Energy-Culture Across Altitude

Ada Gansach\textsuperscript{1} and Isaac A. Meir\textsuperscript{2}

\textsuperscript{1}Faculty of Architecture, Technion-Israel Institute of Technology, Haifa, Israel

\textsuperscript{2} DAUP-Dept. of Man in the Desert, Blaustein Institute for Desert Research, Ben-Gurion University of the Negev, Sede Boqer Campus, Israel

ABSTRACT: This paper argues that environmental aspects of vernacular architecture are culturally situated, and tests this proposition in the relationship between ecology, climatic conditions and architectural culture. The site of our study is the Himalaya of Nepal, where sharp change in altitude and ecology over short distances constrain and fragment human settlement. Migrants have evolved to form delimited ethnic groups occupying delineated areas, and developed local cultures and building traditions. We study and compare plans, sections, use of materials and people’s interpretations of their architecture in several case studies. We examine how these change in relation to shifts in socio-cultural contexts in order to develop an insight into the formation of architectural variety. Our study demonstrates how digressions, differences and contradictions between house construction and environmental performance articulate the socio-cultural process of their formation.

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INTRODUCTION

The paper demonstrates how local traditions related to energy in the built environment are temporal, reflecting a cultural process, which negotiates environmental conditions, and social and economic practices. Our study of contradictions and differences in building design shows that the embodiment of local knowledge of environment, climate and construction is a part of the historical process of change.

We study a series of dwellings along and across the Himalaya in Nepal. Altitude here is a major factor in defining the ecology, as it rises from 100 to more than 8,000 meters above sea level over a relatively short distance and cuts through changing environments from humid to arid, from cultivated land to dense forest or bare desert. The fractured geography of high mountains sliced by deep river valleys has fragmented settlement and sheltered a process of localizing cultures, whereby immigrants formed delimited ethnic groups with place-specific economic practices, social and religious traditions (of both Hindu and Buddhist cultures), and developed different building traditions. At the same time, centripetal forces, propelled by the growing integration of the communities into the state since it was formed in the middle of the 18\textsuperscript{th} century, accelerated by the recent incorporation of Nepal into the global processes, have acted to link, though indirectly, the disparate communities, providing common grounds for our comparative study.

The contradictory process of evolving differentiation and growth of common grounds, which has evolved in these circumstances, has articulated localities even in the most remote valleys. This process gives us the opportunity to trace the relationship between climate, environment, construction and organisation of space, and highlight the ways in which these are embodied in cultural practices.

The first part of the paper looks at variations in the design of buildings within one ethnic group, the Nyinba in the high mountains of Humla. We examine environmental aspects of changes in the design of houses and discuss the context of their formation. The second part explores differentiation and change in architecture across the same ecological zone of the high Himalaya. We show how time and space, not only place, play a pivotal role in articulating the environmental aspects in the design of the vernacular. The third part of the paper compares building traditions along the cross section of the mountains. We look at architectural characteristics identified with particular ethnic groups, discuss their differences and evaluate these against the yardstick of environmental constraints and climatic comfort.

Figure 1: Marsyangdi Valley - view from the middle hills to the high Himalaya. [A.Gansach, 1992]
2. TRANSFORMATION OF ALTITUDE, ECOLOGY AND CONSTRUCTION

The Himalayan folds rise from the low Terrai plains in the south (at 100-200m altitude) to the high ridges of the north (reaching peaks of over 8000m) (Fig.1). The climate is variable and topologically complex (Fig.2) – where the summer monsoons of the humid plains and the middle hills stand in sharp contrast to the arid areas at the rain shadow of the mountains to the north, where precipitation is limited to mainly winter snow. Precipitation varies with geography from less than 250 mm to over 5,200 mm per annum [1]. The change in climate from the humid east to the more inland, dryer west and distinct microclimates created by the geography, gives rise to intricate ecological constructions. This fragmentation of the land and the variety of conditions for buildings to evolve have created a variety place-specific architectures.

Figure 2: Seasonal trends of PET at selected elevations in Nepal. Spaces between the lines indicate vertical gradients [2].

