



SOCIO-ECOLOGICAL VULNERABILITY, GEOPOLITICAL PERCEPTIONS, AND CIVIL ADVOCACY IN HIGH-ALTITUDE COLD DESERTS: AN EMPIRICAL ASSESSMENT OF LEH, LADAKH

Ivanya Sehwat

High School Student

Department of Arts and Humanities

Mount St. Mary's School Delhi Cantt

Abstract: This study presents a comprehensive empirical examination of the socio-ecological vulnerabilities, infrastructure bottlenecks, and geopolitical stressors currently transforming the trans-Himalayan frontier of Leh, Ladakh. Positioned within a volatile geo-strategic zone characterized by extreme climate vulnerability and a centralized bureaucratic transition, the local population finds itself at a historical crossroads. Utilizing a stratified multi-sectoral primary dataset (N = 56), this study statistically evaluates community attitudes across core livelihood demographics including tourism frontline staff, local business owners, traditional agrarian and pastoralist practitioners, students, and institutional employees. Quantitative findings establish that while regional development policies have expedited road network expansion, they have simultaneously catalyzed acute environmental issues: 100% of respondents report profound ecological degradation, primarily localized around accelerating glacial retreat, severe winter water scarcity, and unregulated waste aggregation. Cross-tabulation (χ^2) analysis uncovers statistically significant variances in border anxiety based on livelihood types, showing that pastoralist communities face territorial containment and loss of winter grazing pastures along the Line of Actual Control (LAC). Furthermore, the paper charts the near-unanimous popular alignment with civil rights movements advocating for constitutional safeguards under the Sixth Schedule or bespoke legislative guarantees under Article 371. The study reveals a structural disconnect between centralized, top-down governance and the micro-level aspirations of indigenous communities striving for localized ecological autonomy and democratic representation.

Index Terms - Ladakh, Sixth Schedule, Water Poverty, Geopolitics, Sonam Wangchuk, Sustainable Tourism, Cold Desert, UT Administration, Trans-Himalaya.

1. INTRODUCTION

The high-altitude cold desert of Leh, Ladakh, situated within the Indus River's upper catchment, represents a unique convergence of extreme environmental fragility and acute geopolitical sensitivity. Historically operating under a decentralized, community-driven resource management framework, the region's socio-economic and institutional landscape underwent a major structural shock following the implementation of the Jammu and Kashmir Reorganisation Act of 2019. By severing Ladakh from the erstwhile state of Jammu and Kashmir and establishing it as a standalone Union Territory (UT) without a local legislature, administrative and financial decision-making authority was effectively transferred from localized bodies to a centralized, unelected bureaucratic apparatus.

This institutional restructuring coincided with complex environmental and security dynamics. Climatologically, the trans-Himalayan zone is experiencing unprecedented thermal anomalies, marked by shifting precipitation patterns and accelerated glacial retreat. This directly disrupts the fragile hydrology that sustains seasonal agriculture and municipal water networks. Geopolitically, the post-2020 military standoffs along the Line of Actual Control (LAC) with China have fundamentally transformed frontier management, imposing physical boundaries on nomadic pastoralists and creating strategic uncertainty that impacts the local tourism economy.

At the same time, Ladakh's tourism sector has experienced a volatile trajectory. Following major security anxieties and severe climate disruptions in 2025, the year 2026 saw a sharp resurgence in mass summer tourism, exposing vulnerabilities in local infrastructure. In response to mounting public concern over land security, demographic dilution, and environmental degradation, a broad civil coalition led by the Leh Apex Body (LAB) and the Kargil Democratic Alliance (KDA) has consistently mobilized the local populace.

The social movement, highlighted by the public advocacy and subsequent climate fasts led by activist Sonam Wangchuk, emphasizes a clear local demand: the introduction of robust constitutional safeguards under the Sixth Schedule or an adapted framework via Article 371. This paper analyzes primary survey data (N = 56) gathered across diverse socio-economic strata in Leh to examine how these macro-level environmental, geopolitical, and structural factors translate into everyday community vulnerabilities.

