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How Traditional Knowledge Systems help in creating Sustainable and Resilient Communities: Lessons from the hilly Garhwal region for the world

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Abstract :

The traditional knowledge system evolved from the experiences of communities. It has a mechanism to cater to socially, ecologically responsive, and disaster-resilient lifestyles. In harsh mountain ecosystems like Garhwal in Uttarakhand, the natural setting is extreme, livelihood resources are minimal, and they have an extra threat of constant disasters. In such cases, the traditional knowledge system is the key to live life better. The aim is to study and document the traditional knowledge system for Uttarakhand state (Garhwal region), develop an understanding of the various systems, evolve mechanisms to benefit the community and enable them to develop more resilient communities and cities utilising the lessons learnt from this study. The study also allows one to understand that traditions and culture have a significant impact on lifestyle and the built form.

Keywords :

Sustainable Communities, Settlements, Traditional Housing, Resilience

1. Introduction

Sustainable Cities and Communities are a need for the future of the continuation of human settlements. An ideal city, according to Sustainable Development Goal 11, should be inclusive, safe, resilient, and sustainable. However, while succumbing to the demands of wanton urbanisation, we should not ignore the cradles of our indigenous communities, whose timeless traditional knowledge systems in building resilient environments have stood the test of time and may give vital pointers towards building sustainable cities of the future. After all, sustainable communities lead to sustainable urban spaces. Importantly, traditional knowledge systems should never be ignored and have to be reinterpreted and used appropriately in the modern urban context for increased sustainability and resilience. The goals set by UN also reflect the same, as sustainable communities which showcase traditional knowledge systems have been given due importance through Inclusive Societies and Sustainable Cities and Communities [goal 16], International Economic Parity and Sustainable Cities and Communities [goal 10], Gender Equality and Sustainable Cities and Communities [goal 5], Innovation and Sustainable Cities and Communities [goal 9] and Climate Change and Sustainable Cities and Communities [goal 13]. All these indicate a clear intent to protect ecosystems and species that are central to our cultures that may disappear if the climate crisis is left unchecked. Here we discuss one such shining example in the form of mountain ecosystems in the Garhwal region in Uttarakhand.

The traditional knowledge system evolved from the experiences of communities. It has a mechanism to cater to socially, ecologically responsive, and disaster-resilient lifestyles. In harsh mountain ecosystems like Garhwal in Uttarakhand, the natural setting is extreme, livelihood resources are minimal, and they have an extra threat for constant disasters. In such cases, the traditional knowledge system is the key to live life better. The aim is to study and document the traditional knowledge system for Uttarakhand state (Garhwal region), develop an understanding of the various systems, evolve mechanisms to benefit the community and enable them to develop more resilient communities and cities utilising the lessons learnt from this study. The study also allows one to understand that traditions and culture have a significant impact on lifestyle and the built form.

2.1 Evolution of Settlements

Uttarakhand has a rich past in architecture. Communities developed their style of architecture using locally available materials. Both the Garhwal and Kumaon region have their own set of traditional wisdom of building construction. The following study covers evolution, types of settlements, different techniques and the style used in the Garhwal region for construction.

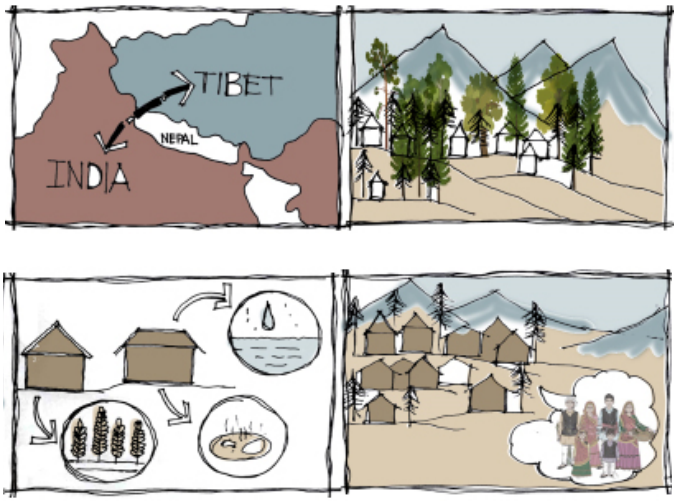


Figure 1: Evolution of settlements

The initial settlements came in the higher region of Uttarkashi valley due to the old Indo-Tibetan route. The communities believe that the majority of the settlements were not permanent. Many temporary settlements slowly turned permanent as the communities started inviting their friends and relatives. These practices are passed down through generations by oral traditions in the villages during festivals through folktales and folk songs. (Routela, 2015)

