

Tourism Infrastructure, Landslides and Disaster Risk

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Abstract

Original Research Article

Tourism in Himachal Pradesh depends heavily on safe roads, reliable energy systems, stable slopes, functioning hotels and homestays and visitor confidence in destination safety. Yet the state's mountainous terrain and increasing exposure to climate-induced hazards make tourism infrastructure highly vulnerable to landslides, flash floods, cloudbursts, heavy rainfall, heatwaves, water stress and energy supply interruptions. This study examines the relationship between tourism infrastructure, landslide susceptibility and disaster risk in Himachal Pradesh. The study analyses district-wise landslide, cloudburst and flash flood incidents in 2023 and evaluates their implications for road access, tourist safety, business continuity, maintenance costs, energy reliability and local livelihoods. The findings show that landslides were the most widespread hazard in 2023, with 5,480 recorded incidents, led by Kullu and Shimla, while flash floods and cloudbursts showed distinct district-level patterns. It further argues that disaster risk in Himachal Pradesh's tourism sector is not only a natural hazard problem, it is also an infrastructure governance problem. Resilient tourism requires landslide susceptibility mapping, climate-sensitive road planning, early warning systems, disaster-preparedness protocols, stable energy supply, sustainable construction practices, community participation and destination-specific risk management. It concludes that tourism infrastructure must be planned as climate-resilient public infrastructure rather than as isolated visitor facilities.

Keywords: Himachal Pradesh; tourism infrastructure; landslides; disaster risk; flash floods; climate resilience.

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1. INTRODUCTION

Tourism in Himachal Pradesh is deeply dependent on infrastructure. Roads, bridges, hotels, homestays, restaurants, power supply, water systems, communication networks, recreational facilities, parking areas, trails and emergency services form the physical base of the tourism economy. Without safe access and reliable services, even highly attractive destinations can lose visitors. In a mountain state, however, infrastructure is not merely a development asset, it is also a site of risk. Roads pass through steep slopes, hotels and settlements expand in fragile terrain, tourist routes depend on weather-sensitive corridors and seasonal visitor pressure increases demand for transport, energy, water and maintenance.

The relationship between tourism infrastructure and disaster risk has become increasingly important in Himachal Pradesh because climate change is intensifying existing vulnerabilities. Heavy rainfall, landslides, cloudbursts, flash floods, glacial retreat, heatwaves and altered precipitation patterns disrupt tourist mobility and destination functioning. These hazards damage roads and

buildings, interrupt energy supply, strand tourists, reduce footfall, raise safety concerns, increase repair costs and create uncertainty for tourism-dependent communities. Tourism infrastructure therefore sits at the intersection of economic development and climate risk.

Himachal Pradesh has been identified as one of India's most vulnerable states to natural and climate-induced disasters (Chakraborty & Joshi, 2014). Its mountainous terrain increases exposure to landslides and flash floods, while fragmented habitats, restricted ecological ranges and topographic constraints make adaptation more difficult (Hughes, 2010). The state's vulnerability is also regionally differentiated. Districts such as Kullu, Shimla, Chamba, Mandi, Kinnaur and Kangra face different combinations of landslides, flash floods, altered precipitation, glacial retreat and water stress (Ugupta *et al.*, 2013). These vulnerabilities matter for tourism because the sector relies on safe access, predictable routes, functional accommodation and environmental stability.

The tourism sector has expanded rapidly in Himachal Pradesh and contributes to employment and economic prosperity (Thakur, 2023). However, the same expansion increases the importance of risk-sensitive infrastructure planning. Adventure tourism, trekking, rural tourism and high-altitude tourism bring visitors into areas where road networks, slopes, weather systems and emergency access can be fragile. If infrastructure development does not consider climate and geophysical risks, tourism growth can become vulnerable to repeated disruption.

This study examines tourism infrastructure, landslides and disaster risk in Himachal Pradesh. It focuses on district-wise landslide, cloudburst and flash flood incidents and the climate vulnerability related to tourism infrastructure and disaster risk.

2. Research Problem and Objectives

The central research problem is that tourism infrastructure in Himachal Pradesh is increasingly exposed to climate-induced hazards, especially landslides, flash floods, cloudbursts and related disruptions. Tourism development depends on mobility, accommodation, energy and visitor safety, but the mountainous and climate-sensitive geography of Himachal Pradesh makes these systems vulnerable. When roads close, energy systems fail, water becomes scarce or extreme events damage infrastructure, the impact extends beyond physical assets. Tourism businesses lose revenue, tourists face safety risks, workers lose income and local communities experience economic instability.

The study has four objectives. First, it analyses the district-wise pattern of landslide, cloudburst and flash flood incidents in Himachal Pradesh in 2023. Second, it examines how these hazards affect tourism infrastructure, especially roads, hotels, recreational facilities and energy supply. Third, it discusses the broader socio-economic consequences of disaster risk for tourism businesses, local communities and destination reliability. Fourth, it identifies risk-reduction strategies for building climate-resilient tourism infrastructure in Himachal Pradesh.

