Lumbini to LoManthang (L2L)

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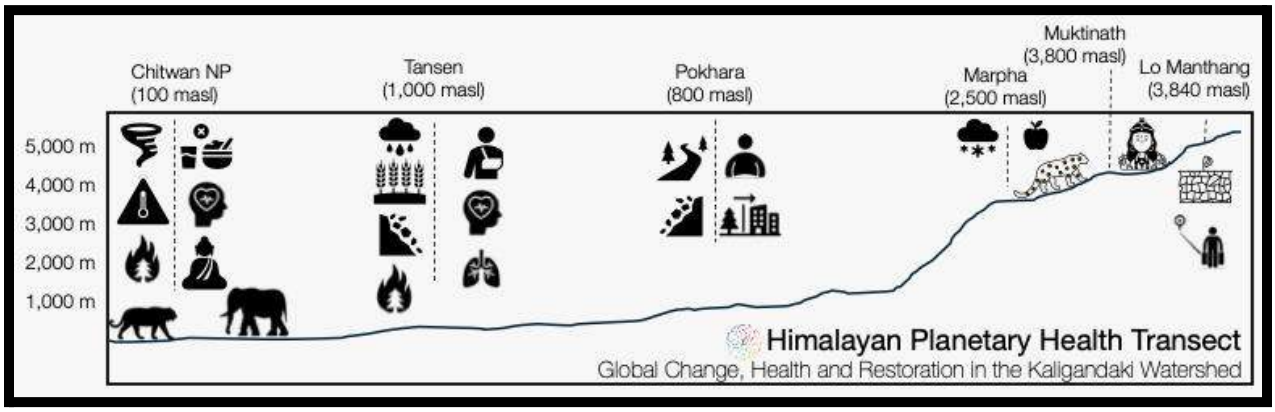
PlanetLab, Duke University, USA (Primary funding institution)
The Himalayan University Consortium, Nepal (Contributor)
Forum for Energy and Environment Development, Nepal (Implementing Institution)
Institute of Himalayan Risk Reduction (IHRR), Nepal (Implementing Institution)
Karma Flights Foundation, Nepal (Implementing Institution)

1. Overview

The Climate & Health+ Lumbini to Lo Manthang (L2L) Transect is an innovative interdisciplinary initiative designed to explore the acute impacts of climate and social change on human health and on the diverse ecological and cultural landscapes of Nepal.

Globally, rising temperatures, shifting rainfall patterns, and biodiversity loss are undermining the very foundations of planetary health, which recognizes that human well-being is inseparable from the stability of Earth's natural systems. The people of Nepal face these challenges in particularly acute ways: from heat stress and flood hazards in the Gangetic plains to erratic monsoons triggering landslides in the Middle Hills and declining snowpack in the high mountains that threatens water security for millions. The pressures of globalization and rapid development further compound these climate-related hazards. Infrastructure expansion has altered landscapes, food production and increased disaster risks, while outmigration, urbanization, and shifting land use are redefining the environmental determinants of health in complex ways. Gender imbalances, social hierarchy (casts and ethnicity) and religious diversity further impact how communities and individuals interact with land and landscapes.

To investigate these interconnected challenges, the L2L field school brought together students and faculty from five countries, each bringing with them a diverse range of educational and professional backgrounds, for a three-week interdisciplinary field transect through the Lumbini and Gandaki Provinces of Nepal. The academic and cultural diversity of the transect team provided a unique opportunity for the multidisciplinary exploration of Nepal and Planetary



Health, while creating lifelong globe-spanning connections.

Nepal's unparalleled topographic, climatic, ecological, economic, and cultural diversity positions it as a living laboratory for students to experience the real-world intersections of climate, health, and development. By linking global discourses on planetary health and sustainable economies to local realities across the transect, the program not only fostered academic learning but also provided practical insights expected to inform equitable, health-focused environmental interventions across the Himalayan region. We also fostered experiential learning through a multi-day trek through mountain landscapes to observe land use

changes and experience the challenges of traveling at high altitude. Introducing participants to Nepal's culture and religion, as well as their influence on society, was essential for building a comprehensive understanding of the country's issues and social infrastructure, providing a complete picture of community health and connectedness, and their resulting impact on the natural environment.

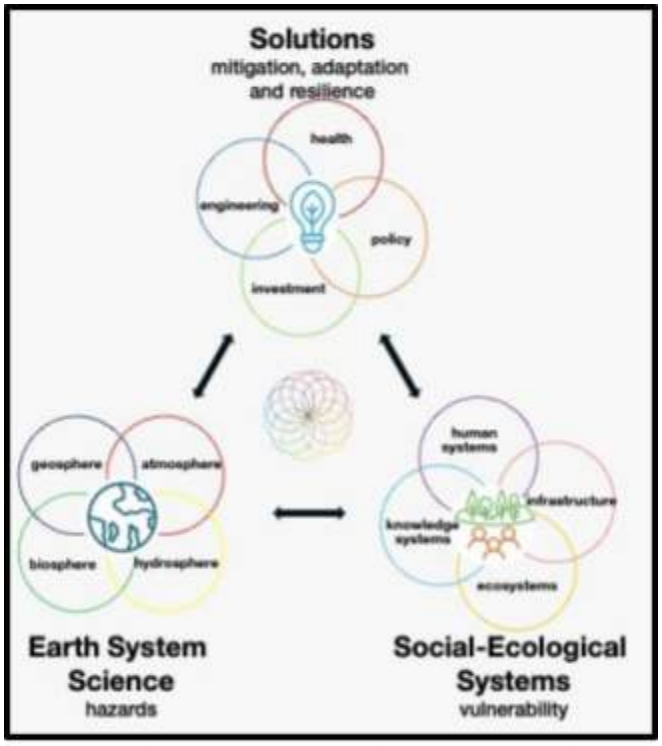
The team discusses environmental shortfalls along a trek through the Annapurna foothills towards Muktinath.

Along the journey, participants witnessed changes in climate and land-use and their direct implications for human health; they engaged with local officials, community leaders, researchers, and NGOs to better understand adaptation strategies in diverse ecological and cultural contexts; equally important, participants documented lived experiences through photojournalism, using visual storytelling to capture the human face of climate change. Through these experiences, students gained a new understanding of the human relationship with the environment and have been inspired to view the global challenges of their careers and research through the lens of Planetary Health.