2.2 Types of Settlements

Due to the difference in geography, different types of settlements have evolved depending upon the location. These settlements can be categorised into four types- valley, hill top, spur, and gap. Local communities have developed their response towards site planning as per the existing conditions. The following tables 2 and 3 describe the features of each typology. (Rawat, 2019)

3. Styles of Architecture in the Garhwal region

3.1 An overview

In the Garhwal region, the houses in this region are placed after careful site selection in the areas which provide protection from the cold winds in winter. The traditional houses are built along contours of the hills and are generally of two or three floors, having a rectangular plan. It is observed that buildings in the Kumaon region are more elaborate and detailed than Garhwal architecture (S. K. Negi, 2017) . The detailed study of Garhwal region architecture is discussed as following:

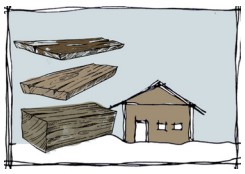
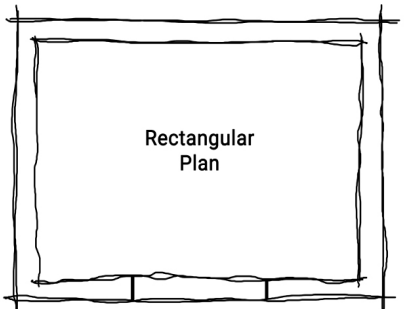
1	Soil Testing: The locals examine the soil and then consult the priest regarding the site's good or bad aspects.	 *Figure 10 Site Selection & Soil Testing (source: author)*
2	Small Doors and Windows: Old houses have some characteristics which protect them from extreme weather conditions. Most of the houses in this region have one or two small windows.	 *Figure 11 Small doors and Windows (source: author)*
3	Extensive use of timber: Timber is found in abundance. Villagers believe that wooden houses are best suited according to the geographical conditions of this place.	 *Figure 12 Extensive use of timber (Source: author)*

Table 4 Common Characteristics of Traditional Housing (Source: Author)

3.2 Koti Banal Style of Construction

Despite being a part of a seismically vulnerable region, Garhwal shows an elaborate earthquake-safe construction style called Koti Banal architecture. The local communities have practiced this style for the past 1000 years. Koti Banal is a village near Yamuna valley in the Uttarkashi district with its own set of building features. (Piyoosh Rautela, 2008) The salient features of this technique include a raised platform, simple symmetrical plan, and properly aligned walls.



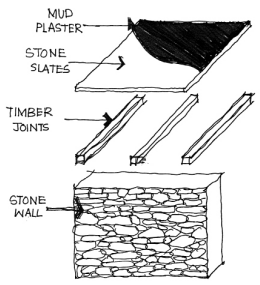


Figure 13 : Rectangular plan (source: author)
Figure 14 : Construction

3.3 Garhwali Stone Construction

The geometry of these houses is rectangular and straightforward, which provides stability and makes it less disaster-prone. Thick masonry walls are made from stone and timber. The sloping roof is constructed with locally available slate tiles. It is covered with mud plaster and placed above the timber beams. (S. K. Negi, 2017)

