Chapter 3

WATER RESOURCES

In Sikkim, the role of water resources in the environment is paramount. It is recognized that water is a scarce and precious natural resource to be planned, developed and conserved in an integrated and environmentally sound basis. In doing so, the preservation of the quality of environment and the ecological balance are also of prime consideration. The Teesta is the major river system in the state.

THE TEESTA and ITS TRIBUTARIES

Teesta river originates as Chhombo Chhu from a glacial lake Khangchung Chho at an elevation of 5,280 m in the northeastern corner of the state. The glacial lake lies at the snout of the Teesta Khangse glacier descending from Pauhunri peak (7,056 m) in north western direction. Teesta Khangse glacier and Chho Lhamo are also considered as the source of Teesta river by many authors. Along its traverse from its origin to the plains, the river receives drainage from a number of tributaries on either side of its course. The tributaries on the eastern flank are shorter in course but larger in number whereas the tributaries on the western flank are much longer with larger drainage areas, consequently contributing much more amount of discharge to the main Teesta river. Furthermore, right-bank tributaries drain heavily glaciated areas with large snow-fields. The left bank tributaries, on the other hand, originate from semi-permanent and much smaller snow-fields as compared to right bank tributaries.

The major tributaries of Teesta river are listed below. For better understanding of Teesta river system, it has been divided into a number of river sub-systems which are described in the succeeding paragraphs. These sub-systems are: i) Chhombo Chhu/ Teesta river upstream of Zemu Chhu-Teesta confluence, ii) Zemu Chhu, iii) Teesta river between Lachen and Chungthang, iv) Lachung Chhu, v) Chungthang-Mangan and Chakung Chhu sub-system, vi) Rangyong (Talung) Chhu, vii) Dik Chhu, viii) Teesta river between Mangan and Singtam, ix) Rani Khola, x) Teesta river between Teesta-Rani Khola confluence and Teesta-Rangpo Chhu confluence, xi) Rangpo Chhu, xii) Rangit River, and xiii) Jaldhaka River.

Table 3.1 Major Tributaries of Teesta River

Sl. No.	Left-bank Tributaries	Right-bank Tributaries
1.	Lachung Chhu	Zemu Chhu
2.	Chakung Chhu	Rangyong Chhu
3.	Dik Chhu	Rangit River
4.	Rani Khola	
5.	Rangpo Chhu	

After perambulating a distance of about 40 km from Melli in hilly terrain, the river enters into the plain of West Bengal at Sevoke near Siliguri. Further ahead, it fans out and attains the width of 4 to 5 km at places. In the Sub-Himalayan plains, it is again joined by a number of tributaries *viz*. Leesh, Geesh, Chel, Neora from the north-eastern end and the Karala from the north-western end. After traversing a length of about 414 km in India and Bangladesh, it meets the river Brahmaputra (Jamuna) in Bangladesh at an elevation of 23 m. In the mountain gorges, the width of the river Teesta is not much. At Chungthang, the width of the river is 30 m and at Singtam 40 m during autumn. The average depths of water are 1.8 m and 4.5 m, respectively. From Chungthang to Singtam, the bed slope varies from approximately 35 m/ km to 17 m/ km. From Rongpo to Teesta Bazar, the average slope is approximately 3.8 m/ km. The velocity of flow in the hilly region is a high as 6 m per second while in the terai, the velocity is 2.4 to 3 m per second. The banks are alternately steep and sloping according to the position of main current.

Table 3.2 Catchment Area of Teesta river (in sq. km)

Hilly Region	(i) Sikkim	6930	**8,051**
	(ii) West Bengal	1121	
In Plain	(i) West Bengal	2104	**4,108**
	(ii) Bangladesh	2004	
		Total in India :	**10,155**
		Total in Bangladesh :	**2,004**
		Total :	**12,159**

DRAINAGE CHARACTERISTICS

Unique in its complex and diverse drainage characteristics, the antecedent river Teesta offers a fascinating study for Himalayan drainage basin evolutionary processes under fluvial environment in particular. Studies of the Teesta drainage characteristics particularly of the river channel changes including river deposits and fluvial or fluvioglacial processes in the Sikkim Himalayan terrain have been in progress for more than a decade. These landforms and drainage patterns include mainly the four tier terraces, canyons or gorge-valley at different altitudes, asymmetric valleys, polyprofilic U-shaped valleys and steps or troughs, lakes, alluvial cones, truncated ridge-spurs, soil profiles, terracettes (soil landscape systems), rectangular-barbed-parallel-trellised-radial –sub-dendritic, etc. drainage patterns, straight meandering braided etc, channels and others.

