

Geo-tourism for Rural Sustainability in the Garhwal Himalaya

Vishwambhar Prasad Sati^a 

^a Senior Prof., Mizoram University, Department of Geography and Resource Management, Aizawl, India.
ORCID: 0000-0001-6423-3119

Abstract

The Garhwal Himalaya has numerous geographical and geomorphological features (geo-sites) that can be developed for promoting geo-tourism. This study aims to examine the potential of geo-tourism in the Garhwal Himalaya and its role in fostering rural sustainability. The region has an agricultural economy with low output; however, a large number of people are engaged in traditional farming practices. Meanwhile, the development of geo-sites can enhance rural livelihoods, conserve the environment, and integrate these sites into educational curricula. This study is empirical in nature, employing a qualitative approach. In addition, the observation method was properly used to identify the geo-sites of the region through extensive field visits conducted by the author. All geo-sites were listed, mapped, and explained. These geo-sites are distributed throughout the region, though they are more concentrated in three districts – Uttarkashi, Rudrapur, and Chamoli – mainly situated near highland sacred sites. The study suggests that the sustainable development of geo-sites can increase income, improve livelihoods, and provide valuable educational resources. It further recommends that suitable policy measures involving local communities and policymakers can pave the way for sustainable geo-tourism.

Keywords: Geo-sites, Traditional agriculture, Geo-tourism, Rural sustainability, Garhwal Himalaya

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Sağbetullah MERİÇ

Corresponding Author

Vishwambhar Prasad Sati
sati.vp@gmail.com

1. INTRODUCTION

Geo-tourism, an emerging field of tourism, focuses on providing enjoyable and meaningful experiences. It has a history of over a hundred years, primarily in England, Australia, and Iceland. Around the same period, Geo-tourism also emerged in other countries (Gray, 2004; Turner, 2013). Coratza et al. (2018) discussed two related terms – geo-heritage and geo-diversity. It is closely associated with geo-heritage and geo-diversity, both representing the abiotic components of nature (Hose, 1995; Newsome & Dowling, 2010). Geo-tourism encompasses several sub-sectors, including rural geo-tourism, urban geo-tourism (Riganti & Johnston, 2018), celestial and space geo-tourism, roadside geo-tourism (Strba et al., 2016), community-based geo-tourism, cave geo-tourism (Garofano, 2018), submarine geo-tourism (Lima et al., 2014), mining geo-tourism, adventure geo-tourism, and volcanic geo-tourism (Woo et al., 2010). The role of geo-tourism in the 21st century is significant in areas such as management, planning, and marketing. Geographers began studying modern tourism from a geographical perspective nearly 60–70 years after modern tourism first emerged in the 1840s (Chen et al., 2015). Tourism and the geological background of the environment are inherently interconnected.

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Geo-tourism refers to a form of tourism that encompasses geological and geographical features as tourism destinations. It emphasizes sustainable practices and the conservation of the natural environment, cultural heritage, and local communities. It highlights the unique characteristics of places, landscapes, ecosystems, and cultural traditions. It specifically focuses on geological and geographical aspects while also integrating natural, cultural, and ecological dimensions (Dowling & Newsome, 2010). It relates to Earth's geological heritage, which can promote tourism and is closely associated with sustainable development and conservation efforts. It not only highlights geological attractions – such as rock formations, volcanoes, caves, and fossils – but also incorporates cultural, environmental, and aesthetic elements. Tourists engaging in geo-tourism require knowledge and understanding of the geology and geomorphology of geo-sites. The provision of interpretive and service facilities that facilitate such experiences is a defining feature of geo-tourism (Hose, 1995).

The key elements of geo-tourism, as outlined by Sadry (2013), include abiotic nature as the main attraction, interpretation of geological heritage, and positive outcomes for nature. It also has the potential to regulate other forms of tourism. The fundamental principles of eco-tourism emphasize participant learning and positive ecological and sociocultural impacts (Weaver, 2011). The protection and management of geological heritage for educational purposes and sustainable development are essential for the growth of geo-tourism. UNESCO Global Geoparks represent exemplary models of such initiatives (Newsome, 2012; Dowling, 2011; Farsani, 2011).

The geological history of the Garhwal Himalaya is closely linked to that of the Himalayan mountain system as a whole, which originated during the Tertiary Period of the Geological Era as a result of the collision between two major landmasses – the Angara Land from the north and the Gondwana Land from the south (Negi, 2006). Consequently, the region contains thousands of geological and geomorphological features, collectively referred to as geo-sites (Valdiya, 1980). These geo-sites vary in form and are distributed across all parts of the Garhwal Himalaya, reflecting the diverse topographical conditions of the region. Many of these sites remain unexplored, while those that are known have not yet gained formal recognition as geo-sites (Rana & Rawat, 2013). Furthermore, several of these sites are located in remote areas with limited accessibility. The sustainable development of such geo-sites for geo-tourism could significantly enhance rural livelihoods and promote livelihood sustainability, particularly in the Garhwal Himalaya, where rural communities are economically marginalized despite the region's high geo-tourism potential (Sati, 2026).

