Chapter – VII

IRRIGATION AND WATER MANAGEMENT

Water Requirement and Potential

Water is required for meeting domestic, industrial, hydropower development and agricultural needs, besides the fundamental ecological functions. Here, an attempt is made to calculate the annual water budget of the state, which will take into consideration water requirements and availability.

As mentioned earlier, on completion of the ongoing major and medium irrigation projects, a total irrigated area of 106,950 ha per annum would be created (See Chapter-II). As per an estimate of the Irrigation and Flood Control Department (IFCD) of the state government, the water requirement for these major and medium irrigation schemes is approximately 0.0972 Mham.

The water requirement for domestic consumption for Imphal is estimated at 100 million litres per day (MLD) and that of the 29 other towns at 30.09 MLD. Thus, the aggregate water demand of all towns inclusive of Imphal is approximately 130.09 MLD. The rural population of Manipur as per Census 2001 data is 18,18,224. The rural daily domestic water requirement estimated is at 72.72 MLD. Hence, the total demand for water for domestic consumption in the state is 202.81 MLD or 0.07402 Mham. The industrial demand is estimated at 0.1206 acre feet or 0.014876 Mham. Additional requirements of surface water per annum for power generation for the period up to 2000 AD is estimated to be approximately 0.939 Mham. The total requirement for water for the above mentioned purposes amounts to approximately 1.1251 Mham+0.0413 Mham=1.1764 Mham.

The total water resources of Barak and Manipur river basins are about 1.8487 Mham. The overall water balance of the state amounts to 1.5728 Mham in the annual water budget. The water resources of the Chindwin system and the water requirement for its ecological functions have not been taken into account. Water recycling is also expected augment the overall water of the state.

The current installed capacity for Imphal and other towns for domestic purpose is 113.12 MLD, which is 78.47 per cent of the estimated demand. Although this figure seems impressive, the ground reality is quite pathetic. The water supplied in most areas even within the capital city is inadequate and irregular. The existing water supply schemes in towns besides Imphal are designed and installed as per the rural standard, i.e., supply at the rate of 40 lpcd. The Public Health Engineering Department is trying to augment the existing water supply schemes to upgrade this to the urban standards, i.e., 70 lpcd in phases.

Under the Central Plan's Accelerated Urban Water Supply Programme, 16 towns are already included. Under the State plan, work is reportedly in full swing in four towns. Out of 2,815 rural habitations in the state, the state governments claims that 2,461 are provided with safe drinking water, 302 are partially covered and 28 are not covered. twenty-four habitations were deserted at the time of the survey. Although the official rural coverage position appears quite impressive, there are reports that many rural water supply schemes are neither sustainable nor functioning. In many parts of the state, people continue to drink unsafe water from traditional sources, such as ponds and tanks. It is also worrying that the newly created irrigation facilities are not producing the desired results, either in terms of an increase in net sown area or cropping intensity.

In Manipur, where agricultural activities and irrigation facilities are largely confined to paddy cultivation, the effective utilisation of irrigation should be directly felt in the area of rice cultivation and production. The figures in paddy acreage, production and yield over the years do not show any significant positive impact of irrigation (see Table 7.1).

Table 7.1: Rice Cultivation in Manipur Over The Period 1985-86 to 2003-04.

Year	Area under rice (000 ha)		Production (000 tons)	Irrigated (000 ha)	Area under improved variety (000 ha)	Yield kg/ha
	Settled	Jhum				
1985-86	137.37	25.23	332.53	50.81	37.56	1629
90-91	133.6	23.81	274.17	57.29	60.07	1742
95-96	105.14	29.79	338.05	33.54	52.68	2505
00-01	117.20	39.79	381.69	44.98	77.29	2470.3
01-02	120.10	42.47	387.26	40.14	86.16	2420.3
02-03	109.93	43.18	335.67	50.97	47.36	2192.4
03-04	116.04	41.79	381.24	39.98	60.28	2415.51
04-05	130.97	44.70	435.93	54.21	101.32	2472.52

Source: DES & SAM 2005 (p.147, 150, 152 & 175).