Huge amount of water enters into the Teesta catchment in the form of rain and snow which is drained off as the discharge of water by a system of drains of the Teesta and its tributary streams. Primarily the Teesta drainage basin is constituted by this system of drains or channels (straight, sinuous or meandering, braided etc.) both of natural and artificial, relating to the action of draining the higher mountains and piedmonts in Sikkim. In an interpretative sense, the Teesta drainage catchment is found to have been occupied by a complex hydrographic net works of branching streams in hierarchical order from its smallest tributary like Andherijhora etc. to the trunk stream Teesta, the main channel for drainage. This hierarchy and other characteristics of the hydrographic net works of the Teesta drainage may be expressed in terms of morphometric attributes (drainage texture, orders, bifurcation ratio, texture ratio index, stream length ratio etc.).

The Teesta basin includes (a) surface bodies like rivers or lakes, in the superjacent air, and (b) underground drainage of various types and origins. Hence, three types of surface drainage have been distinguished in the basin area. Primarily, surface drainage relates to (i) precipitation of moisture or rainfall and flowing in accordance with the varied topography (ii) drainage conspicuously confined along these streams specially during dry or non-dry periods and (iii) the static water bodies, lakes including glacial lakes stagnant pools of water etc. being typified by seasonal flow only during floods or extreme (catastrophic) meteorological events which are common in the Teesta drainage area.

Rain water which contributes substantially to total runoff, flows according to the variations in slope of the hills and valley-side surfaces at different elevations. Here, the actual amount of rainfall diverted in various ways (surface runoff, interflow, ground water, soil moisture etc. are found to have varied greatly in the different sub-basins of the humid Teesta catchment area where the intensity of rainfall normally exceeds the infiltration rate even in the upper reaches at 3,000 m and more In most of the elevated watershed surfaces the higher intensity of falling rain which has determined largely the infiltration capacity and surface runoff, finds its way down the slopes along the distinct channels of flow of running water i.e. tributary streams, or river including ephemeral stream channels of lower drainage order within the Teesta basin.

The infiltration capacity forming an important control of stream flow relating to drainage conditions is found to be associated with soil-landscape systems, a dynamic entity, and is dependent on seven factors like (i) soil texture, (ii) soil structure, (iii) vegetative cover, (iv) biologic structures in the soil including such features at rodent perforations and amount of humus and vegetal debris, (v) amount of moisture in the soil (antecedent soil moisture), (vi) condition of the soil surface as determined by whether it has been cultivated recently or is baked or sun cracked, and (vii) the temperature of the soil at different positions in the hills and valley slopes in the Teesta and its tributary or sub-basins.

The Teesta drainage has been resulted from both physical and cultural environments in the course of geoecological adjustment of those Himalayan geocomplex like climate, structure, vegetation, soil, topography or other terrain factors determining the rapidity of runoff. It relates to geomorphology including hydrology, and the flow characteristics in the Teesta and tributary streams especially after storms, human intervention over the mountain and piedmont plain. The human intervention mainly concerns with the utilization of water for irrigation, hydel power generation, fishery development, and the various arrangements which in turn obstruct the normal flow of water in terms of constructing embankments of canal and reservoir, human settlements, roads, railway and like. However, this drainage of different types especially of surface drainage with varying depth, surface spread, frequency or mobility at different seasons is closely associated with irrigation work.