Geo-tourism is a relatively new concept; therefore, only a few studies have been conducted on it so far. The Garhwal Himalaya supports various forms of tourism, including cultural (pilgrimage) tourism, nature-based tourism, adventure tourism, and eco-tourism, all of which are well-documented in the literature (Bhasin & Kaul, 2001). However, studies specifically focused on geo-tourism remain scarce. To bridge this gap, the present study aims to examine geo-tourism as a distinct and promising subsector of the tourism industry. It emphasizes the importance of thoroughly exploring the geological and geographical features that underpin geo-tourism in the Garhwal Himalaya, particularly in the context of sustainable tourism and rural livelihoods. The study identifies and explores major geo-sites such as potholes, hot springs, waterfalls, gorges, river terraces, U-shaped valleys, glaciers, V-shaped valleys, piedmonts, and culturally significant heritage sites. It seeks to answer the key questions of what constitutes a geo-site and how these sites can be developed for sustainable geo-tourism. The study further suggests that formulating a comprehensive policy for the sustainable development of geo-sites can significantly enhance the rural economy and livelihoods in the Garhwal Himalaya.

2. CONCEPT OF GEO-TOURISM

The concept of geo-tourism is vivid, comprehensive, and diverse (Fig. 1). It requires extensive geological and geographical exploration to identify and understand lesser-known features and to promote their sustainable development for geo-tourism. It primarily depends on two key aspects: regions with high potential and their geological and geographical characteristics. Overall, it

emphasizes sustainability, community participation, cultural appreciation, and educational enrichment. Sustainability can be achieved through responsible geo-tourism practices that minimize negative impacts on the environment and local communities.

Community involvement in planning and development is crucial, as geo-tourism is often practiced in remote rural areas where local people possess in-depth knowledge of their surroundings. It fosters shared benefits, enabling local communities to enhance their livelihoods. It also promotes geodiversity conservation, visitor education, and the empowerment of local populations by increasing awareness of geological resources and creating employment opportunities (Joshi & Chauhan, 2015). Moreover, it has the potential to showcase cultural richness and conserve the cultural heritage and traditions of tourism destinations, highlighting the interconnectedness of geology, culture, and local identity (Sati, 2022). Ultimately, it helps visitors gain a deeper understanding of both cultural heritage and landscape dynamics.

