

Rocks, ridges, and recreation: the geotourism renaissance in Dhaubadi area of Gandaki province, western Nepal

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Abstract: This study aims to assess new and known sites along the Kawsoti–Dhaubadi–Dedgaun–Kaligandaki route for geotourism potential based on regional geology, geomorphology, and socio-cultural factors. This study includes the methods to identify geosites, geoheritage, and geomorphosites of the area by field visits including data collection and mapping. It explores the diverse tectonic zones including Dun Valley, Siwalik and the Lesser Himalaya bound by significant tectonic features like the Central Churia Thrust, the Main Boundary Thrust, and the Devachuli Thrust. The presence of plant fossils in Siwalik and Gondwana rocks, the renowned Dhaubadi iron deposit, and coal seem to enhance the geotourism potential. The Ramche landslide can be emphasized as a site for landslide research. The region features from the lowland of Narayani River with the Chitwan National Park to the Ghoral Conservation Area at high hill morphology. The captivating experiences of the Dhaubadi area's changing climate, panoramic mountain views, and the Kali Gandaki River enhance its charm parallelly with cultural and historical sites like Maharajathan, Devachuli temples, and Rudrapurgadi. The unique culture of the Tharu and Magar community and trekking sites like Dhaubadi and Devachuli hills boost the potential of the area. Overall, the study highlights the Dhaubadi area's geotourism scenarios and proposed for in-situ geoconservation and geoparks development.

Keywords: geotourism, ecotourism, geoheritage conservation, Dhaubadi, Devachuli, Gandaki

Introduction

Geotourism is all about enjoying and protecting our planet. It's like traveling with a purpose – making sure that the beautiful places we visit can be enjoyed by us and future generations too. Geotourism is the harmony between sustainability and tourism. It focuses on both natural and urban geological features which promotes economic viability, community enrichment, and geological conservation and offers informative and interpretative experiences. The local community will be benefited and engaged that ensures a satisfying tourism experience.

So, geotourism is a travel philosophy that focuses on exploring geological wonders. It focus of landforms, rock formations, mineral resources, imprint of geological history etc. This aims to give knowledge about geological history to the

visitors and to conserve those geological treasures for sustainable support to the local (Newsome & Dowling, 2010). The Great Barrier Reef in Australia and Machu Picchu in Peru are two excellent examples of geotourism destinations that follow sustainable tourism methods. In order to protect its natural and cultural history, Machu Picchu has put in place measures including waste control, walking trails with specific boundaries, visiting restrictions, and community involvement (Chauvin, 2022). Similar measures are taken by the Great Barrier Reef to safeguard its marine biodiversity, including stringent boating and fishing rules, marine protected zones, and ecotourism programs. In order to maintain the long-term viability of these famous locations, these initiatives aim to find a balance between tourism and conservation (Australian Government, 2024).

Nepal is divided into five geological subdivisions: the Terai, the Siwalik, the Lesser Himalaya, the Higher Himalaya,

and the Tethys Himalaya. This diverse geology of Nepal can be one of the key resources for tourism development. Also, disaster and geology can play the role of two sides of the coin for geotourism in Nepal.

Dhaubadi area is a unique zone, which consists of three major geological sections of Nepal Himalaya including the Terai, the Siwalik, and the Lesser Himalayan rocks. So, the Tourism can be the vital source of economy for the region, which will be based on the nature, geology, and geography of Nepal Himalaya.

A review of geotourism potential and challenges

According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), geotourism is a form of travel where tourists understand that the landscape, they see is made up of unique forms created by dynamic processes (Sanz *et al.*, 2020). It establishes a form of sustainable tourism that focuses primarily on experiencing the earth's geological features in a way that fosters environmental and cultural understanding, appreciation, and conservation; moreover, this type of tourism is beneficial for localities (Cai *et al.*, 2023). By investigating into geosites, geomorphology, and the planet's rich past, tourists get an educational and experiential adventure (Joyce, 2006; Dowling, 2011; Reynard & Brilha, 2018). This path fosters awareness of Earth's processes, promotes the conservation of geoheritage sites, empowers local communities, and contributes to national economic growth (Drumm & Moore, 2005).

The growing trend of geotourism, about immersive experiences in Earth's history, vibrates deeply with travelers seeking sustainable adventures and authentic connections with nature. Nepal, a geological paradise boasting diverse landscapes and geological entities. From the towering heights of the Himalayas to the fossil-rich Siwalik and the plains of the Terai and its geological knowledge unfolds the story of mountain building, ancient life, and dynamic river systems. Its diverse geomorphology, geological features, breathtaking natural landscapes, and iconic trekking trails paint an unparalleled picture of our planet's history (Gautam, 2011; Bhote, 2018). This pattern of biodiversity, cultural heritage, historical sites, and the warmth of its people sets Nepal apart, offering unrivaled exposure to geography, nature, and diverse cultural experiences, attracting investors, and fostering economic opportunities.

Building a flourishing geotourism industry requires careful consideration of essential infrastructure. Access to food, comfortable accommodation, nutritious options, recreational activities, tranquility, and safety are key pillars for both ecotourism and geotourism success (Nepal, 2002; Bulatović, 2017). Striking a harmonious balance between tourism development and environmental protection is critical. Sustainable management of geological information gleaned from outcrops and landscapes ensures responsible growth without compromising the actual resources that attract visitors (Drumm & Moore, 2005).

Only a few of the sections are uncovered and in practice for geotouristic approach. Kaligandaki section (Butwal–Mustang) is the most explored section due to its easy accessibility and word-wide recognition as it carves a dramatic path, showcasing towering cliffs, intricate rock formations, and the majestic Dhaulagiri and Annapurna snow-capped ranges (Upreti & Yoshida, 2005). The fossil field of the Dhaulagiri whispers tales of the Triassic history with its ancient marine fossils, while the *shaligram*, ammonite fossils from Mukti-nath area reveal secrets of prehistoric Tethys Ocean from the region. Annapurna Base Camp is another renowned section for its trekking trails, this region also presents captivating geology (Parsons *et al.*, 2014). The Annapurna Conservation area, with its glacial valleys and towering peaks, offers insights into mountain building and erosion processes. Sagarmatha (Mt. Everest), the world's highest peak, is another region boasting dramatic glaciers, deep gorges, and diverse rock formations. Studying the geology of the Khumbu Himal provides valuable insights into plate tectonics and mountain building (Anderson, 2010; Yoshida *et al.*, 2011). Recently, Acharya & Paudyal (2023) have purposed a captivating geotouristic site along the Chandragiri-Chitlang Range, southwestern part of the Kathmandu Valley of central Nepal.

Beyond these well-known areas, Nepal holds hidden gems with unique geological stories. Unlocking their potential requires targeted promotion, infrastructure development, and engaging explanation resources.

