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REVIEW

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A Comprehensive Assessment of Anthropogenic Effects on Environmental Degradation, Community Structures and Socio-Economic Dynamics in Himachal Pradesh

Gurinder Kaur Walia¹, Poonam Devi² and Diksha Chopra³

Department of Zoology and Environmental Sciences, Punjabi University Patiala, Punjab, India
Correspondence for materials should be addressed to DC (email: chopradiksha31@gmail.com)

Abstract

Himachal Pradesh, a mountainous state in northern India, is known for its rich biodiversity, pristine ecosystems, and picturesque landscapes. However, over recent decades, anthropogenic activities such as industrialization, deforestation, urbanization, and tourism have exerted immense pressure on its environment and local communities. This paper provides a comprehensive review of these human-induced impacts, highlighting the interconnection between environmental degradation, socio-economic transformations and the well-being of local populations. This study also explores the consequences of developmental activities and evaluates potential strategies to promote sustainable development in the region.

Keywords: Environment; Himachal Pradesh; Industrialization; Tourism; Anthropogenic effects

Introduction

Himachal Pradesh, located in the Indian Himalayas is one of the world's critical biodiversity hotspots and a significant hub for conservation efforts. Various studies have emphasized on the importance of biodiversity in a particular area (Khangotra, 2022; Joshi and Puri, 2024; Dlamini and Dlamini, 2024; Kumar, 2024). This region is characterized by its diverse climates and landscapes, which contribute to its rich biodiversity and ecological importance. It is renowned globally for its breathtaking natural beauty, drawing visitors from all over the world. This ecological diversity supports a wide variety of flora and fauna, making the state a vital area for biodiversity conservation (Gupta and Pal, 2016). The ecosystems range from alpine meadows and temperate forests to subtropical valleys, providing habitats for numerous species, including endangered wildlife such as the snow leopard and Western Tragopan. Additionally, the region is the source of major rivers like the Sutlej and Beas, which are crucial for agriculture and hydropower generation in northern India (Sharma and Chand, 2018).

The local communities of Himachal Pradesh, including indigenous groups like the Pahari, Kinnauri and Gaddi, play a pivotal role in maintaining the state's cultural diversity. These communities have preserved traditional knowledge and practices that are intricately linked to the environment, such as organic farming, herbal medicine and eco-friendly construction techniques. These sustainable practices are essential for adapting to the regions rugged terrain and harsh climatic conditions (Negi and Samal, 2002). The cultural heritage of these communities is also evident in their festivals, music, dance, and craftsmanship, which contribute to the state's unique identity (Pandey and Negi, 2018). Economically, Himachal Pradesh relies heavily on agriculture and horticulture, with apple orchards



being a prominent contributor to the economy of the state. The fertile soil and favourable climate support the cultivation of a wide range of fruits, vegetables, and medicinal herbs, providing livelihoods for a significant portion of the population (Sharma and Chand, 2018). Tourism is another vital economic sector, driven by the natural beauty and cultural richness. Popular destinations such as Shimla and Manali, along with ancient temples and Buddhist monasteries, attract millions of visitors annually, bolstering the local economy through hospitality services, adventure tourism, and the sale of local handicrafts (Gupta and Pal, 2016).

However, the rapid pace of human activities in Himachal Pradesh has led to significant environmental degradation. The expansion of road networks, industrial pollution, mining and deforestation are causing severe ecological damage. These activities have accelerated habitat destruction, soil erosion and water pollution, leading to a decline in biodiversity which threatens the natural resources (Kumar and Singh, 2015). The impact of these activities extends to the socio-economic fabric of the region, as livelihoods dependent on agriculture and tourism are increasingly at risk. The influx of outsiders due to industrialization and tourism has also led to social tensions and competition for resources, further exacerbating the challenges faced by local communities (Sarkar and Singh, 2020).