2. Guiding Conceptual Frameworks

2.1) Planetary Health

Planetary Health provides the central conceptual lens for the Transect, situating human wellbeing within the boundaries of Earth's natural systems. As articulated by *Myers and Frumkin (2020)*, the rapid expansion of population, consumption of resources, and the use of high-impact technologies have pushed human activity beyond the planet's capacity to regenerate resources or absorb waste, in turn disrupting climate, biodiversity, freshwater, and land systems in ways that profoundly shape health outcomes. Importantly, such impacts are not evenly distributed, with vulnerable communities bearing disproportionate burdens. Planetary Health therefore calls for a systems-oriented, equity-driven approach that recognizes both risks and co-benefits, such as how climate mitigation can simultaneously improve air quality and reduce disease.



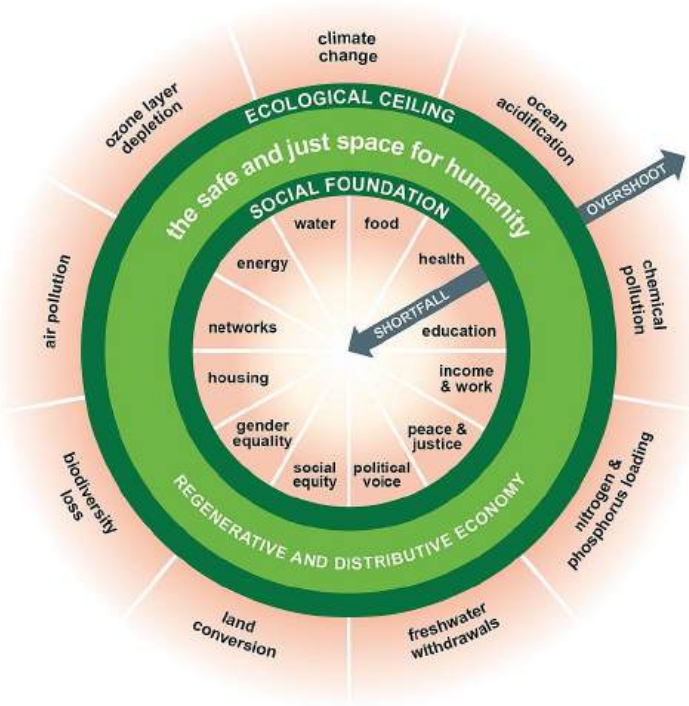
Planetary Health infographic illustrating the balance between social foundations and ecological ceilings across Transect sites (Adapted from Duke University PlanetLab)

By weaving together global conceptual models and local empirical insights, Planetary Health offered a powerful framework for the Transect. It enabled us to see how planetary boundaries shape the conditions for life at the community scale and how community actions—whether the conservation of sacred landscapes in Lumbini or adaptation to climate extremes in Mustang—are integral to sustaining planetary resilience. Ultimately, this perspective underscores the urgency of adaptive, community-centered interventions that safeguard both ecosystems and human wellbeing, ensuring that health is protected not in isolation but as part of a thriving and resilient Earth system.

2.2) The Doughnut Economic Model

The Doughnut is a visual framework for sustainable development that combines the concept of planetary boundaries with the complementary concept of social boundaries. The centre hole of the model depicts the proportion of people who lack access to life's essentials, such as healthcare, education, and social equality, while the crust represents the ecological ceilings, or planetary boundaries, on which life depends and must not be overshot.

The concept was developed by University of Oxford economist Kate Raworth in her 2012 Oxfam paper, "A Safe and Just Space for Humanity." She aimed to regard the performance of an economy by the extent to which the needs of people are met without overshooting Earth's ecological ceiling. The primary objective of the model is to reframe economic challenges while



establishing goals for globally conscious economic development. Per the doughnut, an economy is considered prosperous when all twelve social foundations are met without overshooting the nine ecological ceilings. This situation is represented by the area between the two rings, which its creator believes is a “safe and just space for humanity.”

In the context of the Transect, the Doughnut model offers a valuable complement to the Planetary Health framework. Where Planetary Health emphasizes the health pathways linking environmental disruption to human wellbeing, the Doughnut situates those pathways within a broader economic and societal lens. By integrating these perspectives, the Transect demonstrates how local challenges can be interpreted as both planetary boundary transgressions and social foundation gaps, underscoring the need for adaptive and multidisciplinary strategies that operate within the safe and just space.

2.3) Photojournalism and Visual Storytelling

One unique aspect of this program was the integration of photojournalism as a documentation tool, a form of storytelling, and one type of experiential learning praxis. Under the instruction of photojournalist Tom White, students were introduced to the ways photography-led journalism pairs images with written narratives, conveying stories in a more powerful and memorable way. Each day, students captured photographs, collected stories via observations and both formal and informal interviews, and recorded reflections in their field notebooks. These visual and narrative records were reviewed, tagged, and indexed with Planetary Health terminology, enabling connections between personal experiences and broader global frameworks.

The power of photojournalism lies in its ability to have a profound immediate impact. Research shows that images can communicate complex information instantly, make events more tangible, and remain in memory far longer than text. In the context of the L2L program, photojournalism enabled participants to both document their journey and amplify the voices, experiences, and environments they encountered, transforming observations into compelling visual narratives that resonate beyond the written word. This experience also taught students an invaluable communication skill for use in research applications and beyond.

3. Key Themes

Together, students identified five thematic takeaways for reflection and future exploration after the transect. This report's narrative excerpts are drawn from essays addressing these themes, which have inspired research projects, institutional partnerships, and lasting perspectives for transect participants to bring to their various academic and career fields. These themes will also provide a groundwork for future transect teams to explore.

Theme 1: Urbanization, Pollution, and Public Health

Across Nepal's growing towns and valleys, urban life reveals both vitality and strain. Expanding roads, tourism, and commerce have brought opportunity and mobility, but they have also deepened inequality and environmental stress. Rising air pollution, contaminated waters, and unmanaged waste illustrate how human health is inseparable from the condition of the environments they inhabit. What emerges is a story of interconnected vulnerability. The health of the environment falters, and so too does the well-being of the community. The transect underscored that public health cannot be isolated from the natural systems that sustain it.