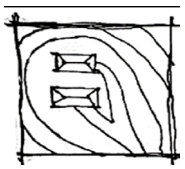
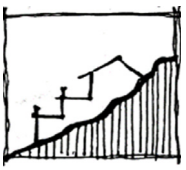
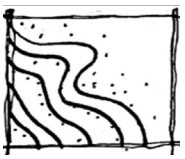
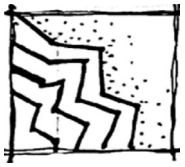
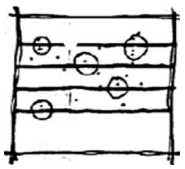
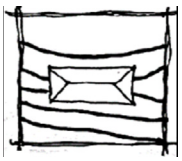
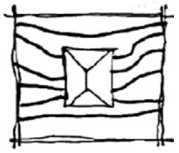
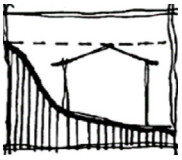
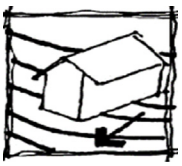
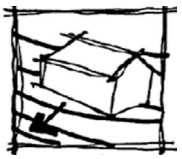
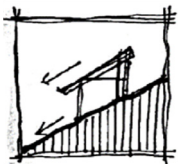
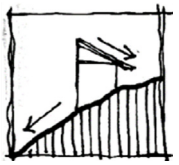
No.	DO		DO NOT	
1	Structures should minimise the grading and preserve the natural features		Constructing the building by destroying the natural slope and landscapes	
2	Terraced decks minimise the visual bulk		Overhanging makes building look more massive	
3	Grading angle should be gradually transitioned to the angle of the natural slope		Steeper slopes with an angular profile should be avoided	
4	Trees and shrubs in concave areas are preferred		Avoid uniform coverage of trees	
5	Building parallel to the natural contour		Buildings perpendicular to the natural contour	
6	Vertical structures should be below the ridge elevation		Structures with massive form and height destroy the silhouettes of hill	
7	Gable end perpendicular to the direction of the downhill side		Gable ends of the house on the downhill side	
8	The angle of roof slope should be parallel to the slope		The angle of roof opposite in direction with a slope of contour	

Table 1: Design Guidelines for a sloping site (Source of table as well as sketches: author)

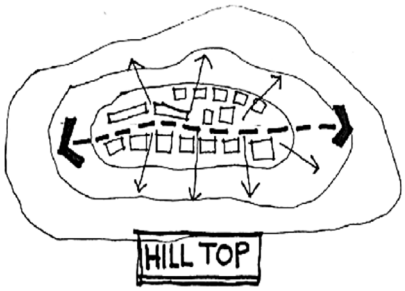
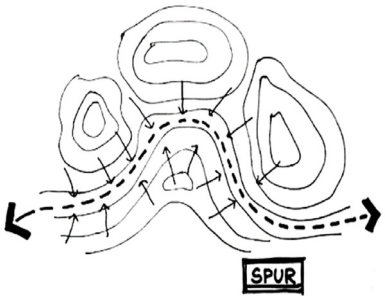
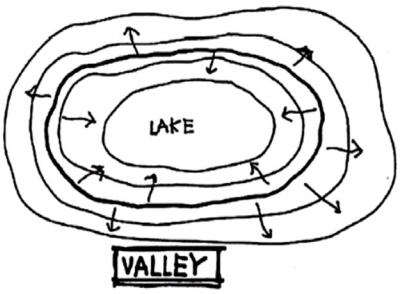
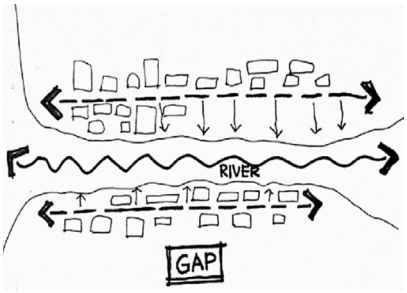
	Site Planning Approach	
Hilltop	They spread along the central functional axis, which is parallel to the contour and ridge. They spread from the central axis outwards.	 *Figure 2: top settlement pottern (source: author)*
Spur	Spur settlements grow inwards. They spread towards the major axis or major road.	 *Figure 3: Spur settlement pattern (source: author)*
Valley	They spread in outwards direction, from major axis towards up and down areas of the valley.	 *Figure 4: Valley Settlement pattern (source: author)*
Gap	These settlement types have the least scope for spreading and are divided into 2-3 parts due to river or stream. The structures are built along the linear axis parallel to the edge of the river.	 *Figure 5: Gap settlement pattern (source: author)*

Table 2: Site planning of different settlement types (Source: Author)

Valley	Location: 	Pros: Centrality, adequate space for physical expansion, easy accessibility of water, ease for transportation and utility services network Cons: The presence of a river system or water body and its catchment	 *Figure 6 Thalisain Village in Pouri Garhwal (Source: Google earth)*
Hilltop	Location: 	Pros: Healthy climate, scenic beauty, strategic position, and free drainage Cons: Virtual absence of flat land and lack of water supply	 *Figure 7 Narendra Nagar in Tehri Garhwal (Source: Google earth)*
Spur	Location: 	Pros: Transition between valley floors and hilltops, Natural defence, panoramic landscapes, moderate climate, and limited loss to the agricultural fields Cons: Restricted accessibility, frequent landslides, and limited scope for expansion	 *Figure 8 Pauri town in Pauri Garhwal Source: Google earth)*
Gap	Location: 	Pros: Coverage of routes, transition points, water availability Cons: Limited scope for expansion	 *Figure 9 Devaprayog in Tehri Garhwal (Source: Google earth)*