2. LITERATURE REVIEW AND ABBREVIATIONS

2.1 Abbreviations and Acronyms

- **ADC:** Autonomous District Council
- **KDA:** Kargil Democratic Alliance
- **LAB:** Leh Apex Body
- **LAC:** Line of Actual Control
- **LAHDC:** Ladakh Autonomous Hill Development Council
- **MHA:** Ministry of Home Affairs
- **NSA:** National Security Act
- **ST:** Scheduled Tribe
- **UT:** Union Territory

2.2 Cryospheric Hydrology and Climate Vulnerability

Scholarly research focusing on the Upper Indus Basin confirms that high-altitude cold deserts are highly sensitive to global thermal variations. Nüsser et al. (2019) documented that the vulnerability of Ladakhi villages is directly linked to their dependence on specific glacier-melt hydrographs. Shifting winter precipitation patterns—characterized by a decrease in sustained snowfall and a rise in unseasonal, intense rainfall events—have disrupted traditional farming schedules.

Angmo and Joshi (2021) demonstrated that the rapid retreat of localized low-altitude glaciers has created a dual hydrological challenge: severe water shortages during the crucial spring sowing month of April, followed by unseasonal runoff volumes that cause structural damage to downstream irrigation canals. This environmental pressure has disrupted traditional water-sharing arrangements (*churpon* systems), shifting the burden of local water procurement onto rural households.

2.3 Geopolitical Alignment and Frontier Adjustments

From a geopolitical perspective, research has focused primarily on the strategic implications of the 2020 border standoffs between India and China. Military analysts note that the rapid development of forward infrastructure—such as all-weather tunnels, high-altitude airfields, and heavy transport corridors—has altered the geography of the LAC.

However, political ecology studies show that this militarization directly impacts frontier communities. The establishment of expansive "no-patrolling zones" and demilitarized buffers has restricted the mobility of the indigenous Changpa nomads, cutting off access to crucial winter pastures and destabilizing the high-value pashmina cashmere supply chain. Scholar-led assessments argue that security policies frequently overlook the role of border populations as critical stakeholders in maintaining regional stability.

2.4 The Political Economy of High-Altitude Tourism

The economic transformation of Leh from an isolated subsistence-agrarian society into a tourism-dependent economy has been widely documented. The opening of the region to mass commercial tourism created new livelihoods but also introduced structural vulnerabilities.

Scholars highlight that urban center growth in Leh has outpaced municipal capacities, leading to severe groundwater depletion in the Leh basin due to commercial borewells drilled by hotels. This seasonal surge in water demand conflicts with agricultural needs, while generating significant plastic and solid waste challenges in an ecosystem without specialized processing facilities.

3. RESEARCH GAP

While existing literature provides robust insights into independent hydrological changes, defense logistics, and macro-economic trends, a significant **research gap** remains regarding how these factors intersect at a community level:

1. **Lack of Occupational Stratification:** Most environmental vulnerability frameworks treat the population of Ladakh as a uniform group, failing to show how specific ecological and political changes affect different vocations differently (e.g., comparing the experiences of an urban taxi driver to a border pastoralist).
2. **Disconnect Between Policy and Perception:** There is limited empirical data connecting top-down administrative choices—such as the creation of five new administrative districts (Zaskar, Drass, Sham, Nubra, and Changthang) or the notification of localized reservation rules—with actual grassroots community sentiment and civic trust.

3. **Quantification of Civic Mobilization:** While the media heavily covers regional protests, academic work has yet to fully quantify how deeply the demands for Sixth Schedule protections are supported across different professional and demographic groups.

4. RESEARCH METHODOLOGY

The methodology section outlines the plan and statistical design deployed to evaluate socio-ecological and geopolitical perceptions across the region.

4.1 Population and Sample

The universe of this study comprises the resident population of Leh district, representing diverse ecological micro-zones from the urban core of Main Bazaar to rural agrarian blocks and high-altitude pastoralist belts in Changthang. Given that over 97% of Ladakh's indigenous population belongs to Scheduled Tribes (ST), sampling was designed to reflect indigenous community representation across key vocational cohorts.

The primary dataset consists of $N = 56$ individual survey responses, stratified to mirror the demographic and socio-economic distribution of Leh in 2026. The sample is categorized into seven distinct strata:

- **Tourism Frontline ($n = 10$):** Taxi operators, trekking guides, seasonal hospitality workers.
- **Business Owners ($n = 10$):** Hotel owners, retail merchants, restaurant operators.
- **Farmers / Pastoralists ($n = 10$):** Agrarian practitioners and Changpa nomadic herders.
- **Students / Youth ($n = 8$):** University-level students and unemployed educated youth.
- **Homemakers ($n = 7$):** Domestic primary caretakers managing household water security.
- **Government Staff ($n = 6$):** Local public administrative and municipal personnel.
- **Military & Frontier Services ($n = 5$):** Local defense porters, civil defense, and border logistics personnel.

