

**A DETAILED REPORT ON
IMPLEMENTATION OF CATCHMENT AREA TREATMENT
PLAN OF TEESTA STAGE-V
HYDRO-ELECTRIC POWER PROJECT (510MW)
SIKKIM - 2007**



**FOREST, ENVIRONMENT & WILDLIFE MANAGEMENT
DEPARTMENT
GOVERNMENT OF SIKKIM
GANGTOK**

BRIEF ABOUT THE ENVIRONMENT CONSERVATION OF TEESTA STAGE-V CATCHMENT.

In the Eastern end of the mighty Himalayas flanked by Bhutan, Nepal and Tibet on its end lays a tiny enchanting state 'Sikkim'. It nestles under the protective shadow of its guardian deity, the Mount Kanchendzonga. Sikkim has witnessed a tremendous development in the recent past year under the dynamic leadership of Honorable Chief Minister Dr.Pawan Chamling. Tourism and Power are the two thrust sectors which has prompted Sikkim further in the road of civilization. The establishment of National Hydro Project (NHPC) Stage-V at Dikchu itself speaks volume about an exemplary progress.

Infact, an initiative to treat the land in North and East districts is yet another remarkable feather in its cap. The project Catchment Area Treatment (CAT) pertains to treat the lands by various means of action such as training of Jhoras, establishing nurseries and running a plantation drive. Catchment Area Treatment (CAT) was initially started in the year 2000-01 within a primary vision to control the landslides and to maintain an ecological equilibrium in the catchment areas with a gestation period of nine years. Forests, Environment & Wildlife Management Department, Government of Sikkim has been tasked with a responsibility of nodal agency to implement catchment area treatment programme by three circle of six divisions viz, Territorial, Social Forestry followed by Land Use & Environment Circle.

The officials of Forest Department from lower echelon to higher posts such as F.G, B.O, R.O,DFO,C.F and upto PCCF has carried out a tremendous job in making this project a success in close coordination of NHPC Ltd.

Apart from bringing wide revolution in biodiversity conservation in the catchment area, catchment area treatment has also provided unemployment by deploying numbers of local unemployed youths of both genders under this project. The successful implementation of Teesta Stage- V, catchment area treatment has paved a benchmark model for the planned Hydro-Electric Power Project implementation in future in the State.

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CONSOLIDATED REPORT ON TREATMENT OF CATCHMENT AREA OF TEESTA STAGE V HYDRO ELECTRIC POWER PROJECT (510 MW)-SIKKIM

The state of Sikkim is located in between two neighboring countries, Nepal in West and the Kingdom of Bhutan in East. The Southern boundary shares with the state of West Bengal. Northern boundary is adjoined with International Boundary (IB) of Tibet at Chholamu, the only cold desert of eastern Himalaya. The Great Teesta River starts from the lake Chholamu at an elevation ranging between 5488m-6098m. It transverse north to south direction finally debouching into the plains of West Bengal and finds its main destination at the Bay of Bengal.



Sikkim is very rich in natural resources, flora and fauna, culture and tradition showcased in a varied rugged topographical and geographical terrain. Sikkim is endowed with the world's third highest mountain peak Mt. Khangchendzonga flanked by majestic mountain peaks such as Sinolchu, Talung, Kabru, Pandim, Gurudokmar, Simvo, Mt.Narsing and many exalting snowcapped mountains and hills. The Zemu glacier and numerous big and small glaciers, snow melt,

ice berg, monsoon shower and small streams are another source of water volume of the Great Teesta. There are a large number of water bodies distributed throughout the State in the form of fresh water lakes and streams. The lakes vary in size and depth. It forms highly important complex of wetland ecosystem highly potential to sustain many hydrological outs of the state and contribute to sustain the river system of the state.

The river passes through the cold desert of Chho Lhamu, Lachen valley and joins Lachung chu at Chungthang and continuously flows down through the deep gorges of Toong, Naga Singhik and meets another glacial river from Khanchendzonga at Namprikdang Dzongu forming a confluence of Teesta Kanaka Khola. The volume and dimension of Teesta River further increases by almost half of its size. Further it passes through the rugged terrains in the Dzongu valley at Sangkalang, Heegyathang and Lower Dzongu at Phidang and joins Dikchu in East Sikkim at a distance of 1.5 Km away from the site of Teesta Stage V Dam. It then joins another big river Rongni Chu at Singtam and Rangpo Chu at Rangpo at the Border with West Bengal. It flows down the drain on the right flank supported by Sikkim hills and left bank by West Bengal and finally leaves Sikkim by joining the other big river Rangit at Melli confluence and seams in the plains of West Bengal.

The river meandering between the rough and rugged boulder beds, plains of cold desert lands and at places it forms beautiful water falls. The nature of river varies from very gentle flow, to a sudden furry and ceaseless cascade falls. As winter months sets in, the volume of river remain clean, clear and blue. As monsoon starts in, entire countenance of the river transforms into full of furry, muddy,

rough carrying boulders, sediments, silts and it is difficult to fathom its nature. It has been observed over decades of experiences with the nature of river character which is due to various factors responsible for abrupt dynamism and may be difficult to contend by the modern science and technology.

Hydro Power Potential of Teesta River

As per the studies of Teesta River system, it has tremendous potential for development of hydro power generation as the river starts from a very high elevation of 3600 m to about 300 m over a distance of more than

175 km north-south. It descends through various rich alpine forests, temperate forests and the river could be harnessed under cascade development and six stages of power generation were identified.

Sl. No	Teesta HEP Stage	Area/Location	Installed/ Capacity/MW	Remarks
1	Stage I	Zemu Lakes	320	Under study
2	Stage II	Lachen/Lachung/ Chungthang	750	Survey under way
3	Stage III	Chungthang	1200	Environment clearance accorded for operation by Teesta Urja Ltd.
4	Stage IV	Singhik/Swayam	495	EIA, EMP under study by NHPC
5	Stage V	Dikchu/Shirwani	510	Nearing completion
6	Stage VI	Shirwani/Rangpo	500	Environment clearance accorded for operation by LANCO

Besides the above hydro power, potentiality there are many small streams and rivers manageable for generation of micro Hydro Electric Power Projects which are being planned by the state.

