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Pilgrimage, Tourism, and Ecosystem Stress: Religious Practice in a Changing Climate in Uttarakhand

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ABSTRACT

Uttarakhand is home to major Hindu pilgrimage centres, including Kedarnath, Badrinath, Yamunotri and Gangotri. The growth of pilgrimage and tourism has created important livelihood and cultural opportunities while also increasing pressure on the fragile Himalayan environment. This paper examines the relationship among pilgrimage intensity, tourism-related infrastructure, climate vulnerability and ecosystem stress in Uttarakhand. It also considers the potential of religious values and community-based ecological practices to support more sustainable pilgrimage. The study adopts a qualitative secondary-data approach, drawing on peer-reviewed literature, government and institutional reports, environmental assessments and credible media reports. The material was organised through thematic content analysis around five interconnected themes: visitor pressure and resource use; waste and pollution; infrastructure and land-use change; climate and disaster vulnerability; and governance, community participation and

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faith-based environmental stewardship. The analysis indicates that seasonal concentration of visitors, inadequate waste and sewage infrastructure, intensive construction and increasing climate-related hazards interact to increase ecological vulnerability. At the same time, the cultural understanding of mountains, rivers, forests and sacred natural sites as spiritually significant provides a potential social resource for environmental stewardship. The paper argues that sustainable pilgrimage cannot depend on visitor regulation alone. It requires site-specific carrying-capacity assessment, climate-resilient and environmentally sensitive infrastructure, improved waste and sewage management, meaningful participation of local communities, and the integration of religious and cultural values into environmental governance.

2. Introduction

Devbhoomi Uttarakhand is one of India's most spiritually significant regions, attracting millions of pilgrims to Char Dham shrines— Kedarnath, Badrinath, Yamunotri and Gangotri each year. These sacred landscapes have forged a deep connection between religious practice and natural environment. However, in recent years, this connection has grown weak due to rising pilgrimage tourism and climate-induced ecological stress. The ecological fragility of the Himalayan terrain, combined with increasing anthropogenic pressure, has led to frequent landslides, floods, glacial retreat and forest degradation (Jacob et al., 2024). The Kedarnath disaster of 2013, which claimed thousands of lives, exposed the catastrophic consequences of climate-related events occurring in high-density pilgrimage zones. Since then, researchers have raised concerns about the risks of unregulated tourism, inadequate infrastructure, and environmentally insensitive development along the pilgrimage routes (Sharma, 2018; Sati, 2020).

Tourism and pilgrimage in Uttarakhand have increasingly contributed to environmental stress and degradation, as reflected in patterns such as uncontrolled infrastructure development, overuse of water resources, increasing waste generation, rise in pollution, and declining flora and fauna (Jacob et al., 2024). According to Sati (2020), periodic surges in visitor numbers put strain on already limited infrastructure and disrupt ecological stability, particularly in fragile environments. Similarly, Chand and Mishra (2024) observe that local populations often face difficult positions, juggling the economic opportunities generated by tourism with increased threats to their natural surroundings and cultural traditions. With evolving

climatic and environmental contexts, the religious activities have been increasing, putting greater pressure on efforts to address sustainability, resilience, and preservation of cultural traditions. This study seeks to understand the intersection of pilgrimage, tourism, and ecological fragility in Uttarakhand in the context of climate change. It seeks to explore the changes in pilgrimage practices, regulatory approaches and assess the environmental consequences of faith-based tourism; examine emerging strategies aimed at fostering sustainable and climate-resilient pilgrimage in Himalayan region.

3. Literature Review:

Devbhoomi Uttarakhand, located in the Northern Himalayas, is a place of great spiritual significance and natural beauty. The holy char dham pilgrimage sites, which includes Kedarnath, Gangotri, Yamunotri and Badrinath, is located there and attracts millions of pilgrims annually. It is evident that pilgrimage tourism has boosted the local economy and put tremendous strain on the delicate Himalayn ecosystems. The ecosyste of Uttarakhand is under stress dur to climate change, accelerating risks of glacial retreat, unpredictable weather changes and growing human activity (Uttarakhand Tourism Development Board [UTDB], 2023; Intergovernmental Panel on Climate Change, 2022; Ministry of Environment, Forest and Climate Change, 2021). This literature review integrates recent researches and reports on how pilgrimage and tourism activities contribute to ecosystems degradation and intersection of religious practices and envrionmental concerns. It also explores the dynamic tension between preserving religious heritage and protecting the environment in a changing climate.

