

## International Practices in Hilly Regions

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### ABSTRACT

In today's time when the construction is growing on the mass level, the attention has been shifted from the plain to the hilly terrain. Hills are the places which have preserved the vernacular aesthetic value of that own very place. New and various construction methods are being undergoing and experimental stage in which the vernacular and the modern methods can be club together to preserve the existing architecture of any hilly region. Hills have a variety of weather condition, an extreme hot dry or facing winters with snowfall almost all round the year. And under such climatic condition, building methods varies so that building can stand the natural conditions and sheltered the population residing there in comfort. An attempt has been made in this paper to analysis the different practices which have been adopted in different regions in term of climate, construction techniques, and materials on hilly terrain.

**Keywords:** Building, Climate, Materials, Topography, Varnacular

### INTRODUCTION

Architecture, being a repository of human interaction with land and topography, has responded positively when it has laid its foundation on them and responded awfully when it has not been taken into cognizance. Any area which lies 600 meters above the sea level is considered as hilly. The architecture of hilly regions, where the land is predominantly mountainous, often presents an amicable picture of interaction with local climate and available materials.

But erecting structures like hotels and architectural jargons can be a challenge in the hilly and mountainous regions as the construction needs to be strong enough to resist the topography of the land, bear the load of the building along with being aesthetically appealing to the tourists and locals alike. In this paper, an attempt shall be made to bring to light popular practices of constructions in hilly regions prevalent across the globe and their reactions to human and nature.

### 1. TOPOGRAPHY AND CLIMATE

**1.1** Mountains form an important part of relief in Iran. The Elbroz and Zagros mountain chains separate the central areas of Iran from Caspian Sea in the North and Mesopotamia in the west. The weather ranges from severe chill in winters and temperate weather in summers with extreme difference in day and night temperatures.

The city texture in mountainous region has been developed in manner so as to cope up with extreme cold while presenting an amicable picture of harmonious relationship with the surrounding.

It has been characterized by

- Compact and intensive texture
- Small and enclosed areas
- Taking advantage of the sun and earth directions
- Narrow passages along the ground level.



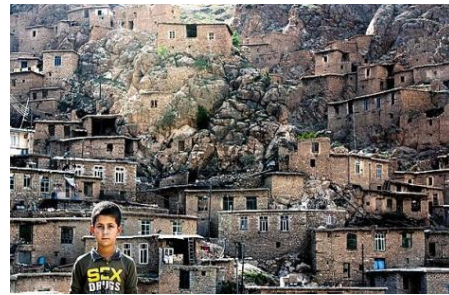
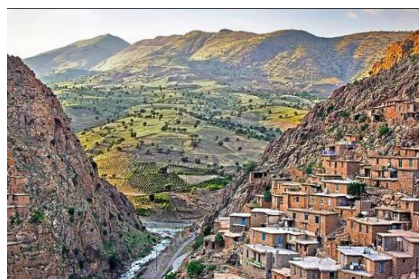
Fig.1 Location of Elbroz and Zagros Mountain<sup>1</sup>

<sup>1</sup>Iran a land of mountains and investment opportunities,  
[http://cf.cdn.unwto.org/sites/all/files/pdf/3\\_5\\_mahmoud\\_hashemi\\_iran.pdf](http://cf.cdn.unwto.org/sites/all/files/pdf/3_5_mahmoud_hashemi_iran.pdf)

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The buildings in the cold and mountainous region have a compact plan and texture. The houses that are built are mostly in the shape of cube and cubic rectangle which reduces the outer surface of the building in relation to its inner volume and keeps it to the minimal. The traditional houses in the cold mountainous regions of Iran have yards which are smaller in size than their counterparts in plateaus.

