SIKKIM STATE COUNCIL OF SCIENCE & TECHNOLOGY

ANNUAL REPORT 2011-12

Foreword by Member Secretary

It is my privilege to reflect the activities of the Sikkim State Council of Science & Technology in the form of annual report for the year 2011-12. Having joined as Secretary, Department of Science & Technology and Climate Change recently in April 2012, I must agree that the activities taken up by this Council is worth appreciating as it encompasses the areas and activities which are need based and require focused attention for sustainable development of the State.

The mandate of the Council presents vast areas and opportunities of interventions and investment that suits the local developmental needs without compromising the overall goal of sustainable development, research and development, poverty alleviation as mandated in the bylaws of the Council. Diverse issues of paramount importance are being addressed such as biodiversity and biotechnology, remote sensing technology, transfer of appropriate technology for the benefit of rural as well as urban population and communication and popularization of science. Thus, we must acknowledge the Council's role of serving as a bridge between Science & Technology in one hand and society and state on the other working hand in hand with line departments, NGOs, VOs, and individuals

Recent initiatives on issues of climate change with the goal of strengthening adaptive capacities of the target (rural) communities to reduce their vulnerability to climate change through sustainable Climate Change Adaptation (CCA) measures will strengthen our outreach with diversity of stakeholders which includes NGOs, farmers, line departments, research institutes, students and teachers. The Council is concurrently working with GIZ (German Development Cooperation) and Kfw (Germen Development Bank) for technical cooperation and financial cooperation respectively to realize the above goals of climate change adaptation measures. While taking up various project and programmes, we have tried to incorporate, wherever possible, time tested vast indigenous knowledge base, so that technologies are easily accepted, adapted and appreciated by the beneficiaries.

All activities of the Council are in harmony with the science & technology related policies of the state government as well as government of India concurrently ensuring that we stay within the mandate of the Council. Any comments and critiques on the work presented in this report would be gratefully received.

(P.T.Euthenpa) IAS
MEMBER SECRETARY

Member Secretary
State Council of Science & Technology for Sikkim
Development Area, Gangtok
East-Sikkim.

Department of Science & Technology in the State has been created during 1996 mainly for Research and Development in various identified areas relevant to the state, generation of scientific awareness and also for transfer of appropriate technologies for economic upliftment of the weaker section of the society.

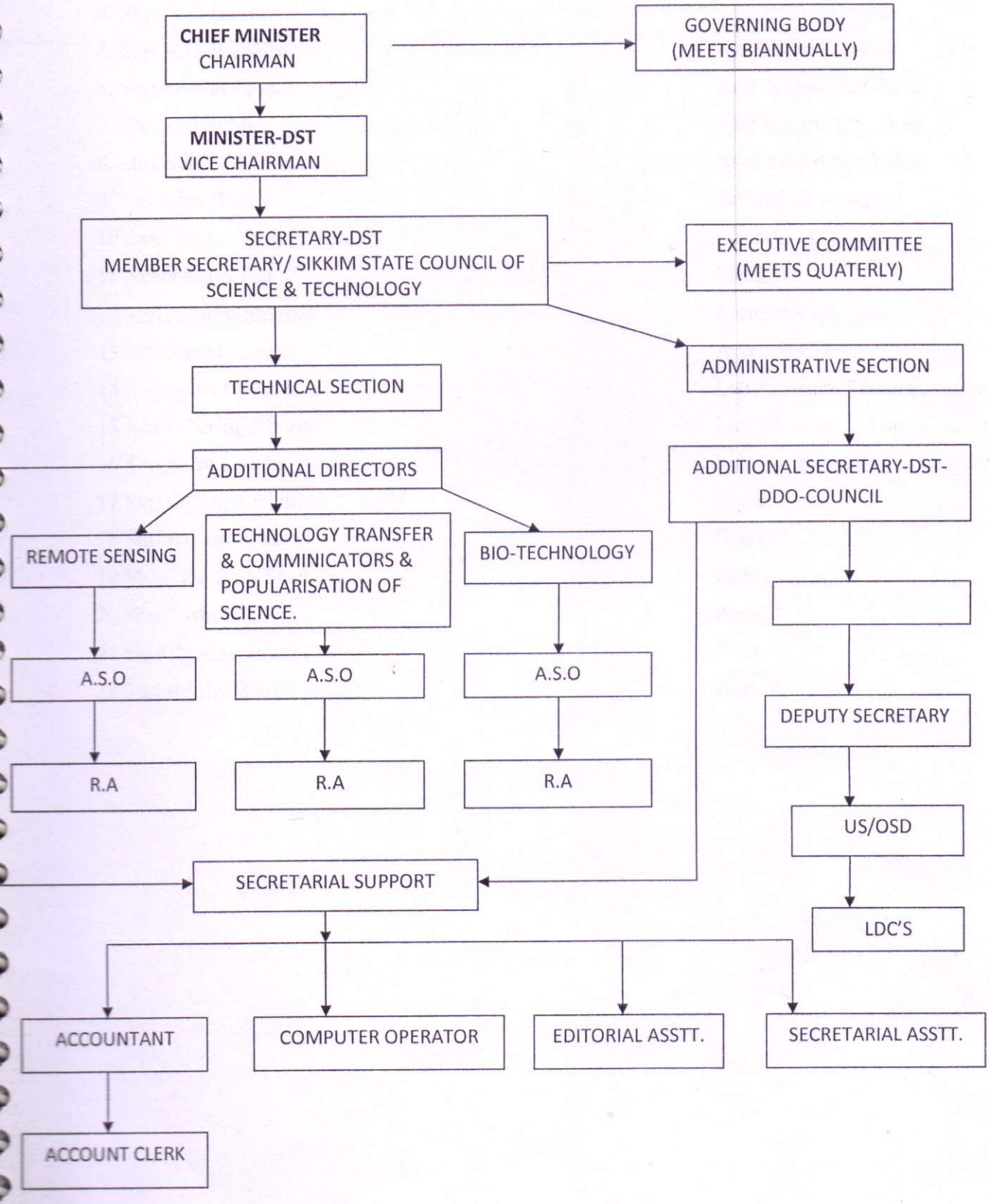
Further, Sikkim State Council of Science & Technology was also created keeping in view the importance of Science & Technology for overall development of the state and with a view to provide sufficient autonomy for implementation of various scientific programmes. The Council takes up various progarmmes funded by the State Government as well as projects funded by the Government of India agencies like the Department of Science & Technology, Ministry of Environment & Forests, Department of Bio-technology and Department of Space as well. The Sikkim State Council of Science & Technology is the functional arm of State Science & Technology Department for implementation of various scientific programmes in the State.