3. METHODOLOGY

This study is based on a qualitative research design that relies entirely on secondary sources for data collection. The secondary sources include reports, policy documents, statistical data and research studies published by governmental bodies such as the Himachal Pradesh Tourism Department, the Ministry of Statistics and Programme Implementation (MoSPI) and the Ministry of Environment, Forest and Climate Change (MoEFCC). In addition, data from reputable non-governmental institutions, including research organisations and international development agencies, were utilised to supplement the analysis. The data

analysis primarily involved thematic analysis, in which key trends, patterns and linkages between tourism, construction, human development and climate change impacts were identified and critically examined. This ensures a comprehensive and multidimensional understanding of the issues, while maintaining the credibility and reliability of the findings.

4. Disaster Vulnerability in Himachal Pradesh's Tourism Geography

Himachal Pradesh's disaster vulnerability emerges from the interaction of terrain, climate, infrastructure and development pressure. The state's mountainous topography creates natural exposure to landslides and flash floods. Climate change then intensifies this exposure through altered precipitation patterns, extreme rainfall, glacial retreat and rising temperatures. Tourism adds another layer because visitor mobility and tourism facilities depend on infrastructure that is often located in or passes through hazard-prone zones.

The study identifies several vulnerable districts. Chamba is susceptible to altered precipitation patterns which increase the risk of landslides and flash floods (Upgupta *et al.*, 2013). Kullu, a major tourism district faces risks from glacial retreat and changing precipitation, which create concerns for water availability and flood risk (Upgupta *et al.*, 2013). Shimla frequently experiences heavy rainfall and landslides that disrupt daily life and tourism activity (Upgupta *et al.*, 2013). Mandi faces challenges related to precipitation shifts, glacial retreat, water-resource management and landslide risk (Upgupta *et al.*, 2013). Kangra is prone to heavy rainfall and drought affecting both agriculture and tourism activities (Upgupta *et al.*, 2013).

These district vulnerabilities show that disaster risk is not evenly distributed. Different districts face different hazard combinations and therefore require different infrastructure responses. A tourism route in Kullu may need glacial-risk and flood preparedness. A road corridor in Shimla may require slope stabilisation and rainfall-linked warning systems. Chamba may require integrated planning for precipitation change, flash floods and tourism access. Kangra may need systems that address both heavy rainfall and drought-related stress. A uniform tourism infrastructure strategy would therefore be inadequate.

Himachal Pradesh's vulnerability also reflects the broader challenge of mountain development. Road networks are essential for tourism but can also become vulnerable points. Hotels and recreational facilities improve visitor capacity but can be exposed to slope instability, drainage problems and water stress. Energy supply is necessary for tourist comfort and business continuity, yet extreme weather can interrupt power systems. Tourism infrastructure must therefore be understood as a connected system, not as separate assets.