Buildings in these regions have verandas but their depth is far lesser than verandas in the southern regions of the country and they don't have any sitting space outside. The floor of the building yards in cold regions is 1 to 5 meters below the sidewalk level to direct the current water of creeks and brooks towards yard garden. The ceilings of rooms of this region are considered lower than the similar rooms in the other regions to decrease the volume and the outer surface gets the minimum in relation to the building volume. The buildings of this region are made of locally available material since they have good thermal capacity and the resistance to keep the building warm in its inner area. The body of these buildings is from stone or wood, cob mortar, adobe and bricks and the roofing is from timber and cob. Thus one can see climate plays a pivotal role in architecture of the region.

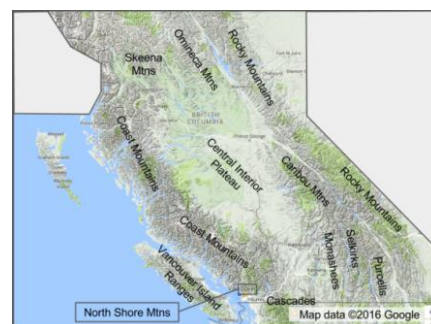


**Fig2.** Houses built with natural topography<sup>2</sup>.

The principles that have been thought for adaptation to climatic conditions of these regions are very important; and they are as follows:

- Using common walls as much as possible and creating a heaped and compacted texture in complexes;
- Preparing compressed and compact planes; Forming the building to create shade in summer and receive proper heat in winter;
- Placing heat generating spaces like kitchen in the center of building plane;
- Considering non important spaces like store as heat insulator in sides or cold parts of building;

1.2 In the snowy mountains and hilly areas of British Columbia, heavy timber detailing and natural stone are often combined with grand roofs capes in vogue from the beginning of the 20th century. The design is characterized by sloping roofs, use of wood and stone and generally abundant use of natural materials primarily timber and local stone. The shapes of the building are determined by its functional masses. The building mass resulting from the shape of the walls, floors and roof have been broken into smaller scale components in order to avoid brutal and overpowering proportions. Special emphasis has been given in the construction of roofs as they are the first one to capture the splendor of the eyes.



<sup>2</sup><https://www.farsnews.com/photo/1392042300134>  
7



Fig3. Mountains in British Columbia<sup>3</sup>



Fig4. Houses location<sup>4</sup>

1.3 Dalhousie is a hill station in the Chamba district in the northern state of Himachal Pradesh located at 1970 meters above the mean sea level. The technique which is put to widespread use in this region is called *kathkuni* which includes locally available material such as stone, wood, slate.

- Parking on the roof which comes to the level of the road and further building is continued downwards.
- 2) Sloping roofs are used because of the climatic condition of the city to protect the building from snow and rain.
- Step construction is generally practiced to make the proper use of sloping site.



<sup>3</sup> Relating pressure to mountain elevations, [https://www.eoas.ubc.ca/courses/atcsc113/snow/met\\_concepts/06-met\\_concepts/06n-pres-level-mtn-elev/](https://www.eoas.ubc.ca/courses/atcsc113/snow/met_concepts/06-met_concepts/06n-pres-level-mtn-elev/)

<sup>4</sup> <https://biv.com/article/2017/01/bc-has-record-year-home-sales-2016-bcrea>



Fig5. Dalhousie<sup>5</sup>

The construction in the hilly areas of Mauritius has been carried out meticulously in order to cause least disturbance to the topography of the hills. Buildings and structures have been set far back enough so that they do not appear perched on the edge and the mountain slope acts as a backdrop of the building. Buildings are placed far enough to reveal views of the mountain and natural landscape in hindsight from other buildings and dwellings. The form, massing and architectural features of buildings are designed to blend with natural terrain and preserve the undulations of the slopes. The slope of the hillside has been maintained by deploying stepped foundation and setting the building into the hillside to help integrate it with the natural landform. On downhill elevations, the use of single plane walls that exceed a single storey have not been constructed and the upper storeys are stepped back from the level below. The existing vegetation has only helped to soften structural mass and blend buildings into natural settings. None of the buildings that have been constructed in the hilly regions exceed 7.5 metres in height. The buildings are made up using dark or earth tone colors so as to present a harmony with the surroundings in which it exists.