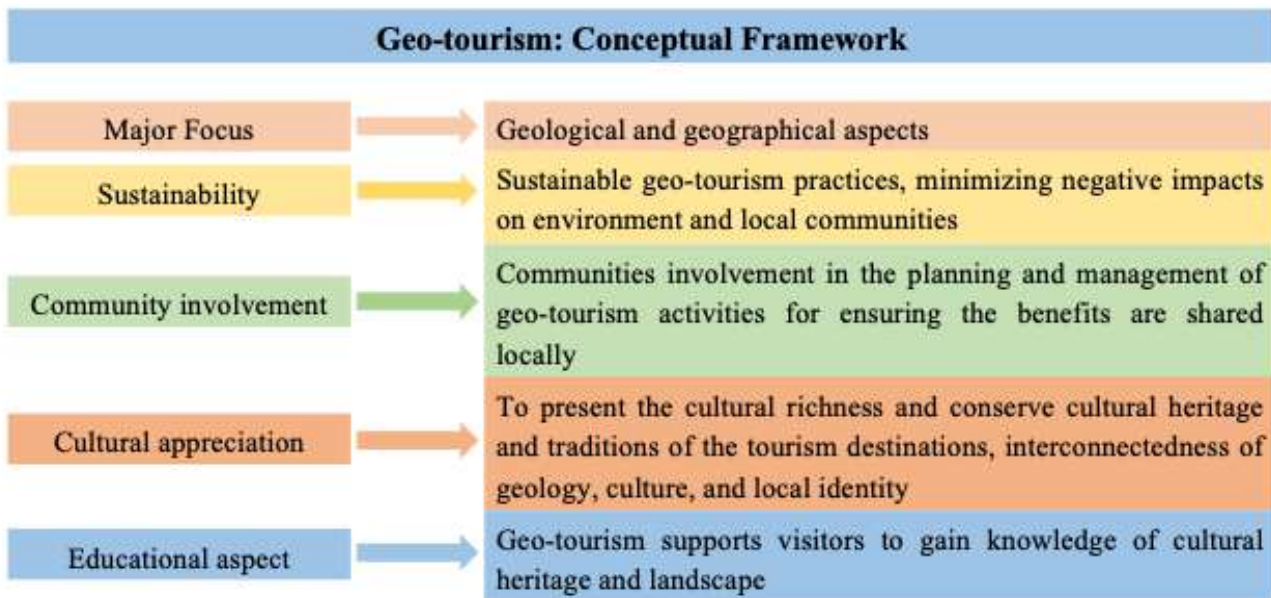


Fig. 1. Major aspects that impacts geo-tourism

3. STUDY AREA

The Garhwal Himalaya, located in the northwestern part of the Uttarakhand Himalaya, exhibits a wide range of fascinating geomorphological features. The Great Himalayan Ranges, alpine pasturelands, Middle Himalaya, Lesser Himalaya, Shivalik Hills, and the picturesque Doon Valley together define its diverse geomorphic landscape. Landforms shaped by glaciers and rivers further enhance the region's unique physiography. The Ganga River system—one of the largest river systems in India—originates and flows from the Garhwal Himalaya (Sati, 2021). It comprises two major sub-systems: the Yamuna system and the Bhagirathi–Alaknanda system. The region is home to numerous mountain peaks exceeding 6,000 meters in elevation, including the prominent Chaukhamba, Kamet, Trishuli, Nanda Devi, Shivling, and Kedar peaks. Administratively, the Garhwal Himalaya consists of seven districts: Uttarkashi, Chamoli, Rudraprayag, Pauri, Tehri, Dehradun, and Haridwar (Fig. 2). Each district possesses distinctive geo-sites and associated features. These include rock formations, gorges, waterfalls, rapids, rivulets, potholes, geysers (hot springs), national parks, wildlife sanctuaries, and sacred sites. The Valley of Flowers National Park and Gangotri National Park are UNESCO-designated World Heritage Sites (Bhasin et al., 2001). In addition, trekking and mountaineering destinations across the region also serve as significant geo-tourism attractions for visitors.