In light of these challenges, sustainable management of Himachal Pradesh environment is crucial. Balancing conservation efforts with development initiatives is essential to preserve the natural resources of the state, support resilient livelihoods for local communities and sustain the cultural heritage that makes Himachal Pradesh a unique and cherished destination in India (Chauhan and Verma, 2017). By prioritizing sustainable practices, the state can mitigate the impacts of climate change, maintain ecological balance, and ensure the long-term viability of its economic activities.

Study area and methodology

This study focuses on Himachal Pradesh, a mountainous state in northern India covering 55,673 square kms, or 1.69% of India's total landmass. Located between latitudes 30°22'N to 33°12'N and longitudes 75°45'E to 79°04'E, the state is bordered by Jammu and Kashmir, Punjab, Haryana, Uttarakhand, and China. Himachal Pradesh is divided into three geographical zones: the Siwalik's (up to 1,500 meters), the middle Himalayas (1,500 to 3,000 meters), and the Himadris (above 3,000 meters). The region experiences diverse climatic conditions, with one-third of the area covered by snow and glaciers, an average annual rainfall of 1,800 mm, and temperature ranges from below freezing to 35°C. The state is crossed by major rivers such as the Sutlej, Beas, and Yamuna, and is administratively divided into 12 districts, including three tribal areas, with a projected population of 7.52 million as of July 2024.

The study employs a descriptive approach, relying on secondary data from a wide range of sources, including academic literature, government reports, and credible internet resources. Data was specifically gathered from departments such as the Department of Tourism, Himachal Pradesh Tourism Development Corporation, and the Department of Economics and Statistics, providing essential insights for the analysis. This comprehensive data collection allows for a thorough examination of the environmental, socio-economic and cultural dynamics of Himachal Pradesh, framed within the region's unique geographical and demographic context.

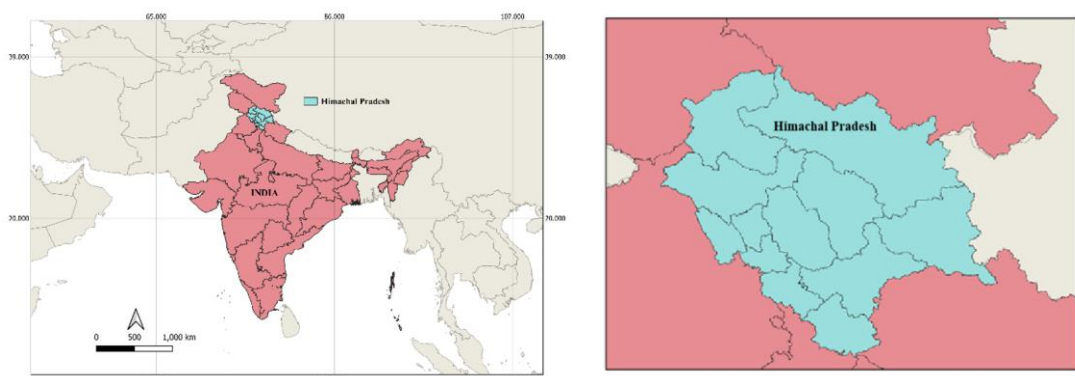


Fig. 1. Himachal Pradesh in Indian map

Results and discussion

Himachal Pradesh, situated in the Himalayan region, faces significant environmental challenges due to anthropogenic activities. Industrialization, agricultural expansion, deforestation, road construction, mining, urbanization, and tourism have contributed to habitat loss, ecosystem

fragmentation, and increased risks of landslides and soil erosion. Air and water pollution from industrial activities and vehicular emissions threaten both environmental and human health, posing risks to livelihoods dependent on agriculture and forestry.

Tourism, while economically beneficial, has placed additional strain on local infrastructure and natural resources, leading to socio-economic disparities and altering traditional practices. Mining, although contributing to the economy, has resulted in soil and water contamination, adversely impacting the environment and local agriculture. Urbanization and infrastructure development have increased the demand for land and resources, exacerbating water scarcity and environmental degradation, particularly in the fragile Himalayan terrain. Efforts to mitigate these impacts include promoting sustainable tourism, implementing stricter environmental regulations, and engaging local communities in conservation efforts. Achieving a balance between economic development and environmental preservation is essential for safeguarding Himachal Pradesh's biodiversity, supporting sustainable livelihoods, and protecting its cultural heritage for future generations.

