

Nripal Adhikary

Bamboo, Earth, and Resistance: Reclaiming Nepali Vernacular Architecture in the Face of Conservation and Reconstruction

Bambú, tierra y resistencia: Reivindicar la arquitectura vernácula nepalí como vía para la conservación y la reconstrucción

Bambu, Terra e Resistência: A Valorização da Arquitetura Vernácula Nepalesa Face à Conservação e à Reconstrução

Abstract | **Resumen** | **Resumo**

Nepal's mountainous geography has historically fragmented its communities, giving rise to over a hundred languages and a diversity of vernacular architecture built from locally sourced materials such as timber, stone, bamboo, and earth. These traditional practices, supported by common resources and communal labor systems such as *parma*, produced earthquake-resistant, culturally authentic housing rooted in this land. Drawing on the author's experience as founder of ABARI, a social enterprise dedicated to earth and bamboo construction, this essay presents case studies demonstrating that locally sourced, low-carbon materials can meet modern safety standards while restoring natural landscapes and cultural sovereignty.

La geografía montañosa de Nepal ha favorecido históricamente el aislamiento de sus comunidades, lo que ha dado lugar a más de un centenar de lenguas y a una gran diversidad de arquitectura vernácula construida con materiales locales como madera, piedra, bambú y tierra. Estas prácticas tradicionales, sustentadas en recursos comunes y en sistemas de trabajo comunitario como el *parma*, dieron lugar a viviendas resistentes a los terremotos, culturalmente arraigadas y estrechamente vinculadas al territorio. A partir de la experiencia del autor como fundador de ABARI, una empresa con fines sociales dedicada a la construcción con tierra y bambú, este ensayo presenta varios casos de estudio que muestran cómo los materiales locales y de baja huella de carbono pueden cumplir las normas de seguridad actuales y, al mismo tiempo, contribuir a la recuperación de los paisajes naturales y de la soberanía cultural.

A geografia montanhosa do Nepal fragmentou historicamente as suas comunidades, dando origem a mais de uma centena de línguas e a uma diversidade de arquitetura vernácula construída com materiais de origem local, tais como madeira, pedra, bambu e terra. Estas práticas tradicionais, apoiadas por recursos comuns e sistemas de trabalho comunitário, como o *parma*, produziram habitações resistentes a sismos e culturalmente autênticas, com raízes nesta terra. Com base na experiência do autor como fundador da ABARI, uma empresa social dedicada à construção com terra e bambu, este artigo apresenta estudos de caso que demonstram que materiais de origem local e com baixas emissões de carbono podem cumprir as normas de segurança modernas, ao mesmo tempo que restauram as paisagens naturais e a soberania cultural.

< Monks meditating under the bamboo truss (Chemi Dorje Lama)

Introduction

Roughly two-thirds of Nepal's landscape is mountainous, making interregional travel and communication historically challenging. In former times, mountains were barriers to interaction between communities, resulting in the emergence of hyperlocal, context-specific knowledge systems within remarkably short distances. This geographic and cultural fragmentation explains why Nepal, a small country 1,400 km long and some 300 km wide, has over a hundred languages, reflecting distinct worldviews, arts, crafts, agricultural practices, and architectural traditions.

With limited materials at their disposal—mostly timber, stone, bamboo, and earth—these communities designed and built extraordinary structures (Tiwari 2010; Bernier 1997). Some were multistoried and conceived to withstand both earthquakes and the harsh Himalayan climate (Rijal et al. 2010).

Association of Forest and Shelter

Materials were locally sourced from common resources, at scarcely any cost: timber from local forests, stones from local quarries (abundant in the mountains), and soil procured on-site. Labor was bartered. If A helped in the construction of B's house for ten days, then B would reciprocate in the construction of A's house for ten days. This labor exchange system is called *parma* in Nepali. If the owner was disabled or elderly, neighbors would lend a hand without expecting any return. Thus one could build a house with little capital thanks to strong communal links and access to common resources. In these communities homelessness was rare.

As "development" and capitalism crept in, these independent communities began to be subject to regulation. Common resources such as forests, quarries, and rivers became state rather than communal property (Regmi 1999), and the state started charging citizens for materials that were hitherto free.