Fig6. Mauritius mountain map<sup>6</sup>

<sup>5</sup> [https://www.google.bt/search?rlz=1C1VFKB\\_enB\\_T604BT604&biw=1366&bih=613&tbm=isch&sa=1&ei=4xaaW7KtO47I8wWXioDICw&q=dalhousie+pics&oq=dalhousie+&gs\\_l=img.1.8.0i67k1j019.2.1473.22536.0.28132.6.6.0.0.0.515.515.5-1.1.0....0...1c.1.64.img..5.1.514....0.7tCg-gOkqRQ#imgrc=87FZERGfhdM-DM:](https://www.google.bt/search?rlz=1C1VFKB_enB_T604BT604&biw=1366&bih=613&tbm=isch&sa=1&ei=4xaaW7KtO47I8wWXioDICw&q=dalhousie+pics&oq=dalhousie+&gs_l=img.1.8.0i67k1j019.2.1473.22536.0.28132.6.6.0.0.0.515.515.5-1.1.0....0...1c.1.64.img..5.1.514....0.7tCg-gOkqRQ#imgrc=87FZERGfhdM-DM:)



Fig7. Central land area<sup>7</sup>

1.5 In British Columbia in Canada, the snowy mountains present a unique and different challenge for architect since the land is completely covered with snow and the temperatures there is below zero degrees Celsius. The construction that has been carried out there is completely in tandem with the environment that exists there and completely suits the notion of mountain resort existing in snow covered conditions which would act as a means of escape from stressful urban existence. The design is characterized by sloping roofs, use of wood and stone and generally abundant use of natural materials primarily timber and local stone. The shapes of the building are determined by its functional



Fig8. City morphology<sup>8</sup>

<sup>6</sup><https://www.mauritius-holidays-discovery.com/mauritius-kestrel.html>

<sup>7</sup><http://www.govmu.org/English/ExploreMauritius/Geography-People/Pages/GeographyPeople/Landforms.aspx>

The building mass resulting from the shape of the walls, floors and roof have been broken into smaller scale components in order to avoid brutal and overpowering proportions. Snow management is peculiar to this architecture of this region as the area is snow covered for most of the year. The roofs of the houses are designed in such a manner that pedestrians are safe from the danger of falling snow from roof overheads. The chimneys of the houses are built with stone finish so as to avoid accumulation of snow. Like many good examples of mountain architecture, the architecture of this region also combines different wall finishes, which change from the bottom to the top of the building. The base of the buildings is made up stones which are solid and continuous and the upper ceilings are made up of wood.

1.6 The district of Manang lies approximately 6000 m above sea level located in the North Central Himalayas in Nepal. The climate of this region is characteristically cold and dry and is windswept for most of the year. Since stone is the most easily available material in this region, most of the houses in this area are built with stone. Since wind is an integral part of the climate of this region, plants are also used as source of fence making of the houses. The common parts of the plants which are used for fence making are stems and branches.

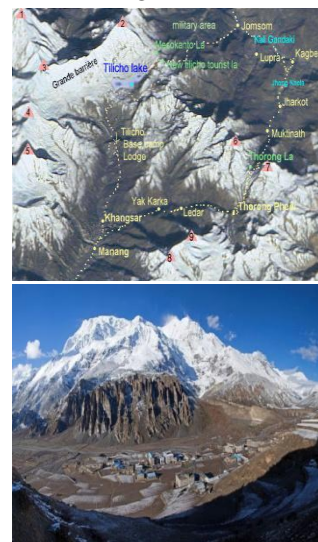


Fig9. Manang terrain<sup>9</sup>

<sup>8</sup><http://globetrotteralpha.com/>, :  
<https://en.wikipedia.org/wiki/Vancouver> Google Maps: <https://www.google.com/maps/place/Van...>,  
<https://www.wsj.com/articles/british-columbia-cracks-down-on-foreign-housing-speculators-1519173162>

<sup>9</sup>[https://www.caingram.info/Nepalpeaks/tilicho\\_la\\_ke.htm](https://www.caingram.info/Nepalpeaks/tilicho_la_ke.htm)



