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Original Research Article

Climate-Compatible Green Construction for Tourism Infrastructure

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Abstract: Tourism development in Himachal Pradesh depends on buildings, roads, utilities, accommodation and visitor facilities constructed within a physically fragile mountain environment. Climate change is making that dependence increasingly consequential. More intense rainfall, flash floods, landslides, heat stress, water scarcity and shifting precipitation patterns disrupt construction activity while exposing weaknesses in conventional design and land-development practices. This study examines how climate-compatible construction can reduce the vulnerability and environmental footprint of tourism infrastructure in Himachal Pradesh. The analysis distinguishes climate-compatible construction from a narrow disaster-proofing approach. It argues that resilient tourism infrastructure requires an integrated framework combining appropriate siting, slope-sensitive planning, durable drainage, locally suitable low-carbon materials, passive design, energy efficiency, retrofitting, circular material use, worker protection and enforceable building regulation. The findings show that technical solutions are constrained by weak coordination, limited monitoring, financial barriers and inconsistent enforcement. A transition towards climate-compatible tourism construction therefore depends as much on governance as on materials and engineering. The study concludes that Himachal Pradesh should treat every tourism-related construction decision as a combined mitigation, adaptation and ecological-safeguard decision.
Keywords: Climate-compatible construction; tourism infrastructure; green buildings; mountain resilience; Himachal Pradesh; climate adaptation.

1. INTRODUCTION

Tourism and construction are mutually reinforcing components of Himachal Pradesh's regional economy. Tourism creates demand for accommodation, roads, transport facilities, recreation infrastructure and public services, while construction expands access to destinations and supports the visitor economy. This relationship contributes to employment and regional development, but it also produces a difficult planning problem like the infrastructure supporting tourism is frequently located on steep slopes, in ecologically sensitive valleys and along transport corridors vulnerable to extreme weather. Development that is poorly sited or inadequately designed can intensify the very risks from which tourism infrastructure needs protection.

Climate change adds a further layer of uncertainty. Construction schedules and costs are increasingly affected by extreme rainfall, floods, landslides and heatwaves. Higher temperatures can lower labour productivity, increase cooling requirements and alter material performance, while water and raw-material scarcity can raise project costs (Aon Insights, 2023; Wunderbuild, 2023). In Himachal Pradesh, changed precipitation patterns and terrain instability require infrastructure that can endure slope movement, intense runoff, disrupted access and variable seasonal conditions. Conventional construction practices that assume relatively stable climatic baselines are consequently becoming less reliable.

At the same time, construction contributes to climate change. Cement, steel, transport logistics, land conversion and building operations generate emissions and deplete natural resources. Tourism-related construction also changes drainage, vegetation cover and slope stability. Climate compatibility must therefore address two directions of causation, firstly, infrastructure must be adapted to climatic hazards and secondly, its design and operation must reduce emissions and ecological degradation. Treating these dimensions separately risks producing buildings that survive hazards but remain energy- and resource-intensive or low-carbon facilities that are unsuited to mountain risk.

This study analyses climate-compatible green construction as a planning pathway for tourism infrastructure in Himachal Pradesh. Its central argument

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is that resilience cannot be delivered through isolated technological additions. It requires a coordinated system spanning site selection, design, materials, energy, drainage, maintenance, labour safety, regulation and institutional monitoring. The analysis remains grounded in the construction, policy and climate-action.

2. Research Problem and Objectives

The research problem arises from the mismatch between rapid tourism-linked infrastructure growth and the ecological and climatic limits of a Himalayan state. Infrastructure is needed to sustain tourism, local mobility and livelihoods, yet unplanned construction can remove vegetation, destabilise slopes, obstruct drainage, raise resource demand and expose visitors and communities to additional risk. Climate change makes these consequences more severe by increasing the frequency or intensity of disruptive weather and by shortening the useful life of infrastructure designed for earlier conditions.

The study has four objectives. First, it identifies the climate-related pressures affecting construction for tourism and connected infrastructure. Second, it examines the mitigation and adaptation value of green materials, passive design, retrofitting, drainage and resilient engineering. Third, it evaluates the policy and institutional constraints that prevent these practices from being implemented consistently. Fourth, it develops an integrated framework for aligning tourism infrastructure with climate resilience and environmental responsibility.

