



Review paper

Tourism Development and Its Impact on Mountain and Himalayan Lakes in Kashmir: A Review

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ARTICLE INFO	ABSTRACT
Keywords Kashmir Himalayan lakes tourism impact sustainable tourism conservation   DOI 10.5281/ib-2583026 *Corresponding author Kowser Jan  Email kowser.pirzada@gmail.com 	Kashmir's mountain and Himalayan lakes from the urban lake systems of Srinagar (Dal, Nigeen, and Manasbal) to the Ramsar-listed floodplain lake of Wular and the high-altitude trekking and pilgrimage lakes of the Kashmir Great Lakes circuit and the Amarnath Yatra corridor lie at the center of the region's tourism economy and its most acute environmental crises. This review synthesises peer-reviewed and policy literature on tourism-driven pressure on these lake systems to characterise the region's tourism growth trajectory and its spatial concentration around lake and meadow destinations, identify the principal mechanisms by which tourism degrades lake ecosystems, including houseboat and hotel sewage, solid and plastic waste, shoreline encroachment for tourism infrastructure, and high-altitude trekking and pilgrimage pressure. It will also synthesize lake-specific evidence from Dal, Wular, Manasbal, and the high-altitude Great Lakes and Amarnath corridor. The review finds that tourism is not the sole or always the primary driver of lake degradation in Kashmir sewage from resident and agricultural populations, encroachment and climate change are consistently identified as compounding factors but that tourism-related infrastructure, waste generation, and visitor pressure interact with these drivers in locally significant ways, and at several sites now exceed documented ecological carrying capacity. The analysis finishes with a synthesis of suggestions for sustainable tourism, and identifies the most urgent unmet need as quantitative research on carrying capacity for Kashmir's high-altitude lakes.

1. Introduction

Mountain and Himalayan lakes have a disproportionate ecological, hydrological and socio-economic value compared to their surface area. They regulate catchment hydrology, sustain fisheries and horticulture, support globally significant biodiversity and in the case of Kashmir, underpin an entire regional tourism economy. The tourism industry of Jammu and Kashmir has grown rapidly in the last decade with an average annual growth of over fifteen percent between 2021 and 2024. It now contributes about seven percent to the Gross State Domestic Product of the region and provides direct and indirect employment to about seventy thousand people

(Greater Kashmir, 2025). This increase has been mainly concentrated around a limited number of lake- and meadow-focused attractions Dal Lake and Srinagar, Gulmarg, Pahalgam and Sonamarg as well as an emerging set of high-altitude trekking routes and the Amarnath Yatra pilgrimage route.

At the same time, a large and increasing body of hydro-ecological research reports on the severe, and in some instances accelerated, deterioration of only these lake systems. In 2024, a comprehensive review of lakes in the Indian Northwestern Himalaya found that the combined effects of population growth, land use and land cover changes, urbanisation, and growing tourist influx are leading to a widespread degradation of water quality and ecological status

throughout the region. Similarly, linkages between increasing tourist influx and decreasing forest cover, sedimentation, and pollution have been documented in comparable Himalayan Lake catchments such as Nainital (Shah et al., 2024). This review is specifically concerned with the causal pathways between tourism development and lake degradation in Kashmir, and attempts to synthesise site-specific evidence from Dal, Wular and Manasbal lakes with that of the high-altitude lakes of the Kashmir Great Lakes trekking circuit as well as the Amarnath Yatra pilgrimage corridor, to elucidate where tourism is a primary driver of degradation, where it acts to compound other pressures such as untreated municipal sewage and encroachment, and what governance responses have been attempted.

2. Kashmir's Mountain and Himalayan Lake Systems: An Overview

2.1 Urban and Peri-Urban Lakes

Dal Lake, Nigeen Lake, and Manasbal Lake represent Kashmir's urban and peri-urban lake tier, situated within or immediately adjacent to Srinagar and directly integrated into the city's tourism infrastructure through houseboats, shikara (boat) tourism, lakeside hotels, and the Mughal Gardens. Dal Lake alone is described in the tourism literature as the "liquid heart" of Kashmir and the primary driver of the houseboat and hospitality economy on which thousands of Srinagar families depend. Manasbal Lake, though smaller and less intensively touristed, has experienced catchment land-cover change from stone quarrying linked to regional infrastructure and tourism-adjacent development, with documented consequences including the local extinction of native fish and aquatic plant species (Shah et al., 2024, citing Rashid et al., 2013).

