



Schemes under Land Use & Environment Circle

Catchment Area Treatment (CAT) Plan

One of the hydroelectric projects Teesta Stage Five-510 MW was initiated by NHPC during the year 1999-2000, Since then simultaneously CAT plan was drawn up and implemented right from 2000-2001 and still some of the maintenance works is being implemented. The Four major sectors of the department are involved for executing the CAT Plan i.e. Territorial, Land Use & Environment, Social Forestry and Wildlife carried out the treatment works.

The period for implementation started from 2001-01 to 2010-11. The details are listed below:-

(In lakhs)

| Sl. No. | 2000-01 | 2001-02 | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | Total |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------|
| Fin | 67.12 | 296.07 | 475.16 | 399.48 | 644.16 | 726.15 | 332.66 | 722.39 | 186.97 | 15.48 | 7.74 | 3680.4 |

SIKKIM ECOLOGY FUND AND ENVIRONMENT CESS ACT 2008,

This Act was enacted in the state vide notification number 183 of 28th April 2005 by the state Government and the rules were made vide notification number 93 dated 2nd April 2007. In accordance to this rule the department has been enacting various activities for conservation and restoration of ecology in the state. Till date the department has spent following amount for the CESS work.

(In lakhs)

| Sl.No. | Name of the District | 2008-09 | 2009-10 | Total |
|--------|----------------------|--------------|--------------|---------------|
| 1 | South District | 21.50 | 14.00 | 35.50 |
| 2 | North District | 23.00 | 10.88 | 33.88 |
| 3 | West District | 29.00 | 25.00 | 54.00 |
| 4 | East District | 16.26 | 29.83 | 46.09 |
| | Total | 89.76 | 79.71 | 169.47 |

The activities done were:-

1. Dry Stone Rubble Masonry Walls were erected in various location of the districts which were prone to landslides, and also reached out to the degraded areas.
2. Efforts were made to restore the distinct species like *Rhododendron* in Gurase dara in West Sikkim.
3. Awareness Programme for the waste Management and distribution of eco-friendly Gunny bags for proper disposal of waste to tourist and local vehicles.
4. Even the degraded areas were treated by carrying out plantation with hardy and ornamental plants.
5. The funding was also made for the ancillary work in the Zoological Park in East Sikkim.

12th Finance Commission



The Circle has also been entrusted with the job of implementing activities notified in XIIIth Finance Commission. The achievement in this scheme is under:

(in lakhs)

| Sl.No | Year | East | West | North | South | Total |
|-------|--------------|--------------|--------------|--------------|--------------|---------------|
| 1 | 2006-07 | 12.95 | -- | 5.38 | -- | 18.33 |
| 2 | 2007-08 | 6.99 | -- | -- | 0.37 | 7.36 |
| 3 | 2008-09 | 18.51 | 1.91 | 11.25 | 0.99 | 32.66 |
| 4 | 2009-10 | 21.64 | 24.53 | 28.20 | 20.66 | 95.03 |
| 5 | Total | 60.09 | 26.44 | 44.83 | 22.02 | 153.38 |

Wetland Conservation in Sikkim

The Himalayan State of Sikkim shelves a large number of fresh water lakes of varied sizes and dimension specially located in high elevated areas. These fresh water wetlands have been the main source of Teesta River in North Sikkim and Rangit River in West Sikkim. They are the perennial water supply to various tributaries of the river system and also serve as a halting station for long distance migratory ducks. Some of these wetlands are glacier fed and others are snow fed.

Few of the wetlands have shown adverse reaction to the effects of global warming. There is a drastic decrease of water level and subsequent degradation of catchment area. The conservation of these wetlands is very important to sustain the aquatic eco-system and water supply.

Considering the imperative role of these wetlands, the experts of Ministry of Environment & Forests, Government of India, Wetland Division Dr. S. Kaul, Director, was invited to the State during 2006 and selected largely degraded wetlands due to anthropogenic factors for appropriate management & conservation strategies. The programme was followed up by visit of Senior Scientist in the subsequent year too. The selections of the wetlands were based on a cluster of small fresh water lakes forming into a complex of wetland in order to match the standard of wetland as per the Ramsar Convention.

As follow up, the guidelines of Government of India, State Level Steering Committee under the Chairmanship of Chief Secretary was constituted to oversee and review the wetland conservation activity in the State. Around 115 such wetland were indexed and six wetlands were included in the National Wetland Conservation Programme of Ministry of Environment & Forests, Government of India. Out of these six wetlands, four wetlands have received financial assistance for management and conservation practices since 2008-09.