There is a visible link between buildings and the environment in which they are built. Mud, cane, stone and timber are the main building materials in the villages, used with little processing, where most of the labour is invested into the assembly process. Usually, local materials are used, and only rarely they are transported over distances.

We begin by a detailed study of a house of the Nyinba community in the High Himalaya, examine environmental aspects of the design and develop an understanding for the context of change.

2.1 House in Nyimathang, Humla District, NW Nepal

Nyimathang, the higher of four villages of the Nyinba community, is located at 3,500m above sea level, at the upper edge of the tree-line. It is an arid-hyper arid environment (25-147 mm yearly)[3]. Precipitation is limited to mainly snow during the winter (November-February), though at the altitude of the village it rarely accumulates. Today the slopes are carved into cultivated terraces, but stories tell that they were forested at the time of the early settlers, carved into cultivated terrace s, but stories tell that the village it rarely accumulates. Today the slopes are carved into cultivated terraces, but stories tell that they were forested at the time of the early settlers.

Nyimathang consists of 28 loosely clustered houses at a fold in the topography, which protects the village from the strong afternoon winds. The houses have three stories where animals are housed on the ground floor, people occupy the first floor, with servicing spaces and a terrace above. A ladder leads from the ground to the Phyi Khor (Nb.), a central lobby on the first floor. This gives access to the living space, Khyim (Nb.) in the middle of which a hearth serves as the centre of family life, where most of the household activity takes place. The room is flanked by a Nangma Khyim (Nb.), a cold store at the northern hill-side of the house, and a Lho Khang (Nb.), a general storage space at the south facing side of the house. The third floor consists of a terrace, a prayer room or an additional store and a partially covered area where fodder is stored for the winter.

The rectangular envelope of the house is made up of 45cm thick stone and mud-mortar walls. They are restrained by paired timber beams, one at the inner and one at the outer face of the wall, held together with a notched timber tie, at height intervals of 80cm.

The floors are made in red mud reinforced with dried juniper branches, laid over rough-cut boards, resting on timber post and beam structure (Fig.3). The roof is flat, built like the floors, with an added layer of black mud and a final layer of fine white mud beaten in to seal the slab.

The house is divided vertically into three zones. The living quarters are located above the heat releasing animal space at the ground floor and under a relatively insulating upper zone where hay is stored on the roof. Such zoning is a typical reaction to the highlands cold climate, known from other areas like the Balkans and the Middle East. The building materials – stone, mud mortar and render of the walls, floors and the roof are of high thermal mass, thus providing a thermally stable indoor environment. The roof topping of white mud provides a waterproofing layer suitable for the “wet snow” typical of the early winter, although eventually, water penetrates the roof layers and causes higher heat loss through enhanced conduction.

2.2 Variations Within Altitude- Changes Through Time

The description above represents villagers’ idea of the typical house in Nyimathang. However, looking at the storage spaces around the Kyim, which directly affect energy efficacy and level of comfort in the house, a close examination (Fig.4) reveals a variety of forms. Whilst half follow the design described above, three houses (of freed slaves) have a different design, and eleven have one single storage space. Of
these, eight houses have only the *Lho Khang*, the outer storage space, which provides long term storage for common items (like grain, salt, and clothing), and sometimes serves as a place for a brother to live separately with a second wife (despite the practice of polyandry). Three houses have the *Nangma Khyim*, the inner storage room, where dearer consumption goods like alcohol and meat, as well as household treasures are stored, and it is thus perceived as more prestigious.

Figure 4: House types and adjacency, western ward, Nyimathang, Humla District. [A.Gansach, 1992]

We point out the discrepancy between an ideal and actual spatial arrangement of the plans when they are environmentally analyzed. Considering the climatic constraints of the region, an outer storage space would serve as a buffer zone for the living quarters and improve indoor conditions. However, here, thermal comfort and climatic protection are compromised for the sake of presentation of well being and status the *Nangma Khyim* is considered to display (the windows seen on the external walls of such houses are always closed by shutters, as we discuss below).

Diversions from the archetype like this illustrate a gap between image and practice. The following examples look at the increase in ceiling height and the use of metal stoves. These changes, which exhibit aspiration to status, were recently adopted despite the reduction in environmental comfort they instigate. Whilst this has been recognised by the villagers, it has not, or not yet, checked, or informed the adaptation of the new designs.