Anthropogenic activities in Himachal Pradesh

Deforestation

Deforestation in Himachal Pradesh is a multifaceted issue driven by a combination of human activities and environmental factors. According to (Chaturvedi et al., 2011), agricultural expansion, infrastructure development, and illegal logging are the main contributors to forest loss in the Himalayan region. Rapid urbanization, road networks, and hydropower projects have led to the depletion of forest cover in critical ecological zones. Additionally, climate change has intensified this problem by increasing temperatures and reducing snowfall, making forests more vulnerable to wildfires. (Ahmad et al., 1990) emphasizes that deforestation, compounded by overgrazing and poorly planned development, has severely affected the Himalayan ecosystem. This has resulted in frequent landslides, water shortages, and harm to local wildlife, while exacerbating poverty, particularly for women who face additional burdens due to environmental degradation. The authors call for more responsible planning and environmental impact assessments in the region to minimize further damage. Contrary to the belief that all climate change impacts are negative, (Deshingker et al., 1997) observed that in some areas of Himachal Pradesh, tree cover has increased due to climatic shifts.

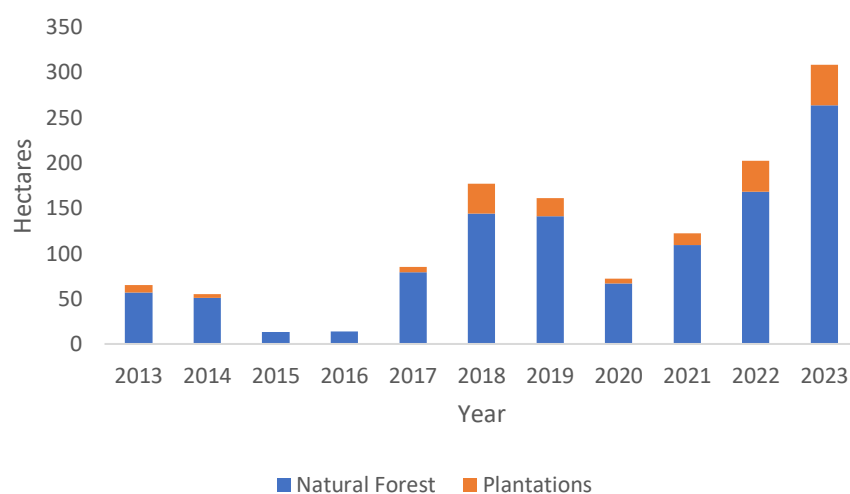


Fig. 2. Forest loss in natural forest in Himachal Pradesh, India
(<https://www.globalforestwatch.org/dashboards/country/ind/13/>)

However, human-induced deforestation remains the larger threat, leading to biodiversity loss and promoting the dominance of certain species over others. The study advocates for sustainable forest management and planting resilient tree species to combat these challenges. (Negi, 2018) explores the broader social and environmental consequences of deforestation, noting that it severely affects local communities by limiting their access to essential resources such as firewood and fodder. The research underscores the importance of involving local communities in forest management and restoring indigenous tree species to ensure sustainable governance of forest resources. The forested area in Himachal Pradesh spans 15,443 square kilometers, representing 27.73% of the state's total geographic area. The officially recorded forest area encompasses 37,948 square kilometers, making up 68.16% of the total geographic area of the state. Between 2001 and 2023, Himachal Pradesh experienced a loss of 5.33 thousand hectares of tree cover, marking a reduction

of 0.23% of the global total. From June 25, 2024, to July 2, 2024, no deforestation alerts were reported in the state. (Gupta et al., 2020) further highlights the dangers posed by the widespread plantation of Chir pine for commercial purposes. This tree species has expanded to cover around 17.8% of the state's forest area, increasing the susceptibility of forests to fires during dry seasons. This monoculture, along with the decline in fire-resistant species like oak, has resulted in significant biodiversity loss and disrupted the region's hydrology.