Teesta Stage V

The Teesta Stage V is the second Hydro Electric Power Project entrusted to NHPC, the first being the Rangeet Hydro Electric Power Project

located in West District commissioned in the year 2000-2001. The salient features TSV are as under:-

LOCATION

State	Sikkim
River	Teesta
Dam Site	2 Km downstream of the confluence of Dikchu and Teesta river Near village Dickchu
Longitude	88 ⁰ 27'30" E
Latitude	27 ⁰ 15'00" N
Access to the project from Bagdogra Airport	Distance from dam site -140 km Power house site-110 Km
Railhead	New Jalpaiguri & Siliguri

HYDROLOGY

Catchment Area	4307 Sq.Km
Free draining area	2020 Sq.Km
Design discharge	9500 Cumecs (PMF)

RESERVOIR

Full Reservoir Level (FRL)	EL 579.00m
Max. Reservoir Level (MWL)	EL 580.72m
Min.Draw Down Level (MDDL)	EL 568.00m
Gross Storage up to FRL	13.25 MCM

DAM

Type	Concrete Gravity Dam
Height of dam from deepest Foundation level	96.45m
Elevation of top of dam	EL 583.20m
Length of dam at top	182.50m

SPELLWAY

Design Flood	9500 Cums (PMF)
Type	Central Ogee Shape
Crest Level	EL 551.00m
Maximum Head over crest (w.r.t.FRL)	28.0m
Type of Gate	Radial-Sluice
Number & Size	5 nos. (11m wide x 16m high)
Energy dissipation	Trajectory bucket
Top of road	EL 583.2 m

DIVERSION TUNNELS

Number	2
Shape & Size	Horse Shoe 12.2 m dia
Lengths	600m & 460m (approx.)
Diversion flood	3251 cumec

COFFER DAM

Length	U/S C.Dam	131m
	D/S C.Dam	78m
Height	U/S C.Dam	25m
	D/S C.Dam	10m

INTAKE

Invert Level	EL 556.50m
Number & Size	3 nos., 6.5m dia
Design discharge	117 cumec each

DESILTING CHAMBER

Type	Dufour type
Length	315 M
Number of Chamber	3 NOS.
Design discharge	117 Cumec each chamber
Particle size to be removed	0.2 mm and above (90%)
Size of Chamber	20m (width) x 22.5m (height)

HEAD RACE TUNNEL

Number	One
Shape	Horse Shoe
Size	9.5m dia
Length	17.78 Km
No.of Adits	5
Design Discharge	292.37 cumec

SURGE SHAFT

Type	Semi underground
Diameter	25.0m
Height	92.0m
Maximum Surge Level	EL 615.0m
Minimum Surge Level	EL 544.0m

PENSTOCK/PRESSURE SHAFT

Type	Vertical Pressure Shaft
Number	Three, Steel lined
Design Discharge through each	97.45 cumec
Diameter	4.7m dia each
Depth	Approx. 175m

POWER HOUSE

Type	Underground
Type of Turbine	Francis
Design Discharge (cumecs)-3 units	292.37 cumec
Size of Machine hall	100.5m x 22m x 49m
No. & capacity of Units Service	3 nos. of 170 MW each
Bay Level	EL 367.30m
Generator floor Elevation	EL 362.30m
Bottom of Draft Tube	EL 342.20m
Centre Line of turbine	EL 354.70m
Minimum Tail Water Level	EL 359.50m
Maximum Tail Water Level	EL 360.00m
Maximum Flood Level (for Q=9500 cumec)	EL 370.75m
Gross Head	216.73m
Net head	197.57m

TAIL RACE TUNNEL(Concrete lined)

Type	D-Shaped
Length	135m
Width	6m

POWER GENERATION FIGURES

Installed capacity	510MW
Dry season peaking capacity	510 MW
Annual energy production in a 90% dependable year	2573 GWH

LOCATION AND EXTENT

The main drainage and catchment of TEESTA STAGE V HEP Project is located in the East and North district of Sikkim, the dam and the

power house is located in the east district and the other office and colony lies in the south district of the state.

WATERSHED CODE/AREA/VOLUME/LOCATION OF CATCHMENT AREA OF TEESTA STAGE -V.

Dzongu Catchment

There are nine sub- watersheds spread in the upper catchment in north district i.e. three sub watersheds in Dzongu viz. T10 the main drainage at the vicinity of the dam site covering Rongdol, Phedang, Gorsangtok, T11 covering part of Ring Khola or Manchu Drainage covering entire village of Samdong, Tarang, Goan, Samdong, Sudur, T12 Lingdok, Barfok, Manzing, Bringbong, part of Sudur Drainage.



Dzongu Catchment contd

Watershed code	Type of land	Area	Volume	Location
3TA1B3-T10	Non Agri.	752 ha.	1400 cum.	Phedang, Rongdul, Gorsangtok, part of Lum
	Agri. land	100 ha		
	Part Agri.		3000 cum.	
3A1B3T-11	Non Agri.	711 ha	500 cum	Part of Menchu, Ringkhola, Samdong, Tarangoan, Sudur, Hee-gyathang
	Agri. land	174 ha.	5000 com	
	Part Agri.		1375 cum	
3A1B3T12	Non Agri.	775 ha	1300 cum	Lungdung Barfok, Manzing,Bring bong, Sudur, Part of Heegyathang
	Agri. land	225 ha	2000 cum	
	Part Agri.		3500 cum	

Mangan Catchment

Watershed code	Type of land	Area	Volume	Location
3A1B2-T1	Non Agri.	1330 ha	1000 cum	The main drainage of Rangrang nalla, Kalay RF Chandy, Ringchim, Armbithang, Thingchim Mangshilla, Ralak.
	Agri. land		8000 cum	
	Part Agri.		175 cum	
3A1B3-T2	Non Agri.	520 ha.		Namok, Tanek Dikchu, part of Mangshilla Swyam.
	Agri. land	100 ha.		
	Part Agri.		1000 cum	
3A1B3-T3	Non Agri.	1005 ha.		Labrang, Phodong, Chewing, Phamtam, Menrongong, Phensang.
	Agri. land	375 ha.		
	Part Agri.		2000 cum	

Phodong Catchement.