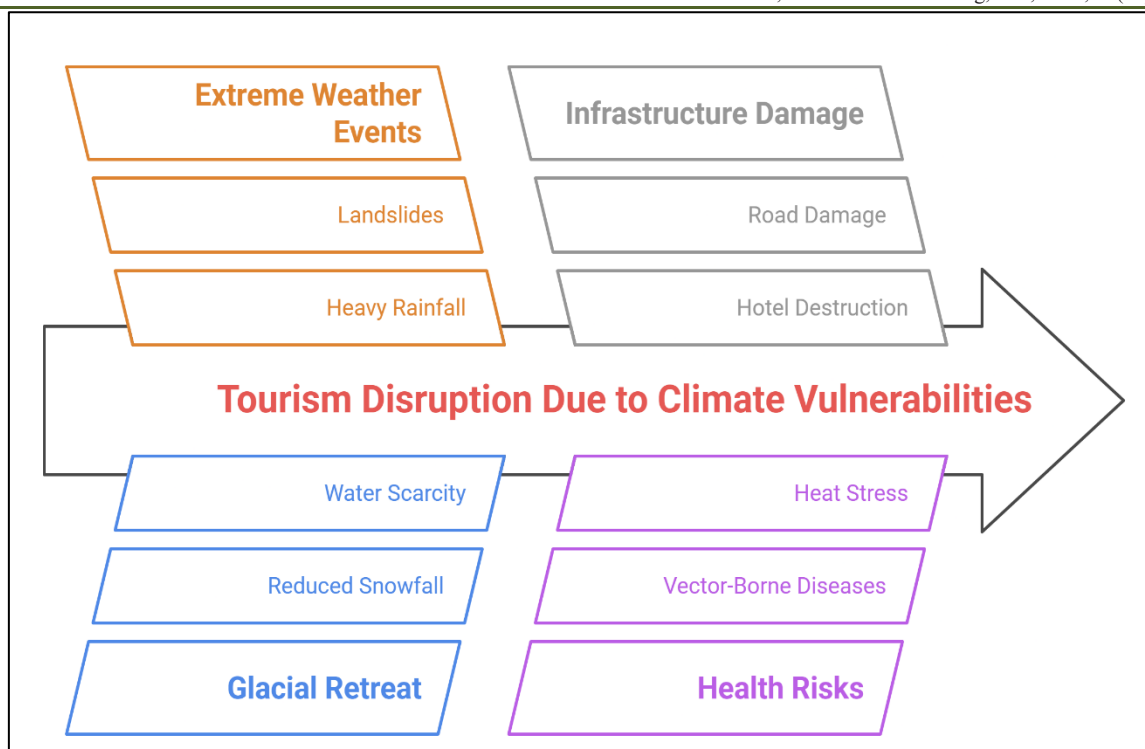


Figure 1: Climate Vulnerabilities Impacting Tourism in Himachal Pradesh

Figure 1 illustrates how multiple hazards affect tourism. Heavy rainfall, landslides, flash floods, glacial retreat, snowfall change, water scarcity, health risks and infrastructure damage interact to reduce destination reliability. It shows that tourism vulnerability is multi-dimensional. A landslide may close a road, but it can also trigger cancellations, reduce tourist confidence, damage facilities, raise maintenance costs and affect local incomes. Similarly, water scarcity is not simply an environmental concern, it affects hotels, restaurants, households and visitor satisfaction.

5. District-Wise Pattern of Landslides, Cloudbursts and Flash Floods

The State Emergency Operation Centre and District Control Rooms recorded significant natural

disaster impacts across Himachal Pradesh during 2023. Landslides were the most widespread hazard, with 5,480 incidents recorded across the state. Kullu reported the highest number of landslides with 2,600 cases, followed by Shimla with 1,960 incidents. Kinnaur, Chamba and Mandi also recorded significant landslide activity, while Hamirpur and Una recorded none. Cloudbursts were fewer in total but geographically concentrated with 14 incidents during the monsoon season. Kullu alone accounted for 12 cloudbursts while Shimla and Solan recorded one each. Flash floods were also significant with 83 incidents across the state. Kangra recorded the highest number of flash floods with 25 incidents, followed by Kullu with 20 and Lahaul-Spiti with 12 (Sphere India, 2023).

Table 1: District-wise Landslide, Cloudburst and Flash Flood Incidents in Himachal Pradesh (2023)

S. No.	Name of District	Landslide Incidents	Cloudburst Incidents	Flash Flood Incidents
1	Bilaspur	03	0	01
2	Chamba	241	0	04
3	Hamirpur	00	0	01
4	Kangra	02	0	25
5	Kinnaur	257	0	01
6	Kullu	2600	12	20
7	Lahaul & Spiti	13	0	12
8	Mandi	203	0	10
9	Shimla	1960	01	05
10	Solan	184	01	0
11	Sirmaur	17	0	03
12	Una	00	0	01
Total		5480	14	83

Source: Sphere India, 2023

Table 1 shows that landslide risk is particularly concentrated in Kullu and Shimla. Together, these two districts account for the overwhelming majority of recorded landslides. This is significant for tourism because both districts are important tourist regions. Kullu is associated with adventure, snow, nature and high visitor movement, while Shimla is a major hill destination and administrative centre. High landslide incidence in these districts means that tourism infrastructure cannot be planned without slope stability assessment, road monitoring, drainage management and emergency response systems.

Kullu's risk profile is especially notable because it records high numbers across all three hazards, 2,600 landslides, 12 cloudbursts and 20 flash floods. This suggests that Kullu requires an integrated disaster-risk framework rather than separate responses for separate hazards. A road or tourism facility in such a district may face slope failure, intense rainfall, drainage overload, flash flooding and access disruption within the same risk environment. Tourism development in Kullu must therefore be guided by multi-hazard planning.

Shimla's 1,960 landslide incidents indicate serious slope and rainfall-related vulnerability. As a major destination, Shimla's tourism economy depends on access, mobility, accommodation, public services and visitor confidence. Landslide risk in Shimla affects not only roads but also urban services, hotels, parking areas, pedestrian movement and emergency access. The data therefore point to the need for urban tourism resilience, not only rural or high-altitude risk planning.

Kangra presents a different pattern. It records only two landslides but 25 flash flood incidents, the highest in the state. This indicates that tourism risk in Kangra may be more hydrological than slope-dominated in the 2023 dataset. Infrastructure planning in Kangra should therefore pay particular attention to drainage, river systems, flood forecasting, safe siting of tourist facilities and visitor movement during intense rainfall. Lahaul-Spiti, with 12 flash floods and 13 landslides, also requires attention because remote and high-altitude areas may have limited emergency access.