Theme 2: Environment, Ecosystems, and Biodiversity

Moving through Nepal's forests, lowlands, and mountainous foothills made visible how deeply life is dependent on them. Forest cover, fertile soils, and thriving biodiversity sustain food, water, and livelihoods, yet these systems are increasingly fragile under the weight of climate change and human activity. Each ecosystem was experiencing significant changes, including the shrinking of wetlands, the migration of forests, and pressure on species. As a result of natural degradation, communities are adapting to altered rainfall patterns, disease outbreaks, and shifting harvest seasons. Maintaining living systems is not only an act of preservation but a commitment to creating healthy futures.

Theme 3: Climate Change, Hazards, and Resilience

From the humid plains to the frigid plateau, climate change revealed itself not as a single crisis but as a series of lived disruptions. Ongoing environmental changes bring about physical and mental damage, and simultaneously push people to adapt and innovate. Practices of local communities in Nepal taught us that resilience is less about overcoming nature and more about learning to live with change. Communities persist through cooperation, tradition, and ingenuity to create solutions that make sense for their specific experiences.

Theme 4: Mental Health and Well-Being

The human consequences of environmental change were not only physical, but also emotional. Across regions touched by disaster, people spoke of fear, exhaustion, and loss. These stories revealed that floods and landslides leave invisible wounds as lasting as any physical scar. Upon listening to these accounts, we understood that well-being encompasses safety and belonging, and the health of individuals reflects the health of their surroundings. Gender and social hierarchies, such as caste systems, were found to be major determinants of well-being and mental health. Further, they often impacted individuals' views on their society and the surrounding environment.

Theme 5: Culture, Heritage, and Human–Nature Relations

Cultural landscapes across Nepal demonstrate an enduring dialogue between people and the natural world. Sacred mountains, ancient monasteries, and seasonal rituals embody ways of knowing that tie survival to respect for the land. These traditions offer insight into how societies have long navigated uncertainty through reverence and shared memory. Religious and linguistic diversity are factors that influence how communities manage land and interact with nature. The transect demonstrated that culture and shared tradition can be a form of resilience.

4. The Transect

4.1) Kathmandu

We began our adventures in Nepal in Patan (also known as Lalitpur), a neighboring city to Kathmandu in the Kathmandu Valley. Here, participants and organizers met together for the first time after globe-spanning journeys for some and, for others, a drive across town.

At Patan's Kathmandu Guest House, our students received a primer on various aspects of Nepal's geography, culture, economic systems, and natural disasters. We had the opportunity to hear each of our program organizers and multiple guest speakers discuss their expertise and how it relates to our journey, from disaster risk reduction to photojournalism. We also underwent deep instruction regarding the concepts of planetary health and doughnut economics as guiding frameworks for our transect. At the same time, we learned about each other's backgrounds, interests, and cultures, becoming excited to collaborate and live together on our transect.

Spending a few days in Kathmandu revealed an intricate cultural network and complex human-environment interactions. Among streets lined with temples and multi-generational artisans, the city's collective identity and continuity were unique and beautiful.

In a cultural tour of our neighborhood in Patan, we observed traditional infrastructural practices unique to the region. Local artisans maintain handcrafted wooden windows, lattices, and stone idols throughout the neighborhood; we learned that locals believe in replacing individual pieces of temples as they degrade, rather than implementing costly and environmentally damaging retrofits–a practice that demonstrates strong cultural continuity.

Earthquake restoration efforts in Patan, following the 7.8 magnitude earthquake of 2015, highlight the integration of modern resilience planning with heritage preservation. Seismic retrofitting and reconstruction of the historic Patan Durbar Square respect traditional architecture, while ensuring the structural integrity is safeguarded. The Pimbahal Pokhari, a reclamation basin, further illustrated the intersection of tradition and ecology:

> **"The Pimbahal Pokhari, for example, is more than an ornamental pond. It functions as a water reservoir for emergencies such as fire, supports groundwater recharge, and offers cooling effects that help regulate the urban microclimate, a beautiful intersection of tradition and ecological function.**
>
> ***~ Saniya Bhusal, Kathmandu University, Nepal***

Pimbahal Pokhari, at the heart of Patan

Just outside Kathmandu, the team visited the International Centre for Integrated Mountain Development, where a living laboratory showcased nature-based solutions in action, inspiring transect members to consider various natural applications.

> **"The Lab showcases practical tools created with everyday community use in mind. This included a wide array of ovens that are safe for families to use, water filtration pumps, and a miniature demonstration of how early flood warning systems work. With the understanding of the collaborative work that ICIMOD does in the region, it was great to see how engineers and community experts worked together to create technologies that can directly help communities that are being impacted by current, and changing, living conditions."**
>
> *~ Aaron Andino and Pia Visaria, Duke University, USA*

Another key focus of our time in Kathmandu was the Bagmati River. Flowing through the urban landscape, it demonstrates the challenges of managing ecological ceilings in a densely populated context. The river is highly polluted, carrying untreated sewage and industrial effluents, while adjacent agricultural communities face significant risks of flooding and water scarcity. Yet, the Bagmati retains substantial cultural and spiritual importance, with rituals such as Shraddha; death anniversary rituals performed along its banks, maintaining social cohesion despite environmental degradation.

The river also serves as a hub for activity, with numerous temples, markets, and even urban farms surrounding its banks, revealing a complex relationship with the city's activities. The high monsoon season brings floods, which rises water in the river up to tens of feet higher. While serving as a community center, the river is also a hazard, a unique and fascinating relationship.

> **"Mr. Tandulkar [an urban farmer] shared how crop diseases have increased with the use of poor-quality water, an invisible cost borne silently by the urban farming community. The challenges do not end there. In September 2024, three days of relentless rainfall caused a massive flood that destroyed wells, buried land under debris, and washed away months of agricultural work. Without institutional support, farmers like Mr. Tandulkar took the burden of flood recovery into their own hands..."**
>
> *~ Saniya Bhusal, Kathmandu University, Nepal*

Mr. Tandulkar works on his shared farm on the banks of the Bagmati.

With an introduction to Nepal and the many subjects we planned to investigate, it was time to fly to Lumbini to begin our transect from the south of Lumbini to the north of Mustang.