WATER REGIME

The per-humid climate of the Teesta basin in Sikkim is characterized with enormous water surpluses. The prevalent monsoon climates have supported evergreen (broad leaf) rainforests including grasses which become dense and luxuriant in some parts of middle Teesta basin. It is important to note that depending upon the terrain properties e.g. structure, rocks in different geological formations, surface cover, and slope, the water surplus takes its course either through surface run off or deep percolation to underground regions. This becomes available for exploitation as ground water. In certain years, due to strong monsoonal activity or frequent occurrence of depressions and local severe storms, the precipitation may be much greater than normal; local water surpluses do occur, for brief periods producing not only enormous surface flow resulting in severe floods but also significantly contribute to the ground water resources. The orographic influence of the Sikkim Himalayan terrain including their hill-side and valley-sideslopes is, however, responsible for the occurrence of wet climatic types throughout the upper and middle Teesta basin. Practically, per humid climatic types are found in the whole mountainous terrain according to the moisture regime which plays a decisive role in the water potentialities of various sectors within the basin. Obviously, the southwest monsoon season which is the principle rainy period for almost the entire Teesta basin is responsible for more than 80% of the total annual rainfall in these mountainous ecological sites, and significant in controlling the water balance.

GLACIERS AND SNOWFIELDS OF TEESTA BASIN

Inventory of the glaciers and permanent snowfields of Teesta basin has been carried out at 1:50000 scale. Geocoded FCCs of IRS LISS III data were utilized for interpretation and mapping of glacier features and snowfields. Results obtained during this investigation suggest presence of 84 glaciers in Teesta basin which are distributed in 10 sub-basins. This covers an area of 440.24 sq. km. In addition total permanent snowfields were also mapped. The total extent of permanent snowfields was measured as 251.244 sq. km. These are distributed in 12 sub-basins. Total glacial and permanent snow cover stored water in Teesta basin is estimated as 145.05 cu. km. Average altitude of snow line is 5093m. This is 342 m lower than average middle altitude for the glaciers of the Basin.

Table 3.3 Total Glacier Area in each Sub-basin of Teesta Basin

Sl. No.	Sub-basin Name	No. of Glaciers	Total Area (sq. km)
1.	Tsakchurong Chu	8	30.80
2.	Prek Chu	3	20.37
3.	Rilli Chu	2	1.30
4.	Rangyong Chu	8	71.15
5.	Umaran Chu	4	25.93
6.	Zemu Chu	2	80.00
7.	Goma Chu	22	82.72
8.	Chumbo Chu (Teesta River)	15	41.81
9.	Lachung Chu	11	49.15
10.	Sebuzung Chu	9	37.01
	Total	**84**	**440.24**

Source: Glacier Atlas of Teesta Basin, ISRO 2001

Table 3.4 Total Area (sq. km) of Snowfields in each Sub-basin

Sl. No.	Sub basin Name	No. of Snowfields	Area (sq. km)
1.	Tsakchurong Chu	1	1.263
2.	Chakung Chu	3	0.909
3.	Rangyong Chu	8	17.233
4.	Umaran Chu	20	22.959
5.	Ringi Chu	3	1.501
6.	Tista River	11	20.860
7.	Zemu Chu	14	36.870
8.	Goma Chu	35	30.670
9.	Chumbo Chu	29	40.389
10.	Lachung Chu	8	21.960
11.	Lachung Chu	49	47.474
12.	Sebuzung Chu	16	9.156
	Total	**197**	**251.244**

Source: Glacier Atlas of Teesta Basin, ISRO 2001

Table 3.5 Mean of Glacier Depth and Water Equivalent (cu. km.) of each Sub-basin

Sl. No.	Sub basin Name	No. of Glaciers	Total Area (Sq. Km)
1.	Tsakchurong Chu	8	2.237
2.	Prek Chu	3	1.714
3.	Rilli Chu	2	0.040
4.	Rangyong Chu	8	7.92
5.	Umaran Chu	4	2.075
6.	Zemu Chu	2	12.380
7.	Goma Chu	22	5.814
8.	Chumbo Chu (Testa River)	15	2.442
9.	Lachung Chu	11	3.415
10.	Sebuzung Chu	9	2.961
	Total	**84**	**40.998**

Source: Glacier Atlas of Teesta Basin, ISRO 2001

Table 3.6 Distribution of Glaciers in different range of areal extent

Area (sq. km)	No. of Glaciers	Total Area (sq. km)
<5	61	126.02
5-10	11	64.32
10-15	7	80.75
15-20	3	50.05
>20	2	119.16
Total	**84**	**440.30**

Source: Glacier Atlas of Teesta Basin, ISRO 2001

Table 3.7 Distribution of Permanent Snowfields in different ranges of areal extent

Area (sq. km)	No. of permanent Snowfields	Total Area (sq. km)
<1	112	59.80
1-3	56	99.55
3-5	14	53.26
>5	6	38.62
Total	**188**	**251.22**

Source: Glacier Atlas of Teesta Basin, ISRO 2001

RAINFALL FEATURES

In Teesta Basin in Sikkim, the southwest monsoon normally sets around mid-June and withdraws by end of September.