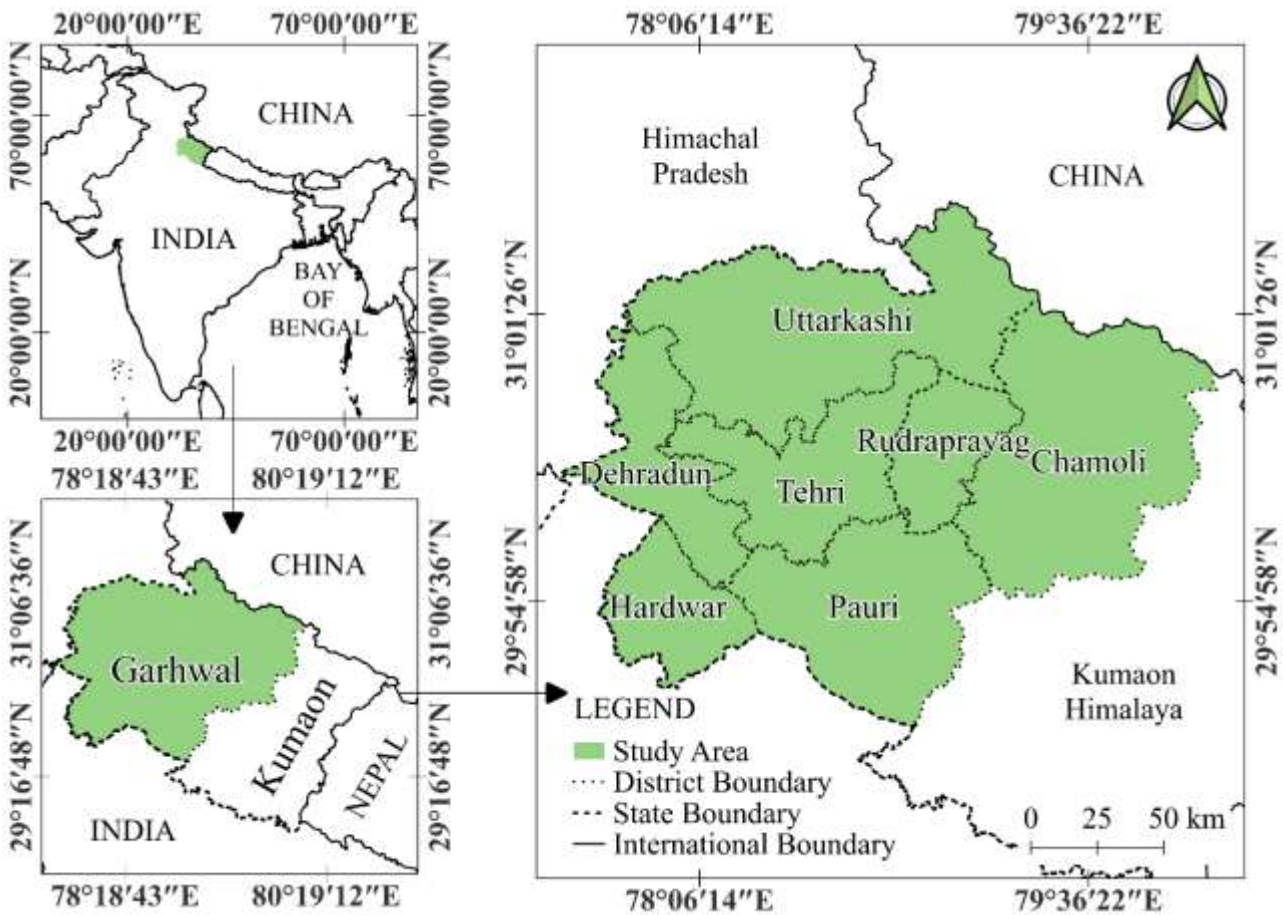


Fig. 2. Location map of the Garhwal Himalaya

4. METHODOLOGY

This study is empirical and primarily employs a qualitative approach. It is based on the observation of the geo-tourism sites/destinations by author. The author visited the entire Garhwal Himalaya several times, covering the Yamuna River valley, the Tons River valley, the Bhagirathi River valley, the Alaknanda River valley, and the valleys of their numerous tributaries. Various geo-sites such as trekking routes, hot springs, mountaineering routes, waterfalls, gorges, and sacred sites situated along the river valleys, mountains, alluvial plains, and piedmonts were visited. These geo-sites were presented on a map to facilitate understanding of their locations. In addition, two geo-sites—Koteshwar Gorge near Rudraprayag and Birthi Waterfall on the way to Munsiyari—were selected as case studies. A survey of 25 service providers at these two sites was conducted. The survey mainly focused on tourist inflows, the number of restaurants and homestays, households involved in providing services, family size, household income, per capita income, and people’s satisfaction.

Data were also presented through tables and graphs. A conceptual framework of geo-tourism was developed, geological and geomorphological features were elucidated, hot springs were identified and mapped, sacred landscapes were described, and the challenges and opportunities were elaborated.

5. RESULTS

5.1. Geological and Geomorphological Features for Geo-tourism

The Garhwal Himalaya hosts diverse geomorphological and geological features, including elements of cultural heritage. It offers opportunities for trekking, mountaineering, cave exploration, and experiencing a unique cultural landscape. The region exhibits a variety of geomorphological

features shaped by geology, tectonics, and glacial activity. Key features include high-relief, formerly glaciated areas; structural and denudational hills; zones of mass wasting; river terraces; and floodplains. The area also provides evidence of both past and ongoing tectonic activity, such as uplifted terraces, fault scarps, and shifting river channels.

The Garhwal Himalaya comprises a diverse and complex geomorphic landscape shaped by tectonic forces, glacial activity, fluvial processes, and weathering. Prominent geomorphic features include V-shaped valleys, alluvial fans and cones, karst and limestone formations, caves, sinkholes, and underground drainage systems, all of which provide suitable sites for geo-tourism. Fluvial features, along with alluvial fans and cones, are evident along the courses of major rivers such as the Bhagirathi, Alaknanda, and Yamuna, as well as their numerous tributaries. In the High and Middle Himalaya, rivers carve out panoramic V-shaped valleys. In several areas, sinkholes and underground drainage systems create spectacular landscapes. The author observed numerous potholes in the upper basins of the Alaknanda and Bhagirathi rivers. Boulders and pebbles along these river valleys, particularly in the middle and upland regions, also form attractive sites for geo-tourism. In the Doon Valley and the Kotdwar Bhabar region, piedmont and alluvial plains are predominant. The Valley of Flowers, Gangotri Glacier, Nanda Devi Biosphere Reserve, and Devprayag are recognized as UNESCO World Heritage Sites. The Valley of Flowers, a glacial valley formed during the Pleistocene period, is rich in endemic flora, further enhancing its value as a geo-tourism destination.



Fig. 3. Geo-sites (a) Panchachuli Mountain peaks (b) Birthi waterfall (c) Koteswar gorge and (d) Devprayag (world heritage site). Photo: By author

Geo-diversity in the Garhwal Himalaya is high due to its location within a tectonically active zone. The region is characterized by major structural features such as the Main Central Thrust (MCT), Main Boundary Thrust (MBT), and Vaikrita Thrust. Among the geomorphological features,

U-shaped valleys, hanging valleys, moraines, and glacial lakes are prominent. This region serves as an ideal site for geological field studies, eco-education, and climate change research, particularly concerning glacial retreat and erosion processes. Some of India’s important trekking routes, including Hari Ki Doon, Auli, and Tungnath–Chopta, are located in this region, where local guides, homestays, and trekking services are readily available (Sati & Banerjee, 2025). The Dudhatoli region is renowned for its scenic alpine pasturelands and trekking routes, while Mussoorie Hills, Lansdowne, and Pauri Hills also attract visitors for their natural beauty. The Chaukhamba Massif and the Tehri Dam are additional notable geo-tourism sites in the Garhwal Himalaya.

Table 1 presents some of the major and diverse geological features that make the Garhwal Himalaya a significant region for geo-tourism. These include glaciers, glacial lakes, alpine pasturelands, river terraces, waterfalls, gorges (Fig. 3), hot springs, caves, mountaineering and trekking routes, as well as national parks and wildlife sanctuaries. Major glaciers such as Gangotri, Bandarpunch, Chaurabari, Khatling, Pindari, Sundardhunga, Alkapuri, and Yamunotri serve as the sources of several major rivers of India. Among the glacial-fed lakes, Roopkund, Homkund, Hemkund, Satopanth, Gandhi Sarovar, and Bedini Kund are prominent; these are located in remote regions and can be reached through treks of 20–30 km.

