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Melting Borders: Glacier Governance in the Hindu Kush Himalayas

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Figure 1. Aritificial glaciers in Zanskar, Ladakh. Photograph by Fabio Saitto.

An exploratory piece on the ecological, geopolitical and cultural interdependencies in HKH, drawing on research, field notes, data, and lived experience. Here the mountains act as a single, volatile system: glacial loss, monsoon shifts, military pressure, and transboundary rivers collapsing into one another, revealing an atmospheric region that doesn't respect any border it flows through. The case reads like a place already living in the future "Beyond Cloud Theft" dramatizes, where the weather is political, and risk travels faster than jurisdiction.

Part 1: The Entanglement of Risk

In the Hindu Kush Himalayas (HKH), ecology meets geopolitics. Variously known as the Water Tower of Asia and the Third Pole of the Earth, the region spans 3,500 km and supplies freshwater and vital ecosystem services to two billion people across sixteen countries (including three nuclear powers). It is home to some of the planet's most vital biodiversity, a site of deep civilizational heritage, and holds critical influence over global climate patterns.

For centuries, its landscapes have sustained livelihoods and fluid exchanges among peoples, species, and cultures. Snow leopards, bharal, and black-necked cranes rely on high-altitude corridors for seasonal movement and survival, just as pastoralists—like the Kuchis in Afghanistan's Central Highlands—navigate seasonal grazing routes. Buddhist pilgrim trails dating as far back as the 10th century connect sacred geographies across Ladakh, Mustang, Tibet, and beyond. Historic Silk Road arteries like Nathu La in Sikkim and Lipulekh in Uttarakhand remain active sites of seasonal cross-border trade between India and China, moving goods like raw silk, yak tails, and woolen textiles through landscapes once shaped entirely by altitude, rainfall, and kinship. But this deep ecological and civiliza-

tional interconnectedness is fractured by colonial cartography—arbitrary, ahistorical borders that have calcified into militarized fault lines, protectionist policies, and unresolved land disputes.[1]

When seen through the lens of the "global," HKH appears as a patchwork of national interests and strategic rivalries. But a planetary lens reveals it as a deeply entangled system of relationships and shared risks, where the futures of numerous ecologies and communities are mutually dependent.

Part 2: Unpacking Entangled Risks and Futures

The region is already feeling the weight of direct climate threats such as biodiversity loss, glacial melt, extreme flooding, and water scarcity. But these are just the visible edges of a much more complex risk terrain. What lies beneath is further risk of cascading impacts: infrastructure failure, food insecurity, mass displacement, and rising geopolitical tensions.[2] **These risks are not linear.** They interact with systemic amplifiers like the albedo effect, asymmetries in military power, and governance vacuums, creating feedback loops that surpass the capacity of a single nation or institution to manage.

In this piece, we explore some of the strands that make up this tangle of risks, drawing on the voices of those living and working in the region: experts in environmental history, glacial management, water governance, climate adaptation, and peace and security. Together, they help us trace the contours of planetary risk—and imagine what new forms of cooperation and resilience might emerge from within it.

1. Evolving Flood Regimes and the Weaponisation of Water

This dynamic of entangled, escalating risk is perhaps best embodied by the Yarlung Tsangpo (which becomes the Brahmaputra downstream), a dense network of interlinked tributaries which contribute not only water, but also sediment, rhythm, character, and temperament to the overall river system. Its inherent dynamism is shaped by long-term geological forces that have historically produced both volatility and opportunity.

For centuries, the primary drivers of flood risk in the river basin were the seasonal monsoon and sediment load, creating a largely predictable pattern of flooding and renewal. These monsoon-fed overflows replenished agricultural lands, sustained cultural practices, and supported diverse herbivore populations. As environmental historian Arupjyoti Saikia notes, "The flooding essentially helped the river to remain vibrant, remain dynamic, and also it gives life to the human and non-human actions." It created fertile lands, and allowed communities to grow rice, mustard, and jute.

