II.1 INTRODUCTION:

As a result of urgent and dual problems of conservation and increase in production, agricultural research in the last decade has tended to move from 'maximization of production' towards 'optimal use' of agro-eco-system. This approach has been more beneficial in the developing countries, where it has ensured enhancement of productivity without disbalancing much of the ecological set up for agricultural activities. Thus, the latest emphasis in agricultural development has been to adapt agriculture to respective eco-systems. This approach strikes a balance between the agricultural development and agro-ecological systems and therefore, provides a sustainable basis for agriculture in general and land use in particular.

Agro-ecology studies the agro-eco-systems in the biosphere. It is largely a matter of establishing the condition and relationship between the land and the use of land


2. Ibid., p. 83.
in an ecological context. Agro-ecosystems are studied mainly under 'production' and 'conservation ecology'. In 'production ecology' such parameters are studied that increase the agricultural production while in 'conservation ecology' such parameters are studied that explain the basic pre-requisite components of agriculture.

The agro-ecological study of landuse can be studied in a region wherein there is a near homogeneity in the agro-ecological parameters. To achieve this Kashmir Valley is regionalised into agro-ecological regions on the basis of selected parameters of agro-ecology: structure, terrain, slope, surface hydrology, soil, climate, vegetation and the secondary components in the form of land capability classes for agricultural land uses.

---


"Agro-ecosystem is that econ-system in which there is a flow of energy, inputs and material from one land unit to another, from one utilization of land to another, and from land utilization to environment and vice versa. This flow is through a process of interrelated and multidimensional system of linkages."


"Primary Components of agro-ecosystem are those natural components that explain the existence of agriculture in the agro-ecosystem, viz., physical, climatic, soil, drainage, etc. The secondary components are those that contd..."
II.2 STRUCTURE AND GEOLOGY:

Lydekkar's study about the geology of Kashmir was extended by Middlemiss, Burrad and Hayden, Terra, Wadia and others to unravel the stratigraphic complexity of the underlying rock beds. The tectonic processes that led to the emergence of the bordering mountain systems are intrinsically linked to the physical make up and genesis of Kashmir Valley. Besides, being the repository of worn down rock

---

fn.5...contd...

explain the potentiality of agriculture such as soil moisture index, water retaining capacity, level of erosion, etc. The superficial components include those farm inputs that increase the production, yield and productivity of agriculture like fertilizers, hybrid seeds, mechanisation etc."


materials from the surrounding mountain slopes, the valley offers scope for the study of complete succession of rock strata belonging to geological periods from Paleozoic period onwards. These are mainly exposed in the anticlinical ridges.

Most of the geologists divide the geological structure of Kashmir Valley into five main groups. (Fig.II.1).

Karewa:

Karewa systems belong to the Pleistocene epochs. These are found spread all along the foothills of mountain slopes. These flat topped elevated plateaus are chiefly formed of alluvial or lacustrine deposits.

The Tertiary system:

This system mostly consists of limestone, compact quartzite, calcareous slate and shale. These rocks are generally underlain by massive Pleistocene and other traps which pass into the fossiliferous beds. At places their origin can be traced back to carboniferous age.

The Panjal:

The Panjal system derives its name from the Pir Panjal range which forms the outer boundary of Kashmir Valley eastwards from Hazara to beyond the river Jhelum. The rocks consist mainly of dark slates, sandstones, quartzites, conglomerates and lava. Roughly they belong to Silurian and Cambrian ages.
FIG. 11.1

KASHMIR VALLEY
GEOLLOGICAL STRUCTURE

INDEX:

- TERTIARY SYSTEM (Recent)
- KAREWA SYSTEM (Pleistocene)
- ZANSKAR SYSTEM (Mesozoic)
- IGNEOUS PANJALS (Permian)
- PANJAL SYSTEM (Palaeozoic Archaean)
- WULAR LAKE

The Zanskar System:

The Zanskar systems are the Mesozoic Carboniferous rocks of the Archean age. The crystalline rocks forming the basement of this system is of pre-cambrian origin. These systems hide in themselves a diversity of mineral resources such as garnet, microline, tourmaline etc. The mode of occurrence of Zanskar system in Kashmir leads to the conclusion that the Valley is formed on the line of synclinal axis of newer palaeozoic and mesozoic rocks. The original symmetry has been partially destroyed by faulting and other movements. It is probable that the area now covered by alluvial and lacustrine deposits is mainly underlain by the Zanskar rock system.

The Igneous System:

There is abundant evidence to show that igneous or volcanic forces were actually at work in the Kashmir Himalayas during the Palaeozoic and Eocene periods. This is further provided by the outpouring of vast quantities of volcanic rocks. Remains of volcanoes have not, however, been detected among any of the volcanic rocks, and none of the volcanoes are known to have erupted since the eocene period.11 The persistence of subterraneous thermal action

is, however, indicated by the prevalence of numerous hot springs, some of which are of relatively large size. The earthquakes, some of them severe and devastating, have been of frequent occurrence in Kashmir.

An interesting feature of the geological formations in the Valley of Kashmir is the ultimate connection between the Panjal and the Zanskar systems. The eastern boundary of the Zanskar rocks in the Valley runs across the western side of the Tral Valley. It emerges again on the northern side of the peak above Awantipora. Along this boundary line the characteristic carboniferous fossils are found in plenty.

The first strip of Zanskar is found from Kazi Nag upto Kishtwara. Its second strip is found in the Liddar Valley at Pahalgam and at halfway between Pahalgam and Anantnag. These rocks gradually pass downwards into a great mass of traps of the Panjal system. Below Aishmuqam, there is one more series of the sedimentary Panjal rocks which, to the south, are inverted upon rocks of the Zanskar system of Anantnag. Towards the southwest, the rocks of the Zanskar system extend so far as the northern flanks of the Pir Panjal range of Banihal. On the opposite side of Zanskar range across the Jhelum river three small patches of Zanskar rocks occur in the neighbourhood of
### Table II.1: KASHMIR VALLEY: GEOLOGICAL FORMATIONS

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Age</th>
<th>Formations</th>
<th>Localities</th>
</tr>
</thead>
<tbody>
<tr>
<td>CANOZOIC</td>
<td>Quaternary</td>
<td>Recent</td>
<td>Recent Alluvium, Older alluvium, Karewa deposits and river terraces</td>
<td>Jhelum river valley, Karewa uplands bordering the valley; river terraces in the upland valleys</td>
</tr>
<tr>
<td></td>
<td>Pliocene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TERTIARY</td>
<td>Eocene</td>
<td></td>
<td>Nummulities, Ranikot series</td>
<td>Southwestern flank of the Pir Panjal range</td>
</tr>
<tr>
<td>MESOZOIC</td>
<td>Cretaceous</td>
<td></td>
<td>Shales, agglomerates, agglomeratic Conglomerates and Volcanic series</td>
<td>Astor, Burzil, Drass, Ladakh</td>
</tr>
<tr>
<td></td>
<td>Jurassic</td>
<td></td>
<td>Spiti Shales, Kioto limestones</td>
<td>Banihal</td>
</tr>
<tr>
<td></td>
<td>Triassic</td>
<td></td>
<td>Pir Panjal trap, triassic shales interbedded with limestone, dolomites</td>
<td>Sind Valley, Liddar valley and northern slopes of Pir Panjal</td>
</tr>
<tr>
<td></td>
<td>Permian</td>
<td></td>
<td>Zewan beds, shales, dark arenaceous shales and limestones</td>
<td>Pir Panjal, upper Sind and Liddar Valley</td>
</tr>
<tr>
<td></td>
<td>Carboniferous</td>
<td></td>
<td>Panjal trap, agglomerates, limestones and shales</td>
<td>Pir Panjal range, Zanskar ranges, Banihal valley</td>
</tr>
<tr>
<td></td>
<td>Devonian</td>
<td></td>
<td>Muth Quartzites</td>
<td>Liddar valley, Pir Panjal (southern flank)</td>
</tr>
<tr>
<td></td>
<td>Silurian</td>
<td></td>
<td>Sandy shales, shale sandstone and yellow limestone</td>
<td>Liddar Valley (Anantnag)</td>
</tr>
</tbody>
</table>

contd...
### Table II.1...

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Age</th>
<th>Formations</th>
<th>Localities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordovician</td>
<td></td>
<td></td>
<td>Quartzite, Limestone, grey-wackes</td>
<td>Sind and Liddar valleys</td>
</tr>
<tr>
<td>Cambrian</td>
<td></td>
<td></td>
<td>Soft quartzites, massive clays, limestone</td>
<td>Baramulla and Anantnag, Pir Panjal, Banihal valley</td>
</tr>
</tbody>
</table>

| Arc     | Cambrian |          | Fundamental gneisses, intruded granites | Great Himalayan range, Pir Panjal |

the Wular lake. The small patches of such rocks lead to a larger mass at Bandipura. At the extreme northwestern end, the Zanskar rocks are met with the Trehgam in Lolab Valley. Underlying Zanskar rocks in the neighbourhood of Srinagar and Manasbal, the pleistocene rocks of the Pir Panjal system attain a great development. These rocks form almost the whole of Hari Parvat and Shankaracharya hills in Srinagar city.

The chronological sequence of rock formation is given in the Table II.1.

II.3 RELIEF AND DRAINAGE:
Relief:
The Valley of Kashmir is a lacustrine valley. The Pir Panjal mountains separate the plains of Punjab from Kashmir. They extend from Chenab river in the northeast to the Jhelum river in the northwest. The length of the range from Kishtwar to Muzafarabad is about 93 kilometres while the width ranges between 10 kilometres to 12 kilometres. These ranges run almost parallel to each other and have three main segments. (Fig.II.2) Firstly, on the south are the outer hills on which Jammu city is located. They begin with a height of 30 metres to 60 metres above the plains and reach the altitude of 300 metres. Secondly, on the north the mountains are very high with most of the peaks having permanent snow. The conspicuous peaks in this range are Tatakuti (4,732 m), Kalinag (4,732 m), Kaunsarani or
FIG. II2.

KASHMIR VALLEY RELIEF

INDEX:

- ABOVE 4266 Mts.
- 3656—4266 Mts.
- 3047—3656 Mts.
- 2438—3047 Mts.
- 1928—2438 Mts.
- 1524—1928 Mts.
- WULAR LAKE

Vishnopad (4,731 m), Tosamaidan (4,572 m), Afarwat (4,420 m), Rupri (3,962 m), Darahal (3,962 m), Pir Panjal (3,359 m) and Banihal (2,804 m). The important rivers that rise from these mountains are Vishav, Rambiara, Romshi, Dudhganga, Sukha Nag and Ningal; and joining the Jhelum river at Sangam, Kavini, Kapapura, Chhatabal, Trikulbal and Tarazu, respectively. Some important lakes in these ranges are Kausar Nag, Vishnopad, Nandan Sar and Chandan Sar, Ram Sar, Dudhasar, Watasar, Tsahar Sar, Indra Sar, and Damasar-Ailapatar. These hills are barren on the southern side but northern side slopes are covered with lush green forests. On the north side these mountains rise like a wall from the Valley of Kashmir while on the south they slope down gradually.

