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Case Study-07

Climate-Resilient Adaptation of Built-Form in Hilly Regions through Traditional Wisdom and Best Practices - The case of Himachal Pradesh

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Contents

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Abstract: Traditional settlements have evolved over centuries in an organic spatial pattern with certain inherent factors that deal with externalities like disasters and natural calamities. It is largely accepted now that indigenous knowledge evolved through times, is characterized as an alternative way of addressing climate change issues, which has evolved through times. Indigenous knowledge is often evolved on the principles of trial and error, which is then followed in mainstream sciences. On the contrary, modern planned settlements that are based on man-made scientific interventions are designed to deal with resilience towards calamities. However, in hilly terrains, we often find that rampant, unregulated and accelerated modern urbanisation has led to new urban fabric that is inorganic in nature and not tolerant to environmental requirements of a hilly region. This has led to incidences of frequent landslides, flash floods and large-scale losses during earthquakes. Even though such incidences are linked to urbanisation patterns, such interlinkage is not clearly established. Given the significance of rich local indigenous knowledge, this case study attempts to map, document and critically evaluate the traditional construction techniques, skills and knowledge prevalent amongst the local communities in north-western part of Himachal Pradesh region.

In this case study, a detailed examination of a few settlements in the hilly region of Dharamshala and Kullu region were carried out. The study reveals the reasons why the traditional buildings and settlements are able to survive the impacts of disasters in the long run, that in turn has resulted in their heritage status. Further, the study documented the new and old concepts with respect to planning and design of traditional buildings and settlements that are with traditional patterns, materials and technologies of past in Dharamshala and Nagar regions of Himachal Pradesh. Special attention is given to Kathkuni construction style, a local architecture construction technique that has survived over a period of time. A descriptive interpretative approach has been employed to document and interpret the traditional methods, tools, planning and design. Based on the findings, the essence of traditional knowledge and wisdom gained through this study are recognized. Further, the lessons learnt from these cases studies pave the way for sensitizing architects and planners to promote sustainable and resilient built-environment in hilly regions.

1 Introduction

Numerous traditional and vernacular practices and styles have developed over the years for planning of settlements and construction of buildings in the Himalayan region of north India. This has evolved over past centuries to meet the requirements of local needs and suitable for local climate. These vernacular practices are developed by the people, for the people, without any technical/professional training; with the help of locally available, natural and environmentally friendly construction materials and indigenous construction techniques that people have learned, developed, and refined over centuries. These vernacular practices and styles are developed with the objective to have sufficient protection against harsh climatic conditions and natural calamities. Ritual beliefs, customs, social structure, profession, economic status and culture are often reflected in vernacular buildings through their form, scale, size, colour, materials and facades. Vernacular practices have minimal impact on environment in and around hill settlements and different salient features of vernacular practices evolved in hilly areas like the use of local materials, thermal comfort, environmentally friendly design, smaller foot print, contextual appropriate development is also considered as the essential requisites of sustainable development. Along with various benefits of vernacular practices and styles, vernacular buildings have some crucial issues and concerns like, need for regular maintenance, low strength of materials and/or building components, unavailability of skilled craftsmen who can work with traditional materials, shortage of traditional materials and reluctance of some residents to continue maintaining their buildings with vernacular practices in contemporary times lead to reduced use of these sustainable vernacular practices for construction of new buildings in hilly areas. Moreover, there is increased urbanisation, and need construction of multi-storeyed buildings; and with improved transportation to promote the use of contemporary materials in hill settlements, one can observe a spurt in modern buildings in the region. Improvement in living and economic conditions, improvement and increase in building services; better, fast and easily understandable and workable construction techniques and equipment further affect the use of vernacular practices for planning and design of new buildings in hill settlements. In parallel, it is observed that there is a general and gradual change in climatic conditions in the form of longer and colder winters, frequent flash floods, landslides and reduced sun-days. While the shift is gradual and not extensive enough, it affects the relatively poor hill communities in their livelihood generation capacity and survival. In such changing climatic conditions, this study attempts to find out the best practices, which have withstood the harsh cold conditions over the years and evaluate them in terms of their replicability.

Massive development with contemporary materials results in pollution, loss of vegetation, increase in soil erosion, increase in surface runoff, lowering of water table, flooding, change in micro climate and increase in occurrences of instability, which cause severe damage to sensitive and fragile environment in and around hill settlements. To minimise different ill impacts of new and massive development on natural environment in and around hill settlements and to maintain environmental quality, various building regulations are enforced, but problems related to environmental deterioration persist and further intensifies in hill settlements. Thus, there is a need to draw lessons from sustainable vernacular practices for formulating building regulations and design of new buildings in hill settlements of North India. Given the need and significance of rich local indigenous knowledge, this case study attempts to map, document and critical evaluate

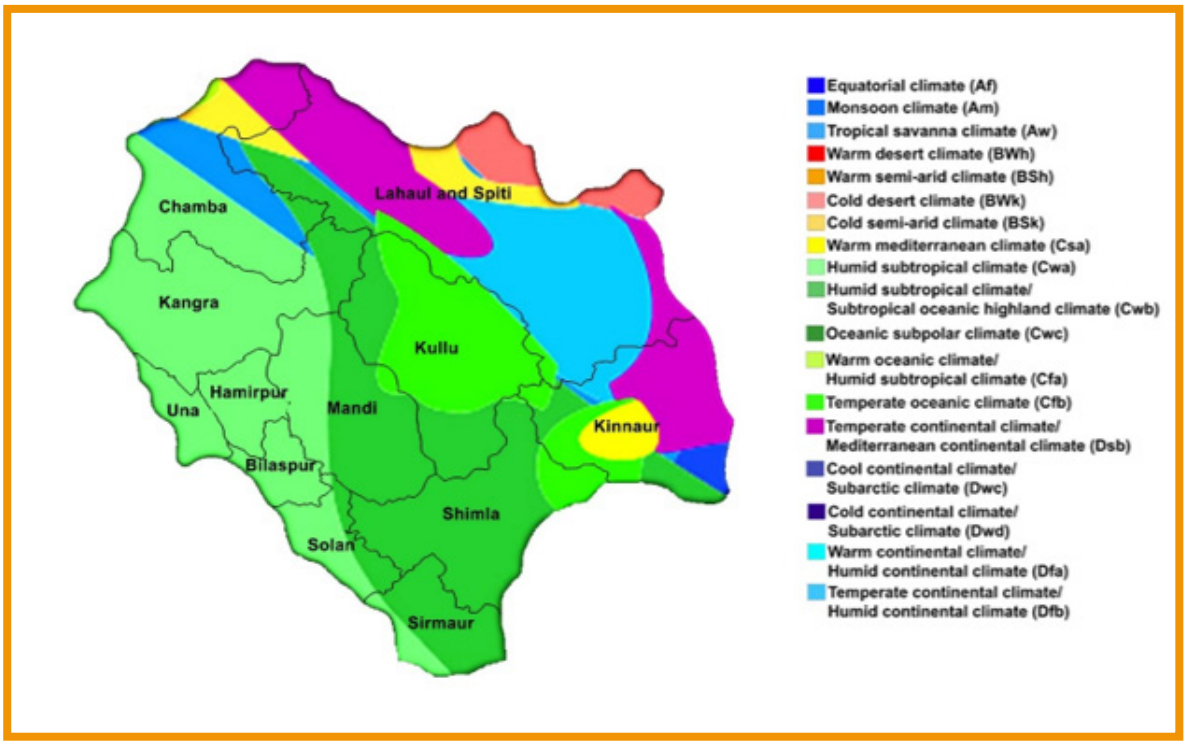


Figure 1 Climatic Zones of Himachal Pradesh
Source: Kottek, M., Grieser, J., Beck, C., Rudolf, B., & Rubel, F. (2006). World map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift, 15(3), 259-263.