Whereas before the 1970s almost everyone in rural areas was decently housed, once the government regulated access to forest resources, timber, a primary structural material, became scarce. Many vernacular buildings erected after this time lacked timber reinforcement, making them seismically vulnerable, and in the 2015 Gorkha earthquake, post-1970s vernacular buildings suffered greatly (Adhikary 2016). Lately, using the rhetoric of climate change, the government has further curtailed forest access, forcing people to rely on materials such as cement and steel.

Conservation and Climate Change Versus Indigenous Rights

The notion of "conservation" is a colonial construct born in response to the West's encounter with the tropical East (Wilber 1979). The British used the conservation concept to justify their control of Indian forests, fenced off from local communities. Similarly, in the 1970s, in order to "conserve" nature from traditional forestry access, Nepal created its first national park in Chitwan with the help of the army, driving many Indigenous people out of their homeland. This sometimes violent drive for the creation of national parks extended through the 1970s and on to our time (Upreti 2001). The discourse is now about climate change mitigation, under which more Indigenous people are being stripped of forestry access rights. Even some international conservation organizations have proved to be directly funding evictions (Domínguez and Luoma 2020).

When Indigenous people are denied forestry rights, they are denied their rights to shelter, food, medicine, and even their traditional worldview.

Reconstruction after the 2015 Earthquake: A Missed Opportunity

On April 12 and May 22, 2015, two massive earthquakes struck central Nepal, measuring 7.8 and 7.3 on the Richter scale and killing 8,856 people. Considering their magnitude, the casualties were

few, for similar earthquakes in Pakistan (2005) and Turkey (2011) had a combined death toll of over 80,000. In the aftermath, the media and government decried vernacular houses as weak and unsafe, yet properly built traditional structures survived the quakes even at the epicenter (Adhikary 2016).

In a country where 74% of buildings were made of local materials, the building codes that had allowed traditional construction were soon supplanted by new government regulations and guidelines, leading to a sharp decline in this tradition of construction and craftsmanship. In the name of "Building Back Better," the World Bank-funded reconstruction program did little to promote traditional building. Even when its methods could be applied, cement had to be included in the earth mixture in addition to steel reinforcement, and reinforced concrete elements in place of timber.

An average house before the earthquake would cost around USD 5,000, but following these government mandates, a similar house cost over USD 20,000. Many homebuyers have had to go to Dubai and other Gulf States to work under harsh conditions and with few labor rights to earn such money. Thus self-sufficient Nepalis who could once build handsome dwellings with resources from the commons have been forced abroad to be able to pay for a basic concrete house.

Barpak: Building Back Worse

After the earthquake, the Nepali government subjected villages with unique vernacular architecture to cookie-cutter designs lacking both character and functionality (Upadhaya et. al 2022). One example is the village of Barpak, at the epicenter. Originally with beautiful cobblestone streets, elaborate stone walls, and roofs of slate (Fig. 1), it was a testimony to Gorkha's architectural aesthetic and identity. After the earthquake, with government and foreign intervention and a drive for safety and modernization, it was rebuilt with imported bricks, metal frameworks, and corrugated sheet-metal roofs, wholly foreign to the place. A historic village has been turned into concrete jungle, making one wonder if modernization must be synonymous with loss of cultural identity.

Figure 1: Barpak before the earthquake (Nepali Times)





Figure 2: Barpak after the earthquake (Nepali Times)

Over ten years, the official imposition of cement and steel reduced the percentage of vernacular Nepali architecture from 74% of all homes in 2011 to just 54% in 2021.

ABARI: Celebration of Vernacular Practice

In 2006, after returning from college in Northern New Mexico with a specialization in earth construction, I set up a private social enterprise called ABARI with a mission to reinstate traditional earthen materials in contemporary architecture. I was inspired by the architecture of New Mexico, which repurposes ancient adobe techniques in a modern context.

Far from that arid environment with relatively low seismicity, I explored ways of making earthen buildings in Nepal resistant to earthquakes and monsoons. Traditionally, artisan builders did this by using timber as lateral reinforcement and creating large overhangs with timber struts. But as timber was becoming highly regulated, I had to look into alternative materials.