Nepal's geotourism potential holds immense promise for promoting Earth literacy, sustainable development, and cultural appreciation. By responsibly managing infrastructure, prioritizing environmental protection, and educating both tourists and communities, Nepal can carve a unique path in the geotourism landscape, offering an enriching and transformative experience for visitors while safeguarding its precious geological heritage for future generations.

Study area

Traditional geological excursion routes in Nepal frequently focus on high-altitude treks, creating accessibility challenges for some researchers and enthusiasts. This study suggests a new, additional route from Kawasoti in Nawalpur district to the Kaligandaki River portion that provides abundant geosites, geopark potential, and easy access (Fig. 1). Kawasoti, a rising city in Gandaki province, serves as a vital center for this route, leveraging Chitwan's current tourism infrastructure and providing a gateway to the region's geological wonders.

The area dominantly covers central west of Chitwan Dun Valley of inner terai. It covers of altitude variations from lowest point of 171 m at Narayani River to the highest point of 1,937 m at Mt. Devchuli. The tropical climatic zone with elevation variation gives large flora and fauna diversity within the region.

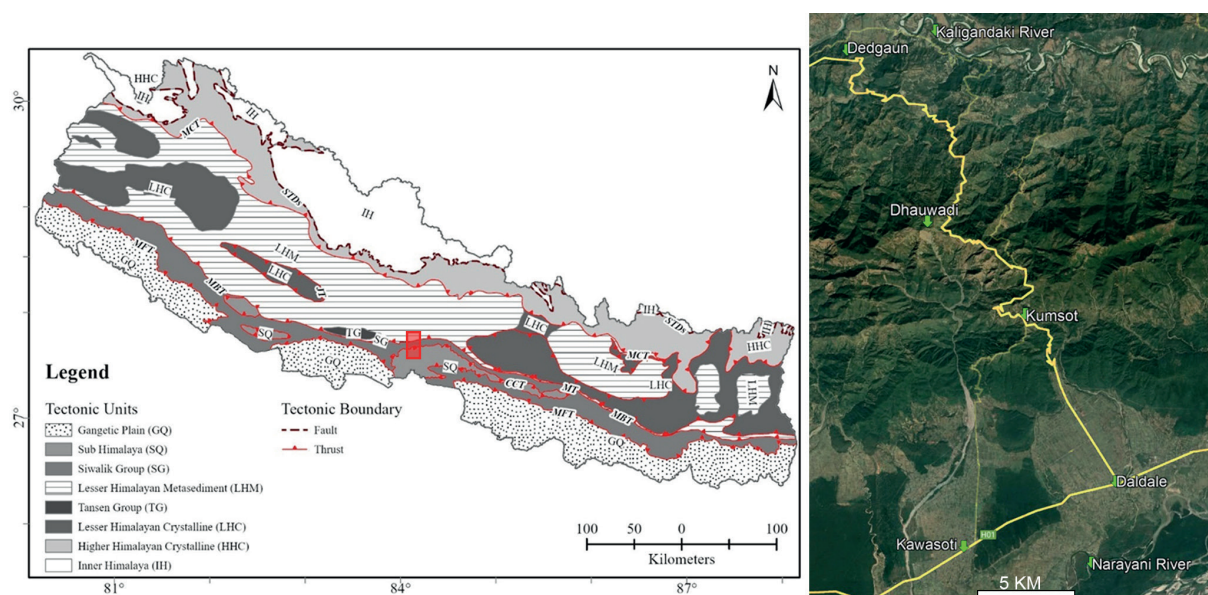


Fig. 1. Geological map of Nepal (modified after Amatya & Jnawali, 1994; Dhital, 2015; Lamsal *et al.*, 2023) along with Google Maps image marking study area (red rectangle) and showing major locations and road network

The proposed route includes notable geological sites that display diverse formations and processes, and it has the potential to be designated as a geopark in the future. This section is easily accessible by road, making it ideal for anyone who cannot hike at high altitudes or is likely to altitude sickness. The Kwasoti–Kaligandaki section offers a comfortable short journey with variety of attractions on geology, culture, religion and environment. This approach shows a great chance to rise Nepal's rich geological legacy for research and geotourism purposes.

Objectives

This study aims to assess new and known sites along the Kwasoti–Dhaubadi–Dedgaun–Kaligandaki route for geotourism potential prominence with regional geology, geomorphology, and socioeconomic factors. The specific objectives are as follows:

- to identify geosites, geoheritage, and geomorphic sites along the route;
- to list possible socio-economic aspects of the area;
- to evaluate new and known sites for geotourism suitability;
- to develop a student-centric tour package for the area.

Methodology

This study aims to discover geosites, geoheritages, and geomorphic sites in the area. It includes a review of existing literature and expert opinions to better understand the subject and find unsolved problems. Clear goals and objectives are

then established. Data are collected using field map preparation, social surveys, observations, and systematic photography. After acquiring the data, analysis is carried out to identify significant patterns and responses. Finally, a report is prepared that presents the findings and future plans for this topic.

There are various processes used to locating geosites, geoheritages, and geomorphic sites. A desk research is first carried out to evaluate previously published studies, maps, and literature in order to assist identify possible places. Subsequently, data collecting techniques such as remote sensing, GIS tools, and historical research are employed to get geological and historical information. In order to accurately record geological features, field study is done including systematic site visits, observation, documenting, sampling, and mapping. Geologists and geomorphologists work together as a professional team to gather and analyse the data. After data collection, analysis and interpretation are done to verify initial assumptions. Finally, research results are recorded in comprehensive reports and maps that are made available to stakeholders and the scientific community via publications and instructional resource.

Results

Geology of the area

The area has diverse geology which consists of three geological divisions as the Dun valley, the Siwalik, and the Lesser Himalaya sections (Fig. 2) from north to south respectively.

