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Human, House, and Habitat - Decoding the morphology and Cultural Landscape of Chalamthang Village

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Abstract

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Chalamthang is a hillside village in East Sikkim, located on the forested lower slopes of the Maenam hills in the Eastern Himalayan state of Sikkim, India. Historically named after its orange orchards, the village is organised into clusters of houses interwoven with stepped agricultural fields, kitchen gardens, cattle sheds, and circulation paths. Together, these elements form a vernacular cultural landscape, shaped through long-term interactions between human habitation, livelihoods, and the Himalayan terrain. Agriculture and community-based ecotourism constitute the primary livelihood systems, reinforcing strong spatial and functional relationships between domestic architecture, farming practices, seasonal cycles, and surrounding alpine forests.

This study documents the morphology and character of Chalamthang through the lens of Cultural Landscape Theory, with a particular focus on understanding the relationship between houses, humans, and habitat. Using contour mapping, site sections, and measured drawings, the research examines how vernacular houses align along contours, negotiate steep slopes through stepped configurations, and collectively stabilize the terrain using plinths, retaining walls, terraces, and paths. The study positions the house as a spatial anchor within a larger socio-ecological system, demonstrating how vernacular architecture mediates between landscape, livelihood, and everyday life in the Eastern Himalayas.

Keywords: Chalamthang, livelihoods systems, Human-Houses-Habitat, Socio-Ecological Systems

1. Introduction

The Eastern Himalayan region represents one of the most ecologically fragile and culturally diverse mountain landscapes in South Asia. Characterized by steep terrain, dense forests, high rainfall, and complex climatic conditions, settlements in this region have historically evolved through close, continuous interaction among humans, the landscape, and livelihood systems. Settlements in the Himalayas are therefore not merely physical aggregations of houses, but dynamic socio-ecological environments shaped by topography, climate, agriculture, water systems, and cultural practices. (Oliver, 2006) (Rapoport, 1969)

Within this broader Himalayan context, the studied village of Chalamthang in East Sikkim presents an important example of houses, agricultural terraces, cattle shelters, circulation paths, forests, and water systems together forming an integrated habitat structure, especially in the composite climate zone and especially in the places that receive significant rainfall. Historically associated with orange orchards and agrarian livelihoods, the settlement demonstrates how built form and landscape are interwoven through spatial, ecological, and social relationships. The morphology of the settlement reflects a continuous negotiation with slope, water flow, climatic conditions, and livelihood practices, resulting in a spatial organization that is both environmentally adaptive and culturally embedded. (Soladhara, 2025)

1.1 Cultural Landscape Theory and Human Habitat

The concept of cultural landscape provides an important theoretical framework for understanding the relationship between human habitation and the environment. Cultural landscapes are not viewed merely as natural terrains or built environments in isolation, but as spatial outcomes produced through long-term interactions between communities and their ecological settings. (Jefferson, 1926) In mountain settlements, these interactions are particularly evident where topography, agriculture, water systems, forests, and architecture collectively shape patterns of inhabitation and cultural identity (UNESCO Cultural Landscapes (Unesco, 2026))

Within the context of Chalamthang, the settlement can be interpreted as a vernacular cultural landscape in which everyday practices such as farming, cattle rearing, water management, seasonal occupations, and community rituals are embedded in the village's spatial organization. Houses, therefore, function not only as individual domestic units but also as spatial anchors within a larger socio-ecological system that mediates relationships between humans, landscape, and livelihood practices (Lefebvre, 1991).

1.2 Human–House–Habitat Relationships

The relationship between humans, houses, and habitat in vernacular Himalayan settlements is deeply interconnected and mutually dependent. Domestic architecture extends beyond the conventional function of shelter to accommodate agricultural storage, livestock management, food processing, social interaction, and ritual practices. Houses are therefore embedded within a broader network of productive and ecological spaces that support everyday life and livelihood systems. (Rapoport, 1969). In Chalamthang, this relationship is evident in the spatial continuity among houses, cattle sheds, terraces, pathways, forests, and water systems. The positioning of built elements along contours, the orientation of openings, and the organization of semi-public transitional spaces collectively reflect how architecture mediates environmental conditions while reinforcing social and cultural relationships. The settlement structure further demonstrates how vernacular architecture responds simultaneously to climate, terrain, resource management, and community interaction. (Norberg-Schulz, 1980)

1.3 Settlement Morphology and Socio-Ecological Systems

Settlement morphology in Himalayan villages is closely associated with the functioning of socio-ecological systems. The organization of built form, circulation networks, terraces, water channels, and open spaces reflects long-term processes of adaptation to environmental conditions and livelihood requirements. Settlement growth typically follows the availability of water resources and stable terrain, resulting in clustered morphologies that negotiate slope through stepped configurations, retaining walls, plinths, and terraced landscapes. (Fikret Berkes, 2002)

The morphology of Chalamthang illustrates how settlement planning is intrinsically linked to ecological systems and resource flows. Water movement, agricultural cycles, livestock management, and forest relationships collectively influence the spatial distribution of houses and community spaces. Such settlement structures demonstrate an integrated environmental logic where architecture functions as a mediating framework between natural systems and human occupation. This interconnectedness contributes to the resilience and sustainability of vernacular Himalayan settlements (Habitat, 2026).

