CHAPTER I

PHYSICAL SETTING

The importance of physical setting of the region can hardly be underscored for helping a proper appraisal of life conditions which go to attract or repel the distribution of human habitations and influence many characteristics of the population. With a view to provide the background knowledge of physical environment in context of the study of population, a discussion of landforms, drainage, climate, vegetation and soils of the area is taken up in the following paragraphs:

A. LANDFORMS

The topography of this region comprises the low hill terrain along southern margins, becoming highly mountainous towards its centre and the north. The elevations above mean sea level vary from about 2000 ft. in the south to over 20,000 ft. in the north. With rise in height, the level of valleys goes on rising from an average 3000 ft. in the south of Dhaula-Dhar, 4000-6000 ft. in mid-Dhauladhar-Pir-Panjal areas to 8000-10,000 ft. in the trans-Pirpanjal zone.

The three parallel Himalayan ranges are generally within 25 miles from each other enclosing areas of simple to difficult mountain relief. While in low Himalayas in the south, there are multi-sized broader valleys and spur protrusions from Dhaula-Dhar range to its valley margins, the difficult high Himalayan relief is characterised by the mountain peaks,
closely-packed ridges, narrow valleys and frequently converging-diverging offshoots of Pirpanjal and central ranges.

The study area can conveniently be divided into the following landform regions, maps showing relief and relative relief (figs. 3 and 4) forming the basis of their discussion:

1. The Area South of Dhaulā-Dhar (The outer zone of low Himalayas),
2. The Dhaulā-Dhar Range,
3. Mid Dhaulā-Dhar and Pirpanjal Area (Transitional zone of low and high Himalayas),
4. The Pir-Panjal Range, and
5. Trans-Pirpanjal Area (Inner zone of high Himalayas).

1. The Low Himalayas:

This area skirts along the southern slopes of Dhaulā Dhar extending from its foot to the margins of Siwaliks in the south. Most of the habitations are in the valleys below 4000 ft. Leaving aside the main valleys of Beas along its middle and lower reaches, there are about twenty major tributary valleys (14 to the north of Beas River and 6 to its south). Another four stream valleys fall each in the drainage of Sutlej to south-east and Ravi in west along two ends of this area. Such a large number of valleys is a rough
indicator of wider scattering of rural settlements and heavier population of low Himalayan terrain.

The landforms consist of well-dissected hill ranges, residual outliers, broad interfluves, series of flat-topped spurs, extensive ravines and low-lying alluvial valleys. The relatively greater rainfall concentrated during summer and active process of stream erosion upon sedimentary strata has, on the one hand, made this tract an area of receding scarplands and a mass of greatly eroded spurs and hills. On the other hand, the huge amount of eroded material washed from hill sides and valley heads has been converted itself into varied depositional features of great human significance. These are marked as riverside flats, wider alluvial plains and broader alluvial uplands of low Himalayan valleys in Chamba, Kangra and Mandi districts. Such sites of flatter terrain are so highly prized for cultivation that village habitations occupy wastelands along hills wherever these are nearby. The relative relief stands equally favourable and is generally less than 1500 ft., seldom rising to more than 2500 ft. although its variations from one individual tract to another are frequent. The gradients are very low in centres of valleys, rising from 2 degrees to an average of 11 on their sides and up to 30 degrees along the much eroded scarplands. Frequently it is not the altitude but the degree and rate of change of slope which goes to
decide the limits of cultivation on these hill lands. The
gentler hill-sides, broader inter-fluvial uplands, rolling
spur-tops are found as good as riverain flats. All these
formations are highly congenial for good agriculture and
fairly dense human settlements. Everywhere it is the relative
thinness of soil and rock exposures along steep slopes exceeding
20 degrees which exercise a restrictive effect for cultivation,
for efforts towards conservation of soil and productive land
management. Thus the stable and depositional phase of these
landforms has provided sites favourable for a dense network
of human settlements, the twin relationship cogently brought out
partly or fully by the typical relief profiles (Diagrams 1 and
10 to 12 of figure 6). Around them are the tracts proving
most suitable for concentration of rich paddy, tea and potato
cultivation as prime requisites of people's life.

2. The Dhauladhar Range:

Literally meaning 'whitish grey' mountain after the hues
of its rocks, it stands highest with convex side facing Kangra
valley and is relatively precipitous in its south central run
bearing general elevations of 12,000 - 15,000 ft. above sea
level. The heights decrease to 8000 ft. along its southeastern
and western extremities marked in Kulu and Chamba respectively.
It makes the northern boundary of low-lying valleys of Beas
drainage extending to its south. The relative relief rises to
3500 ft. along valley margins of its mountain front. On either side of the range from end to end, great elevations, rough slopes, great rock contrasts and a well-developed drainage have made it a physical barrier and an area of erosional landforms.

From the valleys skirting its southern mountain front, there is a straight vertical rise of the range, reaching 10,000 ft. within 7 miles in the case of Kangra zone thereby affording a clearer view of the lowlands. It has made it significant for the populous valleys on the following grounds:

(i) It is the first range of Himalayas on going from plains of Punjab which experiences a number of major snowfalls during October-March period and remains under its cover for a longer part of the year. This keeps its streams and springs generally perennial.

(ii) Its straight rise provides an ascent for the moist monsoonal air during the summer season recording the major burst of the seasonal rainfall along its lower flanks.

(iii) Such an impressive vertical rise of the range from the relative levels of valley-floor has been responsible for the situation of many of them directly in the seismic zone of outer Himalayas. It has, for many years after the great Kangra earthquake of 1905, adversely affected the expansion of hill towns in this part of the region. The human settlements along the slopes of this range are scattered between 4000-6000 ft.
generally. Above this height, the increasing extension of ridge-tops and rock exposures appear as the first virtually vacant zone of the region.

3. The Mid-Dhauladhar Pir Panjal Zone:

The middle zone extends from southern mountain front of Pir-Panjal to Dhauladhar on its south partly falling in low Himalayas and largely in high Himalayas. From north west to south-east, it consists of Churah, Chamba, Brahmour, Banghal and Kulu-Seraj, all on inner side of Dhauladhar range. The number of river valleys, as nerve centres of hill population, is reduced as compared to those in the outer zone, their number not exceeding six each in the case of Beas and Ravi and another three of the Sutlej river. Except a slice of lower valley portions, the populated area is marked between 4000-8000 ft. altitude above mean sea level, the ranges rise to an average of 12,000 ft., the relative relief in local areas hovering between 3500 to over 5500 ft. suggesting greater depths of valleys and equally higher uplift of mountains. As a whole it appears more of a highland tract, the valleys just forming gaps into the Himalayas mostly as a result of river action. It is distinguished more by its intermediary location, a transition between hills and mountains than by any uniformity of landforms. All these factors have contributed to local concentrations of human settlement and population in considerably isolated valleys sharply demarcated by heights and ground of negative value. The mixed terrain in wider area
of this zone has thus thrown up a greater variety of sites for habitations and small to medium-sized cultivable patches mostly given to non-paddy cereal and fruit crops. Those holding greater human significance are found in the lowlands strictly typical of this zone. They range from flat river-side strips (locally called Balh or niml lands) confined to a few low sections of valleys like Kulu-Chamba, scores of fluvio-glacial terraces and plateau-flats along stream banks in upper valleys of Kulu and Churah, all with 15-20 degrees usable slope situated generally between 4500-5500 ft. above sea level. Circumscribed by rugged mountainous topography, the crop-use of terraces in high hills stands in deep contrast with forests covering increasingly rougher slopes away from the river valleys. (Diagrams 6, 7, 9 of fig. 6). Another much distinctive feature of some parts, worth a special mention, is the predominance of plateau uplands as favourable sites of human occupancy. They are characterised by their peripheral location along foot of bordering mountains with an average of 250 ft. above river level, rolling topography with eroded bluffs towards streams, their continuity broken only along river confluences and a longer preservation as a consequence of combination of several natural conditions. The surface variations in their slope (not exceeding 20 degrees), depth of soil and frequency of rock exposures towards their mountain edges explain many of the variations in intensity and diversity
of plateau-farming, spacing of human habitations and the relative limits of grazing and forestlands (Diagram 2 of figure 6).

