Chapter – II

ENVIRONMENTAL SUSTAINABILITY AND NATURAL RESOURCE MANAGEMENT

The World Commission on Environment and Development (1987) defines the concept of sustainable development as a '*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*'. To understand the issue of 'environmental sustainability' in the context of development in 'Manipur', let us review some of the salient features of the economy of the state.

Agriculture and Land Use

Agriculture is the most important economic activity and, land and forests the most vital resource in Manipur. Inadequate irrigation facilities make its agriculture predominantly rainfed. Permanent cultivation is generally practised in the valley districts while terraced cultivation can be seen in some pockets of the hills. Jhum or shifting cultivation is widely adopted in most of the hills. (See Chapter-VI & VIII)

Land Resource of Manipur

Manipur, lies between 23.03^{o} and 25.68^{o} N latitudes covering an area of 22,327 sq. km. The hill ranges are aligned in a series of parallel north-south ridges. The general elevation of the ranges along the eastern aspect varies between 1800 to 2500 m. above MSL whereas the western range gradually gets subdued from 1100 to 800 m above MSL. The central valley has an elevation ranging between 700 m and 800 m above MSL. The central valley along with the Jiribam valley situated at a lower altitude of 400 m in the southwest part of the state outside the western hill ranges of Manipur occupies 11.72 per cent of the total geographical area of the state. The rest of the state is hilly.

Manipur is endowed with a wide range of climatic, physiographic and geological conditions resulting in the formation of different kinds of soils. The area-wise distribution of soil at order and suborder levels of taxonomy is given in Table 2.1.

Soil Characteristics

The state comes under the hot and warm humid/per-humid agro-eco region with a long growing period. However, at micro-level, it can be divided into three distinct sub-eco regions (zones) with thermic and hyper-thermic temperature regimes as follows:

1. Warm-humid agro-eco zone with thermic ecosystem
2. Hot-humid agro-eco zone with hyperthermic ecosystem.
3. Warm pre-humid agro-eco zone with thermic ecosystem.

Table 2.1: Distribution of Soil Orders & Sub-orders of Manipur

S. No.	Soil order	Area ('000ha)	% of TGA*
1.	Inceptisols	858.30	38.40
	(a) Ochrepts	*654.60*	*29.30*
	(b) Aquopts	*203.70*	*9.10*
2.	Ultisols	811.00	36.40
	(a) Humults	*374.00*	*16.80*
	(b) Udults	*436.90*	*19.60*
3.	Entisols		
	(a) Orthents	*515.60*	*23.10*
4.	Alfisols		
	(a) Udalfs	*3.80*	*0.20*
5.	Miscellaneous		
	(a) Marshy Land	*42.40*	*1.90*
Total		2231.00	100.00

*Total Geographical Area

Source: NBSS Publication 56, *Soils of India Series*

Warm Humid Agro-eco Zone With Thermic Ecosystem

This sub-region covers the whole of the north and eastern hills of Manipur and the Manipur valley with parts of the western hills as well, accounting for 72.8 per cent of the total geographical area (TGA) of the state. The length of the growing period (LGP) is in the range of 300-330 days. The soils are derived from shale and sandstone and mostly occur on the hills. The soils are acidic with high organic matter content. The available phosphate is very low in the soils of the upper reaches while it is medium in the soils of the narrow valleys. Valley and flood plain soils derived from alluvium are deep to very deep, poorly to moderately drained. The soils are slightly acidic to neutral with high humus content. The ground water table is generally high.

Land Use

The upper reaches of the hills are under deciduous forest while mixed forest species comprising bamboos, wild bananas, etc. occur in the lower steep hills. Jhum cultivation is practised in places of convenient slope grades on medium hill ranges in normal cycles of 5-10 years. Maize, sesame, potato, ginger, tapioca and vegetables are grown under shifting cultivation. Horticultural crops such as orange, pineapple, lemon, etc. are also terraced on the hill slopes under permanent cultivation. Valley lands are generally well bunded and used for intensive and permanent agriculture. The 'beel' areas have luxuriant growth of submerged weeds of mixed species.