**Fig 10.** Traditional stone build village of Manang. Mountains in the background. Annapurna region, Nepal. Sunny day of Nepal summer. Big mountain, stone houses and fresh air. Eco travel<sup>10</sup>



**Fig11.** Map showing Australian Alps National Parks<sup>11</sup>

1.7 In the rugged alpine terrain in Australia, the structure holding the building into the mountain is aligned to form skinny lines that are angled in the same direction as one's viewing it. Roof is the most important part of the construction of buildings in this region. Rooms are well sealed with no flues or vent to allow snow build up and balconies have been meshed to let the falling snow flow through. The houses that are built here employ a prefabricated hand-lift able modular system that uses high-performance thermal insulated panels. This system has eight times the strength of standard wall framing and a thermal resistance value providing triple the insulation than the standard construction.

## 2. VERNACULAR

2.1 In British Columbia in Canada only, the roofs of houses are steeply pitched without any

<sup>10</sup><https://www.dreamstime.com/stock-photo-traditional-stone-build-village-manang-mountains-background-annapurna-area-himalaya-nepal-region-sunny-day-summer-big-image98188613>

<sup>11</sup><https://theaustralialps.wordpress.com/experience/aawt/>

un-desirable decorations. The land and the street along with their fauna which lay in front and around the buildings have been carved out with great attention. It has been ensured that new trees and shrubs only reinforce the natural species of shrubs that exist along paths and pavements. The mature trees have been preserved where it was comfortably possible. The street furniture has been made of rustic materials like stone and solid wood. All this makes the city an attraction for the locals and visitors alike.



**Fig 12.** Minimum Slope for an Asphalt Shingle Roof<sup>12</sup>

<sup>12</sup><https://www.iko.com/na/residential/building-professional/minimum-slope-for-asphalt-shingle-roof/>

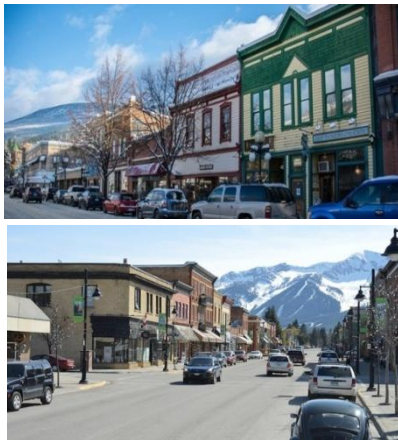
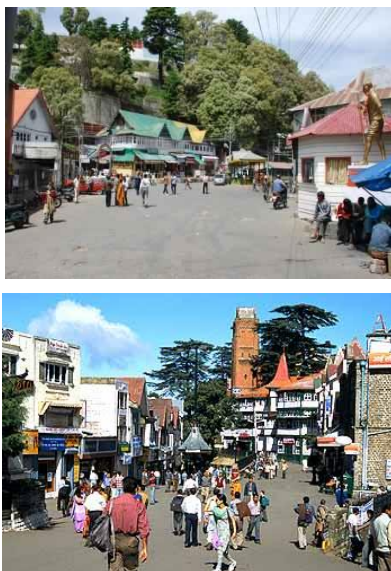


Fig 12. Different views of the city<sup>13</sup>

2.2 Materials used in construction of buildings in Dalhousie are slate, wood and plaster work. Stone was used for construction of walls, Slate for the roofs and dormers. Wood is used in flooring, room separations, doors and window framing. Open spaces in the form of balconies exist in most of the constructions in Dalhousie and these are interactive spaces used for leisure by both residents and tourists. Roofs are the major part of the building. Beautiful sloping roofs which go a bit extra than the space of the house in order to shed out heavy rain and snowfall are the characteristics of the construction of the area. Slate and stones are best available materials locally. While stones are used for finished work on external facades of the buildings and as bonds between blocks to absorb heat, slate is a material which is most used for construction of roofs since it is a sunlight reflective material, is frost resistant, heat absorbing and moisture bearing owing to its high quartz content.