Table 1 demonstrates why region-specific disaster risk reduction is necessary. Landslide-heavy districts, flash-flood-prone districts and cloudburst-sensitive districts require different types of planning. A single disaster policy may provide broad guidance, but tourism infrastructure must be planned at district and destination scale. The same tourist safety protocol cannot fully address the needs of Kullu, Shimla, Kangra, Chamba, Kinnaur and Lahaul-Spiti without local hazard mapping.

6. Landslides and Tourism Infrastructure Disruption

Landslides are among the most significant threats to tourism infrastructure in Himachal Pradesh. Road infrastructure is particularly susceptible to landslides in areas with high altitude, complex lithology, steep slopes and changing climatic conditions (Youssef *et al.*, 2023). The distance to roads is an influential factor in landslide susceptibility, followed by slope (Basheer & Oommen, 2024). This is especially important for tourism because roads are the main access routes to mountain destinations. A road that enables tourism can also be located in landslide-prone terrain.

Climate change projections indicate increased heavy rain, flooding and landslides (Nguyen *et al.*, 2024). The combined effect of climate change and urban expansion can increase landslide occurrence more than either factor considered separately (Bozzolan *et al.*, 2022). This is directly relevant to Himachal Pradesh, where tourism expansion can generate demand for roads, parking, accommodation, restaurants and other facilities. If tourism-related development expands in hazard-prone areas without risk assessment, it can increase exposure to landslides.

During the heavy rainfall event in July 2023, more than 1,300 roads were closed due to landslides, leaving thousands of tourists stranded and causing widespread delays and cancellations (Petley & Petley, 2024). This example shows how landslide risk travels through the tourism economy. The initial event may be slope failure, but the consequences include road closure, tourist stranding, trip cancellation, delayed supply movement, business losses, reputational damage and increased pressure on local administration.

Landslides affect tourism infrastructure in at least five ways. First, they disrupt access by blocking roads and isolating destinations. Second, they damage roads, bridges, retaining walls, parking areas and nearby facilities. Third, they increase maintenance and repair costs. Fourth, they raise safety concerns for tourists and local residents. Fifth, they reduce destination reliability which can affect future visitor decisions. These impacts show that landslide management is not only an engineering issue; it is a tourism governance issue.

Landslide risk also affects adventure and trekking tourism. Emerging tourism niches in Himachal Pradesh increasingly take visitors into higher-altitude and terrain-sensitive areas (Thakur, 2023). Adventure tourism can generate income but it also depends on route safety, weather information, communication networks, trained guides, rescue capacity and emergency evacuation systems. If adventure circuits expand without disaster-risk planning, both visitors and local workers are exposed to danger.

7. Cloudbursts, Flash Floods and Hydrological Risk

While landslides dominate the 2023 incident data, cloudbursts and flash floods also present major tourism risks. Cloudbursts are intense rainfall events that can trigger slope failure, drainage collapse, sudden flooding and road disruption. Kullu recorded 12 of the state's 14 cloudburst incidents in 2023 (Sphere India, 2023), making it a priority district for cloudburst preparedness. Shimla and Solan each recorded one incident showing that cloudburst risk is not limited to one district.

Flash floods present a different type of threat. They can affect river valleys, roads, bridges, campsites, adventure tourism routes, pilgrimage pathways and settlements located near streams or drainage channels. In 2023, Kangra recorded the highest number of flash floods, followed by Kullu, Lahaul-Spiti, Mandi, Shimla, Chamba, Sirmaur, Bilaspur, Hamirpur, Kinnaur and Una (Sphere India, 2023). This spread indicates that flash floods are not isolated events, they are a recurring hydrological vulnerability across multiple districts.

Flash flood risk is especially relevant for tourism because many tourism activities occur near rivers, valleys, trails and scenic water bodies. Campsites, adventure tourism operators, local markets, roadside restaurants, bridges and parking areas may be located close to drainage channels or riverbanks. When rainfall is intense, such locations can become hazardous quickly. Tourism planning must therefore include floodplain awareness, safe siting of facilities, evacuation routes, rainfall monitoring, visitor advisories and restrictions on high-risk activities during severe weather periods.

Cloudbursts and flash floods also affect destination image. Even if only one part of a district is affected, tourists may cancel trips to the larger destination. This means that communication is critical. Accurate information about road conditions, safe areas, closed routes and emergency advisories can reduce panic and support responsible decision-making. Poor communication can either expose tourists to risk or unnecessarily damage tourism livelihoods through avoidable cancellations.

Hydrological risk is also connected to water management. Climate vulnerability in Himachal Pradesh includes changes in precipitation, glacial retreat and water scarcity (Ugupta *et al.*, 2013). Tourism operations require water for hotels, restaurants, sanitation and visitor services. Extreme rainfall and water scarcity may appear opposite, but both can occur within the same climate-risk system. Heavy rainfall can cause flash floods and infrastructure damage, while altered precipitation and glacial retreat can affect water availability. Tourism infrastructure must therefore be designed for both excess water and water scarcity.

