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**EDITORIAL**

# Climate Extremes Are Redrawing Asia's Ecological Boundaries: Conservation Must Catch Up

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Across Asia, climate extremes have emerged as the primary drivers of ecological transformation. Heatwaves, monsoon irregularities, rapid glacier thinning, expanding glacial lakes and marine heat anomalies are reshaping ecosystems at rates far exceeding assumptions embedded in traditional conservation frameworks. These accelerating changes challenge static protected-area boundaries, infrequent monitoring cycles, and management strategies anchored in historical baselines.

Foundational studies published in the *Asian Journal of Conservation Biology* documented early signals of climate-driven change. Chettri *et al*. (2019) documented warming-induced range shifts in *Ophiocordyceps sinensis*, while Bhasin *et al*. (2023) highlighted degradation of high-altitude rangelands in Changthang. Together, these studies underscored the vulnerability of cold-adapted systems well before the recent escalation of climate extremes, which now necessitates a decisive toward climate-adaptive conservation approaches.

## Ecological Reorganization Across Asia

### *Himalayan Cryosphere: Rapid Decline and Rising Hazard Risks*

The Himalayan cryosphere has undergone profound transformation between 2015 and 2025. Satellite-based assessments reveal accelerated glacier thinning across the region (Hugonnet *et al*., 2021; Bolch *et al*., 2022; Miles *et al*., 2023). Recent modelling further suggests that Himalayan glaciers are more sensitive to climate forcing than previously estimated (Shugar *et al*., 2025; Sun *et al*., 2025). Rapid mass loss has driven widespread expansion of glacial lakes across Nepal, Bhutan, northern India and southern Tibet (Zhang *et al*., 2023), accompanied by increasing risks of glacial lake outburst floods (Rounce *et al*., 2023; Veh *et al*., 2024).

Alpine biodiversity is responding accordingly. Upslope migration, reduced regeneration, and increasing fragmentation have been documented among *Saussurea*, *Rheum* and, *Potentilla* species (Becker & Dorji, 2022; Dorji *et al*., 2024). The Himalayan pika is also experiencing climate-induced range contraction (Kafle *et al*., 2023). The ICIMOD Cryosphere Outlook (2023) concludes that cryospheric degradation is fundamentally restructuring hydrological regimes, biodiversity patterns, and downstream livelihoods across the Hindu Kush Himalaya.

### *Heat Stress and Structural Change in Southeast Asian Forests*

Extreme heatwaves recorded between 2022 and 2024 exceeded thermal tolerance tresholds for dominant forest species across parts of Thailand, Laos, Myanmar, and Peninsular Malaysia, resulting in canopy desiccation, leaf loss and localized mortality (Wijeyeratne *et al*., 2023). Heat stress reduces photosynthetic efficiency \ and accelerates shifts toward heat-and drought -tolerant species assemblages (Peng *et al*., 2024). These pressures also facilitate invasive species expansion, pushing some forest ecosystems toward novel states characterized by reduced resilience. Similarly, increasingly frequent and intense extreme weather events in Indonesia have led to habitat destruction, wildfires, soil erosion, altered water availability, and the proliferation of invasive species. The impact on biodiversity are extensive, affecting not only species directly exposed to these disturbance but also those dependent on specific environmental conditions survival (Priatna & Monk, 2023).

Repeated climate extremes have disrupted phenological cycles and increased mortality among amphibians and pollinators, there by amplifying ecological instability. With shortened recovery intervals, several forest systems may be approaching ecological thresholds beyond which structural recovery becomes increasingly unlikely.

### *Monsoon Instability and Freshwater Vulnerability*

Asia's monsoon systems have become increasingly erratic, producing abrupt cloudbursts, prolonged droughts, and severe floods. These changes have altered discharge regimes in the Ganges, Brahmaputra and Mekong river basins (Tan *et al*., 2024), disrupting sediment transport processes, spawning migrations, and floodplain dynamics. Additional pressures from hydropower development, irrigation expansion, and land-use change further exacerbate hydrological instability. Rising variability in flow and sediment flux

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within the Ganges–Brahmaputra basin has already been documented (Dandekar & Ahmed, 2023), with significant ecological and socio-economic consequences.

### *Marine Heatwaves and Coral Reef Decline*

Marine heatwaves intensified sharply during the period 2022–2024, triggering mass bleaching across the Indo-Pacific—including the Andaman Sea, South China Sea, and Coral Triangle (Subramaniam & Wu, 2024). Sustained thermal stress has suppressed coral recruitment, altered reef architecture, and reduced reef-associated fish diversity (Hughes *et al*., 2024). As recovery windows continue to narrow, many reef systems face the prospect of long-term degradation or collapse, threatening coastal fisheries, biodiversity, and natural shoreline protection.

### *Human Dimensions of Climate-Driven Change*

Climate extremes increasingly undermine food security, water availability, human health, and livelihoods across Asia. Glacial hazards, fisheries decline, and agricultural failure are contributing to rural–urban migration and intensifying resource-related conflicts. Urban heat islands exacerbate health risks but also highlight opportunities for conservation intervention through nature-based solutions, including urban forests and wetlands restoration. Integrating ecological resilience with social and economic considerations is therefore essential for climate-adaptive planning.

### *Limitations of Current Conservation Approaches*

Contemporary conservation practice remains largely structured around assumptions of ecological stability. Protected areas rarely account for rapid species redistribution, while annual or seasonal monitoring regimes are insufficient to capture fast-onset disturbances such as coral bleaching events or rapid glacial lake expansion (Ahmed & Dhillon, 2023). Governance frameworks often fail to incorporate climate projections, and financial constraints limit the capacity for rapid response. Meanwhile, infrastructure expansion - including hydropower and transportation projects - frequently overlooks climate–ecology interactions, resulting in maladaptive outcomes.

### *Toward a Climate-Adaptive Conservation Paradigm*

A climate-adaptive conservation approach requires flexibility, anticipation, and responsiveness. Key priorities includes:

1. **Dynamic protected-area networks** that integrate predictive modelling to identify climate refugia and future habitat corridors, supported by the conservation of genetic diversity through seed banks, ex situ programs, and targeted assisted gene flow.
2. **Next-generation monitoring systems** combine remote sensing, automated sensors, environmental DNA and community-based reporting to enable near-real-time ecological assessment and early warning capabilities.
3. **Regional and transboundary cooperation** for glacier-fed river systems, migratory species, and shared marine ecosystems, supported by harmonized monitoring protocols and joint climate-risk assessments.
4. **Climate-resilient restoration strategies** emphasizing climate-tolerant native species, resilient coral genotypes, and hydrologically buffered wetland systems.
5. **Empowerment of Indigenous peoples and local communities** through tenure security and participatory governance mechanisms to strengthen both social and ecological resilience.

## CONCLUSION

Climate extremes are redrawing ecological boundaries across Asia at unprecedented speed. Cryospheric decline, heat-induced forest transitions, monsoon instability, and coral reef degradation collectively demand a shift toward a flexible, anticipatory, and socially grounded conservation paradigm. The *Asian Journal of Conservation Biology* has played a critical role in documenting early climate-driven ecological responses and remains central to guiding transformative conservation action as climate volatility continues to intensify.

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