Thirdly, between Kashmir Valley and Ladakh there is a continuation of the main range of the Himalayas. They separate the valleys of Chenab and Jhelum from the Valley of Indus. These ranges have only a few passes, such as Bhotakot pass in the east; Burzil and Durikun in the west and Zożila, which is the lowest among all passes in this range, in the middle. The important peaks of this range are Amarnath (5,430 m), Gashabrar (5,449 m), Kolahoi (5,434 m), Kohenhar (5,182 m), Harmukh (5,148 m), Hukhasar (4,590 m), Harbhagwan (4,893 m), Araribal (4,359 m), Burzila (4,115 m), Doriyakun (4,115 m), Tragbal (3,627 m), Margan (3,536 m), Marbal (3,526 m), Mahadev (3,505 m), Zożila (3,444 m), Lidarwat (3,048 m), and Nasta Chhenu.
Further north, presently under the illegal occupation of Pakistan and China, these ranges are overlooked by the world renowned peaks of Nanga Parbat (8,116 m) and Nunkun (7,135 m). The important tributaries of Jhelum that rise in these mountains are Arapati, Lidgar, Arpal, Tsuntikul, Sind, Arin, Madhumati and Pohru. Their places of confluence with the Jhelum are Khannabal, Kitkiteng, Tsraligund, Dubji, Shadipur, Bandipore, Kulsu and Duabagh respectively. These mountains encompass in themselves some important lakes of Kashmir Valley viz., Tarsar-Marsar, Kemsar, Chandrasar, Shishran Nag-Zaunetri Nag, Hatisar Talaw, Gangabal, Brahmsar, Kanasar, Satsar, Nilasar and Salausar.

The Valley of Kashmir is situated to the north of the Pir Panjal range and is of an irregular oval shape. Extending in northwest and southeast direction, the Valley is about 135 kilometres long and 48 kilometres wide with a total area of about 6,890 square kilometres and average height of about 1,585 metres above the mean sea level. Surrounded on all sides by an irregular ring of mountains, the slopes and ridges of the Valley vary in height and appearance. On the southern side (Pir Panjals) peaks vary in height from 2,438 metres to 4,572 metres with dense forest growth on the slopes and perennial snow cover on the summits. On the north of the Valley, the mountains are still higher approaching a height of 5,486 metres in some peaks. These
mountains are bare and rugged in appearance but lofty peaks are snow capped. The important lakes in the Valley are Dal, Wular, Anchar, Manasbal, Tarsar, Hakursar, Khushalsar and Pambsar. These lakes besides having tourist attraction are abound with fish, water-nuts (sighara), and lotus-roots (Nadur). Wular lake (the biggest in the Valley) is 20 kilometres long and 9 kilometres wide. Manasbal (3.5 kilometres in length and 0.75 kilometre in width) and Dal, (6 kilometres in length and 3 kilometres in width) are other important lakes located on the Valley floor. In the eastern parts of the Valley there are smaller valleys like Noubak, Tral, Dachigam, Wangat, Arin and Lolab. There are extensive meadows (marg) mostly located on the hills between the flat land and the mountains. These meadows attract the transhumant groups of the state who graze their cattle during summer and autumn months. Some of the important meadows are Gulmarg, Tangmarg, Khilanmarg, Sonmarg, Minimarg, Vijimarg, Tosamarg, Nunamarg, Badmarg, Zabamarg, Astanmarg, Nandamarg etc.

Slope Characteristics:

Based on Wentworth method* of slope analysis the Valley is divided into 1,036 grids each covering an area of 10.36

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* In Wentworth's method a square grid is superimposed on a contour map of the area under study and all contour crossings are tabulated. The procedure is repeated with an oblique grid being spread over the same area. The results obtained from the two exercises are then averaged and slope is calculated with the help of the formula.

\[
\text{Slope} = \frac{\text{Average number of contour crossings}}{3366} \times \text{Contour Interval.}
\]
square kilometres and tangents are plotted in each grid. The tangent values are then converted into degrees of angle to find out the average slope.

The slope of Kashmir Valley has evolved largely through a sequence of events including changes in base level by folding, faulting and the consequent rejuvenation of drainage channels. It varies between $-5^\circ$ and $40^\circ$. In the valley floor the average slope is between $0^\circ$ and $10^\circ$, in the foothills and outskirts of the Valley it is $10^\circ-30^\circ$ and in the surrounding hills an average slope of more than $30^\circ$ is found.

On the basis of the average slope of the terrain, Kashmir Valley is divided into six regions: (Fig. II. 3)

i) Swamps, bogs and quagmires (less than $5^\circ$)

ii) Valley floor ($5^\circ-10^\circ$)

iii) Karewas ($10^\circ-20^\circ$)

iv) Cultivable slopes ($20^\circ-30^\circ$)

v) Grasslands ($30^\circ-40^\circ$)

vi) Mountain slopes more than $40^\circ$.

i) Swamps, Bogs and quagmires (less than $5^\circ$):

Locally known as 'Numbals' these areas are deeper or at level with the Jhelum bed. These spread all along the undefined banks of Wular lake and the Jhelum. These cover a total area of 371 square kilometres (13 per cent of total area of the Valley). On these lands paddy is cultivated
FIG. 11.3

KASHMIR VALLEY
SLOPE CATEGORIES

INDEX:

- ABOVE 40°
- 30 - 40°
- 20 - 30°
- 10 - 20°
- 5 - 10°
- LESS THAN 5°

in normal years of rainfall. Due to high incidence of floods in this region the agriculture is not very prosperous. Waterlogging, alkalinity and low yields are some of the chief characteristics of this region.

ii) Valley Floor (5° to 10°):

This region, consisting of low-lying plains and almost flat land, is coterminous with the flood plains of the Jhelum river. These slopes are characterised by depositional features laid down by numerous tributary streams of the Jhelum. It accounts for about 14 per cent of the total area of the Valley (1,748 square kilometres). The main crop is paddy which is grown as a kharif crop.

iii) Karewa (10°-20°):

Karewas account for about 19 per cent (2,449 square kilometres) of the total area of Kashmir Valley. These gentle to moderate slopes are mostly located in between the Valley floor and mountain slopes. These slopes have coarse textured surface soil laid over heavy sub-soil. The soils in these areas have very low moisture retaining capacity. Thus, these slopes with coarse and highly permeable soils have restricted the use of Karewa lands to specialised farming. The Karewa lands are constrained regions due to the lack of water for irrigation. On the lower reaches of this region paddy is grown as a mono-culture saffron kharif crop, while higher reaches are devoted to cultivation and horticulture. Soil erosion is a serious problem of these slopes.
PIE DIAGRAM

SHOWING SLOPE DISTRIBUTION IN THE VALLEY OF KASHMIR

INDEX:

<table>
<thead>
<tr>
<th>SLOPE</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;9°</td>
<td></td>
</tr>
<tr>
<td>9°-20°</td>
<td></td>
</tr>
<tr>
<td>20°-30°</td>
<td></td>
</tr>
<tr>
<td>30°-40°</td>
<td></td>
</tr>
<tr>
<td>&gt;40°</td>
<td></td>
</tr>
</tbody>
</table>
iv) Cultivable Slopes (20°-30°):

These encompass 31 per cent (3,978 square kilometres) of Kashmir Valley area. (Fig.II.4) With gentle to undulating slopes, this region forms a transitional zone between the Valley basin and the adjoining mountain slopes. Thus, the landuse changes from crop cultivation to horticulture and culminates into grasslands as one moves higher in altitude and steeper in slope. Maize is the important kharif crop grown in this region. While higher altitudes and steeper slopes are devoted to barley and ragi crop cultivation.

v) Grasslands (30°-40°):

With the increase in altitude the slopes show a change from crop cultivation to grasslands. About 16 per cent (2,030 square kilometres) of Valley area is under grasslands. On these grasslands, locally known as 'marag' the Gujjars and Bakarwals graze their animals visiting the area seasonally. Paddy is grown on terraced fields of the favourable slopes at lower altitudes.

vi) Mountain Slopes (more than 40°):

These slopes account for 16 per cent (2,067 square kilometres) area of the Valley of Kashmir. The gradient of the terrain and the inhibiting climatic conditions restrict any kind of economically productive landuse. On the slopes near river bed limited grazing and collection of forest produce have sustained a sparse and scattered
settlement of semi-nomadic population.

Drainage:

The hydrographic complexity of the Kashmir Valley has been caused by its evolution as well as Jhelum and its tributaries. The drainage network of this river system has evolved as a result of great changes in level, rejuvenation at one time and attaining base level at the other. The river gets choked with the debris brought by its channels and consequent diversion results in mutual capture. The fluvial system of the Jhelum and its tributaries is marked by well developed drainage basins, viz., Sind, Rembiara, Lidder, Pohru, Sandran, Erin, Viji etc. (Fig.II.5) The Jhelum river has some prominent tributaries on its right and left banks. The rivers of Sandran, Bring, Arapat Kol, Liddar, Afarwat, Harwan, Sind, Erin, Madhumati, Pohru and Viji-Dakil constitute the right hand bank tributaries. The rivers of Vishav, Rembiara-Saras, Romshi, Dudh-ganga, Shali-Ganga, Sukhnag-Ferozpur and Nangal constitute the left hand bank tributaries. These tributary basins have an area ranging between 1,433 square kilometres (Viji-Dakil) to 1,936 square kilometres (Pohru). The length of these tributary rivers ranges between 82 kilometres (Sandran) to 1,130 kilometres (Pohru). (Table II.2)

Mainly due to the almost level nature of Valley floor the Jhelum river in Kashmir Valley is characterised by two
FIG. II.5

KASHMIR VALLEY
DRAINAGE BASINS

INDEX:

<table>
<thead>
<tr>
<th>DRAINAGE BASIN</th>
<th>RIVER BASIN NAME</th>
<th>RIVER</th>
<th>WULAR LAKE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SOURCE: B-ZUTSHI 1986
Table II.2: KASHMIR VALLEY: DRAINAGE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Drainage Area in No. of</th>
<th>Drainage No. of</th>
<th>Density Texture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>basin sq. km.</td>
<td>length streams</td>
<td>EK/Ak</td>
</tr>
<tr>
<td>1.</td>
<td>Pohru 1,936</td>
<td>1,130</td>
<td>470</td>
</tr>
<tr>
<td>2.</td>
<td>Sind 1,556</td>
<td>766</td>
<td>342</td>
</tr>
<tr>
<td>3.</td>
<td>Liddar 1,243</td>
<td>679</td>
<td>281</td>
</tr>
<tr>
<td>4.</td>
<td>Sukhnag 932</td>
<td>411</td>
<td>203</td>
</tr>
<tr>
<td>5.</td>
<td>Vishav 828</td>
<td>448</td>
<td>163</td>
</tr>
<tr>
<td>6.</td>
<td>Rembiara 751</td>
<td>373</td>
<td>130</td>
</tr>
<tr>
<td>7.</td>
<td>Bring 595</td>
<td>317</td>
<td>176</td>
</tr>
<tr>
<td>8.</td>
<td>Dudhanga 580</td>
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<td>9.</td>
<td>Arapal 571</td>
<td>355</td>
<td>119</td>
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<tr>
<td>10.</td>
<td>Ningal 538</td>
<td>232</td>
<td>76</td>
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<td>11.</td>
<td>Madhumati 476</td>
<td>397</td>
<td>157</td>
</tr>
<tr>
<td>12.</td>
<td>Romshi 459</td>
<td>262</td>
<td>70</td>
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<tr>
<td>13.</td>
<td>Harwan 395</td>
<td>144</td>
<td>102</td>
</tr>
<tr>
<td>14.</td>
<td>Arapatkol 362</td>
<td>255</td>
<td>96</td>
</tr>
<tr>
<td>15.</td>
<td>Erin 321</td>
<td>210</td>
<td>96</td>
</tr>
<tr>
<td>16.</td>
<td>Sandaran 258</td>
<td>82</td>
<td>63</td>
</tr>
<tr>
<td>17.</td>
<td>Viji-Dakil 143</td>
<td>96</td>
<td>30</td>
</tr>
<tr>
<td>Jhelum 12,262</td>
<td>6,697</td>
<td>2,704</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Note: * Drainage texture is the ratio of number of total streams in the river basin (NK) to total area of the river basin (AK)

\[ T = \frac{NK}{AK} \]

main features. It is a sluggishly flowing river which has a highly tortuous course. In its course from Khanabal to Wular lake, the fall of the river is 18 metres in 113 kilometres. The river makes myriads of meanders and lays down a good deal of its suspended load along its banks. The depositional banks facilitates the undercutting and lateral erosion on one banks and deposition on the other thus, encouraging meandering. Hence, big meanders and lakes are formed in its course. Dal lake is an example of one such ox-bow lakes. The Jhelum river meanders through a basin which is not of its making and its menace is its incapacity to transport the load delivered to it by its affluents which bogs it down. After rising from a spring at Verinag the Jhelum finds flat land in a course of 25 kilometres only. It flows to the north-west, with increasing volume and size after Khanabal when the Lidder river (679 kilometres long) meets it. Below Srinagar, the river flows northwest for about 45 kilometres to empty itself into Wular lake. This merger of the Jhelum into Wular lake creates the problem of the silting up of the lake and its encroachments on the nearby flat plains. With this activity of the Jhelum river, most of the swamps (numbals) of the Valley are concentrated around Wular lake. The Jhelum re-emerges from Wular lake in a south-westerly direction and cuts its way through Baramulla gorge in the north-west
extremity of Kashmir Valley. Throughout the Valley the Jhelum covers a drainage length of about 6,697 kilometres and its average width remains 0.35 kilometre. Between Khanabal and Khadinyar (near Baramulla town) the Jhelum is navigable and was the main transport route before the advent of motorized transport. But now-a-days the magnitude of navigation on the river is negligible because of easy accessibility provided by motorable road network.

