Kashmir valley has been a half closed ecosystem, opening up slowly in space and across time. The Jhelum river has been and continuous to be the key element of the system. Kashmir is, indeed, a gift of Jhelum. It is born of it, made up of the detritus brought down by its numerous tributaries such as Sindh, Liddar, Vishav, Dudhganga, Shaliganga, Pohru, Erin and Madhumati rivers; and is united with it through every fibre of its being by sticking to the valley floor and developing the technology of the khul based paddy monoculture symbiotically linked with handicraft activity. The natural configuration of the enveloping crest has tended to strengthen the closed character of the system and has acted as a serious constraint on the processes of its opening up.

Water in the Kashmir Valley is an extraordinary paradox. Considering the total run off, area of water bodies and length of water courses, the Valley has no match in the Himalayas. Infact, its water features are the principal components in its scenic beauty. The geomorphic character of the valley is, however, such that the distribution which render vast stretches of land totally or partially out of use either due to the excess of water or its deficiency. Water is the most plentiful in the low lying parts of the valley, which remain literary deluged, while the adjoining Karewas uplands suffer from aridity imposed by its chronic deficiency. In both these respects the situation seriously constrains the optimal use of the Valley’s land potential. The consequence is that the valley presents the anomalous case of scarcity in the midst of plenty. The rivers carry large volumes of water which they cannot possibly contain as their channels get increasingly choked with silt, making floods a recurrent phenomenon with disastrous consequences on agriculture. Naturally, in the absence of any systematic scheme for water management, the spillover from the ever rising channels spreads all over the low lying tracts, which have been converted into extensive swamps, called the Nambal. The rest of the water flows out practically unharnessed, without being put to any substantial use before it escapes out of the Baramulla gorge.
Recent data show that only a tiny fraction of this vast potential is being utilized for hydroelectric generation, the aggregated annual production from all power houses being about 20,000kws. The only other use of this enormous resource is in gradient irrigation, through the distribution system of khuls, in the making of which modern technology has hardly any contribution.

The above remarks are, however, relevant only in the context of the present understanding of the valley’s water potential, which is by no means complete. It is interesting to note that no serious attempt has yet been made to assess this potential, its mode of occurrence, spatial distribution and temporal variation in its availability. Evidently, no comprehensive planning is possible in the absence of such primary data, whether aimed at draining the swamps, augmenting water supply in agriculture or generating hydroelectricity. In fact, the present state of knowledge inhibits even the estimation of the gap between the water potential and the actual amount is that being used productively.

An attempt will be made here to make an analytical study of the water resources of the valley, both surface and subterranean, temporal variation in its supply as perceived in the incidence of floods or drought and the current level of its utilization. The Jhelum and its numerous tributaries, a large number of lakes, depression and springs are the main water bodies of the valley. The present study will, therefore, deal with the problems of hydrology.

HYDROLOGICAL NETWORK AND DATA

There is a general dearth of consistent hydrological data for Kashmir for any reasonable period of time. This makes a meaningful temporal study of local hydrological phenomena impossible. The meteorological observatory at Srinagar was opened in 1891 and at Gulmarg in 1897. The position has not substantially changed since then. Regular meteorological data are, however, available only for Srinagar, as the Gulmarg observatory functions only during the four summer months June to September for reasons best known to IMD (Indian Meteorological Department) only. The rainfall is measured at a number of places though in many cases the records are far from consistent. Other than Srinagar, there are only four places-Wantipore (Pulwama), Anantnag, Uttarmachipora (Handwara) and Sri Pratap Singhpora (Badgam) which have rainfall records for at least eighty years. Gandherbal has a record
for 56 years only, beginning with 1924 and with a gap between 1933 and 1940.

Despite its heavy contribution to the valley’s moisture supply, snowfall is only casually measured. There are snow gauges at the observations at the last five places are highly occasional. The story of river discharge data is also not much different. A study of the surface run off is, however, handicapped both by inadequate measurement and inaccessibility to data. The present study is based on the average daily data contained in the Departmental files of the central and water and Power Commission for selected years and gauges only. The inconsistency in the data maintained by the central Water and Power Commission is also no less impressive.

The data on ground water resources of the Kashmir valley are not inconsistent, they are simply non existent. The available estimates of the occurrence of ground water and the recharge of aquifers are no better than intelligent geneses as a rigorous hydrological survey is yet to be undertaken.