3. METHODOLOGY

This study follows the qualitative secondary-source methodology. The underlying evidence consists of policy documents, government and institutional reports, statistical data and research studies concerning tourism, construction, human development and climate change issued by agencies 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). The data sources was examined through thematic analysis to identify linkages among climate hazards, construction practice, tourism infrastructure, worker safety, environmental impact and public policy. The analysis approach has two boundaries. First, it is an interpretive synthesis rather than an engineering performance assessment of particular buildings. Second, it does not claim that every recommended measure is already implemented uniformly across Himachal Pradesh. It instead evaluates the practices and policy directions and considers how they form a coherent construction strategy.

4. Climate Pressures on Tourism-Related Construction

4.1 Extreme weather, schedules and project viability

Construction is highly sensitive to weather because project sequencing, material storage, excavation, slope cutting and outdoor labour all depend on workable conditions. Floods, heatwaves and extreme precipitation can damage partially completed structures, interrupt material delivery and force work stoppages. These disruptions increase costs through replacement, remobilisation, extended contracts and additional protective measures (Aon Insights, 2023; Wunderbuild, 2023). Tourism infrastructure is particularly exposed because many projects are linked to narrow mountain roads and seasonal markets. A delayed hotel, access road or public facility may miss a tourist season, converting physical disruption into revenue loss.

In Himachal Pradesh, rainfall variability and landslide risk amplify this vulnerability. Unpredictable precipitation can overwhelm drainage, produce waterlogging and destabilise cut slopes. The new projects increasingly require improved drainage, elevated or strengthened components and early-warning arrangements (Kajal, 2021; Nandi, 2023). These measures reveal an important shift like the climate resilience must enter design at the beginning of a project rather than be appended after damage occurs.

4.2 Terrain, slope disturbance and cumulative risk

Mountain construction changes the physical systems through which water and sediment move. Road widening, excavation, vegetation removal and poorly managed spoil disposal can increase runoff and weaken slope stability. A single project may appear manageable when assessed alone, but multiple hotels, roads, parking areas and utilities can create cumulative pressure across a destination. Climate-compatible planning must therefore extend beyond the structural strength of an individual building to the carrying capacity and hydrological behaviour of the wider site.

The construction of tunnels rather than repeated open slope cutting is one adaptation direction. Tunnels can reduce some forms of surface disturbance and landslide exposure when appropriately designed, although their cost, ecological implications and site suitability require careful assessment (TERI, 2015). Similarly, slope stabilisation, controlled drainage and reinforced structures can reduce risk only when supported by sound geotechnical investigation and maintenance. Engineering cannot compensate indefinitely for development permitted in unsuitable locations.

4.3 Heat, water and material performance

Rising temperatures create operational and occupational challenges. Construction workers face heat stress, while projects require more careful scheduling, hydration and shaded rest arrangements. Buildings that rely heavily on mechanical cooling may lock destinations into higher energy demand. Water scarcity also affects mixing, curing, dust suppression and worker facilities. Climate compatibility therefore requires designs that reduce both operating energy and construction-phase resource demand.

Material choice matters in two ways. It affects embodied emissions and determines how buildings respond to moisture, heat and temperature variation. The recycled steel, bamboo, green concrete and locally available materials as options for reducing environmental impact (Aon Insights, 2023; Wunderbuild, 2023). In Himachal Pradesh, locally sourced bamboo, stone and recycled materials can also reduce transport-related emissions when their extraction and use are environmentally responsible (NIDM *et al.,* 2021). No single material is automatically sustainable, suitability depends on durability, sourcing, maintenance, structural requirements and local climate.