Soil Constraints and Potentials of The Agro-eco Zone

Hill soils being acidic are not suitable for plant growth. Traditional shifting cultivation has been replaced by shorter cycles and frequent burning of the forest leading to loss of fertile top soil through erosion. The water holding capacity is also reduced.

The valley soils are mostly suitable for rice but these are low in available phosphorus and susceptible to flood hazards. Owing to high clay content in places farming becomes very difficult on account of water logging. These soils and agro-climatic conditions are ideal for the development of horticulture and the cultivation of tea. Beels and lakes can be utilized scientifically to expand fish production.

Hot Humid Agro-eco Zone With Hyperthermic Ecosystem
This agro-eco zone, occupying 12.8 per cent of TGA of the state, encompasses parts of Jiribam, Tamenglong and Churachandpur districts bordering Assam and Mizoram. The LGP for this sub-region is between 270-300 days.

The soils are heterogeneous in nature and developed in gently sloping narrow valleys and strongly sloping to moderately steep hills with moderate to severe erosion hazards. These soils are in general, well to excessively drained, fine to loamy skeletal, moderately to strongly acidic, humus rich and have a low base situation. Soils developed in narrow valleys are deep, poorly drained, and fine in texture and with slight erosion hazard.

Land use
The area is primarily under forest cover; sesame, potato, maize, ginger, tapioca and vegetables are grown under the shifting cultivation system. Horticultural crops such as orange, pineapple, lemon, pears, etc., are grown in these areas. Narrow valleys are cultivated permanently for paddy and maize.

Soil constraints and potentials
Hill soils of this region are strongly acidic and have low base status with comparatively less moisture holding capacity. These are low in available phosphate content and highly susceptible to erosion owing to heavy and swift run-off over the steep slopes. Shifting cultivation, land slides and mass movement are additional problems of the region. Horticultural crops may grow successfully here with proper management.

Warm Perhumid Thermic Agro-eco Zone
This region comprising the southwest part of the state covers 14.4 per cent of TGA. The land/surface configuration is mostly dissected hills with narrow valleys. The LGP of this sub-region ranges between 330-365 days. The organic carbon content of the soils is high and has a low base saturation and low cation exchange capacity (CEC). Soils are highly acidic.

Land Use
The area is mostly under forests. Sesame, potato, maize, tapioca and vegetables are grown under jhum cultivation. Some areas are used for fruit tree crops. Narrow valleys are generally used for paddy cultivation.

Soil Constraints and Potentials
Soils of this region are suited to crops tolerant to acidity, including horticultural crops. This region is also favourable for agro forestry and other silvipastoral systems.

Slope
Manipur has a hilly terrain where slopes are the most limiting factor for agriculture, affecting soil properties such as water retention, infiltration and erosion. About 60% of its total area comprises moderately sloping to moderately steeply sloping terrain.

Soil Drainage
Drainage is of two kinds, namely, surface and internal. Soil texture, relief and depth of the groundwater table govern drainage. These influence the soil-air-water

relationship, the redox potential and hence the availability of oxygen and nutrients. Since root growth is related to aeration, drainage can be a limiting factor for evaluating soil productivity for many crops. A little over 60% of the soil in Manipur can be classified as having somewhat excessive to excessive drainage.

Soil Texture

This indicates the relative proportion of primary particles namely sand, silt and clay. It is directly related to soil structure, porosity and consistency; it influences plant growth in many ways. The soils are dominantly loamy in texture (62.6 per cent).

Soil Erosion

Erosion refers to wearing away of the soil surface by external forces like wind, water and ice. It is the prime process responsible for variations in topography. Erosion by water coupled with shifting cultivation in places is the most important factor for soil degradation in the state. The dominant soils are grouped into four soil erosion classes, namely very slight, slight, moderate and severe. Nearly 89% of the surface area is covered by soils, which may be classified as moderate and severe.

Soil Reaction

Soil reaction or pH is the negative logarithm of the hydrogen ion activity of a soil at a specified soil water ratio. Soil reaction is the most important factor in regulating the availability of plant nutrients. The soils of the state are generally acidic. 85.44% may be classified as moderately acidic to strongly acidic.