<u>Water Resources</u>

Although the state is small in geographical area, Manipur is comparatively rich in water resources, especially surface water. (See table 7.2).

Table 7.2: Average Seasonal Distribution of Rainfall (in cm) Over Some Important Meteorological Stations of Manipur (2003)

Station	District	Winter Dec-Jan-Feb	Summer Mar to Mid May	Monsoon Mid-May to Sept	Retreating monsoon Oct-Nov	Tota
Lamphel	Imphal	3.21	10.04	82.66 (79.62)	7.91	103.82
Raj Bhavan	Imphal	3	9.16	70.62 (78.31)	7.4	90.18
Wangbal	Thoubal	3.02	3	86.16 (87.75)	6.01	98.19
Ccpur	CCpur	33.4	69.6	406.38 (73.88)	40.7	550.08
Ukhrul	Ukhrul	6.8	9.9	77.05 (70.95)	14.85	108.6
Senapati	Senapati	8.9	25.4	212.18 (77.56)	27.1	273.58

Source: SAM 2004 (p.43-44)

The average annual rainfall varies from a minimum of 108.5 cm at Wangbal in Thoubal district to a maximum of 287.1 cm in Jiribam. Heavy rainfall in all stations from mid-May to September accounts for 70 per cent or more of the total annual rainfall. The winter and summer months are relatively dry. Thus, although the state receives adequate rainfall for agricultural purposes, it suffers from temporal variation. The low-lying valley portion of the state now regularly experiences floods. This is a major factor affecting agricultural productivity. The impact of this uncertainty must be reduced by putting in place an appropriate water resource management strategy, including appropriate irrigation and flood control measures.

<u>Drainage System</u>

The state is drained by various streams and rivers, which belong to three river systems namely, (a) the Barak system (b) the Manipur system (c) the Chindwin system.

a) The Barak river and its tributaries — Irang, Makru, Tuivai and Jiri — flow through the northern and western hills of the state, and have a total catchment area of 9,042 sq.km. This forms approximately 40.5 per cent of the region.

b) The water resources of the central valley include the Manipur river and its tributaries namely, Imphal, Iril, Thoubal, Nambul, Nambol, Khuga, Sekmai, and Chakpikarong, along with Loktak and its associated lakes. These have a total catchment area of 6332 sq. km and cover 28 per cent of the state's total area.

c) The Chindwin system consists of a number of small streams draining the eastern slopes of Manipur's eastern hills, and has a total catchment area of 6,953 sq. km. This forms approximately 31.1 per cent of the state's total area. The streams in this system are Akonglok and its tributaries, Chamu and Chingai, and Yu and its tributaries, Maklong, Tuyangai, Taret Lok, Lokchao, Lilimlok and Tuiyang.

The swift streams and rivers of the state originate from waterfalls and springs in the hills, lakes and marshes in the valley. A large number of streams in the hill areas are non-perennial while most rivers in the valley carry a fluctuating volume of water throughout the year. There are a number of large and small lakes in the southern part of Manipur valley besides the swamps and marshes along the lakesides and in the inter-riverine tracts. Loktak, the largest freshwater lake of the Northeast with a surface area of 288.96 sq. km, is the most important. Other important lakes are Waithou, Ikop, Kharungpat, Pumlen, Ngakrapat and Loushipat. The water resources of the Barak basin and the Manipur basin are estimated to have an average annual yield of 1.9541 million hectare metres (**Mham**), i.e., 14.98 million acre feet, with the former contributing of 1.3295 Mham. The average annual yield of the Chindwin system is yet to be estimated a rough estimate of it may be obtained by taking the product of its catchment area and the weighted average of annual yields of the Manipur River Basin and Barak River Basin. The estimated annual yield of Chindwin system works out to be 0.7951 Mham. Thus, the total water resources of Manipur add up to 2.7492 Mham. The sub-basinwise break-up of the water discharge is given below (Table 7.3):