The region also contains numerous alpine pasturelands, including Ali Bugyal, Bedini Bugyal, Dayara Bugyal, Auli, and Gorson, which are popular trekking and camping sites. River terraces are well developed at Deval, Tharali, Kulsari, Panti, Gauchar, Rudraprayag, Srinagar, Maletha, Uttarkashi, Chinyalisaur, Purola, and Tyuni. Notable waterfalls include Vasudhara, Kempty, Tiger, Gumkhal, Jharipani, and Bhalugarh Falls. In the Bhagirathi Valley between Gangotri and Uttarkashi, two world famous gorges – Bhaironghati and Lanka are located, which make the rich geo-sites (Sati, 2021). The others signification gorges Koteswar (on the Alaknanda River) in Rudraprayag, on Rishi Ganga in Joshimath, and on the Saraswati River in Mana village. Limestone caves in Garhwal include Bhiar Dhar, Chakrata, and Rover Caves. Prominent mountaineering sites include Gaumukh, Tapovan, and Shivling Peak, while popular trekking routes include Hemkund, Roopkund, Har Ki Doon, and Kedarkantha. These geo-sites offer excellent potential for geo-tourism development. The Garhwal region also hosts numerous national parks and wildlife sanctuaries, which further enhance its suitability for geo-tourism.

Table 1. Geomorphological features of geo-tourism in the Garhwal Himalaya

Geological features	Potential in Garhwal Himalaya
Glaciers	Gangotri, Bandarpunch, Chaurabari, Khatling, Pindari, Sundardhunga, Alkapuri, and Yamunotri
Glacial lakes	Roop Kund, Home Kund, Hemkund, Satopant, Gandhi Sarovar, and Bedini Kund
Alpine pasturelands	Ali Bugyal, Bedini Bugyal, Dayara Bugyal, Auli, and Gorson
River terraces	Deval, Tharali, Kulsari, Panti, Gaucher, Rudraprayag, Srinagar, Maletha, Uttarkashi, Chinyalisaud, Purola, and Tyuni
Waterfalls	Vasudhara fall, Kempty fall, Tiger fall, Bhalugarh fall, Gumkhal fall, Jharipani (Dehradun-Mussoorie Road) fall.
Gorges	Koteswar, Bhaironghati, Lanka, Rishi Ganga Gorge, and Mana Gorge
Caves	Bhiar Dhar Cave near Chakrata and Rover Caves
Mountaineering	Gaumukh, Tapovan, and Shivling Peak
Trekking	Hemkund, Roop Kund, Hari Ki Doon, and Kedarkantha
National parks	Gangotri National Park, Corbett National Park, Rajaji National Park
Wildlife sanctuaries	Govind Pashu Vihar, Nanda Devi Wildlife Sanctuary, Chila Wildlife Sanctuary

5.2. Hot Springs

Hot springs in the Garhwal region, locally known as *Tapta Kund* or *Tato Pani Kund*, are widely distributed from the river valleys to the highlands. They are primarily found in limestone-rich areas. Several of these hot springs are located near important pilgrimage sites in the high Himalaya, giving

them high religious significance. Pilgrims often visit these high-altitude shrines and take a holy dip in the springs for purification of the body and mind. Numerous hot springs occur throughout the Garhwal Himalaya; among them, *Tapta Kund*, *Narad Kund*, and *Gaurikund* are particularly notable. These are situated either at pilgrimage destinations or along pilgrimage routes. As shown in Table 2, most hot springs are found in the highland zones, forming a general east-west alignment across the Garhwal region. Additionally, a few hot springs occur in the Dehradun area, where limestone formations are common. These hot springs represent ideal sites for geo-tourism development in the Garhwal Himalaya.

Table 2. Salient features of the hot springs in the Garhwal Himalaya

Name	Altitude (m)	Location
Sahasstra Dhara	656	On the bank on the Tamas River in Dehradun
Guchu Pani		On the bank on the Tamas River in Dehradun
Soldhar & Rignigad	1900	On the bank of the Alaknanda River in the Chamoli District
Tapovan	1905	On the bank of the Dhaul Ganga in Joshimath
Gauri Kund	1982	On the bank of the Mandakini River in Gauri Kund on the way to Kedarnath
Rishi Kund	2745	On the bank of the Bhagirathi in Gangnani
Narad Kund	3133	On the bank of Vishnu Ganga in Badrinath
Tapta Kund	3200	On the bank of the Vishnu Ganga in Badrinath
Surya Kund	3293	On the bank of the Bhagirathi in Gangotri

Source: Survey of India toposheets

5.3. Sacred Landscapes

This region possesses a rich cultural heritage and exceptional natural beauty, and it holds great religious significance (Sati, 2024). The four *Dhams* – *Panch Badris*, comprising Badrinath, Adi Badri, Bhavishya Badri, Bridha Badri, and Yogdhyana Badri; the *Panch Kedars* – Kedarnath, Madhyamaheshwar, Tungnath, Rudranath, and Kalpeshwar; and the *Panch Prayags* – Vishnu Prayag, Nanda Prayag, Karn Prayag, Rudra Prayag, and Dev Prayag – represent the sacred landscapes of the Garhwal Himalaya (Table 3).