Normal Rainfall: Average annual normal rainfall in Sikkim is about 2534 mm. Month wise details is given below.

Table 3.8

Month	Rainfall (mm/month)
January	37.0
February	53.0
March	104.1
April	151.7
May	287.6
June	442.7
July	480.1
August	440.1
September	331.8
October	156.0
November	30.7
December	19.1
Total	**2533.9**

Fig 3.1 Month-wise Normal Rainfall for Sikkim as a whole

Looking at the monthly variation of normal rainfall, it is seen that the month of July receives maximum rainfall of the order of 480 mm and minimum normal rainfall of 19 mm is recorded in the month of December for the Sikkim as a whole.

Variation in Rainfall: There is significant variation in rainfall in the basin, both temporally and spatially. The altitude of the station also influences the coefficient of variation (CV). The coefficient of variation of various stations as computed is as follows.

Table 3.9 Altitude *vs*. Coefficient of Variation

Station	Altittude in m	CV
Dentam	132	0.09
Rongli	823	0.18
DikChhu	869	0.12
Mangan	1310	0.49
Singhik	1402	0.35
Gezing	1524	0.42
Chungthang	1631	0.34
Gangtok	1756	0.24
Yoksum	1780	0.21
Damthang	1981	0.58
Lachung	2633	0.18
Lachen	2697	0.34
Yumthang	3673	0.16
Thangu	3834	0.44
Chhangu	3841	0.41

Number of Rainy Days

Statistics of average number of rainy days for each month of the year along with their seasonal and annual totals in respect of all the 15 stations are presented in Annexure 3.2. In the monsoon season from June to September, the station Chhangu is seen to experience the rainiest weather with 100.9 average numbers of rainy days followed by Gangtok (99.1), Rongli (98.1) and Yumthung (96.2). Total number of rainy days are maximum for Singhik station at 172.7 days while these are minimum for Gyalzing station at 124 days. Average number of rainy days is 148.3 for the Sikkim state as a whole for the whole year.

Monthly Rainfall

Monthly rainfall values for the 19 rain gauge stations in the state of Sikkim were obtained from IMD for varying time periods. The same are given in Annexure 3.3 (a) to 3.3 (q). Certain gaps are observed in the reported data which are depicted in Annexure 3.3(r). The short gaps in the data have been filled up through standard statistical practices based on station normal and actual rainfall of neighboring stations. The long gaps which are for a continuous spell of years together have not been considered appropriate to be filled up by statistical methods as these are likely to result in great variation from actual figures.

CLIMATOLOGICAL CHARACTERSTICS

Monthly mean values of the maximum and minimum temperatures, mean monthly relative humidity, monthly sunshine hours and monthly mean wind speed are available at Gangtok station VII. These climatological figures are being taken as representative of the Teesta Basin in Sikkim.

Temperature Distribution

Mean daily maximum temperature in the sub-basin varies from about 26.8^{o} C in September to 20.7^{o} C in the month of January. Mean daily minimum temperatures are around 7.5^{o} C in January, 10.7^{o} C in April, 14.5^{o} C in July and 13.3^{o} C in October. The district wise monthly mean temperatures are given at Table 3.10.

Relative Humidity (RH)

Mean daily Relative Humidity varies from 63.8 percent to 88.7 percent over the basin. The mean daily RH is 68.3 percent in January, 66.2 percent in April, 88.7 in July and 68.0 in October. The district-wise monthly Mean daily Relative Humidity are included in Table 3.10 below.

Wind Speed

The mean monthly wind speed varies from as low as 43.2 km/day from July to September to high of 98.4 km/day in the month of April. Month wise details are given at Table 3.11.

