation)
Sustainability Practices	Rewilding initiatives, water management, responsible construction	Limited infrastructure (sanitation, waste management, transportation)	Replicate successful models, attract funding	Climate change (extreme weather events)
Public Perception & Recognition	National recognition of successful sites	Limited awareness outside India	Promote cultural heritage through eco-tourism	Poaching & illegal wildlife trade
Community Engagement	Local community involvement	Limited data on long-term impacts	Collaborate with research institutions &	Land encroachment

Table 1. SWOT analysis of the study area.

			travel agencies	(development projects)
Resources & Funding	Positive example for other destinations	Need for on-going monitoring & data collection	Educate visitors & locals about responsible tourism	Limited funding & resources

Over the last triennium, the Bardar region in the Shivalik region, had undergone a profound ecological transformation, emblematic of the conscientious efforts undertaken by local landowners which underscores the efficacy of sustainable rewilding practices, aligning seamlessly with broader government initiatives for biodiversity conservation and ecosystem restoration. Initiated in 2020, the restoration project meticulously addressed invasive species like *Lantana camara*, *Parthenium hysterophorus*, and *Ageratum conyzoides*. Native tree species were selectively introduced, resulting in a remarkable threefold increase in species richness within a concise three-year period. During this period the presence of flora such as Malabar Neem (*Melia dubia*) and *Bombax ceiba* was also observed. Simple linear regression was used to test if there was a significant rise in the number of bird species over the years in Bardar and the overall regression was statistically significant ($R^2 = 0.935$, $F(1, 3) = 43.15$, $p = 0.007177$). Figure 5 visually portrays the positive impact of these efforts on bird species richness, showcasing the post-2020 rewilding initiative's success in attracting diverse avian life.

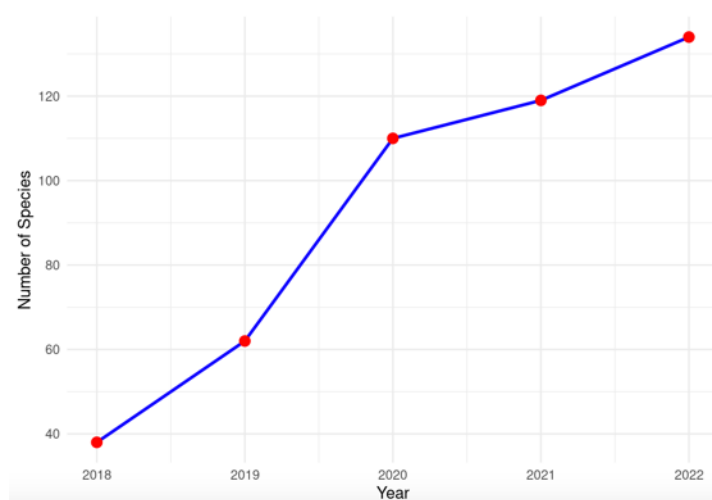


Figure 5. Species Richness trend of avian life in the Bardar region (2018-2022).

The use of camera traps and analysis of tracks and trails yielded valuable information on the mammalian species inhabiting the research area. The findings revealed a flourishing population of Sambhar deer (*Cervus unicolor*), as well as the existence of Wild Boar (*Sus scrofa*), Indian Golden Jackal (*Canis aureus*

aureus), Indian Muntjac (*Muntiacus muntjak*), and the Asian Palm Civet (*Paradoxurus hermaphroditus*). In addition, several eco-tourism sites demonstrated sustainable management techniques, such as the utilisation of solar energy to power various initiatives, the collection of rainwater, and the planting of fruit orchards that showcase *Magnifera indica* and *Psidium guajava*. These projects are in line with ecologically sensitive practices, which contribute to the overall sustainability of the region's eco-tourism.

The involvement of local proprietors and stakeholders in eco-tourism activities was a critical and the efficacy of eco-tourism initiatives is significantly influenced by the collaborative endeavours of these individuals. The ban on hunting has been critical in maintaining a steady ungulate population in the study area, thereby minimising the risk of human-animal conflict. Following the criteria established by the Government of India for ecotourism, the symbiotic interaction between visitors, local people augmenting their income, and individuals contributing to wildlife conservation develops as a mutually beneficial situation. However, the research region is vulnerable to wildfires, which pose a large danger of habitat damage. To solve this issue, state interventions must include provisions for the establishment of fire lanes in specified areas of the environment. Furthermore, avoiding monocultures becomes critical, since such ecosystems are more susceptible to wildfire aggravation, particularly during summer heat waves.