4.2) Lumbini

As the birthplace of the Buddha, Lumbini holds profound cultural and spiritual importance, making it a meaningful starting point for our transect. Located in the hot, flood-prone Terai region, approximately 100 meters above sea level, Lumbini presented a critical example of how climate change and environmental challenges affect human health and well-being. The area's vulnerability to seasonal flooding and heat stress magnifies pressing climate risks faced by lowland communities in Nepal, while also presenting local solutions that have enabled some communities to thrive.

"Visiting the Jagdishpur Water Reservoir, a key component of Lumbini's ecological infrastructure, [illustrated] how cultural values, governance, and environmental management converge. Serving as an irrigation source, flood buffer, groundwater recharge system, and wildlife habitat, the reservoir strengthens the [local] social foundation by sustaining livelihoods, agricultural productivity, and community cohesion. Traditional stewardship practices and participatory management ensure that ecological resources are maintained while reinforcing cultural continuity."

~ Saniya Bhusal, Kathmandu University, Nepal

Interacting with local peoples near the Jagdishpur reservoir, understanding their perspective about climate change, environment, and hearing their experiences.

Additionally, Lumbini's rich biodiversity and institutions like the Lumbini Buddhist University provided insights into the interconnectedness of culture, ecology, and sustainable living. Visiting Lumbini allowed us to ground our journey in both the spiritual heritage and the environmental realities that shape the lives of people in the region.

"The Buddhist principle of ahimsa, or non-harm, toward all living things, is a crucial lesson I learned from the visit to Lumbini Buddhist University... The future of this sacred landscape, I believe, hinges on recognizing the profound relationship between its cultural heritage and its ecological integrity. Protecting its remarkable biodiversity is not merely an environmental goal; it is a continuation of a centuries-old spiritual ethics."

~ Celeus Baral University of Northampton, NAMI College, Nepal

The team engages in a discussion on the historical, cultural and spiritual significance of Buddhism, guided by the venerable teachers of *Lumbini Buddhist University*.

Beyond its spiritual significance, Lumbini is home to a diverse landscape comprising forests, grasslands, farmlands, and wetlands that support over 400 bird species, including the Sarus Crane. Like many others found in Lumbini, the Sarus is a locally and globally threatened species, facing the impacts of habitat degradation, drought, and pollution.

"As a future doctor, I realized how biodiversity loss is not just an environmental tragedy but a medical crisis. Fewer birds mean disrupted ecosystems, rising pests, [and] imbalances that increase the risk of vector-borne diseases. The wetland's health was, in many ways, a diagnostic marker for human health."

~ Ojaswee Karki, Kathmandu Medical College, Nepal

Before traveling to Palpa, we visited the UNESCO World Heritage Site and Buddhist Monastic Zone of Lumbini, which is renowned as the birthplace of the Buddha. This experience provided deep insight and connection to the Buddhist faith, which, along with Hinduism, comprises the faith of the majority of Nepalese people and guides customs, culture, and society in Lumbini and across the country.

"Before reaching [Palpa], we were warmly welcomed by the Siddhababa Temple Management Committee. The temple [is] a site of spiritual significance, and also a symbol of community-led stewardship of sacred natural spaces. Here, we saw how faith and ecology intersect, with the temple grounds maintained through collective rituals and rules reminding us that sacred ecologies can be powerful systems of conservation and how religion can instill a sense of belongingness in people."

~ Ojaswee Karki, Kathmandu Medical College, Nepal

Wrapped in yellow khadas, the L2L team receives a heartfelt welcome from the Siddhababa Temple Management Committee.

4.3) Palpa

Nestled in Nepal's Middle Hills, Palpa represents a vital transition zone between the lowland Terai and the high Himalaya at an altitude of 1350 meters above sea level. This region faces increasing risks from climate-induced landslides, erratic monsoon patterns, and changes in land use resulting from road construction and population migration. As a historic trading hub with a rich cultural heritage, Palpa offered a unique perspective on how environmental changes intersect with social and economic shifts. Meeting with villagers and farmers helped us explore the complex ways in which climate impacts community health and agriculture, especially in mountainous areas vulnerable to natural hazards.

Locals collecting niuro (fern) in Shringar community forest in Palpa, reflecting the link between livelihoods, nutrition, and ecological stewardship.

An insightful visit to Lumbini Medical College connected the team with Dr. Samata Nepal, who shared how the landscape of illness and disease is changing in Palpa and the surrounding areas.

"Doctors at Lumbini Medical College (LMC)... [say they] observed a steady rise in cases of dengue alongside respiratory illnesses. They point to worsening air pollution and shifting climatic conditions as key drivers of these health challenges. What was once an uncommon diagnosis in the hill districts has now become a growing concern for local healthcare providers. Their accounts underline the lived reality of climate-linked health risks—where changing weather patterns are reshaping the disease landscape of Nepal, leaving even upland populations vulnerable to illnesses once confined to the plains."

~ Alex Pradhan, Jigyasa University, Nepal

"For the people of Palpa, LMC has grown into... a symbol of hope, education, and progress. [Dr. Samata] offered a powerful reflection on how the health landscape of Palpa is shifting. She explained that the leading causes of hospital admission today include hypertension, chronic obstructive pulmonary disease (COPD), diabetes, stroke, gallstones, pneumonia, and even prostate diseases. What stood out was the clear dominance of non-communicable diseases (NCDs)—a dramatic change from the days when infectious diseases... filled hospital beds.

~ Pratistha Kattel, Kathmandu Medical College, Nepal

Dr. Samata Nepal shares historic disease trends and answers questions about health in the Middle Hills.

Changing trends over the last decade were staggering, and reflect ongoing shifts in Nepal and other parts of Southeast Asia. Not only is climate change exacerbating vector-borne diseases, but an emerging economy is also impacting lifestyle choices, leading to diet, smoking, and stress-related diseases. Dr. Nepal emphasized the hidden burden of mental health issues, especially amongst women, who are often left to care for their household alone as their partners travel abroad to find work – a common practice in Nepal.

"Our last stop in Palpa was the storied Rani Mahal... [which] stands in solitude on the banks of the Kali Gandaki River... For the entire evening, we paused at the riverbank, not just as tourists but as future stewards of landscapes and legacies. The Kali Gandaki, which would guide much of our remaining expedition from Lumbini to Lo Manthang, stretched ahead of us, timeless and turbulent."