Additionally, between 2013 and 2023, 87% of tree cover loss occurred in natural forests, which contributed to CO₂ emissions amounting to 529 kilotons. Between 2001 and 2023, three key regions in Himachal Pradesh accounted for 54% of the total tree cover loss. Kullu experienced the highest reduction, with 1.16 thousand hectares lost, well above the regional average of 444 hectares. Kangra followed closely, with a tree cover loss of 1.08 thousand hectares, while Chamba recorded 645 hectares. Other notable regions include Shimla and Mandi, with losses of 589 and 552 hectares, respectively. Overall, between 2000 and 2020, Himachal Pradesh witnessed a net change of 33.3 thousand hectares, which represented a 1.7% decrease in tree cover.

Road construction

Road construction plays a critical role in developing infrastructure in Himachal Pradesh, a state with challenging mountainous terrain. These roads improve connectivity between isolated communities and provide access to essential services such as healthcare, education, and markets. By reducing travel times, they stimulate key economic sectors like tourism, agriculture, and local industries, facilitating the movement of goods and people. However, road construction poses environmental risks. Clearing forests to create road alignments disrupts local ecosystems, contributing to biodiversity loss and increased soil erosion. The risk of landslides is also heightened, particularly during the monsoon season, impacting road safety and nearby communities. The increase in tourism, driven by improved road networks, further stresses the environment, highlighting the need for sustainable practices to preserve natural landscapes. To mitigate these challenges, the state conducts Environmental Impact Assessments (EIAs) and employs eco-friendly construction techniques, such as slope stabilization and erosion control. Engaging local communities is also a priority, ensuring that development benefits are equitably shared.

By 2014, Himachal Pradesh had 2,196 kilometers of National Highways. By 2018, this network expanded to 2,642 kilometers, with the completion of 16 major National Highway projects. An additional 4,312 kilometers of state roads were proposed for conversion into National Highways, aiming to increase the total NH network to 6,954 kilometers. Significant ongoing projects include the Rs. 299 crore upgrades of the Kullu-Manali road to a two-lane highway and the Rs. 4,084 crore construction of a 9-kilometer tunnel connecting Manali to Kelang. The state plans to invest Rs. 40,000 crores in road development over the coming years to boost connectivity and economic growth.

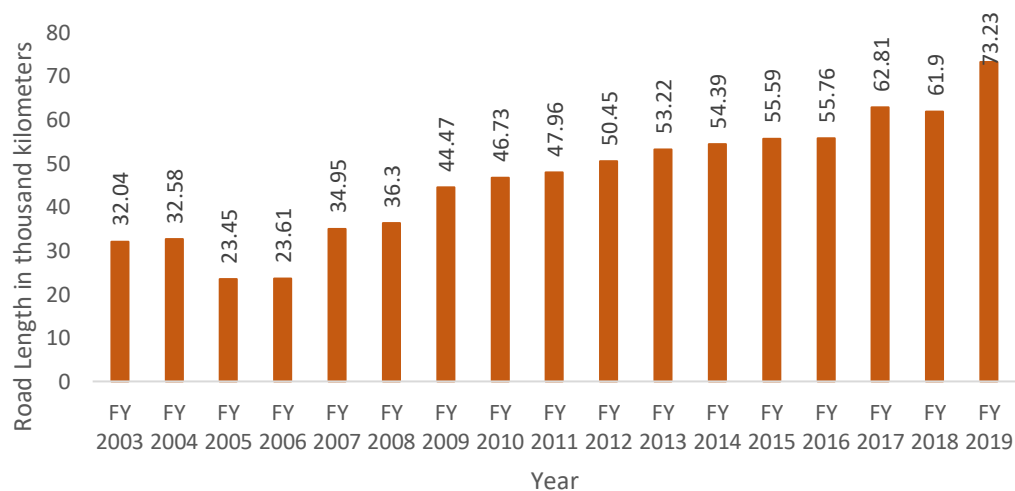


Fig. 3. Road length in thousand kilometers from 2003-2019 in Himachal Pradesh (<https://www.statista.com/statistics/1078800/india-length-of-constructed-roads-himachal-pradesh/>)