FACTORS IN WATER AVAILABILITY

The availability of water in a region is a function of the whole set of variables which determine the quantum of water inflow, outflow, and storage changes at a given point of time. While meteorological factors play a fundamentals role in these processes, geological strata and topographical setting are decisive in determining the complexion of storage changes. The inflow, whether in the form of rainfall, snow or run off over or through the surface, is of critical importance as later changes in its state or place are only consequential in nature. The Kashmir valley receives precipitation both in the form of rain and snow. It has been noted that the rainfall has a peculiar distribution pattern through the year. It is overwhelming concentrated in the winter and spring months in all parts of the valley. The share of the winter and spring rainfall is, however, more than three- fourths of the annual total in the north-west (e.g. Handwara, Baramulla, Langet and Sopore), while it is only about one third in the central and the south eastern parts of the valley (e.g. Srinagar, Pulwama, Anantnag, Kulgam and Ganderbal). The annual rainfall shows a regular increasing trend from Badgam and Srinagar in all the directions. It is the lowest at Badgam (579mm) and increases towards the northwest from Srinagar (663) through Sopore (756), Langet (873) to Handwara (1005) and towards the southeast from Pulwama (592) through Kulgam (898) to Doru
Another interesting feature of the rainfall of Kashmir valley is its low average intensity per rainy day. An analysis of the fifty years data has indicated that the average intensity varies from 5.08 mm to 26.3 mm. There is a high expectancy of heavy rainfall in August or September which is often caused by a sudden cloudburst and is invariably followed by widespread floods in the Jhelum.

SURFACE WATER RESOURCES

The surface water resources of Kashmir valley are by any definition very large. The total run off that escapes down the rivers or accumulates in a large number of lakes and marshes is a powerful indicator of this plentiful supply.

The river systems of valley are fed by rain and snow. Naturally the flow is poor during winter months as most of the precipitation comes in the form of snow. The quantum of surface run off increases with the onset of summer when the snow melt, and, with the rain, generates a higher run off. Normally, not less than three-fourths of the total annual discharge of the Jhelum flows during the summer months- April to August. In winter the discharge passes down during November-February, and not more than fifteen percent during October – February.

The major streams of the Jhelum system have their sources in the snow fields of the surrounding mountains which fed them during summer. The streams rising in the Pir Panjal have a lesser share of the snow-melt and their supplies are augmented by summer rains. The streams of the great Himalayan range, on the other hand, are dependent more on snow than on rain. This produces interesting contrasts between the flow pattern of the Pir Panjal river is not only low, it is highly available as the quantity of rainfall is the major component.

A study of the decennial averages of the monthly discharge of Jhelum at Baramulla shows that only 11.65 percent of the total annual run-off flows during the four winter months (November-February). This is as much as the total discharge for the months of September and October and a little more than the discharge for the month of March alone. The five summer months (April-August) account for 68.65 percent of the aggregate discharge. The maximum comes in June although may also does not lag far behind.

TABLE
Average Monthly Discharge of Jhelum at Baramulla (data in cusecs)

<table>
<thead>
<tr>
<th>Months</th>
<th>Discharge</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>148985</td>
<td>3.48</td>
</tr>
<tr>
<td>February</td>
<td>214583</td>
<td>5.10</td>
</tr>
<tr>
<td>March</td>
<td>368565</td>
<td>8.60</td>
</tr>
<tr>
<td>April</td>
<td>587480</td>
<td>13.70</td>
</tr>
<tr>
<td>May</td>
<td>665498</td>
<td>15.52</td>
</tr>
<tr>
<td>June</td>
<td>672382</td>
<td>15.68</td>
</tr>
<tr>
<td>July</td>
<td>514356</td>
<td>12.00</td>
</tr>
<tr>
<td>August</td>
<td>503680</td>
<td>11.75</td>
</tr>
<tr>
<td>September</td>
<td>286413</td>
<td>6.68</td>
</tr>
<tr>
<td>October</td>
<td>189565</td>
<td>4.32</td>
</tr>
<tr>
<td>November</td>
<td>73685</td>
<td>1.72</td>
</tr>
<tr>
<td>December</td>
<td>62340</td>
<td>1.45</td>
</tr>
</tbody>
</table>

4287532  100.00

TABLE
Streams and Water Discharge (data in cusecs)

<table>
<thead>
<tr>
<th>Streams</th>
<th>Water Discharge</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Vishav river</td>
<td>206,408</td>
<td>4.9</td>
</tr>
<tr>
<td>2. Rembiara river</td>
<td>103,920</td>
<td>2.3</td>
</tr>
<tr>
<td>3. Sind river</td>
<td>1,171,631</td>
<td>28.9</td>
</tr>
<tr>
<td>4. Liddar river</td>
<td>831,845</td>
<td>18.5</td>
</tr>
<tr>
<td>5. Pohru river</td>
<td>1,025,315</td>
<td>27.6</td>
</tr>
<tr>
<td>6. Other</td>
<td>948,532</td>
<td>17.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,287,532</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

There are sharp variation in run off from year to year and from day to
day even in the park period. In a lean year, say 1965, the discharge in April
deviation from the decennial average by 8.5 percent; it deviated by minus 2
percent in may and by minus 28 percent in June. Such a high level of
fluctuations in water discharge creates a situation of scarcity of water for
few months before the onset of the snow fall.