Watershed Code	Type of land	Area	Volume	Location
3A1B3-T4	Non Agri.	179 ha.		Ramthang, part of SangaTanek, Phodong
	Agri. land	175 ha.	2000 cum	
	Part Agri.		800 cum	
3A1B3-T5	Non Agri.	50 ha.		Bakcha chu to main drainage, Labi, part Phensang, Kabi, Gaikhana, Nakchok, Tsonaknam, Panch Pokhori.
	Agri. land	1125 ha.	1000 cum	
	Part Agri.		600 cum	
3A1B3-T6	Non Agri.	709 ha.	1250 cum	The main drainage is the northern flank of Rateychu which separated at BII the state boundary between North and east district. The upper area covers Tamze Valley, Kabi Lungchok, Barfungchen BII.
	Agri. land	175 ha.		
	Part Agri.		800 cum	

Gangtok/ Ratey Chu Catchment.

Watershed Code	Type of land	Area	Volume	Location
3A1A3-T7A	Non Agri.	640 ha.	1000 cum	Ratey chu eastern flank, part of Tamze valley.
	Agri. land			
	Part Agri.		2000 cum	
3A1A3-T7B	Non Agri.	500 ha.	2500 cum	Rakchu, Pithangiha.
	Agri. land	125 ha.	220 Rmt	
	Part Agri.		1000 cum	
3A1A3-T7C	Non Agri.	150 ha.		Phengla, Navey Shotak, Tashi View Point.
	Agri. land	75 ha.	300 cum	
	Part Agri.		2000 cum	
3A1A3-T8	Non Agri.	400 ha.	2500 cum	Lingdok, Nampong, Rakshey Khola
	Agri. land	50 ha.	1000 cum	
	Part Agri.			
3A1A3-T9	Non Agri.	220 ha.	1000 cum	Rakdong Tintek, 4 th Mile, Dikchu.
	Agri. land	100 ha.	2000 cum	
	Part Agri.			

Modus Operandi for Execution of Catchment Area Treatment (CAT) Activities and Responsibilities:

The CAT Plan involves multi-disciplinary approach activities of soil conservation through biological measures added with engineering works. The environmental improvement, landscape management vis-à-vis economic generation activities are one of the important inputs. The catchment area has rich and varied floral and faunal composition and diversity. The medicinal plants/resource is another important component of the CAT plan.



The Catchment area has vast tract of degraded land both in agriculture and forest lands which require appropriate technologies and expertise. In order to contend the situation, the FEWMD Govt. of Sikkim has constituted six substantive

functional divisions having vast experience, skill and technology for treating river valley projects. The six divisions are mainly, Territorial Division who has access to land ownership and legal rights to deal with the land falling within the catchment area. The Territorial North and East District are entrusted with selected items of CAT activities. The Social Forestry Circle is another sector responsible for CAT Plan. The North and the East Social Forestry Division are involved for same purpose to carry out specific treatment of private and Government land. The catchment area has vast extensive landslide zone and soil erosion prone area which require appropriate technologies to tackle the problem. The Land Use North and East Division have been entrusted to carry out the treatment of the problematic area. The different item of the work, activities distributed to each circle are as under:

Territorial Circle

Regeneration of degraded forest land through artificial and natural regeneration activities are given to the Territorial circle. Both ex-situ and in-situ conservation of medicinal plant resources of the catchment area and pasture development within the degraded high elevated forest and also improvement of Goucharan land is another responsibility. Seed sowing is another activity of the Territorial Circle. Live-hedge fencing with appropriate

species having quick regeneration of cuttings and rhizomes is also given to them. Construction and development of necessary infrastructure and entry check post within the catchment. Beside the above activities, protection of the assets through deployment of watch and ward and fencing with stone wall and barbed wire angled iron post are also entrusted to them.

Social Forestry Circle

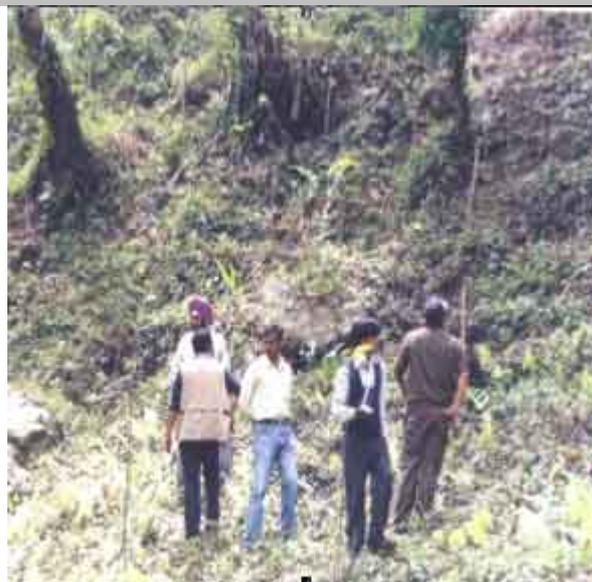
The main activities of the Social Forestry Circle are fuel wood plantation, broom grass plantation, silvi-pasture development programme, Horticulture plantation of selected species, brushwood plantation and creation of avenue plantation. The maximum work are carried out in private holdings, Goucharan and Khasmal land to meet the perpetual local demands and protect the adjoining forest from local pressure and to control sediment flow from the agriculture lands. The protection through mechanical and social fencing is also part of the work allocation. They were also given bamboo

plantation in selected sensitive areas of the catchment.



Land Use & Environment Circle

These are two main activities given to this circle viz. biological items are bally benching, Bamboo plantation, contour bonding and engineering activities includes sausage wall, 1:4:8ccm wall, dry stone masonry work, catch water drain, jhora training work on both agriculture land as well as forest land and government land within the catchment area. The landslide, soil erosion prone zone from biotic interfere by construction of dry stone masonry work and angled iron post and barbed- wire fencing too. The other technological inputs are selection of right species depending on the elevation, adaphic factors and moisture regime availability.



NURSERY CREATION AND MAINTENANCE

There were several hectares of old and abandoned nurseries within the catchment area which were considered for production of quality seedlings/rhizomes after the detail survey of CAT Plan preparation. There were total 19 ha in east district and 14 ha in north district which were taken under CAT project since the beginning of the project as these nurseries are

within the reach of the catchment area of Teesta Stage-V. Some of the existing mother nurseries were taken under the project to accelerate timely production of seedlings requirement for the CAT project. The following are the nurseries created and taken form existing abandoned location for the project of CAT Plan of TSV since 2000-01.