2.2 Floodplain and Wetland Lakes

Wular Lake, designated a wetland of international importance under the Ramsar Convention in 1990, functions primarily as a flood-regulation and fisheries resource for the wider Kashmir Valley rather than as a direct tourism destination, but is nonetheless affected by tourism-adjacent catchment change including willow plantation expansion tied to the sporting-goods (cricket bat) industry that also supplies tourism-linked retail alongside its dominant pressures of sewage, industrial waste, and agricultural runoff. The lake has shrunk by roughly a quarter of its historical area since 1980, with siltation from a denuded catchment and untreated sewage discharge identified as the principal proximate drivers of its eutrophication.

2.3 High-Altitude Trekking and Pilgrimage Lakes

A third tier comprises the high-altitude glacial and meadow lakes accessed almost exclusively through organized trekking tourism and religious pilgrimage: the seven lakes of the Kashmir Great Lakes circuit (*Vishansar, Krishansar, Gadsar, the Satsar cluster, Gangabal, Nundkol, and Tarsar*), together with the glacial environment surrounding the Amarnath cave shrine, reached via the Pahalgam and Baltal routes through the Lidder and Sindh valleys. Unlike the urban lakes, these systems have essentially no permanent resident population and no non-tourism economic base, meaning that ecological pressure at these sites is attributable almost entirely to seasonal tourism and pilgrimage traffic rather than to a mixture of resident, agricultural, and tourism sources.

3. Tourism Growth Trajectory in Kashmir

Tourist arrivals in Jammu and Kashmir have followed a strongly upward, if politically and seasonally volatile, trajectory. Domestic tourist visits rose from approximately 2.5 million in 2020 to over 23.5 million in 2024, and the Kashmir Valley alone attracted approximately 2.67 million visitors in 2022. An academic assessment of tourism growth and environmental impact in the Kashmir Valley similarly documented a sustained rise in tourist arrivals across the preceding decade and found that most popular destinations in the valley are now visited by tourist volumes exceeding their respective ecological carrying capacities, producing over-production of sewage, litter, habitat loss, deforestation, and pollution across essentially all environmental media (Aslam et al., 2018).

This growth is spatially concentrated: Gulmarg, Pahalgam, and Sonamarg development authorities, together with Srinagar's Dal Lake precinct, account for a disproportionate share of both tourist volume and associated infrastructure (hotels, guest houses, and transport fleets), placing sustained pressure on a small number of high-value, ecologically sensitive lake and meadow sites rather than distributing pressure across the wider landscape (Aslam et al., 2018). Winter tourism to Gulmarg alone has recently been reported to generate over 2,000 kilograms of litter daily from hotels, motels, and vendors, illustrating the scale of waste generation concentrated at individual tourism nodes.

4. Mechanisms of Tourism-Driven Impact on Lakes

4.1 Sewage, Houseboat, and Hotel Effluent

The dominant tourism-linked pathway of lake degradation in Kashmir is inadequately treated wastewater from houseboats and lakeside hotels. On

Dal Lake specifically, over fifty thousand people inhabit the lake itself in houseboats, dongas, or islands, deriving their livelihood substantially from tourism, and the resulting sewage load has been identified as a primary driver of the lake's extreme loss of water quality over the past four decades (Kumar et al., 2022). An economic-valuation study combining water-quality monitoring with community survey data found the highest pollutant loads — including elevated biological and chemical oxygen demand at sampling sites closest to hotel and settlement effluent discharge points on Dal Lake, directly implicating tourism-adjacent infrastructure in localized water-quality decline (Parray et al., 2024). A hydrochemical and GIS-based characterization of the lake similarly identified urbanization and associated effluent discharge as key drivers of spatial variation in water chemistry across Dal Lake's basins (Khanday et al., 2018).

4.2 Solid Waste and Plastic Pollution

Solid and plastic waste generated by tourism is a second major, and increasingly visible, pressure across Kashmir's lake and meadow destinations. Field assessments of Kashmir's tourism destinations describe the widespread use of polythene bags by tourists as a significant sustainability challenge, with each tourist estimated to abandon approximately one kilogram of plastic waste per day of visit. Popular destinations including Gulmarg, Pahalgam, Sonamarg, Yusmarg, and Doodhpathri are reported to show visible heaps of garbage along roadsides, in public parks, and directly in water streams and forest areas, posing a direct contamination risk to the lakes and streams that feed the valley's broader hydrological system (Greater Kashmir, 2025). At the specific case-study level, municipal solid waste management in the hill town of Pahalgam gateway to both general tourism and the AmarnathYatra's Chandanwari route has been documented as a significant and tourism-induced challenge for local authorities, with waste-management infrastructure consistently outpaced by seasonal visitor volume (Bashir & Goswami, 2016).