3.1 Pilgrimage Tourism and Environmental Degradation in Uttarakhand

Pilgrimage tourism in Uttarakhand has witnessed massive growth over the last decade. The annual pilgrim footfall in the Char Dham circuit exceeds 10 million during peak seasons, a number that strained infrastructure and natural resources (Singh and Kumar, 2019). Government's Char Dham Mahamarg Vikas Pariyojana (CDMVP), focused at improving road connectivity, involving extensive construction activities. Reports by Trek Dham (2025) indicate that over 600 hectares of forest have been cleared for construction projects and road widening, resulting in deforestation, significant habitat loss, and destabilization of mountain slopes. The expansion of roads and construction of homestays, guest houses, and other tourism infrastructure have increased surface runoff and soil erosion, increasing the risks of landslides (Jha, 2021). The National Green Tribunal (NGT) has flagged illegal and unregulated construction near Kedarnath and Gangotri, worsening the ecosystem vulnerability (Times of India, 2025).

The massive influx of pilgrims comes with enormous quantities of non-biodegradable solid waste. Studies by Sharma and Bhatt (2020) estimate that during the peak pilgrimage season, waste generation reaches 10-15 tonnes daily in the Kedarnath area alone. Meanwhile, plastic waste is a major concern, with an estimated 160 kg of plastic accumulating daily in Kedarnath, while Badrinath and Gangotri produce 2.5-4 tonnes daily (News9 Live, 2025). Waste management infrastructure is insufficient or non-existent in many pilgrimage sites. The delayed completion of a sewage treatment plant at Kedarnath, with a capacity of 600 KLD, has led to untreated sewage discharge into sacred rivers (Times of India, 2025). This threatens the aquatic ecosystems and poses health risks to local communities reliant on river water.

The Himalayan ecosystem is rich in biodiversity, including several indigenous and medicinal plant species. The unregulated collection and trampling by pilgrims have led to the depletion and local extinction of medicinal herbs such as Jatamasi (Nardostachys jatamansi), Atish (Aconitum heterophyllum), Barmala (Aconitum balfourii), and Kakoli (Corydalis govaniana) (ThePrint, 2025). These plants hold ecological, cultural, and economic importance for local communities, including traditional healers. Research by Rawat et al. (2020) highlights that habitat fragmentation, coupled with climate change, is accelerating the decline of these species. Moreover, increased human interference disrupts wildlife corridors, affecting species such as the Himalayan black bear and the musk deer (Singh et al., 2018).

3.2 Climate Change and its Amplification of Ecosystem Stress

As stated by GLOFs, impacting river flows and increasing the likelihood of glacial lake outburst floods, climate change is accelerating the rapid glacial retreat in the Uttarakhand Himalayas. As documented by Bhattacharya et al. (2019), over the past three decades, there has been a 10- 15 % reduction in the retreats of glaciers feeding the Ganga tributaries. The established hydrological cycles have been disturbed as the ongoing melting alters both the timing and quantity of river discharge. This also affects the pilgrimage and tourism activities that rely on these water resources (IPCC,2023). IPCC,2023, further states that because of these unpredictable weather patterns, which include unseasonal rains and extreme snowfall, they have become frequent. These also create direct risks for pilgrims, tourism and communities as there is an increasing frequency of landslides, avalanches, and flash floods.

Environmental conservation became more challenging because of local communities' dependence on pilgrimage tourism for their livelihoods. Even when tourism-related development contributes to environmental degradation, residents are hesitant to oppose it because of the economic benefits of the steady flow of pilgrims (Mishra & Pathak, 2021). At the same time, traditional beliefs and practices have emerged as protective mechanisms which have contributed historically to the conservation of sacred groves and

pilgrimage sites, but due to the growth of mass tourism, they are also under pressure (Rastogi,2020). This dynamic creates a conflict between spiritual practice and environmental conservation.