Table 7.3: Manipur River Basin

S. No.	Name of Basin/Sub-basin	Catchment area in sq.km	Average annual yield in Mham
	A. (Upto Ithai Barrage)		
1.	Imphal River	560	0.0863
2.	Iril River	1260	0.0794
3.	Thoubal River	920	0.0652
4.	Sekmai River	426	0.0198
5.	Heirok River	305	0.0136
6.	Khuga River	458	0.0294
7.	Manipur River upto Ithai	200	0.0112
8.	Loktak lake through Khordak	980	0.1172
	B. (Beyond Ithai Barrage)		
9.	Maramba Maril	122	0.0050
10.	Chakpi River	660	0.790
11.	Tuining River	140	0.1049
12.	Others including Manipur river from Ithai to Myanmar Border	301	0.0136
	Total	6332	0.5192
	C. Barak River Basin		
1.	Barak including Irang river, Makru river and other tributaries	6865	0.8412
2.	Tuivai River	1860	0.3453
3.	Jiri River	316	0.1430
	Total	9042	0.3295

Source: IFCD, 1984, Government of Manipur, Imphal.

Ground Water

The Central Ground Water Board (CGWB) surveyed the hydro-geological conditions in 29.5 per cent of the state area. The valley area investigated for groundwater potential in Manipur is approximately 1,800 sq km, which is roughly 8 per cent of the total geographical area and lies in central Manipur, western Jiribam and Khuga in Tamenglong district. In places where the top soil is sandy or clayey, the depth of the watertable varies from 3 metres to 4 meters below the ground level. Tubewells are installed at various places in the valley, with yields ranging from 0.6 to 4 cubic meters per hour. On the basis of monitoring well water levels, the annual recharge is estimated at 44 million cubic meters. However, the development of this resource has limitations due to the clayey nature of the topsoil. The potable water quality was analysed by partial chemical tests of these water samples.

Table 7.4: Quality of Groundwater in Central Manipur Valley, Khuga Valley and Jiribam Valley.

S. No.	Characteristics	Central Manipur Valley	Khuga Valley	Jiri Valley
1.	pH	6.7-8.3	6.5-8.3	7-7.7
2.	Cl (ppm)	2-60	5-13	4-13
3.	Total hardness (ppm)	15-200	Calcium hardness 5.25	<100
4.	Bi-carbonates	55-680	39-263	30-190
5.	Iron	Slightly high for drinking		

Source: PHED, Govt. of Manipur

Not much information is available regarding the hydro-geological conditions prevailing in the valleys of Manipur. The only elaborate groundwater exploration project was executed between September 1999 and March 2001 by the Public Health Engineering Department (PHED) of the State government in collaboration with the Government of France. The study classified the Imphal valley into 10 high-potential zones or hydrogeological units. A study of groundwater recharge in these units revealed that aquifers are fully replenished even after a short spell of rain, indicating that groundwater recharge rates are very high and can be utilised on a large scale without risking unsustainable depletion of groundwater.

The most productive areas are situated at a higher level north of Imphal city. This is advantageous as extracted groundwater can flow easily from these areas to Imphal. These potential zones could be used for water supply to the secondary towns of Imphal valley, including Thoubal, Kakching and Bishnupur. The estimated renewable resource for the various hydrological units of Imphal valley is given in table 7.5.

Table 7.5: Renewable Resources of the Hydrological Units of Imphal Valley

S. No.	Hydrological unit	Annual Renewable resource (million m^3)	Equivalent daily continuous production (m^3/hr)
1.	Keikol-Potsangbam	5.6	640
2.	Khurkhul	2.5	300
3.	Mgneingkhol	1.5	170
4.	Irengbam	1.2	140
5.	Kanglatombi	4.8	550
6.	Kangchup	1.2	140
7.	Kharam	1.0	100
8.	Yairipok	1.4	150
9.	Heirok	0.36	40
10.	Palel	2.3	250
	Aggregate	21.86	2480

Source: PHED, Government of Manipur.

A groundwater-based water treatment and supply plant operates at Potsangbam. This plant has a capacity of 6.81 million litres per day (MLD). There is an approved project to further tap the groundwater from Potsangbam and Sekmai areas, in Phase II of the existing Potsangbam Phase I plant. The capacity of the Phase II plant is also expected to be 6.81 MLD. In the secondary zones of the Imphal valley, such as Thoubal, Kakching and Bishnupur, several areas with high groundwater potential were identified and studied. For each of these, a hydro-geological balance, including the renewable reserve, productivity of units and recharge of aquifer, has been prepared.