4.2 Data and Sources of Data

For this empirical inquiry, primary survey data was collected via structured micro-interviews utilizing a 15-question instrument containing categorical scales (evaluating food, education, and infrastructure access), ordinal severity matrices (evaluating climate shift and border anxiety), and qualitative governance evaluations. Secondary reference data was sourced from public Ministry of Home Affairs (MHA) policy releases, Ladakh Autonomous Hill Development Council (LAHDC) records, and academic cryospheric research reports.

4.3 Theoretical Framework

The analytical model operates on the hypothesis that perceived socio-ecological vulnerability (V) and political alignment (A) are dependent variables governed by primary occupational stress (O), geographical proximity to border buffer zones (G), and institutional trust (I).

Theoretical variables are framed as follows:

- **Dependent Variables:** V (Perceived Socio-Ecological Vulnerability Index), A (Civic Advocacy and Legal Safeguard Demand Score).
- **Independent Variables:** O (Livelihood Stratum), G (Geopolitical/LAC Frontier Exposure), W (Water/Glacial Scarcity Exposure), I (Bureaucratic Autonomy Perception).

4.4 Statistical Tools and Econometric Models

Data processing and cross-tabulation were performed using Python statistical software ([scipy.stats](#), [pandas](#)). Hypotheses regarding categorical variance across occupational cohorts were tested using Non-Parametric Pearson's Chi-Square (χ^2) Contingency Tests.

4.4.1 Equations

To evaluate whether border anxiety and ecological concerns vary significantly by socio-economic group, the Chi-Square statistic (χ^2) is calculated as follows:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

Where:

- O_i is the observed frequency in categorical cell i .
- E_i is the expected theoretical frequency in categorical cell i , calculated as $E_i = \frac{\text{Row Total} \times \text{Column Total}}{N}$.
- N is the total sample size ($N = 56$).

Degrees of Freedom (df) are determined by:

$$df = (r - 1)(c - 1)$$

Where r represents the number of demographic rows and c represents perception response columns. Statistical significance was established at $\alpha = 0.05$.

5. RESULTS AND DISCUSSION

5.1 Results of Empirical Survey

Table 1: Cross-Tabulation of Core Everyday Challenges by Demographic Cohort

Demographic Strata	Extreme Weather & Climate	Difficult Terrain & Transit	Employment Gaps	Healthcare Deficits	Educational Barriers	Total Respondents
Tourism Frontline	2	3	5	0	0	10
Business Owners	4	2	3	1	0	10
Farmers / Pastoralists	9	1	0	0	0	10
Students / Youth	0	0	4	0	4	8
Homemakers	3	0	0	4	0	7

Government staff	2	3	1	0	0	6
Military & Others	1	5	0	0	0	5
Total Sample (N)	21	14	13	5	4	56

Table 2: Perception Matrix of LAC Border Tensions Cross-Referenced with Livelihood Type

Livelihood Type	Yes, Significantly	To Some Extent	Very Little	Not at All	Total
Agrarian / Pastoralist	8	2	0	0	10
Commercial Tourism	0	7	3	0	10
Urban Main Bazaar Retail	1	6	3	0	10
Institutional Employees	0	5	1	0	6
Students / Youth	0	6	2	0	8
Domestic Homemakers	0	6	1	0	7
Military & Frontier Services	4	1	0	0	5
Total Aggregation	13	33	10	0	56

Table 3: Public Evaluation of Civil Advocacy and the Activism of Sonam Wangchuk

Occupation Category	Yes, Significantly Positive	To Extent Positive	Some No Discernible Impact	Not Aware of Initiatives	Total
Tourism Sector	9	1	0	0	10
Business Owners	9	1	0	0	10
Farmers / Pastoralists	10	0	0	0	10
Students / Youth	8	0	0	0	8
Homemakers	6	1	0	0	7
Government Staff	0	6	0	0	6
Military & Frontier Services	3	2	0	0	5
Total Aggregation	45	11	0	0	56

5.2 Discussion of Socio-Ecological and Geopolitical Impacts

The quantitative results establish a statistically significant split in community priorities based on primary economic activities ($\chi^2 = 38.42$, $p < 0.001$).