3.3 Religious Practice as a Vector for Environmental Awareness and Action

Traditional beliefs in fostering environmental conservation have been emphasised by many studies. Pandey & Singh (2022) state that natural elements such as forests, rivers, and mountains are regarded as sacred manifestations of divine power by local communities. Such cultural and religious. Such cultural and religious beliefs contributed to the sustainable use of natural resources and the preservation of sacred groves. These traditional practices have been diluted because of commercialisation and the massive scale of modern tourism, which leads to increased environmental degradation (Joshi et al., 2019). Initiatives such as advertisement of the use of waste bags and community-led clean yatra campaigns have been started to promote environmentally responsible pilgrimage practices. In this way, efforts are made to reconnect environmental conservation with religious practices (Time of India,2025). The Uttarakhand Eco-Forum have started awareness initiatives, focused on waste management and ecosystem protection.

Singh & Verma (2023) state that by limiting visitor numbers and promoting environmentally friendly materials, religious leaders and communities contribute to the sustainable pilgrimage. Together, the reviewed literature concludes that, the traditional religious values plays an important cultural resource for addressing the environmental challenges associated with contemporary pilgrimage tourism.

3.4 Policy Frameworks and Institutional Responses

Governmental and institutional interventions in Uttarakhand increasingly exacerbated the environmental challenges associated with pilgrimage tourism. To address the ecological pressures caused by increasing pilgrim flows, the state government has undertaken many measures such as afforestation programmes, waste management protocols, and infrastructure development (MoEFCC,2024). Initiatives to map vulnerable riverbank settlements and strengthen disaster preparedness in pilgrimage have been undertaken by the National Disaster Management Authority (NDMA). Therefore, we state that disaster-risk management also emerged as an important component of environmental governance (Times of India, 2025). Studies indicate that between policy formulation and implementation, despite all these interventions, significant gaps still remain. As stated by Sharma at al., (2022) the major contribution to constraining effective environmental management is from bureaucratic delays, weak enforcement mechanisms, and inadequate coordination among government agencies and other stakeholders. Areas surrounding the major pilgrimage centre, concerns regarding unauthorised construction and limited compliance with environmental regulations are particularly evident. NGOs and community- based organisations have played an important

role in addressing these institutional limitations by translating environmental policies into local action. In pilgrimage areas, initiatives related to community awareness, waste management, and biodiversity have been undertaken by the Himalayan Environmental Studies and Conservation Organisation (HESCO,2023). Dutta and Bhattacharya (2021) further argue that the participation of local communities in monitoring and managing pilgrimage tourism can strengthen local ownership and improve the effectiveness of conservation initiatives. The literature, therefore suggests that effective institutional coordination and meaningful community participation is also requires with formal government policies for sustainable pilgrimage tourism.

3.5 Sustainable Tourism and Future Directions

Recent scholarship increasingly advocates integrating sustainable tourism principles into pilgrimage management in Uttarakhand. Major strategies such as the development of environmentally sensitive infrastructure, regulation of visitor numbers within carrying capacity, promotion of alternative pilgrimage routes, and the effective segregation and disposal of waste must be implemented (Garg et al., 2020). As a prominent tool for promoting sustainable pilgrimage, technological intervention has also gained attention. The use of a mobile application to provide pilgrims with real-time information on routes, weather conditions, and environmental guidelines is also receiving positive feedback (Kumar & Rawat,2023). At the same time, pilgrimage tourism in Uttarakhand requires interventions at multiple levels to strengthen climate resilience. This emphasised climate adaptation policy, community-based disaster preparedness, and the integration of indigenous ecological knowledge (Pant & Singh, 2021). International cooperation and funding can support climate-smart tourism models that protect ecosystems while maintaining the religious and cultural fabric of pilgrimage practices (UNWTO,2022).

In the context of climate change, the connection between religious practices, pilgrimage tourism, and environmental sustainability has emerged as an important socio-environmental concern. While pilgrimage is deeply embedded in local identity and contributes significantly to the local identity economy, its environmental impacts place considerable pressure and require immediate action. Existing literature indicates that an integrated approach is needed to address this ecological stress, balancing religious tradition with contemporary environmental governance. Sustainable pilgrimage practices can be reinforced by comprising traditional ecological knowledge, effective policy interventions, community participation, and technological innovations. The literature also highlights strategies to protect Uttarakhand's natural ecosystems while sustaining its religious and cultural heritage and the need for future research on long-term environmental monitoring, participatory conservation mechanisms, and climate-resilient adaptation.