The geo–scientists and other experts involved in the project have recommended the development of groundwater for water supply on the basis of the water quality, availability and recharge rate, etc.

As per the estimates of the Central Ground Water Board, the aggregate dynamic groundwater for the state is 4357.46 million cubic metre (MCuM), of which utilizable groundwater for irrigation is 3703.44 MCuM and for drinking and allied uses is 433.25 McuM (Table 7.6). The gross draft of the available groundwater is negligible in all the districts, which means that groundwater development has not taken place in the state. This could now be tapped, adopting the most efficient and sustainable method possible.

Table 7.6: Ground Water Resource of Manipur & Its Potential (in Million Cubic Metres)

District	GW resource dynamic	Utilizable GW for Irrigation	Utilizable GW for Drinking & Allied	Gross draft
Bishnupur	1484.00	1261.00	2.23	negligible
Chandel	522.12	443.80	78.32	negligible
Churachandpur	756.80	643.28	113.52	negligible
Imphal East	79.27	67.38	11.89	negligible
Senapati	701.30	596.10	105.20	negligible
Tamenglong	772.82	656.90	115.92	negligible
Thoubal	41.15	34.98	6.17	negligible
Total*	4357.46	3703.44	433.25	negligible

* Imphal West and Ukhrul districts are not included in this.
Source: Central Ground Water Board

Irrigation and The Economy

With appropriate rainwater management, the monsoon rain should suffice for the growth of rabi crops in large parts of the valley and hill terraces. The temporal spread of rain may be more conducive to traverse intercropping instead of multiple cropping in the hills. There is a lot of scope to increase the cropping intensity, as can be seen in Table 7.7. The creation of irrigation facilities would encourage the farmers to adopt modern inputs, such as improved and/or high yield variety seeds, fertilisers and multiple cropping. The combined impact of all these can result in a quantum jump in production. It is worth mentioning that paddy cultivation is an extremely labour-intensive activity. Increased cropping intensity here would mean more employment opportunities. The construction and maintenance works related to irrigation facilities also creates employment. A well functioning irrigation system will thus promote agricultural productivity and employment generation.

Table 7.7: Cropping Intensity in Manipur Valley.

Year	Net area sown (ha)	Area sown more than once (ha)	Intensity index
1972-73	70,106	21224	130.27
1980-81	210,000	10,000	104.76
1982-83	135969	4315	103.17
1985-86	139982	5600	104.01
1990-91	146693	5765	103.93
1995-96	153772	6752	104.21
1998-99	155136	10478	106.75
1999-00	155212	10,575	106.81
2000-01	155287	10575	106.81

Source: DES, G. Brajamani Singh (2003), p-51.

Irrigation Capacity: Potential, Actual and Utilisation

Major and Medium Irrigation Projects

In the first three Five-Year Plans (1951-66) and the annual plans of 1966-69, no major or medium irrigation project was taken up for the state. The first major irrigation project, the Loktak Lift Irrigation (LLI) Project, was taken up in the year 1973-74, and the total expenditure on irrigation during the Fourth Plan was Rs 1.41 crore.

An outlay of Rs 22.51 crore was provided in the beginning of the Fifth Plan (1974-79). During this period, besides LLI, new projects comprising three medium river irrigation projects namely, Imphal Barrage, Sekmai Barrage, Khoupum Dam,one multipurpose project, Singda Multipurpose Project, were taken up.

In 1980, the Planning Commission approved the Thoubal Multipurpose Project for Rs 4,725 lakh. This earmarked project ran into all sorts of problems relating to land acquisition, rehabilitation and resettlement of oustees, law and order, etc. As a result, it remains incomplete. It is now targetted for completion by the end of 2006-07. The benefits of this project include an annual irrigation potential of 33,400 ha, water supply of 10 MGD and power generation of 7.5 MW. Another earmarked project, the Khuga Multipurpose Project, sanctioned by the Planning Commission in 1980 is targetted for completion in 2004-05. Its benefits will include an annual irrigation potential of 15,000 ha, water supply of 5 MGD and power generation of 1.75 MW, including a micro-hydel power component of 0.25 MW. The Dolaithabi Barrage Project, was sanctioned in the year 1992. The completion is targetted for 2006. This project is expected to create an irrigation potential of 7,545 ha.