Towards centre of this region (Brahmour and Bara Banghal tracts) the limbs of Pirpanjal, as high as the main range itself, get connected with Dhaula-Dhar and along with the highland tracts of Kulu-Seraj, the areas form such a difficult mountain relief that the human significance of landforms is reduced, leaving them largely as a collecting ground for snow, rock and water. Here only the limited extent of mid-mountain flanks, as a result of accelerated gradational process, maintain congenial soil-slope relations with 20-26 degrees gradient and have come to achieve importance for the life of man. Usually marked in 5500-7000 ft. altitudinal belt, such slopes (locally known as 'Manjhat' 'Parbat' or 'Majaith zone') are noteworthy for hardy hoe cultivation and a thin line of straddling settlements, the houses sometimes arranged in a tiered fashion. There is a distinct central group of hamlets marked only in a few better cultivated localities carrying 15-20 degrees gradient. With virtual non-existence of stream-side settlements, the 'Manjhat' zone is demarcated by rocky, barren or inaccessible down and up slopes exceeding 29 degrees. Above this zone, over steep unterraced mountain sides or rolling ridge tops, with slopes falling in the range of 26-29 degrees extending sometimes up to 8000 ft. ASL (known as Gahars and Kutals), either a periodical cultivation of
hardy grains in stonier soil of marginal fertility is
practised, or graziers and forest labourers stay temporarily
to make use of grasses and trees. The profile diagrams 3, 7
and 8 (figure 6) provide typical instances of the settlement
locations in the zone described above.

4. The Pir-Panjal Range:

The middle range of the Himalayas is known as Pang,
Dhar in Chamba and Pir Panjal in Kulu areas of this region.
It is uniformly high having pitched symmetrical folds, greatly
precipitous slopes and permanent glaciers on both sides
throughout its length. It keeps a mean altitude of 14,000-
18,000 ft. with elevations not below 12,000 ft. along its
offshoots. The minimum height of mountain passes is 13,000 ft.
which is more than the near maximum observed in the case of
Dhauladhar range. Quite a large area on both sides of the
range is unsuitable for permanent occupancy or even seasonal
settlement. Its greater heights, expansiveness of rocky
precipitous slopes and snow waste make it a big vacant zone
of this region. It has proved to be not only a physical divide
but even a cultural barrier, isolating more effectively one
valley from the other. Its importance lies for the sources of
Beas, Ravi and many of their perennial tributaries flowing
through the region.

5. The Trans Pirpanjal Area:

This part of high Himalayas is typically mountainous
having intervening valleys at an altitude of 8000-10,000 ft.
above sea level. It is enclosed by the two great ranges of Pirpanjal on its south and greater Himalayas on its north, both merging into each other in northeastern part of Kulu. The relative relief in individual tract is nowhere below 4500 ft. locally rising even to 8000 ft., the highest in the whole region. The landforms are extensively glaciated in Lahaul towards upper portions of Chenab valley. The dominance of erosion in all tributary valleys and along uppermost reaches of the main river demarcates them as zone of no population.

The depositional features of glaciated landforms are observed in the form of morainic plateaux, lacustrine deposits, and river terraces mostly along middle reaches of the main river. But for these depositional features, these valleys of considerable relief would have remained useless for building up their cultural landscape. It is clearly noticed by the absence of any permanent human settlement beyond 12,500 ft. away from valley of the Chenab, even in tracts otherwise bearing a congenial slope. Behind the riverside morainic plateaux with 20-22° slope are steep, 26-29° of talus slopes of rubble ending in vertical walls of rocks. The clusters of habitations and almost a string of thoroughly irrigated agricultural blocks of land overlooking the deep river beds are observed as cultural landmarks amidst ruggedness of world's highest mountains all around (Diagram 4 of figure 6).

Downstream in Chambe-Lahaul portion of this area, as much of the river course is deeply carved, the valley becomes
RELIEF PROFILES AND LOCATION OF RURAL SETTLEMENTS

1. VALLEY OF UNDER SEINE VALLEYS (CHAMBA-CHURAM)

2. UPPER SEINE-BAIRA VALLEYS (CHURAM)

3. UPPER BAIR VALLEY (BAEAHOUR)

4. UPPER CHENAB VALLEY (LAHAL)

5. LOWER CHENAB VALLEY (PANG)

6. UPPER BEAS VALLEY (KULU)

7. LOWER BEAS VALLEY (KULU)

8. SOUTH KULU (CHICHOR-SEBA VALLEYS)

9. SUTLEJ VALLEYS (KASSO)

10. MID BEAS VALLEYS (JOGINDER NAGAR)

11. BEAS VALLEYS OF KANGRA

12. BEAS VALLEYS OF PALAMPUK

FIG 6
constricted with stupendous rise of the marginal mountains, the depositional formations are scarce in the virtual absence of congenial slope. A few riverside habitations are observed only at old sites of lacustrine deposits at places along the stream course. In the Pangi portion of this area more to the west, a slightly greater distribution of such strips along last course of Chenab river in this region makes them locally important for human occupancy. Along mountain sides, only small extent of mid slopes could be found suitable for wresting insignificant parcels of cultivable land, near which scattered and small hamlet groups are marked close to the lower margins of forests (Diagram 5 of figure 6).

The vast area along still greater heights, glacial slopes and a number of small-sized icy streams appears as a third vacant zone of Greater Himalayas to the north of the region, resorted seasonally by man for the value of its high alpine pastures.

B. THE DRAINAGE

As the valley formations falling in various drainage basins have patterned the hydrographic distribution of regional population and are marked by the greatest concentration of cultural features, the latter are readily-recognised as areal units of study. The human interest in the study of mountainous landforms highlighting the close underlying relationship between them and the life of man gets strengthened by making a cross reference to drainage.
The catchment areas of four of the five major affluents of Indus system are included in this region (Figure 5). It consists of the mountain course of Chenab (Chandrabbhaga), Ravi and Beas rivers. Sutlej forms the southeastern boundary and a small part of its basin falls within it. At about 32.20° N and 77.10° E., a knot of the mountains, close to the meeting point of outer and middle Himalayan axis, is observed. It separates the three river catchments, parting them by making them flow in three different directions. Almost half of the region falls into the drainage basins of Beas constituting the southern portion. Ravi and Chenab systems occupy the middle and northern latitudes, with Sutlej confined to a smaller southeastern slice of territory. In order of population, Beas and Sutlej catchments are most populous areas, that of Ravi ranking next, Chenab basin being the least populated.