8. Energy Supply Interruptions and Destination Reliability

Tourism infrastructure depends on reliable energy. Hotels, resorts, homestays, restaurants, transport systems, lighting, heating, cooling, communication, digital bookings and safety systems all require stable power supply. The energy supply interruptions as a significant challenge for Himachal Pradesh's tourism infrastructure. Power outages affect essential services such as heating, cooling and lighting in hotels, resorts and other tourism establishments (Sood, 2025; Manisha *et al.*, 2023).

Energy interruptions affect tourist experience. Visitors expect basic comfort and safety, especially in mountain destinations where weather conditions may be cold, wet or unpredictable. Frequent power outages can reduce satisfaction, increase complaints and discourage repeat visits. For businesses, outages increase operational costs because establishments may need backup power systems. They can also disrupt food storage, water pumping, digital payment systems, booking platforms, communication with guests and emergency operations.

The energy issue is closely connected to disaster risk. Landslides, floods, heavy rainfall and storms can damage power lines, block access for repairs or interrupt supply chains. When energy systems fail during or after a disaster, tourism businesses face compounded disruption. A hotel may have road access but no power, a homestay may have guests but no heating, an emergency response system may be weakened by communication failure. Tourism resilience therefore requires energy resilience.

The sustainable energy solutions such as solar and wind energy can reduce dependence on traditional energy sources and improve reliability (Sood, 2025; Manisha *et al.*, 2023). For tourism destinations, decentralised renewable systems can provide backup capacity, especially in remote areas. Solar lighting, solar water heating, battery backup, microgrids and energy-efficient design can reduce vulnerability to power interruptions. Such measures are particularly important for homestays, small hotels, remote trekking facilities and emergency shelters.

Energy reliability should be considered part of destination planning. Tourism infrastructure approval should assess whether facilities have safe electrical systems, backup capacity, energy-efficient design and disaster-ready communication. Renewable energy should not be treated only as a sustainability measure, it is also a risk-reduction measure.

9. Socio-Economic Consequences of Infrastructure Disruption

The impacts of landslides, flash floods, cloudbursts and energy interruptions extend beyond physical infrastructure. They affect businesses, workers, tourists and local communities. Road closures reduce

tourist arrivals, create cancellations and disrupt supply chains. Damage to hotels, roads, trails and recreational facilities increases maintenance costs. Power outages increase operational expenses. Repeated hazards reduce tourist confidence and can affect destination reputation.

Tourism businesses are particularly sensitive to disruption because income depends on visitor movement. If tourists cannot reach a destination, hotels, restaurants, guides, transport providers, vendors, photographers and local shops lose income. Even short disruptions during peak season can have significant financial effects. Small businesses may be less able to absorb cancellations, repair costs or backup power expenses. Therefore, disaster risk can deepen economic vulnerability.

Local communities also experience indirect impacts. Tourism provides income and employment, but disaster disruption can reduce livelihood opportunities. Communities may face damaged roads, interrupted power, higher repair costs, reduced business activity and lower quality of life (Manisha *et al.*, 2023; Sood, 2025; Petley & Petley, 2024). In this sense, tourism infrastructure is also community infrastructure. Roads that serve tourists also serve residents, power systems that support hotels also support households, disaster preparedness that protects visitors also protects local people.

The relationship between tourist safety and community well-being is therefore important. When tourists are stranded, local communities often become part of the response system, providing shelter, food, information, transport support or informal assistance. If communities themselves are under-resourced, disaster response becomes more difficult. Tourism risk management should therefore include local residents as stakeholders, not only tourists and businesses.

Infrastructure disruption also affects public expenditure. Frequent repairs to roads, retaining walls, bridges, drainage systems and public facilities require funds that could otherwise be used for development. If infrastructure is repeatedly damaged because it is not climate-resilient, long-term costs increase. Investing in resilient infrastructure may appear expensive initially, but repeated repairs, economic losses and safety risks can be more costly over time.

10. Risk Reduction and Resilient Tourism Infrastructure

The study identifies several strategies for reducing disaster risk in tourism infrastructure. These include resilient infrastructure, early warning systems, diversification of tourism offerings, landslide susceptibility mapping, stable energy supply, sustainable energy solutions, community participation and disaster preparedness (Pebam *et al.*, 2024; Dharna & Vyas, 2022;

Jangra & Jattan, 2024; Mohan, 2025; Sood, 2025; Manisha *et al.*, 2023; Petley & Petley, 2024).

Landslide susceptibility mapping is a key tool. The study notes the importance of developing landslide susceptibility maps and using approaches that consider land cover and climate change (Youssef *et al.*, 2023; Bozzolan *et al.*, 2022). Such mapping can help identify which roads, slopes, settlements, tourist facilities and proposed development zones are at risk. It can guide where construction should be avoided, where slope stabilisation is needed, where monitoring systems should be placed and where emergency routes should be developed.