Tourism and its environmental impact

Tourism is a double-edged sword in Himachal Pradesh, contributing to both economic growth and environmental degradation. (Batta, 2006) argued that ecotourism offers mutual benefits for

conservation efforts and local communities by providing economic alternatives that reduce pressure on natural resources. However, the success of ecotourism depends on careful planning, sustainable practices, and community involvement (Kant and Gupta, 2021) focused on the negative impacts of tourism in Manali, where pollution, habitat loss, and pressure on natural resources are significant concerns. The authors emphasize the need for sustainable tourism practices and strict enforcement of environmental regulations to protect the region's natural beauty for future generations. Himachal Pradesh is a widely recognized tourism destination, known for its stunning natural landscapes and a variety of attractions that draw visitors from both India and abroad. Tourists can indulge in activities such as camping, trekking, adventure sports, religious tourism, eco-tourism, wildlife safaris, white-water rafting, yoga, and participation in cultural festivals. Here are some of the most notable tourist destinations.

Mandi: Established in 1948 from the merging of Mandi and Suket princely states, Mandi is situated along the Beas River and is often called "Chhoti Kashi" for its cultural and religious significance. It serves as a gateway to popular valleys like Kullu and Lahaul-Spiti.

Shimla: Known as the "Queen of Hills," Shimla became the capital of Himachal Pradesh in 1966. It attracts tourists year-round for its serene environment and is easily accessible by road, rail, and air.

Kufri: A small town located about 17 kilometres from Shimla, Kufri is popular for activities like trekking, skiing, and yak-riding. The Himalayan Nature Park and Indira Tourist Park are key attractions.

Rewalsar: A spiritual destination in Mandi district, Rewalsar is significant for Hindus, Sikhs, and Buddhists. It is known for its lake with floating islands and religious landmarks like monasteries and the Lomas Rishi Temple.

Dharamshala: Nestled in the Dhauladhar mountain range, Dharamshala is the administrative center of Kangra district and home to the Dalai Lama. It is often referred to as "Little Lhasa" due to its Tibetan culture.

Kullu and Manali: Known as the "Valley of Gods," Kullu is famous for its apple orchards, temples, and the international Dussehra festival. Manali, located in Kullu district, is one of India's most picturesque hills stations.

Chamba: Located in the Shivalik ranges, Chamba is famous for its ancient temples and the globally recognized Minjar fair.

Kangra: This town, located at the base of the Dhauladhar range, is famous for its ancient temples and scenic beauty, attracting thousands of visitors annually.

Other Attractions

Several other tourist spots in Himachal Pradesh include Chail, Kasauli, Lahul-Spiti, Kinnaur, and Bilaspur. These destinations offer a mix of cultural and natural experiences, drawing tourists throughout the year (Attri and Kaushal, 2019).

Tourist arrivals in Himachal Pradesh increased from 15.1 million in 2022 to 16 million in 2023, despite disruptions caused by heavy rainfall, floods and landslides. In the first half of 2023, the state welcomed over 10 million visitors, including 9,978,504 domestic tourists and 28,239 international tourists, reflecting a 6% rise in total arrivals compared to the previous year. Himachal Pradesh Tourism Development Corporation Ltd (HPTDC) reported earnings of ₹71.4 crore by November 2023, underscoring the significance of tourism to the state's economy. Tourism accounts for approximately 7% of the state's GDP. The tourism department has registered 4,610 hotels and 3,870 homestays, offering a total bed capacity of 1,25,862 and 23,846 beds, respectively.