Table 3: Types of settlements (source: (Rawat, 2019)

3.4 Salient structural features of Koti Banal architecture:

- Load Resisting System: The masonry used for construction is dry rubble masonry. The live load and dead load get distributed from roof to wooden structural logs to the dry masonry walls, and the wall transfers the load to the strong stone foundation avoiding damage during earthquakes. (Joshi, 2008)
- Good aspect ratio (1:1.5) of building: This is in-line with building code requirements, which state that the structure should have a simple rectangular plan layout and be symmetrical in terms of mass and rigidity. (Joshi, 2008)
- Timber reinforced stone wall with dry masonry: There are load sharing mechanisms in the 1.5 feet thick dry masonry wall. In wall construction, wooden beams are installed from above which improves the structure's seismic resistance. (Joshi, 2008)
- Massive solid platform: It is located at the structure's base and aids in keeping the structure's centre of gravity and centre of mass close to the ground. In the higher stories, lighter materials are used. (Joshi, 2008)
- Use wooden beams for structural support: The building's beams are usually rectangular and 20cm to 30cm thick. These wooden beams have sections that are larger than required for safety. Minimal angular displacement is possible as a result of this. (Joshi, 2008)

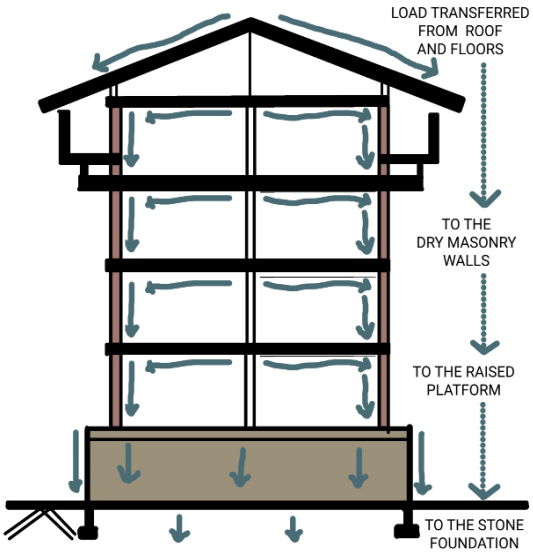


Figure 15 Load transfer mechanism (source: author)

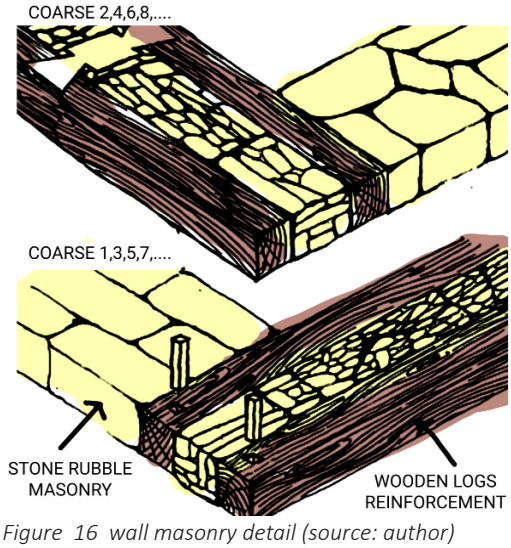


Figure 16 wall masonry detail (source: author)

3.5 Socio-Economic Aspects

Generally, one family occupies one housing unit. Due to the succession of family, nowadays, different floors are allocated for different children. During the day, a maximum of five members are present in the house, and in the evening, five to ten members are present. In most houses, the ground floor is used for cattle, and the upper floors are used as living and kitchen spaces. The traditional houses have three kinds of spaces- open, semi-open, and closed. The spaces formed due to a cluster of two-three adjacent houses act as a private shared gathering space.