Table 3.10 District-wise Monthly Mean Temperature & Relative Humidity (%)

District	Temp/ RH	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
NORTH	Max Min RH	Data Not Available											
EAST	Max	14.7	16.1	19.4	21.8	23.8	24.8	24.1	24.6	23.8	22.5	19.5	16.6
	Min	4.6	5.0	8.0	11.0	13.4	15.9	16.7	16.1	15.5	11.8	8.0	6.0
	RH	74.4	75.3	72.6	73.9	79.6	85.1	88.2	81.7	85.5	78.9	73.8	71.5
WEST	Max	27.4	27.4	26.1	26.6	23	23.3	24.0	26.1	27.6	27.8	27.2	28.7
	Min	8.4	7.3	11.6	8.7	8	9.1	7.1	8.2	8.6	9.9	8.5	4.9
	RH	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SOUTH	Max	20.1	20.3	20.8	25.3	28.4	29.2	27.9	29.6	29.2	27.5	24.4	23.3
	Min	9.5	10.1	11.4	12.4	16.4	19.1	19.8	20.1	20	18.2	13.1	10.2
	RH	62.1	52.2	58.3	58.5	68.1	82.9	89.1	80	65.4	57.1	65.3	56.2
State	**Max**	**20.7**	**21.3**	**22.1**	**24.6**	**25.1**	**25.8**	**25.3**	**26.8**	**26.9**	**25.9**	**23.7**	**22.9**
	Min	**7.5**	**7.5**	**10.3**	**10.7**	**12.6**	**14.7**	**14.5**	**14.8**	**14.7**	**13.3**	**9.9**	**7.0**
	RH	**68.3**	**63.8**	**65.5**	**66.2**	**73.9**	**84.0**	**88.7**	**80.9**	**75.5**	**68.0**	**69.6**	**63.9**

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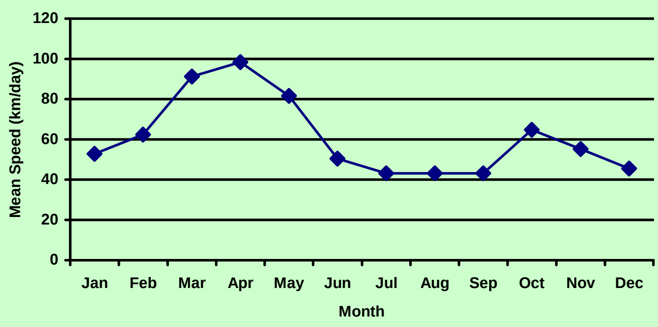
Fig 3.2 Monthly Mean Wind Speed



HYDROLOGY

Assessment of surface water resources of a basin is an important component for planning and development of water resources for various uses. The state of Sikkim is characterised with enormous water resources available through various rivers and hill streams. However, the same could not been put to utilization because of the land availability constraints. Teesta is a perennial river with substantial flows even in lean season. The river flows generally in North South direction bisecting the State of Sikkim. It is the single major river in the State draining 95 % of the total area of the State. Enormous fall of the order of 3,300 m over a river stretch of 175 km. makes this river an ideal and reliable source of hydropower. This necessitates the establishment of a hydrometeorological network for collecting the gauge, discharge and precipitation data to estimate the water availability in the Teesta valley for development of power. The collection of discharge data during the lean as well as monsoon seasons is equally important. The former is required for assessing the firm power draft while the later is required for the design of hydraulic structures for hydro power projects.

Table 3.12 Average annual runoff of Teesta river at various sites

Sl. No.	Site	Period of data availability	Mcm	Mm
1	Chungthang	1976	4332	1554
2	Sanklang	1989	7860	2047
3	DikChhu	1984	9580	2249
4	Khanitar	1980	11569	2374

Table 3.13 Details of snow-covered and rainfed area

Location	Catchement area (sq km)			Snow covered area as % of total area
	Snow covered	Rainfed	Total	
Chhungthang	1598	1189	2778	57
Sankalang	1939	1900	3839	51
Dikchu	2240	2020	4260	53