Name of the Division	District	Location	Created	Abandoned taken	Total Area	Remarks.
East (T)	E	Lingdok		6+1	7	
North(T)	N	Pakshyap		1	1	
		Tingchim		1	1	
		Heegyathang		2	2	
		Lingdong		2	2	
East(SF)	E	Rakshey	-			
		Salingay bagay		1	1	
		Amlatar		-		
		Sai dara	1	2	3	
		Lagyap		2.5	2.5	
		BII		2	2	
North(SF)	N	Gormathum	1		1	
		Laborbhotey		1	1	
		Goansamdong	1	-	1	
East (LU&E)	E	Dhanbari		2.5	2.5	
		Dipudara		1.00	1	
North (LU&E)	N	Phidang	-	1	1	
		Namprickdang	-	1	1	
		GoanSamdong	-	1	1	
		Chawang	-	1	1	
		Tanek	-	1	1	
Total			3	30	33	

Watch & Ward

The CAT Plan has provision of engagement of watch and ward /supervisors and chowkidars for protection of the plantation, regeneration areas in all the sectors. The watch & ward and others were engaged along with the projects implementation and capacity building of new hands followed. AS a result these individual have gained basic technical, knowledge as well as skill development, experiences and extension services for proper

implementation scheme/project. Therefore, the CAT project has provided training and capacity building of local youths of both genders residing with the catchment for conservation, protection and maintenance of the catchment area activities within their villages and adjoining forests. They are fully aware of process of catchment area treatment inputs and benefit of it for their improvement of land and other natural resources management.

Involvement of Local Inhabitants and Local Panchayat Body

The catchment area falls within Revenue Blocks in east district and Revenue Blocks in North district. The implementations of the entire scheme in each block were consulted with the local residents through the local gram Panchayats.

The participation of local communities and local Panchayats were given priority for planning and implementation of the schemes of the catchment area treatment activities. As a result, there is transparency, high rate of survival percentage and greater impact of CAT works.



There is over all understanding of proper land use for better economic benefits and environmental improvement because of mass community participation at the grass root level and they carry a sense of belonging and understanding of the activities extended in their farms and adjoining forest.

Soils of Catchment

The soils of catchment area as reported are limited to a few orders like Entisol, Inceptisol and Molisol and are in the process of new soil formation. In most of the areas soils are in order of Inceptisol, Umbric or Typic moisture regime. The soil texture classes varies from fine loamy, coarse loamy, coarse loamy to fine loamy, coarse loamy stones, coarse loamy, loamy and silty loamy with depth varying from moderate, deep moderate, moderate deep, moderate skeletal within 7-8 location of the catchment area. The soil ph value varies from 4.1-6.6 in some places. The organic carbon matter of soil at Rangrang, Dikchu has the lower

component, but lower Namok at the same level appears high.

The available and distribution of Nitrogen was medium almost throughout watershed, Phosphate availability is limited in acidic soil. The Potash availability indicated low to medium in most case. The over all soil fertility status indicated medium Nitrogen, Phosphate and low to medium Potash considering the soil ingredient and mineral and chemical component, the selection of planting material and their choice of each were considered while afforestation works were carried out in the catchment.



The Forest, Environment & Wildlife Management has procured relevant maps of Satellite imaginary, topo-sheet and erosion Intensity map from RRSSC Kharakpur. On the basis of the catchment area maps, watershed

was wise identified and delineated in the entire catchment area. Each items of catchment area treatment activities were drawn as per the ground situation of the catchment and documented for treatment.

Catchment Area Treatment Activities TSV - Land Use Circle

There are two substantive Divisions posted one in North District, Paksyak, Mangan, North Sikkim and another in East district, Deorali, Gangtok East Sikkim dealing mostly with soil conservation, landscape, environment conservation, wetlands conservation, perennial water sources and implementation of Environment Protection Act 1986. The catchment area treatment activities, implementation of environmental clearances conditions for various HEP projects and other developmental activities in the state. Responsible for development of degraded land reclamations and rejuvenation programme and treatment of landslide and erosion control measures of area identified by National Soil Survey Organization and All India Land Soil Survey Organization, a branch of Ministry of Agriculture and Co-operation, Government of

Biological/Measures: The biological inputs are bally benching, Bamboo plantation and afforestation activities.



India



Both the Division are entrusted with the treatment of Catchment of Teesta Stage V encompassing rough, degraded, eroded and landslide prone zones of north district composed of two components, viz, the Biological Measures and Engineering Measures.

The slushy, swampy eroding zones were taken up for operation bally benching work. The Bally benching techniques and technologies composed of selection of slope with moderate to severe soil erosion and gradual landslide areas. As soon as the area/site within the catchment are identified 27 numbers of small terraces over one hectare are created across the slope in a staggered manner and cutting, live poles/saplings of quick and easily sprouting species arranged measuring vertical 1.2m long and 7-5 cm to 10 cm diameter were arranged. Total 7 nos of such poles were used per 27 benches over one hectare land treatment.

The effect of the technology is that the movement of soil erosion is controlled gradually and debris, biomass collected across the benching slopes and soil habitat receives improvement. In this process secondary succession of vegetation take places momentum and local species started growing within the benches and around the area. The sites are

conducive for afforestation/regeneration work and also reduce the silt flow down the main stream/river, thereby checking rate of sedimentation in the reservoir. This also enhances the ecology and surrounding environment of the site area and improves the quality of the adjoining cultivation and forests area.

BAMBOO PLANTATION

The Bamboo is another effective techniques used for treatment of catchment area of TSV both in North and East Sikkim. The bamboo plantations were also carried out in degraded forest land, landslide zone, private land along the river bank. The collection and procurement of bamboo seed was very difficult due to prolong variation in bamboo flowering and seed production.

The solid bamboo propagation techniques were introducing in the nursery through constant monitoring and study of growth rate of solid bamboo preparing for Quality Planting Material.



Massive Bamboo Plantation with barbed wire fencing.