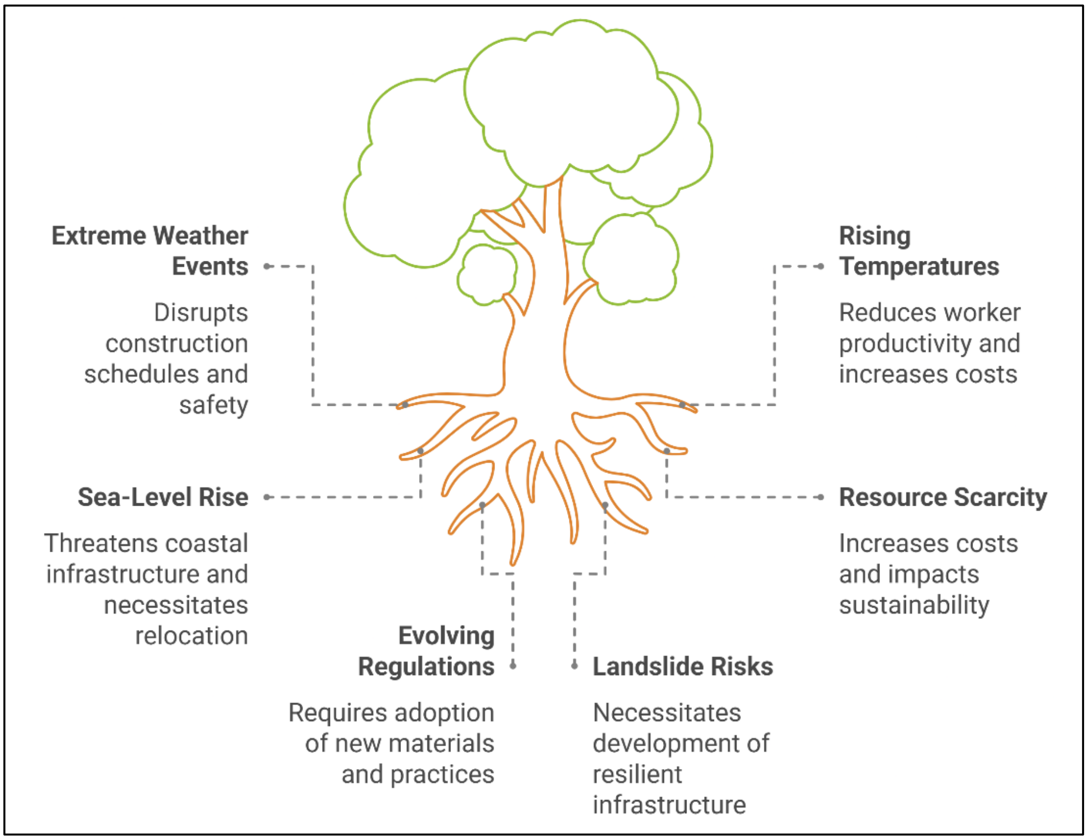

Figure 1: Climate Change Challenges in Construction Sector

Figure 1 brings together the multiple pathways through which climate change affects construction. Its value lies in showing that project risk is not confined to a single hazard. Weather, worker productivity, material performance, cost, resource availability and regulation interact. A climate-compatible construction policy must consequently avoid single-issue interventions and address the entire project lifecycle.

5. Components of Climate-Compatible Green Construction

5.1 Climate-sensitive siting and land-use control

The first principle is avoidance. Buildings should not be placed where their occupation, access requirements or drainage effects create unacceptable risk. Climate risk assessment should therefore precede land conversion and building permission. Slope, drainage, vegetation, road access, water availability and emergency evacuation must be considered together. This is especially important for tourism facilities because visitor populations fluctuate and may be unfamiliar with local hazards.

Carrying-capacity-based development is central to this approach. The Himachal Pradesh Tourism Policy links tourism growth with environmental conservation and the development of less pressured destinations (Government of Himachal Pradesh, 2019). For construction, this means that permission should depend not merely on plot-level compliance but on cumulative destination conditions. Approvals must consider whether local roads, water systems, waste facilities and emergency services can support additional accommodation or visitor infrastructure.

5.2 Passive design and operational energy efficiency

Passive solar heating, natural ventilation, shading, insulation and orientation can reduce dependence on mechanical heating and cooling (Aon Insights, 2023; Wunderbuild, 2023). These strategies are especially relevant in mountain climates where diurnal and seasonal variation is substantial. Climate-responsive envelopes can improve guest comfort while reducing energy demand and operating costs. The State Action Plan on Climate Change identifies energy-efficient building design as a priority action, creating a policy basis for such measures (Government of Himachal Pradesh, 2021).