Today, however, this once-predictable and life-giving dynamism is being radically reshaped by the combined forces of climate change and large-scale infrastructure development. Massive dam-building efforts—particularly the hydropower race between India and China along the Yarlung Tsangpo—have introduced entirely new and increasingly erratic flood risk profiles. "Dams release water very suddenly," Saikia explains, "forcing the releases to get inundated quickly." Erratic sedimentation patterns erode soil fertility, disrupt crop cycles, and destabilize the ecological chains supporting pastoral and agricultural livelihoods. Flooding, once a

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1 Notable colonial-era boundaries include the following: *Radcliffe Line*—drawn by Sir Cyril Radcliffe, a British lawyer with no prior experience in the region, in just five weeks during the hurried 1947 decolonization of British India. Created under Lord Mountbatten's direction to divide Punjab and Bengal along religious lines as part of the Two-State Solution, it directly established the India–Pakistan border and underpins the current Line of Control (LoC) in Kashmir, a site of repeated wars, insurgencies, and ongoing militarization. *McMahon Line*—negotiated by Sir Henry McMahon, then British Foreign Secretary in India, at the 1914 Simla Convention to secure a buffer zone against China in the Eastern Himalayas. China was excluded from the final agreement, rendering the line unrecognized by Beijing, as well as disregarding Tibetan consent. Today, it underpins India's claim to Arunachal Pradesh and China's rejection of the eastern sector of the Line of Actual Control (LAC). *Durand Line*—established by Sir Mortimer Durand in 1893 to formalize British India's northwest frontier and to contain Russian influence via Afghanistan during the "Great Game." The line fragmented Pashtun and Baloch tribal regions and remains unrecognized by Afghanistan, fueling instability along the Afghanistan–Pakistan border. *Johnson–Ardagh Line*—first surveyed by William Johnson (1865) and later formalized by Sir John Ardagh (1897–1899), the line represented Britain's maximal territorial claim in Ladakh and Aksai Chin as part of the Great Game strategy to counter Russian influence. It informs India's present claim in the western sector of the LAC, though China currently controls the region. *Macartney–MacDonald Line*—proposed in 1899 by Sir Claude MacDonald, British envoy to China, to settle border ambiguities by ceding Aksai Chin to China while retaining the Karakoram—an attempt to stabilize borders with the Qing Empire. Although unratified, China now cites it to legitimize its occupation of Aksai Chin, contrasting India's claim based on the earlier Johnson–Ardagh Line.

2 Zehra Zaidi and Prateek Shankar, *Crisis Landscapes at the Third Pole: Situational Risk Assessment of the Hindu Kush Himalayas* (Dark Matter Labs, June 2024).

3 The interviewee is the father of co-author Prateek Shankar, a fact acknowledged here in the interest of transparency.

predictable seasonal event deeply understood by communities living alongside the river, has become an unpredictable and systemic threat.

Simultaneously, control over water is increasingly at risk of being weaponized. "Water is [now] being used as an armament. Imagine if water is scarce on either side of the border, and there's a river flowing between the two countries: you open a dam and flood the other, you shut a dam and create drought," warns Major General Shankar,[3] former General Office Commanding of a strategic frontline Indian Army division in the northern region of HKH. He points to China's infrastructure development on upstream rivers as a serious concern: "China has created more than 80,000 check dams on the riverbeds in Tibet. They are harnessing this water. So how much is going to come into the Brahmaputra?"