1. **Chandrabbhaga River Basin**

   It comprises two main headstreams of Chandra, Bhaga and their combined river flowing for 150 miles at 7000-10,000 ft. altitude. Their course runs parallel to one of the highest mountains and grandest precipices from southeast to northwest direction in inner zone of Chamba and Lahaul. Arising close to each other, the two tributaries flow in opposite directions and take a full round of the triangular mass of snow and rock occupying the heart of Lahaul. The drainage of such a high-lying mountainous area is not wide-spread, with just four major
tributaries, all others nothing more than icy torrents after the snow melt. Only the major tributaries and the combined stream of Chandrabhaga have opened the way for movement of man and for human settlements. While the thin line of settlements separated by intervening chunks of unpopulated territory in the centre of this vast area of bleak landscape is marked along main rivers, smaller streams have supplied water heads for taking-out irrigation channels without which nothing could be grown in this dry area. 'Rangloï', 'Garh' and 'Pattan' in upper part of this basin are time-old subdivisions of Lahaul associated with Chandra, Bhaga and the Chandrabhaga river courses. In its westernmost part along downstream of Chandrabhaga or Chenab is another tract of inner zone locally known as 'Pangi proper'. The courses along river heads, because of great heights plus a continuous mass of ice and rock, are totally barren. It is the middle constricted part of Chenab (locally known as Chamba-Lahaul) which with its very few sizeable human habitations acts as a local buffer zone between, relatively populous and laboriously cultivated Lahaul and Pangi on its east and west respectively.

2. The Ravi River Basin:

Ravi is the river of Chamba valley proper, as almost the whole of its mountainous catchment area of 3100 sq. miles lies in this part of the region. The 100 miles long river throughout its inhabited portion flows mostly at a level of 3000-6000 ft. till it cuts transversely through the spurs of Dhauladhar towards, southwest of the region. As the basin spreads
along southern slopes of the middle range largely falling in
the rainshadow of Dhauka-Bhar with an average rainfall of
40-60", the spacing of streams is less close as compared to
their density to the south of the latter. A fairly long part
of these channels are deeper and valleys narrower except for
some distance along the central portion of the mainstream and
its major south-flowing tributaries. Consequent upon relatively
wider spacing of streams along the hillsides and their deeper
channels downslope, they have proved far less significant for
the gradational process and for irrigation as compared to the
streams of Beas basin. Upper Ravi valley in Brahmour is
unfavourable for intensive cultivation, is thinly populated
and is patchily settled mostly along mid-mountain flanks. The
two relatively well-settled and well-cultivated tracts consist
of an average 10-13 miles long 2 miles wide central portions
of Ravi and Seoul river basins ( the second one being the most
important tributary ) up and down their central places of
Chamba and Tissa respectively. The largest dendritic group of
Seul-Baire affluents of Ravi in Churah area of Chamba has played
a vital part in opening out the whole width of western part of
the region right from outer to middle Himalayas. The network
of these streams in Churah has made this part of the region
remarkably favourable for becoming one of the most intensely
populated tracts, as much as Kulu is in same latitudes in eastern
half of this study area.
River Beas is the life line of thickly settled outer Himalayan region. It has numerous valleys in Kulu, Mandi, Kangra and outer Chamba. In Kulu, it flows parallel to the mid-Himalayan ranges till it becomes a sizeable stream at about 4000 ft. at a distance of 40 miles from its source. At this southern end of the valley it takes two right-angled transversal turns cutting a very constricted course through southerly branch of Dhauladhar range. Besides the mainstream, two longer side valleys (20-25 miles long) on its east and south and half a dozen smaller (with 8-12 miles direct length) tributaries are important from human viewpoint. Generally speaking, longer the valley, greater the extent of depositional landforms throwing up more space for cultivation and settlement. At the same time as we move from rainier south to drier north of Kulu, with fall in stream density the ruggedness of landscape becomes bolder and the imprint of man's work is confined to the main river valley and its few major affluents. Along the whole course of Beas valley in Kulu and along middle reaches of large-sized tributaries, the most intensively cultivated and populated tracts are found occupying the depositional formations on either of the sides.

Towards Mandi section of Beas river generally at 2500-3000 ft. altitude, in place of its deeply grooved valley the denser network of six tributary streams from the south and
1. A string of tiny river-side plateaux distinctly set apart by steeper downstream and uphill slopes, have the greatest concentration of population in high mountains typical of Churah.
(Courtesy Himachal Pradesh Census Dept.)

2. The village of Tissa to the north of Chamba is fast growing into a small town with expansion of its functions in the depth of hill interior.
(Courtesy Himachal Pradesh Census Dept.)
four from north are more important for spatial distribution of cultural features. As the whole section falls in the rainier (60-80" annual rainfall) part of outer Himalayas, most of the streams are rainfed, become torrential during summers, many times destructive in their central portions but equally responsible for adding periodical loads of fresh alluvium. Uhl is the only important snowfed tributary but is far less significant for distribution of habitations, except in its relatively wider upper catchment.

The denser and meandering network of these streams has reduced the slope along the hill sides, has etched deep into the interfluves and has brought huge quantities of eroded material to central parts of valleys. A commonly noticed gorge near the confluence of tributaries with main river and a large number of interfluves have characteristically subdivided the area into a series of isolated glens, creating a mosaic of 'cul de sac' hollows between the hill ranges.

In southern part of the region, there is a land of countless number of perennial 'Khads' viz. hillside ravines of Kangra-Palampur area. The drainage consists of six main groups of these ravines having the largest number of their affluents, almost one after every 1-2 miles. Together they form a very dense hydrographic network in this rainiest part (100" a year) of the region. The generalized direction of flow is from northeast to southwest till they join Beas within
20 miles to south of the region are big sized, deeply carved tributaries. The level of the stream valleys at 3000-4500 ft. at the foot of snow-clad Dhaula-Dhar, maximum amount of stream dissection and small size leading to easy manageability of their water have favoured the thickest distribution of rural settlements. The maximum closeness of the streams carrying a great excess of water during the peak rainy season making them partly destructive and partly aggradational is witnessed in middle part of Kangra-Palampur valleys. Here they imperceptibly merge into each other forming an apparently continuous, partly levelled and partly undulating valley plain, 32 miles, from northwest to south east and 8-10 miles from northeast to southwest. This remarkably wider plain has proved most favourable for an equally close-spaced distribution of habitations dotting the countryside amidst most intensive cultivation of land in the whole region. The central portions of the valley are the hub of rural settlement. The rugged mountain front to the north and low barren hillsides to the south, although lose much of their demographic significance, yet supply perennial water within short distances and impart a distinct physical and cultural setting for life in this area.

A small group of four tributaries of Beas, on an average 8-10 miles long sweep along southwestern terminal spurs of Dhaula-Dhar describing a thin line of separation between Ravi and Beas drainage basins. Three of them form a combined stream of Chakki which drains two-thirds of Bhattiyat tract of Chamba.
to the south of Dhaula-Dhar range. By the time they reach their middle courses, they become very closely-spaced in this 60-80" rainfall zone. In these parts, 2-6 miles longitudinal course makes them look like sizable hill torrents. Over these the valleys, most thickly settled few making it possible to use the maximum of their water and alluvial deposits. Their greatest human significance for local rural settlement clearly corresponds to gradation of valley slopes, alluvial filling of the basins, collection of waters and their suitability for providing irrigation.

4. Sutlej Drainage Basin:

River Sutlej forms the south-eastern border of this region and a group of some six important streams, each 20-30 miles long arising from eastern terminal ranges of Dhaula-Dhar. Flow north-southerly across the area. Their valleys 1-2 miles broad and 4-6 miles long in upper-middle portions at 3500-5500 ft. ASL are the widest, unlike their narrow course (having a number of waterfalls) in the lower-middle reaches. Their short longitudinal courses in central tracts where the main streams are only 3-4 miles distant from each other have achieved a medium density of hydrographic net in an area experiencing 40-60" yearly rainfall. It makes these parts thickly dotted with hamlets keeping close to the alluvial strips, but 1-2 miles away from the river sides. In contrast the land along the lower reaches is relatively bare and rocky and streams deeper, that along valley heads considerably forest-clad. In the same order, the settlement although scattered, has more or
or less an even spread over the hilly terrain in south and
is found readily suitable for extending the human use of
forest clearings in the north.