Table 3.14 LIST OF SMALL HYDRO PROJECTS IN SIKKIM

SL.No	Name of project	Installed capacity	Status
1	Chatten micro mini HEP	100 KW	Commissioned
2	Rabomchu Small HEP	3 MW	Commissioned
3	Lachung Micro Mini HEP	200 KW	Commissioned
4	Lachung Small HEP	3 MW	Under execution
5	Meyongchu Small HEP	4 MW	Commissioned
6	LLHP Small HEP (I)	12 MW	Commissioned
7	URHP	8 MW	Commissioned
8	RHES (II)	2.5 MW	Commissioned
9	JPH	2.1 MW	Commissioned
10	Mangley HEP	2 MW	Under execution
11	Rongli Small HEP	5 MW	Under execution
12	Rimbi Small HEP (I)	60 KW	Commissioned
13	Rimbi Small HEP (II)	1 MW	Commissioned
14	Kalej Khola Small HEP	2 MW	Commissioned
15	Relli Small HEP	6 MW	Under execution

HOT SPRINGS OF SIKKIM.

The Himalayas is one of the largest geo-thermal areas of the world. The Himalayan belt is l50 km wide, extending 3000 km through parts of Tibet, India, China, Myanmar and Thailand.

Table 3.15 MONITORING OF THE HOT SPRINGS OF SIKKIM HIMALAYAS

Sl. no	Parameters	Sampling Site				
		I	II	III	IV	V
1	Colour (HazenUnit)	Less than 5	Less than 5	Less than 5	Less than 5	Less than 5
2	Appearance	Clear	Clear	Clear	Clear	Clear
3	Turbidity (NTU)	22	20	15	20	16
4	Conductivity uMHOS/cm	950	980	1000	1000	1020
5	Total dissolved Solids (Dried at 105°C)	280	250	600	580	580
6	Ph	8	8.2	8.5	8	7.6
7	Temperature at source °C	50	40	34	40	35
8	Temperature at bathing pool °C	45	38	32	38	34
9	Dissolved Oxygen mg/I	1.5	4	NO	NO	NO
10	Carbonate hardness as $CaC0_3$mg/1	NO	NO	NO	NO	NO
11	Calcium Hardness as $CaC0_3$ mg/I	NO	NO	NO	NO	NO
12	Chlorides as CI mg/I	7.2	7.0	3.5	3	8.0
13	Silica as $SiS0_2$mg/1	22	26	24	22	14
14	Chromium as C mg/I	NO	NO	NO	NO	NO
15	Fluorides as F mg/I	NO	NO	NO	NO	NO
16	Sodium as Na mg/I	40	44	81.6	85	100
17	Potassium as K mg/I	4.2	4.0	1.5	1.8	1.8
18	Manganese as Mn mg/I	NO	NO	NO	NO	NO
19	Sodium chloride as NaCI mg/I	80	90	100	95	140
20	Nitrates as N mg/I	0.8	0.7	0.3	0.3	0.2
21	Phosphate as $P0_4$ mg/I	ND	NO	NO	NO	NO
22	Sulphates as $S0_4$mg/1	38	41	25	28	20

Source: State of Environment Pollution, Sikkim, 2004

List of Hotspring (*TSHACHHU*) in Sikkim as per the Notification 70/Home/2001

i. Phurtshachhu at Khadosangphug, South/West Sikkim.
ii. Ranglop tshachhu at Borong, South Sikkim.
iii. Gangyab chhutshen, West Sikkim.
iv. Takrumtshachhu, North Sikkim.
v. Yumasamdongtshachhu, North Sikkim.
vi. Yumthangtshachhu, North Sikkim.
vii. Zee tshachhu, North Sikkim.
viii. Shagyong phedok tshachhu, North Sikkim.
ix. Tholung kangtshachhu, North Sikkim.

DISTURBANCE AND THREATS

The increase in human activities in the hot spring areas has led to various ecological stresses. The people demand on the surrounding forests for firewood due to lack of alternative fuel. There is a lack of proper solid waste disposal as huge quantities of solid wastes are generated during the peak season. Waste materials lie scattered along the surrounding huts and the river banks. The sanitary facilities available are unhygienic and insufficient as temporary toilets are constructed on the river bank where the faecal matter is directly discharged into the river without any treatment. The demand for meat and meat products had further accelerated the rate of fishing in the rivers. The large number of patients with various communicable diseases frequenting this hot spring may further spread these diseases. It is feared that due to the unhygienic conditions prevailing around these hot springs, the people on their way back may be infected by new diseases. The hot springs in Sikkim are regarded as place of worship and hold a high religious esteem in the hearts of the local people. The people drink the hot water and bathe in it, considering these factors detailed microbiological and radio-activity study of these water is felt essential taking into account, the study of the geomorphologic aspect of these hot springs and their economic exploitation.