Table 3. Sacred landscape of the Garhwal Himalaya

Rich cultural heritage	Unique cultural resources - lifestyles, cuisine, ceremonies, music, religious beliefs, traditions, and history
Four-Dhams	Badrinath, Kedarnath, Gangotri, and Yamunotri
Panch Badris	Badrinath, Adi Badri, Bhavishya Badri, Bridha Badri, and Yogdhyana Badri
Panch Kedars	Kedarnath, Madhyamaheshwar, Tungnath, Rudranath, and Kalpeshwar
Panch Prayags	Vishnu Prayag, Nanda Prayag, Karn Prayag, Rudra Prayag, and Dev Prayag

Some of the prominent hot springs, gorges, waterfalls, *Prayags*, and national parks are shown in Figure 4. Most of the geo-sites are located in the Chamoli, Rudraprayag, and Uttarkashi districts, where the four major highland pilgrimages are situated. The Dehradun district also hosts several geo-sites, including caves, waterfalls, and hot springs. These geo-sites possess high potential for promoting sustainable geo-tourism.

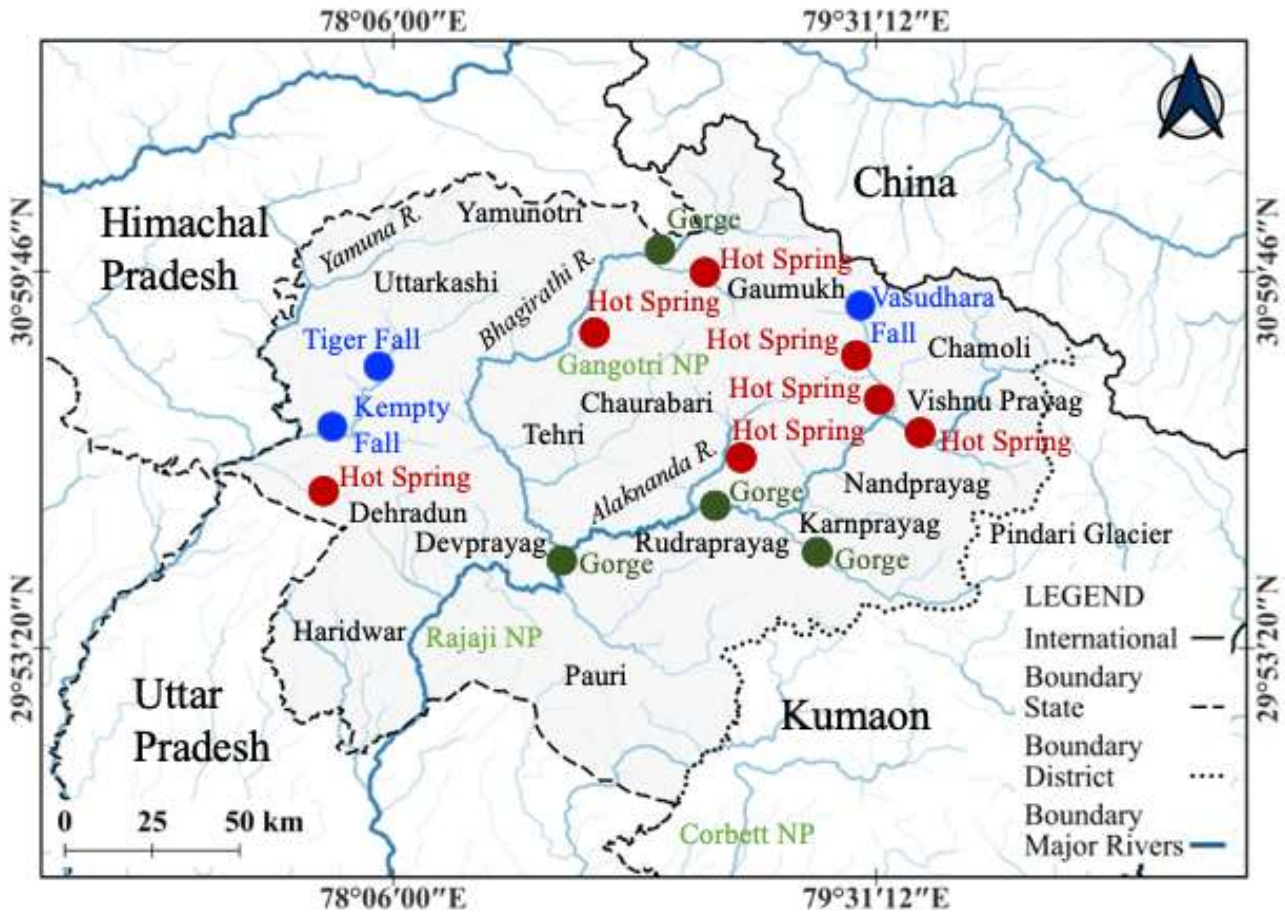


Fig. 4. Prominent geo-sites in the Garhwal Himalaya

5.4. Case Study of Two Geo-sites

The author visited two specific geo-sites and conducted a case study. The first one is the Koteswar Gorge, formed along the Alaknanda River before it flows through Rudraprayag city. On the right bank of the Alaknanda, a renowned Shiva Temple is located inside a large cave. During the months of Shravan and on the occasion of Maha Shivaratri, grand festivals are celebrated, attracting thousands of devotees who visit the temple. The gorge at Koteswar is natural and visually striking, located at an altitude of 885 m with a height of 40 m. The average tourist inflow to the Koteswar Gorge is about 110 visitors per day, and 10 households are engaged in providing various services. There are a total of 10 restaurants in the vicinity of the gorge. The average daily income generated from tourism is approximately 100 USD, with a per capita income of around 20 USD. About 60% of service providers report satisfaction with their income from tourism activities.