Renewable-energy systems can complement efficiency, but they should not substitute for demand reduction. Solar or other renewable systems deliver stronger results when buildings first reduce heat loss, overheating and unnecessary consumption. Accommodation providers also need monitoring to compare predicted and actual energy performance. Without post-occupancy measurement, green design claims may remain disconnected from operating outcomes.

5.3 Resilient drainage and water management

Intense rainfall and water scarcity appear contradictory, yet mountain destinations can experience both. Climate-compatible buildings require drainage capable of handling extreme runoff as well as systems that conserve water during dry periods. Sustainable drainage, permeable surfaces, rainwater harvesting and properly maintained channels can reduce pressure on municipal networks. Flood-resistant components and protected utility systems help essential facilities remain functional during extreme events.

Water conservation should also be incorporated into construction and operation. Reuse, efficient fittings and rainwater systems can reduce demand from hotels and visitor facilities. These measures support adaptation by addressing scarcity and mitigation by lowering the energy required to pump and treat water. They are most effective when integrated with destination-scale planning rather than installed as isolated building features.

5.4 Low-carbon and circular material practices

Material production, transport and disposal account for a substantial share of the environmental burden of construction. Circular practices seek to reduce this burden by preventing waste, reusing components and selecting materials with lower lifecycle impacts. Recycled inputs, design for repair and careful construction-waste management can reduce demand for virgin resources (Aon Insights, 2023; Wunderbuild, 2023).

Local materials may reduce transport emissions and support regional livelihoods, but local sourcing must be regulated to prevent quarrying, forest pressure or landscape damage. The relevant criterion is lifecycle compatibility implies that materials should be safe, durable, repairable, appropriately sourced and suited to the local climate. Procurement rules for publicly supported tourism infrastructure can make these requirements explicit.

5.5 Retrofitting existing tourism assets

New construction represents only part of the tourism building stock. Existing hotels, guest houses and public facilities can be improved through insulation, efficient windows, renewable-energy systems, drainage upgrades and safety retrofits. Retrofitting can avoid some emissions associated with demolition and replacement while extending asset life. The improved insulation, energy-efficient windows and renewable systems as practical emission-reduction measures.

Retrofit programmes should prioritise buildings in high-risk or resource-stressed destinations. Small operators may require technical assistance and concessional finance because upfront costs can prevent adoption even where long-term savings are likely. A standardised audit covering energy, water, drainage, structural vulnerability and emergency access could guide investments.

5.6 Construction-site resilience and continuity planning

Climate compatibility must extend to the period before a building becomes operational. Construction sites contain exposed excavations, temporary power, stored materials, worker shelters and partially completed structures that can fail during intense weather. Site-specific continuity plans should identify safe material-storage areas, drainage routes, shutdown thresholds, evacuation points and responsibilities for securing equipment. Such planning can reduce damage, remobilisation costs and the release of sediment or construction waste into surrounding ecosystems.

Weather information should be incorporated into daily work planning rather than used only after an official emergency is declared. Contractors can sequence excavation and slope work outside the highest-risk periods, protect unfinished drainage and avoid leaving unstable cuts exposed before forecast rainfall. Early warnings are most useful when linked to predetermined actions. A warning without a stop-work rule, an evacuation route or a responsible decision-maker may not protect either workers or the project.

Continuity planning also requires redundancy. Tourism infrastructure frequently depends on a single road, electricity line or water source. Backup power, protected utility connections and alternative access arrangements can help essential facilities operate during disruption. However, redundancy should be proportionate and low carbon, uncontrolled diesel-generator dependence may increase emissions and local pollution. Efficient backup systems and renewable storage can connect operational resilience with mitigation.

6. Governance and Implementation Constraints

6.1 Regulation and enforcement

Green standards and resilient design have limited value without consistent enforcement. The weak monitoring, fragmented policies and non-compliance as continuing constraints (Government of Himachal Pradesh, 2021). Building permissions, environmental safeguards and tourism registration should be connected so that a facility cannot operate legally while avoiding construction or resource-use obligations.