1.4 Comparative Theoretical Frameworks for Human - House - Habitat Relationships

The study of vernacular settlements and their relationship with human habitation requires an interdisciplinary theoretical approach that extends beyond the documentation of individual buildings. In the context of Himalayan settlements such as Chalamthang, architecture is understood as an isolated physical object, but is a holistic approach when complemented with components of a larger socio-cultural, ecological, and environmental system shaped through long-term interactions between humans, livelihood practices, terrain, and natural resources. Consequently, several theoretical frameworks from architecture, landscape studies, anthropology, and socio-ecological research provide important perspectives for interpreting the relationship between Human - House - Habitat within vernacular environments.

The following comparative framework evaluates key theories and conceptual approaches relevant to understanding the spatial organization, settlement morphology, livelihood integration, environmental adaptation, and cultural identity embedded in Chalamthang village. While each framework contributes distinct insights into aspects such as domestic architecture, ecological systems, spatial production, or settlement growth, their applicability varies depending on the scale and focus of analysis. The comparison, therefore, helps identify the theoretical framework most aligned with the broader objectives of this study.

Table 1. Framework and Methodology.

Theory / Framework	Key Thinker(s)	Core Idea	What It Helps Explain in Chalamthang	Limitation in Your Context
Cultural Landscape Theory (Jefferson, 1926) (Cultural landscapes: A bridge between culture and nature, 2011) (Kawthar Alrayyan, 2022) (Ar. Nishant Upadhyay, 2021)	Carl Sauer, UNESCO	Landscapes are shaped through long-term interaction between humans and nature	Settlement morphology, agriculture, water systems, sacred landscapes, terrain negotiation, livelihood integration	Less focused on detailed architectural tectonics

House Form and Culture (Rapoport, 1969) (Duque, 2002) (Adeniran, 2018)	Amos Rapoport	House form is shaped by culture, lifestyle, and social organization more than climate alone	Family lineage, cluster evolution, domestic spatial hierarchy, cattle integration, ritual spaces	Focuses more on house form than larger landscape systems
Socio-Ecological Systems Theory (Giovanni Zurlini) (Bishwas, 2020) (Sebastian Moffatt, 2008) (Shruthi Dakey, 2023) (Berkes, 2009)	Berkes & Folke, Elinor Ostrom	Human systems and ecological systems function interdependently	Water–cattle–manure–farm cycles, resource flows, ecological resilience, livelihood systems	Less architectural and spatially descriptive
Production of Space (Lefebvre, 1991)	Henri Lefebvre	Space is socially produced through everyday practices	Activity mapping, outdoor spaces, food processing, community interaction, spatial occupation	Abstract and highly theoretical for settlement morphology studies
Phenomenology / Genius Loci (Norberg-Schulz, 1980)	Christian Norberg-Schulz	Architecture creates a sense of place rooted in landscape and experience	Sacred water source, ancestral house, visual connectivity, settlement identity	Less useful for technical morphological analysis
Settlement Morphology Theory (Chiaradia, 2019) (Mala) (Arise, 2021)	M.R.G. Conzen, Spiro Kostof	Urban/rural form evolves through terrain, circulation, and land-use patterns	Cluster formation, contour adaptation, paths, terraces, settlement expansion	Less attentive to cultural and livelihood dimensions
Climate-Responsive Architecture (Olgyay, 2015)	Victor Olgyay	Built form responds passively to climatic conditions	Thermal comfort, orientation, ventilation, roof overhangs, material performance	Too building-centric for your broader settlement study