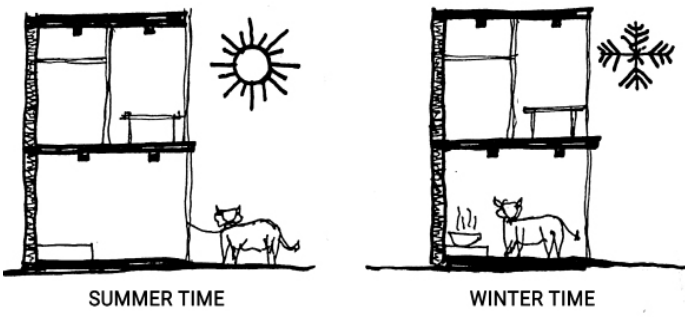


Figure 17 : Different Use of ground floor in different season (Source: author)

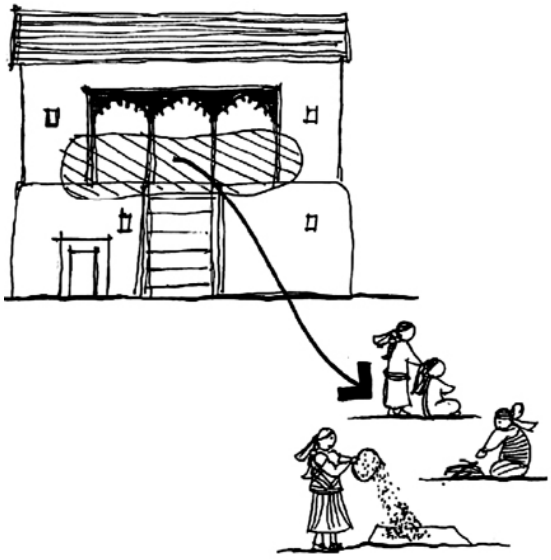


Figure 18 : Use of central open space (souce: author)

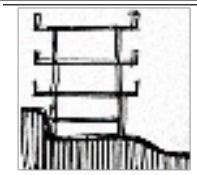
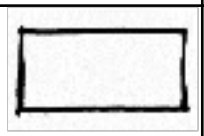
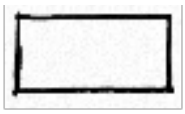
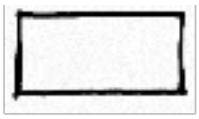
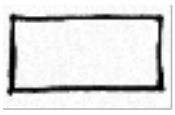
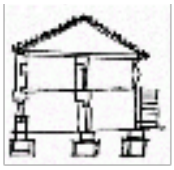
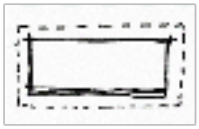
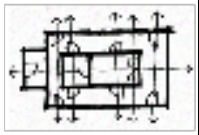
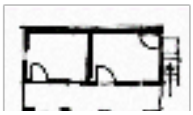
	Traditional Architecture		Contemporary Architecture		Inference
House	Residence in Mussorie	Panwar Residence	Pant Residence	Residence in Tilod	
Year&Location	1810, Mussorie	1700s, Uttarkashi	1998, Uttarkashi	1995, Uttarkashi	
Site	 *Figure 19 Source: author*	 *Figure 20 Source: author*	 *Figure 21 Source: author*	 *Figure 22 Source: author*	Traditional houses have stable sites
Plan	 *Figure 23 Source: author*	 *Figure 24 Source: author*	 *Figure 25 Source: author*	 *Figure 26 Source: author*	The geometry in traditional houses is symmetrical in both cases
Projections	 *Figure 27 Source: author*	 *Figure 28 Source: author*	 *Figure 29 Source: author*	 *Figure 30 Source: author*	More robust joinery in traditional houses and more articulated.
Openings	 *Figure 31 (Rawat, 2019)*	 *Figure 19 (Rawat, 2019)*	 *Figure 19 (Rawat, 2019)*	 *Figure 19 (Rawat, 2019)*	Openings are bigeer in modern houses without ornamentation

Table 5 Comparative analysis of Traditional and Modern villages in Uttarkashi district (source: (Rawat, 2019)

4. Case studies

4.1 Case study 1: Koti Banal Village

Location: Near Barkot, Rajgarhi, and Uttarkashi. Area: 1.1 sq. km.