The solid bamboo about 6-8 ft. length of any thickness with close nodes were collected from the local farmers and also forest area specially where the growth of bamboo is thick due to over age or cluster congestion thick clumps. One small hole in between the nodes were created with knife and the solid bamboo bally is laid in the bed of organic soil in the nursery. The hollow bamboo is filled up with water at $\frac{3}{4}$ of the chamber between nodes and cover with leaves or plastic pieces to avail entry of foreign materials. The watering is continued maintaining the same level, the rhizomes starts generate from the below the laying bamboo after 10-14 days and small shoots also starts above the rhizomes within a month. Bamboo Rhizomes is ready by the end of 5-6 month, which is cut between the nodes and a solid bamboo is capable of producing average 8-9 rhizomes/solid bamboo ready for planting. The bamboo plantation with the catchment of Teesta Stage V were carried out with bamboo Rhizomes prepared with local innovation in addition to the seed raised rhizomes and rhizomes arranged from the local growers. The

Bamboo Plantation raised at Bakcha chu near the Baksha Bridge, Chewing, Ramthang, Tanek, BII, Phesang, Tingchim, Rongdol, Phedang, Barfok, Ringkhola, Bringbong, Rangrang, Ralak, Dickhu has shown more than 90%

Contour Bounding

The contour bounding techniques are preparation of contour terraces across the slope measuring 10x5m x 0.30 x 0.8-5 supported with dry stone rubble structure.



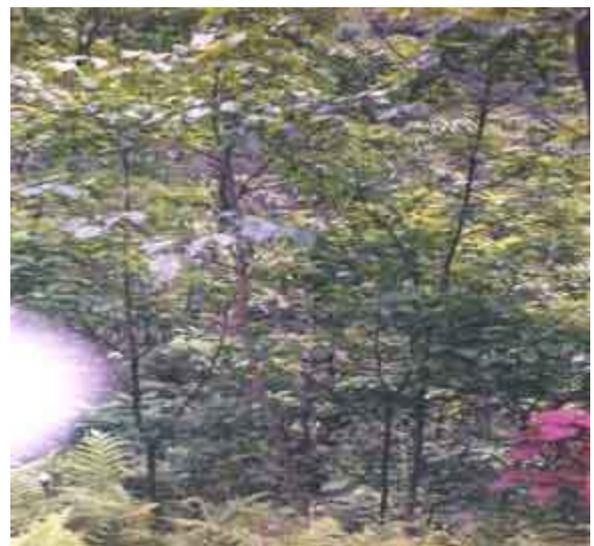
The Planting with fast growing hedge, grass, broom grass in the private land which were not fit for cultivation due to lack of moisture regime availability, soil nutrient and organic matter. The desired slope area is 20⁰-30⁰ for contour bounding activities, but in actual such slope were not available within the catchment. Hence, slope exceeding more than 40⁰-50⁰ area were treated with contour bunds and created cultivable site for growing vegetable, fruits. During the monitoring/implementation of the area, it was noted that a large chunk of highly

success. The Bamboo Plantation has rendered effective control of soil movement, stabilized soil erosion and strengthened extensive landslide and reduced siltation and sedimentation of river.

degraded private land with steep slopes were converted into suitable cultivation land. The farmers have grown vegetables fruits and fodder in the contour terraced. The creation of contour bounding has several advantages such as increase of moisture regime, reduced runoff, improved soil nutrient and controlled soil erosion and landslide. The net cultivable agriculture land increment noted and promoted economic conditions of the farmers by sustaining improved local environment.

Afforestation

Afforestation and natural regeneration is one of the important biological measures undertaken by the Territorial Division till 2004-05.



The progress of the work could not match with the target due to inadequate skilled manpower within the Territorial Division, and other

administrative obligations on the other hand the progress of the project site was moving at a faster rate, in order to synchronize the progress of the afforestation work with that of the project site, some sartorial distribution of works were rearranged after 2004-05. Afforestation work of 485 ha was entrusted to Land Use & Environment Cell, North Division, another 500 ha was to Social Forest East Division and 142 ha to Social forestry North Division.

The progress of work received desired results of afforestation. The degraded forests land, Khasmel and Gaucharan lands were also treated under the same programme. The survival rate of afforestation works were highly visible and result oriented.

Engineering Measures or Mechanical Inputs

The main landslide, soil erosion prone zone and a large number of nallahs and natural Jhoras running from both side of the main drain the Teesta River were assessed locally for proper treatment. Almost all the natural Jhoras, nallah and artificial nallah created due to extensive road construction within the catchment and aggravated by faulty agricultural techniques were given priority for restoration, control, diversion and proper training with both CCM work component.



CCM wall Protects Forest Land and Cardamom field.

The Engineering works composed of mainly structures with 1:4:8 CCM wall, sausage wall, jhora training work, catch water drain, dry stone masonry work and contour bounding activities. As per the CAT Plan 1:4:8 CCM wall partly required for construction within the agricultural land, but jhoras, nallah are located in the mid of the village and construction of engineering work to guide the overflow, runoff, in the nallah and to train the excess runoff coming from the agricultural land into the main nallah was taken up for treatment. The approved Catch Water Drain scheme was limited to 520 cum which was constructed in east district to divert runoff generated for agriculture land which was causing landslide and erosion and posing threat on the main communication to the Dam area. It has provided safety and protection of the agriculture land and also communication besides control of silt generation.

The dry stone masonry work was another effective catchment area treatment

activities provided in the CAT Plan. It is composed of dry stone masonry work collected from the adjoining area and arranged in a wall with proper trenching foundation work. The walls were constructed across the gentle slope to steep slope depending upon the topography of the subwatershed. Besides constriction of rubble wall, the training of rivers/streams were also carried out at Tamze valley of Ratechu watershed falling in both the districts north and east. The construction of dry stone rubble structures has checked the silt generated from the road construction at Tamze valley under the main drain Ratechu. The dry stone wall across alpine surface and landscape has improved the site conditions for regeneration process and rendered control over silt generation and soil erosion. Thereby ensure over all surface runoff control across the slope. It was observed that the dry stone masonry work was very useful and effective item of catchment area activities creating compact impact of the watershed. The surface runoff check and control of silt retention of moisture, improvement site quality, restoration of soil nutrient and formation of humus observed. It also rendered protection of plantation against biotic interferences and maintains sustained ecology and environment. The main engineering structures were supplemented with biological inputs such as seed sowing, planting, closure which ultimately improving the site quality strengthening the structures and provided stabilization of the fragile soil erosion zone and landslide prone area of the catchment.