Though the Jhelum river gently flows between the semi-stable banks of deep soil yet during floods river overflows its natural banks and damages the embankments constructed to contain the heavy discharge. While the essentially aggradational role of the river is largely responsible for the recurrent floods in the Valley, man has also contributed to its devastating effects. The expansion of Srinagar city through historic times and its beautification drive deprived the river of many of its outlets into Dal and other lakes. Thus, presently, the flood water carried by the Jhelum river is forced to pass through a narrow waterway across the city. An elaborate network of spill channels is constructed to divert the flood waters from a point above Srinagar to a series of swamps towards the west of the city. This water is ultimately drained into Wular lake.
Drainage Patterns:

Since the slope and the nature of underlying rock material show marked changes in Kashmir Valley, the river systems show disparate drainage patterns. The drainage pattern of the Great Himalayan slopes in Kashmir Valley is dendritic. Drainage is of antecedent type and at certain places tends to be linear or irregular. The drainage pattern of the Pir Panjal rivers of Kashmir Valley is also dendritic. The reason being that these ranges are less extensive in width so do not promote the lateral development of stream channels. The streams come down the mountains in parallel and often irregular lines. In the upper reaches they have a dendritic pattern while lower down their courses are aligned parallel to each other. As the streams cut across the Karewa beds, the braiding takes place and perpetually shifting channels get chocked by rapid deposition of sand and gravel in the stream beds. The uplifting of Pir Panjal range during the Pleistocene and later tilting and folding of Karewa beds have all added to the complexity of drainage along southern flanks of Kashmir Valley. The drainage pattern of the rivers of Bring, Pohru and Vishav is dendritic. Shaliganga, Dudhgang, Romshi and Sasara river form linear drainage patterns. The drainage pattern of Sukhnaq and Rembiara is irregular type. Liddar river and Sind rivers represent good examples of radial drainage pattern. The higher reaches of Rembiara
FIG-11-6

KASHMIR VALLEY DRAINAGE PATTERNS

INDEX
1. POHRU RIVER
2. MADHUMATI RIVER
3. SIND RIVER
4. LIDAR RIVER
5. BRING RIVER
6. SANDARAN RIVER
7. VISHAV RIVER
8. REMBIARARA RIVER
9. SASARAN RIVER
10. ROMSHI RIVER
11. SHALIGANGA RIVER
12. SUKHNAG RIVER

SOURCE: W.R. LAWRENCE, 1976

and Vishav river show trellis type of drainage pattern while Madhumati river joining the Wular lake presents an internal drainage (Fig.II.6).

**Drainage Density:**

Drainage density is the length of river channels per square kilometre and is calculated by the formula $D = \frac{\sum LK}{\sum AK}$ where $D$ is the drainage density in kilometres per sq. km.; $\sum LK$ is the sum of the lengths of all channels, and $\sum AK$ is the total area of the river basin.

Drainage density is an indicator of dissection of the land by the geomorphic action of fluvial systems. Among the Valley river basins, Madhumati river basin with 0.83 kilometre of channel for every square kilometre of surface area and Sandran river basin (0.32 kilometre) have the highest and lowest drainage density figures respectively. The drainage density figures for other river basins are low (Table II.2). The overall low values of drainage density for the Jhelum river basin (0.55 kilometre) and its tributary basins is due to hard resistant underlying bed rock, massive topography and dense vegetation cover. Drainage density is highest in mountainous region (0.70 kilometre) and lowest in Valley Floor (0.45 kilometre) while Karewas (0.40 kilometre) falls in between the two relief features.
II.4 PHYSIOGRAPHIC DIVISIONS:

The Valley of Kashmir can be divided into three broad physiographic divisions:

i) The Northern and North eastern slopes and the foothills of the Pir Panjal range,

ii) The slopes and the foothills of the Great Himalaya and north Kashmir ranges, and

iii) The Valley basin.

The Pir Panjal Range:

The northern ranges of Pir Panjal together with the lacustrine bedded Karewa foothills is a relief feature of immense geographic significance. The complexity of lithology and geomorphology of this physical division can be imagined by the fact that no certain causes can be ascribed to the evolution of Pir Panjals. A succession of folding and faulting has resulted in the emergence of sharply defined ridges. These present a typical 'Hill and Valley' topography. The intertwined impacts of the Pleistocene and Sub-Recent uplift and recurrent glaciations have given this physical division a distinctive characteristics. The perpetual sub-aeral erosion, active since the emergence of the mountain range, has created remarkable Valleys and narrow gorges. The northern aspect of Pir Panjals is flanked by a series of Karewa beds which show their continuous up-lifting, folding and tilting. Towards Kashmir Valley slopes
descend gradually and gently while in the south i.e., towards Jammu plains the slope is steep. Thus, northern slopes favour accumulation of snow and this snow sustains the mountain glaciers on the northern aspect of Pir Panjal. Its northern flank can be divided into two segments as per its bi-axes of alignment. First, in its east-west axis it is 48 kilometres long and culminates into the Rupri ridge. The headstream of almost all the left bank tributaries of the Jhelum river rise in this precipitous ridge. Second, segment with north-northwest to south-southwest axis is 64 kilometres long and culminates at Baramulla gorge. Of the two segments the first is more imposing and impressive. On the Pir Panjals the most important feature of developmental importance have been passes; Pir Panjal (3,850 m), Budil Pass (4,263 m) and Banihal (3,226 m). These passes have provided links with the plains in the south.

Great Himalayan Range:

It is an imposing range among the three mountain chains that girdle Kashmir Valley. The average height of this range and its peaks are higher than the other two ranges. The highest peak Kolahoi (5,428 m) is much higher than Tatakuti (4,748 m) of Pir Panjal and Harmukh (4,679 m) of North Kashmir range.

This range encloses Kashmir Valley on the east, northeast and north-northwest. Culturally, topographically and
strategically it has acted as a massive barrier since time immemorial. The ranges extend uninterruptedly for over 150 kilometres from west to east and have an average width of 20 kilometres to 40 kilometres. Its precipitous and snow clad ridges overlook the Valleys of Kishenganga towards the north and Kashmir towards the south. At a point near Zozila the range takes a bend towards the south-west and is often described as the North Kashmir range. It is in this stretch that the range forms the water divide between the Jhelum in Kashmir Valley and the Kishenganga. The altitude of the peaks in this range declines towards west and south-west. A striking feature of the Great Himalayan range is the asymmetrical development of the slopes on the two flanks in sharp contrast to the gentle slope towards Ladakh. The descent from Zozila to Kashmir Valley is very steep.

To the north-west of Baramulla the Kazinag ridge of the North Kashmir range forms the western boundary of Kashmir Valley. To the east of Harmukh the range coalesces with the Great Himalayan range near Zozila. The Harmukh precipice is a vast snow waste which feeds the Madhumati and the Erin river systems that flow into the Wular lake. Like its counterparts it is fordable through certain passes only viz., Wail Gali (4,293 m), Viji Gali (4,249 m), Kuljan
Gali (4,248 m), etc. The Himalayan range forming the eastern boundary of the valley branches off from the main chain close to the peak near Amarnath (5,005 m), east-south east of Zozila. Between the eastern and western branches of the Lidder river, above Pahalgam and south of Amarnath, are the head streams of Liddar and Sind in Kolahoi snow-fields (5,425 m). In its southern extremity the mountain chain coalesces with Pir Panjal near Banihal pass.

The Valley Basin:

Below 1,830 metres contour Kashmir Valley has a distinctive homogeneity in level. This level land of the Valley with combination of depositional and erosional features forms the Valley basin. It is characterised by a very high intensity of human activity. Throughout the length and breadth of the Valley floor fertile land and perennial source of irrigation from the Jhelum ensure conducive environment for paddy cultivation. The lower reaches of this physical division are constantly re-fertilized by the new silts brought down by the Jhelum.

Within the Valley basin three distinctive relief features are encountered. First, the Valley floor with mono-culture of paddy cultivation and predominance of agriculture oriented rural economy. In this almost flat land soil depth is very high and a network of gravity irrigation canals link the agricultural fields. Second,
the low-lying areas around the Wular lake and undefined banks of the Jhelum are either waterlogged or subjected to recurrent inundation. Third, on the bordering lacustrine deposited Karewas prolonged fluvial action has reduced these uplands to a highly dissected land surfaced with a network of ravines and gullies.

II.5 CLIMATE:

II.5.1. Temperature and Seasons:

The weather of Kashmir shows a marked seasonality. Both daily maximum and minimum temperatures start falling by August and are quite low by October. September and October have the highest diurnal range of temperature. Usually the surrounding mountains receive their first snowfall by mid-October but in the plains of the Valley it is belated to the first half of December. By the end of December the whole Valley, in normal years, is seen snow-covered and remains so upto middle of February. During these months the Valley remains under the grip of cold and damp weather and a persistent fog hanging over the surface. The snow melts away by the end of February and is followed by widespread rains. Generalising the weather characteristics, Kashmir Valley experiences four seasons; winter, spring, summer and autumn. To Kashmiri populace the seasons of the Valley are associated with religio-socio-cultural aspects of life. To them the year comprises of six seasons:
(i) Severe winter (Sheshur) between mid-January to mid-March, (ii) Spring (Sonth) mid-March to mid-May, (iii) Summer (Grishim) mid-May to mid-July, (iv) Rainy season (Wahrat) mid-July to mid-September, (v) Autumn (Harud) mid-September to mid-November, and (vi) Winter (Wandh) mid-November to mid-January.

Winter Season:

Winter in Kashmir Valley lasts from November to February. Mainly, two weather conditions determine the winter season here. These are: (i) the southern branch of the westerly Jet stream*, overlying India south of the Himalayas, and (ii) the position of the surface polar front which enables the convergence of the north-westerly continental air mass and the Indian trade winds along a line of discontinuity in north western India. The major synoptic and weather disturbances are created by the western depressions which frequent the Valley during these months. These enter the Valley from the west or northwest. Some of these originate along the surface polar front which has no fixed position and may fluctuate between Afghanistan and the middle of the Ganga Valley. The southern branch of the westerly Jet flowing across northern India plays an important role in

* Jet streams are high altitude fast moving easterlies that move 'down the axis' of Himalayas during winter months.
steering these depressions into India. The depressions move very fast often covering 8° to 10° longitude per day. Although their periodicity and incidence are highly variable, their impact on the weather conditions of Kashmir Valley is extremely marked. They usually come at intervals of seven to ten days and their normal life is as short as three to four days.