International certification systems such as LEED and BREEAM illustrate structured approaches to energy, water, materials and environmental performance (Aon Insights, 2023; Wunderbuild, 2023). However, certification should complement rather than replace locally appropriate statutory standards. Himachal Pradesh needs requirements responsive to mountain slopes, drainage, seismic conditions, water limitations and local construction capacity.

6.2 Institutional coordination

Tourism infrastructure crosses departmental boundaries. Tourism agencies promote destinations, construction and urban bodies issue permissions, public works departments manage roads, environmental agencies protect sensitive areas and disaster authorities oversee risk. If these bodies act independently, economic promotion can outpace ecological safeguards. There is a need for stronger coordination among tourism, construction and urban-development institutions (Government of Himachal Pradesh, 2021).

A coordinated review mechanism should evaluate major tourism projects through a common climate-risk and resource-efficiency framework. Destination-level planning can also identify cumulative constraints before individual permissions are granted. Such coordination would shift governance from project approval towards territorial risk management.

6.3 Finance, skills and monitoring

Climate-compatible construction may involve higher initial design and assessment costs, although it can reduce lifecycle losses. Financial constraints are particularly important for small tourism enterprises and remote public infrastructure. Green bonds, public-private arrangements, international climate finance and targeted incentives are possible mechanisms (Government of Himachal Pradesh, 2021). These mechanisms require safeguards so that public support produces verifiable resilience and environmental benefits.

Skills are equally important. Designers, contractors, local authorities and workers need training in passive design, slope-sensitive methods, drainage, material efficiency and emergency practice. Monitoring should continue after completion, using measurable indicators for energy, water, maintenance and hazard performance. Climate-compatible infrastructure is a continuing management responsibility rather than a one-time construction label.

6.4 Maintenance and community accountability

Infrastructure resilience deteriorates when drains clog, retaining structures are not inspected, energy systems are poorly maintained or emergency routes become obstructed. Capital expenditure therefore needs a corresponding maintenance plan and budget. Approvals for tourism projects should identify who will inspect protective systems, how frequently maintenance will occur and how deficiencies will be reported. Publicly supported assets should publish basic performance and maintenance information.

Local communities can strengthen accountability because residents observe changes in springs, runoff, cracks, slope movement and traffic long before they appear in periodic institutional reviews. Participation should not be reduced to one consultation during project approval. Destination-level committees can review construction effects, operating pressures and maintenance failures over time. This continuing feedback is particularly valuable where multiple small projects cumulatively change a slope or settlement. Community involvement does not replace technical assessment, but it helps connect formal monitoring with everyday environmental knowledge.

7. DISCUSSION

The evidence shows that green construction and climate resilience are often treated as separate agendas even though their measures overlap. Passive cooling reduces emissions and heat vulnerability. Green infrastructure manages runoff while supporting carbon storage. Durable, repairable construction reduces lifecycle material use and limits disruption after hazards. Water conservation lowers resource stress and operating energy. These synergies indicate that mitigation and adaptation should be planned together (Grafakos *et al.,* 2019).

The analysis also reveals the limitations of a purely technical approach. Reinforced structures, drainage systems and efficient equipment cannot correct inappropriate siting, excessive destination density or weak enforcement. Technology may reduce the impact of individual projects while cumulative growth continues to exceed local capacity. Governance must therefore determine where construction occurs, how much is permitted and whether environmental conditions are monitored.

Tourism adds a distinctive requirement: infrastructure must serve visitors without displacing local needs. Roads, water, energy and public space cannot be assessed only through tourist demand. Climate-compatible development should improve community safety and services as well as visitor experience. This makes participation and interdepartmental coordination essential. Local knowledge can identify drainage paths, unstable slopes, seasonal water constraints and maintenance problems that may be overlooked in standard designs.