The Department of Science and Technology has taken up through the Sikkim State Council of Science & Technology various scientific programmes related to (i) Bio-Technology (Bioinformatics & Tissue Culture, Medicinal Plants, Scientific programme on Planting Stock Improvement; Establishment of Sikkim Biotechnology Research and Application Centre) (ii) Glaciers and Climate Studies (iii) Environmental Information System; (iv) Patent Information Centre; (v) Remote Sensing and GIS; and (vi) Technology Transfer and Scientific Awareness, Capacity Building and Skill Development programmes.

The broad objectives of the Sikkim State Council of Science & Technology are as under:

- To increase the Science & Technology infrastructure for meeting the challenging demands in basic research, technological development and scientific services.
- To identify the areas where Science & Technology intervention could significantly improve the existing socio-economic conditions.
- To identify areas of long term development of the State by ensuring application of science and technology developed so far.
- Pilot scale demonstration projects.
- Replication of success models and undertaking pilot scale demonstrations projects.
- Develop appropriate mechanisms for reducing the time lag between an invention and its commercialization.
- To supplement the efforts of the State Government in implementing various projects whenever and wherever called for.
- To popularize technologies and initiate scientific attitude and temperament amongst the people of the State through awareness and training programmes.
- To facilitate the scientists and the entrepreneurs in promoting technology transfers, establishing a strong relationship among the academics, research institutes and industry, guidance for developing entrepreneurship.

ORGANISATIONAL STRUCTURE OF THE SIKKIM STATE COUNCIL OF SCIENCE & TECHNOLOGY.



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CORE MANPOWER OF SSCS&T

1 Shri P.T. Euthenpa, IAS	Member Secretary
2. Dr. Pushpa Tamang	Director
3. Shri D.G. Shrestha	Additional Director
4. Shri D.T. Bhutia	Additional Director
5. Shri B.C. Basiatha	Additional Director
6. Shri Suman Thapa	Asst. Scientific Officer
7. Shri K.B.Subba	Asst Scientific Officer
8. Shri Narpati Sharma	Asst. Scientific Officer
9. Km Eden Bhutia	Secretarial Assistant
10 Smt. Sonam Ongmu Bhutia	Editorial Assistant
11 Neeta Maya Rai	Librarian
12 Shri Nabeen Sharma	Computer Operators
13 Shri Dadul Lepcha	Account Clerk
14 Km Dawa Gyalmu	Lab Assistant (Tissue Culture)
15 Km Tshering Bhutia	Lab Assistant (Tissue Culture)
16 Smt Saroj Lepcha	Lab Assistant (Tissue Culture)
17 Shri Gyampo Bhutia	Driver
18 Shri Bikash Pradhan	Driver
19 Shri Tika Ram Sharma	Peon
20 Shri Tashi Bhutia	Peon
21 Shri Tenzing Bhutia	Peon
22 Shri Karma Bhutia	Peon

MANPOWER IN PROJECTS:

1. Ladong Lepcha	Information Officer	DISC
2. Sambhawana Gurung	TA	DISC
3. Karun Chettri	DEO	DISC
4. S.N Bhutia	Computer Engineer	ENVIS
5. Anju Gurung	RA	ENVIS
6. Kalzang Eden Bhutia	DEO	ENVIS
7. Rajdeep Gurung		PIC
8. Tanzing Bhutia		DNA Club
9. Binita Shrestha		DNA Club
10. D.K. Sapkota	PA	Ethno Vetenary
11. Laxuman Chettri		Ethno Vetnary
12. Sushan Pradhan	JRF	State Bio Tech Hub
13. Smrita Pradhan	JRF	State Bio Tech Hub
14. Pooja Lohar	JRF	State Bio Tech Hub
15. Sovit Khatri	JRF	State Bio Tech Hub
16. Navin K. Chamlagan		State Bio Tech Hub
17. Inchung Lepcha	Lab. Asst.	
18. Tika Pds Sharma	Lab Asst.	
19. Radha Krishna Sharma	Sr. RF	Climate Change
20. P. Pradhan	JRF	Climate Change
21. Deo Km Tamang	JRF	SIS-DP
22. Dili Ram Chettri	JRF	SIS-DP
23. Narbada Sharma	JRF	SIS-DP
24. Rinzing N. Lepcha	PA	Cane
25. Thupden Bhutia	PA	Cane

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SECRETARIAT OF DST & CLIMATE CHANGE DEPARTMENT GOVERNMENT OF SIKKIM

1. Shri P.T. Ethenpa, IAS	Secretary
2. Ms Salara Rai	Additional Secretary
3. Shri N.P. Sharma	Accounts Officer
4. Km T. Donka	Deputy Director
5. Shri D.K. Pradhan	P.S to Secretary
6. Smt Sangita Bomjan	Officer on Special Duty
7. Smt Sarojini Subba	Office Superintendent
8. Km G. Cintury	Head Assistant
9. Shri R.K. Rai	Upper Division Clerk
10. Shri Rohit Chettri	Accountant
11. Shri M.K. Rai	Accountant
12. Smt S. Pradhan	Lower Division Clerk
13. Shri Benoy Pradhan	Research Assistant
14. Km Tshring Eden Bhutia	Laboratory Attendant
15. Nisha Guring	Stenographer
16. Shri R.B. Gurung	Driver
17. Shri Sarad Pradhan	Driver
18. Shri Sonam Bhutia	Driver
19. Shri Kewal Sharma	Driver
20. Shri Ongden Lepcha	Driver
21. Shri Hem Raj Chettri	Peon
22. Shri Suresh Rai	Peon
23. Smt Sancha Kumari Subba	Peon
24. Shri Raju Rai	Peon
25. Mrs Neeru Sunwar	Safai Karmachari

GOVERNING BODY OF THE SSCS&T

1. Hon'ble Chief Minister	Chairman
2. Hon'ble Minister Science & Technology	Vice Chairman
3. Chief Secretary	Member
4. Development Commissioner	Member
5. Secretary Finance Department	Member
6. Secretary Forest Department	Member
7. Secretary Agriculture & Horticulture	Member
8. Secretary Animal & Hus. Department	Member
9. Secretary Industries & Commerce Department	Member
10. Secretary Information Technology Department	Member
11. Secretary RMDD Department	Member
12. Secretary HRDD (Education) Department	Member
13. Secretary Mines, Mineral & Geology Department	Member
14. Vice Chancellor , Sikkim Manipal University	Member
15. Secretary/ Representative of the Dept of Science & Technology,GOI	Member
16. Secretary/ Representative of the Department of Bio-technology, GOI	Member
17. Secretary/ Representative of the Ministry of Env. & Forest. GOI	Member
18. Secretary/ Representative of the Department of Space, GOI	Member
19. Director General, Indian Council of Medical Research (ICMR)	Member
20. Director, Central Institute of Medicinal& Aromatic Plants (CIMAP)	Member
21. Scientist –in- charge, GB Pant Institute of Himalayan Env. & Dev.	Member
22. Representative Planning Commission, New Delhi	Member
23. Secretary, Department of Science & Technology	Member Secretary

Annual Report 2011-2012

Sikkim State Remote Sensing Applications Centre

The Sikkim State Remote Sensing Applications Centre (SRSAC) was established in the year 1997 under Sikkim State Council of Science and Technology in Department of Science and Technology and Climate Change.

Remote Sensing and its applications has certainly gained considerable importance for acquiring the information about the earth's surface and has been found to be great help in mapping of natural resources especially in the remote and inaccessible area of the state. The capacity of high resolution, synoptic perspective being an added advantage for monitoring of Snow, Glacier, Lakes and Vegetation change using the time series satellite imagery.