Koti banal village is one of the most famous villages in the district. It has no proper connectivity to the main road. The settlement is connected with different small public spaces formed organically in the checks. These public spaces act as a gathering space and hold different festival activities. The houses are oriented to the north direction, hence the open spaces between them get ample sunlight, and daily household activities can be quickly done there. The wooden houses in this village are majorly 2 to 3 storied. The ground floor is allocated for cattle, and the family occupies the upper floors. (Planning)

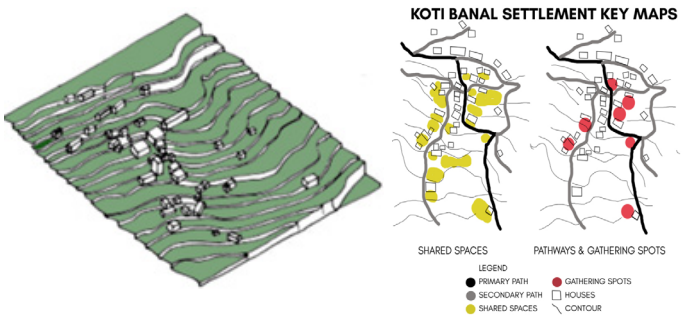
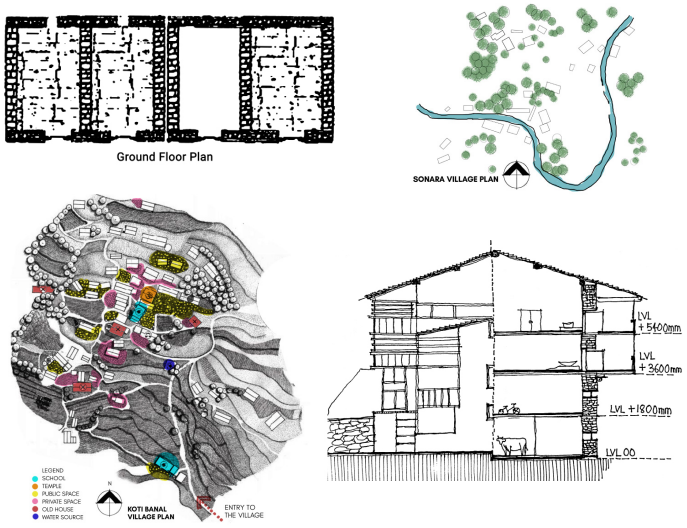


Figure 35 : Site contours and settlement (source: (Planning))
Figure 36 : movement and open space (source: CITATION Uni \l 1033 (Planning))

4.2 Case study 2 : Sonara Village

Location: Rajgarhi,Uttarkashi.

Sonora is a small village with a total area of 113.7 hectares and a population of 334 people. Stone and wood construction is found in the village. In this typology, the ground floor is constructed using stone, and the thickness of each wall is 500 mm. The structure is load-bearing. For constructing the first floor, interlocking rods of wood are used with stone to make the upper structure lighter. This technique centralises the centre of gravity and hence makes the structure earthquake resilient.



Clockwise
Figure 37 : Ground Floor plan of house (source: (Planning))
Figure 38 : Site plan of Sonara Village (source: (Planning))
Figure 39 : Sectional Elevation of House in Sonara village (source: (Planning))
Figure 40 : Site plan of Koti banal village source: CITATION Uni \l 1033

Granaries and structural members are made purely with the Deodar wood only. Random rubble masonry was used in the construction of the wall. This village has rocky terrain; hence, the houses do not require any foundation underground.

4.3 Case study 3: Gona Village

Location: Rajgarhi, Uttarkashi

Gona village has an area of 127.53 hectares with a population of 383 people. Wood and stone are used for construction. In this village, the houses are taller to concentrate the mass to a smaller area. The ground floor is locally known as Goshal or Goth, a space dedicated to cattle and storage. This floor has no formal/defined entrance. Ventilators are used instead of the window to provide insulation. The flooring is coated with cow dung. Sometimes, this space is also used for cooking. The construction is simple and symmetrical; strong interlocking wooden members are joined at the corners. The structure has flexibility as it has no mortar. The thickness of the wall decreases on the upper floors. The building rises to 13 m above the ground with a pitched roof.