The anticipated benefits from irrigation could not be fully achieved owing to the reduction in command area, due to various activities, such as urbanisation and expansion of the area under human habitation, development of ponds and tanks for pisciculture, inundation of agricultural land in the periphery of the Loktak lake caused by the Loktak Hydro Electric Project, etc.

In fact, the drastic fall in net area sown in the year 1982-83 from 1980-81 (table 7.7) is due to the vast inundation of agricultural land in the periphery of Loktak lake as a result of the development of the Ithai Barrage. Estimates of agricultural area inundated due to the project ranges from 20,000 ha. (Officially estimated figure) to as high as approximately 83, 000 ha[i].

Particularly for LLI, the canal systems located near the western foothills are exposed to recurring floods, causing heavy siltation. By the end of the Ninth Plan, the irrigation potential from the completed or partly completed projects is 28,500 ha with a utilisation of only 20,910 ha. As a remedial measure, schemes for modernisation and improvement of these projects were planned since the Seventh Plan period to be completed by the Ninth Plan. Due to lack of proper implementation, the schemes were carried over to Tenth Plan.

The state government is set to complete the three ongoing projects namely, Thoubal multipurpose project, Khuga multipurpose project and the Dolaithabi Barrage project by 2007. On their completion, an ultimate annual irrigation of 106,950 ha, water supply facility of 19 million gallons per day (MGD) and power generation of 10 MW will be achieved. Projectwise details of achievements up to the end of the Ninth Plan, and targets for the Tenth Plan are given in Table 7.8. The percentage of utilisation of potential irrigation created through the eight major and medium projects by the end of the Ninth Plan is 73.37.

By the end of the Tenth Plan, the target for potential irrigation is 106,950 ha whereas for utilization, it is 73,930 ha, which is a utilization rate of 69.13 per cent.

The following new projects have been proposed in the Tenth Plan:

1. Dam on Chakpi River at Chakpikarong, Chandel district. Its benefits include an irrigation potential of 12,000 ha, power generation of 7.5 MW and water supply of 1.5 MGD.
2. Dam on Iril River at Yangnoi, Senapati district. Its benefits include irrigation potential of 6450 ha, power generation of 5 MW and water supply of 5 MGD.
3. Dam on Sekmai River at Kangoi Hiranpham, Chandel district. Its benefits include irrigation potential of 3500 ha, power generation of 5 MW and water supply of 5 MGD.

The major and medium irrigation schemes, by their very nature, are concentrated in the valley. A disproportionately high share of the total budgetary resources (between 46 per cent and 64 per cent of the total revenue expenditure and 90 per cent of the capital expenditure) is spent on major and medium irrigation, drainage and flood control and command area development, all of which are valley-centric activities.

Minor Irrigation Schemes

As per the 2nd Census of Minor Irrigation Schemes (MIS) for Manipur, there were 296 MIS, comprising 36 shallow tube wells, 240 surface flow schemes and 20 surface lift schemes. There are no surface lift schemes in any of the hill districts and no shallow tube-wells in three of the hill districts, namely Chandel, Tamenglong and Ukhrul. The number of villages having at least one scheme under MIS is 264. This implies that MIS extends to approximately 11.04 per cent of the 2,391 villages in the state.

Approximately 75 per cent of the surface flow irrigation schemes were located in the hill districts. These schemes are especially suitable to the hilly terrains, but there is little attempt to put complementary micro hydel schemes in place.

The district-wise distribution of MIS in the state (refer to Table 7.8) shows that the maximum number of 74 MIS was in Churachandpur (25 per cent of the State total) whereas the minimum number of 9 MIS was in Chandel (3.04 per cent of the State).

Table 7.8: Achievement in Irrigation Projects Up to IX Plan and Target for X Plan (Unit in Thousand Ha.).