Table 3.16 Consumption/ Utilization of Water For Domestic and industrial purpose through P.H.E.																	
Sl. no.	Name of Towns	Projected population including floating population 1990			Utility Capacity MLD (1992)	Service Level LPCD (1992)	Covered population 1992	Projected population including floating population 2001			Desired utility capacity	Projected population 2020			Balance Population (Augmentation)		Remarks
		Population 1990	Institution 30%	Total				Population 2001	Institution 30%	Total		Population 2020	Institution -n 30%	Total	2001	2020	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	Gangtok	65257	19577	84834	10.150	120	50900	100195	30059	130254	26.050	253188	75956	329144	79501	278391	
20% Institution consumption, Demand 140 LPCD 5% Population Growth in District + R.M.Cs.																	
2	Jorethang	10593	2119	12712	1.400	110	9988	13300	2660	15960	2.230	23322	4664	27986	5929	17955	
3	Singtam	8887	1777	10664	0.970	97	6932	11158	2231	13389	1.879	19566	3913	23479	6424	16514	
4	Rangpo	6182	1236	7418	2.500	237	7418	7761	1552	9313	1.300	13609	2722	16331	5276	12294	
5	Namchi	5679	1136	6815	1.820	267	6815	8810	2643	11453	1.600	22262	6679	28941		15951	
6	Gvalshing	2629	526	3155	0.180	57	1285	4079	1224	5303	0.740	10307	3092	13399	4015	12111	
7	Naya bazaar	3075	615	3690	0.260	70	1845	3861	772	4633	0.650	6770	1354	8124	2792	6283	
8	Mangan	1783	357	2140	0.130	61	932	2766	83	3596	0.500	6990	2097	9087	2650	8141	
	Total:	**38828**	**-**	**46594**	**7.260**	**-**	**35215**	**51735**	**-**	**63647**	**8.890**	**102826**	**-**	**127347**	**27086**	**89249**	
	Rural Marketing Centers																
	North-South																
I	Chungthang	827	165	992	0.180	181	992	1283	257	1540	0.210	3241	648	3890	253	2603	
2	Old & New Dikchu	1690	338	2028	0.560	276	2028	2122	424	2546	0.360	3721	744	4465	-	454	
3	Phodong	316	63	379	0.038	100	270	397	79	476	0.066	696	139	835	204	563	
4	Lachung	1528	306	1834	0.140	76	996	1918	384	2302	0.322	3363	673	4036	1304	3038	
5	Lachen	1134	227	1361	0.060	44	428	1424	285	1709	0.239	2497	499	2996	1277	2564	
6	Pangthang	1422	284	1706	0.313	183	1706	1785	357	2142	0.299	3129	262	3755	1322	2935	
7	Penlong	386	77	463	0.045	97	321	484	97	581	0.080	849	\70	1019	253	691	

