Climate Change in the Himalayas: Mushrooms as Sentinels of an Ecosystem in Peril

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In the towering peaks of the Nepali Himalayas, climate change is not an abstract concept but a lived reality, transforming ecosystems and communities at an alarming pace. The region's glaciers—the "water towers of Asia"—are retreating faster than almost anywhere else on Earth, threatening water and food security for billions of people downstream. Amid this unfolding crisis, one overlooked ecological indicator may hold critical insights: the region's diverse mycoflora, or mushroom species. The Himalayan region has long been recognized as a biodiversity hotspot, but its fungal diversity remains understudied despite playing crucial roles in these fragile mountain ecosystems. As climate patterns shift, these sensitive organisms are responding in ways that merit our urgent attention.

Water resources under threat.

The Hindu Kush Himalaya Assessment Report, prepared by the International Centre for Integrated Mountain Development (ICIMOD), projects that Nepal's Himalayan glaciers could lose up to 80% of their volume by year 2100 if global warming continues unchecked. Himalayan glaciers are the water source for 10 major Asian river basins that provide fresh water to over a billion people. Eventually too much water will lead to too little, the report from ICIMOD warns. This isn't a distant concern—the effects are already evident in many mountainous parts of Nepal. Sonam Jangbu Sherpa, a high-altitude mountain guide and lifelong resident of Phortse Village—one of the oldest Sherpa settlements in the Khumbu (Everest) region—has witnessed these changes firsthand. "The glaciers above our village have retreated so much that places my father described as ice-covered are now bare rock," he said. "Our farming patterns that worked for generations no longer match what the weather gives us." This testimony from Phortse, situated at over 3,800 meters in elevation, provides crucial ground-truth for scientific observations.

Glacial Lake Outburst Floods (GLOFs) are another significant threat to the region and its people. On August 16, 2024, Thame village in the Khumbu experienced a devastating flash flood and mudslide triggered when two glacial lakes outburst above the village. It was market day in Namche Bazaar, the schools were closed, and many of the village residents had gone to Namche or Kathmandu. While Thame's roads and many of its homes were destroyed, these lucky coincidences spared the lives of its villagers.

New threats to food security.

Climate change is disrupting food security across the region in unexpected ways. In Phortse, the challenge isn't primarily water-related but rather the emergence of new pests that never previously

Image source: depositphoto.com

Meconopsis betonicifolia, blue poppy.

survived at such elevations. "We used to grow potatoes and buckwheat without major problems," explains Sonam. "Now our crops face insect pests we've never seen before. These insects couldn't survive our cold winters in the past, but with warmer temperatures year after year, they've moved up the mountains and reduced many potato harvests. This is entirely new for us—our traditional knowledge has no solutions for these pests." This agricultural challenge represents just one facet of the complex ecological shifts occurring throughout the Himalayas. As warming temperatures allow lowland species—both beneficial and harmful—to expand their ranges upward, high-altitude communities face unprecedented disruptions to systems that have sustained them for centuries.

Mushrooms: the ecological canaries.

This is where mushrooms enter the narrative as ecological sentinels. Jair Putzke, in *The Diversity of the Fungal World*, states that "Fungi exhibit a high sensitivity to changes in the ecosystem, making them valuable indicators of environmental shifts and subjects of study." In Sagarmatha National Park in Nepal, mycologists and the indigenous Sherpa have observed changes in mushroom fruiting patterns. These shifts carry profound implications. Many mushroom species form mycorrhizal relationships with trees, which are essential to watershed protection. When fungal communities change, forest health can deteriorate, further compromising slope stability and water regulation. Additionally, numerous edible mushroom species serve as critical dietary supplements and income sources for Himalayan communities.

Pioneering myco-conservation and safety education.