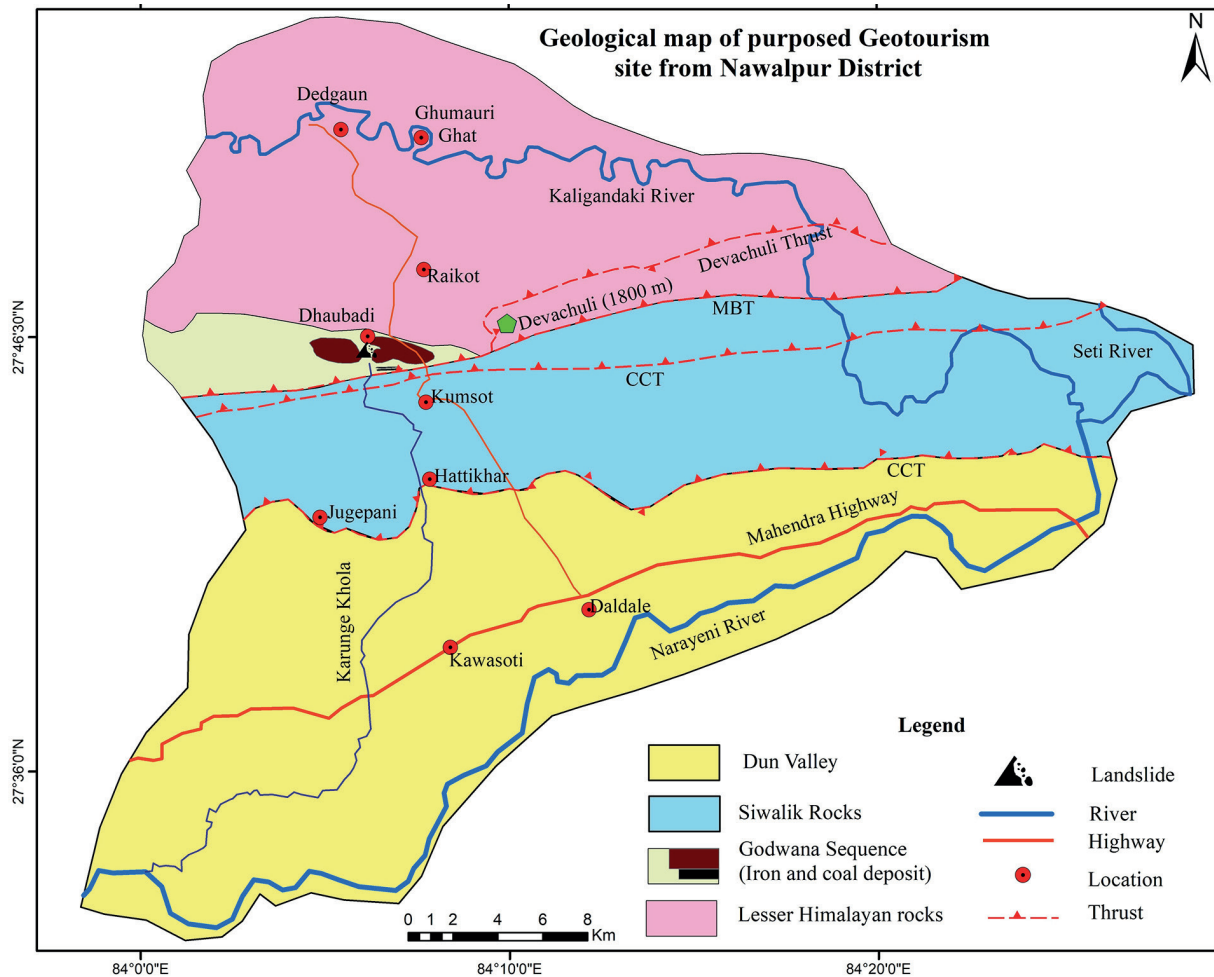


Fig. 2. Geological map of proposed geotourism sites of the Nawalpur district (modified after Amatya & Jnawali, 1994; Paudyal, 2014; Dhital, 2015)

Inner Terai (Dun valley)

The Terai represents the recent alluvium deposits deposited by various streams and the Narayani River. It lies adjacent to the foothills of the Churia range increasing in the lithology of poorly sorted boulders, cobbles and pebbles. It has the potential for groundwater recharging due to the unsorted gravel and stones. During the monsoon season, the most serious issues in this zone are debris flow, gully erosion, and weathering.

Siwaliks

Alluvial deposit of Dun valley is separated by Central Churia Thrust (CCT) from the Siwalik rocks. The Siwalik zone consists of sedimentary rock-like mudstone (Fig. 3A) followed by sandstone and conglomerate deposits from Neogene time. The Siwalik is twice repeated by two intra-tectonic thrusts named as the Central Churia Thrust (CCT) in this area. The Siwalik rocks are observed in Hattikhar and Kumsot area where, the Lower, Middle and Upper Siwalik is well exposed. The Lower Siwalik consist fine grain sandstone

and mudstone. During the traverse from Hattikhar to Kumsot, the transitional contact between Lower and Middle Siwalik is observed. This Middle Siwalik consist salt and paper sandstone with dirty mudstone. Different plant leaf fossils are present in the rocks of Middle Siwalik. Upper Siwalik consist conglomerate. Pebbly conglomerate with sand lenses is observed in the Kumsot area.

Central Churia Thrust (CCT)

Central Churia Thrust (CCT) which is an active thrust within the Siwalik rocks. Presence of small scale landslide, change in lithology determines the CCT in the area. The CCT overlies the Lower Siwalik rocks from Dun valley which is observe around Hattikhar area. It is again observed 500 m north from Kumsot which uplift Middle Siwalik from the Upper Siwalik.

Main Boundary Thrust (MBT)

MBT stands for Main Boundary Thrust. The Main Boundary Thrust divides the Siwalik and Lesser Himalayan rocks

in 1 km south from Pokhari, Dhaubadi (Fig. 3B). Saddle down the cliff, occurrence of landslide can determine the presence of MBT in surface. Moderately weathered, yellowish gray, medium grained mudstone is present in the Siwalik section while moving along the Lesser Himalaya towards Dhaubadi, purple colored, thinly laminated slate is present. Drastic change in lithology also suggest the presence of MBT.

Gondawana rocks

The Gondawana rock consists low grade metasedimentary rocks is in north form MBT. It is surrounded around the Dhaubadi area. It consists of metasedimentary rock as shale, purple-pink, thinly laminated slates is present with interbedding of gray, thin to medium bedded orthoquartzite, quartzite, and phyllite. It mostly consists of red to purple, fine-grained, silty mudstone (Fig. 3C). The Lesser Himalaya zone resembles the large iron deposits as well as few traces of coal seams.

Lesser Himalayan rocks

The Lesser Himalayan rocks are separated by MBT from the Siwalik rocks. From the Devachuli and Dhaubadi area

the metasedimentary rocks of the Lesser Himalaya from the Precambrian age can observe. Rock succession consists of quartzite, dolomite, and phyllites overlying the Gondwana rocks (Fig. 3D). The Lesser Himalayan rocks are divided into different stratigraphic units. The MBT separates Middle Siwalik and the Dhading Dolomite of Lesser Himalaya. Dhading Dolomites is present at Devachuli area. This consists of creamy white, thin to medium bedded, stromatolitic dolomite. The Nourpul Formation overlies the Dhading Dolomite which is separated by the local thrust named Devachuli Thrust (Paudyal, 2013) and the calcite-rich metasedimentary rocks like dolomite and limestone is in the section, in which the different caves are developed. The Benighat Slates is present in Dedgaun area which consists of gray, thinly laminated slates with thinly foliated phyllite and metasandstone.

Devachuli Thrust

The Devachuli Thrust (DT) separates the Dhading Dolomite and the Nourpul Formation of the Lesser Himalayan rocks. This thrust is clearly observed in the Devachuli area. Older rock succession of the Nourpul Formation overlies the younger rock of the Dhading Dolomite due to the Devachuli Thrust.