C. THE CLIMATE

The great diversity of physical features ranging from
low hills to very high mountains has led to considerable contrasts
in temperature and rainfall conditions. On the regional level, the
areas in the south are warmer, those in the middle or along
mid elevations of mountains are mildly warm in summer and cool
in winters and those in the north or along higher elevations
have short summers and severe, cold winters.

The monsoonic rainfall of the summer season experienced
in the south gradually changes as far its intensity and pattern
towards the interior or higher elevations. Ultimately the mon-
soonic influence completely disappears to the north of Pir
Panjal and towards tops of high mountains and precipitation
is largely the result of high level winter storms.

In such a region, temperature is the primary element in
determining its habitability by marking out the absolute limits
beyond which human settlement is impossible. The permanent
snows on high mountain ranges from 14,000 ft. above as a
consequence of sub-freezing temperatures have left them
completely uninhabited. The high areas, roughly from 12,000
to 14,000 ft. have such temperatures as are suitable only for
growing of grasses at favourable sites and are found of some
3. With the backdrop of Pangí range (Pir Panjal) in Churah, the flat-roofed and tiered houses along the slope (Devi Kothi village) leave much of the gentler terrain for scarce cultivation. (Courtesy Himachal Pradesh Census Dept.)

4. Such steep edges along Chenab river and precarious bridges are typical of Pangí (inner zone). The few settlements are often seen perched above, (elevation more than 8000 ft.) midway between forests and the river. (Courtesy Himachal Pradesh Forest Dept.)

5. The houses of the dwellers in a Kulu village (High Himalayas) with steep, forested or bare rocks in the background and a patchy cultivation below the site. (Courtesy Himachal Pradesh Tourist Dept.)
human use just for a few months in summers. From 12,000 ft. which is the last limit of settlement in this region down to 10,000 ft. there is a mere sprinkling of population at a few places, the general temperature conditions favour it only in localized strips in the valleys. Within individual tracts, it is a particular aspect of slope which makes temperature responsible for the location of human habitations, eastern aspect is generally chosen and northern always avoided for construction of houses.

Lower we descend, greater becomes the role of precipitation in influencing relative habitability of areas within local tracts. While the study of temperature conditions is essential in finding out the last frontiers of settlement, that of moisture conditions helps to mark out the areas more favoured for the life of man within the extreme limits of human occupancy.

For this reason, the relevant description of temperature distribution is to be undertaken in the first instance as a primary determinant of life conditions in this mountainous region. The areal variations of precipitation come next as an important factor in influencing the productivity of land under various uses.

**General Temperature Conditions:**

There is a considerable variation in the distribution of seasonal temperatures as a result of elevations above mean
sea level ranging from 2000 to to 20,000 ft. and varied forms of relief comprising ridge-spur tops, valley bottoms and hillsides with different aspects.

### Table 1

**Summarising the Seasonal Distribution of Temperatures**

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<tbody>
<tr>
<td>1. Keylong (10387)</td>
<td>Inner zone valley bottom</td>
<td>14</td>
<td>5.9</td>
<td>-3.5</td>
<td>4</td>
<td></td>
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<tr>
<td>2. Kilar (3411)</td>
<td>-do-</td>
<td>16</td>
<td>14</td>
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<td>3. Manali (6275)</td>
<td>Mid-zone valley head</td>
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<td>14.6</td>
<td>9.9</td>
<td>13.2</td>
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<td>4. Katrain (4800)</td>
<td>-do- valley bottom</td>
<td>21.6</td>
<td>14.6</td>
<td>7.3</td>
<td>14.9</td>
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<tr>
<td>5. Kulu (4500)</td>
<td>-do-</td>
<td>25.8</td>
<td>17.5</td>
<td>11.9</td>
<td>20.2</td>
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<td>6. Chamba (3027)</td>
<td>-do- low valley bottom</td>
<td>25.4</td>
<td>17.6</td>
<td>11.1</td>
<td>19.0</td>
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<tr>
<td>7. Dalhousie (6000)</td>
<td>Outer zone ridge top</td>
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<td>14.0</td>
<td>8.5</td>
<td>16.5</td>
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<td>8. Dharmsala (4500)</td>
<td>-do- spur top</td>
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<td>17.0</td>
<td>9.4</td>
<td>17.0</td>
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<td>9. Brot (6000)</td>
<td>-do- valley head</td>
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<td>10.9</td>
<td>7.5</td>
<td>13.5</td>
<td></td>
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<td>11.0</td>
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<td>11. Mandi (2500)</td>
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<td>18.4</td>
<td>12.5</td>
<td>19.5</td>
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</table>

**SOURCE:** Records of Regional Meteorological Centre, New Delhi, 1962
A careful examination of the table and temperature map (Fig. 7) indicates that the average temperature of summer months falls by about half on proceeding from low-lying outer valleys at 2500 ft. to higher areas situated in the inner zone at over 10,000 ft. altitude. During rest of the year, the temperature in the latter is about 17°C lower as compared to the highest obtained in outer areas. Thus the areas situated to the north of Dhauladhar and Pir Panjal ranges remain relatively colder than the areas to their south. Altitudinally the temperature regime is sub-tropical upto about 3000 ft., a blend of tropical and temperate till-we-reach 5000 ft., cool temperate upto 7000 ft., cold temperate at heights reaching 9000 ft. and closer to Tibetan type above. Within local areas, the vertical decrease in temperature is relatively lower in winters than in summers, greater on south facing slopes than on northern slopes. While summer temperatures are higher in low-lying outer valleys than the places situated on ridge tops or along valley heads, for many days in each winter, there is a temperature inversion in valleys depending upon configuration of the ground. Nearness and their orientation to snow ranges and high mountain passes turns them windier, sharp convergence of slopes casts long shadows across them, both causing a fall in temperatures of such valleys. Thus the highest mean maximum as well as the greatest mean minimum are recorded in valley bottoms in different local areas.
The distribution of temperature from lower to higher and from outer to inner areas and its inversion experienced seasonally in valleys decides the amount of available solar heat and the duration of low critical temperatures. They go to determine the length of agricultural season and the duration of growing period. Longer the duration of mean temperature of $2^\circ C$ below which nothing can grow at all, shorter the growing period. In inner region of Pangi-Lahaul (with an average of 6 months below $6^\circ C$ temperature) the period for growing crops is reduced to 120-210 days in its different parts. Two short-season crops each of about 100 days duration are obtained only in its lowermost valleys. In rest of the area 120-180 days are available for getting one crop a year, the actual length depending upon the nature of crop, altitude and temperature conditions of different local tracts.

The period of agricultural activities lasts for almost whole of the year in warmer areas of the outer zone but its duration is cut to 250-270 days in its colder parts and at places over 6000 ft. high. The winter crop is sown in some higher areas of Lahaul-Pangi, Brahmuir and mountainous villages of outer zone if the snowfall is not earlier, and the required time for sowing is available after harvesting the summer crop. The plants once sown remain dormant under the winter snow and catch up rapidly after its melting in spring season. In the same way as the temperatures below snow layer
remain considerably higher than upon it, the farmers of such areas hasten its melting on the eve of spring season by putting sawdust or dry clay upon it. They do it as the temperatures are otherwise favourable for sowing the crop of short summer season. Where snow melts relatively earlier as in lower valley of Lahaul, two crops, one from April to July and the second from July to September end are obtained during the summers.