Meanwhile, in response to India's recent suspension of the 1960 Indus Water Treaty,[4] Pakistan has accelerated plans for large-scale water infrastructure, reviving long-stalled projects like the Diamer-Bhasha and Kalabagh dams, and announcing a slate of nine additional sites. Prime Minister Shehbaz Sharif has insisted, "These dams are not political; they are a national necessity."[5] Yet hydrological trends note a sharp drop in Indus river flows in recent years, primarily due to climate change and upstream diversions.[6] Experts caution that without sufficient inflows, these dams risk becoming "white elephants,"[7] amplifying ecological stress and undermining the very resilience they aim to ensure.[8]

2. Ecological Kinship, Generational Knowledge, and Changing Livelihoods

Infrastructural development across the HKH is not only reshaping ecological landscapes but also transforming local economies and cultural practices—often with cascading environmental consequences. Improved road access, in particular, is accelerating shifts in land use, livelihood patterns, and in turn, water use, creating unsustainable feedback loops that compound existing vulnerabilities.

One example is the transition from subsistence farming to market-oriented agriculture, driven by new access to larger trade networks and growing demand for cash crops in international markets. In Ladakh, for instance, the opening of three new roads into the historically remote valley of Zanskar—previously only accessible by walking over a frozen river in winter—has triggered rapid transformation. "This region was totally cut off from the rest of the world for six months of the year. Now it's all of a sudden open to the world for twelve months," explains Lobzang Wangtak, a Ladakhi filmmaker and glacier conservationist. The resulting influx of tourists and commercial traffic threatens fragile high-altitude ecosystems and disrupts long-established agricultural practices.

"Earlier people used to grow food for themselves," Lobzang notes, "but now they are growing things to sell." This shift in agricultural focus not only affects soil and water use, but also accelerates the depletion of glacial meltwater, which many communities rely on for irrigation. Meanwhile, tourism has evolved from the long, immersive glacier treks of seasoned mountaineers to short-term, high-consumption visits from casual visitors—bringing with it increased waste, vehicle emissions, and infrastructure demands that further strain the region's delicate ecological balance.

These systemic shifts are destabilizing long-standing ecological relationships, especially for pastoralists whose cultural identities and land-based knowledge systems are deeply rooted in fragile alpine commons. The loss of land commons, the upward migration of treelines, and the changing availability of grazing grounds are disrupting the rhythms of herding communities like the Gaddi tribe, who have passed down grazing rights through generations. "It's sort of almost genealogical... my father and my grandfather had this land [so now I can graze on it]," explains Nisha Subramanian, co-founder of Kullvi-WHIMS, a grassroots social enterprise that works to empower Himalayan wool farmers and traditional artisans. Official grazing certificates formalize a seasonal rhythm and a form of "social contract," where herders coordinate use and avoid overgrazing. For the Gaddi, this relationship to land and animals is not only economic but spiritual. "[In] one of their creation myths [...] about Lord Shiva, Nisha says, [they describe] how he had bestowed the care of sheep and goats on this particular community [...] so they have this very special kinship with the animals. It's almost as if they are their relatives or brothers or sisters."

But this ecological kinship is increasingly fraying. "Younger people are moving out," Nisha notes."They're not interested in grazing anymore. So even that knowledge is going." It's not surprising, she adds, given the mounting complexities. The erosion of land commons—due to industrial development, land acquisition by the military or forest departments, and climate-driven landscape changes—is making traditional grazing paths inaccessible. "Suddenly the glacier that used to be there on our path has melted away. So now what do we do?" What once functioned as open grazing grounds or seasonal water bodies is now subject to new restrictions: conservation enclosures, fencing, or competing land

claims. “A lot of villages over time have closed off their routes to pastoralists,” Nisha explains. Grazing animals are increasingly seen as a threat to community-managed forests, and previously shared spaces have become contested terrains.

In high-altitude regions near sensitive border areas, these challenges are further intensified by security protocols. “You have to get a pass,” Nisha notes, “from the DC [District Commissioner], the police, and even the military at times.” Border flare-ups can bring movement to a complete halt. “If something has gone wrong at the border, they just close the movement.” The combination of ecological instability and policy barriers is eroding both livelihoods and intergenerational knowledge—a wealth of intelligence that has historically served the stewardship of the local ecology.