At present the Centre has Seven Workstation and two PC along with 5Kv UPS, the Centre has one photogramatery LPS-11, two Arc Info-10 and one ERDAS-9 software. The Centre has also A0 size plotter and A0 Size Scanner.

The SRSAC has well trained manpower in the field of Remote Sensing and GIS, the staff of the Centre provided training to the student of Sikkim Government College, Harkamaya College in the field of RS (Remote Sensing) and GIS (Geographical Information System). There are various project funded by Central Government as well as State Government to the Centre, besides these SRSAC also provides the necessary data to the user department for various developmental activities of the state.

On Going Projects

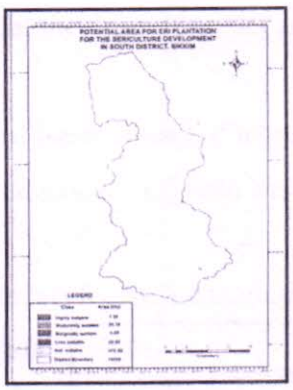
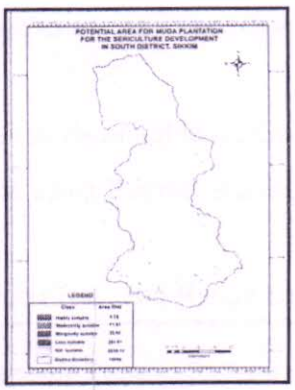
I. Application of Remote Sensing and GIS in Sericulture Development in Sikkim:

(Funding agency: Central Silk Board, India, Coordinating agency: NESAC, Department of Space, Shillong, Meghalaya: Study area: South District, Sikkim)

The project covers application of Remote Sensing and GIS in sericulture development in south district of Sikkim. South district of Sikkim is the small district with only two subdivisions viz. Ravangla and Namchi with a geographical area of 750 Sq km. The district headquarter is Namchi.

Potential areas for sericulture food plants:

The Directorate of Sericulture under the Forest, Environment and Wild life Management Department was consulted for taking up the project in the state. The suitable areas for the cultivation of Mulberry, Eri and Muga food plants in south district of Sikkim have been identified and the maps prepared on 1: 50,000 scale. The maps and area statistics are given below in the table.

Suitable area statistics for different silk worm food plants in South district of Sikkim

Silkworm Food plants	Suitability class	Area (ha)
Mulberry	Moderately suitable	822.863
	Marginally suitable	5071.299
Eri	Highly suitable	7.36
	Moderately suitable	29.18
	Marginally suitable	5.48
	Less suitable	22.52
Muga	Highly suitable	5.78
	Moderately suitable	71.27
	Marginally suitable	35.82
	Less suitable	351.01

Conclusion of the project:

The final suitable areas for the sericulture food plants (Eri and Muga) have been found to be very less as compared to Mulberry food plants. The present study with the help of Remote Sensing and GIS is the first of its kind in the State; therefore there is a scope of such studies for other districts of Sikkim.

II. Programme on Climate change Research in Terrestrial Environment (PRACRITI):

(Funding agency: Space Applications Centre (ISRO), Ahmedabad, Status: Ongoing, Study area: Sikkim)

The main objectives of the project are as below;

- Development of Models to assess response of Himalayan snow and Glacier extent to Climate change.

- Development of snow and glacial melt runoff model and to assess future changes in stream runoff.
- Mapping and change detection of water spread of moraine- dammed lakes/Glacial lakes
- Updation of the extent of selected glaciers of Tista basin using Remote sensing data.

- Generation of Regression Equations Models for SLA calculation (Tista and Rangit basins):

The regression equation for the both Tista and Rangit basins has been generated for the calculation of Snow Line Altitude (SLA). For this, contour generation at the interval of 200m from ASTER DEM using ERDAS Software has been done. The error visible on the contour interval is rectified and generated the final contour interval for further work. The area of each of the contour interval has been calculated, and derived the equations for both Tista and Rangit basins.

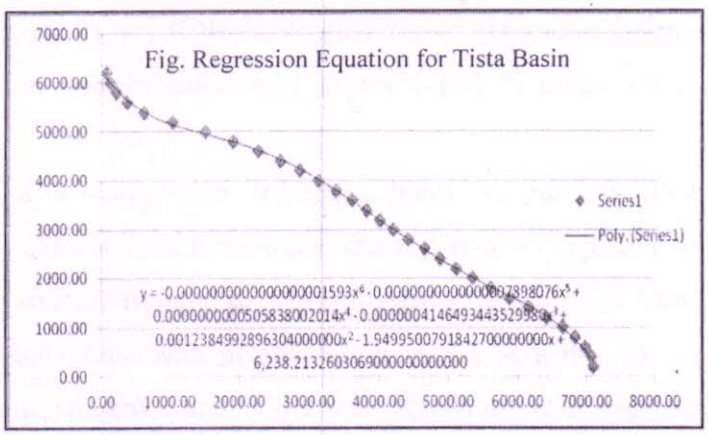


Fig. Regression Equation for Tista Basin

With the help of regression equations, the calculations of snow line altitude have been going on for both Tista and Ranit basins from 2005 to 2010. For the correlation of meteorological data with SLA, the Indian Meteorological Department has been contacted.