Land Capability Classes

Despite favourable climatic conditions, the inherently poor soil characteristics and slope are major limitations. Only 16 per cent of the land comes under arable class suitable for agriculture. However there are some good soils in the form of narrow valleys associated with dominant soils in places.

Soil Degradation Status

The soil physiographic unit area on which soil degradation is found to occur accounted for 77.80 per cent, but the actual extent of degraded area amounted to only 15.10 per cent (Table 2.2). A major share of soil degradation is caused by chemical deterioration by way of acidification, loss of nutrients and organic matter in combination with water erosion and removal of top soil (Wt).

Table 2.2: Severity of Soil Degradation in Manipur.

Soil degradation type	Severity class ('000 ha.)					
	Low	Medium	High	Very high	Total area	% of TGA
Water erosion-loss of top-soil (wt)	147.60 (11.50)	419.60 (58.60)			567.20 (70.10)	25.40 (3.10)
Chemical deterioration (cn) with acidification and loss of nutrients acidification	37.90 (9.20)	274.40 (25.20)	220.10 (3.90)	452.30 (187.20)	984.70 (255.50)	44.00 (11.40)
Physical deterioration						
Water logging (pw)	11.70 (2.00)	63.80 (10.70)			175.50 (12.70)	7.90 (0.60)
Total	197.20 (22.70)	857.80 (94.50)	220.10 (33.90)	452.30 (187.20)	1727.40 (338.30)	77.3 (15.10)

Source: NBSS Publication 56, Soils of India Series, Nagpur

Forest Resources

The state possesses diverse and complex forest resources including a wide range of flora. It is very rich in bio-diversity. In fact, the state along with the rest of the northeastern region is one of the two IUCN recognized biodiversity hot spots in India, the other being the Western Ghats. It has many endemic species such as Lilium mackliniae and Schoenorchis manipurensis. At least 100 species of mammals and over 400 species of avifauna, many of which are extremely rare and endangered, are found here. It has 54 species of bamboo, out of the 125 species reportedly found in India.

Its forests are important sources of livelihood and environmental conservation. The total forest area of the state is currently over three fourths of the total geographical area (TGA) of the state. The forest of the state can be classified in various ways (i) by legal status, (ii) as per crown density, (iii) by composition, (iv) by groups, (v) or by vegetation (See Chapter-V). The share of open forests, that is, forests with crown density less than 40 per cent is more than 70 per cent as per land records though the Manipur Remote Sensing Application Centre, Imphal, reports it to be as high as 95 per cent of the forest area. A vast stretch of the forest seems to be in a very poor condition.

Table 2.3: Average Annual Stocks of Forest Products Across the Forest Divisions of Manipur Over The Period 1993-2000

Division	Timber (in CuM)	Fuel Wood (in Stack CuM)	Bamboo (in '000 numbers)	Cane (in 100 bundles)
Jiribam	71.75	NA	328.14	870
Bishnupur	29.00	106.29	4.14	5.83
Central	NA	1982.00	265.33	455.57
Eastern	NA	2040.50	9599.14	176.83
Northern	974.00	2544.71	NA	1008.57
Southern	2256.86	15147.43	30.86	1197.29
Tengnoupal	2657.00	9990.43	4.71	146.00
Thoubal	29.75	249.00	NA	NA
Western	1962.75	317.75	359.14	229.00

Source: Principal Chief Conservator of Forests, Imphal

According to a 1995 FSI assessment, the total growing stock of the state is 975,10,000 cu.m which is 2.06 per cent of the country's total. The growing stock of the state in terms of volume per ha is 55.34 cu.m, which compares quite poorly to the all India figure of 74.42 cu.m.

The data in table 2.3 clearly indicate the deteriorating condition of the forests of the state. The Northern and the Southern divisions are very rich in timber, fuel wood and cane and the stocks are sharply declining in all categories in these two divisions. The scale of rehabilitation operations will have to be larger for these two divisions. Though the area under dense forest increased over the recent years, there are huge wastelands within the forest areas. According to a report of the Society for Promotion of Wastelands Development, Manipur has 14.24 lakh ha of wasteland in forest areas.