4.3 Shoreline Encroachment and Land-Use Change for Tourism Infrastructure

The construction of hotels, guest houses, access roads, and associated tourism infrastructure has directly encroached on lake margins and catchments across Kashmir. On Dal Lake, encroachment in and around the lake driven by the cumulative expansion of settlements, floating gardens, and tourism-linked structures has reduced the volume of open water and thereby increased the concentration of pollutants entering the remaining lake body (Kumar et al., 2022). A social-ecological systems analysis of Dal Lake similarly identified rapid urbanization and

unplanned settlement expansion, closely tied to the lake's tourism economy, as key drivers rendering the lake's ecological, economic, social, and cultural functions vulnerable to ongoing and future disruption (Sheergojri et al., 2023). At Manasbal Lake, catchment land-cover change linked to quarrying and construction activity associated with regional infrastructure development has directly altered nutrient and sediment loading, contributing to the local extinction of the fish species *Bortia birdi* and the aquatic plant *Euryale ferox* (Shah et al., 2024).

4.4 High-Altitude Trekking and Pilgrimage Pressure

The high-altitude lakes of the Kashmir Great Lakes circuit and the glacial setting of the AmarnathYatra corridor are subject to a qualitatively different form of tourism pressure: concentrated, short-season, high-volume foot traffic through ecologically fragile alpine terrain with minimal permanent infrastructure to absorb it. The AmarnathYatra, an annual Hindu pilgrimage to a glacial ice formation at about 3,888 meters, has grown from about 4,500 pilgrims in 1950 to over 350,000 by 2013 and more than 500,000 by 2024, with daily pilgrim numbers during peak periods (more than 12,000 per day) reported to far exceed the scientifically estimated daily carrying capacity of the Lidder Valley corridor, which is estimated at around 4,300 people (Dialogue Earth, 2021). Environmental Impact Assessment work in the Lidder Valley has found that this prolonged overshoot of carrying capacity coupled with poor sanitation and waste infrastructure along the narrow, cliff-flanked pilgrimage tracks causes soil and water contamination directly as well as deforestation and land degradation due to the construction of temporary shelters (The News, 2024). Independent commentary and Geographic Society reporting have also linked the density of human presence and associated infrastructure along the pilgrimage route to accelerated melting of the glacial ice formation itself, demonstrating a direct mechanistic pathway from visitor numbers to degradation of the very natural feature that draws pilgrims (National Geographic, 2021).

A parallel academic literature on the geography of pilgrimage tourism in the Kashmir Valley has studied the spatial and environmental dimensions of this pressure specifically, and has situated the AmarnathYatra within a broader pattern of religious and adventure tourism in ecologically sensitive high-altitude corridors (Bhat et al., 2017). The Kashmir Great Lakes trekking circuit too has recorded a significant increase in footfall recently, but the total number of visitors is much lower than the AmarnathYatra, which has led to formal government intervention regarding the lack of a waste-disposal

regulatory mechanism at these once lightly visited high-altitude trekking destinations (Tribune India).

5. Case Studies

5.1 Dal Lake

Dal Lake is simultaneously Kashmir's most tourism-dependent lake and its most extensively documented case of tourism-linked degradation. The lake's open-water extent has contracted from roughly twenty-two to eighteen square kilometres in recent decades, a trend attributed jointly to sewage dumping, encroachment, and macrophyte proliferation (Kashmir Times, 2025). A dedicated tourism-and-sustainability case study of the lake concludes that construction activities need to be banned in the catchment area and that wastewater must be prevented from entering the lake from catchment villages and tourism infrastructure alike, arguing that such measures would simultaneously improve water quality and increase the lake's long-term recreational and revenue-generating value framing environmental protection and tourism revenue as complementary rather than competing. A social-ecological resilience assessment employing remote sensing, ecological data, and stakeholder perception surveys similarly concludes that population expansion, urbanization, pollution, and inadequate management all closely tied to the lake's tourism-driven settlement pattern — have disrupted the lake's ecological integrity and socio-economic dynamics, and recommends adaptive management as the central tool for building resilience (Sheerjori et al., 2023).

5.2 Wular Lake

Wular Lake illustrates a case where tourism is a secondary rather than primary pressure, operating mainly through catchment-level land-use change (willow plantation and encroachment for cultivation) rather than direct visitor infrastructure. Nonetheless, the lake's decline a twenty-five percent reduction in area between 1980 and 2018, alongside siltation, sewage, and industrial and horticultural waste inflow — has direct consequences for the region's broader tourism economy, given the lake's role in regulating the floodwaters that periodically threaten Srinagar's tourism infrastructure, and given its status as a globally significant migratory bird habitat that itself draws ecotourism interest (Pulitzer Center, 2023). Reporting from 2026 documents that of the region's 697 historically recorded natural lakes, 315 have disappeared entirely and 203 have shrunk since 1967, with Wular's fishing community explicitly describing tourism, hydropower, and agriculture as jointly and adversely affected by the same underlying pattern of unplanned growth and climate-linked pollution (Associated Press, 2026).