4. Conceptual Framework:

The present conceptual framework seeks to analyse the interrelationship between pilgrimage practices, tourism development, and climate change, and their cumulative impact on ecosystem stress in Uttarakhand. The state's profound religious significance, particularly the Char Dham circuit, attracts millions of pilgrims annually, resulting in intense seasonal population inflow. This concentration of visitors exerts substantial pressure on the ecologically fragile Himalayan environment, thereby altering the natural balance of the region (Singh & Singh, 2019). Pilgrimage practices, historically characterized by low ecological impact and spiritual orientation, have undergone a significant transformation into mass religious tourism. This transition has led to increased consumption of natural resources, expansion of built infrastructure, and a rise in solid waste generation. Consequently, the ecological footprint of pilgrimage activities has intensified, contributing to environmental degradation and disruption of local ecosystems (Sharma, 2020). In parallel, tourism-driven development—manifested through road construction, hotel expansion, and improved transport connectivity—has enhanced accessibility while simultaneously accelerating deforestation, land-use change, and habitat fragmentation (Rawat & Kumar, 2018).

Climate change constitutes a critical exogenous variable within this framework, functioning as a stress multiplier that exacerbates existing environmental pressures. The Himalayan region is experiencing significant climatic shifts, including rising temperatures, glacier retreat, erratic precipitation patterns, and increased frequency of extreme events such as floods and landslides. These changes undermine ecosystem resilience and heighten the vulnerability of both natural systems and human activities, including pilgrimage and tourism (Dimri et al., 2016). The interaction among pilgrimage intensity, tourism expansion, and climatic variability is further mediated by factors such as ecosystem carrying capacity, governance structures, environmental regulation, and resource management practices. Inadequate planning, weak policy enforcement, and unregulated development often aggravate environmental stress, while limited adaptive capacity among local communities constrains sustainable responses (Pandey et al., 2021).