Early warning systems are equally important. Warnings for landslides, heavy rainfall, flash floods, cloudbursts and extreme weather can help authorities, tourism operators, transport providers and tourists make timely decisions. Early warnings should be connected to clear protocols. A warning is useful only if hotels know what to do, transport operators receive route updates, tourists receive advisories and local authorities can coordinate evacuation or closure. Communication systems should therefore be integrated across departments and tourism networks.

Resilient road planning is central to tourism infrastructure. Roads should be designed and maintained with slope stability, drainage, retaining structures, weather monitoring and emergency clearance in mind. Tourism routes should have alternative access where possible. High-risk corridors should be monitored during monsoon periods. Parking and roadside facilities should not be placed in unstable zones. Road planning must also consider the cumulative effect of tourism traffic, construction activity and rainfall.

Energy resilience should be integrated into tourism infrastructure. Solar and wind solutions, backup systems, energy-efficient buildings and decentralised power options can reduce operational vulnerability (Sood, 2025; Manisha *et al.*, 2023). For hotels, homestays and remote tourism facilities, energy reliability affects safety, comfort, communication and business continuity. Energy planning should therefore be included in disaster-resilient tourism policy.

Community participation is also essential. Local communities understand terrain, seasonal patterns, risky routes, drainage behaviour and past disaster experiences. Engaging communities in decision-making and disaster preparedness can strengthen resilience and create more coordinated responses (Manisha *et al.*, 2023; Sood, 2025; Petley & Petley, 2024). Community participation also helps ensure that tourism infrastructure serves local needs rather than only visitor demand.

11. From Tourism Infrastructure to Risk Governance

The analysis shows that disaster risk in Himachal Pradesh's tourism sector is not only a hazard problem. It is a governance problem. Landslides, flash floods and cloudbursts may be natural or climate-induced events, but their impacts depend on where roads are built, how slopes are managed, how hotels are sited, whether warnings are communicated, how energy systems are secured and whether communities are involved in preparedness. Tourism infrastructure is therefore a product of planning choices.

A risk-governance approach would treat tourism infrastructure as part of a wider mountain system. Roads, hotels, drainage, energy, water, waste, communication and emergency services must be planned together. If roads are strengthened but drainage is ignored, flash flood risk may persist. If hotels install backup power but road access remains unsafe, tourists may still be stranded. If early warnings exist but tourists and operators do not receive them, risk remains high. Fragmented planning weakens resilience.

The district analysis indicate the need for differentiated governance. Kullu requires multi-hazard governance because it records high landslide, cloudburst and flash flood incidents. Shimla requires slope and urban tourism resilience because of high landslide incidence. Kangra requires stronger flash-flood planning. Chamba, Kinnaur, Mandi and Lahaul-Spiti require risk-sensitive planning linked with terrain, precipitation, glacial changes and access limitations. District-level tourism planning should therefore be based on hazard profiles.

Risk governance also requires coordination among departments. Tourism, public works, disaster management, energy, environment, rural development, urban local bodies, forests, transport and local governments must work together. Tourism departments may promote destinations, but public works departments manage roads, energy agencies manage supply, disaster authorities manage warnings and local bodies manage services. Without coordination, tourism growth can exceed infrastructure resilience.

Another important issue is timing. Disaster risk is seasonal, but tourism planning often focuses on annual growth. Monsoon periods require special protocols for road monitoring, visitor advisories, construction restrictions, slope inspections and emergency staffing. Winter periods may require snow and road-safety planning. Peak tourist seasons require traffic management and communication. Destination management should therefore be calendar-based and hazard-specific.

A risk-governance approach also shifts the meaning of tourism infrastructure. Infrastructure is not only what enables tourists to arrive, it is what keeps tourists, workers and residents safe. A road is not only an

access route, it is an evacuation route. A hotel is not only accommodation, it may become a shelter during disruption. A communication network is not only for bookings, it is also for warnings. A power system is not only a comfort service, it supports safety, heating, lighting and emergency response.