5. Discussion

The empirical data collected in this research significantly corroborates the concept that eco-tourism, when practiced in a manner that ensures long-term viability, may have a beneficial effect on the natural surroundings. There is a direct correlation between ecotourism and vegetation density and ecotourism encompasses attractions that are related to the non-living environment, living organisms, and cultural aspects [4]. The most crucial factor for the establishment of an ecotourism site is the presence of biotic characteristics, such as biodiversity, animals, and natural regions [12]. The presence of a wide range of animal species, flourishing water-dwelling invertebrates, and a significant rise in the number of bird species in places like Bardar and Majrian as a result of rewilding efforts serve as concrete proof of this favourable relationship. Moreover, the existence of bio-indicator species such as caddisflies and stonefly larvae serve as evidence of enhanced water quality, indicating the effectiveness of water management measures [13]. The success of the rewilding initiative in Bardar not only reflects a heightened ecological consciousness at the local level but also provides a blueprint for broader governmental endeavours aimed at ecological rejuvenation. Active participation of the local community and landowners promotes the sharing of cultural knowledge and guarantees the appropriate use of resources, establishing a solid basis for sustained achievement [14].

To further enhance this research and ensure the ongoing prosperity of eco-tourism in the Shivalik Hills, it is advisable to implement several crucial measures. To begin, plantation of native tree species such as *Bombax ceiba*, *Butea monosperma*, *Flacourtia ramontchii*, *Dalbergia sissoo*, *Salvadora oleoides*, and *Zizyphus mauritiana* are critical for increasing biodiversity and habitat quality. Furthermore, the installation of tiny ponds assists in water conservation and regeneration, promoting a healthy population of aquatic wildlife. Construction of siltation dams has proven to an effective approach for controlling soil erosion during monsoons [15] and continued efforts to remove invasive plants such as *Lantana camara* and *Parthenium hysterophorus* are critical to preserving local flora and wildlife. Avoiding monocultures in afforestation operations to improve ecological resilience and encouraging cooperation among governmental entities, non-governmental organisations, and research institutes, and promoting responsible tourist activities. Responsible construction, green building standards, and strategically placing structures outside

protected areas show a commitment to environmental protection. Sustainable methods like solar energy, rainwater collection, and fruit orchard planting boost eco-tourism and support environmental conservation. Beyond its ecological benefits, Shivalik Hills eco-tourism promotes cultural exchange and sustainable development. National recognition of successful locations opens the door to broader replication; in this case, the Shivalik Hills are a model for eco-tourism.

Although the research provides compelling evidence of the overall beneficial effects of eco-tourism, there are still some constraints. Further enhancement is needed in the development of monitoring and data gathering methods to accurately measure long-term patterns and provide valuable insights for adaptive management techniques. The study predominantly concentrated on a specific area, highlighting the need for more extensive research including the entire Shivalik Hills in order to provide a more thorough insight into the opportunities and obstacles of eco-tourism in various settings. It is important to prioritise the continuous gathering and examination of data, with a specific emphasis on the extended observation of crucial ecological indicators and socioeconomic effects. Engaging in partnerships with local communities, conservation organisations, and academic institutions may bolster expertise, attract money, and allow the flow of knowledge [16]. To guarantee ethical travel behaviours and foster a collective appreciation for environmental sustainability, it is imperative to enhance education and awareness initiatives targeting both tourists and inhabitants. Via the identification and resolution of constraints, establishment of alliances, and cultivation of a shared dedication to sustainable tourism, the examined area has the potential to become a prominent exemplar of successful eco-tourism and would demonstrate a future in which the preservation of natural environments coexists harmoniously with conscientious travel practices [17].

6. Conclusion

In conclusion the eco-tourism sites in the study area demonstrate a powerful example of how responsible travel can coincide with environmental revival. By prioritising sustainable practices, these destinations are not only creating unforgettable experiences for visitors but also actively contributing to the health and biodiversity of the region and with continued commitment, collaboration, and education, eco-tourism in the Shivalik Hills can pave the way for a future where responsible travel and environmental well-being go hand in hand. To ensure the continued success of eco-tourism and ecological restoration in the Shivalik Eco-region, it is imperative to address ongoing challenges such as urbanisation, industrialisation, and water resource exploitation. Integrated conservation measures, community involvement, and sustainable practices should be at the forefront of future initiatives [18] and in order to fully harness the benefits of eco-tourism in the Shivalik Hills, the participation of local proprietors and stakeholders is critical. Nevertheless, it is imperative to diligently monitor and protect these areas from any potential incursion and sharing best practices with other eco-tourism destinations can encourage the replication of these successful models, leading to a broader wave of positive environmental change. Finally, incorporating the suggested ideas into long-term planning and policy support supports the ongoing success of eco-tourism and ecological restoration in the Shivalik Hills, establishing a precedent for responsible travel and environmental well-being. Therefore, ecotourism can serve as a strategic instrument to augment the local community's income generation while genuinely striving to preserve biodiversity.

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