5.3 Manasbal Lake

Manasbal Lake, often described in the tourism literature as one of Kashmir's cleanest and most scenic lakes, provides a cautionary illustration of how infrastructure development connected to regional tourism and construction demand can degrade even comparatively lightly visited water bodies. Stone quarrying in the lake's catchment, linked to regional construction and infrastructure expansion, altered land cover sufficiently to increase nutrient and silt loading and drive the local extinction of a native fish species and an aquatic plant species historically found in the lake (as cited in Shah et al., 2024).

5.4 High-Altitude Lakes and the Amarnath Yatra Corridor

The high-altitude lakes of the Great Lakes trekking circuit and the glacial cave environment of the Amarnath Yatra together represent the clearest cases in Kashmir where tourism and pilgrimage volume is essentially the sole anthropogenic driver of observed environmental change, given the absence of permanent resident populations or agricultural activity at these elevations. The documented and sustained excess of pilgrim volume over assessed carrying capacity in the Lidder Valley with average daily visitation more than double the estimated safe threshold during peak pilgrimage weeks together with inadequate sanitation infrastructure along narrow trekking corridors, has been directly linked to soil and water contamination, littering, and pressure on the region's glacial features (Dialogue Earth, 2021; The News, 2024). Civil-society organizations focused on tourism and ecology have called for the pilgrimage's duration to be shortened back toward its traditional fifteen-day period specifically to reduce cumulative human footfall in the fragile Lidder and Sindh valley ecosystems, warning of a broader environmental catastrophe for the Kashmir valley if visitation is not regulated (Press Reader, 2017).

6. Socio-Ecological and Livelihood Consequences

Tourism-linked lake degradation in Kashmir carries direct consequences for livelihoods that are themselves substantially tourism-dependent, creating a feedback loop in which environmental decline threatens the very economic activity driving it. Houseboat owners on Dal Lake report that unpleasant surroundings and foul odors from sewage-driven pollution are directly reducing visitor interest in staying on the lake, undermining the primary livelihood of the houseboat community even as that community's own effluent contributes to the underlying problem (Voice of America, 2024; Kashmir Times, 2025). Fishing communities on Wular Lake report substantial income declines — from roughly

eleven US dollars to one or two US dollars per night of fishing attributed jointly to pollution, siltation, and climate-driven hydrological change, with knock-on effects for the broader regional tourism economy that depends on the lake's flood-regulation function and on fisheries-based cultural tourism (Associated Press, 2026).

Community-perception research conducted at Doodhpathri, an emerging high-altitude tourism destination in the Kashmir Valley, found that indigenous residents recognize both the economic benefits and the environmental costs of tourism development, and that residents' support for further tourism development is closely tied to their perception of whether environmental and infrastructural management is keeping pace with visitor growth (Wani et al., 2022). This finding is consistent with the broader pattern observed across Kashmir's lake and meadow destinations: local communities are not opposed to tourism as such, but perceive current management capacity as inadequate relative to the scale of visitor pressure, a perception directly supported by the documented carrying-capacity overshoots at both Dal Lake and the AmarnathYatra corridor.

7. Governance, Carrying Capacity, and Management Responses

Kashmir's principal institutional response to lake degradation has been the establishment of dedicated lake conservation and management authorities most prominently the Lake Conservation and Management Authority (LCMA) responsible for Dal and Nigeen lakes tasked with sewage treatment plant construction, houseboat sewerage connection, buffer-zone creation, and macrophyte removal. These measures directly target the sewage and encroachment pathways identified above as central tourism-linked drivers of degradation. However, independent assessments consistently find that implementation has lagged behind the scale of the problem: the National Green Tribunal's continued oversight of Dal Lake conservation efforts as of 2025, and repeated media and civil-society reporting of persistent untreated sewage discharge despite substantial public investment, indicate a durable gap between institutional response and documented environmental need (Kashmir Times, 2025).