**Table 2**

<table>
<thead>
<tr>
<th>Name of the Region</th>
<th>Average annual rainfall (inches)</th>
<th>Percentage of Summer rainfall</th>
<th>Percentage of Winter rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Outer valleys</td>
<td>65 to over 105</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>(southern latitudes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Middle valleys</td>
<td>25-65</td>
<td>63</td>
<td>37</td>
</tr>
<tr>
<td>(central latitudes)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Inner valleys</td>
<td>less than 25</td>
<td>39</td>
<td>61</td>
</tr>
<tr>
<td>(northern latitudes)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SOURCE:** Summarised from the Meteorological data of the areas included in this region.

With well over 100" of rainfall in areas to the south of Dhauladhar and 25" in areas to the north of Pir-Panjal, 40-70" experienced over greater part of the region, the areal disparity is at once very great. There is a reduction of 40% of summer rain and four times increase in winter rain in the same direction. With overlapping of monsoonal and non-
monsoonal influences to north of Dhauladhar, rainfall of winter and spring seasons parts assuming greater proportion. The annual snow-fall within the populated part of Dhauladhar region is normally 3-6 ft.; it increases from 6-12 ft. in the middle valleys to 8-18 ft. in trans-Pir Panjal villages.

Thus varying amounts and patterns of annual, seasonal and local rainfall are marked only within two degrees of latitudinal and longitudinal extent of the region (Fig.8). The two Himalayan ranges one after another exercise the major blocking effect on moisture-laden winds of India’s summer monsoon. Four about 45 miles east-westerly from Dharamsala to Jogindernagar along southern slopes of Dhauladhar, runs the rainiest belt of this region from where it goes on decreasing concentrically in all directions. Over a straight distance of 10-15 miles, a reduction of 50% is noticed in the rainshadow of these ranges. During winters, the high mountain passes in such ranges remain snowbound for about half of the year, keeping the valleys on opposite sides disconnected for all practical purposes.

Besides the elevation of a place and its overall situation in respect of the direction of mountain, the distance from snow range, the nature and aspect of slope, length, breadth and the section of valley (viz. greater trapping of clouds along valley heads and local drought in deep constricted parts) play their part in determining the final distribution of rainfall. The rainfall diversities have given rise to mosaic
of land use patterns, forestry, agriculture and pasturing, influencing human activities all over the region. In southern parts of the region receiving 85% of rainfall during summer monsoon season, there has been a greater need of irrigation during winter half of the year for raising 'Rabi' crop, during drier part of summers to obtain higher yields and possibly larger acreage under rice. In northern non-monsoonal areas, the security of crops is to be insured differently. As the summers are dry in most parts, irrigation becomes a dire need there too even for growing grasses. This has given rise to almost 100% cultivated area put under irrigation in Lahaul section of the study area (Fig. 9).

The locally greater rainfall received along valley heads helps in a richer growth of trees and grasses while the agricultural crops are more in the need for sun. The deep defiles of river valleys, at the same time, suffer frequently from droughts.

The micro-climatic phenomena like fog, frost and hail are noteworthy for their intensity in specified tracts and for their effects upon crops. The ground configuration and temperature contrasts of surrounding air and land-water surface in Mandi valley at the close of a good rainy season in summer results in formation of fairly thick fog. Its persistence serves as an insurance against the risk of slightly delayed winter rains. The grasses and crop depending upon rain do not wither easily. A drier spell in rainy season, on the other hand, is followed by mid winter frosts particularly in interior
valley of Kulu experiencing shorter rainy season. The zone along mountain fronts of Dhaula-Dhar particularly in Kangra and Seraj (south Kulu) and of Pir-Panjal in Lahaul are known for their highest frequency of hail. The approach of the hail zone limits the profitable maturing of fruit trees in areas where all other conditions for raising orchards are congenial.

Climatic Regions

By taking stock of temperature and moisture relationships, the following types of climatic regions are identified in the area under study (Fig. 7 and 8): (i) The wet sub-tropical climate characterised by warm and fairly wet summers and very mild winters is observed to the south of Dhaula-Dhar between 75°50 to 75°55E longitude covering about 18% area of the region. (ii) The humid temperate conditions with relatively mild winters and summers with an increase in the tendency of winter precipitation are marked partly in valleys to north and partly towards southeast along Dhaula-Dhar and its offshoots, roughly consisting of another 12% of total area of this region. The above two types of climate are found most favourable for plant growth and for the largest number of people dependent upon them. (iii) The cold moist temperate is known for its very mild, slightly less wet summers, moderate rain, fairly cold and snowy winters. The snowfall during winters is heavy and more frequent. About 35% area of this region has this climate mostly including the middle Himalayan
valleys at 4000-7000 ft. height and mountains still higher. Such conditions tend to be more suited for horticulture, the growing of cereals proves rewarding only where peasant can resort to irrigated cultivation on favourable slopes.

(iv) The cold dry temperate climate is met fully in inner areas of Pangi–Lahaul and partially in parts of Baramour, Kulu and Banghal tracts, forming 35% area of the region. It has the lowest average temperatures, annual range lesser than the diurnal, summers largely dry (particularly in Lahaul), winters severer, recording 12-18 ft. of snowfall on an average. This climate has put great curbs on man’s efforts to draw sustenance from land, so much so that the possibility of difficult irrigation becomes a dire need for the existing farming population.

D. VEGETATION

The region is noted for a striking diversity in distribution of vegetation caused by varying altitudes, natural conditions as well as by biotic interferences. Below 5000 ft. the vegetation is generally in a bad shape as cultivation has overpowered the larger forest blocks and indiscriminate grazing has reduced a considerable area to scrub growth. From 5000 to about 8000 ft. altitude, there is a great competition between agriculture and forestry, much of the soil is suitable for both; and an insufficient area under cultivation results into greater
dependence of people (roughly 1/3 of the total population of this region) upon forests. Patches from partially demarcated forests situated on convenient slopes are being reclaimed for raising crops and orchards. Above 8000 ft. as the forests mostly occupy difficult ground, they lie protected, also because the needs of lesser number of inhabited villages in their neighbourhood are not excessive and there are only passing encroachments during summer grazing season near their upper margins. This management of vegetation has affected the expansion and history of settlements, resulting into clear emergence of main, partially and seasonally settled zones respectively (Fig. 10).

The distribution broadly follows the well-known altitudinal zonation making it apparently similar both in the lower and higher Himalayas at corresponding altitudes. But both on account of marked variations in annual precipitation and temperature on different heights and aspects of mountain slopes, the spread of vegetation in local areas becomes highly diverse as far the nature and intensity of different species. Its distribution comes lower on northern exposures and rises on warm southern slopes. Locally the arid, hot, cold or humid phase of climate as determined by the nature of rock and slope sets limit to a particular distribution. Thus the actual appearance becomes dissimilar on opposite sides of river valleys with a change in aspect, slope and the bedrock. These local expansions and limitations of vegetation are worth noting for making a fair degree of coincidence with the lines of human settlements.
The biotic interference by man is visible in the form of park type of grasslands with a few trees (climatic grasslands reportedly few), scrub, overgrazed degraded forests and prized conifers replacing the oaks at various levels. On the one hand, it has been caused by demographic pressure multiplying the need for grazing grounds and cultivation. On the other hand, it has been the policy of Forest Department to grow more of commercially valuable pines in place of natural oaks in all suitable localities. It has created a problem for the life of hillman by disturbing the ecological conditions, the water balance, cutting short the multipurpose locally useful oak tree and leading to badly eroded hillsides at a number of places.