Since the water is being used as a gradient irrigation for agriculture
and most of the settlements are located on the bank of rivers, the life of the
valley people faces the problem of scarcity of both for irrigation and
household purposes. The frequency of such type of disturbances is recorded
largely in the river catchment area originated from Pir Panjal side. The
situation has already been realized to regulate the snowmelt according to the
need of the people for irrigation and household purposes.
The discharge pattern in the three main right bank rivers of Jhelum –Liddar,
Sind and Pohru, is roughly identical, although time series data are not
available for any reasonable period of time. All the three have their
maximum discharge in May with April and June closely following in the
same order. These three rivers share in the total discharge by 80 percent in
the total discharge of the Kashmir valley.

GROUND WATER RESOURCES

The ground water resources of Kashmir valley are only marginally
known. There seem to be two major reasons for this lack of concern. First,
an abundant supply of moisture from the surface sources, particularly in the
flood plain of the Jhelum and other low-lying areas, ruled out the need to
depend on underground water. Secondly, the political situation before and
after the accession of the State of Jammu and Kashmir never aroused the
rulers to care for an integrated development of the valley through optimally
managing the land and water resources of the region. But it is on the Karewa uplands that the water problem is most acute and where agricultural development is contingent on the feasibility of successfully tapping ground water reserves.

Lately the government of Jammu and Kashmir seems to have become conscious of this problem as the Central water and Power Commission has been asked to launch a programme to access the ground water potential are however, available.

**UTILIZATION OF WATER RESOURCES**

The main users are still traditional ones gradient irrigation and generation of hydroelectricity is only marginal, and, if compared with the available potential, infinitesimal.

The main use of surface water resources of the valley is in gravity irrigation with the help of primitive technology. The Kashmiri system of irrigation consists of khuls which take off from water courses at convenient point. The khuls far surpass the government canal in term of area covered as well as length of channels. At present the area irrigated by khuls was as much as 16 times that of government canals. With the abolition of zamindari system the khuls fell into negligence and proved to be a menace to the adjoining agricultural land as the spill over from these channels caused current floods. The government has become conscious of this problem only recently and a comprehensive scheme has chalked out to expedite their restoration and renovation. Initially the scheme was designed to cover 2046 khuls only, though it envisaged an eventual takeover of all the remaining khuls with a command are of 1012 hectares. The government has however displayed little interest in the extension of irrigation to drier parts of the valley, particularly the chronically dry Karewas. Nor will it be possible to extend irrigation to these uplands unless more complex technology is employed which ensure lifting of water to areas tens of meters higher from the river valley floors.

One of the commonest uses of water is for drinking. Despite a plentiful supply of water in the valley, there is no systematic distribution expect in large urban centres. Among the districts of the valley, Anantnag seems to be best served. The town of Pampore, Shupiyan, Awantipura has water supply schemes. Of the nine urban centres in Baramulla district only four Baramull, Sopore, Bandipore and Gulmarg (Tanmarg) have a regular water supply. So far as rural areas are concerned, only large villages of wanigam and Bunagam in Baramula Tahsil; Nadihal, Tiyar, Seer and AAjar
Aithmulla in Sopore; and Sogam in Handwara have been provided with a water supply system.

Although the valley has a considerable potential for the generation of hydroelectricity, no major attempt has so far either industrial or domestic use.

The valley has two major hydroelectricity stations at Ganderbal and Moharra with an installed generating capacity of 15000 and 60000 kws respectively. They cater to the needs of the urban centres beside important tourist resorts and villages. The current situation of electrification of the villages is very satisfactory. But it includes both Hydro and Diesel electricity. The Valley O Kashmir produces about 335 MW shared by only 153 MW by hydro and 182 MW by diesel. Since the hydroelectric potential is so enormous there is no need to produce through the diesel. Only 40 percent of the total hydroelectricity is based on this potential. There are other hydroelectric stations with minimum production while 65 percent is still being imported.

The growth of electrification after independence and till 1960 was very unsatisfactory, till 1975 it increased from 12 villages under electrification to 1000 villages and till 1990 it increased period situation is more or less the same. On the whole about 95 percent villages are electrified on both local and imported electricity.

One may expect that in the foreseeable future water will be put to more and more varied uses as the economy diversifies and new schemes of resource conservation and utilization receive increased attention, it is therefore necessary to fix priorities at the very optimal utilization of the valley’s water resources and the situation of scarcity amidst plenty should be avoided for an integrated development.
NOTES AND REFERENCES

1. Rainfall and other meteorological data are available in the IMD publications: climatologically tables of observations in India and monthly and annual rainfall and the number of rainy days, New Delhi. The IMD did not, however, bring out a similar volume on snowfall – a meteorological variable of great significance for the Himalayan region. The monthly weather reports of the IMD contain such data for the Srinagar city and aerodrome observations. S.N. Bhan of the Srinagar observatory published a useful analysis of snowfall data for Srinagar.

2. Drainage and reclamation in Kashmir valley, central water and power commission, New Delhi.

3. Kulhs are irrigation channels in which river water is diverted by erecting weirs or “projecting snags”. The main channels pass into a network of small ducts and eventually empty themselves, into the Jhelum or into the large swamps (Lawrence, the Valley of Kashmir, P.323.)