The new Nyinba houses, particularly those of the wealthier people, have larger *Khyim* (living room) with higher ceilings - 265cm rather than the 180cm of the past. As the same heat source, the fire in the hearth, now has to heat a larger volume this results in lower temperatures at the lower layer of air in the room, which is occupied by people sitting on the floor. Nevertheless, higher ceiling height is considered a matter of prestige among the villagers, who construct their new houses this way. "This is like the houses of Kathmandu" said the owner of such a house, who revealed that this change was introduced by an engineer from the community who returned after living and working many years in the capital. He also commented that the house feels colder than the old, lower ceiling house.

The introduction of the *Chulo*, a metal stove with chimney, has reduced environmental comfort in the house even more. It was promoted by an intensive government campaign during the 1980s, advertised to reduce the high rate of lung diseases, which developed in the unventilated smoky rooms. Villagers agree that the stove is more efficient for cooking, keeps the house clean from soot, and believe that people are healthier (a belief that can be substantiated by parallel research in other countries) [4]. However, it lowers the temperature in the house. Most of the air circulation in the old houses was internal, as the traditional skylight was insufficient for ventilation. This kept the houses warm (though smoky) during day and night, as most of the heat was retained in stone walls and the ceiling, and released during the night, when the fire is extinguished and people are asleep.

In recent years, two factors, new demand for private dwelling spaces, coupled by recent decline in animal husbandry, have worsened environmental comfort in the Nyinba house. The rooms of the animals on the ground floor are empty, and fodder is not stacked on the roof, so that no longer is the living space located between the heat source of the animals below and the insulating hay above. Here, on the third floor, under the little insulating uppermost roof, enclosed by unsealed timber planks and with no heat source, newly constructed bedrooms in some of the houses, are unpleasantly cold. This, together with the increase in ceiling height and the introduction of the *Chulo*, has made the *Khyim* even colder. Still, with additional bedrooms and absence of animal odours, this design embodies the recently acquired taste for privacy (there has not been a private place for individuals, and all activity took place in the shared spaces of the house) and sense of cleanliness brought by members of the community who engage in trade in Kathmandu and abroad. Despite the reduction in environmental comfort, the new, extended house design is valued as more 'progressive' by the villagers.

These examples show how new desires are imported, myths created and design ideas are incorporated into the traditional. These examples demonstrate how the application of the traditional design involves situated decisions, which act to transform an imagined model, which is preserved in people's minds. Such decisions are located in time, and embody shifts in ideology, social identity and affiliation.

3. WITHIN THE TIBETAN COMMUNITIES IN THE NORTH

Having looked at changes in the design of houses within one ethnic community, we now extend our examination across ethnic groups, but remain within the ecological zone of the high Himalaya, and within the domain of the Tibetan cultures. We study two aspects of the architecture, which we test against their environmental evaluation: adjacency and window design. The first articulates historical differences, the second embodies cultural similarities, and both embody the dialectical process of
architecture where social practices can override economic or environmental considerations.

In the Tibetan villages of the Himalaya, houses are built close to one another. The desire to minimise Man's imposition on the land by restricting the dispersal of houses reflects the Tibetan idea of occupation of space, namely, the relationship between Culture and Nature, Deities (Lha) and Spirits (bTsam), Order and Chaos. The close clustering of houses, which reduces exposure to the extreme conditions of the environment, is ubiquitous in the Tibetan villages of the Himalaya. In contradistinction to this, the form of adjacency, determined by the use or absence of party walls (a strategy of efficiency in terms of costs of construction, repair and energy use) we studied, varies. As we show below, it reflects local social and economic histories.

In Braga, in Manang District, houses are grouped in complex clusters (Ga.Di), where residential units have been added to one another over time, sharing one or more party walls (Fig.5). In Tog.Khyu, in Dolpo, houses are adjacent to one another but do not share party walls: each house has its own external wall constructed 10cm apart from its neighbour. In Nyimathang, in the district of Humla, adjacency is uncommon, and where this exists, it derives from a historical fraternity, where households share the site, but not a party wall [5]. Unlike Tog.Khyu and Nyimathang, where adjacency occurs only between close kins, in Braga, adjacency is unrelated to kinship; construction and repair of shared party walls are administered according to historical conventions.