Bamboo

After timber, bamboo has been used for centuries in Nepal in building, for rafters, beams, and wall elements in traditional architecture. In the 2011 census, 1,096,988 homes, representing 20.23% of the total, were reported as having bamboo in their outer walls.

Bamboo possesses several structural advantages: it is ductile, flexible, and lightweight, making it well suited for earthquake-resistant construction. Historically, bamboo use was constrained by a lack of treatment facilities, and so builders would design bamboo components to be easily replaceable. Untreated bamboo is susceptible to biological degradation, including termite and beetle damage and fungal decay. In sheltered indoor conditions, its lifespan typically ranges from two to six years, and it deteriorates within a year if exposed to the elements. Hence it was used primarily for temporary structures or replaceable objects.

Additionally, due to limited joinery techniques—mostly rope bindings—bamboo was rarely used for primary structural members. Even today, it is associated with makeshift shelters, scaffolding, and low-cost structures, particularly in rural and marginalized communities. Given its limited lifespan when untreated, it is considered a poor man's timber.

Bamboo as Grass

Bamboo belongs to the *Poaceae* family, which includes plants such as rice, wheat, and maize. It is one of the fastest-growing plants on earth and abundant in Africa, South America, and Asia, where it is celebrated as a symbol of refinement, humility, and resilience. Light and strong, it is comparable to bird bone in density and to steel in strength, and also to carbon fiber. For these reasons, in 1906 Santos-Dumont made the first ever sustained flight in Europe in a biplane with a bamboo fuselage (International Civil Aviation Organization, n.d.).

Studies by the International Network for Bamboo and Rattan (INBAR) have shown that bamboo is a natural composite with a strength-to-weight ratio comparable to that of mild steel in certain applications.

Bamboo is also an integral part of the Nepali cultural landscape, as more than 10% of the population is reliant on it. Nepal has 55 bamboo species, ranging from tropical to alpine. But despite its rich history, until recently the interest in using it in contemporary contexts has been limited. The availability of concrete and steel on one hand, and the stigmatization of vernacular architecture and craft on the other, have impeded any revival.

Accordingly, my design and research firm ABARI has set out to reinvestigate traditional construction materials for contemporary uses. Luckily, since bamboo is considered grass, it is not regulated by forestry laws, thus making it easy to plant, harvest, and move about.

Challenges to Making Bamboo Mainstream

- Non-Durability in Natural State

The first challenge was to find an effective treatment method that was cheap and portable. We modified the Boucherie system of applying pressurized preservative to the basal end of bamboo, sending boron through the vascular bundles and pushing out starch through the branches and the top end. This method, also known as sap displacement, increases durability by more than 50 years through replacing the starch with alkaline material.



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Figure 3: Boucherie system applied to bamboo by the author

Figure 4: Multiple bamboo culms connected by custom-made brackets (Chemi Dorje Lama)

The Boucherie method works when bamboo is treated within 24 hours of harvesting, i.e., while its vascular bundles are green. Cheap and efficient, it is great for small-scale projects and when plantations are scattered.

- Pressure Treatment

Better suited to larger-scale construction is a vacuum-pressure system in which bamboo is placed in a large vacuum chamber and pressurized preservatives are forced in at the nodes. The bamboo does not need to be green, and should contain less than 20% moisture. This is a scalable technique used by many industries, including timber.

- Joinery

Bamboo is a heterogeneous material with inconsistent geometry and its variable diameters make standardization and connections challenging. It is most commonly assembled by means of fish-mouth joints, with the ends being carved to fit snugly into other pieces. There are no specialized power tools, so these joints are often made by hand. Traditionally, they were reinforced with cane or rope; today, special nuts and bolts are used, sometimes grouted with cement. Such connections become complex when one has to join more than two pieces—especially when designing a three-dimensional truss.

Accordingly, ABARI has developed metal brackets for anchoring bamboo culms with threaded rods. These are custom-made for different angles and tolerate diameter variations of up to 3 mm. This hybrid system permits standardization of joints, using industrial plates. It also allows one to design complex trusses and to assemble multiple pieces.

- Fighting Preconceptions

More than technical issues such as treatment and joinery, public perception is the main difficulty with bamboo. As it has traditionally been seen in Nepal as a temporary material, bamboo houses are regarded as a sign of poverty, and changing such perceptions is not easy.