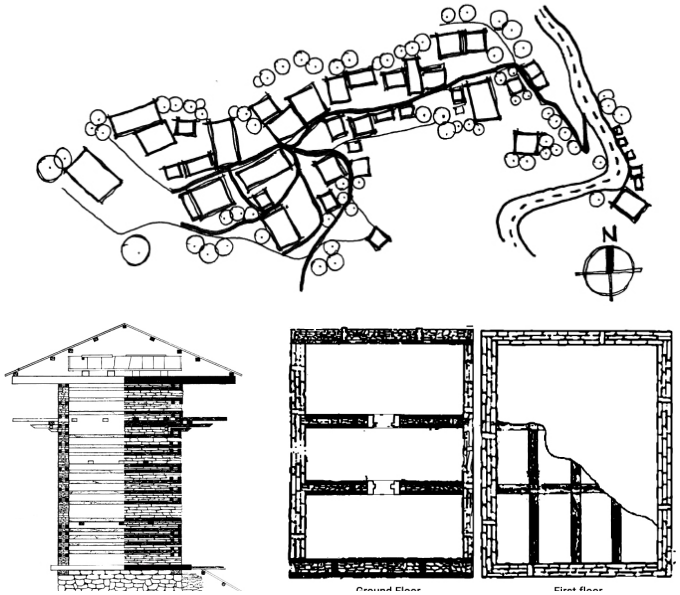


Figure 41 : Site plan of settlement of Gona village
Figure 42 : Section and elevation detail
Figure 43 : Ground and 1st floor plan of house (source: (Planning))

4.4 Case study 4: Khirsu Village

Khirsu is a small village of a population of approximately 1000 people located in Pauri Garhwal district in the Garhwal region. It is placed at an altitude of 1700m. A total of 245 families live here. Farming is the primary source of livelihood of the village. Hence the daily activities are either household or agriculture-related. The spaces built based on traditional knowledge help them perform their daily chores. The open spaces get uniform sunlight due to the north orientation of the building. The following visual explains the traditional house form and activities around the same. (Compartment S4)

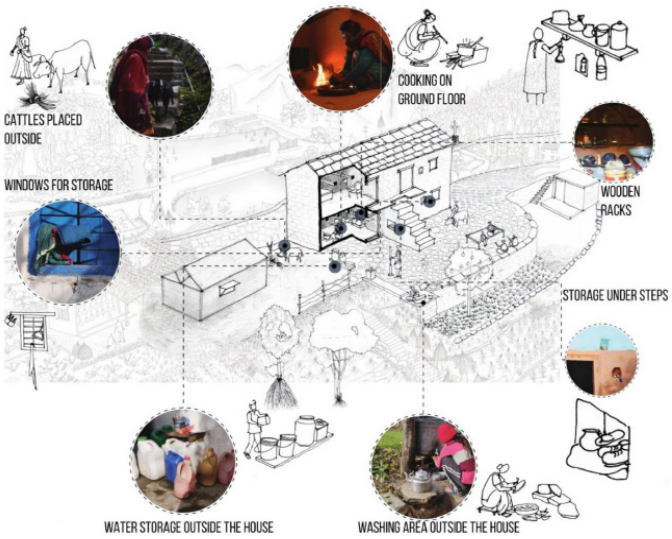


Figure 44 : House form and activities around it (source: (Compartment S4))

5. Conclusion

The modern construction style needs to become more sustainable and disaster resilient. Hence, the wrath of natural hazards has increased in recent years. So there is a lot to learn from traditional knowledge systems like that of Garhwal region, which has its own set of cultures, and construction styles.

The above study shows that the traditional knowledge systems have had a major impact on the built environment. The whole study started from macro-level planning and gradually proceeded to micro-level planning. Macro-level planning includes the process of selecting the site, developing and arranging the built form which will respond to the natural landscape. Traditional wisdom was used to develop the built form considering the needs of open, semi-open and closed spaces. Micro-level planning includes the selection of materials, disaster resilience, climatic response, structural stability, aesthetical value and the use of small spaces for different purposes.

Traditional knowledge has sustained many settlements as well as protected lives from disasters. It can be concluded from this study that our traditional wisdom can provide sustainable solutions in the present context. These can be studied more in order to further similar research. This study has been done based on secondary sources including DMMC reports, research papers and government reports. Considering the scope of traditional knowledge systems in the Garhwal region, there is a major scope to find out numerous unidentified styles of construction methods and disaster resilience strategies.

The study highlights the important role of appropriate design based on respecting nature and utilising context appropriate traditional wisdom play in the volatile circumstances existing today, wherein ecosystems and species that are central to our cultures are at the risk of disappearing altogether in the wake of climate change and other associated perils. It is high time we gather together the lessons from these resilient, surviving communities and interpret them appropriately in our quest to build sustainable cities of the future.

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