Normally, the daily maximum temperature in Winter vary from 16° Celsius in November to 5° Celsius in January and the daily minimum from 0° Celsius to -3° Celsius. An abrupt fall in the night temperatures is a peculiar phenomenon of the winter months. The night temperature commonly deviates by 10° Celsius to 12° Celsius from annual average temperature, but at times this deviation is more than 20° Celsius. These western depressions are also the chief bearers of winter snow and rains in Kashmir Valley. The snowfall is often accompanied with rain and sleet. In the low-lying areas of the Valley snowfall usually commences by the middle of December and continues upto the end of March. The highest occurrence is observed between middle of December and last week of February. Another significant feature of snowfall is its concentration during morning hours between 0430 hours and 1230 hours. This eight hours period account for about 40 per cent of total occurrence and magnitude of snowfall. The three months of December, January and February, on an
average, receive 120-125 centimetres of snow, the share of January alone being 40 per cent. The low-lying areas of the Valley receive about 30 per cent of annual rainfall during winter months while in the higher reaches it accounts for 35 per cent to 40 per cent of total annual rainfall. The average humidity hardly falls below 85 to 90 per cent during winter months.

Spring Season:

Major climatic phenomena in spring season (March to May) of Kashmir Valley are not fundamentally different from those of winter. The frequency of the western depressions remains equally high in early spring and declines substantially as summer advances and the southern branch of westerly jet finally withdraws from the Indian region.

With the advent of spring the temperature in Kashmir Valley registers increase. The days become brighter and the nights warmer. The day temperature ranges between $12^\circ$ Celsius and $15^\circ$ Celsius with marked variability. The night temperature too show a steady increase from $4^\circ$ Celsius in March to $12^\circ$ Celsius in May. Spring season is characterised by rainy weather conditions. Almost all places in Kashmir Valley receive from 33 per cent to 45 per cent of total annual rainfall during spring months. March is the rainiest month of the year in Kashmir Valley. The total spring
rainfall varies between 197 millimetres in Pulwama to 410 millimetres in Handwara. The number of rainy days in these months vary from 14 in Pulwama to 17 in Anantnag. Spring rain is often associated with violent thunder showers and hailstorms. About 45 per cent to 50 per cent of the total annual thunder-showers and hailstorms in the Valley occur in spring months with highest frequency and magnitude in the months of April and May.

Summer Season:

Weather conditions in Kashmir Valley are least influenced by the general monsoon regime of the Indian sub-continent. The lofty Pir Panjal forms a formidable physical barrier to restrict the movement of southwest rain bearing monsoons. The southwest monsoons supply only 15 per cent to 25 per cent of the total rainfall received in Kashmir Valley. Thus, unlike the rest of the sub-continent, Kashmir Valley has no specific rainy season. Regarding the magnitude of rainfall one can hardly differentiate between the pre-monsoon and monsoon periods.

The day temperatures remain remarkably high and constant between June and September. The average summer temperature remain between 28 Celsius and 31° Celsius. The increase in temperature coupled with high relative humidity make the weather sultry. The humidity ranges between 70 to 80 per cent. Rainfall shows a general decreases with increasing
distance from Banihal pass. Summer season is also characterised by a high incidence of thunder-storms.

Autumn Season:

Autumn marks a transition from the warm sub-tropical summers to temperate winters. This makes it the best season of Kashmir Valley. The autumn is characterized by the least disturbed weather, highest amount of sunshine, high diurnal ranges of temperature and little rain or snow. In this season the determinants of the summer weather are the weakest, while those of the winter are yet to gain significance. The days in September are marked by high temperatures 25° Celsius to 28° Celsius which start falling sharply by middle of October (13°-22° Celsius). Nights, on the other hand, are cool (7° to 15° Celsius). Although, dryness is a distinctive feature of autumn weather yet rain or snow is not entirely unknown. An early influx of western disturbances occasionally causes widespread snow or rain in the last week of October and, thereby, resulting in inundation of lower parts of Kashmir Valley.

II.5.11. Rainfall:

The role of the girdling mountain ranges as a major determinant of the rainfall characteristics in Kashmir Valley can hardly be over-emphasized. The southern arm of Pir Panjal acts as an effective barrier to summer monsoon rainfall. The summer rainfall regime of Kashmir Valley
clearly reflects this rain-shadow effect. The Great Himalayas, however, exercise little obstructive influence on the influx of the westerly troughs which frequent the valley from west and north-west during winter months. The lack of a regular rainy season is a peculiar feature of the rainfall in Kashmir Valley. Thus, the Valley has a sub-Mediterranean type of climate in so far as the distribution pattern of rainfall is concerned. Contrary to the monsoon type, Valley receives about 65 per cent of annual rainfall during winter and spring months. This share accounts for more than 75 per cent in the north-west parts of the Valley (Handwara, Baramulla, Langet, Sopore). The winter contributes 33 per cent of total annual rainfall received in central and southeastern parts of the Valley (Srinagar, Pulwana, Anantnag, Kulgama and Ganderbal). The total rainfall received during south-west monsoon period is only 50 per cent to 60 per cent of the rainfall recorded during spring months. Further, the behaviour of summer rainfall is highly erratic.

The variation of rainfall within the Valley is remarkable and is largely governed by altitude and aspect of the region. The annual rainfall shows a gradual increasing trend from Badgam and Srinagar in all direction. It is lowest at Badgam (58 centimetres) and increases north-westwards from Srinagar (66 centimetres) to Sopore (76 centimetres), Langet (87 centimetres) and to Handwara (101 centimetres).
South eastwards it increases from Pulwama (59 centimetres) through Kulgam (90 centimetres) to Duru (120 centimetres). Based on the tehsilwise data of average annual rainfall Kashmir Valley can be divided into four regions. (Fig.II.7)

Areas of Very High Rainfall:

This rainfall region experiences average annual rainfall between 100 centimetres and 130 centimetres. It comprises of three tehsils of Duru (128 centimetres), Pahalgam (127 centimetres) and Kupwara (112 centimetres). The very high rainfall region is concentrated in the north-west and south-east extremities of the Valley. Duru tehsil being nearest to the Pir Panjal gap experiences the heaviest rainfall among the tehsils of Kashmir Valley.

Areas of High Rainfall:

This region having rainfall of 70-100 centimetres, comprises of the tehsils of Handwara (84 centimetres), Shopian (77 centimetres), Chadura (75 centimetres) and Gulmarg (74 centimetres).

Areas of Moderate Rainfall:

This region (40-70 centimetres) comprises of the low lying areas of Sopore (69 centimetres), Kulgam (69 centimetres), Anantnag (68 centimetres), Bandipore (67 centimetres), Srinagar (66 centimetres), Ganderbal (61 centimetres), Beerwah (61 centimetres), Badgam (51 centimetres), Baramulla (50 centimetres) and Tral (40 centimetres) tehsils.
KASHMIR VALLEY RAINFALL

(AVERAGE ANNUAL FROM 1960 TO 1981)

(TEHSIL LEVEL)

INDEX

RAINFALL IN CENTIMETERS PER ANNUM

<table>
<thead>
<tr>
<th>Range</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 - 130 cms</td>
<td></td>
</tr>
<tr>
<td>70 - 100 cms</td>
<td></td>
</tr>
<tr>
<td>40 - 70 cms</td>
<td></td>
</tr>
<tr>
<td>&lt;40 cms</td>
<td></td>
</tr>
</tbody>
</table>

LINE OF CONTROL

N.A. DATA NOT AVAILABLE

SOURCE:
1. FLOODS AND IRRIGATION DEPTT. SRINAGAR (JK) 1983
2. INDIAN METEOROLOGICAL DEPTT.
KASHMIR VALLEY
RAINFALL VARIABILITY

INDEX:

- 20 PER CENT. VARIABILITY
- 25 PER CENT VARIABILITY

Areas of Low Rainfall:
This region (less than 40 centimetres) comprises of the rainshadow tehsil of Pulwama (26 centimetres). The data is not available for the tehsils of Uri, Karnah, Sonawari and Bijbehara.

Rainfall Variability:
The coefficient of variation of annual rainfall is more or less same for Srinagar (22 per cent), Anantnag (24 per cent) and Baramulla (21 per cent). In the lower reaches the rainfall variability is low (Fig. II.8) but in the Karewa uplands it is very high (upto 40 per cent). While on the mountainous slopes the rainfall variability is as low as 10 per cent to 15 per cent. The highest rainfall variability is experienced in the summer months at almost all places in Kashmir Valley and it is the least in the winter and spring months.

Droughts and Floods:
The southwest monsoons, whenever enter into the Valley with heavy intensity, cause a great concern to the local planners and populace due to its erratic behaviour. The failure of monsoons and the late arrival of western depressions often combine to cause long spells of dry weather. In the eight decades of the present century the Valley has experienced thirty droughts of three months duration each, eight droughts of four months duration, five droughts of
### Table II.3: KASHMIR VALLEY: INCIDENCE OF DROUGHTS AND FLOODES

<table>
<thead>
<tr>
<th>Over 3 consecutive months</th>
<th>Over 4 consecutive months</th>
<th>Over 5 consecutive months</th>
<th>Over 6 consecutive months</th>
</tr>
</thead>
<tbody>
<tr>
<td>August-October (1902, 1959, 1973)</td>
<td>August-November (1894, 1932, 1958)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>October-December (1901, 1906, 1910, 1950, 1966)</td>
<td></td>
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</tr>
</tbody>
</table>

**Source:**
FIG. III.9
KASHMIR VALLEY
FLOOD AND DROUGHT PRONE AREAS

INDEX

<table>
<thead>
<tr>
<th>Flood Prone Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drought Prone Areas</td>
</tr>
</tbody>
</table>

WULAR LAKE
JHELUM RIVER

five months duration, and seven droughts of over six months duration each. The Table II.3 depicts the details of the incidence of droughts in the Valley of Kashmir in the present century.

Floods and accompanying devastation are a recurring phenomenon in Kashmir Valley. The low-lying areas of the Valley are worst affected by these floods in respect of frequency and devastation (Fig.II.9). Since the Jhelum river carries the cumulative discharge of all its tributaries through a narrow passage down the Valley, the perpetually ongoing silting of the river chokes it and, thus, incapacitates it from transporting the load with the flow. The past behaviour of Jhelum shows that it has a maximum capacity of safely carrying half of a high flood discharge. The other half spills over the banks during high water level of the river. The flood situation is aggravated with the breaching of embankments that have been constructed to contain floods. Thus, in a topographical situation in which the Jhelum is flowing, the floods are but a natural phenomenon. Learning from the experiences of the seventeen major floods of the Valley the spate of the Jhelum river is attributed to the following factors: Growth of population

and consequent increase in human settlement; Encroachment on forest land by agriculture and non-agricultural activities; General layout of the villages; Channelising of rivers; Creation of embankment bunds; Construction of transport lines in the flood plains; Siltation of the river Jhelum due to ever increasing soil erosion; Increase in the bed level of the Jhelum; Concentration of swamps along the river and the Wular lake; and Unplanned land reclamation.

Thus, it can be inferred that though floods are a natural phenomenon in Kashmir Valley yet man has aggravated it by the indiscriminate deforestation, unplanned embankments, badly managed land reclamation and general increase of population.

The floods can be checked to a large extent by taking measures like afforestation, regular dredging of the Jhelum, strengthening and realigning the bunds without raising them, construction of more spill channels, and planning the reclamation of land. The flood prone areas of the Valley are low lying parts of left banks of the Jhelum river (Badgam Sonawari, Beerwah, Sopore and Handwana), the lower reaches of Lolab Valley and the adjoining areas of Wular lake.

Of the topographic divisions of the Valley the swamps (numbals) are most prone to inundation. The low lying areas are affected by high floods. On the Karewa uplands summer
aridity is very pronounced while highland slopes have the menace of soil erosion instead of floods.