For the high-altitude and pilgrimage lake systems, governance has centered on periodic Environmental Impact Assessment exercises — such as the Lidder Valley assessment establishing a daily carrying-capacity threshold of approximately 4,300 pilgrims — and on ad hoc facility audits following unusually high visitation years, rather than on binding, consistently enforced visitor caps (Dialogue Earth, 2021). A 2026 opinion analysis of the AmarnathYatra explicitly frames the persistence of this gap as a scientifically

established but administratively unresolved question, noting that helicopter service expansion and pilgrimage-duration extension have proceeded without publicly available environmental assessments matching the pace of visitor growth (Kashmir Times, 2026). At the level of individual trekking destinations, government bodies have in recent years begun exploring mechanisms to regulate tourist inflow to previously lightly visited sites such as the Kashmir Great Lakes circuit and Gurez, following documented concern from elected representatives over the absence of waste-disposal infrastructure keeping pace with rapidly rising footfall (Tribune India).

8. Toward Sustainable Tourism: Recommendations

Drawing on the mechanisms and case evidence reviewed above, four categories of intervention are consistently identified across the literature as necessary, though not sufficient individually, to reconcile continued tourism growth with lake conservation in Kashmir. First, comprehensive houseboat and hotel sewerage connection to treatment infrastructure already partially implemented for Dal and Nigeen lakes needs extension and enforcement across all lake-adjacent tourism accommodation, given the consistent identification of hotel and houseboat effluent as a primary, spatially concentrated pollution source (Parray et al., 2024; Kumar et al., 2022). Second, mandatory solid-waste and single-use-plastic management systems are needed at high-volume tourism nodes, particularly Gulmarg, Pahalgam, and Sonamarg, where daily litter generation already measures in the thousands of kilograms and where existing infrastructure is explicitly described as inadequate to current, let alone projected, visitor volumes. Third, catchment-level construction and encroachment restrictions are needed around all three tiers of lake system, informed by the demonstrated link between quarrying- and settlement-driven land-cover change and downstream nutrient and sediment loading at Manasbaland Dal lakes specifically (Shah et al., 2024; Sheergojri et al., 2023). Fourth, and most urgently for the high-altitude tier, binding visitor caps informed by rigorously updated carrying-capacity assessments are needed for the AmarnathYatra corridor and the Kashmir Great Lakes circuit, given the well-documented and sustained overshoot of the Lidder Valley's assessed daily carrying capacity during peak pilgrimage periods (Dialogue Earth, 2021).

9. Knowledge Gaps and Future Research Directions

Three priority research gaps emerge from this review. First, quantitative, updated carrying-capacity

assessments are almost entirely absent for the Kashmir Great Lakes trekking circuit, in marked contrast to the single, now more than a decade old, Lidder Valley assessment underpinning current AmarnathYatra policy discussion; comparable ecological threshold studies for Vishansar, Gadsar, Satsar, and Gangabal are needed as trekking volumes on this circuit continue to rise. Second, no study identified in this review directly attributes water-quality or contaminant loading in Dal, Wular, or Manasbal lakes specifically and quantitatively to the tourism-linked share of total pollutant inputs as distinct from resident-population and agricultural sources; source-apportionment studies separating tourism-attributable from resident-attributable sewage and solid-waste loading would substantially strengthen the evidence base for targeted tourism-sector interventions. Third, the socio-ecological resilience framework applied to Dal Lake (Sheergojri et al., 2023) has not yet been extended to Wular, Manasbal, or the high-altitude lake systems, despite each facing a structurally similar, if differently weighted, combination of tourism, climate, and land-use pressures; a comparative social-ecological resilience assessment across Kashmir's full lake portfolio would support more consistent, evidence-based prioritization of conservation investment across the region's tourism-dependent water bodies.

10. Conclusion

Tourism development in Kashmir is neither uniformly nor solely responsible for the region's well-documented pattern of lake degradation, but it is a consistently identified and, at several sites, now dominant contributing driver operating through sewage and effluent discharge, solid and plastic waste generation, shoreline and catchment encroachment for tourism infrastructure, and, at the region's high-altitude trekking and pilgrimage sites, direct visitor-volume pressure on ecologically fragile terrain that in some cases now substantially exceeds scientifically assessed carrying capacity. The evidence reviewed here spanning Dal Lake's houseboat-driven eutrophication, Wular Lake's catchment-level encroachment and siltation, Manasbal Lake's quarrying-linked species loss, and the AmarnathYatra corridor's documented carrying-capacity overshoot — indicates that Kashmir's tourism economy and its lake ecosystems are now locked in a genuinely reciprocal relationship: environmental degradation is beginning to measurably undermine the tourism revenue and community livelihoods that depend on these same lakes remaining ecologically and aesthetically intact. Closing the persistent gap between institutional conservation response and the documented scale of tourism-linked pressure — through sewerage extension, waste-management investment, encroachment enforcement, and binding,

science-based visitor caps at high-altitude sites — should be treated as inseparable from, rather than opposed to, the continued growth of Kashmir's tourism sector.

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