Sl.No.	Name of Project	CCA	Potential		Achievement up to IX Plan		Target for X Plan		Achievement up to 3/06	
			Revised	Ultimate with modernization	Potential	Utilization	Potential	Utilisation	Potential	Utilisation
A. Completed Projects										
1	Loktak lift irrigation	16.0	32.0	32.0	6.0	2.4	26.0	26.0	6.0	3.2
2	Sekmai barrage	5.0	6.8	7.0	6.9	6.2	0.1	0.9	6.9	6.2
3	Imphal barrage	3.6	6.4	6.7	6.5	5.4	0.2	1.4	6.5	5.4
4	Khoupum Dam	0.6	1.0	1.1	1.1	0.8	NA	0.3	1.1	0.9
5	Singda Dam	2.4	4.0	4.2	4.0	2.4	0.2	1.8	4.0	2.5
	Total for A	27.6	50.2	51.0	24.5	17.1	26.5	30.3	24.5	15.1
B. Ongoing Projects										
1	Khuga	9.5	15.0	15.0	NA	NA	15.0	15.0	NA	NA
2	Thoubal	21.8	33.4	33.4	4.0	3.8	29.4	0.2	4.0	3.8
3	Dolaithabi	5.5	7.6	7.6	NA	NA	7.6	7.6	NA	NA
	Total for B	36.9	56.0	56.0	4.0	3.8	52.0	22.8	4.0	3.8
	Total for A+B	64.5	106.1	107.0	28.5	20.9	78.5	53.0	28.5	21.9

Source: Draft Annual Plan 2006-07, Government of Manipur, Volume-I, p. 34.

Table 7.9: Outlay for Major & Medium Irrigation Projects in Manipur Over The Plan Periods

Plan	Outlay in Rs crores
4th	1.41
5th	20.00
6th	40.00
7th	74.00
8th	125.00
9th	222.00
10th	414.57

Source: ES, 2002-03,

Table 7.10: Distribution of Minor Schemes

District	Frequency	Irrigation (in ha)			No. of villages
		Potential	Utilization	Share	
Bishnupur	19	4171	2571	14.08	16
Churachandpur	74	4272	2485	13.61	66
Imphal	46	5643	2369	18.45	45
Senapati	35	2326	1398	7.65	31
Thoubal	47	2411	1345	7.36	39
Chandel	9	1476	885	4.85	9
Tamenglong	37	9524	5697	31.19	32
Ukhrul	29	822	515	2.82	6
Total	296	30645	18265	100	264

* Average utilization rate: 59.6%, Source: 2nd Census of MIS of Manipur.

Table 7.11: MIS Scheme Types, Irrigation Potential and Utilization, Lifting Devices Used.

District	Frequency	Irrigation (ha)		Lifting devices		
		Potential	Utilization	Diesel	Electrica	Others
A. Shallow tube wells						
Bishnupur	3	33	29	2	0	1
Churachandpur	2	7	7	1	0	1
Imphal	9	93	55	4	0	5
Senapati	3	4	3	3	0	0
Thoubal	19	171	101	13	0	6
Chandel	0	0	0	0	0	0
Tamenglong	0	0	0	0	0	0
Ukhrul	0	0	0	0	0	0
Total	36	308	95	23	0	13
B. Surface lift irrigation						
Bishnupur	4	648	388	4	0	0
Churachandpur	0	0	0	0	0	0
Imphal	11	2200	1309	2	9	0
Senapati	0	0	0	0	0	0
Thoubal	5	602	352	5	0	0
Chandel	0	0	0	0	0	0
Tamenglong	0	0	0	0	0	0
Ukhrul	0	0	0	0	0	0
Total	20	3450	2049	11	9	0
C. Surface flow irrigation						
District	Frequency	Irrigation (ha)		Type of Scheme		
		Potential	Utilization	Storage	Permanen	Temporary
Bishnupur	12	3490	2154	0	12	0
Churachandpur	72	4265	2478	0	54	18
Imphal	26	3350	2005	0	26	0
Senapati	32	2322	1395	0	30	2
Thoubal	23	1632	983	0	23	0
Chandel	9	1476	885	5	4	0
Tamenglong	37	9524	5697	1	35	1
Ukhrul	29	822	515	0	15	14
Total	240	26887	16112	6	199	35

Source: 2nd Census of MIS for Manipur.