The combined biological and engineering techniques for contending landslide and erosion and control of silt flow and reduction of runoff velocity at Rongdol Lower Dzongu, B-II, Ramthang, Tanek, Ratechu, Ralak, Mangshilla, Tingchim has stabilized the long felt problem of agriculture land, communication and improved the local environment. The people of lower and upper Dzongu have appreciated the landslide problem and control works at Rangdol slip created under the project. The generation of alluvial form type of landslide below Rangdol slip has been abruptly reduced and controlled. Thereby checking movement of mass volume of sediment into the main River Teesta. Besides the control of landslide, erosion and protection of agriculture land the local youth of both genders have deployed and gained experiences to handle small scale contract works as a part of the project implementation.

Territorial Circle:

The Territorial Circle has two functional divisions Territorial Division, North Mangan and Territorial Division East Gangtok. The main item of works approved under the CAT Plan TS-V were afforestation, natural regeneration, medicinal plantation, pasture development, seed sowing, live hedge fencing. In addition to the above activities the protection through mechanical fencing and biological fencing were also entrusted to them.

The afforestation work at Chandy, Rangrang, Ralap R.F, Tingchim, Hee-gyathang, Mangshilla, Chewang, Menrangong, Ratechu

R.F, Pangthang has shown 90-95% survival rate although the site condition were extremely poor degraded. The plantation under the scheme carried out in the area bare excellent results. The plantation in these areas gained optimum height and growth with broad canopy spread, as a result, birds squirrels, palm civet, leopard cat and host of butterflies are common sightings which did not happened in the past. The presence and occurrence of wildlife is a strong indicator of habitat improvement. The natural regeneration works were carried out by the territorial divisions in the high forest areas where the growth of desired species are stunted due to congestion and competition on photoperiod and moisture availability. The open degraded land within the RF creating fresh blaze of landslide and erosions due to high rainfall and absence of vegetation were also treated under the programme of natural regeneration. The obnoxious weeds and a creeper were cut and burnt creating conducive site for natural regeneration take up. A large degraded area of high forest covering over 700 ha of area brought under natural regeneration programme both under North and East districts. Although the natural regeneration works were successfully implemented in the catchment, but post management by gap filling and improvement and protection against biotic interferences such as grazing and control of weeds seemed indispensable factor of maintaining the natural regeneration work for better output.

The medicinal herbs plantations of 100 ha of 60 ha in North and 40 ha in east districts were carried out. The main activities including

growing of medicinal herbs nursery, raising through plantation of any selected species both in high altitude and low altitude. The conservation of rare and valuable species through in-situ conservation practice were also attempted. The raising of medicinal plantation has improved the soil conservation and reduced surface runoff.

The seeds of local species were also collected and sowing and broadcasting mechanism was conducted in the landslide zones and erosion prone area by creating suitable sites within the catchment area. The seeds of *Alnus nepolensis*, walnut, *Erythraea* and grasses have shown better success. The total seed sowing area covered in north district was 150ha and 50ha in east district. The dibbling of walnut has indicated better performance over other species elevation ranging from 915m to 6500m.

Pasture development activities included planting of grass and legumes in the selected abandoned cowshed, overgrazed area and degraded alpine landscape. The growth of grass in the abandoned cowshed has indicated higher rate of survival and improvement as compared to overgrazed area and alpine zone especially in Tamze Valley, Nakcho, Kaley RF and at Ratechu watershed. The total area treated under this programme was 600 ha in North Division and 100ha under East District. It was observed that there were improvement of grass growth and total biomass, but control grazing practices is strictly enforced and contemplated would bring better results.

SOCIAL FORESTRY

The fuel wood and fodder plantation was one of the very important items of catchment area treatment under social forestry sector. There were vast tract of wasteland, government land such as Gaucharan, Khamal at the fringe of the villages and the villages depend their source of fodder, fuelwood from their lands due to regulate use of these lands, the fodder availability in the Gaucharan and fuelwood from the Khamal has become scanty with high growing demand. The each and every villager in the catchments area has 2-3 cattle heads for their own supply of milk and nutrition, but the grass and fodder is limited. In order to meet their demand over 700 ha of fodder and fuel wood plantation covering 300ha in east district and 400ha in north districts were carried out with selected fodder plants and fast growing fuel wood species of, local origin. The creation of these plantations has reduced accessibility in the adjoining forest land by the adjoining farmer and controlled further degradation of land. The runoff, soil erosion and landslide checked and reduced. As a result there was marked change in the environmental conditions.

The silvi-pasture development was another item of work carried out by the social forestry sectors wide spacing planting of tree species providing undergrowth with grass such as Nepir, Gautmala, broom grass and succulent fodder species were carried out. The Silvi-pastue development programme has promoted requirement of fodder and small timber by the village in the catchment and it also served as soil protection cover. The total areas covered

under these sectors were 500ha out of 200ha area treated in east district and 300 ha in North district.

Afforestation works were also taken up by the social forestry sector covering 500ha in east district and 142 ha in North district. The creation of afforestation was in addition to their allocation. The afforestation work at BII, BI and Rateychu ha shown desirable success and high survival rate.

Broom grass is another item of activities carried out by them. This item of work was entrusted to the local farmers to grow in their farms land without disturbing the cultivable land. The broom grasses were grown/planted in the edge of the terraced land, bunds and the land not fit for cultivation. Over 1000 ha was carried out by them and has achieved cent percent success. The broom grass plantation has reduced active of landslide, control soil erosion and gradual stabilization of loose soils rendered. Further, the foliage is used as fodder twigs/stems and are valuable firewood and inflorescence is used as broom sticks which has ensured substantial economic promotion of the villagers as the gestation of the plant is 1-2 years only. In fact broom grass should be the main item of catchment area treatment activities for all HEP projects.

Horticultural plantation works were also carried out by the social forestry sectors to enhance the local economy, so that the stress on the catchment would be reduced. The main fruits plants are Pears, Peach, Plum, Walnut,

Citrus, and Oranges. The plantation of horticulture plants has improved the patch wasteland available within the watershed and also substantiated economy of the farmer to some extent. It was observed that this item is not very significant input for catchment area treatment. Total physical area of 200ha in the east district and 300ha was treated in north district.

Drystone Rubble masonry work was also carried out by social forestry divisions for protection of plantation and enhancing soil moisture regime. The dry stone rubble structures have supported excellent protection as well as helped for regeneration of site conditions in the catchment area

BAMBOO PLANTATION.

A partial Bamboo Plantation covering 15ha in north district and 40ha in east district was also carried out for protection of landslide and erosion at BII slip and BI slip zone along with afforestation programme. The success of Bamboo Plantation rated excellent performances and gave control over active landslide and erosion which use to disrupt the road at BII frequently.