So we realized that people were not ready to build their homes with bamboo. There was demand, however, for public buildings such as schools and community centers. Moreover, public facilities normally require a large span, traditionally accomplished using steel trusses. With bamboo and its high weight-to-strength ratio, we knew that with our jointing system we could build free-spanning trusses such as had never been tried in Nepal. I decided to run ABARI as a social enterprise, with the aim of providing sustainable public construction solutions using locally available materials.

This was not an easy task because we had to set up a whole supply chain—from harvesting and treatment to capacity development—and provide design-and-build services to make natural construction look desirable today. And while advancing what seemed a noble cause, we had to remain competitive.

School in Balimtar

One of our early projects was the construction of a small pre-primary school, which I wanted to be a replicable demonstration. Fortunately, a friend of mine, Justin Wickham, was building a stone school in a remote Gorkha village—so remote that the closest hardware store was five hours away. The idea was to build a model school which would demonstrate that one can build an inspiring space for learning with materials that are locally available and sustainable. I volunteered to build the roof with bamboo and stone according to vernacular tradition. We had a limited budget and the project took us almost three years, but the three-classroom school turned out spectacularly, with reinforced ashlar masonry plastered with earth, bamboo trusses, and stone slates, showing that one does not need a large budget or industrial materials to build a public amenity.



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Figure 5: Classroom interior plastered with earth



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Figure 6: Demonstration Early Childhood Development Center using local materials such as bamboo, stone, earth, and slate

I was becoming disillusioned because I knew I would not be able to pay my bills if I kept volunteering like this. Yet fate had other plans for us. Just after we completed the school, a huge earthquake struck Nepal, with its epicenter 12 km away in Barpak. Our school was one of the very few such buildings to survive the devastation.

Overnight, our work was recognized, as national and international media such as CNN, the New York Times, China Central Television, and the BBC gave us coverage.



Figure 7: Compressed earth block machine designed for community use

Tragic as it was, the earthquake proved that buildings made of earth, bamboo, and stone are seismically resilient. It proved that with local resources, one can still build beautiful spaces that meet people's needs with vernacular flavor. It showed that there is no need for imported industrial technologies or materials to make structures that are safe, nice to be in, and good to look at.

After the 2015 Earthquake

After the earthquake, some 40,000 schools had to be rebuilt, which seemed a good opportunity to pitch our ideas to the government. On the basis of our work at Balimtar, the government immediately approved our prototype design for a modular school. It is rare, even internationally, for a government to approve such materials as earth and bamboo for the construction of public schools.



Figure 8: Open-source rammed-earth design model



Figure 9: Classroom interior (open-source design)



Figure 10: Many schools were built in different districts to our open-source plans

We advocated for an owner-driven reconstruction system, in which the owner has control over design and materials. Our designs became popular and we received many requests to build schools all over the country. We were unable to serve them all, so we put the designs online in open-source documents. We also trained hundreds of people to make their own bricks. Over twelve classrooms were built using these designs, and there were nearly one million downloads. We also released open-source designs for homes of earth and bamboo that can be built for USD 3,000.

Yet after the earthquake, we feared the government would prescribe industrial cookie-cutter designs across the country, undermining thousands of years of vernacular architectural tradition. Unfortunately, that is what happened. Backed by the World Bank, the authorities made natural building difficult, and even when it was allowed, tons of cement and steel had to be added. Many people wanted to build in our style, but Nepali building codes, which had been quite favorable to natural construction before the earthquake, were changed to prioritize concrete and steel. Ten years on, one sees traditional vernacular architecture being displaced by modern industrial dreariness.

We wanted to contribute to the large-scale post-earthquake reconstruction effort, but we were fighting with limited resources against bureaucracies that preferred centralized settlements that could be easily monitored and banks willing to have a large portion of the population in debt. Our idea of owner-driven houses, built of freely available materials, ran contrary to the wider agenda.

Nevertheless, pockets of opportunity opened up among some alternatively thinking individuals and organizations.

Madan Puraskar Pustakalaya

Our biggest commission after the earthquake was for the reconstruction of a public archive, in the middle of the Kathmandu Valley. Erecting such a building of earth and bamboo in an urban area would have been nearly impossible before the earthquake. But the slender, lightweight, ductile bamboo roof was psychologically comforting to those who had witnessed heavy concrete structures come down like houses of cards.