It is of our interest to understand the following macro-zonal arrangement of vegetation on the basis of height and climate as far as it has influenced human activities in various areas:

1. **Vegetation in Outer Zone:**

Here the vegetation consists of scrub, deciduous trees in low-lying cultivated tracts, more numerous where hillside forests are far away and pines occupying fully, partly as well as poorly demarcated blocks. Between 2500 to 5000 ft. in subtropical rainy climate, hill bamboos are found in depressions, scrub type of vegetation is interspersed between shrubs and low-level deciduous trees. The scattered trees and an open undergrowth of brushwood species create what we call a low level tree scrub sub-type between 1500-2500 ft. Much of the
cultivable scrub has already been put to plough and what is left over is barren waste used for rough grazing. The bamboo grows more profusely in the relatively rainier parts of Kangra-Palampur and because of its many uses, it is metaphorically considered to stand by man when all relatives deny their help. This along with other trees around habitations supply numerous domestic needs of people and fodder for the cattle.

'Chil' (Pinus longifolia) is the only important subtropical pine which is suited to cooler northern aspects at lower heights and on all aspects at higher elevations within the zone. Although it grows throughout the region to the south of Dhaula-Dhar between 2500-5000 ft., its best growth is observed between 3500-4500 ft. above mean sea level. As it is the least exacting of all Himalayan conifers, though prefers well-drained sites, valued more for extraction of its resin than for timber, its acreage has gone on increasing. The biggest benefit of these forests has been the supply of seasonal jobs to the local people in resin extraction work. At the same time the large-scale replacement of oak by this pine towards upper margins of 'chil zone' is reported to have adversely affected the undergrowth of grasses and replenishment of underground water supply in its belt.

2. Vegetation in Middle Zone:

In this part of the region, the subtropical deciduous trees are found greatly mixed with semi-temperate types in valleys
and numerous pines of commercial importance occupy different belts along the mountain sides, till a parkland appearance of grasslands beyond the tree limit is marked. Within the altitudinal range of 5000-9000 ft., climate becomes temperate with milder summers, cooler winters, moderate rainfall, greater and longer snowfall during winters. In the intervening valleys in place of bamboo, willows and poplars are frequently seen along water courses. Along hillsides, broadleaved maples, chestnuts, elm and oaks occupy the lower slopes and depressions, merging with valley vegetation towards low margins and coniferous pines towards their upper edges. This pattern of distribution is observed widely all over the higher parts of outer zone in areas to the south of Pir Panjal range.

Below 7000 ft., white or 'Ban oak', around 7000 ft. green or 'Harhu' oak, and near the tree limit of 9000 ft. 'Kharsu' variety of oak is found. The last one is more xerophytic, while the first two varieties are mesophytic in nature. Thus oaks of different types are characteristic of different altitudes and stand as the climax vegetation of this zone. They occupy a very important place in agricultural economy of the villages, being a chief source of fodder in winters, serving as an excellent fuel and wood for making agricultural implements. The oak forests are considered to be conserving the supply of underground water in springs, keeping them perennial throughout the year.

Deodar (Cedar), Kail (Blue pine), Silver fir and spruce are the prized conifers of the Himalayas occurring at the same altitudes as the oaks, as they have replaced the latter on all well-drained, sunnier and the colder sites. The mixed distribution
of the four conifers is the result of their varying individual demands. The cedar chooses the best sites from the point of drainage, sun and light; the blue pine taking up cooler, moisture and exposed windy sites; and the spruce and silver fir occupying colder, drier and shadier places; the last are frequently above 8000 ft. above mean sea level.

As the soil under deodar is equally suitable for cultivation and many of its forest blocks in Kulu were once under plough for growing agricultural crops, there is again a temptation to encroach on its forests near the villages for cultivation. Because of this competition and heavier felling, the past, its distribution is seen generally interrupted, scattered and growing singly or in small groups along the crests of spurs and ridges throughout the outer region from Chamba in the west to Kulu-Serej in the east.

The spruce and fir forests are relatively less exploited so far because of their more inaccessible locations, lesser timber value and greater potential for manufacturing of paper pulp. These forests are, therefore, better stocked. Their wood has found a ready use in the making of boxes for packing fruits near the orchard areas and in meeting domestic needs of people living at higher altitudes.

3. Vegetation in the Inner Zone:

Towards the inner areas of higher Himalayas, there is a rapid increase in general scarcity of trees because of arid conditions and a few pine species are seen occupying very small compact blocks along middle mountain slopes.
The areas are marked for having extensive alpine grasses scattered at various levels amid mountain wasteland. Near village habitations, people plant the useful willows by necessity, and nourish them with care. To south of Pir Panjab at heights ranging between 9000-11,000 ft., the 'Kharsu' (i.e. high altitude variety of oak) is seen merging with moist alpine scrub along its upper and spruce-fir forest along its lower margins.

The moist alpine scrub consists of matting colonies of trees and bushes adapted to heavy snow at this altitude. Its counterpart below 9000 ft. forms intervening glades of grasses amidst forests. It is called moist temperate scrub, and appears as thatch parkland within the forest zone. These scrubs are used for grazing of animals during the summers.

To the north of Pir Panjal in Pangi-Lahaul and in some interior parts of mountains, to its south as in Brahmoor, Bare Banghal and Eastern Kulu, the drier regime of temperate climate with severer and longer winters, short and dry summers is experienced. Lahaul basin of Chenab river is exactly typical of such rigorous conditions and dry temperate vegetation. In parts there is a slower growth of deodar and vigorous flourishing of Blue-pine mixed with spruce-fir or replaced by dwarf conifer like pencil cedars and birches near 10,000 ft. limit.

As the conditions suitable for plant growth are found within a few localized areas or sites within small blocks of territory, the distribution of forests is confined to narrower
zones or compact blocks in contrast to the pattern observed to the south of Pir Panjal. Lahaul is deficient in trees because of greater aridity, very low temperatures during winters, severe winds and avalanches scrapping off the loose soil. But Pangi has greater number of trees over one third the area of its compact blocks as compared to similarly placed forests in the outer zone.

Besides natural handicaps, the growing fuel needs of man have depleted the slow-growing but fairly thick forests of pencil cedar in arid Lahaul within last 100 years.

The significance of plant cover in these parts of the region is more for conservational and developmental purposes than for commercial needs because these areas suffer from scarcity of vegetation or inaccessible location makes the exploitation of forest wealth difficult.

4. Vegetation in Alpine Zone:

From 11,000 to 14,000 ft. altitude, the glades of dry alpine scrub among extensive bare rocks are visible everywhere in the region. The final limit of tree growth is marked near 11,000 ft. or a little above. It is the realm of alpine grasses frequented largely by the hordes of local and foreign graziers during summers.

These are found at various stages of erosion with mishapen or lopped trees near their lower margins. It is the cold desert flora of higher Himalayas comprising open patches
of various sizes of dry alpine, dwarf and trailing scrub, xerophytic in character. The terrain is inaccessible, available either for summer grazing or for digging of medicinal herbs. The upper margins of these high-level pastures are marked by permanent snow, glaciers and rock-waste along the tops of main mountain ranges.

E. THE SOILS

Regional Characteristics:

The soils varying greatly within local parts of the region influence the patterns of agricultural occupancy and spatial distribution of population. In localities of nearly uniform climate, landforms and accessibility, the variations in soil characteristics correspond to great local variations in land use and population density.\(^1\)

As soil is resultant of the influences of various environmental factors and large agricultural population depends upon it, it exerts the most primary influence on distribution of region's rural population. Wherever the minimum depth of cultivable soil is available, whether in extensive strips or small parcels, it has been occupied forming a nucleus of human settlement. Rain or snowfall being normally good, it is primarily the soil and only secondarily the irrigation which has always led to locally higher densities of farming population.

The soils of this region are generally young mountain soils, their profiles changing as soon as the grade of slopes is affected by a change in natural factor of site or by the

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action of man's indiscriminate use of soil complexes. Broadly two soil types are met with throughout the region: (i) Residual soils of plateau and spur tops, hills and mountain sides (ii) Transported soils of valley bottoms.