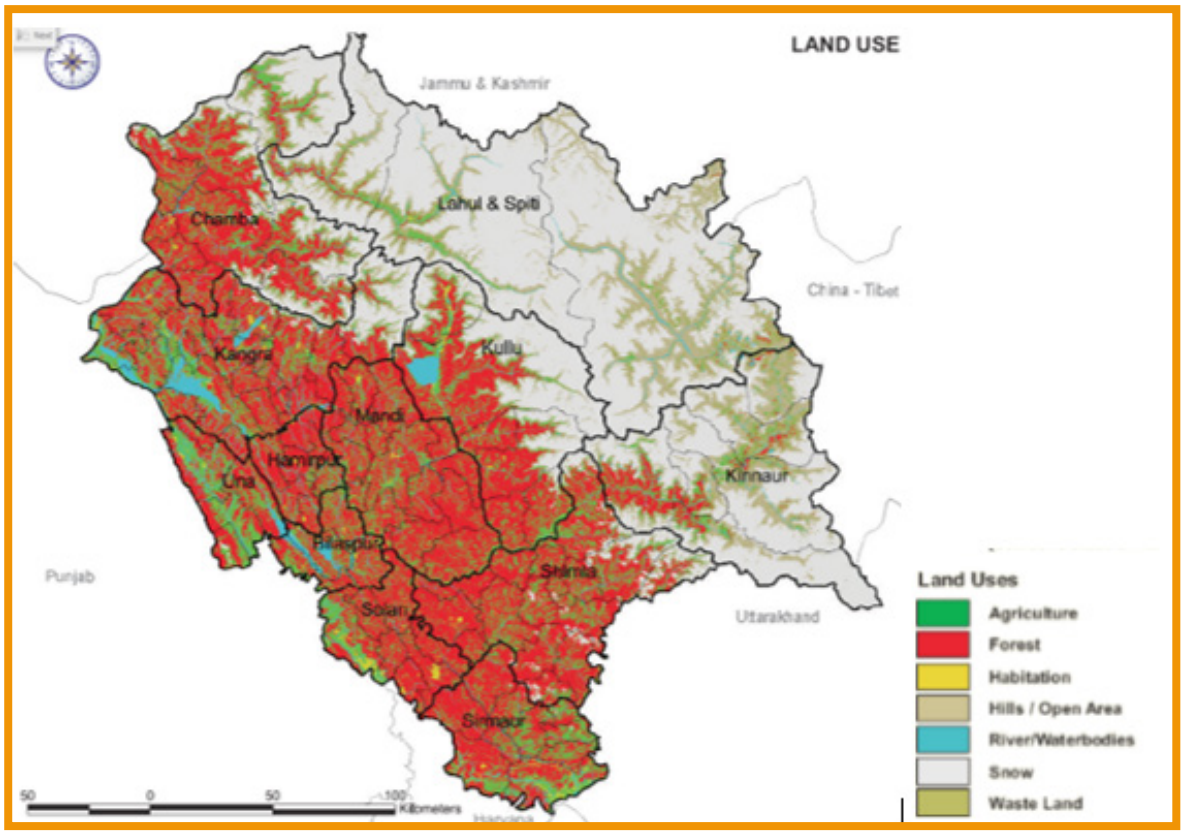


Figure 2 Land-use land-cover map of Himachal Pradesh
Source: Himachal Pradesh Vulnerability Atlas, SEEDS, 2009

the traditional construction techniques, skills and knowledge prevalent amongst the local communities in north-western part of Himachal Pradesh region. Further, similar such qualitative case studies have been carried out across the world, and in this case study a combination of various documentation methods as stipulated by Makondo & Thomas (2018) were followed in addition to architectural documentation.

2 The Hills of Himachal Pradesh

The hills of Himachal Pradesh are nested in Indian Himalayan ranges which spreads across three zones i.e. the outer Himalayas, the inner Himalayas, and the Alpine. Himachal Pradesh is spread over an area 55,673 km² the mountainous region is rich in its natural resources. It is also known as Dev Bhumi (The abode of Gods) and is famous for its tranquillity and peaceful atmosphere. It has a population of 68,64,602 persons (2011 census), and a density of 123 per Sq. Km. Among the 12 districts, the biggest urban agglomeration is Shimla, the capital town of the state.

The state has an elevation ranging from 350 meter to 6975 meter above mean sea level and has high Himalayas on the Northern and Eastern side of the state and lower plains on the Southern and South-Western side. This varied topography results in different climatic zones having distinct landscapes, flora and fauna and built environment. The climate varies from hot and sub-humid tropical in the southern tracts to cold, alpine and glacial in the Northern and Eastern mountain ranges with more elevation, as shown in Figure 1. State experience mainly three weather conditions; hot, cold and rainy season. Summer starts from mid-April and ends in June, with the average temperature ranging from 28°C to 32°C. Winter extends from mid-November till mid-March with snowfall in the Higher and Trans-Himalayan region, temperature during winter drops up to an extreme of -20 °C in some region. March and October are the most pleasant months in the region. The mountain state has rich forest diversity with thick vegetation cover.

3 Hazard Profile of Himachal Pradesh

The state is affected by several natural and manmade hazards such as earthquakes, landslides, flash floods and avalanches etc. Climatic extreme events in recent times have raised the concerns related to resilience and its role in reducing damages both in terms of lives and infrastructure. The state is most vulnerable to natural hazards during monsoon period such as cloud burst, flash floods, landslides etc., due to which there are huge losses of life and property every year. The frequency of these occurrences has gone up in the last two decades and has become more unpredictable. The occurrences of landslide during monsoons is the main natural hazard, which has been further enhanced by rampant deforestation, road construction, building construction, terracing and changes due to growing agricultural pattern. As per the BIS seismic zonation map, Himachal Pradesh falls in Zone IV and V with five districts liable to the severest design intensity of Medvedev-Sponheuer-KARnik (MSK) IX or more. It is therefore practical to explore and document the existing potential of traditional wisdom in architecture and settlement design to enable future growth directions.

3.1 Challenges and Opportunities to Climate Change in the State

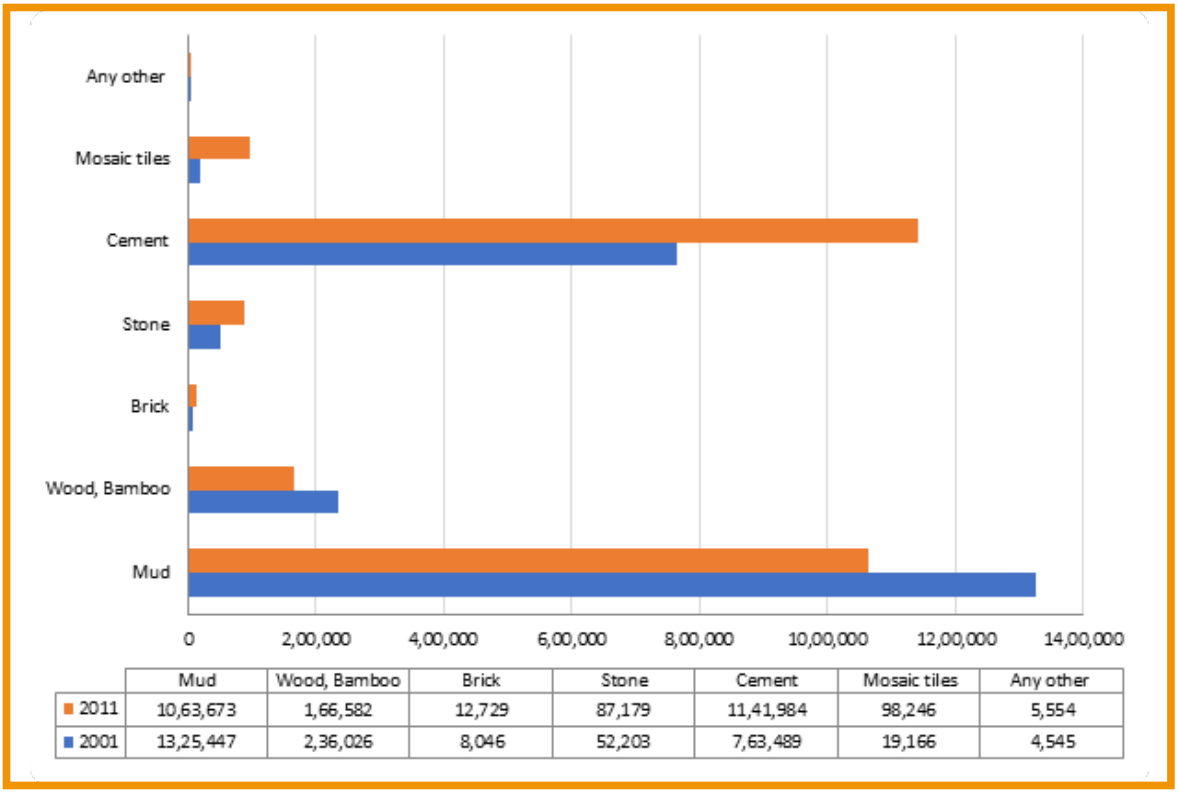
The people of the state are involved mainly in agriculture for their livelihood. The agriculture-based economy engages 69 percent of main working population and contributes nearly 22 percent towards State Domestic Product. Out of total 55,673 km^2 of land area of the state, only 9790 km^2 (17.58%) is operational holding. Figure 2 depicts the land-use land-cover map of the state, and the most of land of the state is under snow bound region, forest and waste land. The cultivated area of the state is only approx. 5590 km^2 (10.4%). About 80% of this cultivated area is rain dependant for agricultural produce. Most of the rain is received during the monsoon period and the produce is badly affected, if there is any change in the monsoon pattern.

