Chapter 2

Natural Resources

Natural resources provide the base on which the edifice of development is raised. Its use depends upon the type of economy, the level of technology and preferences of the culture of a given society. The importance of natural resources is more critical to societies which are at a relatively low level of development. People have to conform their livelihood and life style to the settings of nature. The sustainable use of natural resources to attain high levels of human development has become imperative. Natural resources of Himachal Pradesh have a direct relationship with its physiographic conditions including relief, drainage, climate and geology. These in turn influence the type of soils and the kind of vegetation cover.

Physiographic Zones

Himachal Pradesh has been divided physiographically into four distinctly identifiable zones based on variations in altitude, climate, geology, soil, flora, fauna and topography as follows:

Shivalik Hills

These are the outermost foothills of the state and mark its southern boundary from east to west. Stretching for about 70 km, their average elevation is about 1000 meters. To the north of Shivalik hills lie longitudinal valleys, locally known as duns. These valleys are drained by a network of streams, which deposit vast quantities of sediments that make them highly fertile and support dense populations. Kangra valley, Chakki dun valley and Paonta valley are among the important duns. A small plain tract lying south of the Shivalik Hills falls in Himachal Pradesh. Many seasonal streams known as choes cause flash floods in the rainy season. Markanda and Ghaggar rivers originate in the Shivalik Hills.

Lesser Himalayas

This zone extends to 65 to 85 km with an average elevation of about 3300 mts above the mean sea level, and forms the central part of state. The important ranges here are the Pir Panjal and Dhauladhar Ranges. The Pir Panjal range form the water divide between Chenab river on the one side and the Ravi and Beas on the other. The Dhauladhar is a majestic snow clad range cut across by rivers like the Ravi, Beas and Sutluj. Both north and south facing slopes support luxuriant forests, except in tracts above the snowline. It is marked by several glaciers. The Giri and the Gambhar rivers have their origin in this physiographic zone.

Greater Himalayas

Lying north of the Pir Panjal and Dhauladhar ranges, this zone is marked by lofty snow-capped peaks, glaciers and old U-shaped valleys. Most of the peaks have an elevation of about 5500 meters. Some of the famous passes through the ranges are the Rohtang Pass, the Bara lacha Pass, the Kangla Pass, the Parang Pass and the Pin Parbati Pass. The presence of glaciers, moraines, and U-shaped valleys, indicates that a major part of the state was once under the influence of glaciation. There are several hot springs indicative of geothermal energy. This towering range acts as a barrier for the southwest monsoon, thereby causing a rain-shadow effect in tracts lying to the north.

Trans-Himalayas

This zone lying to the north of Greater Himalayas with an average elevation of 3000 meters is marked by cold desert-like conditions. The Zanskar range is the most important range in the region. It separates Spiti and Kinnaur from Tibet. The Sutluj cuts a deep gorge across the range at Shipki Pass. Leo Parigial (6791

meters) is the highest peak. The zone is devoid of vegetation.

Drainage Network

The state is drained by nine major river systems, and thereby has nine catchment areas. Some of these are the Satluj (30.69%), the Beas (24.5%) the Chenab (14.2%), the Yamuna (10.6%), the Ravi (9.9%) and the Indus (2.6%). These catchment areas are further subdivided by several water divides. The major rivers are glacial-snow fed and perennial in nature. The seasonal streams of the Shivalik foothills depend on rainwater.

Soil Types

The soil of Himachal Pradesh varies from thin and bare soil of high mountains to rich deep alluvial soil of the valleys and to snow-covered soil. These soils can be classified as follows.

1. **UDalfs-Ochrepts soils:** Shallow in veneer and brown in colour, these are high base status soils of humid regions covering parts of Chamba, Lahaul and Spiti, Kinnaur, Sirmaur, Mandi and Bilaspur.
2. **Othents-Ochrepts soils:** A combination of shallow black, brown and alluvial soils, these are found in Lesser Himalayas, including parts of Sirmaur, Solan, Una, Hamirpur, Kangra and Chamba districts. These are also red loamy and red sandy in nature in parts of Kullu, Kinnaur, and are ideally suited for horticulture.
3. **Udolls soils:** There represent the characteristics of a cold desert and are found in Lahaul and Spiti.
4. **Glaciers and snowcap soils:** are spread in part of Kullu, Lahaul and Spiti and Kinnaur where glaciers and snow cover is present throughout the year.

The soil of Himachal Pradesh is under gully and sheet erosion. About two-fifths of the state's area is under the impact of very high intensity erosion.