AVENUE PLANTATION.

Plantation along the state road communication and North Sikkim Highway were implemented by the sector with selected flowering plants, herbs, shrubs having fast growth rate. Among the species planted along the fringe of the road with bamboo basket guard, the cherry, champ, cupressus has shown better output. However, the plantation works

have been damaged due to widening of road NSH between BII- Phensang and also for Dikchu to Rangrang Road.

Protection of plantation area through mechanical as well as biological fencing inputs were also done and provided good results. It also generated employment to the local youth of both gender and created a sense of ownership of the assets.



The revision of the Catchment Area Treatment plan Teesta Stage_V.

The original cost of catchment area of treatment plan of Teesta Stage-V has to be revised due to increase of labour wages in the year 2001 from Rs.40/- to Rs.50/- per day and in the year 2004 from Rs.50/- to Rs.85/- within the project period. Simultaneously a new project has been planned over Dikchu River sharing common catchment of Teesta Stage-V. As a result a part of common catchment area of Teesta Stage-V covering 1190 hac was transferred to proposed Dikchu Hydro Electric Power located in the North & East District

Thus the total revision of CAT Plan was necessitated and the final catchment area was worked out to 10710 hac. A proportionate enhancement of prizes on all store materials during the project period effected. Thus the total project costs for catchment are treatment of Teesta Stage-V has been revised to the tune of Rs.3680.66 lakhs against original cost of Rs.2420.25 lakhs.

While revising the catchment area treatment plan, the overall quality, improvement & maintenance of the catchment area activities were considered besides the increase in labour wages twice in a project period. The main components of the maintenance are usual weeding, gap filling, protection and overall improvement of the quality of the plants under stress. The gap filling of degraded forest within the catchment area over 655hac were also included in the revised CAT-Plan. On the basis of the recommendation of the various monitoring agents, the protection of plantation, regeneration and closure of active landslide through stone wall fencing was also approved in the revised Catchment Area Treatment Plan stretching over 31 km. The maintenance of newly created afforestation schemes has been extended upto 2010-11. The implementation of maintenance of the Catchment Area Treatment activities and balance creation works were geared up to match the progress of construction with that of the project site which is being commissioned later in the year 2007. All the implementing divisions during the schedule time of the catchment area treatment plan were activated to ensure better conservation of soil

and improve the quality of the environment of catchment area and to ensure long life of the Dam.

Administrative Support.

In order to carry out the regular supervision, monitoring and inspection of catchment area activities, one Bolero was purchased and old vehicles attached to the divisions were repaired and renovated and brought on proper running condition.

The catchment area encompassed vast stretch of remote areas where there were no proper infrastructures for the front line field staffs, quarter for Block Officers, FG and Range Office were provided. The Division office, Land Use, North was extended with a provision of inspection room. The approach road to the division office was also constructed. A check post-cum-FG quarter at Dikchu was constructed to regulate entry of forest produce and also in the catchment. This chec post will provide security to the reservoir area and the Dam site from out side interferences.

SALARIES AND ALLOWANCES:

Salaries and Allowances of the field staff working for the catchment area Teesta Stage-V, their salaries and allowances were partly met from the provision of salaries and allowances of the CAT Plan. However, balance allowances & salaries were met from the State Plan and Non Plan in order to reduce entire burden on the HEP.

CAMP SHIFTING

The fund provided under camp shifting were fully utilized for the purpose of making temporary halting shades/ Shelters in the remote working sites to ensure effective implementation of the scheme of CAT. The provision has reduced the walking distance and increase working hours by the labourers and staffs in the remote, difficult terrain and rugged landscape within the catch area. It is suggested that the provision for such item should be provided adequately.

SYSTEM OF MONITORING.

The State Government has notified two monitoring committee of environmental safeguards as per the Environmental Clearance for Teesta Stage-V viz multi-disciplinary Central Level Monitoring Committee composed of experts from different organizations, line department, non-government organization, Forest Department and representatives of Ministry of Environment & Forests, Government of India and Project Incharge, Teesta Stage V and their team. As per the term of reference, the period for monitoring is expected to carry out twice a year, however, the monitoring and evaluation was carried out once a year. This was due to excellent progress of work in the field as well as the project site complying with the conditions of the Environmental Clearance and implementation of Catchment Area Treatment Plan in a well coordinated working norm. The Central Level Monitoring Committee has observed excellent implementation of catchment area activities and they have recommended the case of Teesta

Stage-V for award of Indra Virksha Mitra Award in their monitoring and evaluation report of 2004-05 and 2005-06. They have appreciated the combined efforts of the Forests, Environment & Wildlife Management Department and authorities of Teesta Stage-V for optimum satisfaction of the works they have inspected during their monitoring and evaluation period.

The other committee was the Project Level Monitoring Committee consisted of the PIA CAT Plan, Environmental Officer NHPC and local community who has been regularly inspecting the catchment area activities while working in the field and suggested and provided technical inputs, modification, improvement on the lapses and inadequacies of the work and confirming the specifications quality and quantity. The team of monitoring committee acted as a guide as well as assistance to those people working in the field. Their suggestions, remark and directions were simultaneously carried out by the implementing agencies. The team also made efforts to discuss and interview farmers of CAT Plan in their villages and received positive and clear response from the people residing within the watersheds.

The District Administration also made several suggestions and directions regarding project/schemes/activities located near the farm lands to benefit the locals from the adverse climatic factors and natural calamities. This also has added extra participation of local community through the intervention of district

administration making the plan more transparent and responsible.

The visit of VVIPs also made tremendous impact on implementation of CAT Plan where suggestions on environmental issues were also received from them for better up keep and sustained around the villages.

The senior officers also made frequently inspection of the CAT implementation and their report revealed encouraging remarks and technical inputs for better outputs. The payments for the works carried out by different sections were released after the field inspection by the senior officers of the Forest, Environment & Wildlife Management Department and Project Level Monitoring Committee.

The Forests, Env. And Wildlife Management Department, in addition to the above

achievements has explored to treat the vulnerable landslips within the catchment area of the Teesta Stage- V from various organizations of Government of India and other sectors to improve and maintain the catchment area from further serious calamity problems and managed to get to treat the area under Technology Development Extension and Training programme of DoLR, Ministry of Rural Development Department of Government of India as research base project in Rangang landslide zone north Sikkim. The implementation of the project will provide and develop appropriate technologies from local resources which shall be technically and economically viable inputs. The project has been sanctioned on the due recommendation of the central Level Monitoring committee report.