We finished the library in nine months using rammed earth, wattle and daub, and bamboo trusses, celebrating the technology we had been exploring for the last six years. The two-story structure has



Figure 11: Library interior, celebrating the slenderness of bamboo (ABARI)



Figure 12: Earth paints protected by bamboo overhangs

all of its bamboo members exposed, forming a complex web-like truss network. We separated the walls from the roof, as was done in the vernacular architecture of western Nepal, so that if the walls came down in an earthquake, the roofing would remain in place.

Building a public facility in an urban area with earth and bamboo involved a symbolic victory, because such materials had been considered unfit for public spaces. The library has become a tourist attraction, receiving thousands of visitors.

Mahamudra Hall

The Mahamudra Meditation Center stands atop a mountain about an hour from Kathmandu, accessed on foot or by off-road vehicle in dry weather.

The center is the brainchild of Chogyal Rinpoche, a young Tibetan master and torchbearer of a medieval esoteric lineage of Buddhism. He believes the time has come for ordinary people to have access to knowledge that was hitherto the preserve of Tibetan masters, and envisioned a place of learning where people could enjoy not only mystic wisdom but also architecture and natural surroundings that radiate a sense of spirituality.

Mahamudra Hall has six roof layers supported by handcrafted bamboo forming a mandala-like truss sixteen meters high, making it one of the tallest bamboo structures in South Asia. The walls are of rammed earth, with breathability suited to a place of meditation. The structure has a square layout and its tall copper roof is designed to symbolically channel energy toward the heavens. Tall latticed windows allow the floor of the meditation hall to be bathed in sunlight of varying intensity through the day.