~ Ojaswee Karki, Kathmandu Medical College, Nepal

The team unwinds at the bank of Kaligandaki river, near to Rani Mahal.

4.4) Pokhara

View of boats docked at Phewa Lake

Situated in the mid-hills of Nepal, along the shores of Phewa Lake, Pokhara serves as a critical urban center, bridging the rural and mountainous regions. Known for its stunning natural beauty and biodiversity, Pokhara is also experiencing the effects of climate change through changing rainfall patterns, increased flooding risk, and pressures from rapid urbanization and tourism.

From a Planetary Health perspective, the well-being of Pokhara's residents is intricately tied to the health of its ecosystems. The wetlands, lakes, and forests not only provide water, food, and clean air but also sustain cultural practices, livelihoods, and mental well-being through their spiritual and recreational significance.

The Seti River Valley, which leads into Pokhara, acts as a watershed that drains into Lake Phewa via the Seti River. Sediment buildup has led to a decrease in lake capacity, which has harmed the lake's biodiversity by slowing the oxygenation of the lakebed flora. In turn, the fish population in Lake Phewa has declined, harming both the fish population and access to drinking water, as well as irrigation.

"Pointing across the river, [Purna] Rajbhandari (IHRR) explained that landslides have been triggered by the construction of roads in the upper parts of the Seti River Valley, resulting in more sediment being released into the upstream Seti River. Indeed, I could see disrupted land on all sides of me, looking like ashy stains in a vast green expanse. All of them were adjacent to roads, and it was clear that landslides were connected to human development."

~ Nikhil Sethi, Duke University, USA

"I was told by residents from the Bagladi community that water rushes in at an astonishing rate, carrying a staggering amount of sediment that is slowly filling the lake and shrinking its size. The residents also shared how the water, once pure enough to drink, is now contaminated by household waste, plastics, and untreated sewage. I saw that existing drainage and sewage treatment projects remain incomplete, leaving the lake vulnerable to increasing pollution. I also saw that downstream communities are already dealing with severe flooding that damages hotels and infrastructure. Hard-engineered solutions, like the check dams, have reportedly failed under the intense pressure of monsoon floods, teaching a tough lesson: concrete alone cannot save the lake.

~ Celeus Baral University of Northampton, NAMI College, Nepal

A Sediment check dam sits in the Seti River Valley.

Arjun BK and Devi Sunar shared their story of resilience through a flash flood and landslide that killed members of their community and caused widespread damage. Both worked to rebuild their homes and community while persisting through mental health challenges.

Pokhara sits in a precarious position. On one hand, it has made progress toward the social foundation: access to education and healthcare has improved, tourism has created jobs and income, and connectivity has expanded opportunities for local populations. On the other hand, these benefits remain unevenly distributed, with migrants, women, and informal workers often excluded from stable livelihoods and affordable housing.

At the same time, biodiversity loss in surrounding forests, declining fish populations in the lakes, and carbon-intensive growth patterns—driven by vehicle emissions, construction booms, and rising energy demand—signal that Pokhara's development path risks undermining the very natural assets it depends upon.

"When considering solutions to [issues like] sedimentation, such as building roads lower in the valley, implementing safer construction practices, and regulating shorelines, it will be essential to consider the economic well-being of those impacted by new regulation."

~ Nikhil Sethi, Duke University, USA

4.5) Marpha and Jomsom

Transitioning from the highly populated Lumbini Province to the northern, rural Gandaki Province, we reached Marpha, renowned for its unique cultural heritage and apple orchards, and Jomson, the Mustang District's administrative capital. Situated at an altitude of 2,566 meters above sea level, the towns lie within the trans-Himalayan rain shadow region, where arid conditions prevail. This area is experiencing pronounced climate impacts, including decreased snowfall, water scarcity, and land degradation. Apple orchards—the backbone of the local economy—are declining due to the changing climate and thus biological conditions. Concentrated, sporadic monsoon rains have made it difficult for farmers to time the planting of their crops.

Traditional whitewashed stone houses with stacked wood, alongside Marpha's famed apple orchards, bring color and life to the mountain landscape.

"The treeline has climbed approximately 215 meters, allowing new crops like plums and vegetables to grow at higher altitudes. While this seems like an opportunity, it also disrupts native species and alters the local food web. The impacts are very real for the farmers in these communities. The apple and walnut orchards, which were once the foundation of the local economy, are now struggling with increased fungal diseases and pests that thrive in warmer, humid conditions.

~ Celeus Baral, University of Northampton, NAMI College, Nepal

"Local groups, like the Ama Samuha (mothers' groups), are acting as powerful environmental champions. I learned how they lead waste collection drives, encourage the use of LPG to reduce indoor smoke, and campaign against single-use plastics. It's clear that the municipality's policies, such as banning glass beer bottles in favor of aluminum cans, reflect a growing commitment to sustainable living. I was fortunate to meet inspiring women leaders, like former vice chairperson Sharmila Gurung, who are building crucial connections between farmers, NGOs, and government agencies to tackle both climate and economic vulnerabilities together. Their efforts really show how inclusive governance strengthens through community resilience."

~ Celeus Baral, University of Northampton, NAMI College, Nepal

The group has a discussion with Aama Samuha in Mustang on climate change in Mustang, its impacts on local lifestyles, and community-led interventions.

Mr. Mohan Singh Lachlan, President of the Gharpajhong Rural Municipality, shared local waste reduction and clean energy initiatives.

The team also had the opportunity to meet with representatives of the Annapurna Conservation Area Project (ACAP), which demonstrated practical nature and community-based regulations for the sake of conservation. ACAP offers primary health services, education about the local environment and ecology, and has initiated a program to compensate farmers for any cattle lost to native predators, such as snow leopards, in an effort to discourage their killing. Although Mustang's communities displayed resilience through women-led Ama Samuha groups, forward-thinking municipal policies, and the promotion of renewable energy, the erosion of traditional farming practices, the outmigration of youth, and shifting economic streams reveal critical social gaps.