The Birthi Waterfall is situated at an altitude of 2,200 m, on the way to Munsiyari town in the Pithoragarh district. It is one of the highest waterfalls in the Uttarakhand Himalaya, with a height of 122 m. On average, about 168 tourists visit the Birthi Waterfall each day. Approximately 15 households are engaged in providing services to tourists, earning an average income of USD 150 per day per household. The per capita income is around USD 30 per day, and the satisfaction level among local service providers is about 64%. It has been observed that, in Birthi, tourists often avail of homestay facilities; consequently, the income of service providers is higher than that of those operating near the Koteswar Gorge (Table 4).

Table 4. Salient features of Koteshwar Gorge and Birthi Waterfall

Geo-sites	Koteshwar Gorge	Birthi Waterfall
Location	Near Rudraprayag	Way to Munsiyari
Altitude (m)	885	2200
Height (m)	40	122
Tourist inflows/ day (average number)	110	168
Number of restaurants and homestays*	10	15
Households involved in providing services	10	15
Family size (average)	5	5
Income/day/household (USD)	100	150
Per capita income (USD)	20	30
People’s satisfaction (%)	60	64

Source: By author

*A few tourists halt in Birthi waterfall at least one night

5.5. Challenges and Opportunities

There are several challenges associated with the development of geo-tourism in the Garhwal Himalaya. Unregulated geo-tourism often leads to environmental degradation, while the lack of proper interpretation centers and signage further limits visitors’ understanding of geological features. In addition, the region’s fragile geology, characterized by frequent landslides, flash floods, and glacial lake outburst floods, poses significant risks to both tourists and infrastructure (Dobhal, 2013). Other major challenges include the precipitous terrain and the high susceptibility of the landscape to natural disasters (Sati, 2026). From a conservation perspective, protecting geo-sites and natural landscapes is crucial. Implementing sustainable practices-such as responsible tourism, effective waste management, and minimizing environmental impacts-remains a key priority. Furthermore, the development of essential infrastructure, including transportation, accommodation, and safety measures, along with enhancing community awareness about the value of geo-tourism and conservation, are vital initiatives for promoting sustainable geo-tourism in the Garhwal region (Fig. 5).