Mapping of Glaciers and Glacial lakes using time series satellite data:

The data generation for the glacial lakes/ moraine dammed lakes has been done using the Earthsat images (5th November 1990). Also at the interval of 10 years, the Landsat data of year 2000 was used for the digitization of lakes. The objective was mainly the change detection in the water spread of moraine dammed lakes. The satellite images were downloaded from the Earth explorer (USGS). The digitization of glacial lakes from the recent satellite data is in progress. The glacier mapping, monitoring, the updating the layers with the latest LISS III images is being carried out with the support of the Space Applications Centre, Department of Space, GoI, Ahmedabad.

III. Ground Water Prospects Mapping for Rajiv Gandhi National Drinking Water Mission Phase-IV (Funded by DOS GOI)

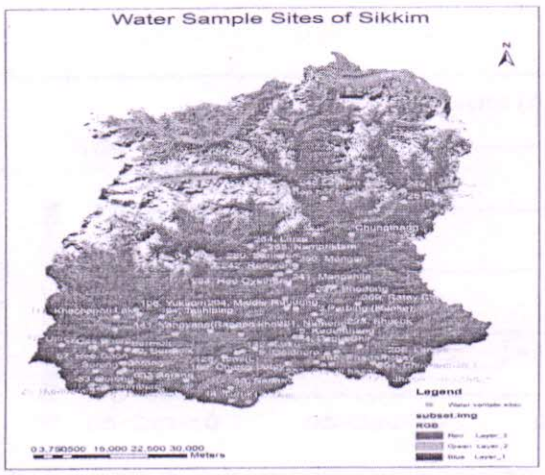
The ground water prospect and quality mapping using Remote Sensing and Geographic Information System techniques on 1:50,000 scale under Rajiv Gandhi National Drinking Water

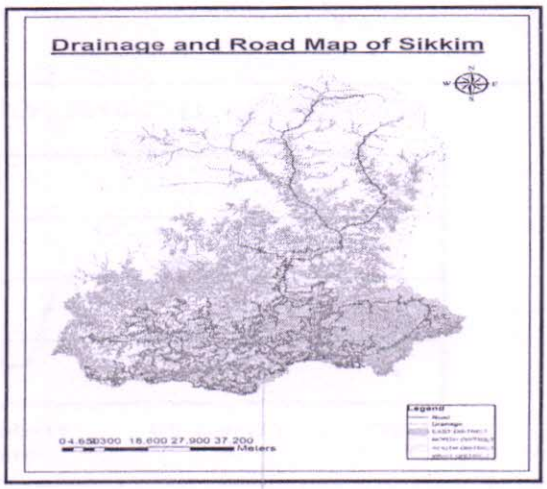
Mission (Ph-IV) has been taken up. The project is sponsored by Department of Drinking Water Supply, MORD, Govt. of India and implemented by National Remote Sensing Agency, Dept. of Space, Govt of India, Hyderabad. The Remote Sensing Centre, Sikkim State Council of Science and Technology have been identified as the nodal organization to take up the project pertaining to Sikkim. The preparation of Digital Ground Water Prospects and Quality Maps, for the State of Sikkim is under progress. The ground Water Prospects Map includes:(i) Base map layers(Administrative Layer, Settlement, Road layer) (ii)Hydrological Layer (Drainage, Water bodies, Spring, Rainfall ,Recharge structure and Irrigated area layers) (iii) Geology Layer (Lithology, Structure and Geomorphology).

Ground Water is the major source of drinking water. It being a hidden resource is often developed without proper understanding of its occurrence in time and space. The main objective of the project is to identify the ground water sources through scientific means especially for Non-Covered (NC) and Partially Covered (PC) habitation with potable water supply schemes. In the case of Sikkim, natural water such as spring, streams water is the main drinking water sources. Safe water should be located within the radius of 1.5 km in plains and within 100 m elevation in case of hilly terrain. The output map shall indicate;

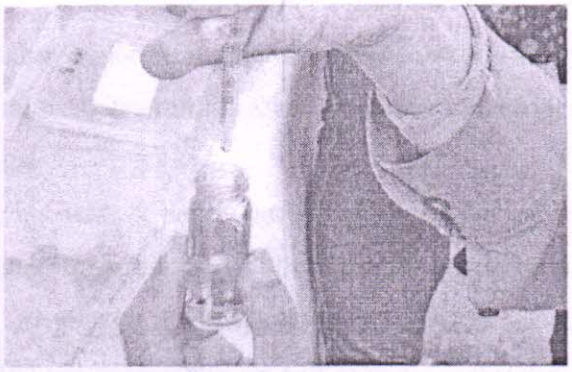
1. Prospective zones for ground water occurrence 2. Tentative location for constructing recharge structure.