Fig. 3. Outcrops in the Lesser Himalayas: A – horizontal beds of mudstone and siltstone of the Lower Siwalik exposed at Baluwadanda area (GPS: 27.719151°, 84.130808°); B – thrust boundary (MBT: Main Boundary Thrust) between two geological units (GPS: 27.750776°, 84.158078°); C – outcrop of red-purple shale of the Gondwana units exposed near Pokhari, Dhaubadi (GPS: 27.751741°, 84.154510°); D – high cliff of quartzite beds of the Lesser Himalaya metasediment sequence exposed at Pokhari, Dhaubadi (GPS: 27.757929°, 84.150888°)

Dhaubadi iron deposit

The hematite deposit is named Dhaubadi Iron Deposit, a national priority project in the area. The iron deposits found in the Dhaubadi area are hematite and limonite of sedimentary metamorphosed type (Fig. 4A, B). The hematite is thin to massive bedded and is interbedded with black to olive green shale, black to green color orthoquartzite, thick bedded white quartzite and black shales interbedded with hematite beds. The ore is compact, fine to coarse-grained oolitic and few beds are silica rich. The mineralized zone is displaced by the local fault. Along with iron deposit some traces of coal seams can be observed within Gondwana sequence.

The iron deposit is stratigraphically associated in Melpani formation, lesser Himalaya. The iron mineralization in the Dhaubadi area is associated with lower Gondwana supergroup of lesser Himalaya deposited during the late carboniferous – early cretaceous.

Ramche landslide

Ramche landslide is one of the top ten major landslides of the Nepal. It is located on the Hupsekot Rural Municipality-5, Nawalpur district of Gandaki Province and Nepal.

The location of Ramche landslide is 27°46'15.76"N and 84°6'23.39"E near Ramche village. It is the origin of the Kerung River. Presence of different factors such as slicken slide, boudinage structure, highly deformed and fractured rock/lithology, breccia, multiple tensile cracks shows the major cause/reason to triggered the landslide is by the fault zone. The tensile cracks, geomorphic scar, present on landslide area also support that the landslide is still active and is still spreading.

The Ramche landslide serves as an example of the forces that shape the landscape (Fig. 4C). Every year, monsoons cause an active landslide that regrettably continues to transform the terrain. The characteristic of landslide is observed on different elements, the tone, the tone of the landslide is variegated. Right flank is represented by lead brown, left flank by lead grey, central part by reddish brown tone. The landslide has monotonous succession of variegated shale with rare intercalation of highly deformed grey orthoquartzite. Different types of sheet, rills and gullies type of erosion are present in the landslide area. Different types of morphology shows it as a complex landslide with soil slide, debris flow, soil fall and rock fall.



Fig. 4. Geological objects described in the text: A – photograph of outcrop of the Hematite deposit in Dhaubadi area; B – photograph of students from Tribhuvan University observing and learning exploration skill in Hematite mineral deposit; C – landscape view of the Ramche landslide

Geography, ecology and sociocultural of the Kawasoti–Kaligandaki route

The proposed route covers diverse landscape with various features of geoenvironment. Featuring the low land of Narayani River to the high hill morphology of the Dhaubadi area. The experiences of its changing climate, panoramic mountain views, and the Kali Gandaki River boost its charm. Here are some key highlights of the area.

Tharu home stay: stay with the Tharu, connect with nature, and find your wild side

This will immerse in the heart of Nepalese culture with a Tharu homestay in the Kawasoti area. This gives unique experience of warm hospitality of the Tharu people, their vibrant traditions, and the natural beauty of Chitwan National Park's buffer zone. This area acts as a gateway to natural wonders by board on jeep safaris, elephant rides, or canoe trips through the jungles of Chitwan National Park's buffer zone. The major attraction of this area are:

- Geology and geography: the Dun valley bound by rock of the siwaliks and the river morphology created by the Narayani River is major objective of the area.
- Cuisines and culture: Tharu houses constructed with bamboo and mud walls will shows the simplicity and warmth of their way of life (Fig. 5A) and the Tharu cuisine, prepared with fresh local ingredients and bursting with flavor like; the *Dhikri*, *Chichar*, *Ghonggi* etc. (Fig. 5B). There will be cultural immersion by witnessing mesmerizing Tharu dances, learning about their unique customs and beliefs.
- Lowland art of agriculture: a Nourishing Panorama. Lowlands are to experience the periodic cycles of main crop cultivation. Large fields of paddy, wheat, and maize wave softly beneath the warm sun with the air. Learn the traditional ways of farming to grow these vital crops, which are the foundation of Nepal's food security.
- Narayani River and Chitwan National Park: river flowing through the plains, and its fertile banks nourish the ecosystems of the Chitwan National Park, a UNESCO World Heritage Site. The Chitwan National Park, home to various flora and fauna such as endangered one-horned rhinos and Bengal tigers, spotted deer, and over 500 species of exotic birds including the majestic hornbills and colorful kingfishers provides a glimpse into Nepal's vast biodiversity (Fig. 6A).
- The Jatayu restaurant: this inspiring story of nature's recovery is more than simply an ordinary eatery; it is also a sanctuary for endangered vultures and a shining example of conservation success (Fig. 6B). This unique community-run facility provides safe food for these majestic birds, assisting in their remarkable population development.



Fig. 5. Glimpse of Tharu community: A – Tharu home stay; B – collection of Tharu cuisines



Fig. 6. Photograph of one-horn rhinoceros from Chitwan National Park (A) and vultures observed in Jatayu restaurant (B)

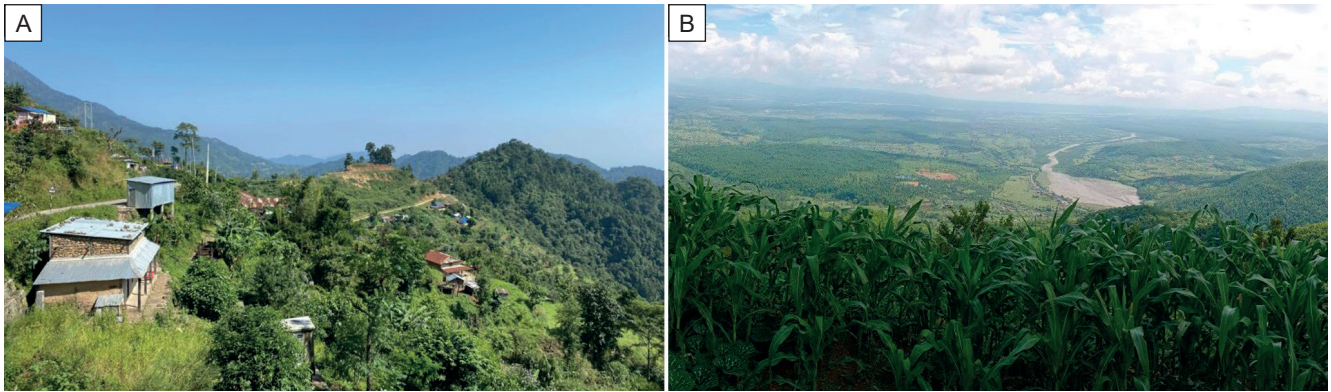


Fig. 7. Landscape described in the text: A – landscape of Kumsot Village (photo after travelinnawalpur.com); B – southern view from Baluwadanda covers almost entire low land of Nawalpur district