The comparative analysis demonstrates that although multiple theoretical frameworks contribute toward understanding different dimensions of vernacular Himalayan settlements, **Cultural Landscape Theory** emerges as the most comprehensive and contextually appropriate framework for interpreting Chalamthang village. Unlike approaches that focus exclusively on house form, climatic adaptation, or spatial organization in isolation, Cultural Landscape Theory enables the settlement to be understood as an integrated socio-ecological and spatial system shaped through continuous interactions between humans, landscape, livelihood systems, water resources, agriculture, and cultural practices over time. The theory is particularly relevant in the context of Chalamthang because of the settlement morphology, clustered housing patterns, agricultural terraces, sacred water sources, livestock systems, circulation networks, and communal open spaces collectively function as interconnected components of a lived cultural landscape. The framework, therefore, allows the study to move beyond architectural documentation toward a broader interpretation of how vernacular settlements evolve through environmental adaptation, cultural continuity, and everyday socio-spatial practices. In this regard, Chalamthang can be understood not merely as a group of houses situated within a mountainous terrain, but as a dynamic cultural landscape where human habitation, ecology, and livelihood systems are deeply interwoven.

2. Aim of the study

The study aims to document and analyse two distinct residential clusters in Chalamthang village, East Sikkim, to understand the relationship between vernacular architecture, settlement morphology, and the evolving habitat character within a Himalayan socio-ecological context. Through a comparative analysis of traditional and evolving house typologies, the research examines the transition from indigenous to contemporary building practices and its implications for spatial organization, materiality, the cultural landscape, and everyday life.

3. Scope of the study

The study focuses on two residential clusters. The first cluster comprises an exclusive vernacular house typology reflecting traditional architectural character, indigenous construction practices, and settlement patterns. The second cluster comprises houses that are spatially and morphologically similar to those in the first cluster but differ in the use of modern construction materials and in altered building techniques. This cluster is organized around two spatial epicenters: a simple single-story house and a comparatively elaborate double-story dwelling.

The scope of the study extends beyond architectural documentation to encompass settlement morphology, analyzing spatial organization, built form, circulation networks, open spaces, contour relationships, and interactions between built and unbuilt spaces. The study also incorporates activity mapping and movement analysis to understand patterns of occupation, livelihood practices, socio-cultural interactions, and the functional use of spaces.

4. Methodology

The research adopts a qualitative, field-based documentation approach combining architectural documentation with landscape analysis. Settlement-level documentation was undertaken through site mapping, contour studies, spatial observations, and movement analysis to examine clustered housing patterns, agricultural terraces, circulation networks, and water systems.

Detailed measured drawings of selected Limboo house typologies, including traditional mud houses, single-story houses, and evolved double-story dwellings, were prepared to document plans, sections, elevations, material systems, and construction techniques, with particular attention to climatic responsiveness and spatial hierarchy.

The methodology further included activity mapping, informal discussions, and participatory on-site tracing exercises with residents to understand community relationships, livelihood practices, and spatial adaptations across generations. Collectively, the methodology enables a comprehensive reading of Chalamthang as a vernacular cultural landscape where architecture, environment, and social life operate as interconnected systems.

5. Morphology of Chalamthang Settlement

Chalamthang is a village located in the Namchi district of the eastern Himalayan state of Sikkim in northeastern India. Situated across the Teesta River from the state capital, Gangtok, the settlement is characterized by its remote mountainous terrain and agrarian landscape. The village is predominantly inhabited by the ethnic Nepali community, whose presence in the region is historically associated not with migration, but with the shifting of political boundaries over time. The community largely follows Hindu cultural traditions and practices a predominantly vegetarian lifestyle.

The socio-economic structure of the village is primarily dependent on agriculture and animal husbandry, which are closely integrated with the region's natural terrain and ecological conditions. The fertile mountain slopes support terrace cultivation and subsistence farming practices, forming an essential component of the settlement's livelihood system and cultural landscape.

The origin of Chalamthang village is closely associated with a natural water source uphill from the present study area, which continues to serve as the settlement's primary source of potable water. This water source holds significant cultural and historical importance within the community and is regarded as the original nucleus of the village settlement. The residents of Chalamthang attribute spiritual significance to the site and continue to worship it as a sacred landscape feature, reflecting the deep interrelationship among natural resources, belief systems, and settlement formation in the region.

Historically, the earliest settlers are believed to have established their habitation in proximity to this water source due to its ecological and functional significance. Over time, as families expanded and spatial requirements changed, the settlement gradually extended downhill towards the river basin. This pattern of incremental expansion illustrates the organic evolution of the village morphology in response to terrain, resource accessibility, and socio-cultural continuity.



Figure 1. Water source of Village, and settlement.

A typical residential cluster within Chalamthang comprises a centrally located primary dwelling surrounded by a series of smaller permanent and semi-permanent structures. These ancillary structures commonly function as storage spaces, outdoor kitchens, cattle sheds, or homestay units, reflecting the close integration of domestic, agricultural, and livelihood-related activities within the settlement fabric.