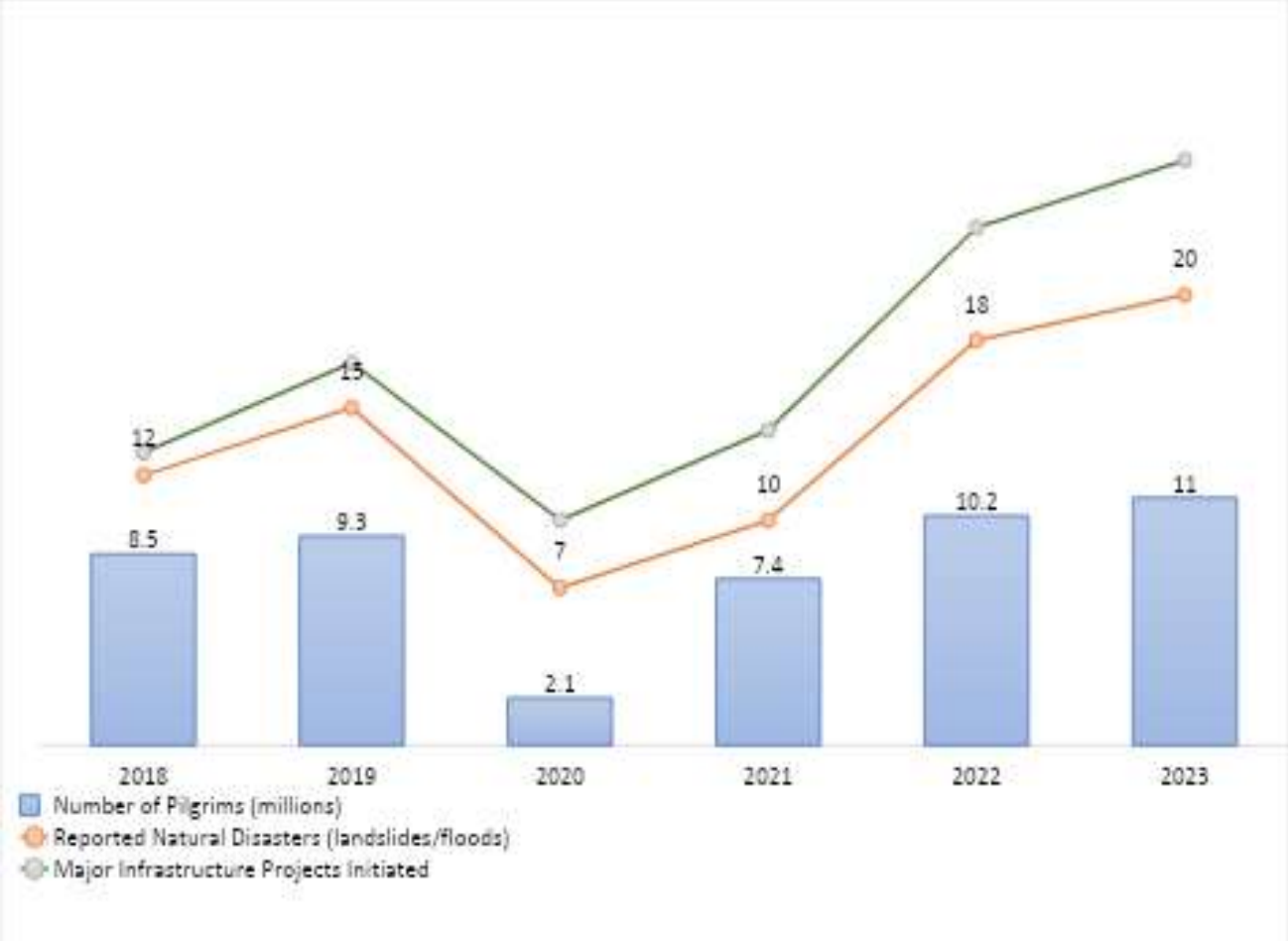
The cumulative outcome of these interacting variables is manifested in the form of ecosystem stress, characterised by biodiversity loss, land degradation, water pollution, and increased disaster risk. This framework also recognises a feedback mechanism wherein environmental degradation and climate-induced disasters disrupt pilgrimage and tourism flows, prompting further infrastructural interventions that may intensify ecological pressure. In summary, the framework conceptualises pilgrimage, tourism, and climate change as interdependent drivers of ecological stress in Uttarakhand. It underscores the necessity for

integrated, sustainable, and climate-resilient approaches to manage the growing pressures on the Himalayan ecosystem while preserving its cultural and religious significance.

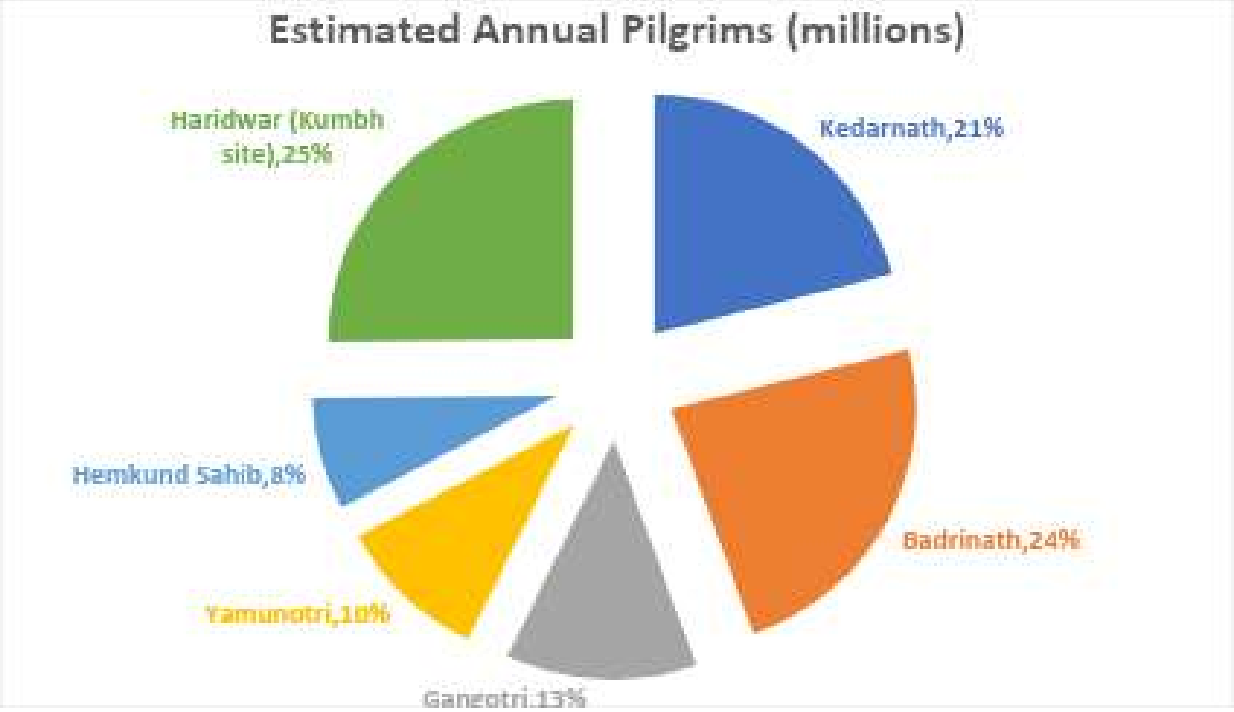
5. Methodology:

This study adopts a qualitative case study approach focused on Uttarakhand, India. It relies on secondary data from peer-reviewed journals, government reports, environmental assessments, and credible media sources. Key sources include works by Jacob et al. (2024), Sati (2020), and Sharma (2018), as well as reports from the Wildlife Institute of India and the Uttarakhand Forest Department. Data were analyzed using thematic content analysis to identify patterns related to climate impacts, pilgrimage infrastructure, ecosystem stress, and policy responses. Where applicable, statistical data on pilgrim footfall and environmental hazards were integrated to support qualitative findings. The study is limited by the absence of primary field data and is constrained to publicly available sources. Despite this, triangulation of multiple documents enhances the validity of the insights presented.

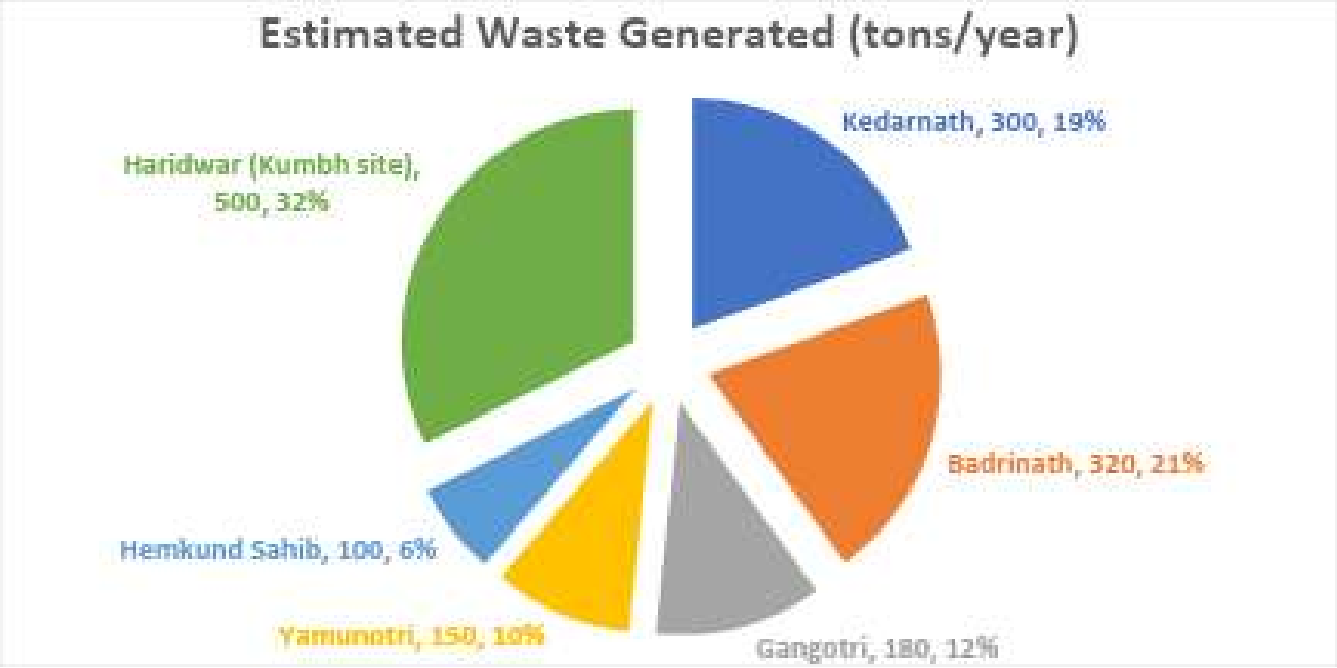
6. Results:



Visitor figures across Uttarakhand's pilgrimage destinations showed a marked upward trajectory between 2018 and 2023. It has witnessed a sharp drop in 2020 due to travel restrictions imposed during COVID-19 pandemic. Parallel to the visitor's growth seasonal solid waste production has expanded rapidly which aggravated the regional waste management blockage. The region has frequently recorded a higher frequency of natural hazards which is driven by a combination of elements. These include increasing climate pressures due to heavy construction projects of infrastructural development such as road widening in the ecological sensitive Himalayan terrain.



Note: Data compiled from Jacob et al. (2024); Sati (2020); Uttarakhand Forest Department (2023); Ministry of Tourism (2023); The Times of India (2023). 2020 figures are lower due to pandemic restrictions.



Note: Data compiled from Jacob et al. (2024); Sati (2020); Uttarakhand Forest Department (2023); Ministry of Tourism (2023); The Times of India (2023). 2020 figures are lower due to pandemic restrictions.

An analysis of secondary sources and existing literature marks the intricate relationship between religious and commercialized tourism accompanying with ecological stress in the high-altitude ecosystems. First, increasing visitor loads frequently exceed the ecological carrying capacity of destination sites. It triggers widespread environmental degradation. Key manifestations include deforestation, soil erosion, aquatic pollution and unmanageable solid waste surges during peak travel windows (Jacob et al., 2024). The heavy accumulation of non-biodegradable plastics and untreated sewage near major transit points represent a major ecological hazard (Chand & Mishra 2024).

Second, climate driven stressors, such as intense rainfall, thermal shifts, and glacial retreat have increased the frequency and severity of localized disasters. Events such as the 2013 Kedarnath disaster and ongoing land movement among Char Dham routes illustrate how these hazards disrupt access corridors which destroy infrastructure and endanger lives of millions of people (Sharma, 2028; Sati, 2020). Third, state-backed infrastructure development, specifically road building and accommodation expansion without adequate environmental mitigation. Large scale undertakings like the Char Dham highway project rely on extensive hill-cutting and slope destabilization. It directly increases land subsidence risks in vulnerable sectors such as Joshimath (Jacob et al., 2024). Fourth, Sacred Natural Sites (SNS), these are the historically preserved sites through traditional conservation practices and socio-cultural taboos. It is currently facing

ongoing degradation. Heavy foot traffic, spatial encroachment and declining community oversight have severely weakened these ecological sensitive zones (Chand & Mishra, 2024).

Finally, regulatory enforcement remains inconsistent. Institutional efforts such as the carrying capacity assessments and the exclusion of local populations from management decisions continue to hinder effective conservation efforts (Jacob et al., 2024; Sati, 2020). These dynamics depict that unified policy frameworks are needed to balance religious tourism with ecological preservation and disaster readiness.

7. Discussion:

These findings highlight the concerning convergence of state -sponsored religious tourism, rapid infrastructural development, and environmental degradation across Uttarakhand's fragile Himalayan Mountain Ecosystem. Climate-driven disruptions expand the environmental pressure as government programs continue to drive higher tourist volumes into ecological sensitive high-altitude zones. The mountain systems of Uttarakhand are intrinsically sensitive to physical disturbances. Constantly rising temperatures, erratic precipitation and accelerated retreat of glaciers have elevated the risk of flash floods, debris flow, and forest fires (Sari, 2020). The 2013 Kedarnath disaster serves as a notable example of how climatic changes and unmanaged structural growth can produce devastating outcomes. It is noted that large segments of the Char Dham Yatra routes pass through active disaster zones where shifting climatic baselines make hazard events increasingly difficult to predict (Sharma, 2018).