By integrating ancient agricultural knowledge with modern adaptation tools, Marpha and Jomsom could emerge as models of resilience in the high Himalayas. Yet their stories serve as a cautionary tale. In a rapidly warming world, mountain communities embody both the precarity of life at ecological thresholds and the possibility of creating adaptive, equitable futures within planetary limits.

4.6) Lubra to Muktinath

Our journey between Jomsom, Lubra, and Muktinath was on foot. Surrounded by beautiful scenery in the shadow of the Annapurna Mountain Range, this was undoubtedly one of the most breathtaking experiences for our entire team. We were able to observe the upper Kali Gandaki River basin and witness the upward migration of its treeline, attributed to warm temperatures. The result is a "compressed tree line"—shrinking habitat zones that endanger biodiversity, destabilize slopes, and amplify disaster risk, a change shared with us by the Aama Samuha group of Jomsom.

Aerial view of Lubra, nestled along the banks of the Panda River amidst Mustang's stark highland landscapes.

Arriving in Lubra, perched at an altitude of around 3,050 meters above sea level in the arid landscapes of Mustang, we entered one of Nepal's most unique and spiritually rich settlements. Lubra is one of Nepal's few remaining villages practicing the indigenous Bon religion, a spiritual tradition that predates Tibetan Buddhism and remains deeply rooted in nature worship, ritual, and local cosmology.

At the same time, Lupra faces significant ecological pressures that define the upper limits of the village's environmental ceiling. Flash floods, erosion, and other climate-related hazards threaten farmland, sacred sites, and the broader landscape, highlighting the fragility of the mountain ecosystem. The village's continued survival thus depends on careful stewardship of its natural resources, including water systems and forests, to maintain resilience in the face of environmental change.

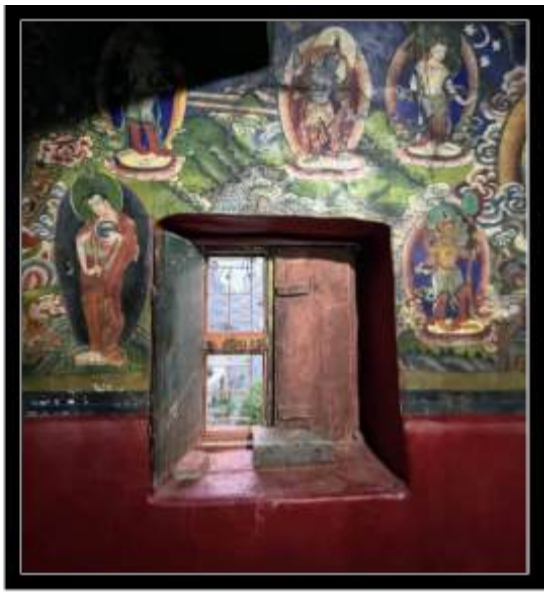
During our short stay in Lubra, we had the opportunity to meet a community spiritual leader, the Lama, who described the impact of transportation networks and environmental changes on the village.

"Bon Buddhism incorporates elements of Buddhism as well as worship of nature. Because of this connection to nature, the Lama believed that the construction of the very road that we followed into Lubra threatens the nature there, corrupting the land and bringing impurity. He told us that the road had possibly 'scared the gods away,' and that 'the land was unhappy.' He told us that they cannot keep up with issues like climate change, which bring destruction like the flood he described. He said that the environmental issues they face are 'too big for [their] prayers.'"

~ Ruth Havener, Duke University, USA

"I admired how the Lama did not deny the existence of climate change, which I heard repeatedly while growing up in a rural region of the United States, but instead that the Bon Buddhists of Lubra had witnessed these environmental changes and created an explanation that aligned with their beliefs."

~ Ruth Havener, Duke University, USA



Scenes from inside Lubra's Bon monastery.

Another seven-hour hike through the beautiful Pandu Khola watershed brought us to the Muktinath Temple, situated at approximately 3,800 meters above sea level. Muktinath is one of the world's highest temples and a rare site of shared reverence between Hindus and Buddhists. The temple complex is a place of prayer and a pilgrimage destination, drawing thousands each year who undertake the journey across the Himalayas to seek blessings and purification. Its 108 spring-fed water spouts, Muktidhara, are where we participated in the custom of bathing and symbolically cleansing oneself of sin and suffering.

"On the surface, a religious site like Muktinath doesn't "improve" planetary health in the same way as, for example, reforestation or a carbon reduction project, but it cultivates values, practices, and protections that indirectly support planetary health. Muktinath is located in fragile ecological zones. The spiritual significance tied to this location has encouraged preservation of the land rather than exploitation. The springs, rivers, and sacred groves are treated with reverence, which reduces overuse and can promote conservation ethics."

~ Kyle Abrahm, Duke University, USA

4.7) Kagbeni

Rituals along the Kali Gandaki River at Kagbeni exemplify the interplay between cultural practices and natural spaces.

Situated at around 2,800 meters above sea level, Kagbeni marks the historic entrance to Upper Mustang and the Tibetan Plateau. Known for its spiritual connection to the sacred Muktinath spring, the village is equally defined by its fragile setting within Nepal's trans-Himalayan desert.

Positioned in the rain shadow of the Annapurna and Dhaulagiri ranges, Kagbeni faces growing challenges from flash floods and climate variability, which are placing increasing stress on its traditional agro-pastoral livelihoods and cultural heritage.

A September 2023 flood, triggered by intense rainfall and snowmelt did more than alter landscapes—it disrupted food systems, damaged homes, and destabilized the delicate balance between people and their environment. Thankfully, due to early warning systems, no lives were lost.

"Sleepless nights, heightened anxiety, and constant fear are common. One community member reflected, "No one took the rising water level seriously until the warnings came. Now, even a drizzle keeps us up at night." This experience underscores the critical role of Early Warning Systems (EWS) not only in saving lives but also in safeguarding mental health. In disaster-prone regions like Mustang, timely and accurate alerts can reduce panic, allow for coordinated evacuation, and provide residents with a sense of agency. When people feel informed and prepared, they are less likely to experience the helplessness that leads to long-term trauma."

~ Anek Rajbhandari, New York University Abu Dhabi, UAE

In Kagbeni, investments in early warning systems, climate education, and infrastructure designed for mountain hazards continue to help the community adapt to intensifying risks.