3. The Paradox of Water Abundance and Scarcity

As temperatures shift and snowfall becomes more unreliable, communities are experiencing a profound paradox: the simultaneous coexistence of water abundance and scarcity. This tension is especially stark in the high-altitude landscapes of Ladakh.

“Zanskar has the largest freshwater reserves in the whole of Ladakh. Ironically, its own villages are facing scarcity,” observes Lobzang. For decades, villages across Ladakh relied on traditional glaciers: small, seasonal accumulations of snow that melted gradually during spring. These sources once provided a reliable flow for irrigation and daily use. However, warming temperatures and increased variability in snowfall have disrupted this equilibrium, leaving many communities with water shortages despite their proximity to ice.

To cope, communities began building “artificial glaciers” i.e. check dams that freeze flowing water in winter to create reservoirs. Later, conical “ice stupas” were developed to slow melting by reducing the surface area exposed to sunlight. But Lobzang is frank: “We cannot call them solutions for that matter... a few days of really warm weather and it will all melt.” These techniques help in some locations, but not all villages have winter water flow. “It’s not replicable everywhere.”

In response, Lobzang’s group began moving away from reliance on snowfall and small traditional glaciers. “We’re not looking up at snowfall anymore... now we are looking down,” he says, referring to the rivers in Zanskar, given that a majority of villages in Ladakh lie near major rivers. They are now using pumps and pipes to bring river water up to fields during early spring. The model is low-cost and modular, but Lobzang is cautious. This infrastructure may last 10 to 15 years, but it depends on external funding and continued maintenance, and remains “just a band-aid solution”.

But water scarcity is not just a local challenge; it is reshaping and shaped by geopolitical relationships. As glaciers recede and water stress intensifies, long-standing bilateral treaties are coming under strain. Yet, as Ashok Swain, professor of peace and conflict research at Uppsala University points out, renegotiating these agreements is considered political suicide, despite the fact that they no longer reflect the realities on the ground—mirroring Maj Gen Shankar’s warning on the weaponisation of water.

4. Climate Borders and the Logics of Militarization

The ecological consequences of infrastructure, agriculture, and shifting water systems in the Himalayas cannot be separated from another powerful force reshaping the region: militarization. As climate change and geopolitical tensions escalate, military activity in ecologically sensitive zones has expanded—bringing with it a heavy environmental toll. India, China, and Pakistan together emit nearly one million

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4 United Nations, *Indus Waters Treaty between the Government of India, the Government of Pakistan and the International Bank for Reconstruction and Development*, United Nations Treaty Series, vol. 419, no. 6032 (September 19, 1960).

5 Syed Irfan Raza, “Premier Pledges to Defeat India’s Water Aggression with Resolve and Wisdom,” *Dawn* (Karachi), June 6, 2025, https://www.dawn.com/news/1915727.

6 Pakistan’s western rivers have declined by 11% (from 135.6 MAF in 1976–1998 to 120.8 MAF in 1999–2022), while eastern river flows have plummeted by over 68% in the same period (from 9.35 to 2.96 MAF). See: Nadeem Memon, “No Surplus Water,” *Dawn* (Karachi), June 16, 2025, https://www.dawn.com/news/1917442. Accessed June 18, 2025.

7 The phrase “white elephant” derives from Southeast Asian royal traditions, particularly in Siam (modern-day Thailand), where sacred albino elephants were revered but financially burdensome to maintain. In contemporary usage, it denotes large, costly projects whose maintenance outweighs their utility or benefit.

8 Memon, “No Surplus Water.”

9 Shakil A. Romshoo et al., “Anthropogenic Climate Change Drives Melting of Glaciers in the Himalaya,” *Environmental Science and Pollution Research 29*, no. 35 (2022): 52,732–52,751, https://doi.org/10.1007/s11356-022-19524-0.

10 Hydrometeorology (or hydro-met) is a branch of meteorology and hydrology that studies the transfer of water and energy between the land surface and the lower atmosphere.