Industrialization

Since the economic reforms, numerous Indian states have increasingly prioritized industrial development. However, most existing literature primarily focuses on national or major state perspectives, with limited studies examining industrial growth in emerging economies like Himachal Pradesh. This study, therefore, explores the industrial policies implemented by the Government of Himachal Pradesh and evaluates the growth and structure of its industrial sector at both the aggregate and district levels. Himachal Pradesh is emerging as a significant player in the industrial landscape, with the state government establishing institutions like the Department of

Industries, HPSIDC, HPFC, HPSHHC, HPCED, and other key agencies to promote industrialization. Moreover, several industrial policies have been introduced to foster industrial development within the state. These organizations and policies have played a crucial role in expanding industrial capacity with the aim of positioning Himachal Pradesh as a prominent industrial hub in India.

Despite the state's efforts, disparities in industrial growth across districts remain a significant concern. There is a growing divide between more developed and less developed districts. The advanced districts account for over 95% of industrial units, employment, and investments in large and medium-scale sectors, while about 70% of such activities are concentrated in small-scale sectors in less developed districts. Among the more developed districts, Solan, Sirmour, and Una have emerged as highly industrialized, mainly due to their proximity to neighboring states like Punjab, Haryana, Uttarakhand, and the Union Territory of Chandigarh. The special incentive packages announced by the government in 2003 for Himachal Pradesh and Uttarakhand have further attracted businesses to these border districts, benefiting from better access to raw materials and improved road and rail connectivity with neighbouring states and Chandigarh. These districts receive similar policy incentives and concessions as other districts in the state, contributing to their significant industrial development (Kumar and Pattanaik, 2017).

Data

Himachal Pradesh's industrial sector has experienced substantial growth, averaging an 8% growth rate over the past four years. The state has made significant progress in industrialization in recent years.

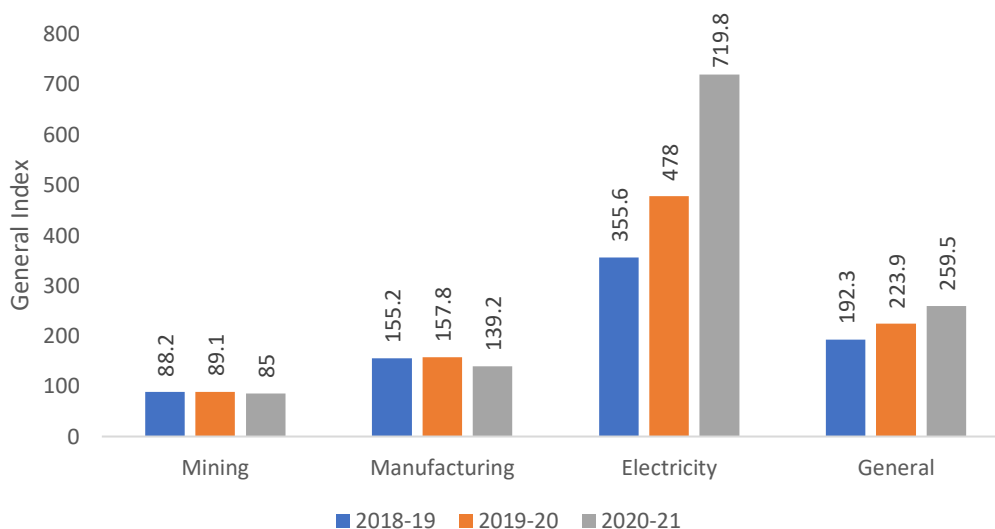


Fig. 4. Index of industrial growth in Himachal Pradesh
(<https://hpgeneralstudies.com/industrialization-in-the-state-of-himachal-pradesh-hpas-mains/>)

According to data from March 31, 2016, there were 40,150 small-scale units with a total investment of Rs. 7,164.34 crores, providing employment to approximately 2,25,889 individuals. Additionally, there were 505 medium and large-scale enterprises with investments amounting to Rs. 11,879.16 crores, employing around 61,040 people.