12. Recommendations

First, Himachal Pradesh should prepare district-specific tourism disaster-risk profiles. These profiles should identify landslide-prone roads, flash-flood-sensitive valleys, cloudburst-prone areas, energy-supply vulnerabilities, tourist concentration zones and emergency access limitations. Kullu, Shimla, Kangra, Chamba, Kinnaur, Mandi and Lahaul-Spiti require differentiated risk plans based on their hazard patterns. Second, landslide susceptibility mapping should be integrated into tourism infrastructure planning. New roads, hotels, parking areas, viewpoints, trails, campsites and recreational facilities should be assessed for slope stability, drainage, land cover and climate risk before approval (Youssef *et al.*, 2023; Bozzolan *et al.*, 2022). Third, tourism road corridors should be made climate-resilient. Road planning should include slope stabilisation, retaining structures, drainage channels, regular inspections, emergency clearance systems, alternative routes and monsoon-specific monitoring. High-risk corridors should have real-time advisories and traffic control during extreme weather. Fourth, early warning systems should be linked directly with tourism operators. Hotels, homestays, travel agencies, taxi unions, guide associations, adventure operators and local tourism offices should receive weather and disaster alerts in usable formats. Warnings should be accompanied by clear action protocols. Fifth, energy resilience should be treated as part of tourism resilience. Tourism establishments should be encouraged to adopt solar energy, backup power systems, energy-efficient designs and emergency lighting. Remote destinations should explore decentralised renewable energy systems to reduce dependence on vulnerable supply lines (Sood, 2025; Manisha *et al.*, 2023). Sixth, disaster preparedness should be mandatory for high-risk tourism activities. Adventure tourism, trekking, camping, riverside tourism and high-altitude tourism should require risk assessment, trained staff, emergency communication, evacuation plans, first-aid capacity and weather-based closure protocols. Seventh, community participation should be institutionalised in tourism disaster planning. Local residents, panchayats, youth groups, women's groups, guides, drivers, homestay owners and business associations should be involved in identifying risk zones, preparing emergency plans and monitoring infrastructure. Eighth, post-disaster recovery planning should include tourism businesses and workers. Repairing roads is necessary, but recovery also requires support for cancelled bookings, damaged facilities, lost income, stranded tourists and local businesses facing increased operational costs. Ninth, destination communication systems should be strengthened.

Tourists should receive reliable information on road closures, weather alerts, safe routes, emergency contacts and local restrictions. Accurate communication can reduce panic, prevent unsafe travel and protect destination reputation. Tenth, tourism infrastructure should be evaluated through long-term resilience rather than short-term capacity expansion. New projects should be assessed for climate risk, maintenance burden, energy reliability, water availability and community impact before implementation.

13. CONCLUSION

Tourism infrastructure in Himachal Pradesh is increasingly exposed to landslides, cloudbursts, flash floods, heavy rainfall, heatwaves, water stress and energy interruptions. The 2023 district-wise data show that landslides were the most widespread hazard, with Kullu and Shimla recording the highest numbers. Flash floods were particularly significant in Kangra, Kullu and Lahaul-Spiti, while cloudbursts were concentrated mainly in Kullu. These patterns demonstrate that disaster risk in Himachal Pradesh is regionally differentiated and requires district-specific planning.

The study has shown that disaster risk affects tourism through multiple pathways. Landslides block roads, strand tourists, damage infrastructure, increase maintenance costs and reduce visitor confidence. Flash floods and cloudbursts threaten valleys, routes, campsites and facilities. Energy interruptions affect hotels, resorts, homestays, communication, heating, cooling and business continuity. These disruptions affect not only tourists but also workers, businesses and local communities.

The central argument is that tourism infrastructure must be planned as climate-resilient public infrastructure. Roads, hotels, energy systems, drainage, communication networks and emergency services are all part of destination safety. Resilience requires landslide susceptibility mapping, early warning systems, climate-sensitive road planning, stable energy supply, community participation and coordinated governance. Tourism growth that ignores disaster risk may create short-term economic gains but long-term vulnerability.

Himachal Pradesh's tourism future depends on its ability to align tourism development with mountain risk realities. The state cannot eliminate landslides, flash floods or extreme weather, but it can reduce vulnerability through better planning, stronger infrastructure, informed communities, reliable warnings and responsible destination management. A resilient tourism infrastructure system will protect visitors, support businesses, safeguard local livelihoods and help sustain the state's tourism economy under changing climate conditions.