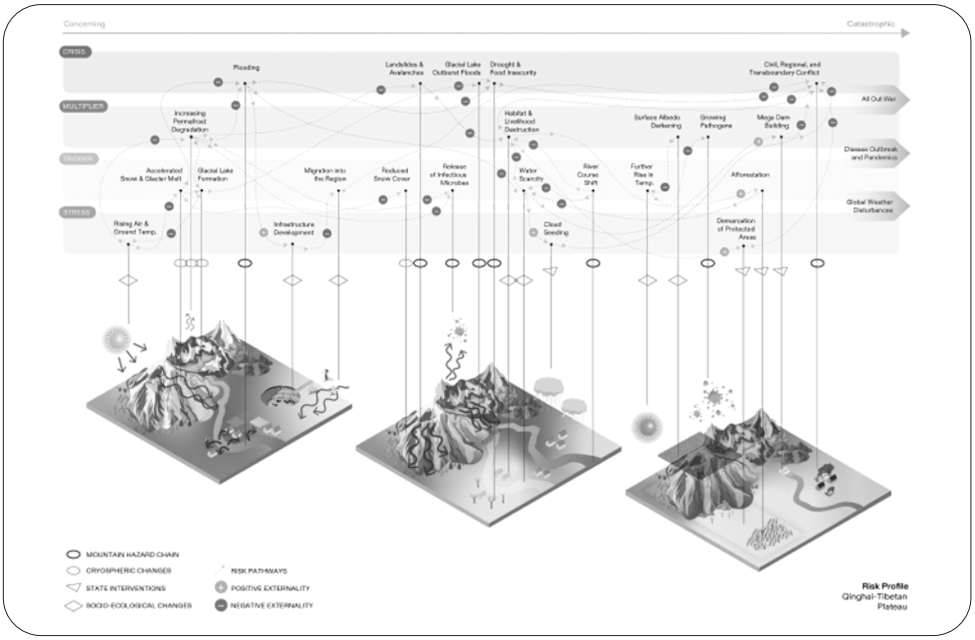

Figure 2. Illustrative 50-year risk profile of HKH. Visualization by Prateek Shankar.

tons of CO_2 in the region annually through military operations alone.[9] These emissions are especially damaging in high-altitude environments, where black carbon from fuel combustion accelerates glacier melt.

Yet, as Maj Gen Shankar explains, militarization is not a discretionary action but an operational imperative. "We are compelled to maintain posts at these heights to prevent adversarial incursions," he says. Following the deadly Galwan river valley clash between Indian and Chinese forces in 2020, over 30,000 Indian troops were airlifted into Ladakh within days, each sortie contributing to carbon emissions in an already fragile zone. Sustaining forward posts along more than 340 kilometers of glacial terrain requires continuous movement of personnel and materials, including kerosene heaters essential for survival in temperatures that can drop to -40°C. "Just imagine the amount of waste generated: food waste, human waste, material waste," Maj Gen Shankar reflects.

These operations often run adjacent to or through local villages. Communities become entangled in the security apparatus, with road construction, infrastructure, and even basic access shaped around strategic priorities. The cumulative environmental toll is vast.

Still, Maj Gen Shankar is clear: "Militarization has a negative impact, but it is a functional necessity. Imagine if we were to pull back." He describes this dilemma through what he calls the "climatization-securitization-militarization" triangulation, three interdependent logics shaping strategy in the Himalayas. Climate volatility generates new risks, which become security concerns in their own right. Securitization in this framing, means extending the logic of defense beyond territorial threats to include environmental risks that undermine state stability and livelihood, which in turn broadens the mandate of the military, drawing it deeper into environmental zones under the rationale of risk containment—despite the ecological costs it compounds.

Part 3: Opportunity Spaces for Planetary Risk Adaptation

The structure of risk in the HKH reveals a clear mismatch between the scale and complexity of the challenges and the institutional capacity to address them.