II.6 SOILS:

Soils of Kashmir Valley have developed through a long geomorphic and lithological history influenced mainly by alternations of fluvial and glacial phases. The soils vary from alluvial to lacustrine and glacial. This variation has been caused more by climatic processes than the nature of present bed rock. The soils of Kashmir Valley have been deposited in their present sites by two main agents - rivers and glaciers. The contemporary scenario of soil in the Valley is a product of the ongoing transformation both by natural and human agencies.

The soil cover has enormous thickness in the bowl of Kashmir Valley and in the adjoining terraces of side valleys because of the massive deposition since pleistocene times. It is richest in the low-lying area along the Jhelum river, where it is periodically renewed and enriched by recurring floods. The thickness of the soil cover and its fertility, however, deteriorates with increase in altitude. In the highlands the rock bed is often devoid of soil cover as the slope is too steep. Low temperatures have slowed the soil forming processes at such altitudes.
Soil Zones:

The broad division of soils of Kashmir Valley coincides with its physical divisions. These are: (i) the Valley basin and the side valleys of the Jhelum, (ii) soils of the Karewa uplands and (iii) the highland soils.

The Valley floor Soils:

These occur up to 1850 metres above sea level. These soils of the Valley basin and the low altitude terraces are rich in nitrogen content, organic matter and other fertility raising plant nutrients. With high contents of phosphate and potash these soils are fairly rich in calcium and magnesium. Their pH value varies from 6.5 to 7.2. Texturally, they vary from clayey loam to loams with a nitrogen content varying from 0.4 per cent to 0.08 per cent*. These soils are wholly devoted to mono-culture paddy cultivation.

The Soils of the Karewa Uplands:

The flat topped lacustrine deposits are composed mainly of silts and are graded as poorer soils than the Valley basin soils. These soils are distinguished on the basis of colour differences. The colour of the soil varies from light (Ompara Karewa) to red-hued (Badgam Karewa), to dark blackish (Pampora Karewa) soils. As per fertility status dark blackish soil (locally known as surzamin) is rated the

* Per cent to total soil elements.
best, followed by red silts (gurti) and yellow-hued (shatt). The nitrogen content in these soils vary from 0.644 to 0.00132 per cent and potassium from 0.04 to 0.08 per cent. These soils are devoid of any vegetal cover and lack in organic matter. Owing to the heavy concentration of coarse sand in the upper layers, the moisture retaining capacity of these soils is poor. These are often composed of horizontal beds of coarse sand mixed with small pebbles. The upper most layer constituting about 50 per cent of total soil depth is pebble studied coarse sand. This is replaced by one metre thick fine sand. It is followed by compacted fine grained sand which is 4.5 metres thick. The lower layer of the these soils is composed of blue sandy clay of 1.0 metre thickness. Presently, the upper layers of Karewa soils are modified by the respective landuse. Irrigation is the main hinderance in an effective utilization of these soils. The lower reaches of these soils are devoted to paddy cultivation, while the upper reaches are devoted to saffron cultivation and horticulture.

The Highland Soils:

Owing to the factors like site, nature of slope and altitude, the highland soils are developed mainly in the hanging valleys and patches of flat lands. Because of the inertness of decaying agents, these soils contain very high undecayed vegetational content. These soils are acidic and deficient in bases, thus, making it the least productive
KASHMIR VALLEY
SOILS
for
AGRICULTURAL LANDUSE

INDEX:
- SILTS GURTI
- SWAMPS CLAY SOIL
- SILT LOAM SURZAMIN
- LOAMY SOIL BAHIL
- KARWA SOILS WOODER
- SANDY SOILS SIKIL
- IMMATURE MOUNTAIN SOIL
- ACIDIC SOILS
- WULAR LAKE
- GURTI LOCAL NAME
- POSITIVE FOR Cultivation
- NEGATIVE FOR Cultivation

soil of Kashmir Valley. Texturally, these soils are mostly silty and clay loams. These soils have a good water holding capacity. Because of the high rainfall and low evaporation the proportion of total soluble salts in these soils is low. Erosion is the serious problem of these soils. The pH value of these soils range between acidic to neutral (3.0 to 7.0). The available nitrogen content is medium to low. The proportion of organic matter is positively correlated with altitude. These have a low content of calcium carbonate. Their degree of weathering suggests that they are mostly skeletal and juvenile and at times are classified as degraded Podzols. Terrace paddy cultivation, maize cultivation and grazing are chief agricultural activities on these soils.

For the purpose of agricultural landuse the soils of Kashmir Valley can be divided into eight categories (Fig. II.10) which are (i) Gurti (silts), (ii) Sekil (Sandy), (iii) Bahil (loamy), (iv) Numbal (swampy and clay), (v) Surzamin (Black loamy), (vi) Woodar (Karewa), (vi) Immature mountain soils and (viii) Glacial soils. But to a Kashmir peasant the soils are mainly of four types: viz., Gurti, Bahil, Sekil and Dezanlands.

Gurti (silts):

These soils have a high percentage of clay and silts. Because of its higher water-retaining capacity, it supports
good crops even in the years of scanty rainfall. But at the same time due to excessive rainfall there remains a danger of inundation and resultant waterlogging. The fertility status of the soil is very high and is perpetually improved by recurring floods. This soil zone is roughly coterminous with the Jhelum flood plain which is largely subjected to fresh deposition of silts by Jhelum floods. This soil zone is demarcated by a hypothetical line joining the towns of Verinag, Duru, Achhabal, Anantnag, Awantipora, Pampur, Bandipore and Sopore on the right bank; and Kulgam, Shopian, Bijbehara, Pulwama, Badgam, Magam, Sumbal and Southern Baramulla on the left bank.

Bahil (loamy soils):

These are the best quality loamy soils with varying proportions of silt, clay and sand, from region to region. The proportionate share of silt and clay progressively declines with increasing distance from the flood-plains of the Jhelum and its tributaries. Inspite of its high fertility status these soils are given excessive doses of fertilizers and manures. It is darkish in colour and coal black when dried up. The main zone of occurrence of bahil soils lies above the level of the flood plains.

Sekil (sandy soils):

These are coarse texture soils with varying contents of sand. As there is an increase in the sand content in the soil the bahil changes into sekil. With assured supply
of irrigational water, **Sekil** soils can yield high agricultural returns due to its high humus content. At present these soils are under-utilized for cultivation as these are mainly under forest cover. This belt of soil is mainly found in the Sind Valley both in the lower reaches and in the terraces higher up.

**Dazanland (swamy)**:

These soils of the waterlogged and reclaimed lands are concentrated on the left bank of the Jhelum. **Dazanland** soils are of two types depending upon the nearness to the permanent waterlogged areas. The **dazanland** proper is found along the fringe of the swamps. It is highly compacted and heavy and yields good crops in normal years of rainfall. Second, the 'numbal' soils are swampy and reclaimed soils. These low-lying tracts near the banks of the Jhelum and Wular lake remain waterlogged seasonally. These are rich in peat contents and show good response to paddy cultivation.

The description of the Karewa, the immature mountain, and the glacial soils has been already stated in general groups of Valley soils. Other soils of lesser importance are **lemb, rad, tand, zabalzamin, kharzamin, rout, shath, tatz, wooder** etc. These soils are a variation between silts and Karewa soils.
II.7 NATURAL VEGETATION:

In the highland areas like Kashmir Valley, the variations in altitude and aspect are of great significance in affecting the character of natural vegetation. In a direct response to the varied factors of ecology, the natural vegetation of Kashmir Valley is highly variegated. The palaeontological evidences\(^\text{14, 15}\) show that the vegetal cover of Kashmir Valley has undergone great changes from tropical and sub-tropical to temperate types during the glacial phase of pleistocene. While recurrent glaciation destroyed the original vegetation, the uplift of Pir Panjals also played a key role in this climatic and floral transformation by preventing the southwest monsoons from penetrating into the Valley. This expedited the disappearance of broad-leaved species, which are now confined in the low-lying areas, and their replacement by coniferous types such as *deodar*.\(^*\) On the other hand the mesophytic flora of the northern slopes of the Pir Panjal is attributed to the uplift of the range that brought about a climatic change


\(^*\) The botanical names of tree and grass species found in Kashmir Valley is given in Table II.4.
Table II.4: KASHMIR VALLEY: BOTANICAL NAMES OF TREE SPECIES

<table>
<thead>
<tr>
<th>No.</th>
<th>English name</th>
<th>Botanical name</th>
<th>Kashmiri name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Deodar</td>
<td>Cedrus deodara</td>
<td>Deodar</td>
</tr>
<tr>
<td>2.</td>
<td>Himalayan Bluepine</td>
<td>Pinus excelsa</td>
<td>Kairu (Kail)</td>
</tr>
<tr>
<td>3.</td>
<td>Himalayan Silver Fir</td>
<td>Albies Webbi-</td>
<td>Budal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ana</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Yew</td>
<td>Taxus baccata</td>
<td>Poshtal</td>
</tr>
<tr>
<td>5.</td>
<td>Elm</td>
<td>Ulmus Wallichiana</td>
<td>Brenn</td>
</tr>
<tr>
<td>6.</td>
<td>Walnut</td>
<td>Juglens regia</td>
<td>Dun</td>
</tr>
<tr>
<td>7.</td>
<td>Italian Poplar</td>
<td>Populus nigra</td>
<td>Phraast</td>
</tr>
<tr>
<td>8.</td>
<td>White Poplar</td>
<td>Populus alba</td>
<td>Duchi Phraast</td>
</tr>
<tr>
<td>10.</td>
<td>Willow</td>
<td>Salix tetrasperma</td>
<td>Vir</td>
</tr>
<tr>
<td>11.</td>
<td>White Birch</td>
<td>Betula Utilis</td>
<td>Burza</td>
</tr>
<tr>
<td>12.</td>
<td>Plane</td>
<td>Platanus orientalis</td>
<td>Boin (Chinar)</td>
</tr>
</tbody>
</table>

Source: W.P. Lawrence, Valley of Kashmir (Kesar Pub., New Delhi, 1976).
from sub-tropical to temperate type of vegetation.

Responding to the ecological habitat, particularly climatic and edaphic factors, the biotic types of Kashmir Valley sharply differ from those of the southern face of Pir Panjal. Kashmir Valley forests are generally composed of a large number of species, although tracts with stands of pure communities are also found. The chief characteristics of the flora of Kashmir Valley are (i) absence of oaks as a predominant species, (ii) absence of laurels and low-level rhododendrons, (iii) a preponderance of fir, and (iv) negligible occurrence of spruce.

The natural vegetation of Kashmir Valley can be studied under two broad heads, viz. (i) grass lands and (ii) forests.

**Grasslands and Meadows:**

Along the meadows and grasslands lies the paradise of Gujjar, Bakerwals and other nomadic populations. With transhumance and pastoral economy as their way of living, this section of population of the Valley has achieved a greater attention in recent years in order to bring them with the national mainstream of development. Excessive grazing and encroachment on grass lands is threatening the pastoral way of life of these nomadic populace.

There is sufficient sunshine and moisture in the surrounding highlands of Kashmir Valley. These have promoted the
KASHMIR VALLEY
PASTURE LANDS

INDEX:

<table>
<thead>
<tr>
<th>III</th>
<th>FOREST CUM PASTURE AREA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rup</td>
<td>PASTURE LAND</td>
</tr>
<tr>
<td></td>
<td>CULTIVATION DOMINATED AREA</td>
</tr>
</tbody>
</table>

growth of a variety of temperate and alpine species of grasses. These highland pasture lands cover extensive areas in the periphery of glaciers, on moraines and other deposits, and on the favourable mountain slopes where any other type of landuse is not possible.