The clusters are generally encircled by agricultural fields and orchards along the downhill slopes, while the uphill edges are often defined by ridgelines, access roads, or pedestrian trails. The spatial organization of these clusters demonstrates

a strong responsiveness to the mountainous terrain, where built structures are typically situated on relatively flattened land parcels formed along gentler and more widely spread contour gradients. This arrangement enables efficient use of topography while maintaining functional relationships between habitation spaces, agricultural activities, and circulation networks.

5.1 Cluster Organization and Spatial Hierarchy

The spatial organization and evolution of the selected study clusters can be interpreted through the lens of Cultural Landscape Theory, in which settlement morphology emerges as the product of continuous interaction among human habitation, livelihood systems, environmental conditions, and topographical constraints. Rather than functioning as isolated houses or architectural entities, the clusters represent interconnected socio-spatial systems shaped by generational adaptation to terrain, resource availability (water, wood, fertile soil, etc.), agricultural practices, changing material preferences, and geographical accessibility. The clusters, therefore, illustrate varying stages in the transformation of vernacular Himalayan settlements while simultaneously retaining strong relationships with the surrounding ecological and cultural landscape.

Cluster 1 (Fig. 2) demonstrates a transitional condition within the settlement morphology of Chalamthang, reflecting the gradual transformation from traditional vernacular construction systems toward contemporary architectural practices. The coexistence of a traditional vernacular dwelling alongside a recently constructed structure illustrates the changing aspirations, material preferences, and construction techniques emerging within the settlement. While contemporary materials and altered structural systems have been introduced in the newer house, the cluster's broader spatial organization continues to follow the traditional settlement logic shaped by contours, access routes, agricultural interfaces, and visual connectivity across the slope. This coexistence of old and new built forms reflects an evolving cultural landscape in which modern interventions are inserted into historically established spatial and ecological relationships.

Cluster 2 (Fig. 2), on the other hand, reflects a more intact vernacular settlement condition characterized by compact clustering and stronger socio-spatial integration between domestic architecture and livelihood activities. Situated on a relatively stable and leveled terrace within the sloping terrain, the houses are organized in close proximity to one another, reinforcing kinship-based settlement patterns and collective living practices. The cluster demonstrates a highly integrated relationship among houses, agricultural terraces, orchards, livestock areas, storage areas, and shared outdoor spaces, collectively functioning as an interconnected habitat system. The spatial arrangement allows visual and functional continuity between domestic life and productive landscapes, enabling efficient movement, surveillance, resource sharing, and environmental adaptation.



Figure 2. Cluster Plan.

The organization of both clusters further reflects the influence of terrain and water systems in shaping settlement morphology. Houses are positioned strategically along contours to negotiate slope stability, solar orientation, and

accessibility while minimizing extensive land modification. Agricultural terraces and utility spaces transition downhill from the residential core, establishing a layered spatial hierarchy that corresponds with livelihood activities and ecological processes. Such settlement configurations demonstrate how the built environment in Chalamthang evolves not through rigid planning principles, but through incremental adaptation to the Himalayan landscape, reinforcing the interpretation of the settlement as a lived cultural landscape shaped by long-term human–environment interaction. The selected study clusters demonstrate distinct spatial and architectural characteristics that reflect varying patterns of settlement evolution and construction practices within Chalamthang village.

Terrain Adaptation - Settlement morphology evolves along stable contours and naturally levelled terraces to minimize terrain disturbance and slope instability. Stepped plinths, retaining walls, and terraced formations negotiate steep Himalayan topography through incremental adaptation. Spatial organization demonstrates a strong geomorphological response to elevation, drainage, and accessibility conditions.

Water Systems - Water sources are primary determinants of settlement formation, expansion, and spatial hierarchy. Gravity-driven water movement establishes interconnected relationships between domestic, livestock, and agricultural zones. Springs, ponds, and streams contribute toward ecological regulation, resource continuity, and microclimatic moderation.

Agricultural Integration - Agricultural terraces, orchards, and kitchen gardens are spatially integrated within the domestic settlement fabric. Productive landscapes operate as extensions of habitation rather than segregated economic zones. Cyclical resource flows between livestock, manure systems, and farming practices reinforce ecological sustainability.

Clustered Settlement Pattern - Compact settlement clustering reflects kinship-based spatial organization and collective living practices. Proximity between houses strengthens social cohesion, shared resource management, and visual connectivity across the slope. Shared outdoor domains serve as transitional socio-spatial interfaces that support communal interaction and seasonal activities.