1. Reframing Policy: From Band-Aids to Basin-Wide Strategies

Current responses to water and ecological crises in the HKH are often reactive, piecemeal, and short-sighted. As Lobzang Wangtak notes, many so-called solutions, such as artificial glaciers or pump-based irrigation, are mere stopgaps. What is needed is a comprehensive, long-term water conservation policy for the Himalayas, that accounts for the entanglement of environmental flows, cultural practices and livelihoods, infrastructure develop-

ment and security realities.

2. Multistakeholder and Polycentric Governance

- **Community-Embedded Resilience:**

Opportunity lies in strengthening local governance structures and embedding polycentric approaches that recognize the agency and expertise of frontline communities. In Zanskar, Lobzang Wangtak describes how disputes over irrigation are often resolved not by regulation but by consensus and community trust. "There is a community-appointed water chief who oversees the system [...] Even if water is not reaching their land, they don't complain because they know that their turn will come." In Nepal, ICIMOD trained schoolteachers in flood-prone areas to read and relay early warning messages. "They were already involved in community processes and had the trust of the local people," Birendra Bajracharya, ICIMOD's Interim Senior Intervention Manager and former Chief of Party of SERVIR-HKH, explains. In one case, a teacher received a flood alert and contacted a cement factory operating along the riverbank. "He alerted the factory, and then they moved their stuff which was near the riverbank," Birendra says. "And actually, there was a flood that night. So they were able to save a lot of money because of his alerting the factory." Still, Birendra is careful not to overstate the reach of the model. "These are kind of sporadic success stories," he acknowledges. "To really mainstream the use of these tools, we need to have more institutional take-up."

- **Adaptive Diplomacy and Mesh Agreements:**

From bilateral agreements to regional and whole-of-river-basin cooperation, diplomacy must root itself in genuine multistakeholder approaches. Traditional multilateral forums are struggling to negotiate swiftly and inclusively on interconnected, boundary-transcending risks. In 2020, efforts to convene ministers from China, Bhutan, Nepal, Bangladesh, Pakistan, Afghanistan, and Myanmar to address shared environmental challenges took over two years and ultimately fell through due to COVID-19. This highlights the need for alternative diplomatic pathways that move beyond static hierarchies and take a more relational approach. Alongside formal Track 1 diplomacy, we already see Track 2 and Track 1.5 dialogues—blending state and non-state actors such as academics, religious leaders, retired senior officials and NGOs. As Marc E. Oosthuizen observes, "multilateralism is being replaced by multistakeholderism." Given the risk profile of the HKH, diplomacy may need to go even further—inviting ecologies and future generations into the conversation, or adopting "minilateral" strategies that enable smaller groups of regional and local actors to collaborate outside arenas dominated by traditional power. In "the global", diplomacy has long functioned as a narrow instrument of statecraft. Yet there is no room for zero-sum, winner-takes-all logic in a context where national interests are deeply entangled with collective outcomes. For "the planetary" to emerge, we must begin to think of diplomacy as a dynamic, relational, and distributed infrastructure–one that can reframe fragmented and competing sovereign interests through the lens of shared security, and engage actors across sectors and scales amidst different world-structuring logics, value systems, and horizons of risks. This shift requires moving beyond static hierarchies and siloed diplomatic tracks toward a more fluid, networked model–where states, corporations, communities, and ecosystems are linked through ongoing flows of information, influence, and resources. In this approach, diplomacy is no longer about discrete actors negotiating fixed positions, but about cultivating the relational infrastructure necessary for collective sensemaking and coordinated action. Dark Matter Labs calls this emerging orientation "mesh diplomacy." Changing environmental baselines are demanding dynamic rather than static agreements: Diplomacy must focus on negotiating for shared security and prosperity grounded in the recognition that enduring solutions require ongoing agreement-making. This means diplomatic agreements themselves can no longer remain static documents, negotiated once and referred to only in moments of crisis. They must become dynamic frameworks, adapting to shifting environmental baselines and evolving stakeholder commitments.