As regards the area irrigated under MIS, Tamenglong district scores the highest, whereas Ukhrul accounts for the lowest share (Table 7.10). Amongst the 56 water-lifting devices used in MIS in the state, 34 were diesel pumps whereas only 9 were electrical, due to the poor availability of electricity in rural areas. Electricity is an important requirement for minor irrigation schemes, such as lift irrigation and tubewells. Inadequate infrastructure and low investment in minor irrigation has meant that the valley accounts for over 65 per cent of the area under irrigation in the state. Though hill districts have not been covered in the 3rd Census of MIS, Manipur, informations for valley districts are encouraging. Potential from MI schemes in the valley districts has gone up to 26992 ha from 12225 ha whereas the utilization figure has gone up to 19679 ha from 6285 ha.

Traditional Water Management Practices in the Valley

Ponds or *pukhris*, are the most prevalent traditional water harvesting structures. Till a few decades ago, almost every household had a pond of its own. Community ponds are also commonly found in the settlements. These are generally larger in size and better maintained than private ponds. The water supply situation in the State in terms of coverage and adequacy continues to be pathetic in most settlements. Hence, even today, a large majority of the population depends on ponds to meet their water requirements.

Private ponds are drying up in townships and heavy settlement areas where the premium on land is high. However, fortunately, the community ponds in these areas are still untouched. In fact, the heritage of the community pond seems to have strengthened in the absence of a satisfactory or reliable water supply system. Paradoxically, the extension of piped water supply worsened the water situation in some settlements as the residents began neglecting the ponds in their area. As the ponds went into disuse and dried up, water supply services became unavailable or very poor in many of these places. A substantial amount of the vegetables produced in the state are grown in private kitchen gardens, which use water from ponds.

It was quite common to have a small pond at the lower end of the plot in paddy fields. It was useful during the dry spells between the rains after sowing. However, most of these ponds are now filled up and reclaimed for cultivation. Rainwater harvesting is suitable for meeting the domestic water requirements of the State. This is due to the (*1*) heavy and widespread precipitation; (*2*) many houses already have GI sheet-covered sloping roof tops, and installing the simple structure required will be easy; (*3*) most of the residential houses are small, owner-occupied houses; (*4*) people are familiar with this concept, and (*5*) the relatively pollution-free atmosphere. However, the available storage structures are small in capacity. This is an area that NGOs are best suited to address.

Floods

In Manipur, floods are a phenomenon confined to the Imphal valley. Flash floods are quite frequent within the urban settlement areas during rainy season due to poor drainage conditions. The primary causes of flood in Manipur valley are:

(i) changing land use patterns and growing urbanisation, resulting in the destruction of basins in the valley. (ii) the high intensity of rainfall in the hilly areas i.e., the upper catchments of various rivers draining the valley during the rainy season and (iii) heavy runoff and low infiltration in degraded watersheds in the upper reaches of the rivers resulting in flash floods.
Regulation of water in the various streams and rivers occurs in two ways. The Loktak lake serves as an inland basin/reservoir for many streams and rivers.The Manipur river drains the rivers that do not form a part of the Loktak basin. The Khordak stream connects the Loktak lake with the Manipur river. These two drainage systems are, therefore, crucial to the condition of the water system in the state. Earlier, the various lakes of Manipur, mostly located in the southern part of the valley, served as effective reservoirs of excess runoff. Most of the lakes are severely degraded in quality to the extent of complete disappearance, resulting in severe curtailment of their water holding capacities.