Fig. 8. Landscape image of Dhaubadi village, Ramche landslide and historical Rudrapurgadi in one frame

Baluwadanda and Kumsot village: a scenic getaway for outdoor lovers

Situated in the green slopes of the Chure range, Baluwadanda and Kumsot village present an attractive haven for those who like the outdoors. These villages attract everyone with breathtaking rising landscapes of the wide lowlands below, making them perfect for quick, uphill bike rides (Fig. 7A, B). The major attraction of this area is as follow:

- Geology: The major spots to observe the Siwalik rocks along with tectonically active thrust CCT twice in the region. The study of Himalayan orogeny, geological hazards and the fossil records can be fruitful activities for the enthusiastic persons.
- Village Warmth: The warmth of wood-fired cooking and the friendly welcome of the local villagers. As the sun sets, changing the environment into a haven for

nighttime activities. The calm glance of Devachuli Dada, adds a touch of spirituality to the experience for those seeking peace and spiritual regrowth.

Dhaubadi: a journey through history, nature, and culture

Dhaubadi hill is located between 1,300 and 1,650 m above sea level. It follows an elevation within the Siwalik Range. From this height, we can see and observe low-lying terai regions as well as high Himalayan peaks such as the Annapurna, Dhaulagiri, and other Himalayas. This area is center of attraction with following highlights:

- Geology and geomorphology: it is exciting to look into Earth's ancient history by the combination of Precambrian and Paleozoic rocks in proximity, including the massive landslide (Ramche landslide) and one of the largest iron deposits of the Nepal (Fig. 8).

- History: Rudrapurgadi, a 16th-century fort whispering tales of past fights, offers a beautiful mixture of historic remnants, magnificent landscapes, and lively cultural events (Fig. 8).
- Wind energy potential: Dhaubadi, is the place where strong wind blows 24 h a day. It has a great possibility of generating wind energy. A wind and solar energy plant to generate 10 kW of energy is installed (Fig. 9A). Exploring this initiative, buried in the amazing scenery, offers a practical view on using natural resources reliably and promoting environmental sustainability.
- Ghoral conservation area: to the west of Dhaubadi, in the jungle and Rocky Mountains, we can travel/hike to witness Himalayan ghorals, which are easy to spot near water sources. The jungle has been designated as a “Mahabharat Ghoral conservation area” by the assistance of locals and the government. This protected region features high-hill morphology with steep slopes and limited valleys (Fig. 9B). The varied vegetation and habitat conditions provide an opportunity for research into ecological interactions and conservation efforts in this mountain environment.
- Flora and faunas: in the jungle areas surrounding Dhaubadi, many varieties of rhododendrons can be seen, including the red *Laligurans*, the national flower. This is the nearest place from the lowlands to observe the national flower.
- Home stay: Dhauwadi’s homestays provide an insight into the rich customs and friendly hospitality of the Magar and Gurung people for a more in-depth experience. By experiencing their lively dances, delicious food, and rural life.
- Agriculture as a hillside treasure: the hills provide a robust environment for cultivating millet, a drought-resistant grain that thrives on less fertile heights, ensuring food security and economic stability for hill

residents. Visitors can observe the farming techniques used to grow millet, appreciating its role in sustaining difficult terrains. In areas like Raikot, Bobok, and Lhape, vibrant orange farms cover the hillsides, showcasing the meticulous processes local farmers employ to produce various sweet and juicy orange varieties. Additionally, the cultivation of Amriso (broom grass) serves both commercial and ecological purposes, offering income through broom production and preventing soil erosion with its thick roots. Tourists can learn about the sustainable methods used to grow Amriso, gaining insight into its multifaceted benefits.

Devachuli Dada: a beacon of natural splendor and cultural significance

Highest among the verdant landscape of Nawalparasi district, Devachuli Dada shows its mesmerizing blend of natural beauty and cultural significance (Fig. 10). Renowned for its breathtaking sunset views, the hilltop transforms into a canvas of fiery hues as the sun dips below the horizon, leaving behind a spectacle of color and wonder. The major highlights of the area are:

- Geology and geomorphology: the peak is formed by the carbonate rocks thrust over the quartzite by the Devchuli Thrust (DT). Development of caves and karst topography is another phenomena to consider during the visit.
- Hiking and climbing: beyond the visual enchantment, Devachuli Dada offers a challenging climb reward to daring hikers with panoramic views of undulating hills and valleys, and the distant majesty of the Himalayas.
- Cultural importance and spirituality: the hilltop holds deep spiritual significance for both the Magar and Tharu communities, who revere it as a sacred place. Visitors can witness their traditional ceremonies and rituals provides a glimpse into the region’s rich cultural tapestry.

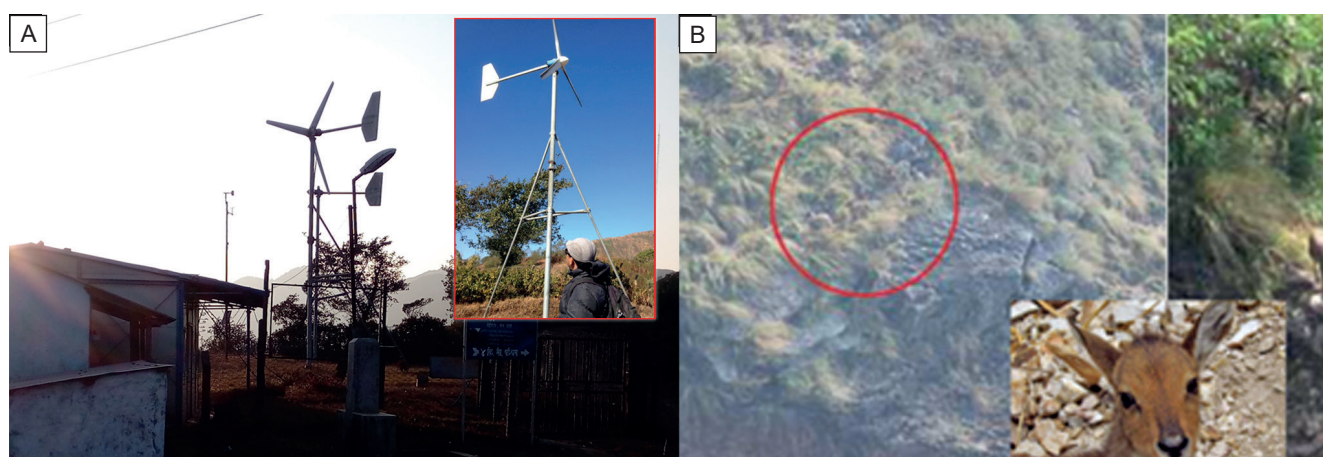


Fig. 9. A windmill of Dhaubadi to generate wind energy (A) and the photographs of Musk deer spotted in Ghoral Conservation Area (B) (Jha *et al.*, 2015)