Water Resources

The state normally enjoys good rainfall. The mean annual precipitation of the eastern aspect of this hilly terrain including the central plain varies from 1200 to 1350 mm whereas rainfall in the western aspect varies from 2000 to 2400 mm. There are rich water resources, especially surface water. The state has three river basins namely the Barak , Manipur and Chindwin River basins. The first two cover about 70 per cent of the TGA of the state and their combined water resources have been estimated to be

about 18,487 million hectare metre (Mham) in the form of average annual yield. Besides the numerous rivers and streams there are numerous large and small lakes, swamps and marshes, ponds and other water bodies, all of which together form the surface water resources of the state. (See Chapter-VII)

Hydro Energy

Manipur is richly endowed with hydropower potential. However barely 108.2 MW has been harnessed in the form of one medium project and some micro projects. The Loktak Hydro Electric Project (3x35 MW) commissioned in 1984 is so far the main source of power supply in the state. There are a large number of perennial streams and rivers in Manipur, which can be exploited for generating power through mini and small hydel projects. The total hydro potential of the state is estimated at about 2000 MW. There are also the ongoing multipurpose projects such as the Singda Project, Khuga Project and Thoubal Project (See Chapter-VII). However, a proper environmental impact assessment study of the Projects, which includes its impact on ecosystems, biodiversity and human society, should be carried out and debated.

Fishery

A majority of the population of Manipur eats fish. Though fishing activities in the state are mostly at a basic subsistence level, it is a powerful income and employment generator in the state. A survey of fishermen carried out in 1998, showed that out of the 34,067 persons found engaged in fishing activities, 19,889 were full time fishermen, 8398 part time and 5780 only occasional fishermen.

Potential

Manipur has about 1, 00,000 ha area suitable for fishery purposes. This supports as many as 130 species of fish, 27 of which have commercial value. The flood plains in Manipur valley, extending about 21,000 ha are suitable for 'capture and culture' fishery. There are also a number of water bodies harbouring commercial fish species besides the Loktak Lake, covering 19,000 ha. The state's river systems with a total length of 2000 km provide good grounds for capture fishery. There is also scope for paddy cum fish farming in 40,000 ha.

Of the estimated potential of fish production of 62,000 tonnes, the state is able to utilize only 20.5 per cent. The per capita production of fish for 2000-2001 was 6.99 kg as compared to an estimated per capita requirement of 11.44 kg, registering a shortfall of 4.45 kg per head per annum. The valley districts provide about 75 per cent of the fishery resources and about 85 per cent of the total production.

Inland fisheries development requires the setting up of experimental-cum-production fish farms, production of economically important fish seed and their distribution, intensive/semi-intensive and composite fish culture and technical and material assistance through extension services. Inland fisheries training is currently being imparted through the fisheries training centres within as well as outside the state. Under a centrally sponsored scheme, eight fish farmers' development agencies (FFDA) are functioning in the state at Imphal West, Thoubal, Bishnupur, Churachandpur, Chandel, Senapati, Ukhrul and Tamenglong districts.

However, FFDAs' achievements are limited: (1) Water area reclaimed: 2395.38 ha.; (2) Number of farmer beneficiaries: 7141 (3) Number of fish farmers trained: 4320. This

sector has the potential to bring about income enhancement, employment and supplement nutritional requirements.

Table 2.4: Contribution of Fishery Industry in SDP, 2003-04(P) (Rs. Lakhs)

Sector	At current price	
	GSDP	NSDP
Fishery	10760	9696
All sector	403440	367985
% of fishery to total	2.67	2.63

Note: (P): Provisional
Source: SAM 2005, p.108-111

Table 2.5: Production of Fish in Manipur (Excluding Imphal-West District).