"The first step is to implement a system of ecological land-use zoning around the river, formally mapping and protecting high-risk areas to prevent further construction and farming. This must be complemented by the formalization of land rights for villagers in safer zones, providing them enough security to invest in long-term resilience. We can then build living revetment systems, using deep-rooted native species to create natural flood barriers that stabilize riverbanks and slow debris flow."

~ Celeus Baral, University of Northampton, NAMI College, Nepal

Flood-affected site in Kagbeni following a September 2023 flooding event.

4.8) Ghami

Ghami, nestled within Mustang's stark Trans-Himalayan landscape, is a village where heritage, environment, and livelihoods intersect in fragile balance. The Royal Palace's renovation into a hotel and the restoration of 350-year-old murals by artists illustrate how cultural continuity strengthens communities, preserving collective memory and sustaining identity across generations.

Dawa Lama, an art restorer, demonstrating the restoration of a wall painting in Ghami's royal palace using a 2012 reference photograph.

Ghami's cultural fabric extends far beyond the palace walls—we walked amongst its whitewashed houses, ancient chortens, and traditional farming systems, all of which are expressions of resilience in a harsh, high-altitude desert. Traditional subsistence farming, based on barley, buckwheat, and potatoes, is increasingly challenged by unpredictable seasons, pest infestations, and soil degradation. These pressures push residents toward livelihood diversification, such as tourism and migration, which in turn reshape social structures and dependency on external markets.

> **"My first real revelation solidified at Ghami. The community here is battling water scarcity and soil erosion caused by altered snowfall patterns. What was so groundbreaking wasn't the problem itself, but the human response. Instead of succumbing to the pressure, they are actively pursuing community-led ecological solutions. They are reviving ancient agricultural practices, cultivating medicinal herbs like jimbu as an alternative economic resource, and leveraging eco-tourism to fund local conservation. This is more than survival; it's a proactive, intelligent adaptation."**
>
> *~ Alex Pradhan, Jigyasa University, Nepal*

The revival of cultural heritage, such as the palace restoration, builds local pride and strengthens tourism appeal, providing income opportunities that could reduce reliance on environmentally intensive farming. Community-led practices, such as sharing water systems, reflect embedded social capital that aligns with the principles of planetary health, including equity, resilience, and cooperation. However, these gains will only be sustainable if they are coupled with ecological safeguards, including managing tourism flows, conserving water, and incorporating traditional ecological knowledge into local planning. In this way, Ghami represents both the vulnerabilities and possibilities of Himalayan settlements in transition.

4.9) Lo-Manthang

A bus ride from Ghami brought us to Lo Manthang, our ultimate transect destination. Reflecting on the past few weeks of travel through Nepal, it was an insightful final destination to apply and reflect on what we had learned while traveling through Lumbini and Gandaki.

Lo Manthang, the ancient walled capital of Upper Mustang, is situated at an elevation of approximately 3,840 meters above sea level on the edge of the Tibetan Plateau. Established in the 14th century as the center of the former Kingdom of Lo, it remains Nepal's only living walled city and a repository of Tibetan Buddhist culture, ancient monasteries, and unique high-mountain traditions. Despite its rich heritage, Lo-Manthang is situated in one of the most climate-sensitive regions of Nepal.

Climate change is accelerating glacial retreat, drying springs, and increasing hazards like desertification. The introduction of modern building styles such as reinforced concrete houses undermines thermal resilience and erodes vernacular practices adapted to Mustang's cold desert climate.

> **"I was inspired to see the Jigme Foundation's Local Adaptation Plan of Action (LAPA) not as an external blueprint, but as a collaborative process that integrates traditional ecological knowledge with modern bioengineering principles. This holistic approach empowers villagers to actively fortify their own landscape against climate extremes."**
>
> *~ Celeus Baral, University of Northampton, NAMI College, Nepal*

Meanwhile, youth migration and reliance on tourism income reflect shifting patterns of livelihood. More connections to urban areas and China, whose border lies just miles outside of the town, have moved the town closer to modern life in many ways.

> **"As I walked around, I saw two women, a bit younger than the others, looking at a smartphone. I got curious and looked at what they were watching. It was a YouTube video of people chanting mantras, and they were chanting along with it. When I asked what they usually watch, they smiled and said, 'We only watch Rinpoche.' They were watching AI-generated Buddha statues chanting mantras, using new technology to continue old traditions."**
>
> *~ Rinchen Tamang, Patan Multiple Campus, Nepal*

Much of the transect team visited Lo Manthang's health outpost, a small but essential part of life for the town. Lo Manthang is otherwise remote from any health clinics, so treatment for major illnesses could be up to 10 hours away by road in Jomsom or Pokhara. Some of the community's medicinal needs have been addressed by Amchi medicine, a holistic approach to healing that utilizes natural remedies—including medicinal herbs, stones, and even gems—along with dietary and lifestyle modifications. The balance of the two was fascinating to investigate.

> **"My visit to the Lo Manthang Health Post and conversations with [a nurse and patient] revealed a more complex picture of healthcare in this remote Himalayan community. In a place where distance and financial barriers impede patients' access to quality care, Amchi is no longer seen as alternative medicine but a primary source of treatment, education, and preventive care...**

...while both systems are essential to meeting the community's healthcare needs, there appears to be a significant rift in communication between the two, resulting in patients often lacking awareness of when to use natural versus Western remedies. Together, these practitioners' perspectives illustrate that effective healthcare in this remote Himalayan community relies not only on medical knowledge but also on understanding and integrating local traditions and lived experiences. These lessons from Lo Manthang highlight the potential for a novel model of healthcare that integrates traditional remedies with medical innovation to improve patient outcomes and accessibility in isolated, yet culturally rich regions."

~ Navya Kancharla, Duke University, USA

Inside Lo Manthang's health outpost.

While in Lo Manthang, our group had the opportunity to visit a neighboring village, Namasung, where some of the world's first true climate migrants reside. Forced to migrate from their former settlement, Samdzong, due to water scarcity and mineral leaching, many young children and older adults moved to the new village, while most working-age residents have left in search of education or employment.