- **Data Sharing and Trust-Building Architecture:**

Critical here is the need to innovate the underlying architecture of trust-building, negotiation, and agreement-making that supports diplomacy. In the HKH region, data sharing between countries remains limited, often hindered by restrictive data-secrecy policies. While ICIMOD has developed systems for regional forecasts on high impact weather including floods—in practice, they could not issue alerts directly. "All the line agencies are obliged to stick to the government hydro-met[10] agencies." ICIMOD has supported national hydrological departments across the region to develop early warning systems and flood forecasts, and focuses on capacity building and installation of its tools inside official government systems, "not working in parallel, but working together." "Regional flood forecasts are very important," Biren-

dra Bajracharya explains, "[...] because floods don't really stop at the borders." The challenge, he notes, isn't technical. "The issue is whether the countries will be ready to share timely data [on issues such as river discharge]." Ultimately, forecasting itself remains politically sensitive. "If you make ten right forecasts and one wrong forecast, people again tend to lose their trust in the system," Birendra notes. But even embedded forecasts are sometimes ignored. Birendra recalls one instance in Afghanistan: "There was a drought outlook that we issued, and the government didn't believe it as there was some early rain. However, with the onset of time there was severe drought." Working in areas of such complex sociopolitical and climatological terrains is therefore a matter of delicate and consistent collaboration. Birendra nores, "[In the end], we worked together with the government to develop a drought response plant for the livestock sector". To get to meaningful agreements, we must rely on new forms of technological and procedural scaffolding that can actively help build relationships across differences, by addressing information asymmetries and disinformation that obstruct problem diagnosis, erode trust, and stall negotiations. Emerging tools such as AI, real-time geospatial tracking, and blockchain can help dynamically model trade-offs and align diverse interests through more adaptive, transparent processes. Meanwhile, metrics that track trust, reciprocity, and accountability can provide critical feedback loops to negotiators to enable them to identify breakdowns in negotiations and coalitions and design interventions to rebuild trust.

3. Military in Service of Cooperation, Adaptation and Resilience-Building

Alongside deterrence, Maj Gen Shankar underscores the military's growing role in disaster response—"whenever there's a flood, a flash flood, a landslide, a glacial lake outburst—we are the first to reach"—but argues for a more systemic shift in military strategy beyond crisis response under what he calls "greening the defence". He explains, "the first category of green defense is to see how much you can reduce your carbon footprints. The second is to say how much can you recycle your waste... And the third part is how deeply can you integrate the locals into your system." In Ladakh, for instance, local residents are increasingly recruited into military operations: "They are hardy people, they are born there, [and] they have a stake in what they need to do futuristically." For Maj Gen Shankar, this integration is not only operationally effective but also ecologically necessary, positioning the military as a potential partner in long-term adaptation and community-based resilience.

Conclusion

Rehearsing Planetary Responsibility

To see the HKH through a planetary lens is not to abstract its crises, but to more precisely locate them within the dense web of shared risks and responsibilities that define our current epoch. These mountains hold deep memories of seasonal rhythms, kinship systems, and socio-ecological contracts that long predate the nation-state. What is unraveling here is not just a set of biophysical systems, but the very architectures of trust, predictability, reciprocity, and cohabitation that have historically made life in this region possible.

The evidence is clear: systemic risks cascade, compound, and outpace the institutional tools we have to contain them. Yet scattered across this landscape are fragments of another logic: community-appointed water chiefs, teacher-led early warning systems, cross-border data flows, and soldiers who double as stewards. These are not yet a system. But they are signals. They point to the possibility of an alternate infrastructure that is distributed, dynamic, and deeply situated.

The task now goes beyond adaptation or resilience in the conventional sense, but a deeper reorientation: toward governance architectures that can hold contradiction, toward agreements that evolve with the climate, and toward security paradigms grounded in an understanding of shared vulnerability. It is a demand to rehearse responsibility at planetary scale: messily, urgently, and together.