Land Resources

The total area of Himachal Pradesh is 55,673 sq. km. This would give less than one hectare of land to every one among the 6.1 million people recorded in the state in 2001 census. Hardly 10 per cent of the total area is cultivated and the actual forest cover extends to 22.5 per cent of the total area. Permanent pastures and other grasslands account for about 24 per cent of the total area. Barren and unculturable land covers about 14 per cent of the area of the state. About 23 per cent of the total area remains unsurveyed.

Himachal Pradesh can be divided into the following five zones on the basis of geographic and socio-cultural patterns:

i. North-eastern region
ii. Northern region
iii. Central region
iv. South-eastern region
v. South-western region

The north-eastern region spreads over an area of 23,695 sq. km., which is around two-fifths of the total area of the state. It comprises the districts of Kinnaur, and Lahaul and Spiti, and Pangi and Bharmaur blocks of Chamba district. The entire region is sparsely populated and has no urban centre. Population density is hardly 7 persons per sq. km. More than 70 per cent of the population belong to the category of Scheduled Tribes. The entire territory has been declared a scheduled area.

The northern region has an area of 3497 sq. km. It has a population density of about 100 persons per sq. km. The development blocks of Tira, Saluni, Chamba, Bhattiyat and Mehla, all in Chamba district, belong to this region. Its economy combines agriculture with pastoral activities. Chamba, Bakhloh, Chauri Khas and Dalhousie are the only urban centres of any significance.

The central region comprises the districts of Kullu and Mandi as well as the Baijnath development block of Kangra district. It covers an area of 10,751 sq. km. Population density is around 125. Agriculture is the main avocation of the people, and the region is predominantly rural. Mandi, Sundernagar, Kullu and Jogindernagar are the important towns.

The south-eastern region comprises Shimla, Sirmaur and Solan districts. Apart from agriculture, horticulture, tourism, trade and commerce and industry have emerged as notable activities. Industrial centres include Paonta Sahib, Nahan, Kala Amb, Solan, Nalagarh, Baddi, Barotiwala, Parwanoo, Dharampur and Chambaghat.

The south-western region largely covers areas which were transferred to Himachal Pradesh after the linguistic reorganisation of Punjab in 1966. It comprises Kangra, Bilaspur and Una districts. Hills, mountains and wide valleys intermingle here. Population density is around 300. This region suffers from serious ecological problems, such as soil erosion, deforestation, land degradation and depletion of the water table.

On the basis of land use, Himachal Pradesh can be subdivided into three broad regions:

i. Intensively cultivated, moderately forested southern region with marginal presence of pastures and other grazing lands;

ii. Moderately cultivated, highly forested central region with a considerable proportion of pastures and other grazing lands; and

iii. Poorly cultivated, and sparsely forested northern region with a high proportion of pastures and other grazing lands.

From the above description, it is clear that considerable improvements are required for an optimum utilisation of land. First, the forest cover needs to be extended to more areas, as it is much below the target of the national forest policy, according to which a hill state should have 60 per cent of its area under forests. The state government may also frame policies for sedentarising the migratory *gujjar* graziers. They may be encouraged to change their traditional mode of livelihood. They may adopt new agro-economic activities, combining livestock rearing, with cottage industry and vegetable cultivation.

Secondly, there is need for proper management of extensive wastelands, culturable fallow or other lands. A co-ordinated and regularly monitored intervention is required.

Thirdly, the policy of shifting the management of common lands from the community to the state has not proved beneficial, as it has reduced the scope of the people's participation in resource management. This process should be reversed.

Above all, the unsurveyed parts of the state need to be studied and mapped by the Remote Sensing Cell using satellite data.

Water Resources

Water is one of the most vital natural resources of Himachal Pradesh. The state is richly endowed with a hilly terrain having an enormous volume of water from the catchment areas of Satluj, Beas, Ravi and Chenab rivers. These rivers form part of the Indus system. As such, the state has enormous potential of water resources in the form of glaciers and rivers but ground water resource is limited.

Inspite of the fact that there is a large volume of water available in the state, only one-third of its cultivated area is irrigated because of physiographic constraints. It is ironical that this water rich state is also not free from drought at times. The normal monsoon rainfall (June-Sept) in the state varies from 17 to 120 cm. Mandi, Bilaspur, Sirmaur, Una, Hamirpur and Kangra are high rainfall districts where the annual rainfall exceeds 100 cm. Lahaul and Spiti and Kinnaur districts receive a low annual rainfall of about 20 cm.