At the forefront of efforts to understand and protect Nepal's fungal diversity is my friend Dr. Shiva Devkota, one of Nepal's leading mycologists. According to Dr. Devkota, nearly 1,300 wild mushroom species have been documented in Nepal. Through his work with my company, International Mountain Trekking (IMT), Dr. Devkota has led a myco-tourism program to document the country's rich mycoflora while creating sustainable economic opportunities for local communities. Dr. Devkota's approach brings together academic scientists, foreign researchers, and citizen scientists to find, identify and catalog Nepal's mushroom species.

The first collection of *Amanita tullossiana* in Nepal.

Boletus "edulis."

Dr. Shiva Devkota with a *Leccinum* species.

Working in collaboration with IMT, Dr. Devkota has developed an innovative model for myco-tourism that attracts visitors interested in fungal biodiversity while generating income for local communities traditionally dependent on more precarious and seasonal livelihoods. Equally significant is Dr. Devkota's work on mushroom poisonings through his Mushroom Safety Project, supported by the Himalayan Climate & Science Institute (hcsi-nepal.org). This vital initiative addresses a growing social and physical concern. "Climate change is creating confusion," Dr. Devkota explains. "Species that never grew in certain areas are appearing where they weren't known historically. This creates dangerous situations where villagers might mistake a newly arrived toxic species for a familiar edible one." Through the Mushroom Safety Project, Dr. Devkota leads workshops in vulnerable communities, distributes identification guides in local languages, and maintains an emergency consultation service for suspected poisoning. "We've seen a reduction in reported poisoning cases in villages where we've conducted our educational programs," Dr. Devkota notes. "This work saves lives while also preserving traditional mushroom foraging practices that are central to many communities' food security and cultural identity."

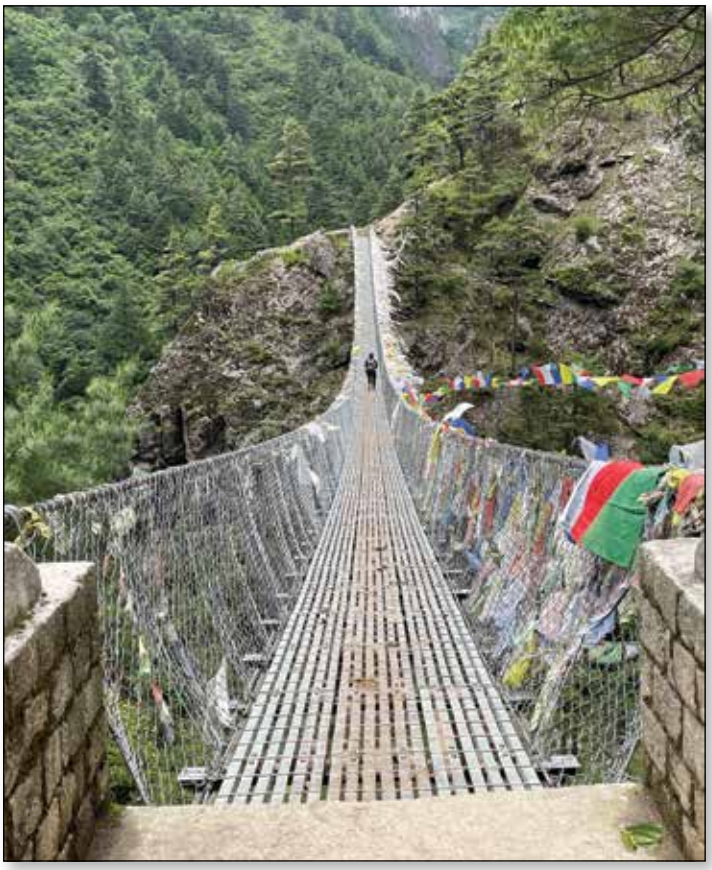
Dr. Devkota's myco-tourism work is particularly significant in the context of the work of high-altitude guiding in Nepal's Himalayas. Being a high-altitude guide can be an important source of employment and economic security, but it comes with considerable risks. Sonam, who has guided clients in Nepal's Himalayas including Everest from both the north and south faces told me: "During an Everest climb, our clients might make a few trips through the Khumbu Icefall, but Sherpa guides make a dozen or more trips through the same dangerous section. We carry the heavy loads, fix the ropes, and face the highest risk." Statistics from the Khumbu Climbing Center in Phortse demonstrate that Sherpa guides are often five times more likely to suffer fatal injuries compared to foreign climbers. In the early morning of April 18, 2014, seracs on Mt. Everest broke off the mountain, resulting in an avalanche of ice that took the lives of 16 Sherpa guides and porters who were hauling loads of gear. Asleep in their tents, no foreign climbers were killed. "The mountains have always been dangerous," Sonam continues, "but climate change makes them more unpredictable. Warming temperatures destabilize the ice. What was solid climbable ice 20 years ago might now collapse under your feet." The seasonal nature of mountaineering work further compounds economic vulnerability. Most major climbing expeditions occur during the early spring, leaving guides with an uncertain income for much of the year. By contrast, myco-tourism can operate across multiple seasons taking advantage of the rich and biodiverse region, offering more stable employment while reducing exposure to the most extreme dangers of high-altitude guiding.