Kin and clan relationship is the basis for economic and social association in Nyimathang, which was established in the 17th century, when four unrelated families from disparate farms decided to relocate into one space; since then it has evolved in a process of concurrent expansion and densification, where expansion was restricted by a family's limited labour power to clear the forest. People in five of the total six instances of adjacency in Nyimathang tell of a past fraternity between the families; however, with no traditions to depersonalise or administer liabilities, such adjacent houses are reconstructed without shared party walls. In Tog.Khyu of Dolpo, where association for agricultural work is based in the distance between clusters, and timing irrigation can often bring up conflict of interests between neighbours [4], adjacency is common. However, the sharing of a wall, used metaphorically to describe animosity between friends as "the devil between neighbours", is vehemently disapproved.

Thus the presence or absence of party walls reflect differences in socio-economic formations, or, specifically, the difference between societies participating in exchange economy and abiding by contractual ethics, and others whose practice is essentially local and agricultural, and where kinship structures social relations.

Whilst the above discusses differentiation between architectural traditions, the examination of changes in the Tibetan window design shows the growth of similarities between these different traditions in the same ecological and cultural zones. The window in the Tibetan house has changed in recent years. The availability of glass and industrial paints has reduced the use of timber and the need for specialized labour, whereby the design and the expressive meaning it had, have altered. Traditionally, the window has been the only, and the most important expressive element in the Tibetan house; its height is fixed by structural tie-beams, but its width varies. Made in timber frame and fixed panels carved with Buddhist symbols and patterns, the complexity of the window reflected the owners' wealth and social standing. Usually the actual opening is only 10% of the area of the window, which is normally closed by shutters, to reduce the penetration of cold air directly into the living space. The ideas of lit spaces, brought from Kathmandu and associated with modernity, the notion of 'the picture window' embraced from visiting tourists, together with the rising cost of timber and skilled wood carvers' labour, have induced change in recent years. The availability of glass, nails and industrial oil-paints has made it possible to construct large windows with glazed openings, simplify the joinery and reduce the expensive decorative work, where painting by locals has replaced the skilled work of outside carvers. It is obvious that such changes bring with them a different thermal behaviour of the building as a whole: poorer ventilation but also less air infiltration and heat loss. However, whilst the villagers testify that the houses are colder, lack of rigorous monitoring does not allow us yet to state whether such changes are an asset or a liability.

This displays the ways in which new materials make it possible to adapt the design to new ideals
while retaining the content of the traditional window design.

4. TRANSFORMATION WITH HEIGHT – HOUSES IN THE MIDDLE HILLS

So far we looked at changes within and across ethnic groups in the ecological zone and the cultural world of the high Himalayan Tibetan Buddhist societies. We now ‘zoom out’ to look at the differences across altitude and ethnic boundaries, and continue to gauge our examination by the yardstick of environmental performance to evaluate the vernacular as a process intrinsic to cultural transformation.

Upon descent from the high valleys, one can observe a series of changes and transformations in the architecture: stone walls give way to timber, cane and mud constructions, and the flat mud roofs change to pitched roofs in thatch or timber shingles. However, more than availability of raw materials, which is constrained by climate and ecology, what differentiates the architecture of ethnic communities are the social and political structures which define the investment of know-how and labour in their processing. This we can demonstrate by looking at the differences between the architecture of the Newar and the Gurung communities who occupy the same ecological zone of the middle hills.

In contradistinction to this, the Gurung, who occupy the hills in the same ecological zone of the middle hills, is a society of farmers; their agricultural subsistence economy produces little surplus, while employment and monetisation are recent. The Gurung build their houses in stone, mud, timber cane and reed they gather (Fig.7). The labour required for the construction work is unskilled, and is recruited from kin related networks in the village.