For Quality Mapping, it is necessary to mention the type, location, date and element-wise water quality values of the spring sources from which the drinking water samples is collected. The type of the spring indicates the perennial and non-perennial sources to which the drinking water sample belongs. The date of the sample collection indicates the period in terms of pre-monsoon and post-monsoon in which the water sample is to be taken. The location of the spring indicates the latitudes and longitudes of the place from which the water is supplied for drinking purpose. The element-wise (as per the manual provided by the National Remote Sensing Centre, Hyderabad) water quality value indicates the concentration of the element in the spring water sample analyzed. There are many dissolved minerals and organic constituents present in drinking water in various concentrations. In water chemistry, these substances are called common constituents. They are not harmful if they are within permissible limits. Few elements are highly toxic and hazardous to health of both human and animals. Among them dissolved mineral substance which has been tested are: pH. total hardness, alkalinity, chloride, iron, fluoride, nitrate, nitrite, ammonia, phosphate, residual chrorine and total dissolved solid (TDS). The findings are being tabulated.





Water source: Lachen



Testing water qualities

IV. Monitoring of Snow and Glaciers of Sikkim Himalayas. Phase –II

(Funded by SAC, DOS, GOI)

Mapping and Monitoring of snow cover is an important part of snow and glacier studies. Its monitoring for a longer period helps in understanding the changes that takes place in our environment. The database created on the extent of snow cover also help in various studies to overcome the challenges posed by the global warming and climate change effects. At present monitoring of snow cover of entire Himalayas of India from Jammu and Kashmir to Arunachal Pradesh is going on under the Joint Project of Indian Space Research Organization and Ministry of Environment and Forests, Govt. of India.

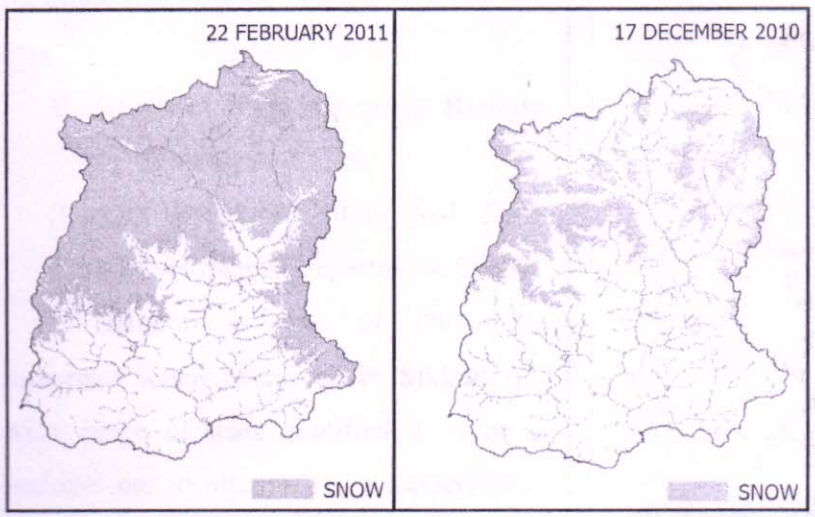
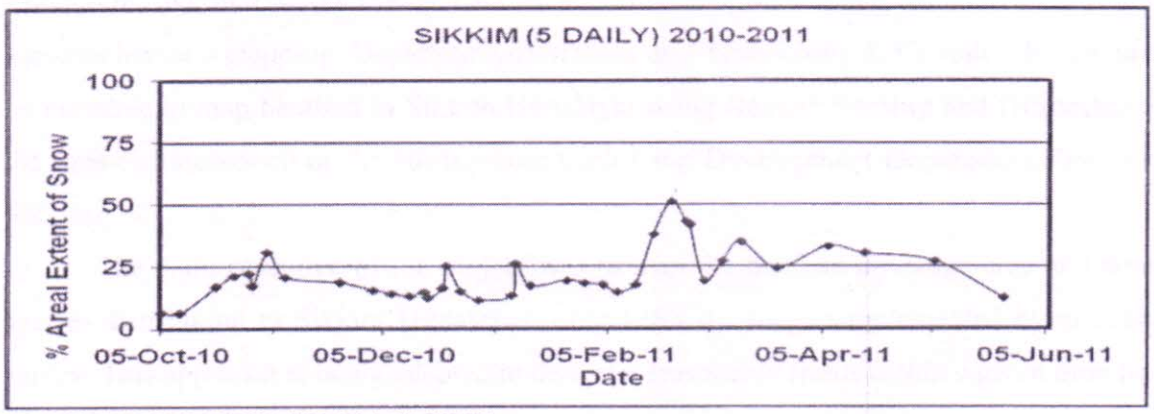


Figure: Map showing maximum snow cover on 22 February 2011 and minimum snow on 17 December 2010 during 2010-2011 monitoring year.