The rain also contributes for the development and maintenance of the snow bound regions of the state, that in turn is responsible for the run off in the several rivers and rivulets across the hill region of the state. The state has been identified as one of the states in the country having highest hydropower potential, due to which there are several hydro power plants (big and small) developed in these rivers and rivulets. However, it has been found that there is a decrease in rainfall in the region in last 25 years, from 1996 onwards. Similarly decreasing trend in seasonal snowfall has been noticed resulting in lesser winter discharge in rivers. This has an effect on the hydroelectric production of the state, apart from its effects on the agriculture and horticulture produce. It is evident that due to the emerging concerns of climate change, the economy and people likelihood will be adversely affected, which is certainly a threat for the sustainability of the people of the state.

Roads are the predominant means of transport in the State. Roads provide connectivity to major tourist destinations of the state and connect remote areas and enable development by movement of goods and essential items of survival. There is poor connectivity by air and rail in the state, making roads as the major lifeline. However, the development of roads is very difficult due to the topographical challenges. There has been a large-scale development of roads in the last decade wherein the road density in the state has gone up extensively (Census, 2011). While the presence of roads has led to development, the inevitable cutting of slopes, drilling and adjustment of terrains have had its ill effects. There has been a steady trend of rise in temperature in the Himalayan Region in the last century, along with reduction in forest cover area, an increase in forest fire incidents, flash floods and landslides. These phenomena could be read as the symptoms of climate change in Himachal Pradesh.

4 Trends of Built Environment in Himachal Pradesh

The tangible part of the vernacularity is the native built environment is organic in nature. The use of stones, mud and wood and other native building materials is largely prevalent in most of the settlements in this region, evident in Figure 3, 4 and 5 respectively. However, there has been an increase in the per capita income of Himachal Pradesh, due to various policy reforms at the country and state level with improved agricultural and horticulture practices, coupled with higher influx of tourists and the like. This increase in per capita income has resulted in higher affordability along with better availability of modern building materials in local markets. This was further enabled by better road connectivity. As problems associated

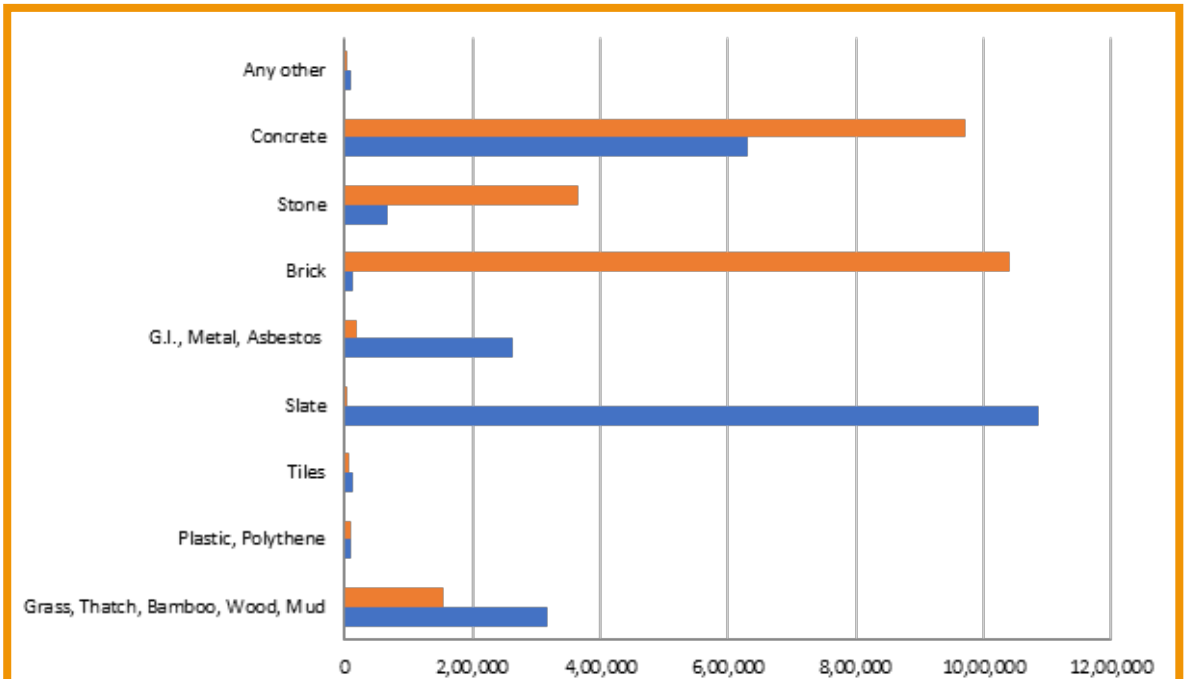


	Mud	Wood, Bamboo	Brick	Stone	Cement	Mosaic tiles	Any other
2011	10,63,673	1,66,582	12,729	87,179	11,41,984	98,246	5,554
2001	13,25,447	2,36,026	8,046	52,203	7,63,489	19,166	4,545

Figure 3 Material of floor in houses of Himachal Pradesh (2001-2011)
Source: Census of India 2011

	Grass, Thatch, Bamboo	Plastic, Polythene	Mud, Unburnt brick	Wood	G.I., Metal, Asbestos	Burnt brick	Stone	Concrete	Any other
2011	19,437	5,109	5,31,484	40,656	13,193	10,07,568	9,32,974	22,319	3,207
2001	21,828	4,824	6,61,793	48,634	13,305	6,24,616	10,12,603	18,423	2,896

Figure 4 Material of walls in houses of Himachal Pradesh (2001-2011)
Source: Census of India 2011



	Grass, Thatch, Bamboo, Wood, Mud	Plastic, Polythene	Tiles	Slate	G.I., Metal, Asbestos	Brick	Stone	Concrete	Any other
2011	1,55,522	8,460	6,482	4,089	18,422	10,41,373	3,64,872	9,72,713	4,014
2001	3,16,167	8,960	13,213	10,85,593	2,64,285	13,033	67,367	6,30,907	9,397

Figure 5 Material of roof in houses of Himachal Pradesh (2001-2011)
Source: Census of India 2011

with vernacular architecture began to increase there has been a shift towards development of buildings using modern materials. This shift hastened in recent years and has resulted in panoramic change in the settlement patterns across the state.