"The case of Old Samdzong demonstrates the human costs of climate change. Water scarcity, soil degradation, and shifting weather patterns continue to displace communities in high-altitude Himalaya today. This raises questions about the role of government, NGOs, and international aid in supporting communities under climate stress: while Namasung received significant external assistance to relocate, many other villages are facing similar conditions without the same support. The future of these communities remains uncertain as environmental pressures continue to build.

~ Hannan Yoon, Duke University, USA

Transect members meet villagers in Namashung, who share their experiences relocating from Old Samdzong.

"The village of Namasung wasn't founded by choice, but by necessity; a profound act of communal resilience. It is a living testament to humanity's ability to forge a new beginning from the remnants of an old one. Just over a decade ago, this community lived in Samdzong, a village nestled in the high Himalayas. But their life line; the glacial streams and mountain springs, began to vanish. "The springs stopped flowing."

~ Celeus Baral, University of Northampton, NAMI College, Nepal

Before beginning the long journey back to Kathmandu, the team had the opportunity to enter Lo Manthang's walls and visit the grand, ornate monasteries inside them. The reverence for religious life and culture in Lo Manthang was the key component of its social fabric, influencing the very traditional way of life often lived there.

"Meditating in the walled city's monasteries was an experience unlike any other. I felt deeply grounded, close to my spirituality, and that of the ancient community I had just entered. The significance of the place was ever-apparent."

~ Nikhil Sethi, Duke University, USA

The rainy stone streets of Lo Manthang.

5) Final Remarks

By Bishwas Dughana

"The Lumbini to Lo Manthang (L2L) Expedition was more than just a field study. For me, it was a personal pilgrimage across Nepal's diverse geography, unfolding the soul of the nation one village, one conversation, and one mountain pass at a time.

Our journey began at the Kathmandu Guest House in Patan, where the air buzzed with excitement and anticipation. I remember sitting quietly, absorbing the wisdom of experts like Prof. Dr. Brian McAdoo, Dr Sanjay Devkota, and Anil Chitrakar. Anil Sir's poetic description of Nepal as 'the cheese between two slices of bread, India and China' made me smile and think deeply about our unique geopolitical and cultural identity. His explanation about religious importance and the science behind the architecture of Patan swelled my heart with pride to be born in this land.

Flying from Kathmandu to Lumbini, the birthplace of Gautam Buddha, was symbolic, a transition from the noise of the city to the spiritual calm of the Terai. Visiting the Mayadevi Temple in the golden evening light felt surreal. Despite the heat, my mind and body found peace in the serenity of the temple. I remember how the sweat on my forehead evaporated the moment I stood near the sacred pond. It was as if time slowed down to honor the sacredness of the place.

The next morning, I found myself watching birds with Mr. Hem Sagar Baral, who left me in awe with his love for Nepal's biodiversity. The simplicity of Lumbini's landscape, its people, and its spiritual aura made me feel grounded. The visit to Lumbini Buddhist University, where the dual streams of Applied and Core Buddhism are taught, reminded me that spirituality and science can coexist beautifully.

From Lumbini, our journey took us to Palpa, passing through Jyotinagar in Butwal, where I met a man who had survived two major debris flows. His voice trembled when he told me, "I have invested all my money to build this house. I can't leave." His pain echoed the dilemma of many Nepalis torn between safety and attachment to home. My heart sank as I imagined the fear of every drop of rain during monsoon.

In Palpa, I walked through a community forest where I met women collecting fiddlehead ferns. Their stories were rich, grounded, and made me think of how nature still provides for those who know how to live with it. At Ranimahal, beside the Kali Gandaki River, I felt like I had walked into a forgotten fairytale. We sat there for hours with friends from across the world, laughing, teasing, and absorbing the magic of the place. I didn't want to leave. I really didn't.

Pokhara brought a different kind of joy. Sharing a Chinese dinner with my friend from China was more than just a meal, it was a moment of cultural exchange, laughter, and new friendship. Our walk through Durephat and visit to Phewa Lake showed me how environmental problems like siltation are not just scientific concerns but also emotional ones, especially for communities who rely on these landscapes.

Then came Marpha, Jomsom, and the trans-Himalayan villages that took my breath away. The apple orchards, the cold air, the simplicity of stone houses—all reminded me of resilience. I remember our long hike to Muktinath, where I took a shower under the 108 holy spouts. Every

drop felt like a blessing, washing away my fatigue and doubts. There, on that sacred ground, I felt a rare moment of clarity and gratitude.

Meeting the Bon community in Lupra felt like opening a door to a forgotten story. Their warmth, strength, and struggles humbled me. Then there was Kagbeni, where I witnessed the harsh reality of development gone wrong: houses built in vulnerable zones, ignoring the angry warnings of nature. I felt a deep concern. How do we protect people from their own misjudgments?

In Ghami, I met Yangchen Dolker, a woman leading her community with quiet strength and vision. Her energy was inspiring. Exploring the caves of Dakmar was both thrilling and humbling, as I imagined the people who once lived or meditated there.

Finally, we reached Lo Manthang, the crown jewel of our journey. The walled city, its monasteries, the people, and the highland air—all made me feel like I was standing at the edge of the world. Yet, I also saw the stark reality—limited health facilities, outmigration, and drying water sources. Visiting Old Samdzong, now abandoned, left a deep mark on me. The empty houses, the grazing horses, the small pond—it all felt like a quiet monument to climate change and displacement. My heart ached.

As we descended back, stopping at Tatopani for a hot spring bath, I was filled with a strange mix of joy, exhaustion, and sadness. On the final day, we shared our learnings and hugged each other goodbye.

The transect team gathered in front of Muktinath Temple.

"This journey has changed me. It showed me the fragility of life, the strength of communities, and the deep connection between people and their land."

- *Bishwas Dughana, Tribhuvan University, Nepal*

References

Fanning, A. L., & Raworth, K. (2025). Doughnut of social and planetary boundaries monitors a world out of balance. Nature. https://doi.org/10.1038/s41586-025-09385-1

Myers, S. S., & Frumkin, H. (2020). Planetary health: protecting nature to protect ourselves. Island Press.

Raworth, K. (2012). A safe and just space for humanity can we live within the doughnut? Oxfam Discussion Papers. https://www-cdn.oxfam.org/s3fs-public/file_attachments/dp-a-safe-and-just-space-for-humanity-130212-en_5.pdf