Mitigation strategies: present and future.

Addressing these interconnected challenges requires action at multiple scales. Locally, efforts to document both scientific and indigenous knowledge about Himalayan mushrooms must be prioritized before this information is lost. Community-based monitoring programs that track fungal fruiting patterns could provide valuable early warning signals of ecosystem stress.

For food security, diversification and adaptation are essential. While maintaining traditional crop varieties where possible, communities must find ways to address new threats. In Phortse, some families have begun experimenting with natural pest deterrents and plastic greenhouses to protect potato crops from both insects and increasingly unpredictable weather patterns. "We're learning to adapt," notes Sonam, "but it requires new knowledge. We're combining what our elders taught us with new techniques. Some families are now growing different potato varieties more resistant to these new pests, while others are diversifying with crops our ancestors never needed to grow at this altitude."

The myco-tourism model pioneered by Dr. Devkota and IMT represents one promising approach to economic diversification.



Superlatives everywhere in Nepal: tall bridges, and mushrooms. The Hillary Bridge (aka the "Epic Bridge") (top) spans the Dudh Koshi River 410 feet below, making it one of the highest pedestrian suspension bridges in the Himalayas.

By creating value from biodiversity conservation rather than resource extraction, these programs align ecological and economic interests. Early results suggest that communities engaged in myco-tourism develop stronger conservation ethics while reducing dependence on more dangerous livelihood strategies. "Many young Sherpas feel they have no choice but to work as high-altitude guides if they want to support their families," Sonam reflects. "If we had alternatives like the mushroom tourism that Dr. Devkota and IMT are developing, maybe fewer of my friends would risk dying on the mountains. Maybe our children could earn good livelihoods without risking their lives." The Mushroom Safety Project demonstrates how scientific knowledge can directly save lives while building community resilience. As climate change introduces new ecological risks, such initiatives bridge the gap between traditional knowledge

systems and emerging challenges.

At national and international levels, stronger climate policies remain essential. Nepal's contribution to global emissions is minimal, yet it bears disproportionate climate impacts. Developed nations must fulfill climate finance commitments to support adaptation in vulnerable regions like the Himalayas.

The noble mushroom—seemingly insignificant amid towering peaks—may ultimately prove to be one of our most valuable allies in understanding and responding to climate change in this critical region. By paying attention to these fungal sentinels and the communities who know them best, we gain precious insights into an ecosystem in peril. The time to listen—and act—is now.

Richard Silber is the Executive Director of International Mountain Trekking. To learn about joining IMT and Dr. Devkota on a mushroom expedition in Nepal, please go to IMTNepal.com.

Article photos courtesy B. Bunyard.