Livelihood Systems - Domestic architecture remains intrinsically linked with livestock rearing, agricultural processing, storage, and resource management. Spatial transitions between houses, cattle sheds, poultry areas, and terraces facilitate functional continuity within everyday livelihood systems. The settlement demonstrates a highly interdependent human–environment relationship embedded within vernacular spatial practices.

Cultural and Sacred Landscape - Sacred water sources, ancestral houses, and ritual spaces reinforce cultural continuity and collective identity within the settlement. Vernacular spatial organization embodies intangible cultural values associated with memory, lineage, and community practices. The landscape functions simultaneously as a productive, ecological, and symbolic environment shaped through generational inhabitation.

Human - House - Habitat Relationship - Houses function as spatial anchors within a larger socio-ecological and cultural landscape system. Built form, terrain, livelihood systems, and environmental processes operate as interconnected components of a lived habitat. Settlement morphology reflects long-term adaptation between human occupation, ecological systems, and Himalayan environmental conditions.

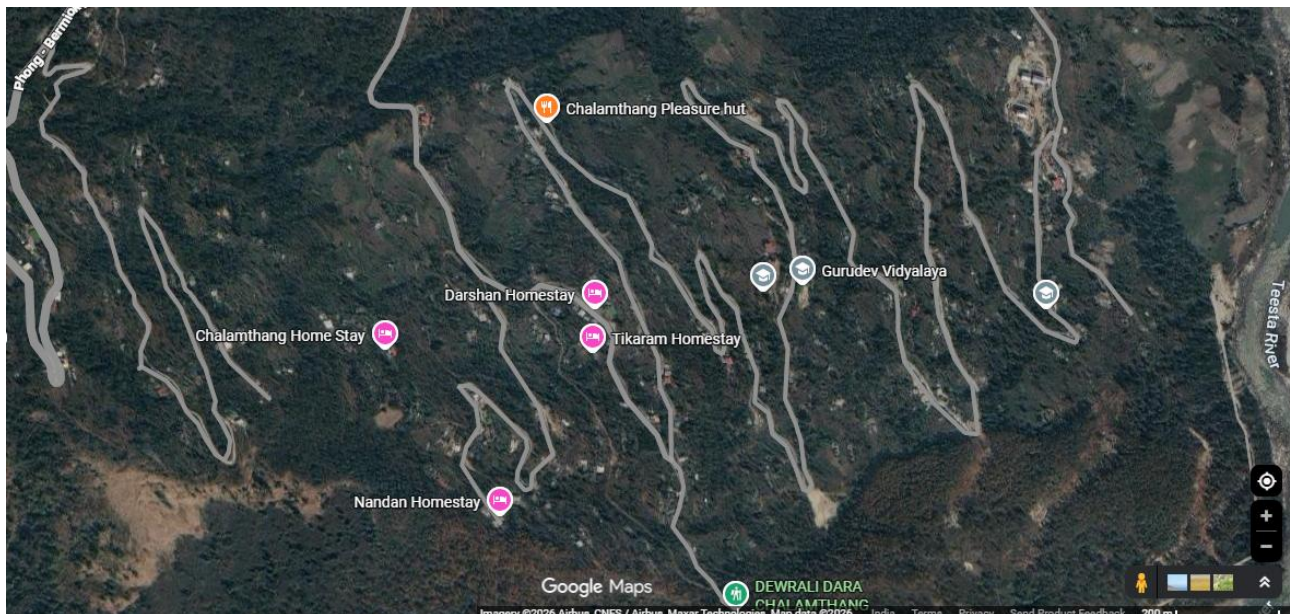


Figure 3. Landscape of the Chakamthang.

The spatial hierarchy within Chalamthang emerges from a layered organization of built form, livelihood spaces, circulation networks, and ecological systems, structured in response to the terrain and everyday functional relationships. Residential clusters occupy relatively stable, elevated terraces along the contours, forming the primary habitable domain within the settlement. Transitional spaces surrounding the houses, including semi-open spillover areas, shared courtyards, and circulation paths, serve as intermediate socio-spatial interfaces that connect domestic life with productive landscapes. Agricultural terraces, cattle sheds, poultry areas, storage spaces, and utility zones are systematically distributed downhill from the residential core, establishing a gradual transition from private to collective and productive spaces. This spatial arrangement reflects a hierarchy governed not by rigid planning principles, but through incremental adaptation to

topography, resource accessibility, livelihood practices, and community interaction, collectively reinforcing the Human–House–Habitat relationship embedded within the settlement morphology.