Recognised mainly as bio-edaphic communities these grasslands are of a temperate variety. These meadows (margs) cover about 10 per cent of the total geographical area of Kashmir Valley and are dominant in the hilly tehsils. Some of the important grasslands of the Valley are Gulmarg, Bungas, Nagmarg, Vijimarg, Gangabalmarg, Badmarg, Sonamarg, Poshpatar, Liddarwat, Astarmarg, Minimarg, Marganmarg, Wardwanmarg, Konmarg, Kongwatan, Rupimarg, Nandansarmsarg, Kharmarg, Yusmarg, Dudpather, Toshamaidan etc. (Fig.II.11)

Forests:

Forests of Kashmir Valley can be studied on the basis of (i) altitude, (ii) genetic characteristics, (iii) composition and (iv) management and economic exploitability.

Altitude:

The ecological niche and locational factors generate variations in the character and composition of plant communities at any level. The zoning of vegetation in the

KASHMIR VALLEY
ALTITUDINAL FOREST ZONES

ALTITUDE IN METRES

4570 - BIRCH
4265 - JUNIPERS
3960 - SILVER FIR
3656 - SHRUBY RHODODENDRONS
3351 - CONIFERS
3047 - PINUS EXCELSA
2742 - CEDRUS DEODARA
2437 - PINUS LONGIFOLIA
2132 - YEW CYPRESS
1830 - BROAD LEAVED WALNUT, ELM, OAK
1525 - POPLAR, MAPLE

FOREST TYPES (Species)

vertical plane as observed in Kashmir Himalayas is far more intricate. This zoning of forests in the Valley has been determined by altitude, locational factors such as terrain, slope, aspect, and soils. On the basis of altitude Kashmir Valley can be divided into the following four forests belts. (Fig.II.12)

(a) Between 1,524 metres and 2,286 metres is the mixed vegetation of broad leaved varieties of low altitude temperate forests. The important species are poplars, walnut, elms, conifers and deodars.

(b) Between 2,100 metres and 3,200 metres are found predominantly the coniferous varieties. Above 2,135 metres the broad-leaved varieties are outnumbered by coniferous. The elm is, however, known to occur upto 2,745 metres. The main conifers found in this belt are blue pine, fir and low-level silver fir.

(c) Above 3,200 metres are the species of alpine forests, the common variety is birch. Between 3,600 metres and 4,100 metres the common species are Junipers of different varieties, rhododendron, 'comanulatum,' Salix denticulata, 'Syringa emodi' and 'lomicera.'

(d) Above 4,008 metres are found the 'poa,' 'glyceria' and 'festuca' species of temperate forests that are intermingled with alpine meadows.
FIG II.13

KASHMIR VALLEY
FOREST TYPES

INDEX

- - - - BROAD LEAVED
III CONIFERS
- - - - ALPINE FORESTS

Genetic:

Genetically the forests of Kashmir Valley can be divided into montane, temperate and alpine forests. In the lower zone (1,500 metres to 2,100 metres) of montane and temperate forests, there is a dominance of broad leaved varieties. While in the higher reaches (2,100 metres to 3,200 metres) there is pre-dominance of conifer species. Above 3,200 metres in the alpine forests birch species are found with junipers and rhododendrons.

Composition:

The forests of Kashmir Valley can be divided into coniferous and broad-leaved varieties. The contour of 2,100 metres marks the dividing line between the dominance of broad-leaved species in the lower reaches and conifers in the higher reaches. (Fig.II.13)

Management:

Management-wise the Valley forests are divided into reserved, protected and unclassified types. This distinction is made between first class forest estates meant for better production (either reserved or protected) and the inferior stands of forests which are left unprotected and unclassified. Depending upon economic importance and accessibility, the Valley forests are grouped into commercial and non-commercial forests. Forest with pure stands and easy accessibility are labelled commercial while economically unprofitable species
and with poor accessibility are graded uncommercial forests. Out of the total of 7,315 square kilometres forest area,* of the Valley 45 per cent is reserved, 30 per cent is protected and 25 per cent is unclassified forests. 72 per cent forest area of the Valley is commercial while 28 per cent of forest area is uncommercial.

Among the districts of Kashmir Valley, Baramulla district with 69 per cent of geographical area under forest cover, leads the other two districts - Anantnag (58 per cent) and Srinagar (27 per cent). In all 51 per cent of total geographical area of Kashmir Valley is under forest cover (7,315 square kilometres). The share of the tehsils of the Valley in the forest area is shown in the Table II.5. Among the tehsils Anantnag tehsil with 1,881 square kilometres forest area has the highest forest area while Karnah tehsil with only 103 square kilometres has the least forest area.

Among the tehsils of Kashmir Valley, Sopore tehsil with 85 per cent of geographical area under forest cover has the highest concentration of forests. Closely following in this very high forest concentration region is Handwara tehsil with 80 per cent of tehsils geographical area under forests. In the high forest concentration regions are the tehsils of

## Table II.5: KASHMIR VALLEY: TEHSILWISE FOREST AREA

<table>
<thead>
<tr>
<th>Tehsil No.</th>
<th>Geographical Area sq. kms.</th>
<th>Forest Area sq. kms.</th>
<th>Percentage of forest area</th>
<th>Regionalisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sopore</td>
<td>2,652</td>
<td>941</td>
<td>85%</td>
<td>Sopore 85% Above 75%</td>
</tr>
<tr>
<td>2. Karnah</td>
<td>407</td>
<td>103</td>
<td>25%</td>
<td>Handwara 80% Very High</td>
</tr>
<tr>
<td>3. Handwara</td>
<td>1,588</td>
<td>1,299</td>
<td>80%</td>
<td>Srinagar 70% 50%-75%</td>
</tr>
<tr>
<td>4. Uri</td>
<td>6.97</td>
<td>302</td>
<td>41%</td>
<td>Anantnag 68% High</td>
</tr>
<tr>
<td>5. Baramulla</td>
<td>829</td>
<td>351</td>
<td>40%</td>
<td>Pulwama 69%</td>
</tr>
<tr>
<td>6. Sonawari</td>
<td>394</td>
<td>217</td>
<td>53%</td>
<td>Sonawari 53%</td>
</tr>
<tr>
<td>Distt. Baramulla</td>
<td>6,568</td>
<td>3,200</td>
<td>69%</td>
<td>Uri 41% 25%-50%</td>
</tr>
<tr>
<td>7. Anantnag</td>
<td>2,688</td>
<td>1,881</td>
<td>68%</td>
<td>Baramulla 40% Moderate</td>
</tr>
<tr>
<td>8. Kulgam</td>
<td>1,571</td>
<td>592</td>
<td>36%</td>
<td>Kulgam 36%</td>
</tr>
<tr>
<td>9. Pulwama</td>
<td>1,172</td>
<td>779</td>
<td>66%</td>
<td>Ganderbal 26%</td>
</tr>
<tr>
<td>Distt. Anantnag</td>
<td>5,431</td>
<td>3,214</td>
<td>58%</td>
<td>Srinagar 25% 25% Low</td>
</tr>
<tr>
<td>10. Ganderbal</td>
<td>1,453</td>
<td>390</td>
<td>26%</td>
<td>Badgam 16%</td>
</tr>
<tr>
<td>11. Badgam</td>
<td>1,242</td>
<td>210</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>12. Srinagar</td>
<td>469</td>
<td>298</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Distt. Srinagar</td>
<td>3,121</td>
<td>901</td>
<td>27%</td>
<td></td>
</tr>
<tr>
<td>Kashmir</td>
<td>15,120*</td>
<td>7,315</td>
<td>51%</td>
<td></td>
</tr>
</tbody>
</table>

* Excludes 733 sq. km. area that lies beyond the jurisdiction of districts.

Srinagar, Anantnag, Pulwama and Sonawari with respectively 70 per cent, 60 per cent, 66 per cent and 53 per cent of total tehsil geographical area under forest cover. In the moderate forest concentration region, are the tehsils of Uri, Baramulla, Kulgam and Ganderbal with 41 per cent, 40 per cent, 36 per cent, and 26 per cent of tehsil geographical area under forests respectively. The low forest concentration region is composed of Karnah and Badgam tehsils. Karnah tehsil has 25 per cent of its geographical area under forests while Badgam tehsil with 16 per cent geographical area under forests has the least forest area.

II.8 WATER AVAILABILITY:

The Valley of Kashmir has a large quantity of run-off along with large areas under water bodies. But the geomorphic character of the Valley is such that the distribution of water resources is extremely uneven. Vast stretches of land are rendered totally or partially out of use either due to excess of water or due to its deficiency. (Fig.II.14) Water is the most plentiful resource in the low-lying areas of the Valley. The Karewa uplands suffer from aridity caused by water deficiency. Thus, the optimal use of these lands is restricted by the availability of water. As a consequence, the Valley presents an anomalous case of scarcity in the midst of plenty. 17 Further, in absence

17. M. Raza et. al., op. cit., p.78.
FIG II 14.

KASHMIR VALLEY
HYDROLOGICAL NETWORK

of any systematic scheme for water management, the spill-over from the silted channels fill the low-lying areas, which have been converted into vast expanses of swamps (numbals). The rest of the water remains practically unharnessed before it escapes from the Baramulla gorge. Besides limited hydro-electric generation the only other use of this enormous resource is in gradient irrigation. The irrigation channels are wholly primitive in nature and are directed by the slope.

The total run-off that escapes down the rivers or accumulates in a large number of lakes and marshes is the indicator of the plentiful surface water resources of Kashmir Valley. Since the river systems of the Valley are fed with rain and snow, the flow is poor in all channels during winter months as most of the precipitation comes in the form of snow. The volume of surface run-off increases with the onset of summer season when the snow melts. Further, the summer rainfall augments the run-off. Normally, not less than 75 per cent of the total annual discharge of the Jhelum flows during April and August. In winter the discharge falls down substantially. Only 10 per cent of annual discharge passes down during November and February and less than 15 per cent during October and February.

The streams originating from Pir Panjal have a lesser share of the snow melt water and their discharge mainly
Table II.6: AVERAGE MONTHLY DISCHARGE OF RIVERS (1960-1980)

<table>
<thead>
<tr>
<th>Month</th>
<th>Percentage to Total Annual Discharge</th>
<th>Vishav</th>
<th>Rembiara</th>
<th>Sind</th>
<th>Liddar</th>
<th>Pohru</th>
<th>Jhelum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January</td>
<td></td>
<td>5.01</td>
<td>5.59</td>
<td>2.84</td>
<td>3.87</td>
<td>4.30</td>
<td>2.30</td>
</tr>
<tr>
<td>February</td>
<td></td>
<td>5.73</td>
<td>6.17</td>
<td>3.42</td>
<td>4.96</td>
<td>5.54</td>
<td>4.81</td>
</tr>
<tr>
<td>April</td>
<td></td>
<td>14.55</td>
<td>14.19</td>
<td>13.87</td>
<td>14.54</td>
<td>15.84</td>
<td>13.21</td>
</tr>
<tr>
<td>May</td>
<td></td>
<td>15.62</td>
<td>15.82</td>
<td>13.76</td>
<td>15.46</td>
<td>16.15</td>
<td>16.02</td>
</tr>
<tr>
<td>June</td>
<td></td>
<td>15.91</td>
<td>13.18</td>
<td>12.13</td>
<td>14.14</td>
<td>15.43</td>
<td>19.16</td>
</tr>
<tr>
<td>July</td>
<td></td>
<td>15.88</td>
<td>10.78</td>
<td>11.52</td>
<td>12.76</td>
<td>10.39</td>
<td>15.39</td>
</tr>
<tr>
<td>August</td>
<td></td>
<td>9.02</td>
<td>12.84</td>
<td>10.72</td>
<td>12.03</td>
<td>9.89</td>
<td>9.94</td>
</tr>
<tr>
<td>September</td>
<td></td>
<td>5.08</td>
<td>7.00</td>
<td>8.64</td>
<td>7.42</td>
<td>6.97</td>
<td>6.13</td>
</tr>
<tr>
<td>October</td>
<td></td>
<td>2.57</td>
<td>2.21</td>
<td>6.71</td>
<td>2.00</td>
<td>2.56</td>
<td>2.62</td>
</tr>
<tr>
<td>November</td>
<td></td>
<td>1.64</td>
<td>1.70</td>
<td>4.30</td>
<td>1.73</td>
<td>1.39</td>
<td>2.04</td>
</tr>
<tr>
<td>December</td>
<td></td>
<td>1.38</td>
<td>1.39</td>
<td>1.76</td>
<td>1.27</td>
<td>1.20</td>
<td>1.55</td>
</tr>
<tr>
<td>Total Annual Discharge (Cusecs)</td>
<td>2,05,892</td>
<td>1,03,872</td>
<td>11,71,561</td>
<td>8,31,777</td>
<td>10,35,263</td>
<td>43,02,644</td>
<td></td>
</tr>
</tbody>
</table>