(i) The Residual Soils: These marked on scarp slopes of the sub-Himalayas and on outer Himalayan spurs, partially residual diluvium is observed on plateau tops (remnants of old deposition) situated between ravines and along the foot of bordering ranges.

These soils are generally coarser, soon becoming thin and shallow on approaching the hills and bluffs along streams. These are agriculturally poor also because of little irrigation available. Forest growth upon them is better, but under pressure of population and inadequacy of cultivable area, they have been put to plough all over the region.

(ii) Transported Soils: What was initially the stream alluvium, rock screes, landslides and glacial moraines, has gone into the mature category of transported soils where they have developed sufficient depth at a favourable site under congenial conditions.

Such alluvial or fluvio-glacial soils within the settled zone are observed on valley flats or riverside terraces, but they nowhere conceal the character of the original rock material from which they were once derived.

This soil is the deepest in centres of valleys and of mountain depressions and thinner outwardly. It is the most fertile soil of this region and is everywhere equally.
rewarding for the practice of intensive cultivation provided irrigation is supplied. Thus the depth of soil formed under paramount control of topographic and climatic factors in downfolds and mountain depressions, its fertility maintained or improved by man's labour in manuring and irrigating it have supplied the cultivated area as a major source of subsistence.

Soil and Hill Man's Struggle

As the regional distribution of cultivable soil is both uneven, insufficient and critically placed, man in the hills is under compulsion to constantly direct the process of soil erosion and soil changes. For instance he has to adopt terracing of fields and suitable agricultural practices. The erosion and deposition of soil goes on simultaneously on every hill slope and it is he who is to maintain a balance between the two, for keeping the grade favourable for its accumulation. Although erosion on the one hand needs to be sufficiently advanced on the hillsides to enrich the soil elsewhere at a favourable site, it has to be suitably directed in the interest of farmland.

For instance the useful modification of site by man in the form of terracing and fruit cultivation on pedo-elic soil of coniferous forests has checked the erosion of its thin layer and has changed it into successfully ploughable brown forest soil of high hill zone. Wherever the coniferous forests have been encroached upon in the vicinity of villages within 6000-8000 ft. zone under great pressure of population or of raising
orchards, this change has proved significant in encouraging human settlement, raising population density and bringing about a dispersal of population. It is particularly observed in the middle valleys of Kulu-Seraj, Churah and Chamba. Thus soil erosion is encouraged by too great and too low pressure of population. If its rate increases excessively, say by 1.5 to 2.5 times, the formation of soil and land slips is the result. The cultivable soil is lost and a great strain is put upon the people's major source of livelihood. The slipping, sliding and sheet erosion of soil is particularly noticed in two types of areas of the region: (1) Along southern mountain front of Dhaula-Bhar and its terminal spurs marked by boundary faults, heavier rain and excessive grazing; (ii) Snow erosion at higher elevations on the eve of quick spring melting of snow or avalanching off the slopes carrying loose soil.

On middle elevations around 9,000 ft., the banks of wet snow (the one falling mixed with rain or on wet ground) prove more dangerous in scraping off potato fields at the time of thawing.

The menace in these belts becomes calamitous in years of abnormally heavier rain when natural drainage becomes incapable of clearing off the run-off or very late snowfall mixed with rain is followed by quicker thawing.
The following regional classification of agricultural soils is attempted on the basis of altitude of the area and its climate especially the precipitation. As there is no scientific classification available for the whole region, the traditional variations recognised in local areas and the assessment of land quality have been used to discuss the spatial distribution of soils.

1. **Low Hill Zone Soils**: Average elevation 1500-2500 ft. ASL. Average yearly rainfall 50-70 inches.

These are marked along extreme southern margins of the region occupying hill slope depressions and tiny spurs situated between ravines. The clays and sandy loams of this type suffer from intense leaching during rains, the cracking and drying up of soil moisture during hot season. This makes them far less productive and cultivation of marginal value is practised except in localities achieving relatively greater soil depth.

The soil along these low broken hills presents a marked contrast to that of the outer valleys to north of the area. The water channels are deeply carved, irrigation almost non-existent, wasteland increasing one and a half times, cultivation decreasing by 50%. Such unfavourable soil-water conditions have made these margins as areas of thin to moderate population.

2. **The Soils of the Mid-Hill Zone**: Average elevation 2500-5000 ft. Average yearly rainfall 50-100 inches.

This regional soil group is most widely distributed in and around central portions of all major valleys on both sides
of Dhaula-Dhar range. The disintegrated rock material has been carried away to the valleys by hillside glaciers in the past, by occasionally dammed water courses, the present day 'Khads' (ravines) and series of land slips along the boundary faults. While the fertile alluvial loams are the same everywhere, the diluvial action of streams in rainy season has not only broken the continuity of soil blocks but has also affected their maintenance in the vicinity of ravines. It is not so much the ingredients of soil which make it significant as its relative location, suitable slope, quantity and quality of irrigation and labour of man in keeping it up. In the interior valleys of Kulu and Chamba, the depth of soil becomes lower except along the river strip and soil differences are far less striking as compared to the outer valleys. It is left to irrigation to enter largely in raising their productivity in local areas.

For these reasons, in all schemes of traditional classification, the soils are divided into many grades of 'Ropa' (Irrigated) and 'Bathal' (Unirrigated) in Kulu-Seraj, 'Ek-fasli and Do-fasli' (single and double cropped depending upon irrigation available) and 'Behand Banjar' (barren unirrigated, cultivated after intervals) in Kangra, 'Otar' (unirrigated) and 'Kuhli' (Irrigated) in Chamba. At once the minute changes in distribution of irrigation in different parts of valleys suggest the productivity of soil for agriculture and its value for the settlement of agricultural population,
As we move from the centres of valleys towards bordering ranges, the land becomes uneven, less irrigated generally and finally full of angular fragments of rocks washed down from the slopes with little clay or silt contents. What is 'Maiden Kuhl' (level irrigated) goes on changing into 'Oti Kuhl' (uneven irrigated) and finally 'Gaggal Kuhl' (stony irrigated) around the fringes of valley.

As for the unirrigated land, 'Maiden otar' (level unirrigated) marked on plateau-flats, changes into 'Oti-otar' (uneven unirrigated) and in the long run into 'gaggal otar' (Stony unirrigated) along peripheries of bordering mountain ranges.

This change in soil distribution invariably related to irrigation and site factor, is everywhere reflected in spacing, scattering of human settlements, density of population, intensification and productivity of cultivation.

It is equally worthwhile to note that where the irrigation water is drawn directly from a nearby snowmelt stream, the location of soil with respect to the section of irrigation channel becomes a side factor suggesting its productivity. It is reported from Kulu-Seraj that the irrigated soil of the first order is marked along the central part of irrigation channel where the quantity of water is sufficient and as it has become less cold by the time it reaches there, its quality is rated high. The water supplied near the head of irrigation channel is much cold, and the soil irrigated is
considered of the second order. The quantity decreases much along the tail end of the channel, for which reason the land although irrigated suffers in crop-productivity.

All irrigated soils are transported, renewed from year to year to some extent, possess good drainage even if it is full of stones and retain the youthfulness of alluvial group. The unirrigated soil is largely residual in origin, found on plateau terraces over looking the valley basins. It is particularly true of Chamba where this soil is not renewed, is pure deep clay, sticky when wet and stiff on getting dry.

Thus, while the great development of transported valley soils has made all these parts as the most populous zone of this region, their significance for the life of man and for distribution of population is directly proportional to the degree of evenness of land and and indirectly to the limits to which it could be put to irrigation.