SNOW COVER DEPLETION CURVE

Mapping and monitoring of seasonal snow cover using field methods are normally very difficult in a mountainous terrain, like the Himalayas. Therefore, remote sensing techniques have been extensively used for snow cover monitoring.

In context of Sikkim, the snow monitoring work is being carried out in collaboration with the Space Applications Centre (SAC), Ahmedabad from the year 2004-2005 onwards considering Tista and Rangit basin and Sikkim as a whole. At present the project is in its second phase. In its first phase, snow cover monitoring till 2009-2010 has been taken up and nearing completion. The Snow monitoring of the year 2010-2011 has been taken up for the second phase of the project.

The study of October 2010 to June 2011 cloud free satellite image reveals, the 22nd February 2011 has maximum snow coverage of 51.31% with respect to the total geographical area of the state and minimum 12.51% recorded on 17 October 2010. The snow monitoring, especially for the monsoon period (June to September) get disturbed for not getting the cloud free satellite images.

V. Bamboo Mapping using Remote Sensing and GIS.

(Funded by: Horticulture and Cash Crop Development Department, GOS)

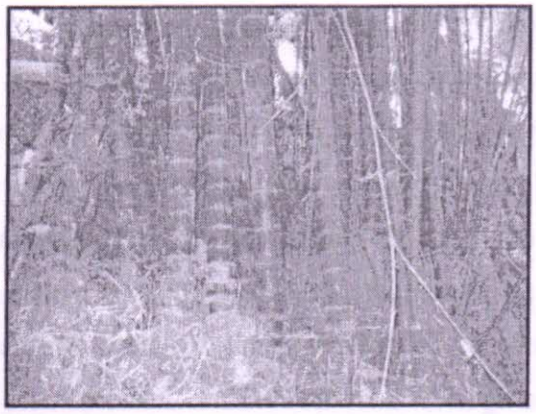
Bamboo is one of the most important forest resources in Sikkim. Its wide range of uses qualifies it to be a multiple use in alternative to timber, food to the rural poor and tribal in particular.

State bamboo mission is working in the state development of economically importance bamboo in Sikkim to know the demands quantitative data on bamboo resource there is a need for accurate bamboo mapping. Department of Science and Technology & Climate Change have taken an initiative to map bamboo in Sikkim Himalayas using Remote Sensing and GIS technique with the financial assistance of the Horticulture Cash Crop Development Department, Government of Sikkim.

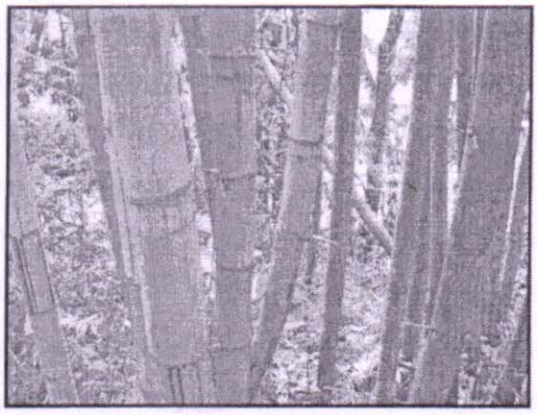
The main objective of the project was to map the bamboo coverage area and dominating species distribution in Sikkim Himalayas using LISS III image supplemented by extensive field survey. This approach is being adopted to deliver a reasonable result within a given time frame and the resources available for the project.

The main genera found in the state are *Arundinaria sp., Bambusa sp., Dendrocalamus sp., Drepanostachyam sp, Phyllostachys sp etc*

Studies revealed that *Arundinaria sp* and *sinarundinaria sp* mainly covers the northern part of Sikkim and, *Phyllostachys sp, Bambusa sp. Dendrocalamus sp* which occurs over extensive area are found in lower hill forests. Cultivated bamboos are also found in the agricultural land areas, roadsides- private and Government Khasmals.



Bambusa vulgaris. Waminii



Bambusa vulgaris strita

Results and Conclusions

During the field visits the following observation has been made,

- Most of the big patches of bamboos (Malingo) are found in mixed with other species of tree like Oak.
- In many areas *Mal (Babusa nutans)* and *Choya Bas(Dendrocalamus hamiltonii)* were found existing together around agricultural area around the elevation between 300 m to 1500 m along the stream.

- Two varieties of *Malingo* were found in the elevation between 1800 m to 3600 m. *Arundinaria racemosa* was found in the higher elevation than *Sinarundinaria maling.*
- *Bambusa vulgaris*, also known as Common Bamboo, Golden Bamboo, or Buddha's Belly Bamboo, is an open-clump type bamboo species, commonly found in nursery.