Place of recorded Discharge

Arwani, Nayina, Prang, Gur, Siul, Baramulla

2. Dept. of Flood Control and Irrigation, Srinagar, Kashmir.
consists of summer rains. On the other hand, the streams rising in the Great Himalayan range are dependent more on snowfall. This presents an interesting contrast between the flow pattern of the Pir Panjal and the Great Himalayan rivers. The discharge of Pir Panjal rivers is not only low, but is also highly variable, as the amount of rainfall received is the major component of discharge. Owing to direct response to south-west monsoon rainfall the discharge of these channels in the Valley is 10 to 12 times that of December. Discharge data (Table II.6) from all rain gauge stations show a marked maximum in May and an equally marked minimum in November, December and January. Only 12 per cent of the total annual discharge of the Jhelum flows during winter (November to February). This discharge equals the total discharge of September and October. Eleven per cent of the total annual discharge of the Jhelum is recorded in March. The summer months account for 69 per cent of the total annual discharge of the Jhelum. The maximum discharge is recorded in June. Besides, there are marked variations in run-off from year to year and from day to day even in the peak period. But the yearly variation in precipitation is not reflected in the river discharge in the early months. It is significant only in mid-summer months.

Owing to the vast expanses of alluvial plains, the prospects of full utilization of water for irrigation are good. But the level of technology and the existing cropping pattern
do not present a conducive base for extension and modernization of irrigation network in Kashmir Valley. It is, therefore, necessary to fix priorities at the very outset and chalk out a comprehensive strategy for the optimal utilization of the water available for irrigation.

Irrigation in Kashmir Valley is easy, and in ordinary years, abundant. It is mainly derived from the surface flow. The irrigational water is channelised from the Jhelum and its tributary rivers at suitable sites and then distributed to the agricultural fields (mainly paddy) by a network of gravity canals (locally called Kuhls, Khais and Deras). Canal irrigation accounts for 97.18 per cent, springs and wells 1.27 per cent and other sources to 1.55 per cent of the total irrigated area. Among the canals the contribution of private canals is 64.07 per cent while that of government canals is 33 per cent of total irrigated area. It explicitly reflects that the utilization of ground water resources is almost negligible. There are two main factors responsible for not tapping the ground water resources for irrigation in the Valley of Kashmir. First, an abundant supply of water from surface flow particularly in the flood-plains and low-lying areas, rules out the need of dependence on ground water sources. Second, the local management and planning of the Valley for optimal use of water resources has been neglected. The bad conditions of the irrigation distributaries (Kuhls),
KASHMIR VALLEY
IRRIGATION
(TEHsil LEVEL)
1981

INDEX:
PER CENT TO TOTAL CROPPED AREA:
- 50.1% - 60.0% Area.
- 40.1% - 50.0% Area.
- 30.1% - 40.0% Area.
- 20.1% - 30.0% Area.
- 10.1% - 20.0% Area.

the negligible number of government owned and run tube-wells and the meagre annual budgetary allocation for irrigation shows that irrigation has been given low priority in the state development plans. Unfortunately, till recently the subsistence level of agriculture was taken for granted and the problem of aridity on Karewa uplands as incorrigible. But it is on these Karewa uplands that harnessing of groundwater resources and employment of non-traditional means of irrigation require utmost urgency.

Geologically the strata of low-lying area and Jhelum flood plains are favourable for the occurrence of economically exploitable ground water resources. Indirect evidence is provided to this fact by the presence of good number of springs in these areas. The springs seem to draw their supply from the affluent seepage of ground water. These springs have shown heavy and continuous discharge*; which is often put to miscellaneous uses and bulk of it remains unharnessed and unexploited.

The irrigation intensity regions are shown in Fig.II.15.

II.9 LAND CAPABILITY CLASSES:

In order to estimate the resultant effect of the agro-ecological factors on landuse of Kashmir Valley, the

* A number of boring in the neighbourhood of Srinagar city have yielded water within a depth of 150 metres. The discharge being as high as 91,000 litres per hour.
KASHMIR VALLEY
LAND CAPABILITY CLASSES

SOURCE: M. Raza et al., 1976.
classification of land needs to be done on the basis of soil characteristics, irrigation, climatic parameters, yield, productivity and the existing type of land use pattern. Classification of land as per its capability encompasses in itself the composite state of the physical conditions of land characteristics like altitude, aspect, terrain, slope, drainage, etc. and the mode of human interaction. Lands can be classified into two broad categories according to its capability: lands suitable for cultivation and lands unsuitable for cultivation. (Fig.II.16)

**Land Suitable for Cultivation:**

In this category of land capability, the agro-ecological factors provide the conditions for cultivation of crops.

**Class I lands:**

This class of land in the Valley of Kashmir is extending all along the length of river Jhelum with heavy concentration in the central parts: Srinagar, Pulwama, Badgam, Sonawari and Ganderbal tehsils. Due to deeper soils, highly fertile loam and clay loams in these lands, this class of land is most intensively cultivated. The soil erosion in this class of land is restricted during normal flow of the Jhelum by the gentle slope of the terrain.

Though, the agro-ecological factors are conducive to intensive cultivation yet the returns in terms of productivity per unit of land are very less because of low level of
technology and farm inputs. Of late, the administration has realised to throw open some incentive and subsidy schemes* to increase the agricultural produce of these lands. Mono-culture paddy cultivation is the dominant agricultural landuse.

Class II Lands:

These occur in two main compact blocks. The southern block covers the most parts of Kulgam tehsil while the northern block extends over the parts of Sopore and Handwara tehsils. These lands are characterised by coarse textured soil and heavy sub-soil. The sub-soil gets heavier with increasing depth. The surface soil has low to moderate permeability - low at sub-soil and very low at substratum. These lands are not prone to waterlogging and soil erosion is very less. Mono-culture Kharif paddy cultivation is predominant agricultural landuse while at places wheat is also grown as a rabi crop.

Class III Lands:

These lands have heavy concentration in Baramulla, Badgam, Pulwama and Kulgam tehsils. The soil cover is thin and permeability is minimal. Owing to the nature of slope of the land soil erosion imposes serious limitation

* 1. Subsidy on HYV seeds, fertilizers and pesticides.
2. Food grains procurement by the government agencies.
3. Free fodder crop seeds for rabi crops.
on the use of this class of land. Paddy is cultivated on the moist lower slopes while higher up slopes are devoted to saffron cultivation and horticulture.

Class IV Lands:

These are covering the surface of slopes suitable for unirrigated agriculture with stretches extending higher up in the side Valleys of the Jhelum river. The soils of this class are shallow with variable texture and permeability. These factors coupled with low moisture retention capacity, do not permit full maturization of the crops. The terraced paddy cultivation is practised by using rigorous measures of soil and moisture conservation and irrigation. On the gentler slopes with assured irrigation the main type of land use is paddy mono-culture. Dry slopes are devoted to maize cultivation and horticulture. Higher altitudes with favouring slope are devoted to barley cultivation.

Lands Unsuitable for Cultivation:

Because of the unfavourable agro-environmental condition these lands are agriculturally unused except for some grazing on highland meadows and collection of forest produce. These lands are concentrated on the steep slopes, high altitudes and submerged areas. Lack of vegetal cover, high level of erosion, steep slopes and unfavourable climatic conditions have restricted any type of profitable agriculture landuse.
Class V Lands:

With steep slopes and stone studded shallow soils these lands are not used for any crop cultivation. On the thin soil cover pasture growth is abundant and can be commercialised with the introduction of temperate farm and pasture technology and incentive based planning. Overgrazing and encroachments on these lands is a problem.

Class VI Lands:

These lands are concentrated in northern Bandipore, northern Kupwara, eastern and northern Karnah, Karnah south, Uri and eastern parts of Pahalgam and Ganderbal tehsils. These lands have steeper slope that are devoid of any vegetal cover. Situated on high altitudes these lands have barren and rocky surface.

Class VII Lands:

These lands are above snow line and are permanently snow-covered. Besides providing perennial source of water to the rivers of the Valley these high altitude ridges and peaks give a unique climatic character to Kashmir Valley.

II.10 AGRO-ECOLOGICAL REGIONALISATION:

An agro-ecological region is the region which has a homogeneity in the flow of energy and material through a designed system of linkages among the agro-ecological components. 18

Kashmir Valley because of its physical, climatic and agricultural setting represents an agro-ecological region at a lesser degree of homogeneity. But within the Valley of Kashmir agro-ecological components vary from place to place, thus it presents various micro agro-ecological regions at a higher degree of homogeneity. The present regionalisation of Kashmir Valley has been done with two methods. First, due to non-availability of agro-ecological data at primary level, that is the village level, the regionalisation has been done on the basis of interpolation of maps of the foregoing subheads of this chapter.* Second, the characteristics of the various agro-ecological components have been ranked as per their favourability for agricultural practices. Then the ranks have been grouped to find out scores. The transitional zones between the agro-ecological regions have not been shown because of their limited size and spatial coverage of area.

Based on the characteristics of agro-ecological parameters Kashmir Valley is divided into five agro-ecological regions (Fig.II.17 and Table II.7):

1. Intensively Irrigated Paddy Region of the Valley Floor;

* The resultant maps of the sub-heads of this chapter have been transferred on to transparencies and then these have been collectively projected on a canvas screen with the help of Overhead Projector. The projected map has been mapped and then reduced back to the scale of the original maps.
FIG. II. 17.

AGRO ECOLOGICAL REGIONS
OF
KASHMIR VALLEY

INDEX.

WULAR LAKE
JHELUM RIVER
NON AGRICULTURAL SLOPES

AGRO-ECOLOGICAL REGIONS:
INTENSIVELY IRRIGATED PADDY REGION OF VALLEY FLOOR
UPLAND KAREWA REGION OF SPECIALISED HORTICULTURE AND SAFFRON CULTIVATION
HILL SLOPES WITH UNIRRIGATED AGRICULTURE
PASTURE AND MEADOW REALM OF TRANSUMANCE
RECLAIMED SWAMPS AND MARSHY (NUMBAL) REGION
ii. Upland Karewa Region of Specialised Horticulture and Saffron Cultivation;

iii. Hill Slopes with Unirrigated Agriculture;

iv. The Pasture and Meadow Realm of Transhumance;

v. Reclaimed Swamps and Marshy (Numbal) Region.

Intensively Irrigated Paddy Region of the Valley Floor:

Below 1,800 metres contour line the Valley of Kashmir shows a homogeneity in the level of land. The land is almost level. It covers about 13 per cent area of Kashmir Valley. The average slope of this region is between $5^\circ$ and $10^\circ$ and it is the main centre of human activity in the Valley of Kashmir. The region is predominantly paddy cultivation oriented. The region is well irrigated by a network of traditional natural gradient system of canals. The lower areas of this region are occasionally inundated by Jhelum floods. The soils are mainly silts and clay loams, which are quite fertile.