Out of these 6 wetland 4 wetlands viz. Gurudongmar, Phedang, Tsomgo and Khecheopalri is being provided the pilot grant. Till now the fund received in the district are listed below:-

| Sl.No. | Name of the District | 2008-09 | 2009-10 | Total |
|--------|----------------------|--------------|--------------|---------------|
| 1 | South District | -- | -- | -- |
| 2 | North District | 12.61 | 15.00 | 27.61 |
| 3 | West District | 10.82 | 49.01 | 59.83 |
| 4 | East District | 15.00 | 16.60 | 31.60 |
| | Total | 38.43 | 80.61 | 119.04 |

Technology Development Extension & Training (TDET) Programme



Technology Development, Extension & Training (TDET) is a central scheme of Department of Land Resources (DoLR), National Wasteland Development Board (NWDB), Ministry of Rural Development (MoRD), Government of India.

The implementation of this project was done in the entire district in the state by Land Use & Environment Circle of the Forest Environment & Wildlife Management Department. This project was implemented in the state keeping in mind the Treatment of Landslide and Soil Erosion in Watershed of the Catchments area.

Sikkim, a small mountainous state in the eastern Himalayas covers an area of 7069 sq. km., extending approximately 114 km from north to south and 64 km east to west. It is hilly state consisting of tangled series of interlocking mountain chains rising range above range from the south to the foot of high peaks which marks the snow line in the north. The topography is such that it has earned itself a characteristic feature and the unavoidable natural disaster of all, the landslide. Landslide has thus been a part of this state since its formation.

Landslide the major natural disaster in the region and its occurrence leads to a lot of soil erosion thus depriving the region of its rich soil. Keeping mind the retention of the soil and treatment of Slides; The Ministry of Rural Development Department of Land Resources Government of India had granted fund for the project for Treatment of Landslide and Erosion Control in the identified area of the three Districts vice North/South and West in the following years.

The objectives of the financial assistance is for the purpose of

- Technology development
- Pilot project
- Field trial of established technologies on farmer fields/village commons/other institutional lands.
- Extension and training

Listed below is the statement showing the Fund allotted and spent for the Scheme:-

| Sl. No | District | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | Total |
|--------|----------|---------|---------|---------|---------|---------|---------|---------|----------------|
| 1 | West | 94.00 | 56.15 | 42.00 | 77.60 | | | | 258.15 |
| 2 | North | | | | 126.00 | 248.00 | 105.00 | Nil | 479.00 |
| 3 | South | | 99.956 | 172.84 | 147.88 | 63.15 | - | - | 483.826 |

Success indicators of these schemes: The TDET schemes in all the districts have shown mass regeneration of flora and retention of slides.