Availability of Water Resources

Surface Water Resource

Most of the surface water resources of Himachal Pradesh flow from perennial rivers which originate from glaciers. The flow in these rivers is further augmented by run-off from the catchment areas.

Glaciers: Glaciers are located in higher Himalayan reaches (above 4000 meters) in Pir Panjal, Dhuladhar, Zanskar and Great Himalyan ranges. There are 601 glaciers in the state and a majority of them are small in size with accumulation zone of 2 to 4 sq. km. These are linear in form, varying in length from 2 to 25 km, and lie on mountain slopes and in depressions. Almost all these glaciers are in a state of constant recession. The glaciers in these mountains are the relics of an older and more extensive series of ice flow. The recent phenomenon of global warming is hastening the process. Glaciers like Bara, Shingri, Gaglu and Sonapani have a yearly recession of 10 meters to 20 meters. The snowmelt contribution to the river systems in the state is as follows (Table 2.1):

TABLE 2.1

Snowmelt Contribution to the River Systems in Himachal Pradesh

Name of basin	*Name of Tributary*	*Location*	*Snow Melt Area Km. Sq.*	*Total Average Snowfall Considered cubic km.*	*Computed Snow Melt run-off (90% of col 6) cubic km.*
Indus	Beas	Mandi	3128	0.405	0.365
	Sutlej	Plain		1.083	
		Ropar	46882	0.0161	0.975
Ganga	Yamuna	Tejewala	1980		0.145

Source: Water Resources of India, CWC Publication No 30/88.

Rivers: 90 per cent of Himachal's drainage forms part of the Indus river system. The rivers that actually have their origin in the state and flow through it are the Chenab, the Beas, and the Ravi. The Satluj has its origin in Tibet and flows through Himachal Pradesh forming the largest river catchment area in the state. The Yamuna river crosses only the south-eastern border but has some catchment area in Himachal Pradesh. The

Giri, Jalal, Tons Bata are its tributaries originating in the state.

Lakes: There are a number of lakes in Himachal Pradesh, such as Manimahesh and Khajiar lakes in Chamba district, Chandratal and Surajtal lakes in Lahaul and Spiti district, Rawalsar, Prashel and Kamrunag lakes in Mandi district.

Reservoirs: These water bodies are man-made, raised for specific purposes, such as irrigation, hydro power generation, flood control etc. These are tabulated below: (Table 2.2).

TABLE 2.2

Water Bodies

Reservoir	*Location*	*Remarks*
Pandoh	15 Km from Mandi Town	Created by Pandoh to divert Beas water to Satluj
Sundernagar project.	Sundernagar	Balancing reservoir of BSL
Gobind Sagar	Bilaspur & Mandi	Reservoir of Bhakra Dam of 618 sq. km.
Pong	Kangra	Reservoir of Beas Dam

Source: State of Environment Report, H.P. (March, 2000).

Groundwater Resources

The groundwater resource occurs mainly in unconsolidated sediments of intermontane valleys and in the submontane tract. Kangra, Una, Hamirpur, Bilaspur, Mandi, Solan and Sirmaur districts, particularly their valley areas depend upon groundwater. The exploitation is done through open wells, tubewells, infiltration galleries and wells. The status of development of ground water resources in the state is given below (Table 2.3).

TABLE 2.3

Status of Groundwater Resources in Himachal Pradesh

Total replenishable groundwater resources	0.036 m ham/yr
Provision for domestic, industrial and other uses	0.007 m ham/yr
Available net groundwater resources for irrigation	0.029 m ham/yr
Net utilisable groundwater resources for irrigation	0.026 m ham/yr
Net draft	0.005 m ham/yr
Balance groundwater resources for future use	0.024 m ham/yr
Level of groundwater development	18.18%
Utilisable irrigation potential by groundwater development	68,500 ha

Source: CGWB, Ministry of Water Resources; Seminar on Artificial Recharge of Ground Water, December 1998.

Traditional Sources of Water

As there is an imbalance between the supply and consumption of water, particularly by the poor and weaker sections of society, the traditional sources of water play a significant role. These include springs, *kuhls*, *baories*, *ponds*, *khaties* and ditches. These systems supplement the water requirements of the rural and urban areas. There are 10512 traditional sources of water in the state for drinking water in rural habitations (1991-93).

Development of Water Resources

(i) Irrigation Schemes: See chapter on 'Agriculture'

(ii) Drinking Water Supply Schemes

A variety of sources are used in Himachal Pradesh to obtain domestic water supply. Details in respect of rural water supply are given below (Table 2.4).