5.2 Water Systems and Settlement Expansion

Water systems play a fundamental role in shaping the spatial organization, expansion, and ecological functioning of Chalamthang village. The settlement demonstrates a strong dependence on naturally available water sources such as springs, seasonal streams, and contour-fed ponds, which historically influenced the locations of early habitation clusters on the hillside terrain. The earliest residential formations are observed in close proximity to stable water sources, reflecting the importance of water accessibility in determining settlement establishment and long-term habitation patterns. Over time, the settlement gradually expanded along the contours and downhill slopes while maintaining functional relationships with these water systems.

The movement of water through the settlement follows a gravity-based spatial logic, in which upper-level sources supply domestic use before extending to livestock areas, utility spaces, and agricultural terraces at lower elevations. This layered transition establishes a continuous ecological linkage between habitation, livelihood activities, and productive landscapes. Water systems, therefore, function not only as physical resources but also as organizing elements that structure circulation, land-use patterns, and spatial hierarchy within the settlement.

The pond adjacent to the clustered settlement further demonstrates water's multifunctional role within the vernacular landscape. In addition to serving as a localized water reserve, the pond supports fish rearing, domestic utility functions, and microclimatic regulation through evaporative cooling. The presence of water bodies in proximity to residential clusters contributes toward thermal moderation, particularly during warmer periods, while simultaneously reinforcing the ecological resilience of the settlement. Such relationships illustrate how vernacular Himalayan settlements evolve through an integrated understanding of hydrology, topography, and livelihood systems.

The expansion of Chalamthang, therefore, reflects an adaptive settlement strategy where water systems, terrain conditions, and ecological processes collectively influence the morphology of the built environment. Rather than imposing rigid planning structures upon the landscape, settlement growth occurs incrementally through continuous negotiation with natural resource systems, reinforcing the interpretation of the village as a lived cultural landscape shaped by long-term human–environment interaction.

The sectional profile of the settlement demonstrates a gravity-based water management system integrated with agricultural terraces along the slope. Surface runoff from upper contours gradually irrigates lower cultivation zones while reducing soil erosion during monsoon conditions. Terraced formations, retaining edges, and vegetation buffers collectively stabilize the terrain and regulate water flow, reflecting an indigenous understanding of hydrology and ecological adaptation within the Himalayan landscape.



Figure 4. Site Section A and B.

5.3 Plinths, Retaining Walls, and Terrain Negotiation

The settlement morphology of Chalamthang demonstrates a strong response to the steep Himalayan terrain through the use of stepped plinths, retaining edges, and terraced landscape formations. Residential clusters are positioned on relatively stable and levelled contours, while agricultural terraces transition gradually downhill following the natural slope. Raised plinths and retaining walls stabilize the terrain, negotiate level differences, and protect the built form from surface runoff and soil erosion, particularly during monsoon conditions.

The terraced organization of agricultural fields further regulates gravity-driven water movement across the slope, allowing gradual percolation and controlled irrigation of lower cultivation zones. Vegetation buffers and retaining formations collectively reduce the velocity of runoff and minimize soil displacement within cultivated areas. Such terrain-responsive spatial organization reflects an indigenous understanding of hydrology, slope stabilization, and ecological adaptation within the fragile Himalayan landscape.

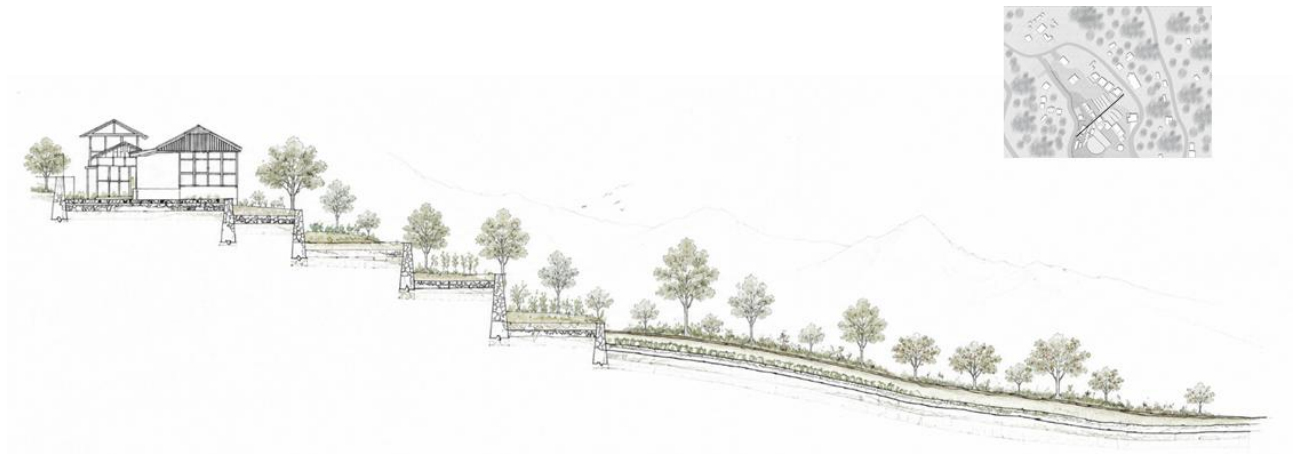


Figure 5 Site section -C.