Figure 3-5 depicts that there is shift in use of materials from vernacular to modern materials over a period of time. Due to this shift, modern construction has affected the rural livelihood of local construction workers and traditional skilled labours. Moreover, the modern materials in frequent use are mainly industrial products whose embodied energy and carbon footprint are much higher than the otherwise used vernacular materials. According to Census of India, database that highest number of houses (5.56 lakh houses) are in Kangra, which is 21.62% of the total house stock of the state. The number of vernacular houses made up of mud walls in the district are 2.42 lakh, which is 43.53% of total houses of the district.

In recent times, it was observed that unregulated modern buildings are coming up leading to new urban fabric that is unplanned and environmentally deteriorating the hilly region. This is leading to incidences of landslides, flash floods and earthquakes and even though such incidences are linked to inappropriate urbanization patterns, the same is not clearly established. This calls for careful attention and study of the traditional wisdom and techniques used in planning and design of buildings and settlements in hilly terrain.

5 Objectives

Keeping the aforesaid knowledge, the following objectives have been framed to explore the traditional wisdom and appropriate techniques towards building resilience in hilly region:

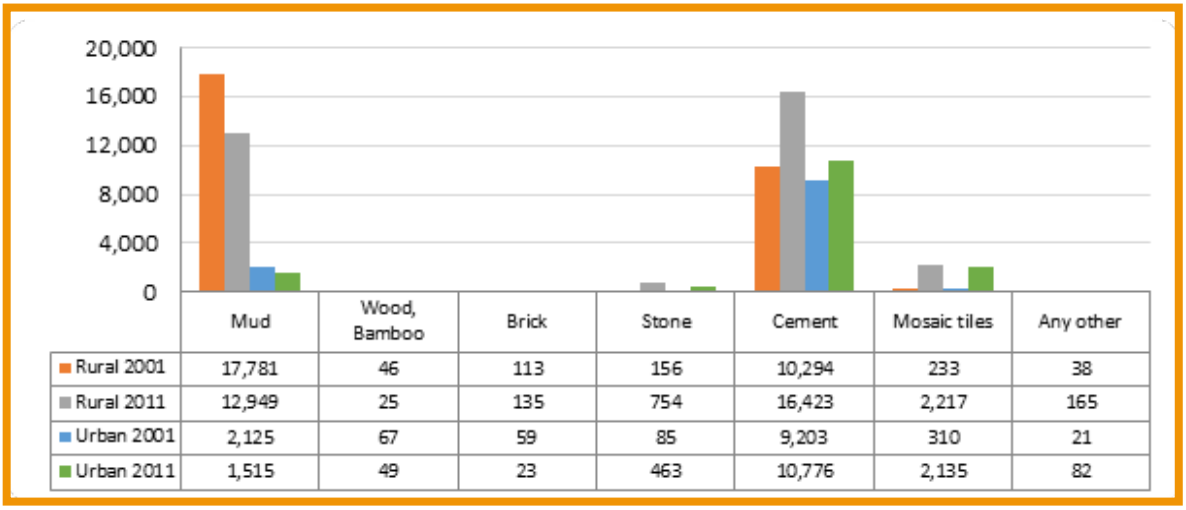
a. To explore traditional/vernacular best practices of built-form towards building resilience in hilly region.

b. To assess the applicability of key design elements and concepts of traditional structures in contemporary planning and architecture.

6 Study Areas

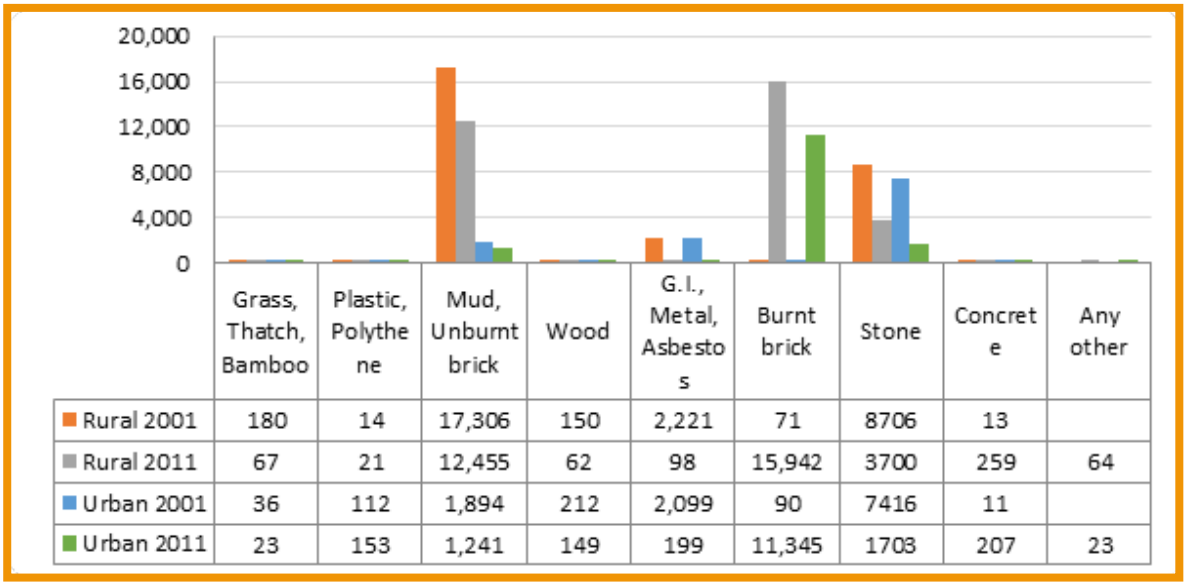
District Kangra and some settlements from the Kullu region have been chosen for elaborate study as they embody the highest numbers of traditional settlements. They are also on a path to rapid transformation with maximum occurrences of indicators of climate change as discussed in the preceding sections. Located in western part of Himachal Pradesh state of Northern India the urban area in Kangra district is spread over an area of 29 km² and population density of 300 persons per hectare. Total Population (As Per 2001 census) is 13,39,030 persons and has a geographical area of 5739 Sq. km., forest area of 2367 km², cultivable area of 1175 km² and unusable area of 2197 km². Dharamshala is the district headquarter and is the most populous urban magnet of the district. The level of urbanisation has increased due to several reasons, including declaration of town as a smart city under Smart Cities Mission of Government of India, which is under implementation. The urban area limits have been modified to include several fringe villages. Due to this inclusion of villages in smart city limit, the development, including construction of buildings have been up scaled, and use of modern construction materials is prevalent leading to the demise of vernacular architecture from the existing system. As per Census of India, the material wise data of houses are presented in the sequel, in Figure 6-8, respectively.

It has been observed from the Figure 6 that the number of houses with mud floors has considerably decreased in both rural and urban areas of Dharamshala from the year 2001 to year 2011 and are replaced with modern materials such as, cement and mosaic tiles in the system.