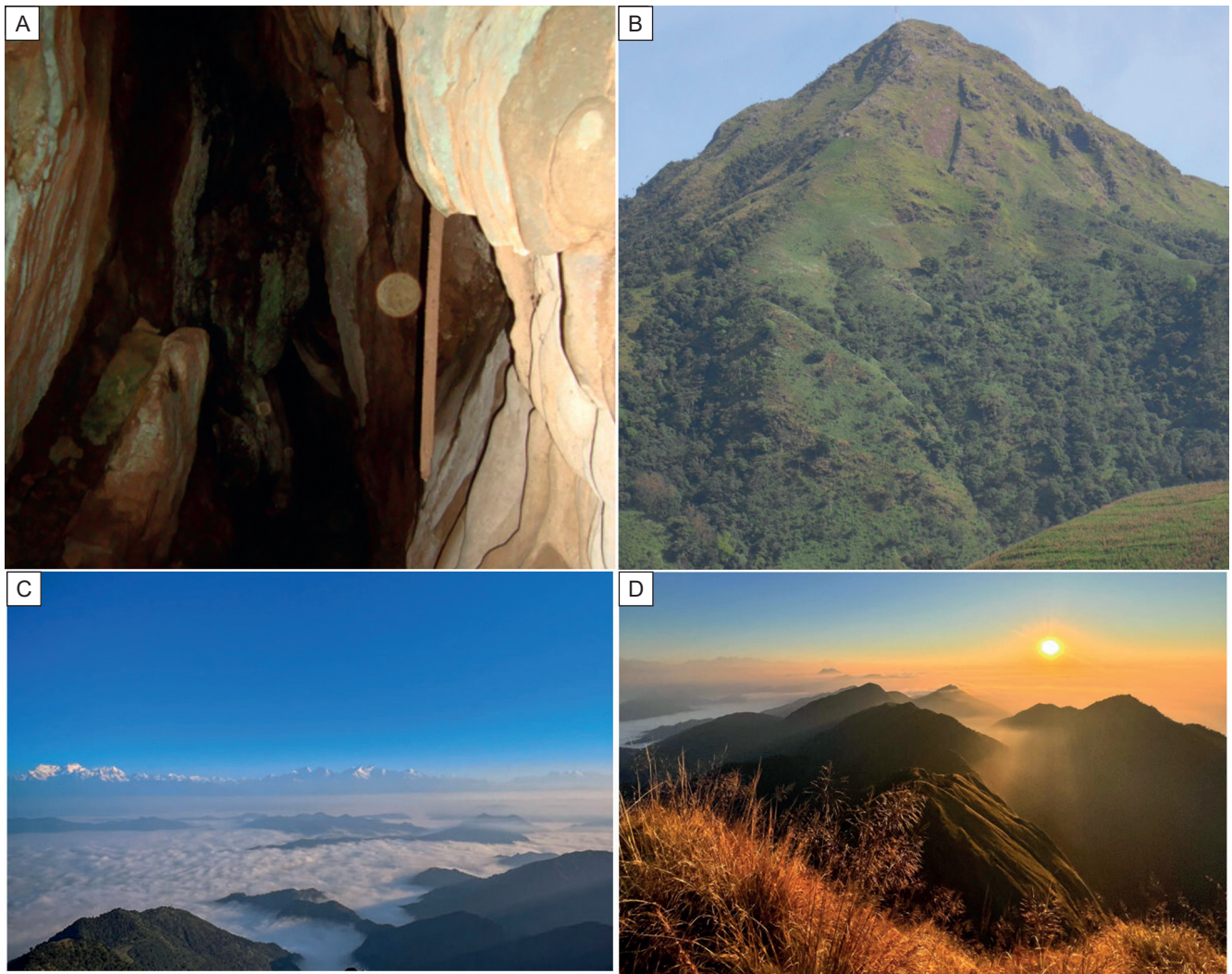


Fig. 10. Different aspect of Devachuli hill: A – Kumarwoti Mai Temple inside the cave built in Dolomitic rock of Devachuli; B – photograph of Devachuli Peak clicked from southern face; C, D – eye catching view from Devachuli peak (photo C, D after travelinnawalpur.com)

Explore the Kaligandaki river corridor: nature, faith, and adventure

The Kaligandaki River flowing through the rugged landscape, is a combination of natural wonder and religious significance for both tourists and scholars. Its morphology and distinct geological features make it a great field for scientific study.

The Kaligandaki River corridor unfolds as an array of natural beauty, spiritual honor, and adventurous activities along with scientific inspiration. The main geotouristic features of the area are:

- Kali Gandaki River: the distinctive geology and river's morphology, shaped by millions of years of erosion witnesses the enormous geological forces at work. Along with stunning scenery, they also serve as important research locations for geomorphologists. Further downstream is Ghumarighat an oxbow-shaped

structure formed by the Kali Gandaki's meandering path. Its geographical significance helps to discover the river's geological creativity enchanting future signs of the river's dynamic past (Fig. 11A).

- Cultural, festivals and spirituality: the popular Akaladevi Temple, located on a pleasing hillside, is accessible via a short hike or bike ride (Fig. 11B). This temple, devoted to a goddess, draws followers from all across the country seeking blessings for a prosperous future. *Chaite Purnima* is a lively spring festival that features rituals with animal sacrifices, giving a unique blend of faith and culture.
- Water fun: this location in the foothills also provides hikes and boat trips options. The huge Kaligandaki River, provides a thrilling trip for whitewater rafting. Recently kayaking was also successfully tested downstream of the river (Fig. 11C, D).



Fig. 11. The Kalingandaki Valley: A – photograph showing river morphology of the Kaligandaki River; B – monument of goddess inside Akaladevi Mandir; C – white water rafting in Kaligandaki; D – Kayaking in Narayani River downstream of Kaligandaki River



Fig. 12. Photographs of different religious places and cultures in the area: A – Maharajathan Temple, Hattikhor; B – Kumarworti Mai Temple, Devachuli; C – Akaladevi Temple, Dedgaun; D – Lathi naach cultural dance of Tharu community; E – Koura dance of Magar community; F – Ghatu dance of Gurung community

Religion and cultural aspect of the area

This excursion route goes above its geological significance to provide a glimpse into the rich diversity of local cultures nestled down in the Himalayan foothills (Fig. 12). Here, the communities of Tharu, Magar and Gurung create rich cultural works of art, mixing their customs and traditions into the fundamental structure of rural existence.

An opportunity for in-depth cultural research is provided by the homestays placed away in these areas. Visitors can stay there to spend time sharing meals prepared in earthen ovens, taking part in colorful festivals, and picking up traditional crafts. Participating in agriculture work and storytelling around crackling fires, helps people to gain rhythm of these rural communities.