<sup>13</sup>[www.google.bt/search?q=british+columbia+towns&tbm](http://www.google.bt/search?q=british+columbia+towns&tbm)



Fig 13. Market square<sup>14</sup>

2.3 The district of Manang due to its far-off and isolated locations presents the best use of local materials for the construction of its houses. The absence of stereotypical materials for construction like mortar, cement makes the houses of the district appear more connected to the surroundings. The height of the houses is pretty low and generally don't go beyond a single storey. This helps in enhancing the visual landscape of the area.

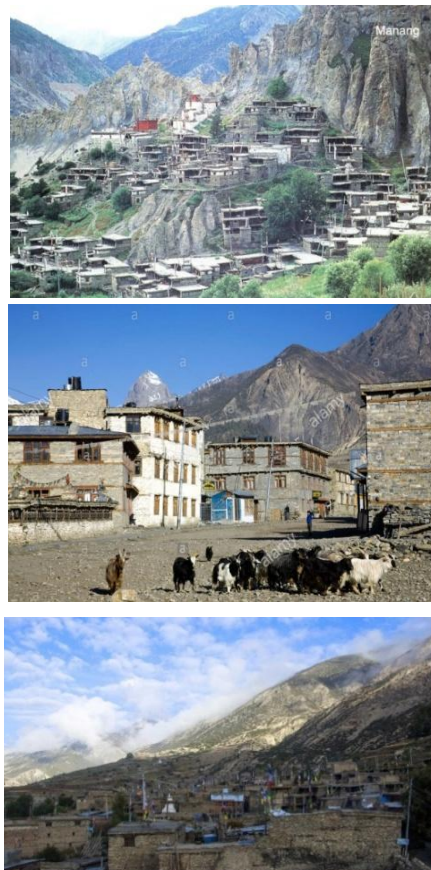


Fig14. Manang is the top destination in Nepal<sup>15</sup>

2.4 In India,

1. Hill settlements in India are usually constructed on the terrain which are

<sup>14</sup>[www.google.bt/search?q=construction+of+building+s+in+Dalhousie+india&tbm](http://www.google.bt/search?q=construction+of+building+s+in+Dalhousie+india&tbm)

<sup>15</sup><http://nepaltraveller.com/home/sidetrack/115>

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considered more stable and less prone to natural hazards like landslides and cloudburst, are less steep and sturdier.



(a) Settlement in Upper Himalayan Region



(b) Settlement in Middle Himalayan Region

**Fig15.** Typology as per the region<sup>16</sup>

2. Traditional settlements in hill regions of India are mostly constructed on southern slopes to allow sufficient solar exposure throughout the day and protection from northern cold winds, so that energy consumption is the least in providing suitable living conditions.
3. Settlements in hill regions are classified into three categories viz. ridge, mid land and valley settlements, each bearing their own character. Planning and design of buildings vary in these settlements. In ridge settlement important buildings like temples, shops, public buildings like post offices and schools, open grounds and other public areas/spaces are often located on or near to the ridge and general houses are located on relatively lower areas. Whereas, in valley settlement main public spaces, temples and other public and community areas and open grounds are generally located in valley (lower areas) and houses are located in upper regions on sloping terrain.



<sup>16</sup>Vernacular practices: as a basis for formulating building regulations for hilly areas



**Fig16.** Kath-khuni architecture of Himachal Pradesh, India<sup>17</sup>

4. Vernacular or traditional buildings have compact planning, small footprints and low built to open ratio, especially in lower Himalayan regions and lot of space is kept open around buildings which can be used for different activities and/or for growing vegetation. This helps in minimizing the impact of development on surrounding environment



**Fig17.** Multi-storeyed buildings in hill stations in contrast to traditional development.<sup>18</sup>

5. In the Nilgiri hills of Tamil Nadu, semi-barrel type huts are built by the Toda tribe residing there. These huts are built of bamboos which are fastened with rattan and straw. The houses are built using pre-fabricated light weight panels of ferrocement. Ferrocement, being one of the most accomplished building materials for construction in hilly areas, is best suited for construction in hilly areas of India because of its ability to bear earthquake and cyclones, is

<sup>17</sup><https://www.slideshare.net/mansiarch/kath-khuni-of-himachal-pradesh-autosavedpdf-low>

<sup>18</sup>Building regulations for hill towns of India

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anti-corrosive and crack proof, can resist fire for 48 hours along with being water resistant.