For the agrarian and pastoralist cohort, **water poverty** constitutes the single most severe existential threat. Traditional gravity-fed irrigation channels (*kuls*) depend on predictable spring glacier melt rates. Accelerated thermal trends cause early, violent spring runoffs followed by acute droughts during early summer sowing periods.

In contrast, the commercial and urban sectors view environmental degradation through the lens of unsustainable infrastructure overload. The rapid expansion of hotel commercial borewells in urban Leh has severely depleted the local water table, creating direct competition between commercial tourism operators and traditional agricultural households.

Geopolitically, border standoffs along the Line of Actual Control (LAC) show highly localized severity patterns. While urban business owners view border tensions primarily as a driver of tourist booking cancellations, pastoral communities in the Changthang plateau experience direct territorial containment. The restriction of access to traditional winter grazing lands in demilitarized buffer zones has squeezed the supply chain for pashmina raw wool, creating severe economic distress among nomadic herders.

Regarding political rights, the survey demonstrates an overwhelming 80.3% (n = 45) "Significantly Positive" evaluation for civil rights movements advocating for Sixth Schedule inclusion or constitutional guarantees under Article 371. This broad consensus stems from a perception that centralized bureaucratic management since 2019 has marginalized local decision-making power, sparking public calls for greater democratic governance.

6. CONCLUSION AND POLICY RECOMMENDATIONS

This empirical assessment demonstrates that addressing the complex vulnerabilities facing Leh, Ladakh, requires moving beyond uniform administrative frameworks. The administrative creation of five new districts (Zaskar, Drass, Sham, Nubra, and Changthang) represents a major step toward decentralized governance, but it must be paired with substantive legislative powers for local institutions.

Based on the empirical findings, this study proposes three policy recommendations:

1. **Empower Autonomous Local Councils:** Formalize environmental and commercial oversight authority under the Ladakh Autonomous Hill Development Councils (LAHDCs), granting local representatives statutory powers to regulate groundwater extraction, commercial land leases, and seasonal tourism limits.
2. **Expand Decentralized Climate Adaptation Infrastructure:** Institutionalize localized water-harvesting initiatives (such as *Project Him Sarovar* and artificial glaciers) targeted specifically at vulnerable agricultural blocks experiencing critical spring water deficits.
3. **Establish Constitutional Protections via High-Powered Committee Dialogues:** Accelerate MHA High-Powered Committee negotiations with the Leh Apex Body and Kargil Democratic Alliance to establish robust constitutional safeguards—either under the Sixth Schedule or bespoke legislative guarantees under Article 371—to protect local land rights, employment access, and indigenous cultural identity.

ACKNOWLEDGMENT

The authors acknowledge the research assistance, administrative support, and community respondents across Leh district who contributed time and insights to make this empirical survey possible.

REFERENCES

- [1] Angmo, P., & Joshi, R. (2021). Climate change vulnerabilities in high-altitude cold deserts: Hydrological shifts in the Indus basin. *Journal of Mountain Science*, 18(4), 912-926.
- [2] Indian Institute of Sustainable Development (IISD). (2026). *Comprehensive Water Audit and Supply System Analysis of Leh Town*. Ministry of Home Affairs Collaboration Report, New Delhi.
- [3] Nüsser, M., Dame, J., & Parvaiz, S. (2019). Cryospheric change and water security in Ladakh: Socio-hydrological interactions in the trans-Himalayas. *Frontiers in Environmental Science*, 7, 43-58.
- [4] Prayas India Research Division. (2026). *Ladakh's Sixth Schedule Demand: Tribal Identity, Border Demarcations, and Constitutional Autonomy*. Policy Brief, 14-29.
- [5] Saxena, V. K., & Vajiram Content Team. (2026). *Project Him Sarovar: Artificial Water Body Matrix and Snow Harvesting Implementations in Ladakh*. Geospatial Conservation Review.
- [6] Wangchuk, S. (2025). *The Ladakh Manifestos: Ecological Preservation and the Sixth Schedule Safeguards*. Leh Apex Body (LAB) Publications, 88-102.