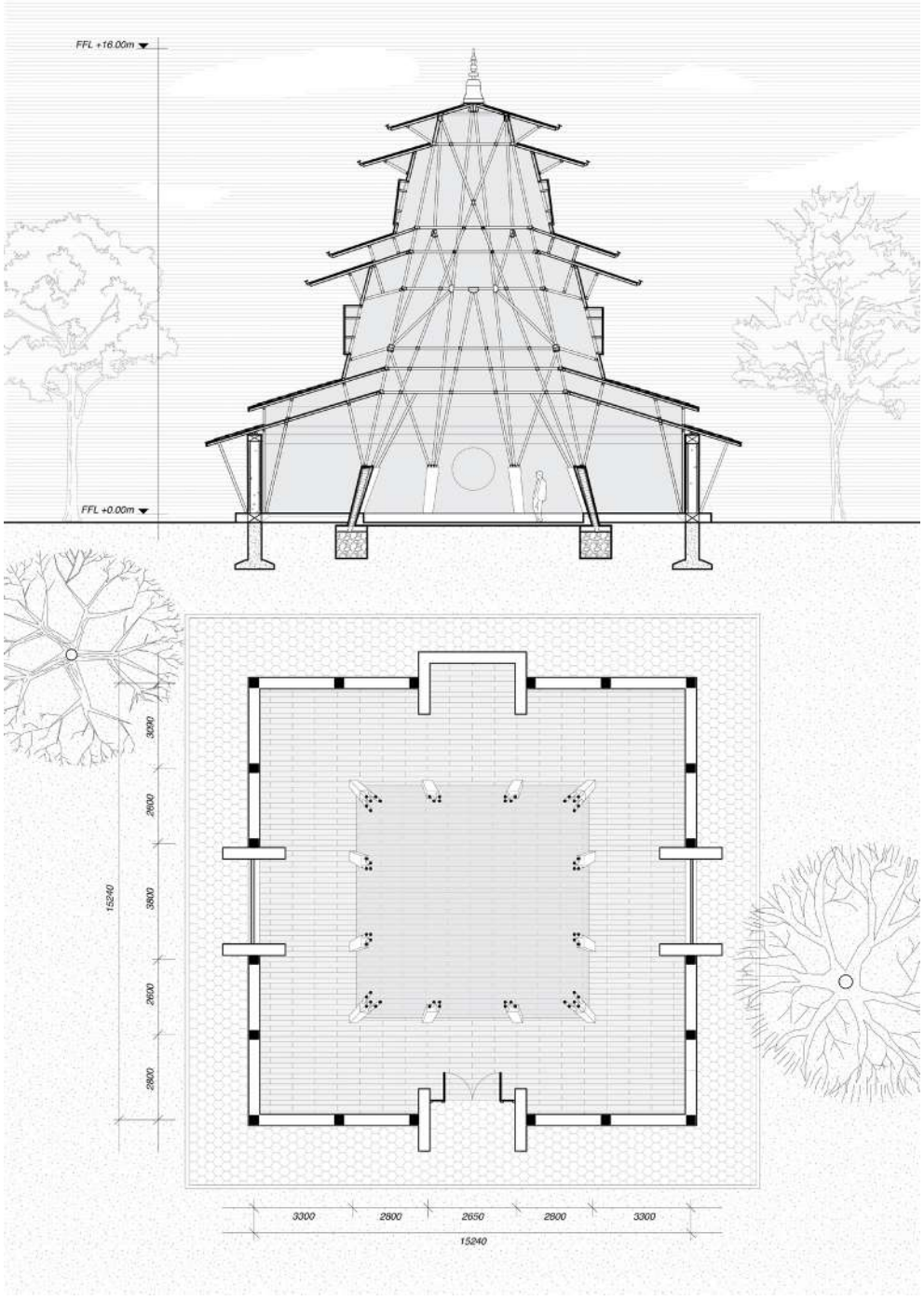


Figure 13: Elevation and plan of the Mahamudra Center (Asmita Sigdel)



Figure 14: Cement-free rammed earth, celebrating the colors of local clay (ABARI)

Similarly, the center's dining hall is vaulted with curved bamboo over wattle-and-daub walls. The curving bamboo seems to encapsulate the devotees, sheltering them from the harsh Himalayan environment. The walls of the accommodations are insulated with sheep's wool and plastered with earth, forming a salubrious haven for spirituality on this solitary mountain.

Figure 15: Mandala-shaped truss (Chemi Dorje Lama)