North Sikkim

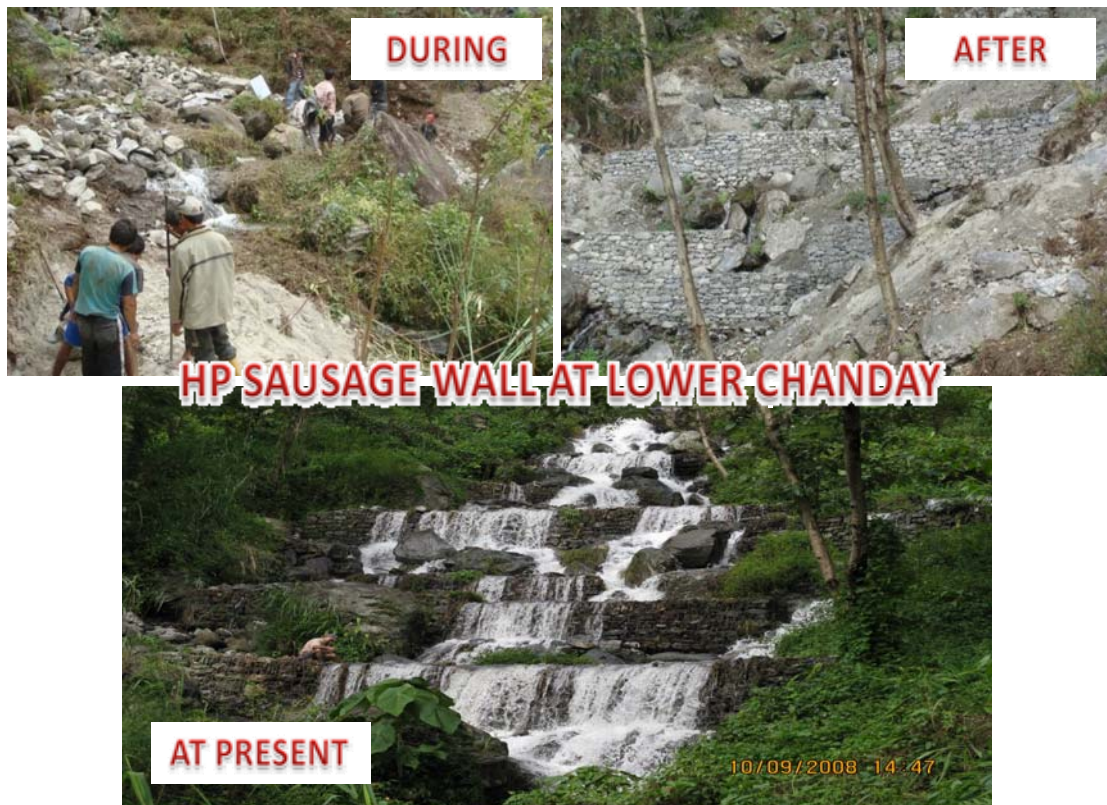


In North District, three watersheds namely Rangrang, Chadey and Namok were observed for treatment. The landslide Ranrang was the major concern for treatment as it is geologically controlled landslide. Therefore the technical advisory committee decided to take up the intervention in the places of concern wherever it is suitable since these places were fragile and needed more attention than surrounding areas.

The effective works done in the area were:-

- Hand packed inside sausage and PCC lining wall.
- Bio-engineering works
- Soil and moisture conservation structures
- Training programme and awareness programme.

Since micro-planning works were done in the area the local people too cooperated in the project. The project were successfully executed which has mitigated the problem. The measures could be replicated in similar terrain.



South Sikkim

In South Sikkim, Turung, Seti khola (Kateng) and Donak landslide areas were treated under the TDET sheme. The works done in the area were:

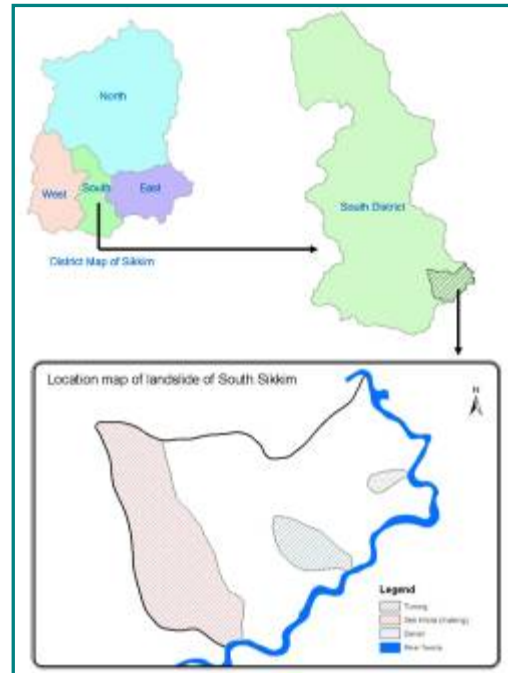


- Hand packed inside sausage and PCC lining wall.
- Bio-engineering works
- Soil and moisture conservation structures.

Results of the Study in South Sikkim

Critical Analysis and Scientific Approach of Vegetation:-

After scientific investigation, it was found that the density of *Alnus nepalensis* is very high in every fresh degraded landslide. The cuttings of *Jatropha* sp. was also an ideal plant in the rain-fed degraded land like in South Sikkim because cuttings initiate root very easily in dry land and also have high growth rate which efficiently binds the soil in proper place. The herbs like *Eupatorium odoratum*, *Lantana camara* known as common weeds of field, due to their high adaptability in the adverse environmental condition. Transplantation of such plants may easily survive in the nutrient deficient slide to check the soil lost. The *Cyanodon dactylon* grass of Poaceae is very common which forms the sod and covers all ground thus prevent soil lost. Plantation of *Populus* sp. could be ideal material to check the soil erosion because it can grow in very fast rate with extensive root system and survive in adverse condition of environment. However, plantation of many bamboo species and plant like *Anthrocephalus cadamba*, *Erythrina indica*, *Bischofia javanica*, *Terminalia myriocarpa*, *Agave americana*, was done in afforestation zone of erosion slide.