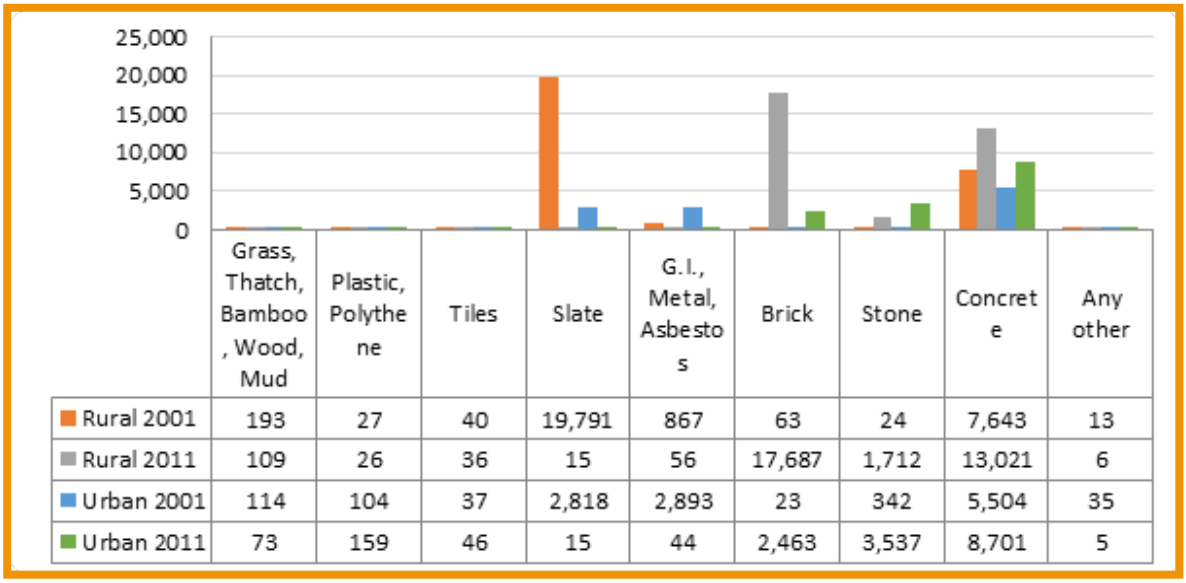
	Mud	Wood, Bamboo	Brick	Stone	Cement	Mosaic tiles	Any other
Rural 2001	17,781	46	113	156	10,294	233	38
Rural 2011	12,949	25	135	754	16,423	2,217	165
Urban 2001	2,125	67	59	85	9,203	310	21
Urban 2011	1,515	49	23	463	10,776	2,135	82

Figure 6 Material of floor in houses of Dharamshala (2001-2011)
Source: Census of India 2011



	Grass, Thatch, Bamboo	Plastic, Polythene	Mud, Unburnt brick	Wood	G.I., Metal, Asbestos	Burnt brick	Stone	Concrete	Any other
Rural 2001	180	14	17,306	150	2,221	71	8706	13	
Rural 2011	67	21	12,455	62	98	15,942	3700	259	64
Urban 2001	36	112	1,894	212	2,099	90	7416	11	
Urban 2011	23	153	1,241	149	199	11,345	1703	207	23

Figure 7 Material of walls in houses of Dharamshala (2001-2011)
Source: Census of India 2011



	Grass, Thatch, Bamboo, Wood, Mud	Plastic, Polythene	Tiles	Slate	G.I., Metal, Asbestos	Brick	Stone	Concrete	Any other
Rural 2001	193	27	40	19,791	867	63	24	7,643	13
Rural 2011	109	26	36	15	56	17,687	1,712	13,021	6
Urban 2001	114	104	37	2,818	2,893	23	342	5,504	35
Urban 2011	73	159	46	15	44	2,463	3,537	8,701	5

Figure 8 Material of roof in houses of Dharamshala (2001-2011)
Source: Census of India 2011

Figure 7 depicts that the number of houses with mud and stone walls have decreased in both rural and urban areas of Dharamshala from the year 2001 to year 2011 and replaced with the use of modern materials such as burnt bricks and galvanised iron (GI) sheets.

Figure 8 demonstrates that the number of houses with slate roofs walls have decreased drastically in both rural and urban areas of Dharamshala from the year 2001 to year 2011 and has been replaced with the modern materials such as bricks, concrete.

Keeping the above observations in mind, the study areas selected are two vernacular settlements namely ***Rajiana*** and ***Rasan*** in Dharamshala. The study delved deeper into the two settlements (as described in forthcoming sections) to reveal the reasons how the

traditional buildings and settlements have been able to survive the impact of disasters in the long run and how they cope with the cold climate and water requirements. Further the study explores the new and old settlements in and around Dharamshala region with relation to planning and design of traditional buildings and historic settlements that are sophisticated with traditional patterns, material and technologies.

7 The Settlement of 'Rajiana'

Rajiana is a potential census town located in the fringes of Dharamshala in the Kangra District of Himachal Pradesh, at the confluence of the Baner River and Manjhi River

The village is located at 31°2 to 32°5 N and 75° to 77°45 E. Average Annual Rainfall is 2050 mm and Average Maximum temperature 25-30□ for about 3 months, whereas, Average Minimum Temperature is 0-4 □ for about 6 months. The map showing the geographical location of the Rajiana village and is presented in Figure 9.

7.1 Settlement Pattern of Rajiana

The settlement pattern of the village is shown in Figure 10. The slopes are predominantly oriented towards South-West, West and North. The houses are built along the contours without disturbing the terrain. The circulation and built form of the settlement are organic, not grid

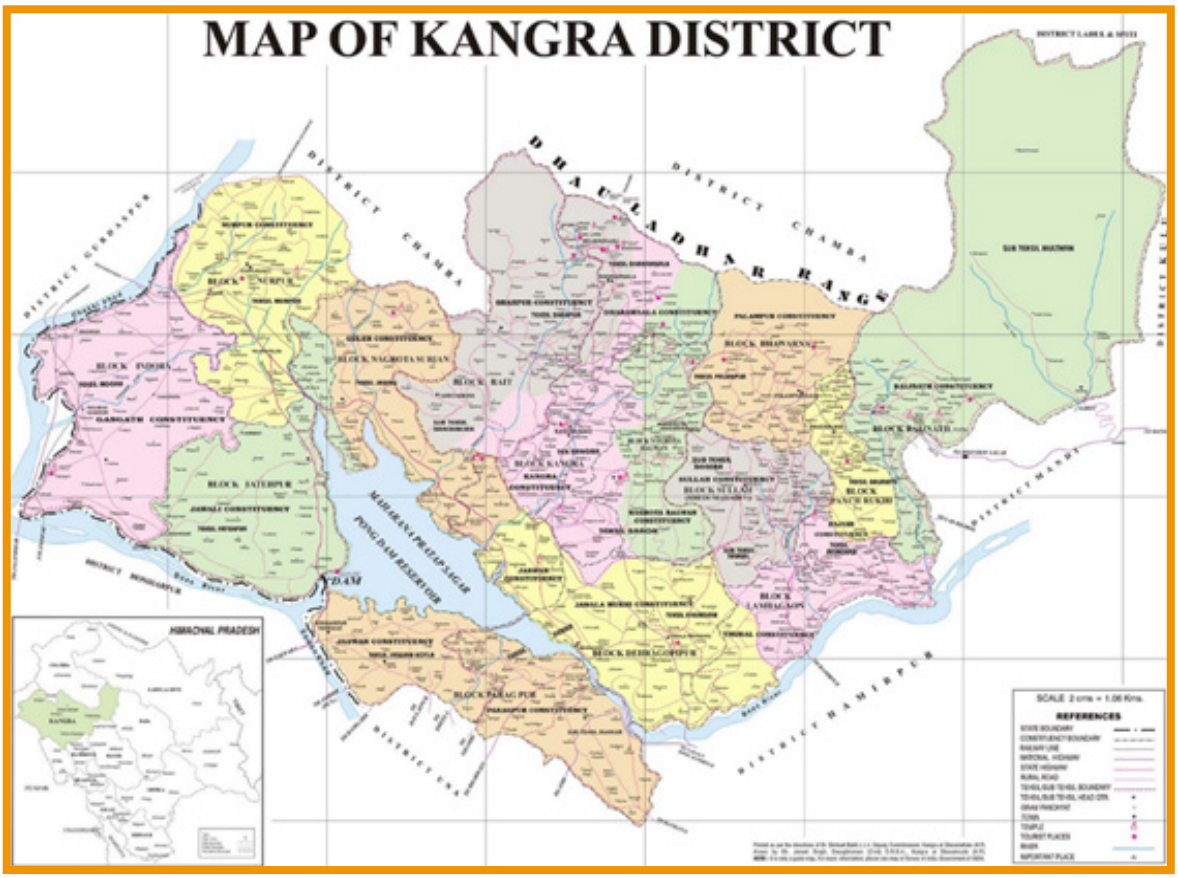


Figure 9 Geographical Location of Village Rajiana in District map of Kangra
Source: District Administration, Kangra