Next to the mid hill zone at higher elevations in all inhabited areas, this group of local soils is largely represented along Dhaul Dhar and its subsidiary ranges towards upper parts of valleys. The soils are primarily related to the chief type of rocks than to the regional climate and are shallow overlying the metamorphic or old sedimentary rocks. They are heavily strewn with boulders negating the effect of fairly levelled—
surfaces wherever these are found. During excessive rainfall, they get easily eroded and the slope is conducive to soil wash or mud flows. At the same time they are significant in enriching the mid hill zone soils downwards in many contiguous tracts. As the valleys are generally narrow, the middle slopes of mountains at this altitude assume greater significance for distribution of soil patches and settlements of hill farmers. Towards higher margins of this zone the small blocks of soil reclaimed from nearby forests are marked by change of forest to agricultural land use. Besides slope and depth of soil, the influence of change in aspect on it is especially noteworthy in these highland tracts. The sunny slope is best in the wet period and for winters, and the shady one in drier periods for amelioration of soil. Above 7000 ft., the soil tends to become unproductive, stony, crops poor, and unvaried from year to year. In order to get best advantages from the patches of cultivable soils scattered at various levels and along different aspects of slope each with a different degree of fertility, the peasant tries to have a part of his fields cultivated at more than one site. This helps him in being mindful of minute changes required in adjusting cropping practices with maximum of natural advantages. The combined result of these measures has made it possible to have extensive cultivation and a fairly widespread habitation of soil localities. Yet the man has to fight periodically against the movement of erosive masses, easy depletion and limited productivity of high hill soils.
4. Arid Cold Zone Mountain Soils: Average elevation above 7500 ft. ASL. Average rainfall less than 35 inches with snowfall lying for greater part of the year.

The high mountain soils of this type are observed at 7500 to 10,000 ft. altitudes mainly to the north of Pirpanjal range, partly to its south in the tract enclosed by the boundaries of Kulu, Lahaul, Brahmour and Mandi in central part of this region and locally elsewhere. Despite slow decomposition of crystalline parent rocks, cultivable soil is relatively deeper and fertile along mid slopes towards lower margins of mountain forests in lower reaches of Chenab to the west of 76°40' E. longitude and uppermost valleys of Ravi, Uhl and tributaries of Beas arising from inner Himalayan ranges. One comes across the isolated pockets of local population on such sites situated midway between forests and deep river beds. Above 9000 ft. in this belt the mountain soils are easily scraped off the slopes, becoming an intermixture of everything making them poor and far less distinct as agricultural soils. They remain under snow for about seven months particularly in Chenab basin. Ice action is not at all efficient in sorting out the rock material and that of the running water is insignificant because of deeply grooved streams and low rainfall.

The soils of Chenab basin to the east of 76°40' E in Lahaul valley are marked between 9000 to a little over 10,000 ft. elevation on plateau terraces along main streams of the area. These are increasingly glacial in origin and morainic in nature.
An incomplete decomposition of the material within 1.6 ft. deep undisturbed horizon (called 'alpine swards' in Lahaul's Forest working plan) filled with grass roots, lichens and mosses has supplied the thin upper stratum of earth.

The melting of glacial ice, gradual change in area's climate and succession of vegetation resulted in the slow emergence of fluvio-glacial deposition stretching far beyond their present limits in Chandra and Bhaga valleys. It is reported that a major part of the soil formed on these alluvial riverside flats, detrital fans and slopes has since been washed away. The rushing waters and streams keep them on the move especially during the process of snow melting. Being light and coarse sandy loam, the soil is easily subjected to gully formation or sheet flows. Sometimes whole fields are swept clear during the process of thawing. Besides rapid snow erosion and soil wash, the severer wind in summers and autumns rob the finer loose soil particles from the bare patches. The multi-sized strips of cultivable soils at places combine into a string of riverside plateau flats, the depth of soil becoming greater in their centre away from the piles of rubble along the foot of marginal mountains. These have made the life of man possible in such cold and arid valleys of inner Himalayas.

Whereas the soil is relatively deeper and the stone admixture is less, as much of it has been brought to plough as could be supplied with much-needed irrigation. The centres of deep soil and of denser population of the area, confined to the riverain zone of Lahaul, are literally co-terminus to each other.
SUMMARY AND CONCLUSIONS

The altitude and pattern of landform as products of geomorphological history have initially determined the scope of human occupancy in this young mountain region. In view of great diversity of landforms, human responses have achieved varied results in its different parts. With increase in the roughness of land, degree of slope and of relative relief in local areas, the spacing of human settlements becomes uneven, agricultural suitability of land limited and the attraction for a denser distribution of population is dispelled. The parallelism of central axis of greater Himalayas in the north, of Pirpanjal in the middle and Dhaula-Dhar in the south is most well-marked dividing the region into inner, middle and outer zones of higher and lower Himalayas respectively. It is such a distinct division both on the basis of relief and corresponding drainage basins of Chenab, Ravi Beas and Sutlej that it goes to form the broad framework for the spatial study of many attributes of population.

From low the high Himalayas, the increase in height of mountain ranges, of intervening valleys and a growing complexity of relief imposes greater and greater isolation between different parts, brings about varying patterns of land use, numerous climatic contrasts and has put curbs on man's efforts to modify nature.
Greater the extent of erosional mountainous topography, the emptier it becomes of population. Wider the distribution of varied depositional formations as along stream valleys, larger are the acreages of agriculturally suitable land favouring denser population.

Easily erodible sedimentary strata, high temperatures, copious rainfall and, in turn, widespread drainage in the south have supplied manageable soils for large-scale settlement. A greater prevalence of resistant folded strata, severely cold dry climate and, in turn, low density of drainage net in the north spares only a few bits of culturable land. While the master streams have opened the way for movement and settlement of men along them, it is the water of their tributaries which could be used for meeting irrigational and other local needs.

In nutshell, the elevation, slope, aspect of land and drainage through their influence on local climates, plant cover formation and irrigation of soil have accelerated or retarded human efforts in habitability of various areas.

Temperature singularly determines absolute limits of habitability beyond which large areas remain virtually vacant and the length of growing season deciding the number and range of crops. At lower heights and within habitable zone, it is the distribution of precipitation which goes to influence the relative habitability of local areas. Heavier rainfall, confined mostly to summer season in low Himalayan valleys and arid climate of inner zone make irrigation equally necessary in both for increasing crop-productivity and for keeping up its security.
Although climate is generally favourable for growth of vegetation in whole of this region except the arid Lahaul, its existing distribution is the result of numerous natural constraints and biotic interferences. The sub-tropical species in low Himalayas have been much reduced to scrub and are largely replaced by low hill cultivation under demographic pressure, numerous temperate varieties in forests along medium elevations of high Himalayas supply three-fold local, ecological and commercial needs, and pastures of alpine zone are the realm of graziers. A striking relationship between different uses of land, distribution of vegetation and of population has given rise to main agricultural belt in low valleys, a 'tension-belt' of competitive forestry and cultivation in partially settled middle zone and to northern belt of limited agriculture and seasonal alpine settlement.

As the region is blessed with a favourable distribution of main perennial snow-fed streams, it is primarily the variations of soil-slope relations which in localities of uniform climate and landforms has created great local variations in land-use and density of population. Being a young mountain region, the topmost soil remains largely critically placed, erosion and weathering essential for soil-formation along hillsides have to be constantly directed to adopt terracing and to keep the grade favourable for its conservation.
The rich agricultural soils consist of transported alluvium deposited on flat riverside formations and the diluvial residual soils of plateau-hill tops are of marginal value.

Within all soil zones of this region, the distribution and density of population are found identical with evenness of land, depth of soil, the quantity plus quality of irrigation rather than the varying soil ingredients, being responsible for productivity of hill-lands.