Acclimatization of Poaceae grasses in degraded nutrient deficient landslide

The outcome survivalists of plantation is nearly 80% but soil is very acidic and nutrient deficit, so once approaching to unfavorable seasonal condition, vegetation could change to nude land. In this condition, if seed of *Schima wallichii* was sown then it can withstand in the acidic soil with prolong dryness. Plantation of any leguminous plants in the degraded land may enrich the soil with nitrogenous fertilizer. Scientific approach behind this reason is that these plants produced root nodule association with the nitrogen fixing bacteria which fix the nitrogen to soil and enhance the fertility status. This all includes in biological and eco-friendly method to implement for the conservation of soil erosion.

West Sikkim

In West District, four areas were targeted namely, Pelling Naku Tadong, Pipalay, Salley, and Rangsang. These areas were a major concern for treatment keeping in view the fragility of the slides which needed much attention and intervention.



Approach and methodology used:-

The project emphasized on soil bioengineering method since it is an excellent tool for stabilizing soil erosion.

The soil bioengineering works include:-

- Hand packed inside sausage (gabion) in landslide areas.
- Jhora training works which include Hand packed inside sausage with PCC lining.

Other works include:-

- S.M.C works
- Afforestation, bamboo plantation
- Bally benching
- Creation and maintenance of nursery=y
- Application of geosynthetic polymers
- Regarding of slopes
- Anchoring.

A case study of Landslide treatment- West Sikkim

The main focus in the landslide areas lay in stabilizing the slip area, keeping in mind, the topography of the area, causes for the erosion, type of landslide that occur ranging from rockslide, rock falls, rock toppling debris slide, debris slide, and rock cum debris slide. The slide areas were huge and no proper demarcation of the slide could be drawn. The proposed work in the landslide sites of west Sikkim and works implemented in this project have complimented very well.

The landslides in all the areas studied have shown colossal growth in terms of its flora. The bio-engineering works and soil moisture conservation works have blended very well to stabilize the area. The topography of all the area studied was different. The type of erosion varied from place to place with debris flow, rock cum debris flow to falling boulders. As a result of which, each area have shown variation in terms of the flora adapted to the region.

Studies in landslide treatment have been done from time to time in Sikkim. Thus for prevention of further erosion and loss of soil by leaching, an extensive study is further required. Although this project has made an effort to reach out to the concerned department in finding solution in terms of geology and soil type in the area concerned. There is a dire need for an inter-departmental and intra-departmental approach for a concrete solution.

Recommendations after the study:-

To ensure complete stabilization of eroded areas, the following initiative needs to be ensured:

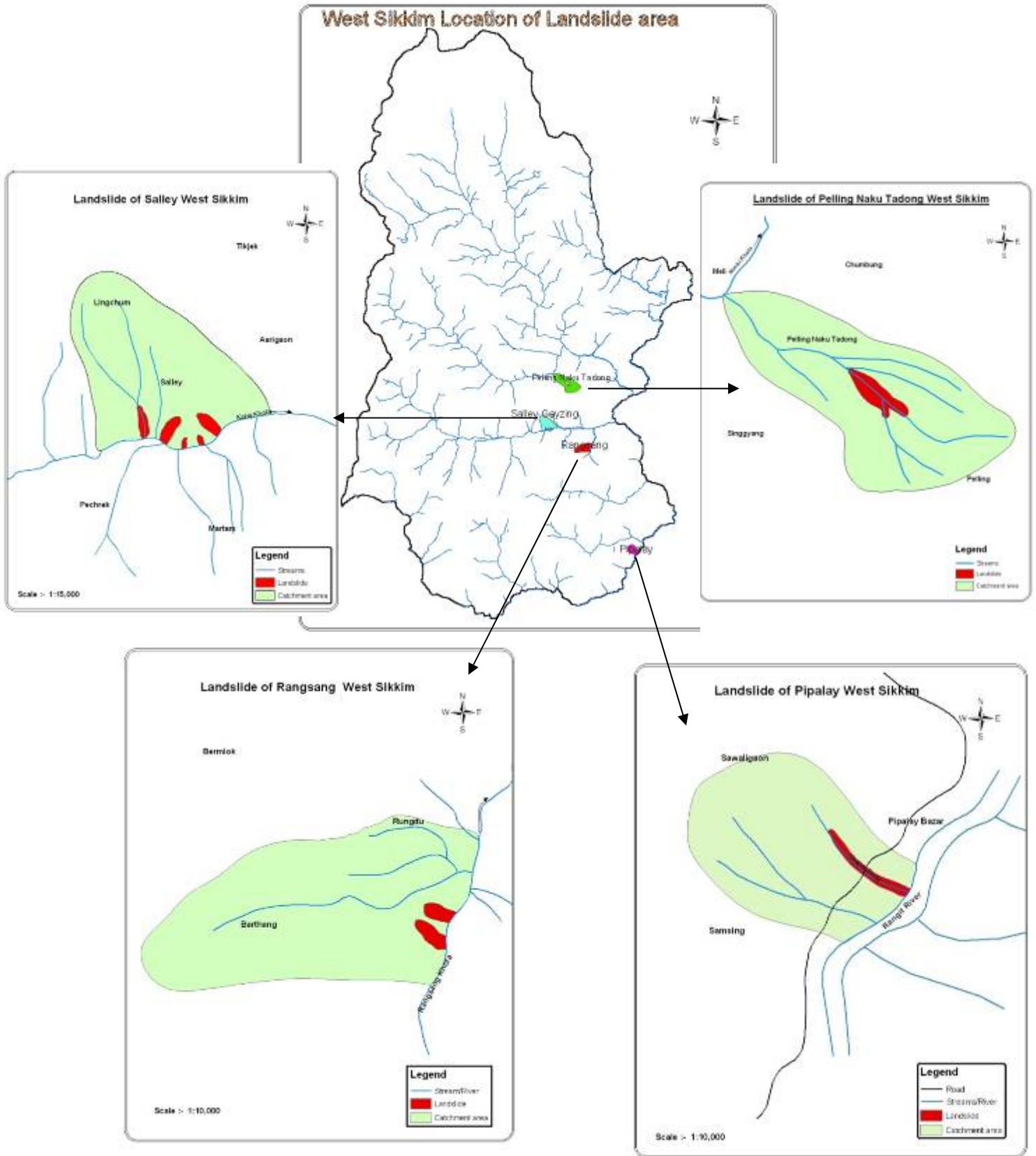
- Extensive drainage system, sub surface drainage pipes, perforated pipes is one solution to excessive leaching of soil which requires more funds; during monsoon season there arises seasonal springs that flows unsystematically in the hilly terrain carrying with it rich soil nutrients, further decreasing the capacity of the soil to retain excess water. Plant species with high evapo-transpiration was suggested for transpiring excess water from the soil.
- Pallarding of *Alnus* may be the solution to reduce pressure of erosion and landslide and to provide adequate increment of daily requirement of fuel wood, timber and fodder to great extent.

Impact of Landslide and Erosion Control Treatment

A study in West Sikkim



West Sikkim Location of Landslide area





- Afforestation;
In certain areas, dense tree canopy can a sole alternative. Species like *Tectona grandis*, *Terminalis myriocarpa*, *Shorea robusta* which is suited to hot and humid climatic condition can be grown extensively. In cold and temperate regions *Alnus spp*, *Viburnum spp.*, *Erythema spp.*, could be initiated and grown profusely.
Plant species like *Agave Americana spp*, *Ageratum conzzoides*, *Dicranopteris linearis* (bhui amala), *Thysanolaena maxima*, *Bambusa natans* have been found to be efficient in soil binding process which can grow in soil which is nutrient deficient.
- Terrace farming to be practiced uniformly in the entire slope leaving no barren stretches of land in between:
In most area farming is done in upper region whereas in lower region it is not. As a result of which, the excess water from the upper region flows erratically to the region below. This will facilitate erosion in the lower region where landslides gain momentum. In the process the above area gets gradually pulled.
- Selection of suitable fodder;
Selection of evergreen fodder species like *Ficus spp*, *Thysanaolaena maxima* can be grown on the fringes of the landslide area. As a result of which, the landslide areas remain un-invaded by humans and animals, leaving it for regeneration.
- Bio-engineering works like hand packed walls inside G.I. sausage have proved to be very effective in stabilizing the slope area; it reduces slope angle, retard run off, trap sediment capture and utilize both surface and sub-surface water.
- Suitable Soil Moisture Conservation works need to be adopted to extend and promote natural regeneration.
- Dry cultivation could be preferred to wet cultivation in steep terrain;
Practice of dry cultivation methods may be encouraged in steep slope owing to it high sustainability of soil and lower risk of erosion compared to wet cultivation practices. The low yield from the dry cultivation may hence be considered trifling as against the prolonged usage of the terrain for agricultural purposes.
- Exploring innovative approaches from the locally available malent or inspirations may also be considered as an effective measure to better understand the nature of the work.



During Treatment: Hand packed stone wall inside sausage being built



After Treatment: Regenerated flora in the region



During Treatment



Series of sausage wall built to retain the soil

After Treatment



Sausage wall with Bio-engineering measures protected the agricultural land



Landslide Site brought under control with gabion structures