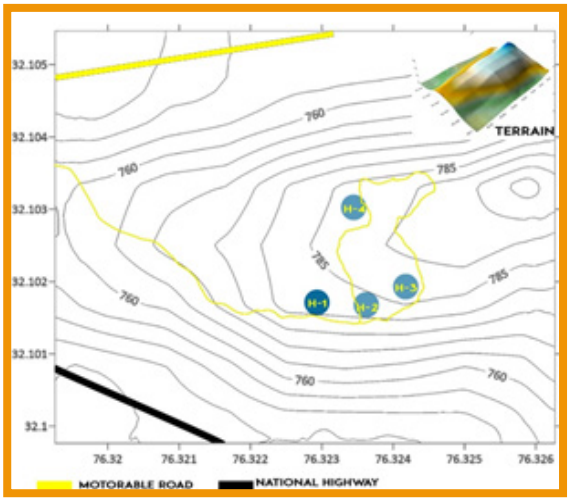


Figure 10 Settlement Map of Rajiana

iron, but form clusters that are 'slope evolved'. There are about 75% open spaces within the settlement of which 20% is the circulation pattern that follow the stream channels and the rest vegetation and plantations.

7.2 Cluster Layout

The built-up area follows the terrain and does not affect the open spaces without disturbing the contour and natural drainage pattern. Open space between the buildings such as courtyards are multi-utility spaces and are used for various social activities, public gatherings, play area for children and sit out during winter season and for agricultural purpose. The open spaces are usually common between various households, and the houses usually surround them from sides preferably from north. This is done to avoid winter winds coming from the snow-capped mountains at the north side. The men folk from these vernacular households prefer to work outside or in the agricultural fields, whereas women usually stay at home for various household activities. The enclosed space formed by surrounded buildings provide a most suitable social interactive space for such women of the cluster and also provide a secure environment for the children of the cluster to play together. Such clusters are called "Mohallas' and are developed based on caste system.

In cluster settlement configuration, there are open spaces between the houses that provide ample sunlight during winters and also offer space for public activities. There are different types of spatial arrangement which can be seen such as linear arrangement along the roads or closely packed clusters with central courtyards.

Figure 11 Open areas between clusters

7.3 Household Design

The household has a simple and basic rectangular planform that offers higher stability to climate and earthquakes. Sloped hip roofs with slate stone offer easy drainage of rainwater. Building materials such as mud, cow-dung, stone and wood preferably locally available bamboo are used for the construction of the houses.

Figure 12 Typical Vernacular House at Rajiana

Figure 13 Features of vernacular house at Rajiana: a) Low ceiling Heights b) Truss with tie beams and c) Internal staircase for heat retention bracing made of local wood

The construction techniques used are as follows:

- Mud and cow-dung treatment at the ground level to tackle and keep away crawling insects.
- Plinth protection with stones from heavy rains.
- Providing more openings towards the south side.

It is seen from Figure 12 that the buildings are built on simple plan forms such a square, rectangle of U-form having sloping wooden rafter hip roofs with slate stone offer easy drainage of rainwater, openings preferably towards the south side and use of stones for plinth protection to protect structure from heavy rains. There are courtyards in almost all houses, which are either formed as a nested space within a U or L formation of the main house for partial or semi privacy or are in front of the house between the road and the house, serving as a social space or an evacuation space during landslide or earthquake. Such courtyards are also observed to be planned as highly active zones and faces the south east for maximising exposure to sun path. The courtyards are used for drying of spices, clothes, utensils, vegetables and also as a cattle yard. They serve as social spaces for gathering and discussions. Many such spaces also are used as kitchen garden and to store water in wells. These houses have proved to be thermally more comfortable and energy efficient (embodied as well as operational energy) as compared to modern houses built in the hills, making these houses more climatic responsive and sustainable. Most of the houses have covered verandah towards south acting as buffer space. The kitchen and storage spaces are usually located on the first floor.

The interiors are mostly found to be cool in summers and warm in winters due to their ability to insulate and retain or refrain heat accordingly. The walls are often observed to be one and half feet thick with layers of mud and cow dung treatment near the ground level to weed out termites. Majority of houses have sloped terraces that function as storage spaces. The intent of the design is explicit enough to cope with harsh climatic conditions with local materials and minimalistic designs.

8 The Settlement of 'Rasan'

Rasan village is located in Nagrota Bhagwan Tehsil of Kangra district in Himachal Pradesh, India. Rasan is a small settlement located in the suburbs of Dharamshala city. The village is located near Tapovan village and is accessible by a two-lane road. It has a population of 1260 persons with 194 households and is spread over approx. 101.3 hectares.

8.1 Settlement Pattern - Rasan

The settlement has predominantly east and southeast slopes. The houses utilise the slope and terrain for storage areas and plantation. The settlement has evolved around a natural spring stream flowing through the settlement and southwards into the fertile soil on the eastern side. The settlement which is on a gentle slope utilises the stream flow to grind wheat flour, to water gardens and the cropping fields around it. There are about 70% open spaces within the settlement of which 30% is the circulation pattern and the rest is vegetation and plantations.

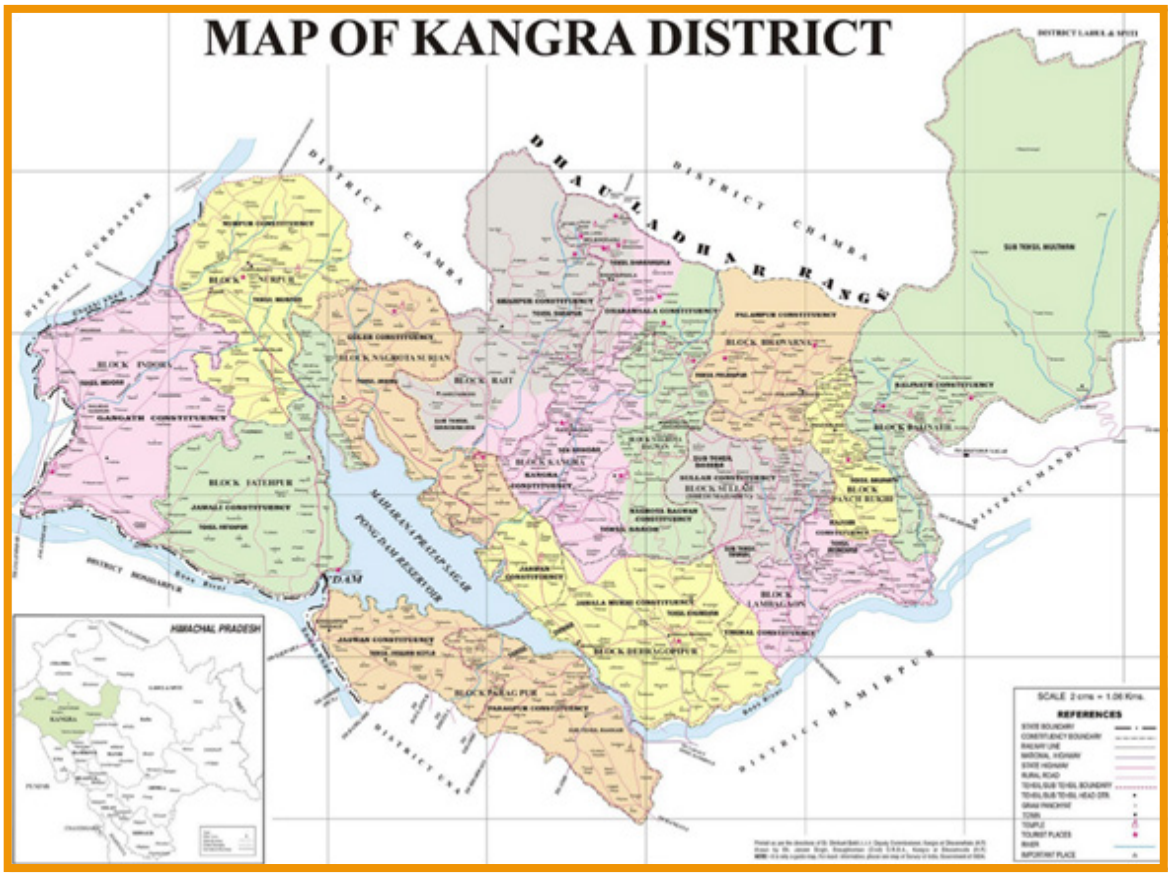


Figure 14 Geographical Location of Village Rasan in District map of Kangra
Source: District Administration, Kangra