5.4. Public, Semi-Public, and Shared Community Spaces

The space between the buildings further contributes toward mutual shading and climatic moderation within the settlement cluster, creating thermally comfortable outdoor environments for everyday social interaction and livelihood activities. These interstitial spaces frequently serve as household courtyards and shared work areas for seasonal agricultural processing, crop drying, storage of tools and firewood, and informal community gatherings. The gradual transition between private domestic interiors and shared outdoor domains establishes a porous spatial character that strengthens collective participation and visual connectivity within the settlement.



Figure 6. House section with semi-public spaces in cluster 2.

The sectional relationship between houses additionally demonstrates how elevated plinths, verandahs, and contour-following pathways collectively create semi-public thresholds that mediate interactions between residents, visitors, and productive landscapes. Such spaces remain active throughout the day and across seasonal cycles, accommodating both domestic and livelihood-based activities while reinforcing the interconnected Human–House–Habitat relationship embedded within the vernacular settlement morphology of Chalamthang.

5.5 Outdoor Spaces and Settlement Transitions

The outdoor spatial organization of the studied settlement cluster demonstrates a highly adaptive and context-responsive settlement morphology characteristic of Himalayan hill settlements situated within the temperate forest and humid sub-tropical agro-climatic zones of Eastern Sikkim. The spatial arrangement reflects a carefully evolved relationship between topography, livelihood systems, water management, and everyday domestic practices. Houses are strategically positioned along the uppermost, stable, and relatively flat edges of the slope, generally near circulation trails and settlement roads, while ancillary livelihood spaces such as cattle shelters, poultry areas, agricultural terraces, and plantations transition gradually downhill along the natural contours of the terrain.

These spatial transitions are neither incidental nor arbitrary, but rather represent an environmentally responsive planning logic that enables continuous visual surveillance across the slope and facilitates efficient movement between domestic and productive spaces. The arrangement further supports a gravity-based flow system for water distribution, where water sourced from ponds, springs, or streams is channeled sequentially through domestic spaces, cattle areas, and eventually

towards agricultural fields. Such spatial sequencing demonstrates an integrated ecological management system embedded within the settlement structure.

The positioning of cattle sheds between residential areas and agricultural land is similarly strategic, reducing the physical effort required for feeding, milking, and managing livestock while strengthening the everyday interaction between humans and animals. Livestock waste generated in these intermediate zones is systematically collected, processed, and reused as organic manure for agricultural activities, establishing a cyclical nutrient flow among habitation, livestock, and farming systems. This reflects a closed-loop resource management practice rooted in vernacular ecological knowledge and sustainable agrarian traditions. The sectional organization of the settlement, therefore, reveals a continuous flow of water, organic material, movement, and livelihood activities from the upper circulation edge and communal spaces, through the domestic core and livestock areas, and ultimately towards the cultivated valley below.

The upper and lower edges of the settlement are further defined through dense vegetation buffers that function as natural ecological boundaries of the habitat. These edges are often reinforced either through anthropogenic plantation or through the preservation of existing vegetation systems. Common species include large fruit-bearing trees such as orange, guava, banana, and jackfruit, avocado, along with bamboo groves that hold both ecological and economic value. In addition to providing food, shade, and slope stabilization, bamboo serves as an important source of locally available construction material for housing and utility structures.

The spillover spaces between houses, cattle sheds, water bodies, farms, and poultry areas collectively function as semi-public community realms. These open spaces support a wide range of seasonal and everyday activities including food processing, drying agricultural produce, social interaction, leisure, and collective gathering. Such spaces reinforce the socio-spatial continuity between domestic life, livelihood systems, and community engagement within the settlement.

Utility areas, including toilets and bathing spaces, are generally located away from the principal inhabitable spaces and are clustered along the slope edge to minimize moisture accumulation and reduce maintenance requirements within the earthen domestic structures. These utility spaces are constructed on stone foundations and often incorporate stone slab flooring systems to facilitate efficient drainage and reduce water retention. Traditionally constructed using timber and bamboo, many of these structures are gradually transitioning towards contemporary construction materials. Their placement along the natural gradient allows wastewater to drain downslope through gravity while maintaining proximity to water sources such as springs, streams, or ponds.