8. Policy Recommendations

First, climate-risk screening should become mandatory before approving tourism accommodation, access infrastructure or major visitor facilities. Screening should combine slope, drainage, water, vegetation, road access and evacuation conditions. Second, mountain-specific green-building standards should integrate passive design, structural resilience, sustainable drainage, water efficiency, low-carbon materials and construction-worker protection. Compliance should be tied to both building permission and tourism registration. Third, destination-scale carrying-capacity assessments should guide the total volume and location of tourism construction. Project-level approval should not ignore cumulative pressure on water, roads, waste systems and emergency services. Fourth, a retrofit programme should support existing hotels, homestays and public tourism facilities through technical audits, concessional finance and measurable energy, water and safety improvements. Fifth, procurement rules for publicly funded tourism infrastructure should prioritise durable, locally appropriate and responsibly sourced materials, construction-waste reduction and lifecycle performance. Sixth, training should be provided to local authorities, engineers, architects, contractors and workers in climate-sensitive design, slope management, heat protection and emergency preparedness. Finally, tourism, construction, environment, public works and disaster-management agencies should use a common monitoring framework. Project approval, operating permission and environmental compliance should be linked through shared records and periodic review.

9. CONCLUSION

Climate-compatible construction is essential to the future of tourism infrastructure in Himachal Pradesh. The sector faces intensified rainfall, landslides, heat, water scarcity and access disruption, while construction itself contributes to emissions, resource depletion and landscape instability. Addressing only one side of this relationship will not be sufficient.

The required transition combines avoidance, adaptation and mitigation. It begins with climate-sensitive siting and carrying-capacity control, continues through passive design, resilient drainage, efficient resource use, low-carbon materials and retrofitting and depends on worker safety, finance, skills and monitoring. Most importantly, it requires consistent governance. Technical measures cannot secure resilience when development occurs in unsuitable locations or rules are weakly enforced.

Himachal Pradesh should therefore treat tourism construction as a lifecycle climate decision. When regulation, engineering, environmental safeguards and community priorities are integrated, tourism infrastructure can support regional livelihoods without reproducing avoidable ecological and climatic risk.

REFERENCES

1. Aon Insights. (2023). *How the Construction Industry is Navigating Climate Change*. https://www.aon.com/en/insights/articles/how-the-construction-industry-is-navigating-climate-change
2. Wunderbuild. (2023, March 12). *The role of climate change in shaping modern construction practices*. https://www.wunderbuild.com/blog/the-role-of-climate-change-in-shaping-modern-construction-practices/
3. Kajal, K. (2021, September 10). In Himachal Pradesh, climate change and unplanned development are causing disasters. *Scroll.in*. https://scroll.in/article/1004622/in-himachal-pradesh-climate-change-and-unplanned-development-are-causing-disasters
4. Nandi, J. (2023, August 25). Unplanned infrastructure to climate crisis: Why Himachal Pradesh, Uttarakhand are reeling. *Hindustan Times*. https://www.hindustantimes.com/india-news/climate-crisis-and-unplanned-development-the-causes-behind-devastating-landslides-in-himachal-pradesh-and-uttarakhand-101692970572839.html
5. TERI. (2015). Green Growth and Buildings Sector: Himachal Pradesh. In *The Energy and Resources Institute*. The Energy and Resources Institute. https://www.teriin.org/projects/green/pdf/HP-Buildings.pdf
6. Government of Himachal Pradesh. (2019). *THE HIMACHAL PRADESH TOURISM POLICY, 2019*. Department of Tourism & Civil Aviation, Government of Himachal Pradesh. Retrieved April 9, 2025, from https://himachaltourism.gov.in/wp-content/uploads/2019/09/Himachal-Pradesh-Tourism-Policy-2019.pdf
7. Government of Himachal Pradesh. (2021). *State Action Plan on Climate Change (2021-2030)*. https://www.nitiforstates.gov.in/policy-viewer?id=GSSNAD000287
8. NIDM, Ministry of Home Affairs, Govt. of India, & HP State Disaster Management Authority. (2021). *Safe Construction Practices in Rural Areas of Himachal Pradesh*. https://nidm.gov.in/pdf/trgReports/2021/February/Report_17-19February2021aak.pdf
9. Grafakos, S., Trigg, K., Landauer, M., Chelleri, L., & Dhakal, S. (2019). Analytical framework to evaluate the level of integration of climate adaptation and mitigation in cities. *Climatic Change*, *154*(1--2), 87--106. https://doi.org/10.1007/s10584-019-02394-w