TABLE 2.4

Water Source Details of Himachal Pradesh (1991-93)

Name of District	*Ground Water*	*Surface Water*	*Rain Water*	*Traditional Source*	*Others*	*Total*
Bilaspur	827	786	0	461	0	2074
Chamba	1717	2433	3	2598	836	7587
Hamirpur	1057	485	0	231	1	1774
Kangra	1602	1317	11	1369	466	4765
Kinnaur	76	217	0	24	2	319
Kullu	0	3392	0	0	0	3392
Lahaul Spiti	1	290	0	57	0	348
Mandi	833	3924	0	1483	840	7080
Shimla	233	3917	5	2518	9	6682
Sirmaur	644	2249	0	535	9	3457
Solan	344	1090	0	1215	316	2965
Una	832	123	1	21	116	1093
Total	**8186**	**20223**	**20**	**10512**	**2595**	**41536**

Source: Survey of Status of Drinking Water in Rural Habitations 1991-93.

The status of drinking water supply to rural habitations in the state given by the Public Health Department till October 2002, is as follows:

	Not Covered (NC)	*Partially Covered (PC)*	*Fully Covered (FC)*	*Total*
No. of rural habitation	921	9613	34,833	45,367

Under the Accelerated Rural Water Supply Programme, special efforts were made by the state government for water supply to rural habitations. During the period 1998 to Sept. 2002, 8103 habitations were covered.

As per the Public Health Department, there are 7130 water supply schemes in the state, 1238 lift, 214 tubewells, and 5678 gravity.

Under urban water supply schemes, augmentation of water supply schemes has been completed in 30 towns. Work is in progress on 21 urban water supply schemes. Further augmentation of water supply has been planned for 15 towns.

Although handpumps do not cover habitations, these are supplementing the existing piped water supply. These have been installed in drought prone acute water scarcity, and other problematic areas. The number of handpumps installed in the state till September 2002, was 11065.

The demand of water in the rural and urban areas based on population projections till 2021 is given in the Table 2.5.

The demand for water in the urban area has been projected by following the norm of 140 lpcd whereas the norm of 70 lpcd has been followed for rural area. By 2021, the urban areas of the state will require 150.49 mld. of water, out of which over one third will be required by Shimla alone. The demand for the water in the rural areas is much higher than in urban areas as a majority of the population of the state lives in the rural areas. Thus, greater thrust is needed for providing drinking water in the rural areas.

Water Quality: Under the National Drinking Water Mission programme, the IPH Department has set up water quality testing laboratories at Dharamsala, Una, Peo and Kandaghat.

The State Pollution Control Board has been monitoring the quality of surface water only. Surface water pollution is on the rise. During the period from 1993-94 to 1996-97, an increase in total coliform has been observed at some places. Dissolved oxygen is lower in deep water. This may prove detrimental to the development of aquatic life.

Groundwater pollution has been observed in the industrial towns of Parwanoo and Kala Amb as per the report of the Central Pollution Control Board, Government of India (1995).

***In situ* Rainwater Harvesting:** Village habitations and towns, which are located at low to high altitude areas of the mountain ranges of Himachal Pradesh, are in dire need of water for domestic as well as irrigation purposes. The only *in situ* water resource available to them is rain water. The most feasible option is to harvest it along the streams as *nallahs*, or the catchment area of watershed and on rooftops etc., and prevent run-off, evaporation and seepage. Fortunately, Himachal Pradesh has abundant rainfall, except at few places and therefore there is a big scope for tapping this resource for drinking and irrigation.

In the towns, rooftop water harvesting in government office buildings, school and *panchayat* buildings and houses should be done on a war footing for *in situ* collection and storage of high quality

TABLE 2.5

Water Demand in Himachal Pradesh (mld.)