The rivers that feed the Loktak lake flow down steep slopes for short distances. The speed of the streams is generally high, as is the load carrying capacity that causes the siltation of lakes. The ecosystem of the Loktak lake is under severe pressure on account of the barrage at Ithai, which has been constructed across the Manipur river. Here, the flow of the river during the monsoons is of the order of 400 cu m, and the river below the barrage does not have the capacity to cope with such high flow. As a result of this, there is waterlogging. This leads to a rapid rise in the water level of the river during the monsoons. Massive deforestation has already rendered the catchment areas quite barren and stripped their capacity to hold and regulate water flow. Moreover, there is a geological rocky formation just below the confluence of the Khuga river with the main Manipur river near the Ithai village, namely, the Sugnu hump. The rocky outcrop of the Sugnu hump serves as a natural barrier to the flow of the Manipur river resulting in the rising of the river bed due to the deposition of sediment.

Degraded land areas occupy 1,545 sq km, which is 24 per cent of the total catchment area and 35 per cent of the hilly region, causing higher erosion and runoff. The geological formation of Disang is predominantly shale and occupies almost 85 per cent of the hilly region. This leads to a low infiltration rate and high runoff. From a study of the pattern of soil erosion, the class of high and moderate to high covers 51 per cent of the area. The high sedimentary loads have made the river courses shallower. (See Chapter-II)

Flood-prone Areas

The high stream velocity of the Thoubal river causes breaching of river banks at Okram, Sabaltongba, Khekman, Ningombam, Leishangthem, Phoudel and Haokha. The confluence of the Imphal river with the Iril river at Lilong, makes it voluminous and rapid, Causing the breach of embankment in Chajing, Haoreibi, Samurou and Lilong. As per the survey report of the Manipur Science and Technology Council, most of the embankments are poorly maintained. At least 11 vulnerable points in Imphal river, 14 in Thoubal river and 5 in Iril river were identified. The rapid increase in the valley's built-up areas is also an important factor for the recent increase in flash floods in urban areas.

Recommendations

Flood Control Works

Strengthening and proper maintenance of the river banks, particularly at vulnerable points, must be taken up quickly. The lakes of the valley should be restored wherever possible. Water storing capacity should be increased by deepening beds and removing massive macrophytes and phumdies. In 2001-02, the outlay and expenditure for flood control works was Rs.70 lakh and Rs 32.44 lakh, respectively.

The estimated area protected to the end of the Eighth Plan was 33,296 ha, and up to the end of Ninth Plan, it was 40,296 ha. The IFCD has planned several flood control schemes in line with the Flood Control Master Plan, which include the improvement/raising of embankments, resection of the cross-section of rivers, construction of cross drainage works and bridges etc.
These flood control works are in the nature of firefighting, short-term measures. A more sustainable way of tackling the problem is to supplement the works with measures to strictly regulate urban land use in the valley, find a way out of the inundation at the barrage and treatment of upper catchment areas. With this multi-pronged approach, the drainage system will improve and siltation will reduce. This is the only long-term solution to prevent runoff and erosion in the hills and floods in the valley.

In the beginning of the twentieth century, there were approximately 500 lakes in the valley of the state. Only a handful have survived the onslaught of nature and man. The major causes for water pollution and degradation of the lakes include (1) disposal of domestic garbage, (2) leaching of chemical fertilisers due to agricultural and piscicultural activities, (3) encroachments for paddy cultivation, (4) draining of insecticides, pesticides and weedicides from the neighbouring crop fields due to rainfall and (5) misuse of toxic chemical for catching fish.

Some recommendations for treatment of catchment areas are given below:

(i) Construction of check dams throughout the catchment and ridge at suitable places in the area.

(ii) Development of suitable plantations over the denuded and barren hill slopes at the maximum possible scale and speed.

(iii) Encouraging terrace cultivation in the hill slopes and proper guidance of jhum cultivation. Construction of contour canals, subsurface dykes, gully plugging, terracing etc should be taken up. This step should be taken urgently as the ratio of settled land in proportion to jhum land under rice in the hill districts has been deteriorating over time, resulting in rapid land degradation in the hills and floods in the valley areas.

The above steps will help in regulating the inflow of water besides checking siltation, and sedimentation in the beds of rivers, streams, and lakes in the state. Local irrigation practices should be encouraged so that the plentiful water resources can be harnessed. Lifting water by pumping along the river levees for irrigation purposes should also be encouraged.

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[i] Singh, H.T. et. al (1994), S. Ibomcha Singh (1992)