Within the studied settlement cluster, the utility spaces are located adjacent to a naturally formed pond (created through the site's geographical contours). Beyond functioning as a water source, the pond also supports small-scale fish cultivation and acts as a critical environmental regulator within the settlement ecosystem. The presence of the water body contributes to localized evaporative cooling during warmer months, moderating microclimatic conditions and enhancing outdoor thermal comfort within the surrounding habitation spaces. Collectively, the integration of water systems, vegetation, open spaces, and livelihood infrastructure demonstrates a highly climate-responsive and ecologically interdependent settlement model rooted in vernacular Himalayan knowledge systems.

6. Discussion

The study demonstrates that the morphology of Chalamthang village is not solely a product of architectural response to climate and terrain, but rather an outcome of long-term socio-ecological adaptation embedded within the Himalayan cultural landscape. The settlement structure reveals a highly interconnected relationship among built form, topography, livelihood systems, water networks, and community practices, in which houses serve as spatial anchors within a larger habitat system. Through the application of Cultural Landscape Theory, the research establishes that the organization of houses, agricultural terraces, cattle sheds, circulation paths, sacred spaces, and water systems collectively contributes to the formation of a lived cultural landscape shaped by continuous human–environment interaction.

The findings further indicate that vernacular settlement planning in Chalamthang is governed by environmental logic rather than formalized planning principles. The positioning of residential clusters along stable contours, the use of stepped plinths and retaining formations, and the gravity-based organization of water systems illustrate a sophisticated indigenous understanding of terrain negotiation and hydrological management. Such spatial strategies minimize terrain disturbance, reduce soil erosion, regulate surface runoff, and simultaneously support agricultural productivity and settlement stability within the fragile Himalayan environment. The integration of ecological systems within the settlement morphology, therefore, reflects an adaptive planning approach rooted in long-term environmental observation and localized knowledge systems.

The study also highlights the significance of livelihood integration within vernacular Himalayan settlements. Unlike contemporary spatial segregation between residential and productive functions, the settlement structure of Chalamthang demonstrates a continuous relationship between domestic life, livestock management, food processing, storage, and agricultural activity. The spatial sequencing from houses to cattle sheds, terraces, plantations, and water systems establishes cyclical flows of resources, movement, and labour that reinforce ecological sustainability and functional efficiency. Such interdependence illustrates how vernacular settlements operate as integrated socio-productive systems rather than isolated residential environments.

Climatic responsiveness emerges as another critical dimension of the settlement morphology and architectural character. The use of locally available materials such as mud, stone, bamboo, timber, and thatch contributes to thermal moderation, moisture regulation, and low-embodied-energy construction practices. Thick earthen walls, ventilated attic spaces, controlled openings, and extended roof overhangs collectively demonstrate passive environmental strategies responsive to the climatic conditions of Eastern Sikkim. The environmental monitoring observations presented in the study further validate the thermal performance of the vernacular house typology, in which indoor environmental conditions remained comparatively stable despite colder winter temperatures. This reinforces the continued relevance of vernacular material

systems and passive design strategies within contemporary discussions on climate-responsive and sustainable architecture.

Simultaneously, the research reveals the ongoing transformation of the character of vernacular settlement through the gradual introduction of industrial materials and changes in construction practices. The coexistence of traditional mud houses alongside newer structures built from concrete, corrugated metal, and contemporary masonry reflects changing aspirations, accessibility, and socio-economic transitions within the village. While these transformations may address issues related to maintenance, durability, and modern living expectations, they also risk weakening the environmental responsiveness, material circularity, and cultural continuity embedded within vernacular construction systems. The erosion of indigenous construction knowledge and spatial practices, therefore, represents a broader challenge for the conservation of Himalayan cultural landscapes.

The study consequently positions Chalamthang not merely as a rural settlement but as an evolving Human–House–Habitat system in which architecture, ecology, culture, and livelihood practices remain deeply interconnected. The documentation of settlement morphology, spatial hierarchy, environmental systems, and vernacular building practices contributes toward the preservation and interpretation of an endangered knowledge system that offers valuable lessons for contemporary sustainable settlement planning. In the context of increasing climatic vulnerability, ecological instability, and homogenization of built environments, the vernacular landscape of Chalamthang demonstrates the importance of context-responsive, low-energy, and ecologically integrated approaches to habitation within fragile mountain regions.

Conflicts of Interest

The authors declare no conflict of interest.

Data Availability Statement

All datasets are included within the article

Institutional Review Board Statement

Not applicable

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All authors have read and approved the final version of the manuscript

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