Beyond the concrete elements of culture, a spiritual air defines the environment in the form of sacred sites. The Mahara-jathan Temple, devoted to a mighty god, and Kumarwoti Mai Temple, located among beautiful forest environments, tell stories of divine guardians. Thumki Devi Temple, situated on a hill, offers beautiful views while also providing space for prayers and offerings. These sacred locations reflect not only religious worship, but also a strong connection to the land and its spirits, and they play an important role in the region's cultural fabric.

Building a sustainable future: a proposal for geopark and natural museum

A geopark is an area that showcases globally important geological heritage, weaving nature, culture, and tradition (UNESCO, 2025). It aims to protect these treasures while using them to empower local peoples, promotion sustainable development and cultural appreciation. In short, a geopark is a bridge between rocks, landscapes and people in harmony.

Components of geopark

The key components of geopark defined by Sadry (2020) is adopted for conceptualizing the geopark development in this area (Fig. 13).

This framework suggests a multidimensional strategy to develop a lively geopark and natural museum. This development process prioritizes the following main components:

- Geoheritage: all the goheritages within the area are preserved with their details. Good approach roads and basic infrastructures will be developed to insure the good experience of visitors.

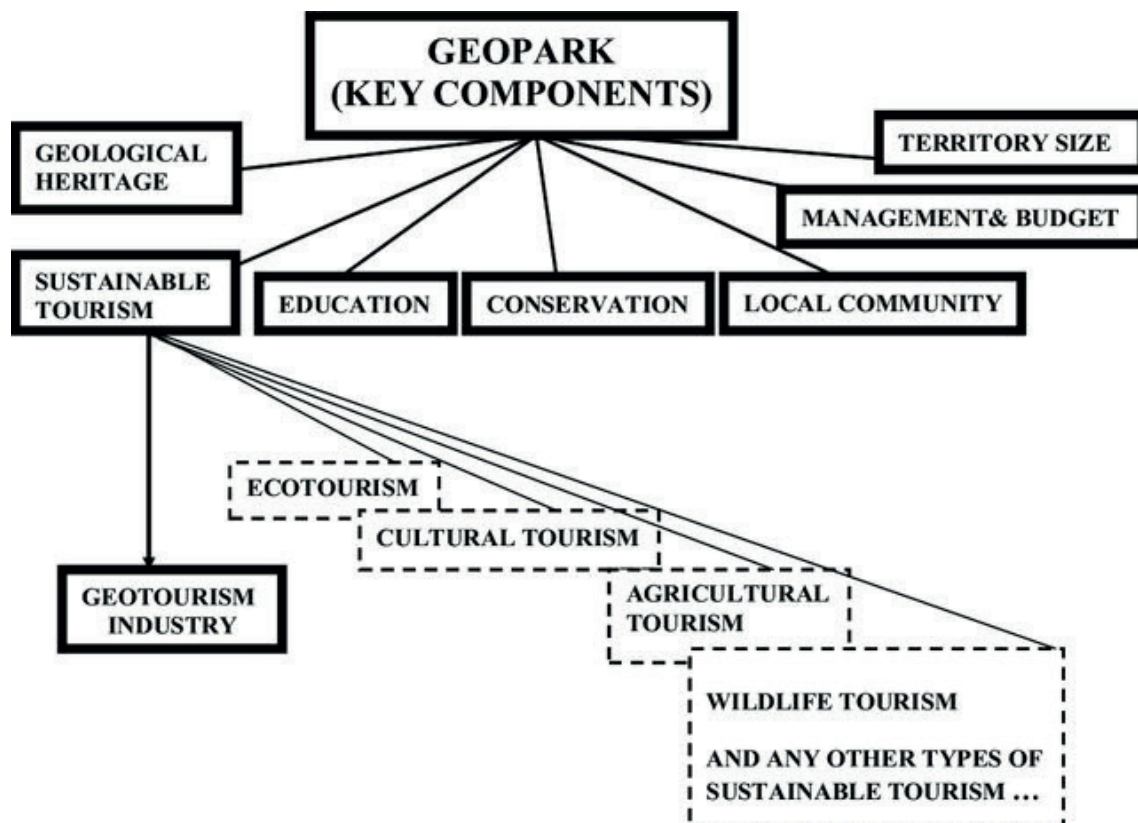


Fig. 13. The core elements and key components of a geopark (Sadry, 2020)