Upland Karewa Region of Specialised Horticulture and Saffron Cultivation:

The Karewas are known after the flat-topped elevated hill plateaus lying all along the foot of the mountains surrounding the Kashmir Valley. These are chiefly of alluvial or lacustrine material and belong to Pleistocene epochs. These uplands border the plain of recent alluvium of Valley floor. They cover about 17 per cent of the total area of Kashmir.
Valley. These Karewas are divided from each other by ravines of 30 metres to 90 metres depth. Occasionally they are surrounded altogether by lower ground, but more generally they connect on to some of the mountains that bound the Valley.

Karewas, and their dividing ravines, occupy a width varying from 14 kilometres to 27 kilometres from Shopian to Baramulla. Beyond Sopore again, the north-western end of the Valley is mostly Karewa ground. The Karewas adjoining the mountains have their surfaces inclined from the latter with decreasing slopes. On the south-eastern side of the Valley, the Karewas reach upwards to an elevation of about 200 metres or 400 metres above the lowest plain of the river alluvium.

These lacustrine hillocks consist of horizontal beds of coarse sand, soft-brown sand, hard but fine grained sand, blue sand, clay, gravel and conglomerates. The coarse sand is occasionally hardened to stone. The southern and northern Karewas are also called 'upper Karewas' and 'Lower Karewas' respectively. Karewas are locally known as 'Wudars'. Some of the prominent Karewas in Kashmir Valley are: Mattan and Kanilwan in Anantnag tehsil; Zainapur, Bijbehara, Babapora, Namnagar, Dadiwular, Khanpur, Gosiwudar, Pampur and Devapur in Kulgam, Pulwama and Bijbehara tehsils; Damodar, Khushipura, Hanjak, Badgam, Tsundapur, Makahom, Tserawudar; Sikandarpura
in Badgam and Chadura tehsils; Kriri, Ushkur, Wagub, Pattan and Bandipur in district Baramulla; and Safapur, Krahama, Wajuludar and Pandach in Srinagar district.

The average slope of this region ranges between 10° and 20° and soils are primarily lacustrine beds with low water retaining capacity. This region suffers from aridity. The upper Karewas are mainly devoted to saffron cultivation while horticulture is the main agricultural use of lower Karewas.

Hill Slopes with Unirrigated Agriculture:

These are the gentle to moderate slopes on which agriculture is practised on terraces. This region covers about 31 per cent area of the Valley of Kashmir. The average slope of this region ranges from 20° to 30°. The predominant soil cover of this region is sandy and immature mountain soils. On the lower reaches paddy monoculture is practised while on the upper reaches maize, and barley are grown.

The Pasture and Meadow Realm of Transhumance:

This region comprises of vast high altitude summer grazing and pasture lands and accounts for about 16 per cent of the total area of Kashmir Valley. The average slope ranges between 30° and 40°. The soils are mainly acidic in nature. Erosion of the soil is the serious problem of this region. This is primarily devoted for the summer pastures and grazing of cattle by the transhumant groups.
of the state of Jammu and Kashmir, particularly Gujjar and Bakerwals.

Reclaimed Swamps and Marshy (Numbal) Region:

This region is almost a flat region and encompasses areas around the Jhelum flood plains and the Wular lake. It accounts for 13 per cent of the total area of Kashmir Valley. Being persistently under water cover this region suffers from water-logging, high alkalinity and very low agricultural productivity. Unchecked land reclamation is a menacing problem of this region which has upset the natural habitat of migratory and domestic birds, games etc. Paddy and oilseeds are the main crops on the reclaimed lands of this region.
Table II.7: KASHMIR VALLEY: MAIN CHARACTERISTICS OF AGRO-ECOLOGICAL REGIONS

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameters</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Altitude</td>
<td>1524 mts-1829 mts</td>
<td>1829 mts-2438 mts</td>
<td>2438 mts-3048 mts</td>
<td>3048 mts-3962 mts</td>
<td>1433 mts-1524 mts</td>
</tr>
<tr>
<td>2.</td>
<td>Age of the Dominant Rocks</td>
<td>Recent Pleistocene</td>
<td>Pleistocene</td>
<td>Devonian and Carboniferous</td>
<td>Pre-Cambrian and Cambrian</td>
<td>Recent Pleistocene</td>
</tr>
<tr>
<td>4.</td>
<td>Terrain</td>
<td>Flat</td>
<td>Hilly and Broken</td>
<td>Mountainous</td>
<td>Mountainous</td>
<td>Low lying</td>
</tr>
<tr>
<td>5.</td>
<td>Degree of Slope</td>
<td>5°-10°</td>
<td>10°-20°</td>
<td>20°-30°</td>
<td>30°-40°</td>
<td>Less than 5°</td>
</tr>
<tr>
<td>6.</td>
<td>Nature of Slope</td>
<td>Flat</td>
<td>Gentle</td>
<td>Moderate</td>
<td>Steep</td>
<td>Reverse Slope (Depression)</td>
</tr>
<tr>
<td>7.</td>
<td>Drainage Source</td>
<td>Snow, Perennial</td>
<td>Rainfall, Seasonal</td>
<td>Snow, Perennial</td>
<td>Snow, Perennial</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Drainage Pattern</td>
<td>Linear</td>
<td>Radial</td>
<td>Irregular</td>
<td>Dendritic</td>
<td>Centripetal</td>
</tr>
<tr>
<td>9.</td>
<td>Drainage Density (per sq. km.)</td>
<td>0.35-0.55</td>
<td>0.55-0.70</td>
<td>0.80-0.90</td>
<td>0.70-0.80</td>
<td>More than 0.90</td>
</tr>
<tr>
<td>10.</td>
<td>Weather condition*</td>
<td>Warm and humid</td>
<td>Dry and humid</td>
<td>Cold and humid</td>
<td>Severely cold</td>
<td>Warm and humid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>contd....</td>
</tr>
<tr>
<td>S. No.</td>
<td>Agro-Ecological Parameters</td>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
</tr>
<tr>
<td>-------</td>
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<td>--------------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>11</td>
<td>Season Sequence</td>
<td>Summer, Spring, Autumn and Winter</td>
<td>Spring, Autumn, Summer and Winter</td>
<td>Winter, Summer, Autumn and Winter</td>
<td>Winter, Spring, Summer and Winter</td>
<td>Summer, Spring, Autumn and Winter</td>
</tr>
<tr>
<td>12</td>
<td>Average Summer Temperature</td>
<td>30° Celsius</td>
<td>29° Celsius</td>
<td>20° Celsius</td>
<td>18° Celsius</td>
<td>31° Celsius</td>
</tr>
<tr>
<td>13</td>
<td>Average Spring Temperature</td>
<td>20° Celsius</td>
<td>18° Celsius</td>
<td>15° Celsius</td>
<td>10° Celsius</td>
<td>22° Celsius</td>
</tr>
<tr>
<td>14</td>
<td>Average Autumn Temperature</td>
<td>23° Celsius</td>
<td>21° Celsius</td>
<td>18° Celsius</td>
<td>12° Celsius</td>
<td>26° Celsius</td>
</tr>
<tr>
<td>15</td>
<td>Average Winter Temperature</td>
<td>5° Celsius</td>
<td>30° Celsius</td>
<td>-3° Celsius</td>
<td>-8° Celsius</td>
<td>8° Celsius</td>
</tr>
<tr>
<td>16</td>
<td>Average Annual Range of Temperature</td>
<td>-3° to 30° Celsius</td>
<td>-5° to 25° Celsius</td>
<td>-10° to 20° Celsius</td>
<td>-15° to 15° Celsius</td>
<td>0° to 15° Celsius</td>
</tr>
<tr>
<td>17</td>
<td>Average Annual Rainfall (in mm)</td>
<td>1000-1400 mm</td>
<td>400-700 mm</td>
<td>700-1000 mm</td>
<td>1000-1700 mm</td>
<td>1200-1500 mm</td>
</tr>
<tr>
<td>18</td>
<td>Rainfall Variability</td>
<td>15%-30%</td>
<td>20%-40%</td>
<td>15%-20%</td>
<td>10%-15%</td>
<td>20%-30%</td>
</tr>
</tbody>
</table>

contd....
<table>
<thead>
<tr>
<th></th>
<th>occasional Flood, No Drought</th>
<th>No flood, frequent Droughts</th>
<th>No flood, occasional Brought</th>
<th>No flood, No Drought</th>
<th>Frequent Flood, No Drought</th>
</tr>
</thead>
<tbody>
<tr>
<td>19. Flood and Drought Proneness</td>
<td>Occasional Flood, No Drought</td>
<td>No flood, frequent Droughts</td>
<td>No flood, occasional Brought</td>
<td>No flood, No Drought</td>
<td>Frequent Flood, No Drought</td>
</tr>
<tr>
<td>20. Average Annual Snowfall (mm of rainfall)</td>
<td>200-300 mm</td>
<td>100-200 mm</td>
<td>300-400 mm</td>
<td>400-600 mm</td>
<td>150-200 mm</td>
</tr>
<tr>
<td>21. Normal Snowing Period</td>
<td>Mid-November to mid-Feb.</td>
<td>November to February</td>
<td>Mid-October to mid-March</td>
<td>October to end March</td>
<td>Mid-November to mid-Feb.</td>
</tr>
<tr>
<td>22. Soil Type</td>
<td>Silts, Loams</td>
<td>Karewa</td>
<td>Sandy, mountain immature mountain</td>
<td>Sandy, mountain immature mountain</td>
<td>Clay loams and swampy</td>
</tr>
<tr>
<td>23. Soil pH value</td>
<td>6.5-7.5</td>
<td>4.0 to 6.5</td>
<td>Less than 4.0</td>
<td>Less than 4.0</td>
<td>More than 9.0</td>
</tr>
<tr>
<td>24. Fertility Status</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td>25. Soil Depth</td>
<td>Deep</td>
<td>Moderately deep</td>
<td>Shallow</td>
<td>Shallow</td>
<td>Deep</td>
</tr>
<tr>
<td>26. Grassland Type</td>
<td>No Specified Grasslands</td>
<td>Seasonal Grasslands</td>
<td>Permanent Grasslands but encroached</td>
<td>Permanent Grasslands but encroached</td>
<td>Permanent and Less encroached Grasslands</td>
</tr>
<tr>
<td>27. Forest Type</td>
<td>Broad leaved</td>
<td>Broad leaved</td>
<td>Coniferous</td>
<td>Coniferous</td>
<td>Alpine and Rho- broad leaved bushes</td>
</tr>
<tr>
<td>28. Common Tree Species</td>
<td>Poplar, willow, Willow, kikar, kikar</td>
<td>Pine, Chir, Silver Fir</td>
<td>Alpine and Rho- Poplar, willow, coniferous grass</td>
<td>Alpine and Rho- Poplar, willow, coniferous grass</td>
<td>Alpine and Rho- Poplar, willow, coniferous grass</td>
</tr>
<tr>
<td></td>
<td>Water Availability for irrigation*</td>
<td>10%-20%</td>
<td>30%-40%</td>
<td>40%-45%</td>
<td>65%-70%</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>29.</td>
<td></td>
<td>60%-70%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>Certainty of Irrigation**</td>
<td>Good</td>
<td>Poor</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
</tr>
<tr>
<td>31.</td>
<td>Land Capability Class</td>
<td>I</td>
<td>III</td>
<td>IV</td>
<td>V</td>
</tr>
</tbody>
</table>

Notes:
1. † First relates to precipitation and second related to relative humidity condition.
2. * Percentage of total area under irrigation from all sources.
3. ** 'Satisfactory' signifies irrigation with more manual efforts.

I: Intensively Irrigated Paddy Region of the Valley Floor.
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