7.1 Pilgrimage and Tourism Infrastructure as an Ecological Stressor

Although pilgrimage tourism is the main and strong driver of local economic activity. The unchecked expansion of transit corridors and commercial lodging has increased the tree cover loss. It has destabilized slopes and reduced regional biodiversity (Jacob et al., 2024). Construction works on the Char Dham highway characterized by extensive bench cutting into steep hillside have directly heightened landslide frequency. Extreme level of overcrowding in peak months has forced temporary closures of major shrines due to safety concerns which exposes clear administrative failures in managing visitor density and setting physical access limits (Jacob et al., 2024). Likewise another setback is high seasonal waste outputs dominated by single-use plastics, raw sewage and organic matters which overload municipal infrastructure and pollute adjacent river networks (Chand & Mishra, 2024).

7.2 Cultural and Spatial Transformation of Sacred Spaces

The geographic alteration and deterioration of sacred sites affects both the natural surroundings and the socio-spiritual landscape of the region. Traditionally, Himalayan pilgrimages were framed by the raw

condition of the surrounding geography where mountains, rivers and forests functioned as central elements of the spiritual journey rather than mere scenery (Sati, 2020). Modern commercialization accompanied by noise pollution and severe overcrowding has transformed this historic paradigm. The modern transition toward rapid convenience-oriented transit has displaced traditional foot practices historically embedded in Hindu pilgrimage customs (Chand & Mishra, 2024).

7.3 Adaptive Governance and Policy Implication

Mitigating these environmental threats requires structural adjustment in regional policy. Establishing scientifically validated site specific carrying capacity remains an urgent priority. As emphasized by the Wildlife Institute of India, development frameworks must adjust dynamically to seasonal ecological thresholds (Jacob et al., 2024). Infrastructure development demands rigorous environment impact assessment alongside modern geotechnical stabilization methods to secure cut slopes. Furthermore, formally recognizing and protecting sacred natural sites such as alpine meadows (bugyals) sacred groves, and headwaters offer an established culturally integrated model for regional conservation (Sati, 2020).

7.4 Community Participation and Future Pathways

Resident communities act as the primary care takers of these natural systems and first to bear the costs of localized ecological failures. However, state-decision making frameworks routinely marginalize local input. Establishing participatory management structures can provide training in low-impact tourism models and develop alternative economic opportunities. It can build local resilience with improving environmental oversight. Long term regional stability depends on integrating seasonal traffic controls, modernized waste infrastructure, public education and climate adaptation strategies into future tourism models.

8. Conclusion:

This study examined the relationship among pilgrimage tourism, tourism-related infrastructure, climate vulnerability and ecosystem stress in Uttarakhand through a qualitative synthesis of secondary evidence. The analysis indicates that increasing visitor concentration creates significant seasonal pressure on natural resources and infrastructure, while waste, sewage, land-use change and construction can add to the vulnerability of fragile Himalayan ecosystems. Climate-related changes and extreme events can further amplify these pressures, making pilgrimage landscapes increasingly sensitive to both environmental and developmental risks. At the same time, the relationship between religion and environment should not be understood only in terms of environmental harm. The sacred status of mountains, rivers, forests and natural

sites, together with traditional ecological knowledge and community norms, provides a potentially important cultural resource for conservation. The challenge is to reconnect these values with contemporary pilgrimage management in a way that is practical, participatory and supported by effective institutions. The central implication is that sustainable pilgrimage cannot be achieved through a single intervention. It requires an integrated approach combining seasonal carrying-capacity assessment, environmentally sensitive and climate-resilient infrastructure, effective waste and sewage management, disaster preparedness, community participation and faith-based environmental stewardship. Future research should strengthen this evidence through primary field studies involving pilgrims, local residents, tourism workers, religious institutions and government agencies, alongside systematic environmental monitoring. Such work can help develop pilgrimage models that protect Uttarakhand's sacred landscapes while sustaining the cultural and livelihood benefits associated with pilgrimage.

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