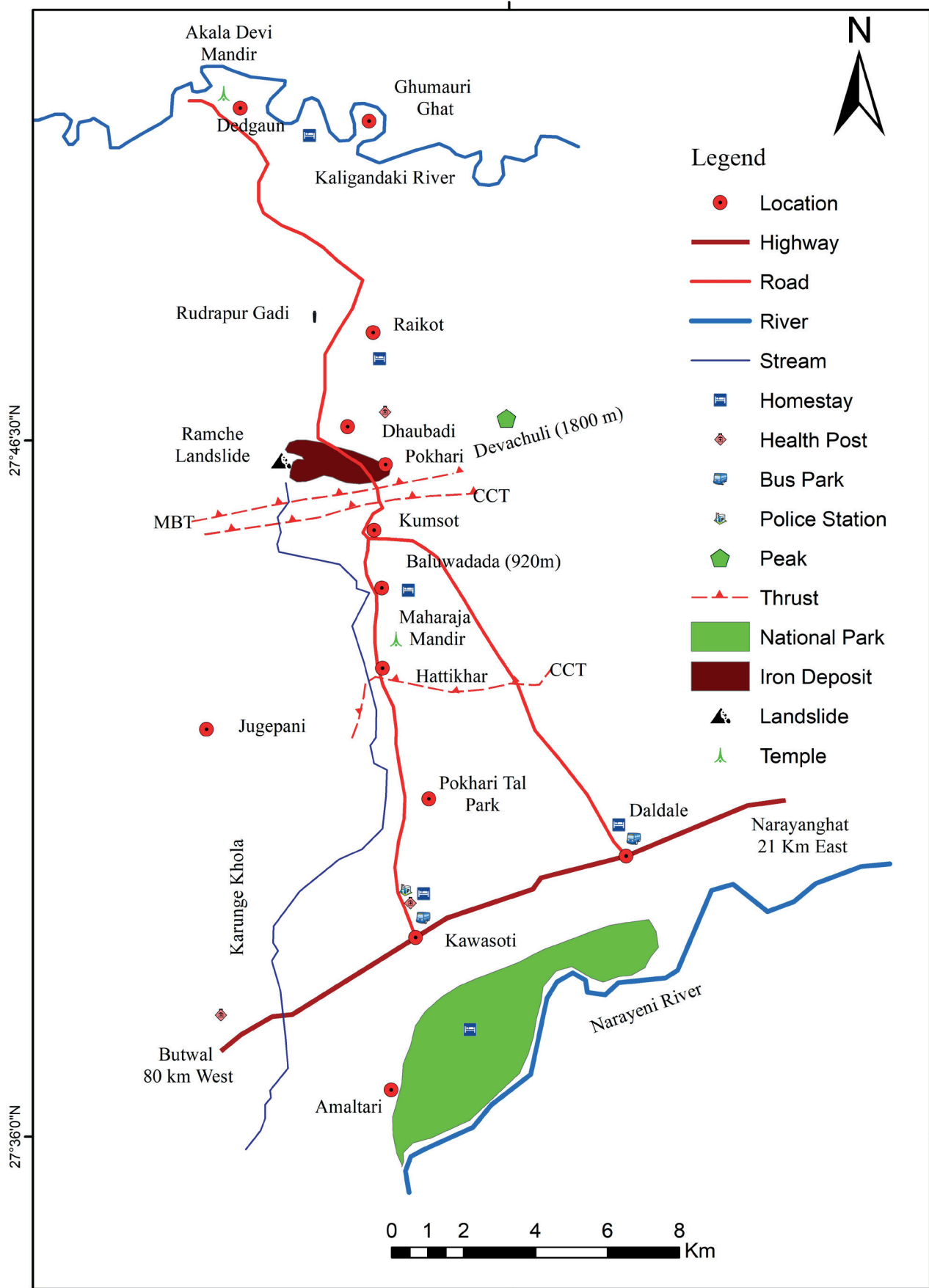


Fig. 14. Various points of attractions in proposed geopark

- Territory: the proposed geopark territory will be divided into two zones. A central zone with about 18 km² (6 km × 3 km) covers most of the geoheritages making the Dhaubadi a central hub. Also, there will be a dedicated natural museum for showcasing the features in a hand. Followed by rim area covering from Kawasoti to Kaligandadi to cover other components of the area (Fig. 14).
- Management and collaboration: the geopark is directly managed by committee formed by stockholders of the local community under the norms of UNESCO geopark. Local government wings will have rights and responsibility for the continuous monitoring.
- To promote Dhaubadi as a renowned location for geotourism, drawing individuals interested in the relation among geology, culture, and nature there will be encouragement to collaborate among geologists, anthropologists, historians, and community leaders to ensure the geopark's overall administration and development.
- Local community: involvement of local communities in the geopark's development and management is must to ensure equitable distribution of benefits and preservation of culture. This practice will encourage geotourism and sustainable business practices to help diversify the local economy and provide new job opportunities.
- Conservation and recognition: the strategy is to prioritize the protection and preservation of distinctive geological characteristics of Dhaubadi area with established conservation strategies and community involvement. There will be continuous advocacy for Dhaubadi's official status as a UNESCO Global Geopark, which will provide international reputation and access to significant resources. This is suggested to create a dedicated natural museum to showcase the region's geological assets while promoting education and public acceptance.
- Education and research: it will focus to create a scientific hub at Dhaubadi to attract scientific skill and generate knowledge on various geological aspect along with environment, history, and anthropology. Further this geopark will create educational programs and resources in conjunction with local schools and institutions to inspire future generations to value and maintain the region's natural heritage.
- Sustainable tourism: to ensure sustainability, prioritize ethical tourism activities and environmental education. Some of the prioritized interdisciplinary tourism is listed below:
 - ecotourism,
 - cultural tourism,
 - agriculture tourism,
 - wildlife and biodiversity tourism,
 - adventure and sport tourism.

Dhaubadi may capitalize on its remarkable geological impact to establish a dynamic geopark and natural museum that benefits both the environment and local populations. This multidisciplinary strategy, which promotes conservation, research, education, and sustainable growth, has the potential to ensure a bright future for unique geological heritage of Dhaubadi.

Purposed tour package

Primitively based on all discussed component a general suggestion for 5 days geological and cultural adventure tour packages is prepared. This proposed plan is ideal for young explorers and adventurous learners. This article mainly focused on student centric geotourism which offer an affordable and educational way to discover the region. Also, this package concept can be updated to geologist, ecologist or outdoor enthusiast yearning to explore the nature and ancient history of rocks.

Day 1

1. Narayani River: witness sunrise and landscapes, practice yoga/meditation, observe wildlife.
2. Biodiversity seminar*: learn about the national park and conservation efforts.
3. Jungle safari: discover the community forest and observe conservation practices.
4. Tharu homestay: immerse yourself in Tharu culture with dinner by the campfire.

Day 2

1. Maharajathan Temple visit: explore this historical gem in Hattikhori, visit Pokhari Tal.
2. Siwalik geology & rock hunting: learn the formation and importance of the Siwalik.
3. Baluwadanda hike: enjoy panoramic views, observe biodiversity and geology.
4. Paragliding (optional)*: fly above the hills for a thrilling adventure.
5. Magar homestay: experience Magar culture with campfire and interaction.

Day 3

1. Kumsot/Pokhari activities: participate in morning events and travel to Pokhari for breakfast.
2. Devachuli peak hike: hike through scenic landscapes, observe biodiversity and geology.
3. Kumarwoti Mai Temple visit, a carbonate cave visit, a peak seminar (optional).
4. Pokhari site visit: explore the area's geological features and Nepal's largest iron deposit.
5. Dhaubadi travel & cultural evening: hike to Dhaubadi and enjoy a Magar cultural.

Day 4

1. Rudrapurgadi and sunrise: visit the ancient fort and enjoy breathtaking sunrise views.

2. Ramche landslide: witness one of Nepal's biggest landslides and learn about its history.
3. Travel to Dedgaun: enjoy a scenic vehicle ride to this beautiful village.
4. Dedgaun exploration: discover the local culture and surroundings.

Day 5

1. Akaladevi Temple: visit the renowned temple and participate in morning worship events.
2. Rafting*: experience an adrenaline rush with white-water rafting on the Kaligandaki River.
3. River morphology*: learn about the river's unique features and geological significance.
4. Departure: farewell and travel back home.

Note

- * Can be exclude to general tourists.
- ** Can be exclude to students.
- # Test flight is successful, commercial flight is yet to develop.

Conclusions

In conclusion, there is far more to the geological treasures of the Kawaṣoti–Kaligandaki path than just affection for their beauty. It constructs a complicated story of resource management, economic growth, and sustainable practices, providing rich ground for a variety of academic interests. From resource exploitation to community-based conservation, the region serves as a practical laboratory for scientists, economists, and enthusiasts together.

There is a cultural treasure store to be discovered along the journey beyond the geological tapestry. The Tharu, Magar, and Gurung communities have delicately created their legacy and spiritual beliefs into the fabric of the landscape. Taking part in a variety of cultural practices, from traditional livelihoods to colorful celebrations, creates a better understanding of the complex relationship between nature, culture, and the human spirit. Thus, the Kawaṣoti–Kaligandaki route exceeds a geological journey, transforming into an enriching tapestry of academic exploration and cultural immersion.

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