Figure 7: Gurung house, Ganpokhara, Kaski District - plan, elevation. [A.Gansach, 1986]

The Newar houses share certain elements with those of the Gurung, such as the low plinth to raise the ground floor level, deep overhanging eaves restrained by brackets below a sloping roof and grilled windows, which protect the house from monsoon floods and its interior from the rain. The two ethnic groups share climatic and ecological zone, and thus, in environmental terms, that is, in terms both of material and comfort, the houses are similar.

The similarity of environmental treatment yet the differences in the architecture of the two communities highlight the critical role of culture in the making of architecture. In terms of materials, for example, the Gurungs gather and shape them for their functional role in the building assembly with very little input of knowledge or labour in their processing. By contrast, the production of building materials has constituted a complex industry in the Newars society. Here production requires technological knowledge and specialized skills, which are protected by caste delineation (such as the Awa, house builders; Loha Kami, stone masons; Kami, carpenters and joiners; Kau, blacksmiths; or Tama, casters of metalwork.) In addition to this, unlike the plain village houses of the Gurung, the city and the architecture of the Newars are important site for cultural expression and a place of representation of status and wealth. This is embodied in the organisation of the city space, where centre and perimeter articulate caste-hierarchy, and in traditional building regulations restricting size, type and the use of materials according to caste status [9]. In the private domain, the Newars invest a great deal in conspicuous expressions, articulated in rich symbolic decoration of the wood carving of publicly visible parts of the building fabric (like tie beams at the walls, windows and brackets at the eaves).

Thus in Nepal, where the fractured geography has played a decisive role in creating territorially
circumscribed ethnic groups, environment and culture together have shaped the architectural characteristics of places. Building elements have evolved locally to become sites where ethnic identity and social distinction are located. In this way it is possible to understand how groups who migrated across the territory maintained the original architecture of the houses which they adapted to its new location. Examples to this are the Newars who were exiled to Chainpur (a leper camp in the 18th century which has evolved into a bazaar town), in east Nepal, where their brick houses and terracotta Jingati roof tiles differ from the Limbu and Rai villages around. In a similar way, people from the Tibetan communities of the high Himalaya, who have migrated to Pokhara and Kathmandu, have maintained, and even emphasized, the culturally expressive character of their houses.

5. ACROSS ECOLOGICAL ZONES

Compared with the Tibetan houses of the cold high Himalaya, where insulation and preservation of heat dominate the environmental considerations in the design of buildings, and with the houses in the moderate climate of the middle hills of Nepal, where protection of houses from heavy rains is pivotal, the reduction of heat load is central to structuring the spaces of the Tharu houses in the low Terrai plains.

The Tharu houses consist of an elongated rectangular space enclosed by low walls and covered with a thick high roof. They are made in cane, timber and thatch; stones, a relatively scarce material in the expanse of silt plains at the foothill of the Himalaya, are used only at the plinth of the house, which raises and protects the interior from monsoon floods. The external walls are thin, made of woven cane mats tied onto the timber frame, rendered with mud plaster and whitewashed. The walls are low - sometimes no higher than 75cm, pierced by small openings below deep projecting eaves. Inside the house, except for one partition to section off the space where animals are kept, there are no full-height partitions, but rather, Dahiri (2m high clay silos for storing grain) divide the space (Fig.8). The house is covered by a pitched thatch roof (which can reach 6m high) with a triangular opening at either end. With the absence of thermal mass in the walls, the natural circulation of air from the shaded area below the eaves through the low windows and up the undivided interior of the large space of the house creates operative temperature differences of approximately 5°C between indoors and outdoors.

6. CONCLUSION

The paper presented a mostly qualitative evaluation of the impact of architectural changes on environmental performance of traditional buildings along and across the high Himalaya of Nepal. We looked at relatively recent changes, which we could situate in the social, economic and ideological context. They represent the incremental process of change in the local architecture. Whereas the original material, technology, details, forms and volumes of buildings are the product of local environmental constraints, we can see that changes, usually exogenous in origin, are incorporated into the local traditions. This takes place in a process where a society articulates its location in context by moulding environmental conditions, ecological constraints, economic dictates, political ideology and aspiration, which both induce and restrain change. We can thus see that environmental performance is a social construct, which alters as building traditions transform, and that vernacular architecture is a dialectical process.

REFERENCES