Figure 15 Settlement Map of Rasan and Cluster surroundings

Figure 16 Typical Vernacular House at Rasan

The settlement is zoned into three elevations in the form of steps – higher terrain, middle terrain and lower plain. These zones have evolved naturally without hampering the terrain character. The houses and circulation pattern follow the natural slopes without cutting across. The settlement allows a natural spring to pass through it in meanders and does not disturb it. It effectively retrieves water from the stream at certain spots or uses its speed to crush food grains at spots. The retrieved water is stored in steps and fed into the terraced agricultural spaces. The settlement portrays an evolution pattern that is closely in communion with Nature and has deep respect for the terrain and its natural features.

8.2 Cluster Layout

Settlement derives its livelihood and food crop from the immediate surrounding open spaces that are used as step cultivated fields. The open spaces between the built-up areas act as means for circulation or movement of residents. Clusters will be considered as independent clusters when surrounded from all sides by vehicular access roads and/or pedestrian paths. The spatial arrangement of the clusters is organic according to the site context

The clusters are formed with the length of each house facing South or South East. The backyards of each cluster use stones to develop load bearing capacities edges for the slopes behind them and have heavy plantations and tree covers that hold the soil together.

8.3 Household Design

Houses are mostly linear and two storied, with kitchen and store on first floor and bedrooms on the ground floor, facing the south and east to derive direct sun. Sloped hip roofs with bamboo structure and slate stone offer easy drainage of rainwater. Building Materials such as Mud, cow-dung are used for the construction of the houses. The construction techniques used are as follows, mud and cow-dung treatment at the ground level to tackle and keep away crawling insects.

9 The Settlements of the Kullu Region

Kullu district forms the eastern part of Himachal Pradeshwith district area of 5,503 Sq.kms. (Census, 2011). The district has four tehsils viz. Manali, Kullu, Banjar and Nermand; and 2 sub-tehsils of Ani and Sainj. From the planning and developmental initiatives, the district has been divided into five community development blocks, viz. Naggar, Kullu, Banjar, Ani and Nermand. The district has a total number of 326 villages. In this case study, the settlement and buildings in Naggar Village is documented for further investigation.

Naggar, is a historical and cultural node of Kullu region. It is known for Naggar castle, Roerich Art Gallery and museum, Tripura Sundari Temple, Kathkuni architecture etc. Apart from these, Naggar is famous for extensive apple orchards fields. Naggar is located at a distance of 25 Km from Manali, with an altitude of 1600m.

9.1 Settlements in Chichogi

Chichogi is one of the villages located south-west of Naggar. This is one of the remote villages, where traditional practices in terms

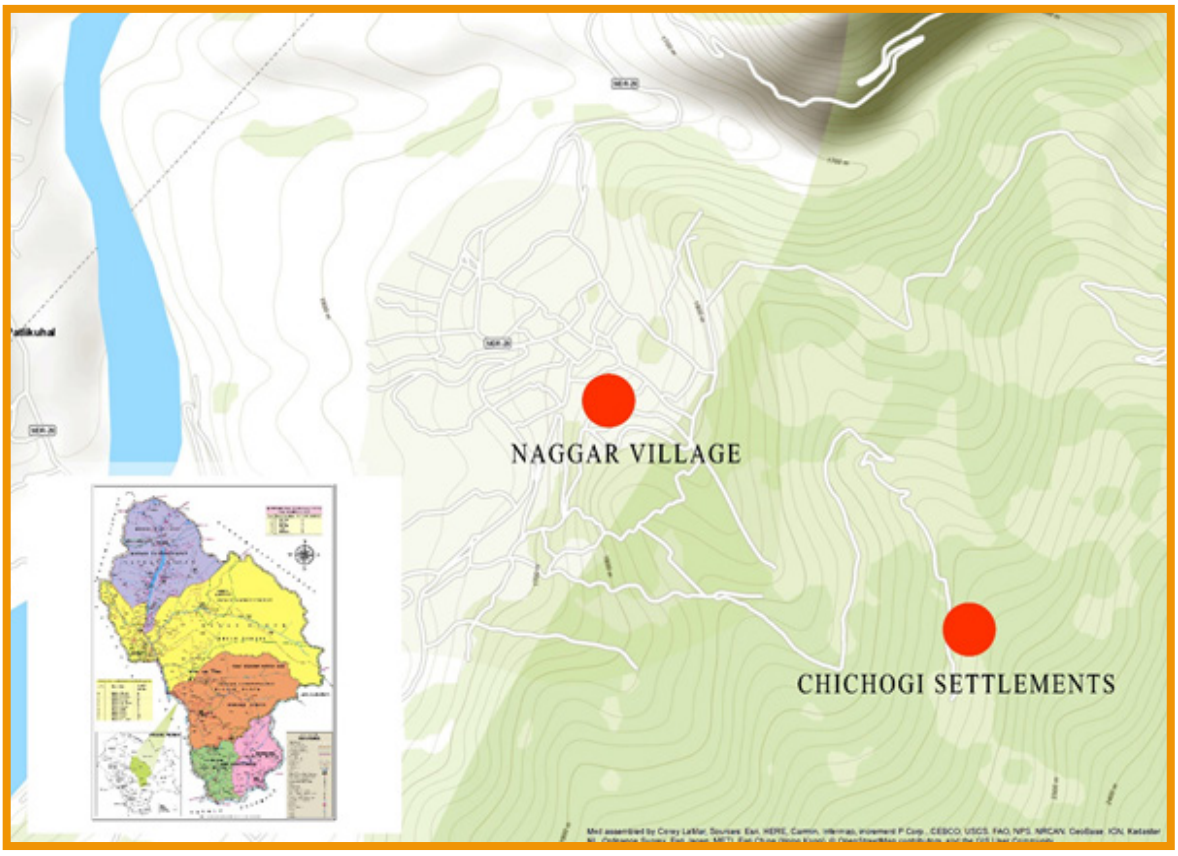


Figure 17 Location of Village Naggar in District map of Kullu and the topographic map of Naggar Village. Source: District Administration, Kullu, ESRI

of settlement planning, building construction, socio-cultural and religious aspects can be traced to its original form. The settlement can be accessed only through rough roads, (Kutcha roads). Access to village remains shut during the winters because of snowfall. The settlement exhibits one of the oldest beliefs, customs, practices and construction techniques.

9.2 The Devi and Devta system: Socio-Cultural and Religious System

Devta or Devi (Gods and Goddesses) are believed to be the manifestation of Hindu deities like Lord Brahma, Vishnu and Mahesh. The local deity is believed to be the supreme leader and the highest authority in the region. The deity rules over all village matters in all aspects. Every Devta or Devi lay down rules that determine the daily lives of villagers, and which the people of that locality abide by. This forms the basic structure of the region's social organization, it plays a central role in the community. The temple complex is the most important building, usually located at the top, or in the centre, of the village. Over time, the community grows either radially with the temple complex as the centre, or extends below it, depending on the topography of the area. The deity's permission is required if something is to be added or changed in the village with regard to construction, land use, services, etc. Most village festivals revolve around worship of the deity, with the festivities usually consisting of carrying the palanquin of the Devta or Devi through the village, or collaborating with neighbouring villages in holding small fairs.