District/State	*1999*		*2001*		*2011*		*2021*	
	Urban	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*	*Urban*	*Rural*
Bilaspur	2.69	22.84	2.90	23.76	4.18	28.90	6.04	35.06
Chamba	4.70	30.18	5.03	31.5	7.06	38.96	9.92	48.12
Hamirpur	3.63	27.39	3.90	28.23	5.58	32.75	7.99	37.85
Kangra	8.30	90.9	8.63	94.44	10.46	114.43	12.67	138.37
Kinnaur	—	5.75	—	5.96	—	7.13	—	8.53
Kullu	2.99	23.61	3.13	24.71	3.88	31	4.82	38.89
Lahaul & Spiti	—	2.47	—	2.55	—	2.96	—	3.46
Mandi	7.64	59.57	7.89	62.1	9.31	76.45	10.98	94.12
Shimla	21.75	37.7	23.81	38.47	37.45	41.6	58.91	42.52
Sirmaur	6.05	28.14	6.48	29.3	9.20	35.81	13.06	43.65
Solan	7.63	27.19	8.22	29.15	11.92	36.12	17.27	44.57
Una	4.83	27.86	5.10	28.84	6.71	34.33	8.83	40.82
Himachal Pradesh	**70.21**	**384.32**	**75.04**	**399.01**	**105.76**	**480.44**	**150.49**	**575.97**

Source: Himachal Pradesh Human Development Report, 2002.

rainwater to meet urgent requirements, after necessary purification measures.

Hot Springs: There are a number of hot springs in the districts of Chamba, Kangra, Kinnaur, Kullu, Shimla and Jaoni. Some of these have therapeutic significance. These could be developed as tourist health spots. Important hot springs, with their location and attributes are given in Table 2.6.

Mineral Resources

Himachal Pradesh is rich in mineral resources such as limestone, gypsum, rock salt, magnesite, silica sand and quartzite etc. In addition, building material such as slate, granite, clay and sandstone is also available. Other minerals reported are iron, beryl, copper, lead, silver, kyanite, uranium etc.

TABLE 2.6

Hot Springs in Himachal Pradesh

District	*Locality*	*Potentiality*
Kangra	Jwalamukhi	Six springs.Average salt content from 20 to 26%
	Lausa	Temp. 22ºC. Water sulphurous
	Tatwani	Temp. 49ºC
	Tira	Temp. 42ºC
Kinnaur	Changrizang	Temp. 46.5º C Strong H_2S
Kullu	Vashisht	Temp. 59º C. Strong H_2S
	Manikaran	14 Spring. Temp. 71.4 to 94.4oC. H_2S Low Saline content
Shimla	Suni	Temp. 57ºC Strongly sulphurous Highly saline
Solan	Jaoni	Temp. 55ºC Highly saline

Source: State of Environment Report, HP, March, 2000.

TABLE 2.7

Mineral Resources of Himachal Pradesh

Mineral	*District*	*Locality*	*Potential*
Limestone	Bilaspur	Gagal-Barmana	117.1 million tonnes
	Kangra	Dharamkot	17.6 million tonnes – 42.52%
	Mandi	Alsinid and Jaunrog	550 million tonnes CaO – 34.4 to 52% MgO – 9.8%
	Shimla	Drawal Kariali Block Jalog-Thench Block	80.43 million tonnes CaO – 4.50% 3.185 million tonnes
		Chamga Nala Shali	224 million tonnes CaO – 44.8% 146 million tonnes CaO – 45.25%
	Sirmaur	Datwardi	101.36 million tonnes CaO – 53.93%
		Hathana	29.87 million tonnes CaO – 53.9%
		Dida	34.65 million tonnes CaO – 53.22%
		Nohra	6.26 million tonnes (Upto 60 m depth) CaO – 53.95%
		Bulain Dhar	1.94 million tonnes (Upto 60 m depth) CaO – 53.60%
Magnesite	Chamba	Muchetar Nala	55,620 tonnes MgO – 39%
Rock Salt	Mandi	Guma	7.55 million tonnes Grade NaCl – 70.40%, KCl – 3% Impurities – 21%
		Darang	-Do-
Slate	Chamba	Rupaina	518400 tonnes
		Bhora	1360800 tonnes
		Chaunda Devi	6480 tonnes
		Renda	172800 tonnes
		Between Kalam Nadi and Sapri	115500 tonnes
	Kangra	Dharamkot	992250 tonnes
		GOT	21600 tonnes
		Bhatti	Impurities – 21%, 162000 tonnes
Stibnite	Lahaul & Spiti	Bara Singri	105682 tonnes 1.65%
Barytes	Kinnaur	Arsomang	3 veins 20 to 60 m long and 15 to 40 cm width. Another vein as 30 m long 97.70% $BaSO_4$
Clay	Kangra	Kothar	15000 tonnes
		Hatli	5076 tonnes
	Sirmaur	Kalidhang	Reserve of clay around Kalidhang, 2.63 million tonnes upto a depth of 20.
Silica sand	Una	Jaijoan Dil Khad	Total reserve for Grade A 50309 tonnes, 97.44% SiO_2
		Bathri	Total reserve for, Grade A, B & C upto a depth of 2m 842570 tonnes
Gypsum	Kinnaur	Shalkar	1.25 million tonnes upto a depth 25 m. Grade not given. Total *in situ* reserve in this belt may be 100 million tonnes
Kyanite	Lahaul & Spiti		Kyanite 40 m in thickness and traceable for 1 km

Source: State of the Environment Report- H.P.-State Council for Science, Technology and Environment, March 2000

The district-wise occurrence and potential of mineral resources (other than Atomic minerals and oil) are given in Table 2.7.