REFERENCES

- Basheer, M., & Oommen, T. (2024). PyLandslide: A Python tool for landslide susceptibility mapping and uncertainty analysis. *Environmental Modelling & Software*, 177, 106055. <https://doi.org/10.1016/j.envsoft.2024.106055>
- Bozzolan, E., Holcombe, E. A., Pianosi, F., Marchesini, I., Alvioli, M., & Wagener, T. (2022). A mechanistic approach to include climate change and unplanned urban sprawl in landslide susceptibility maps. *The Science of the Total Environment*, 858, 159412. <https://doi.org/10.1016/j.scitotenv.2022.159412>
- Brenkert, A. L., & Malone, E. L. (2005). Modeling vulnerability and resilience to climate change: a case study of India and Indian states. *Climatic Change*, 72(1–2), 57–102. <https://doi.org/10.1007/s10584-005-5930-3>
- Chakraborty, A., & Joshi, P. (2014). Mapping disaster vulnerability in India using analytical hierarchy process. *Geomatics Natural Hazards and Risk*, 7(1), 308–325. <https://doi.org/10.1080/19475705.2014.897656>
- Chandel, V. B. S., & Sharma, M. R. (2024). Climate Change and Weather Extremes in Tourist Towns: Challenges for Livelihood in Himachal Pradesh, India. In *Climate Change, Vulnerabilities and Adaptation* (pp. 61–78). https://doi.org/10.1007/978-3-031-49642-4_4
- Dharna, & Vyas, A. (2022). Impact of Natural and Man-Made Disasters and Its Effect on Toppling of Tourism Industry. *Mathematical Statistician and Engineering Applications*, 71–4, ISSN: 2094-0343.
- Gunthey, J. (2023). | THE ENVIRONMENTAL IMPACT OF TOURISM ON MOUNTAIN STATES. <http://genecampaign.org/news/the-environmental-impact-of-tourism-on-mountain-states/>
- Hughes, L. (2010). Climate change and Australia: key vulnerable regions. *Regional Environmental Change*, 11(S1), 189–195. <https://doi.org/10.1007/s10113-010-0158-9>
- Jangra, M. S., & Jattan, P. (2024, August 17). *Hotter Himachal*. Down to Earth. Retrieved April 9, 2025, from <https://www.downtoearth.org.in/climate-change/hotter-himachal>
- Manisha, K., Singh, I., & Chetty, V. (2023). Investigating and analyzing the causality amid tourism, environment, economy, energy consumption, and carbon emissions using Toda–Yamamoto approach for Himachal Pradesh, India. *Environment Development and Sustainability*. <https://doi.org/10.1007/s10668-023-04252-3>
- Mohan, L. (2025, April 6). Climate change poses challenge to tourism industry in Dharamsala - The Tribune. *The Tribune*. <https://www.tribuneindia.com/news/himachal/climate-change-poses-challenge-to-tourism-industry-in-dharamsala/>
- Nguyen, D. N., Usuda, Y., & Imamura, F. (2024). Gaps in and opportunities for disaster risk reduction

- in urban areas through international standardization of smart community infrastructure. *Sustainability*, 16(21), 9586. <https://doi.org/10.3390/su16219586>
- Pebam, L., Gautam, A. K., Devi, A. A., & Kaur, M. (2024). Impact of natural disaster on the tourism possibilities case study of himachal pradesh| International Journal of Innovative Science and Research Technology. *International Journal of Innovative Science and Research Technology*, 9(3), ISSN No: 2456-2165. <https://ijisrt.com/impact-of-natural-disaster-on-the-tourism-possibilities-case-study-of-himachal-pradesh>
 - Petley, D., & Petley, D. (2024, May 29). *Landslides triggered by heavy rainfall on 7 to 14 July 2023 in Himachal Pradesh, India*. Eos. <https://eos.org/thelandslideblog/himachal-pradesh-1>
 - Sood, R. (2025, March 2). Unchecked tourism growth leading to environmental, infrastructure crisis - The Tribune. *The Tribune*. <https://www.tribuneindia.com/news/himachal/unchecked-tourism-growth-leading-to-environmental-infrastructure-crisis/>
 - Sphere India. (2023). *Situation Assessment Report – Himachal Pradesh floods – July 2023*. https://www.sphereindia.org.in/sites/default/files/2023-10/Situation%20Report_Himachal%20Pradesh_Floods_Jul23.pdf
 - Thakur, S. K. (2023). GROWTH OF TOURISM IN HIMACHAL PRADESH: A STUDY OF DISTRICT SHIMLA IN HIMACHAL PRADESH. *International Journal of Engineering Technologies and Management Research*, 10(12). <https://doi.org/10.29121/ijetmr.v10.i12.2023.1383>
 - Upgupta, S., Sharma, J., Ravindranath, N. H., & Center for Sustainable Technologies, Indian Institute of Science, Bangalore 560 012, India. (2013). CLIMATE CHANGE IMPACT AND VULNERABILITY ASSESSMENT OF FORESTS IN THE INDIAN WESTERN HIMALAYAN REGION: A REMOTE SENSING & GIS BASED STUDY OF HIMACHAL PRADESH, INDIA. In *Center for Sustainable Technologies, Indian Institute of Science, Bangalore 560 012, India* [Journal-article]. <https://hpccc.hp.gov.in/Publications/Climate%20Change%20impact%20and%20vulnerability%20assessment%20of%20forests%20in%20the%20Indian%20western%20Himalayan%20region.pdf>
 - Youssef, B., Bouskri, I., Brahim, B., Kader, S., Brahim, I., Abdelkrim, B., & Spalević, V. (2023). The contribution of the frequency ratio model and the prediction rate for the analysis of landslide risk in the Tizi N'tichka area on the national road (RN9) linking Marrakech and Ouarzazate. *CATENA*, 232, 107464. <https://doi.org/10.1016/j.catena.2023.107464>