Table 3.16 Continued…

Sl. No.	Name of Towns	Projected population including floating population 1990			Utility Capacity MLD (1990)	Service Level LPCD (1990)	Covered population 1990	Projected population including floating population 2001			Desired utility capacity	Projected population 2020			Balance Population (Augmentati on -n)		Remarks
		Population 1990	Institution 30%	Total				Population 2001	Institution 30%	Total		Population 2020	Institution 30%	Total	2001	2020	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	(East)																
8	Ranipool	1279	256	1535	0.375	244	1535	1606	321	1927		2816	563	3379		692	
9	Pakvong	1279	256	1535	0.300	195	1535	1984	595	2579		5013	1504	6517	438	4376	
10	Rhenok	2357	471	2828	0.350	124	2505	2959	592	3551	0.490	5189	1038	6227	1062	4238	
11	Rongli	1353	271	1624	0.200	123	1426	1698	340	2038	0.280	2977	595	3572	610	2144	
12	Sang	1172	234	1406	0.136	97	974	1471	294	1765	0.247	2579	516	395	779	2100	
13	Rorathang	1172	234	1406	0.090	64	643	1471	294	1765	0.247	2579	516	3095	1114	2444	
14	Middle Camp	1172	234	1406	0.103	73	733	1471	294	1765	0.247	2579	516	3095	1025	2355	
15	Makha	1172	234	1406	0.136	97	974	1471	294	1765	0.247	2579	516	3095	795	2125	
16	Rumtek	713	143	856	-			895	179	1074	0.150	1569	314	1883	-		
17	Aritar	2224	445	2669	0.257	96	1830	2792	558	3350	0.469	4894	979	5873	1511	4034	
18	Mazitar	1994	399	2393	-	-		2504	501	3005	0.420	4390	878	5268			
	(WEST)																
]9	Chakung	1258	25]	1508	0.]60	]06	1142	1578	3]6	]894	0.265	2766	553	3319	745	2170	
20	Legship	1069	214	1283	0.150	117	]072	1342	268	1610	0.225	2353	471	2824	516	1730	
21	Sombaria	1069	214	1283	0.131	120	935	1342	268	1610	0.225	2353	471	2824	656	1870	
22	Dentem	402	80	482	0.113	234	482	505	10]	606	0.084	885	177	1062	-	252	
23	Kaluk	1072	214	1286	0.124	96	882	1345	269	1614	0.225	2358	472	2830	-		
24	Soreng	1970	394	2364	0.241	102	]722	3056	6] 1	3667	0.051	7722	1544	9266	1952	7551	
25	Hee	14]9	284	1703	0.116	68	827	1781	356	2137	0.299	3122	624	3746	1303	29]2	
26	Bermiok	1719	344	2063	0.160	78	1149	1652	330	1982	0.27	2896	579	3475	836	2329	
27	Rinchenpong	1136	227	1363	0.150	110	1071	1425	285	1710	0.239	2498	500	2998	622	1910	
28	Uttarev	]071	214	1285	0.124	96	881	1344	269	1613	0.225	2356	471	2827	728	1942	
29	Reshi	1250	250	1500	0.200	133	]425	1569	3]4	1883	0.263	2750	550	3300	454	1871	
30	Daramdin	1072	2]4	1286		-	-	1345	269	1614	0.225	2358	472	2830	-	-	

Table 3.16 Continued…

Sl .no.	Name of Towns	Projected population including floating population 1990			Utility Capacity MLD (1990)	Service Level LPCD (1990)	Covered population 1990	Projected population including floating population 2001			Desired utility capacity	Projected population 2020			Balance Population (Augmentatio on)		Remarks
		Population 1990	Institution 30%	Total				Population 2001	Institution 30%	Total		Population 2020	Institution 30%	Total	2001	2020	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	(South)																
31	Melli	2636	527	3163	0.305	96	2169	3309	662	3971	0.555	5801	1160	6961	1791	4781	
32	Rabongla	838	168	1006	0.185	183	1006	1300	260	1560	0.218	3285	657	3942	228	2610	
33	Damthang	327	65	392	0.034	87	244	411	82	493	0.069	720	144	864	247	618	
34	Temi	723	145	868	0.084	97	601	908	182	1090	0.152	1592	318	1910	492	1312	
35	Mazitar (s)	807	161	968	0.093	96	664	]013	203	1216	0.170	1776	355	2131	549	1464	
36	Keetam	433	87	520			-	544	109	653	0.091	954	191	1145			
37	Kewzing	588	118	706	0.068	96	484	738	148	886	0.124	1294	359	1553	400	1067	
38	Y umgthang	1018	204	1222	0.140	115	1004	1277	255	1532	0.214	2239	448	2687	535	1690	
39	Namthang	807	161	968	-		-	1013	203	1216	0.170	]776	355	2131	-	-	
40	Maniram	591	118	709		-	-	652	130	782	0.109	1143	229	1372	-	-	
	Total:	**46464**	**-**	**55755**	**6**	**4082**	**36656**	**59184**	**-**	**71219**	**9**	**109658**	**-**	**132092**	**23992**	**75435**	