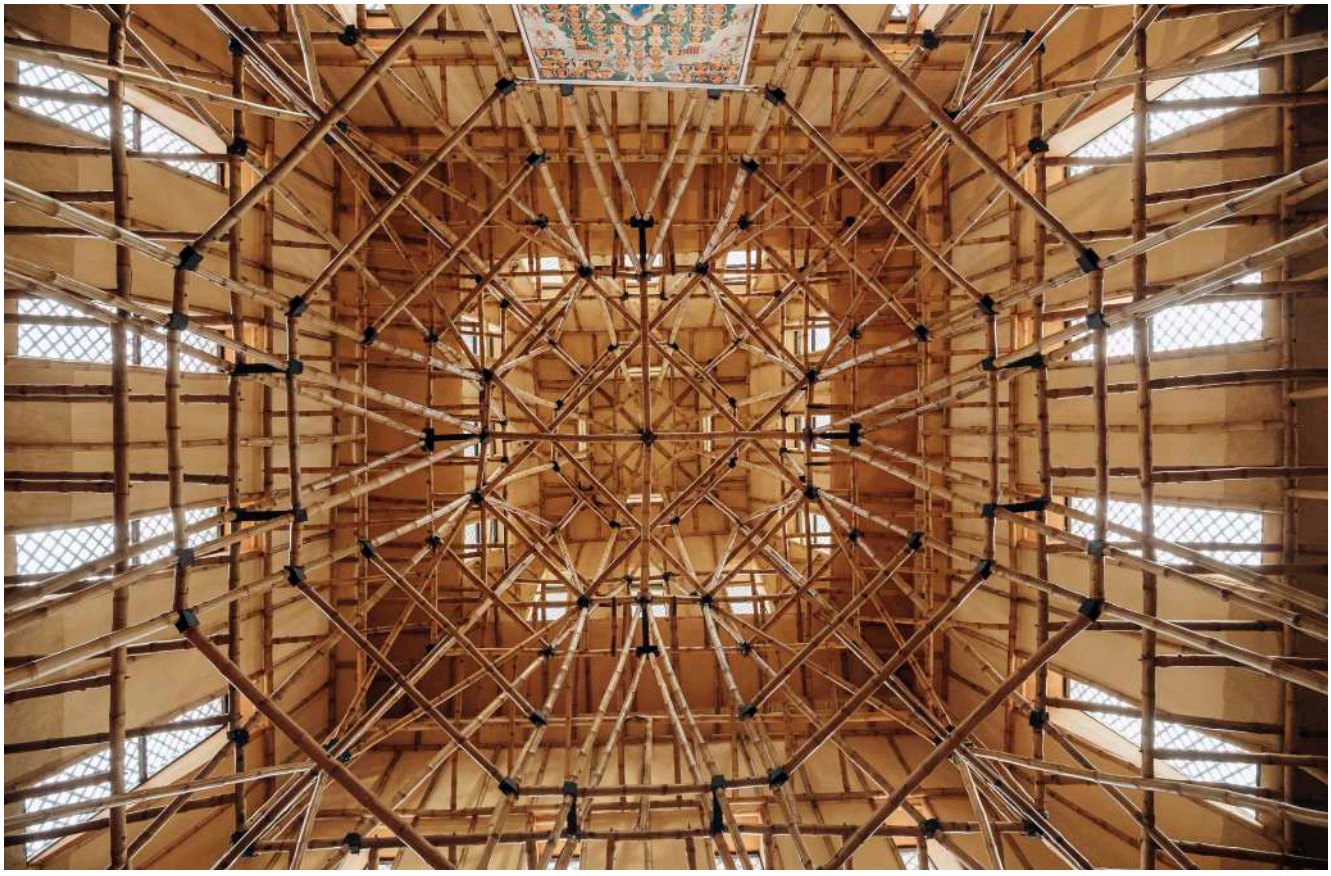




Figure 17: Exterior view of the Center (Chemi Dorje Lama)

Creating a System That Is Good for People and Planet

As mentioned, forests are highly regulated in Nepal, but bamboo is fortunately classified as a non-timber forestry product, which simplifies its plantation, harvesting, and use.

Figure 18: Land devastated by flooding (Google Earth)

Figure 19: Land restored and celebrated (Chemi Dorje Lama)



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In 2010, devastating flooding in Chitwan district forced many families off their land, leaving large deposits of sand that made the soil untillable. So we invested in a recently flooded area with the aim of restoring it and creating a stock of bamboo for use in construction.

Bamboo is hardy and can grow fast in tough conditions, with an extensive root system that helps control erosion. It is pliable, bending with a flood and springing back as the waters recede. All these characteristics make it ideal for land restoration.

After a few years of planting, the whole community got involved. Now we have restored the entire riverbank and in the process created a repertoire of bamboo for building, in an example of how one can build structures and restore land at the same time with multiple benefits for people and planet.

Conclusion

In Nepal there is a belief that true freedom stems from sovereignty over the essentials of life: food, shelter, and clothing—*gas bas kapas* in Nepali. Over time, especially since the colonial era, people's control over these essentials has been steadily eroded. What was once in communities' reach is now regulated and monetized. The ideal of self-sufficiency is increasingly undermined in the name of safety, conservation, and climate action. Despite this, locally sourced materials such as bamboo and earth still offer ways for people to regain control over their housing, with homes that do not come at the planet's expense and offer seismic safety, thermal comfort, and a healthy living environment. Such housing can both support the regeneration of the natural world and, as against the costly and dreary corporate model, offer something better.

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Biography | **Biografía** | **Biografia**

Nripal Adhikary

Based in Kathmandu, Adhikary leads ABARI, a practice centered on rigorous research and experimentation. Through extensive material testing and the study of vernacular traditions, ABARI promotes owner-driven reconstruction using locally sourced stone and materials such as bamboo, reed, and adobe. This research-based approach shows that these natural materials offer strength, flexibility, and earthquake resistance comparable to industrial options while being renewable, lighter, and ecologically sound, especially considering Nepal's bamboo-rich landscape. Beyond testing, Adhikary's research redesigns traditional materials to conform to contemporary aesthetics and functional needs, with a focus on seismic resilience, supported by local supply chains. Notable projects demonstrating this research include the Madan Puraskar Library, Mahamudra Monastery, and Kopila Valley School. He was a 2019 Emerging Architecture Award finalist and won the 2024 Fred Webster Prize.