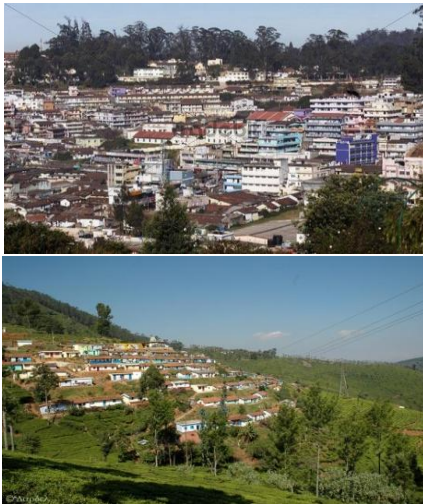


Fig 18. The Nilgiri hills in Tamil Nadu<sup>19</sup>

## TOURISM

3.1 The above two of the characteristics make British Columbia in Canada a sought after tourist destination, where people from warmer parts of the globe come to see snow and engage in activities like skiing.



Fig19. City view<sup>20</sup>

3.2 Dalhousie, because of its location and picturesque natural setup, has come to be one of the most sought after tourist locations in North India. The use of wood in the construction of buildings, especially in the interiors, adds a different charm to the architecture which makes it more connected to its surrounding. The

<sup>19</sup> [www.google.bt/search?biw=1366&bih=613&tbm=isch&sa=1&ei=ATuaW4eABYrMvgSr4ZWQBA&q=Nilgiri+hills+of+Tamil+Nadu&oq=Nilgiri+hills+of+Tamil+Nadu&gs\\_l=img.3](http://www.google.bt/search?biw=1366&bih=613&tbm=isch&sa=1&ei=ATuaW4eABYrMvgSr4ZWQBA&q=Nilgiri+hills+of+Tamil+Nadu&oq=Nilgiri+hills+of+Tamil+Nadu&gs_l=img.3)

<sup>20</sup> <https://thegreenmama.com/local/vancouver/>

cottage and villas cling to the deodar and pine mantled hills of Dalhousie. The fauna includes pink and red rhododendrons and trees are dressed in different shades of green. The shops are small and compact in size. The local handicrafts like gold-thread, cane baskets, colorful woollens are specialties of the region. “PanchPulla” and “Sat Dhara Falls” are major tourist attractions in Dalhousie.



Fig 20. Dalhousie city view<sup>21</sup>

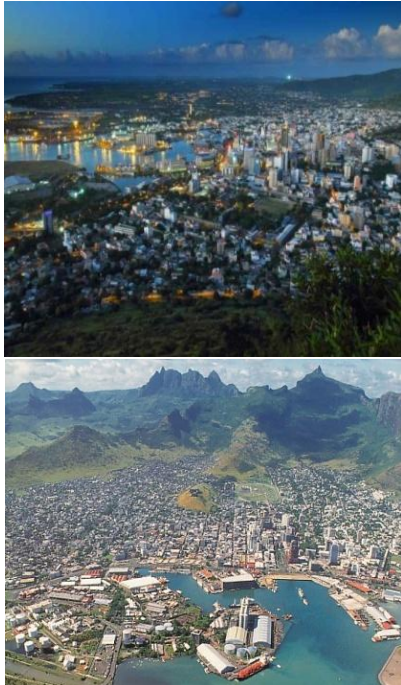
3.3 The city of Mauritius presents a perfect and a distinct blend of nature and architecture. Mauritius is a bouquet of tourist attractions set in the brilliant turquoise waters of the Indian Ocean. Sun-kissed beaches, stunning mountains, calm lagoons, bustling villages, patchwork sugar cane fields and swaying palm trees. Port Louis, the capital city of Bali itself is the major tourist attraction. Set against the backdrop of mountains, Port Louis, is a complete city itself with established infrastructure, market selling spices and is the island’s only port. From waterfront to casinos, shops, and restaurants, the city has every infrastructure for amusement and recreation for both locals and tourists. *Le Caudan Waterfront*, *La Bourdonnais Square* and *Fort Adelaide* are major tourist attractions. *Le Caudan Waterfront* is place where tourist and