Year	Fish seed farm	Production of fish (in '000 tonnes)	Fish seed production (in million)	Estmd requirement (in '000 tonnes)	Gap/deficit ('000 tonnes)	% of deficit to production	Ratio of production to requirement
90-91	14	8.50	-	18.00	9.50	111.80	47.22
91-92	14	9.95	63.00	18.30	8.40	83.90	54.37
92-93	14	11.20	66.00	18.61	7.40	66.20	60.18
93-94	14	11.52	71.00	18.94	7.40	64.60	60.82
94-95	14	12.01	81.00	19.30	7.30	60.70	62.23
95-96	14	12.50	90.50	20.51	8.00	64.10	60.95
96-97	14	12.71	100.92	20.99	8.30	65.20	60.55
97-98	14	13.70	110.05	21.47	7.80	56.70	63.81
98-99	19	15.31	98.20	21.86	6.60	42.80	70.04
99-00	19	15.51	115.00	22.24	6.70	43.40	69.74
00-01	19	16.05	116.00	26.27	10.20	63.70	61.10
01-02	19	16.45	116.20	25.67	10.60	64.00	60.98
02-03	19	16.60	N.A.	27.36	10.76	64.82	60.67
03-04	19	17.60	N.A.	23.83	6.23	35.40	73.86
04-05	18	17.80	N.A.	23.00	5.20	29.21	77.39

Source: DES, Government of Manipur, SAM 2005, p.188

Manipur should not only achieve self-sufficiency but also produce a surplus by 2020. Fish feed is one of the main problems in pisciculture development, and therefore it is essential to establish Fish Feed Plants. In order to increase productivity in the capture fisheries waters, a regular programme of fish stocking of 5,000 ha. of open water bodies with 25 lakh fish fingerlings per year is proposed. River ranching and stock replenishment of the open water bodies must be regularly arranged for obtaining a sustained yield.

There is a growing threat to the local endangered fish species and there is a need to provide viable alternatives to fishing by the use of any destructive devices. At the moment, two Projects viz. Pengba Project and Takmu Project are proposed. This will generate 1,47,000 and 12,68,750 (respectively) person-days of work. If successful, there may be employment opportunities for 6,48,000 fish vendors.

It is important to avoid overlapping of the responsibilities and activities of the Fishery Department and the Revenue Department. The best institutional strategy is to transfer all Registered Government Fisheries, which are now under the control of the Revenue Department to the Fishery Department, for effective conservation of natural fisheries resources and also to augment fish production.

Table 2.6: Fish Production in Districts (In Tonnes)

Year	Bishnupur	Chandel	Churachandpur	Imphal-East	Senapati	Tamenglong	Thoubal	Ukhrul	Total	% of valley production to total
1993-94	4245	320	335	2305	340	310	3340	320	11515	85.89
1994-95	4395	340	355	2425	360	330	3465	340	12010	85.64
1995-96	4545	355	375	2552	380	345	3595	355	12502	85.52
1996-97	4615	361	384	2595	387	352	3650	361	12705	85.48
1997-98	4865	400	425	2840	430	390	3950	400	13700	85.07
1998-99	4870	614	495	3050	490	400	4930	460	15309	83.94
1999-00	4852	460	304	3780	406	370	4902	430	15504	87.29

Table 2.7: Fishery Resources Across District in Manipur (Area in '00 ha.)

S. No.	Items/Particular	State	Chandel	Chura-chandpur	Ukhrul	Tamenglong	Senapati	Imphal	Bishnupur	Thoubal
1.	Lake/Reservoir/Tanks/Canal	132.21	-	-	-	.56.00	-	16.30	96.10	19.26
2.	Water logged/Marshy/Swampy land	115.26	-	-	-	-	-	7.334	3.82	103.70
3.	Biomass	85.96	-	-	-	-	-	46.28	39.69	-
4.	Submerged cropped land	34.81	-	-	-	-	-	12.86	19.16	2.79
5.	River/Stream	138.88	19.76	20.71	17.85	23.86	20.20	14.07	11.36	11.07
6.	Water logged area converted into new agricl. Land	17.38	-	-	-	-	-	2.68	-	14.71
7.	Low lying paddy	40.00	-	-	-	-	-	-	-	-
8.	Total	564.61	19.76	20.71	17.85	24.41	20.20	99.51	170.14	151.52
9.	TGA	22327.00	3313.00	4570.00	4544.00	4391.00	3271.00	1228.00	496.00	514.00
10.	% to TGA	2.53	0.60	0.45	0.39	0.55	0.62	8.10	34.30	29.48
11.	% to Total state fishery resource	100.00	3.50	3.67	3.16	4.32	3.58	17.63	30.13	26.84

Source: MSRSAC, Govt. of Manipur (1990).