Table 1. Recent Index of Industrial Growth in Himachal Pradesh for 2023

Sector	Annual Growth Rate (%)	Key Drivers
Overall Industrial Growth	7.5	Overall growth driven by multiple sectors
Manufacturing Sector	7.9	Pharmaceutical, Textile, Food Processing
Electricity Sector	8.0	Hydropower production and expansion
Mining Sector	1.5	Limited growth due to restricted mining activity

(<https://hpgeneralstudies.com/industrialization-in-the-state-of-himachal-pradesh-hpas-mains/>)

Mining

Mining and industrial activities have had profound environmental and health impacts in Himachal Pradesh. (Prasad and Bose, 2001) observed that while limestone mining is prevalent in the region, it has not led to heavy metal contamination in spring and surface water, suggesting that water remains safe for drinking. However, (Kamaldeep et al., 2011) found that industrial activities have contaminated groundwater, leading to high levels of heavy metals and potential health risks. The

authors recommend strict controls on industrial waste, regular monitoring of groundwater, and the installation of water treatment plants. (Kumar and Shankhan, 2017) traced the significant growth in industrial development in Himachal Pradesh to liberalization policies, with the highest growth occurring between 2002 and 2012. They suggest that the state government should continue formulating effective industrial development policies and offering incentives to attract more entrepreneurs, while ensuring that environmental regulations are strictly enforced to prevent further degradation. Himachal Pradesh has made significant strides in industrialization, particularly after the economic reforms that encouraged state-level industrial development. This shift has been driven by policies implemented by the Government of Himachal Pradesh, aimed at boosting industrial growth both at the aggregate and district levels.

The state has established key institutions like the Department of Industries, Himachal Pradesh State Industrial Development Corporation (HPSIDC), and Himachal Pradesh Financial Corporation (HPFC) to support this growth. These organizations have been instrumental in promoting industrial activities and turning the state into a growing industrial hub. Despite these advancements, the industrial growth across the state's districts remains uneven. More developed districts, such as Solan, Sirmour, and Una, have seen over 95% of industrial units, investments, and employment opportunities concentrated in large and medium-scale sectors. These districts benefit from their proximity to neighbouring states like Punjab, Haryana, and Uttarakhand, which provide better access to raw materials and transport connectivity. The 2003 special incentive package for Himachal Pradesh and Uttarakhand further boosted industrial activity in these border regions. From an economic perspective, the industrial sector in Himachal Pradesh has grown at an average rate of about 8% over the last four years. As of March 31, 2016, the state had 40,150 small-scale units with investments totalling ₹7,164.34 crores, providing employment to over 225,000 people. Additionally, there were 505 medium and large-scale enterprises, with total investments of ₹11,879.16 crores, employing approximately 61,040 individuals. The table provided shows district-wise data on the area under limestone quarrying in Himachal Pradesh up to 2016. The districts included are Sirmour, Bilaspur, Solan and Mandi.

Table 2. District Wise Area Under Limestone Quarrying up to 2016 (area in Hectares) (Nath and Singh, 2020)

District	Working Mines (Number)	Working Mines (Area in Hectares)	Non-Working Mines (Number)	Non-Working Mines (Area in Hectares)	Total Mines (Number)	Total Mines (Area in Hectares)
Sirmour	18	296	20	180	38	476
Bilaspur	1	231	Neg.	Neg.	1	231
Solan	2	793	1	233	3	1026
Mandi	Neg.	Neg.	1	726	1	726
Total	21	1320	22	1139	43	2459

Conclusion

Anthropogenic activities in Himachal Pradesh, such as road construction, tourism, industrialization, and mining, present both opportunities and challenges for the region. While these activities can boost economic growth, provide infrastructure, and improve livelihoods, they also pose significant risks to the environment and local communities. Deforestation, habitat fragmentation, pollution, and social displacement are critical concerns that need to be addressed through sustainable practices and strict regulatory frameworks. The balance between development and environmental conservation is crucial to ensure that the natural beauty and resources of Himachal Pradesh are preserved for future generations. Thoughtful planning, community engagement, and a commitment to sustainability will be key to maximizing the positive impacts of human activities while minimizing their negative effects on both the environment and society.

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GKW, PD and DC conceived the concept, wrote and approved the manuscript.

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Competing interest

The authors declare no competing interests.

Ethics approval

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