Status of Mineral Production and Value

The mineral-wise production and its value during the year 2002-03 is given below in Table 2.8.

TABLE 2.8

Mineral-wise Production (Tonnes) and Value (in lakh) of Himachal Pradesh During 2002-2003

Mineral	*Production in Tonne*	*Value in Lakh*
Major Minerals		
1. Limestone cement grade	5901346	3914.27
2. Limestone fine grade	78656	1022.00
3. Shale	347302	42.26
4. Baryte	929	1.58
5. Rock Salt	1056	10.56
6. Silica Sand used in glass industries/ Sand stone used as raw mix in cement	12643	5.04
Minor Minerals		
1. Bajri	1406552	617.40
2. Sand	1326263	528.16
3. Building stone	627136	146.38
4. Boulder	824086	316.04
5. Quartzite	31484	9.44
6. Slate	7137	104.29
7. Limestone Kiln grade	4496	5.45
8. Aggregate	525170	74.20

Source: State Geologist, Industry Department, Himachal Pradesh.

At present, there are three cement plants in operation. Of these, two are in Bilaspur and Solan each of 2 million tonnes per annum capacity. The third one of 0.2 million tonne per annum capacity is in Paonta Sahib Tehsil, Sirmaur District. Two more cement plants in Solan and Shimla districts each with 2 million tonnes per annum capacity are in the pipeline.

Marketing Strategies of Major and Minor Minerals

- Limestone extracted from the mines of major cement plant is used by them in their own plants.
- Other major minerals mainly limestone and very rare silica sand and Baryte are marketed by the lessee themselves in the open market.
- Minor minerals are also marketed by the lessees/ contractors in the open market.

Recommendations

Water Resources

- In order to meet the demands of drinking water and life saving crop irrigation for the people living on mountain slopes of the state, it is essential that work on *in situ*-water harvesting is taken up on a war footing to maximise the utilisation of rain water by the habitations instead of allowing the water to flow down into the rivers.
- All micro watersheds/watersheds should be identified in each river basin/sub-basin. Watershed development plans should be prepared for execution on priority basis.
- A Traditional Water Sources Cell may be created in the IPH Department for the development of traditional sources of water in the state. The Cell should have professionals like hydrologists, geologists for scientific development of the resources keeping in view the geological formations, groundwater occurrence and movement in the area.
- To lift part of the flow of hillside kuhls or springs to irrigate adjacent slopy lands or to provide drinking water in the villages, the use of hydraulic rams is strongly recommended. Hydraulic rams do not involve any running cost as no fuel or electricity is required. Installation of hydraulic rams or hydrams in the rural areas should be promoted on a large scale and the government should provide subsidy to the needy habitations of hilly areas.
- An extensive programme of installation of deep tubewells may be drawn up for utilisation of 80 per cent of the available untapped groundwater potential to create irrigation potential of 68,500 ha.
- Construction of sump wells with infiltration galleries in river beds should be promoted to irrigate the cultivated land near the river by the lift system.
- The state should exploit the non-committed river water resources for irrigation purposes wherever cultivable land is available to maximise the irrigation potential.
- River basin/sub basin-wise estimation of water resources should be carried out in the state. An Institute of Mountain Hydrology may be set up to collect and generate hydrological data base.

- There should be scientific assessment and development of groundwater resources of all the valleys of Himachal Pradesh *viz.* Nurpur, Una, Nalagarh, Paonta etc.
- The concept of Water User Association and Participatory Irrigation Management may be introduced in the state.

Mineral Resources

- Keeping in view the vast limestone resources of good quality in Himachal Pradesh, it is recommended that additional cement plants be installed besides increasing the capacity of the existing ones for domestic consumption and export of cement.
- Scientific and systematic extraction of sand, boulders and grit from nallah and river beds should be made.
- An assessment of the impact of mining on associated ecosystems of the existing projects should be carried out.
- The emission levels at every stage of the cement plants should be kept below the permissible level in order to avoid environmental problems.