Figure 18 Temple Complex in Chichogi Village around which settlements have evolved

Figure 19 Procession of Devi and Devtas in Kullu religious festival

Figure 20 Tree Devta – worshipped by the villagers in Chichogi

These fares are considered to be an opportunity for the gods of the respective villages, as well as the village residents, to get together. Local deities are very personal to the communities that worship them. They are present in the daily lives of their devotees, guiding, commanding and counselling people, and anticipating problems and helping confront them. Each Devta or Devi have their own customs, and they have indicated how they prefer to be worshipped. As a result, local rituals and forms of worship and prayer vary from area to area. Further, the

Figure 21 One of the oldest indigenous house in Chichogi Village

concept of Devta or Devi also protect the forests in their region of rule. Cutting even a single tree requires their permission. Deities decide on the implementation of governmental and non-governmental policies in the area as well, their approval is mandatory.

9.3 Indigenous construction technique

The building construction techniques in Himachal Region are the finest examples of the local traditional architecture, sustained over centuries under extreme geo-climatic conditions of the region. These indigenous construction techniques primarily include the use of wood, stone etc as construction material. 'Kath-Khuni' is one such construction technique which has been practiced throughout Himachal Region. In this case study, three buildings with Kathkuni architecture in Naggar village is documented.

9.4 Kathkuni Architecture

Detailed field survey was carried out for collecting information on Kathkuni construction practices in Naggar and surrounding region. Kathkuni architecture is created with interlocking horizontal stone (dressed or raw) and timber without any mortar. The quality of these interlocking joint varies depending on the building typology, and these are designed for hash climatic conditions of the region. Kathkuni architecture is dictated by the use of local material like stone and timber for structure and ornamentation. The spatial organization of the spaces remain same, irrespective of building typology or the socio-economic characteristics. However, the decorative or ornamentation greatly vary, i.e. ornamentation in temple architecture is exhaustive in general, regardless of their location. Ornamentation at individual housing units depend on their socio-economic characteristics. With regard to planning, the houses in general are oriented to maximize heat gain through sunlight.

Figure 22 Hidimba Devi Temple and wall system, Manali

Figure 23 North -Stay, Naggar Village

Figure 24 Naggar Castle

Figure 25 Typical Traditional House in Naggar Village

In general, the entire architecture and spatial organization of space is influenced by material and climate. Overall spatial layout is either square or in rectangular in plan. The wall assembly of interlocking timber and stone act as loading bearing element. Timber and stones are abundantly available locally, and are the primary building materials used for construction. Skills required for construction of wall and roof system is kept minimal. Minimal openings are kept to avoid excess cold, and the roof in general is sloped. Height of the habitable are is kept minimum in the lower deck of buildings and in upper decks, the height varies depending on the roof type and structure.

10 Outcome from the case studies

10.1 Settlement Pattern

The findings of the study reveal that the settlements are carefully designed keeping in view the natural topography of the location. The houses are carefully located in the natural environment so that there is minimal modification to the natural setting by minimizing cutting and filling. The settlement pattern is organic in nature that has been derived in a manner that nearness to water source is maintained so as to get perennial water for daily use. Every settlement is deeply interlinked and is in synergy with the surrounding open stepped spaces which are utilised for cropping, horticulture and fodder storage. Use of natural springs are of high significance in each settlement. The springs are channelized in between the houses to form small reservoirs, check dams, and water spouts.

The orientation of clusters and individual household has been decided to maximize the availability of sun in the courtyards and inside the houses. In essence, the settlements have evolved organically over decades without any expert architectural or planning consultation, but having a very high sense of climate adaptation and general adaptive capacity. The orientation of each unit, the space between the units, the material used, the landscape conservation, the circulation pattern, the treatment of flowing water bodies and the use of space and trees are all inclusive in its approach and does not hamper, remove or eradicate anything that is natural. There is a sense of harmony with Nature and effective utilisation of its potential. It is important to imbibe such settlement design principles when we plan newer settlements in hilly regions in order to be contextual and resilient.

10.2 Cluster Level

The village is divided into caste-based household clusters called Mohallas. Each cluster has adequate open spaces in the surroundings. Each of the cluster has a common courtyard used for social interaction, children play area, handling of agriculture produce and also for diverse ceremonies. The spatial arrangement is organic in which adequate space is kept between the houses to maintain privacy. The buildings are usually two storied small structures with ample of open spaces have been left in the surrounding for adequate daylight, natural ventilation and for the ease to watch their surrounding agricultural fields. Use of materials that have insulation properties, that are light weight, stable and locally derived makes the clusters re-buildable easily in situations of calamity using local artisans and builders. The inter-mingling and interactive nature of the clusters with common courtyards, common water resource pools and storage nodes, raises levels of resilience and community support that are critical in building resilience in harsh or unprecedented conditions.

10.3 Unit Level

Every house has evolved through proper choice of slopes and slope orientation to gain stability, face sunlight and minimize risk of landslides. Built form typologies are simple plan forms which are most suitable from the point of natural hazards. Households have ample planned open incidental spaces which plays key role in making the community physically resilient and socially sustainable. The building materials used are

locally available, are economical, sustainable and support livelihoods of local workforce. Interiors are designed in minimalistic approach with emphasis on roof patterns and walls that retain heat. Every house maintains plantation or gardens in the downward slope side with wide girth trees on the upward slope side to provide livelihood and protection from landslide. The houses have proved to be thermally comfortable and energy efficient as compared to their modern counterparts.

10.4 Construction Techniques

'Kath-Khuni' style of construction that has existed over centuries have many advantages in terms climate and earthquake resistance, and also in terms of resource efficiency. The indigenous technique use stone and wood, two environmental friendly materials that are close at hand, together with rubble as an alternative to slow setting mortar. These results in use of resources at hand instead of material produced, processed and moved from outside. Walls of considerable thinner section than the normal stone wall can be made using the Kathkuni construction techniques with the net result that maximum height can be reached using minimum material, which are in turn structural stable, and resilient in terms of earthquake and climate.

11 Conclusion

Vernacular households have proved to be more resilient to earthquake as per historical experience. These households use local materials thereby using lesser cost and supporting rural livelihood. Vernacular households are better thermally and comfortable as compared to modern construction, resulting in better energy efficiency. Demise of vernacular households is due to lack of workforce, high and frequent maintenance, lesser number of storey and is also linked with social status, that has further led to evolution of traditional construction practices i.e. inclusion of modern materials with local materials. In this case study mapping and documentation of some of these traditional settlement and houses were carried out to conserve the traditional construction techniques, skills and knowledge prevalent amongst the local communities in north-western part of Himachal Pradesh region.

The study attempts to bring forward some of the architectural methods, tools and approaches prevalent in hill settlements that are believed by the residents to be resilient to the harsh climatic conditions to make us aware of the choices we have. Contemporary house designs and neighbourhood designs in the region are not completely unaware as we can observe certain individual houses and municipal structures imbibing the techniques and materials used in the hills. However, the incidences of such designs which derive from traditional wisdom are handful and few. Cases of contemporary designs that are completely against Nature and not appropriate to the local climatic and site conditions are many and galore. It is important in such milieu to bring out scientific know-how of the such hill settlements and their wisdom to help young planners and architects become more informed and aware, the underlying purpose of this study.

12 Way forward

Though people have adopted modern construction techniques, they also preserve vernacular households due to various reasons

such cost, thermal comfort, emotions among others. The study has categorised and evolved a structure of the best practices with respect to settlement, cluster and individual units that have evolved through years of adaptation to deal with the challenges of hilly terrain and cold climate. Such categorised traditional wisdom can form suggestive guidelines that can be further applied in contemporary buildings in hilly region for adaptation to climate conditions. Materials and design of roofs, walls, openings, floors, and study of plan form, shape, plot layout, ratio of open-built, and utilization of terrain could be aggregated with an intention of framing design guidelines for the region.

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