The List of Officers / Staffs involved for treatment and Management of CAT Plan of Teesta Stage V

1. Circle: Social Forestry

Head quarter	Incharge	Designation	Duration
Gangtok	S.C.Centuary,IFS	C.F	2000-02
Gangtok	D.D.Sharma,IFS	Addl.CCF	2002-05
Gangtok	S.D.Pulzer	C.F	2005-till date
Division: East Division			
Gangtok	B.P.Thapa	DFO	2000-01
Gangtok	S.K.Tewari	DFO	2001-02
Gangtok	D.C.Nepal	DFO	2002-07
Gangtok	K.B.Gurung	DFO	2007 till date
Range:			
Gangtok	K.B.Subedi	R.O	2000-2007
Gangtok	C.B.Chettri	R.O	2000-2007
Division: North Division (S.F)			
Mangan	S.W.Bhutia	DFO	2000-2005
Mangan	V.K.Rai	DFO	2005-2006
Range: Dzongu(S.F)			
Mangan	Pralad Pradhan	R.O.	2000-02
Mangan	Sonam Pintso	R.O	2002-06
Mangan	Khituk Bhutia	R.O.	2006-07
Blocks:			
	Karma Wangyal		
	Lepcha	B.O.	2005-07
	Tsewang Tashi		
	Lepcha	B.O.	2000-02
Range: Phodong(S.F)			
	Tilak K.Mukhia	R..O	2002-2006
Blocks: Phodong			
	Tsewang Tashi	B.O.	2005-2007
Range: Mangan(S.F.)			
	H.R.Rai	R.O	1998-2003
	Kamal Subba	R.O	2003-2007
Block:Mangan			
	Tseten W.Lachungpa	B.O.	2002-2006.

2. Circle: Territorial

Head quarter	Incharge	Designation	Duration
Gangtok	T.Chandy,IFS	CF(T)	2000-2003
	C.S.Pradhan,	CF(T)	2003-2004
	SBS Bhaduria,IFS	CF(T)	2004-2005
	C.S.Rao,IFS	CF(T)	2005 till date
<i>Division: North (T)</i>			
	B.P.Pradhan, SFS	DFO	2000-01
	A.K. mohanty, IFS	DFO	2001-03
	T.G.Bhutia, SFS	DFO	2002-2007
	Monaliza Dash,IFS	DFO	2007-till
<i>Range: Mangan(T)</i>			
	Abidal Chettri	R.O	1998-2000
	M.B.Subba	R.O	2000-2002
	Gobin Pradhan	R.O.	2004-2006
	Ashok Pradhan	R.O.	2002-2005
	Blacky Tsong	R.O.	2004-2006
	Sonam Pintso	R.O.	2002-2005
<i>Block:</i>			
	Manjil Kharel	B.O.	2000-2007.
<i>Range: Dzongu (T)</i>			
	K.C.Bhutia	R.O	2000-2002
	M.B.Subba	R.O	2002-06
	Tseten W.Lachungpa	R.O	2007-
<i>Block: U/Dzongu</i>			
	Karma S.Bhutia	B.O.	2005-2007
	B.S.Tamamg	B.O.	2000-2003
	N.Sapkota	B.O.	2003-2007
<i>Range: Phodong(T)</i>			
	K.N.Sharma	R.O	2000-2004
	Gobin Pradhan	R.O.	2003-2004
	Jigdal Lachenpa	R.O.	2004-2006
<i>Block: Phodong(T)</i>			
	Nagendra Regal	B.O.	2004-2007
	Sonam Lepcha	B.O.	2004-2007

Division: East Division.

Head quarter	Incharge	Designation	Duration
Gangtok	Shri C.S.Pradhan	DFO	2000-2001
	Shri C.S.Rao	DFO	2002-2005
	Shri B.B Gurung	DFO	2005-till date
<i>Range: (T) Range</i>			
	Mr.N.T.Bhutia	R.O.	2000-2004
	Mr.James S. Lepcha	R.O	2005-till date
<i>Block: Gangtok</i>			
	Mr.G. Gurung	B.O.	2000-2003
	Palden G.Bhutia	B.O	2003-2006
	Neeraj Pradhan	B.O.	2007 till date
<i>Block: Pangthang</i>			
	Ms.Surjalata Rai	B.O.	2000-till date
	Raj Lall Rai	B.O.	2000-2004
	B.B.Pradhan	B.O.	2007 till date
<i>Range: Kyongnosla Range</i>			
	Mr.Lobzang Bhutia	R.O.	2000-2006
	Mr.K.S.Lama		2007
<i>Block: Kyongnosla</i>			
	Churamani Bhandari	B.O.	2000-till date

3. Circle: Land Use & Environment

Head quarter	Incharge	Designation	Duration
Gangtok	B.B.Lama,SFS	C.F.(LU&E)	2000-2005
	C.Lachungpa,IFS	C.F.(LU&E)	2005-till date
<i>Division: North</i>			
	C.Lachungpa,IFS	DFO(LU&E)	2000-05
	M.R.Rai,SFS	DFO(LU&E)	2005-till date
<i>Range: Mangan/Phodong</i>			
	James S.Lepcha	R.O.	2000-02
	N.T.Bhutia	R.O	2002-06
	Karma L.Bhutia	R.O	2005-till date
<i>Blocks: Mangan/Phodong</i>			
	Y.T.Bhutia	B.O.	2000-02
	Joseph Lepcha	B.O.	2002-2007
Head quarter	Incharge	Designation	Duration
<i>Division: East</i>			
	K.Yonzon	DFO	2000-2004
	Gut Lepcha	DFO	2004-2005
	B.P.Pradhan	DFO	2005-2007
	C.B. Bhujel	DFO	2007 till date
<i>Range: Gangtok/Samdong/Singtam</i>			
	K.N.Sharma	R.O.	2005- till date
	S.T.Bhutia	R.O	2000- Till date
	Dhananja Pradhan	R.O	2000-Till date
	P.T.Bhutia	R.O.	2005-2006
	Barun Kumar	R.O	2004-2005
<i>Block: Singtam</i>			
	Saran Subba	B.O.	2006-2007