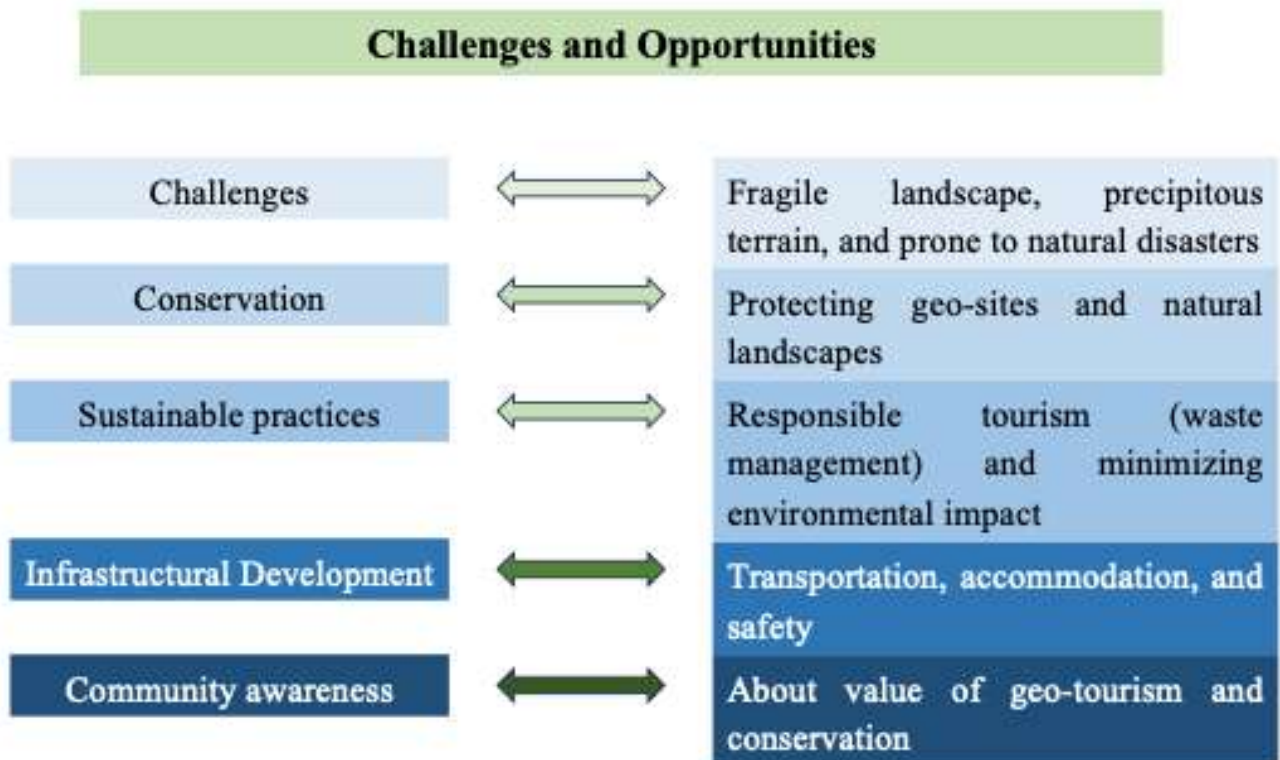


Fig. 5. Challenges and opportunities of geo-tourism

6. DISCUSSION

This study reveals that geo-tourism can play a vital role in promoting rural sustainability in the Garhwal Himalaya. The livelihood of rural communities in this region largely depends on the cultivation of traditional crops, livestock farming, and the collection of timber and non-timber forest products. However, the income generated from these traditional economic activities is minimal, resulting in widespread food insecurity. On the other hand, the Garhwal Himalaya possesses immense potential for it due to its rich geomorphological diversity. The region encompasses the Greater Himalaya, alpine pasturelands, forested landscapes, and river valleys, along with a wide variety of geographic and geomorphic features that enrich its geo-site potential. The sacred landscapes, including highland pilgrimages, and distinctive landforms such as hot springs, gorges, rapids, rivulets, potholes, river terraces, and alluvial fans along the valleys further enhance opportunities for geo-tourism. Additionally, sacred groves featuring banyan and pipal trees contribute to the cultural and aesthetic appeal of these sites. Several national parks and wildlife sanctuaries in the region are recognized as UNESCO World Heritage Sites, underscoring their global significance and potential for sustainable geo-tourism development.

There are several challenges to the development of geo-tourism in the Garhwal Himalaya. The region is highly prone to natural hazards and the impacts of climate change. It is ecologically fragile, geologically sensitive, tectonically and seismically active, economically underdeveloped, and geographically remote (Sati, 2019). Furthermore, geo-hydrological hazards, particularly during the monsoon season, exacerbate the region's fragility and vulnerability, hindering the growth of sustainable geo-tourism. Despite these challenges, the Garhwal Himalaya offers significant opportunities for geo-tourism development. The region's diverse geographical and geomorphological features are visually spectacular and provide excellent sites for geo-tourism activities. Additionally, conservation initiatives, infrastructural improvements, and enhanced community awareness together present strong opportunities for promoting sustainable geo-tourism in the region.

The integration of geological heritage, cultural landscapes, and community-based tourism practices as part of geo-tourism in the Garhwal Himalaya has emerged as an important sector for rural livelihood sustainability. The snow-capped Himalayas, alpine pasturelands, glacial-fed lakes, river valleys, and diverse topography with unique geomorphological features offer high potential for geo-tourism, contributing to both environmental conservation and livelihood sustainability (Dowling & Newsome, 2018). Along with its remarkable geological and cultural diversity, it generates income for rural households and encourages tourists to engage responsibly with the landscape (Farsani et al., 2012; Sati, 2023). Moreover, it promotes homestays, enhances tourists' educational experiences, and creates opportunities for employment and entrepreneurship among local communities (Sati, 2020).

Geo-tourism contributes to livelihood sustainability in the rural areas of the Garhwal region, where the population largely depends on traditional agricultural practices characterized by low production and productivity. Moreover, agricultural practices in the Garhwal region are highly vulnerable to climate change (Hose, 2012). It also fosters environmental awareness and the conservation of fragile ecosystems. In the Garhwal Himalaya, out-migration is a common phenomenon due to limited livelihood opportunities. Therefore, it can enhance livelihood options, diversify income sources, and strengthen cultural identity (Sati, 2021). Participatory planning, carrying capacity assessment, and infrastructure development that respects ecological thresholds can guide geo-tourism initiatives to ensure their long-term viability (Newsome, 2012). Integrating scientific research, policy support, and community empowerment can further promote sustainable geo-tourism in the Garhwal Himalaya.

7. CONCLUSIONS

The Garhwal Himalaya possesses numerous geomorphological features that support geo-tourism. Although these geo-sites are distributed across the entire region, they are most prominent in the highland areas, particularly in the districts of Uttarkashi, Rudraprayag, and Chamoli. The world-famous highland pilgrimages of the Garhwal Himalaya are also located in these districts and attract thousands of pilgrims every month. However, many of these geo-sites remain underdeveloped and inaccessible, despite their proximity to rural settlements. The case study of two geo-sites reveals that the income levels of service providers in these areas have increased, and they express satisfaction with the economic benefits derived from tourism. This increase in the income of these service providers was mainly due to the growing number of tourists visiting these sites. Tourists avail themselves of homestay facilities for overnight stays, thereby enhancing the income of the service providers. This study recommends that the development of geo-sites can promote geo-tourism and enhance rural livelihoods, while simultaneously contributing to the infrastructural growth of the region. Furthermore, incorporating geo-sites into academic curricula would allow students to gain a better understanding of geomorphological features. There is an urgent need to formulate and implement policies for the development of geo-sites by fostering collaboration between community members and policymakers.

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