<sup>21</sup> <http://indiadekho.blogspot.com/2011/01/dalhousie.html>



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locals go to see ships passing from all over the world. The town of Moka, is the only land-locked rural district of Mauritius and the gateway to the East. It is surrounded by mountains on the north, south and east ends. Blessed with forested landscapes, towering mountains and impressive manor houses, here, the University of Mauritius and the Mahatma Gandhi Institute are two centers of the island's academic community.



**Fig21.** Port Louis is the city of Mauritius. History and present, the main attractions, sightseeing<sup>22</sup>

3.4. Thredbo, Australia is famous for its snow and its longest ski run, Thredbo is a small hill town with 470 permanent residents located at an elevation of 2037 m in New South Wales, Australia. Since the place is covered with snow for most parts of the year, thousands of tourists come here to take part in different snow activities like skiing, snowboarding etc. Apart from snow activities, this place is famous for trekking, cycling, rock climbing and also hosts a summer blues music festival.



<sup>22</sup><http://nutritionandhealthcare.info/page/port-louis/mauritius/default.html>



**Fig22.** Thredbo, Australia<sup>23</sup>

3.5. Uttarakhand consists of two main regions viz. Garhwal and Kumaon with similar cultural attributes. Kumaon being a land resplendent in awesome natural splendor offers a plethora of natural marvels like rosette dawns and dusks, azure skies and lakes, fields of yellowing corn, alternated by deep green potato beds, blue ribbons of meandering rivers, eye-catching pink and red rhododendrons, snow-white summits and birds of vivid plumage. Set on the foothills of the Himalayan mountain range, Kumaon is quintessentially a tourist paradise and has been categorized into various tourist circuits for the purpose of identification and appreciation.

### A. Almora Tourism

The town of Almora (1646 m), lies along a saddle-ridge amidst a lush amphitheater of terraced slopes. Overlooking the arterial Mall, where the bus terminus, shops selling balmithai (a famous milk confection of Kumaon), and private lodges and restaurants are located, is flattish bowl-the virtual picture of fertility with its canals, hamlets and the foaming Kosi river. Beyond and behind the ridge lie tiers of hills and dales, edged ultimately by a Himalayan panorama.

<sup>23</sup><https://www.thredbo-accommodation.com/>

### B. Bageshwar Tourism

Situated at the confluence of rivers Saryu, Gomti and latent Bhagirathi lays the holy township of Bageshwar; also revered as the pious land associated with Lord Sadashiva, the redeemer of all sins. This quaint town abounds in religious legends, festive happenings and mind blowing surroundings, famous primarily as a prominent Shaivaite delight.

### C. Champawat Tourism

Champawat is a beautiful town with breathtaking landscapes and terraced fields, which cover the valley. A river snakes past these landscapes and fields forming a beautiful picture. Champawat offers the tourists with virtually everything they expect from nature, ranging from pleasant climate to varied wildlife and good places to trek.

### D. Nainital Tourism

The nucleus of Nainital's exquisite beauty is her lake which is a haven for water sports like Yachting, Kayaking, Canoeing and Boating and is also the main attraction of the place. The lake at south end is called Tallital and at north end is called Mallital. The city of Nainital is developed around this lake. The lake offers yachting and cool boat rides in its waters. A unique feature of the lake is that it hosts the only Post Office on a lake bridge in whole world.