Mineral Resources

The eastern part of the state abounds in narrow belts of fossiliferous cretaceous limestone and formation of the Disang group intruded by serpentinites. The likely reserves of limestone, lignite, chromite, nickel, copper, asbestos, clay and salt are situated in this part of the state. The central valley and Barak basin have distinct possibilities for the occurrence of petroleum and natural gas. The western part of Manipur is considered a potential area for oil exploration. ONGC has applied for petroleum exploration license over a total of 795 sq. km. included in three exploration blocks.

Limestone reserves of the state are estimated at 8.09 million tones and are predominantly located in Ukhrul district at Ukhrul, Hundung, Khankhui, Mova, Kasom and Lambui. They are also found in the Pallel-Chakpikarong belt of Chandel district and Monbung in Churachandpur district. Lignite with proved reserves of 12262 tonnes with associated clay of 2.52 million tonnes has been located in Churachandpur district. The lignite deposits found in the state are of the "Chrome lignite" variety used for stabilizing the drilling mud in oil operations. The Oil and Natural Gas Commission and Oil India Limited require a lot of chrome lignite, most of which is at present imported from foreign countries. The presence of chromite, nickel, copper and asbestos has also been detected in Ukhrul and Chandel districts.

It is believed that serpentinite could become the most important industry of the state. Commercially known as 'green marbel' serpentinite can be processed to make tiles, slabs and other building blocks. Its potential reserves have been estimated at 7500 million tonnes. It occurs extensively in Chandel and Ukhrul districts within the

Ophiolite belt, spread over about 1600 sq. km. This vast area however awaits full scale exploration.

Recommendations

The state should undertake community based participatory programmes to protect, preserve and enhance its natural resources as its major developmental potential is linked with the same.

Land Resource

Increasing urbanization and choking of basins in the valley due to the high pressure on land, unabated deforestation and shortening of jhum cycles are some of the factors responsible for the degradation of the production base (soil, water, vegetation). The severity of soil erosion in the state is very acute and has indeed reached alarming proportions. It is estimated that about 60 per cent of the TGA is degraded.

Forestry

The forestry sector needs to be developed to conserve the environment, regenerate and harvest forest produce and protect and expand the forest based livelihood and employment opportunities for the rural people who live inside or on the outskirts of the forests**.** There is a detailed discussion in Chapter-V, pertaining to issues of forest conservation.

Water Resources and Fishery

The chapter on water has detailed recommendations pertaining to water management (See Chapter-VII). Capture fishery resources in the form of hill streams and rivers have to be revived and steps to conserve endangered game species such as the Chocolate mahseer (Acrassochaelus hexagonolepis) have to be taken. There are many small and medium sized lakes apart from the huge Loktak Lake, which require either partial or complete renovation so as to make them usable for fisheries. The indiscriminate and unhealthy practice of dynamiting as a method of fishing has resulted in the destruction of feeding and breeding habitats of important game fish. Strict community-based regulation of fishing methods will have to be followed in order to revive the upland resources.

Many seasonal and perennial manageable water bodies need to be reclaimed for aquaculture purposes. Larger perennial water bodies should be managed for fish production through judicious ranching and harvesting, cage culture of fast growing fish and utilization of water resources for catering to the fish seed demand by establishing fish seed hatcheries in its vicinity. There are a number of tanks and ponds where intensive aquaculture can be practised. However lack of stocking material in the form of quality seed is the major bottleneck for such activities. Comprehensive, coordinated projects in this specific field need to be taken up jointly by the Manipur Centre of the ICAR Research Complex of the NEH Region, the State Fishery Department, Manipur University Life Sciences Department and Fishing Co-operative Societies, etc.

Minerals

There is potential to develop mineral based industry in the state. For this, an in-depth survey and investigation is necessary for precise estimation of mineral reserves like limestone, lignite, chromite, nickel, copper, asbestos, clay and salt and where they are situated in this part of the state. One immediate step could be to find the ways and means of re-activating the defunct Hundung cement factory in Ukhrul district. Survey and estimation of the available serpentinite reserves will help assess the possibility of establishing serpentinite-based industries. This could generate a lot of employment and is likely to become the most important industry of the state.