### E. Pithoragarh Tourism

Popularly known as “Little Kashmir”, this easternmost district of Uttarakhand is of significant cultural importance. This circuit consists of two chains, one of them being Jolinkong and the other one being Anchherital. While the former is at a height of 4,634 meters, the latter is situated at an altitude of 3,658 meters. The district is dotted all over with many old temples that you visit. There is a shrine at Purnagiri, which is only 20 kms from Tanakpur, and there is another Sikh shrine near Lohaghat called Ritha Sahib.

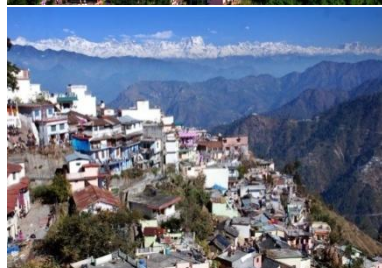


Fig23. Garhwal and Kumaon towns<sup>24</sup>

3.6 The Nilgiri Hills in India are a world renowned travel destination characterized by numerous hill stations of varying altitudes. High mountains, deep valleys, sparkling water bodies, dense forests, and steep slopes are features of the region which attract tourist from all over the

<sup>24</sup>[https://www.google.bt/search?biw=1366&bih=613&tbm=isch&sa=1&ei=W0WaW8XbAsuBvwSk6Z7IDw&q=Garhwal+and+Kumaon+towns&og=Garhwal+and+Kumaon+towns&gs\\_l=img.3...6448.10523.0.10964.6.6.0.0.0.233.1244.0j3j3.6.0...0...1c.1.64.img..0.1.231...0j0i30k1j0i5i30k1j0i24k1.0.hjmTPA6dR5I#imgrc=Sq\\_aakzTstuv\\_M:](https://www.google.bt/search?biw=1366&bih=613&tbm=isch&sa=1&ei=W0WaW8XbAsuBvwSk6Z7IDw&q=Garhwal+and+Kumaon+towns&og=Garhwal+and+Kumaon+towns&gs_l=img.3...6448.10523.0.10964.6.6.0.0.0.233.1244.0j3j3.6.0...0...1c.1.64.img..0.1.231...0j0i30k1j0i5i30k1j0i24k1.0.hjmTPA6dR5I#imgrc=Sq_aakzTstuv_M:)

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world. The Nilgiris is named as one of the world 14 hotspots, a distinction which it earned because of its immensely rich biodiversity. The Nilgiri Mountain Railway, and 114 year old railway service, is one of the biggest attractions in Nilgiris and is a UNESCO World Heritage site. The Coonoor district near Ooty is a bird watcher's paradises as variety of birds are found in the tea-garden town. The Dolphin Nose Point is also a major tourist attraction in the region. This is a spectacular rock formation which lies 10 kilometres away from Coonoor and at an elevation of 1000 meters above the sea level. Shaped like a dolphin nose, it offers a panoramic view of Coonoor with deep ravines on both sides and a view of continuous sheets of water cascading down the Catherine Waterfalls.

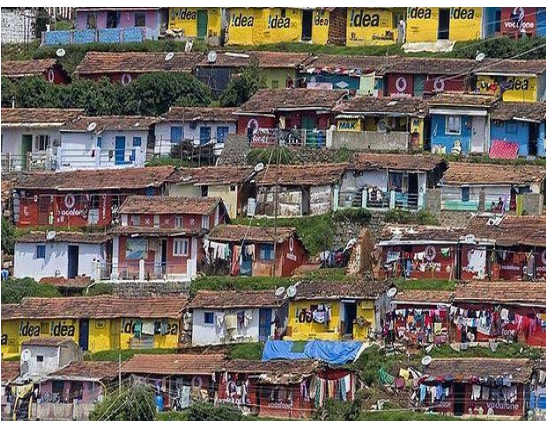


Fig24. The Nilgiri Hill towns in India<sup>25</sup>

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## International Practices in Hilly Regions

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**Citation:** Ms. SehbaSaleem, "International Practices in Hilly Regions" *Journal of Architecture and Construction*, 2(1), 2019, pp. 23-34.

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