  Bamboo species like *Sinarundinaria maling*, *Himalayacalamus hookerianus* and *Drepanostachyam* are observed above 1200meters.

The finalization of the report may be expected by the end of March 2013

VI. Spaced based information support for decentralized planning

(Funding agency: DOS, GOI, NRSC, Hyderabad)

Effective utilization of natural resources and their management are essential and the need is to catalyze the planning process at grassroots level. Planning aims at inclusive, participatory and coordinated approach for local area development to ensure that each *Panchayat* or local body is treated as a planning unit. Reliable and timely information on resources is pre requisite for the development of a plan. Various state departments are involved in collection of information on resources for planning and carrying out developmental activities at district level. Most of the information is not available in a form that can be depicted spatially as various layers. This information is mostly available in tabular format and with many departments. There is a need to provide available information in the form of digital atlases, so that the decisions or planning exercises pertaining to developmental activities can be taken up in a scientific and timely manner for the benefit of the target group. Decentralized district planning comprises of what different planning units within a district can achieve by envisioning collectively, operating their budgets, exercising their skills and leveraging their initiatives. Typically, in an ideal decentralized district planning exercise, each planning unit, namely, *Panchayat*, villages, municipalities and line departments would prepare the plan for execution of each of their functions and responsibilities after consultations with the people. Even common citizens require maps and spatial information for their localized decision-making. Though abundant data is available, not much of it is properly organized and analyzed, which has resulted in limited outcome and wastage of available resources. This has become hindrance in utilizing resource information in most productive and timely manner. By making this resource information available to the people at grassroots level (village/*Panchayat* etc.) in easy and user friendly manner; planning process can be catalyzed due to inherent benefits provided by this system.

Objectives of the project:

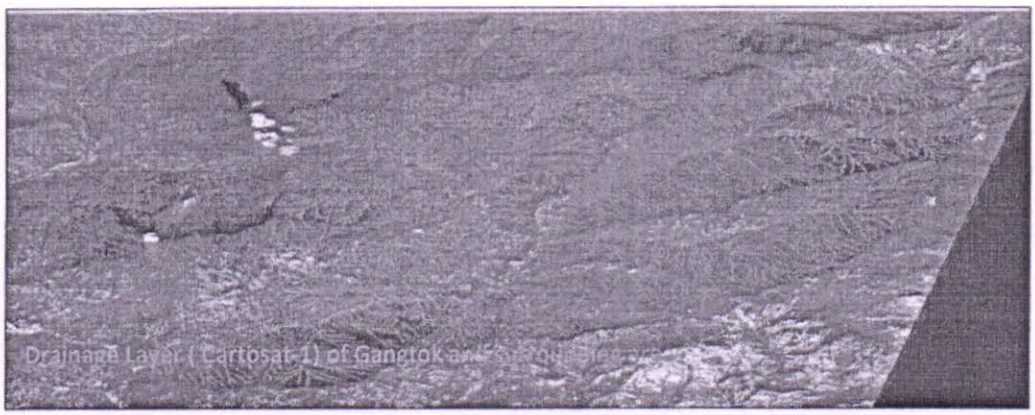
In view of the requirements and to achieve the goal of district level planning using geospatial data, the following objectives are defined:

- Spatial depiction of land & water resource along with their attribute information for preparation of Geospatial District Resource Atlas keeping Village Cadastral data as base in a virtual and seamless manner for entire country; (States which are already covered may be brought to uniform standard with respect to content and accuracies);
- Development of software tools and utilities (including web based GIS applications and standalone) for providing multipurpose user driven applications for speedy, accurate and transparent decision making for district planning; and
- Capacity building in state departments along with training of manpower for spatial data analysis, which will maintain update & manage database for decentralized planning.

Tasks to realize the objectives

- The objective of the SIS-DP mission can be broadly grouped as creation of resource layers, infrastructure & capacity building including creation of trained manpower in this area. If we see the individual component, the following activities or tasks are needed, to achieve the overall objectives of the mission:
- Preparation of land cover, road network, settlement and slope at large scale (1:10,000) using high-resolution satellite imagery (Cartosat -1 PAN and LISS-IV Mx merged) for the latest period. Mapping of soil and preparation of Ground Water Prospect map on 1:10,000 scale for the priority areas;
- Integration of existing 1:50,000 scale layers available with ISRO / DOS on Land Use / Land Cover, Soil, Ground water prospect, watershed, land degradation and wastelands; Creation of digital village cadastral maps along with attribute data captured from digitized Village Cadastral maps and overlay on high-resolution satellite images along with ownership information available with state land record department;
- Bringing the existing digital village cadastral maps to common standards and integrating them with other datasets;
- Extraction of infrastructure, Settlement areas, drainage network layers from high resolution satellite imagery;
- Organization of attribute information available at various departments (e.g. agriculture, irrigation, industry, public health, electricity, PWD, education etc.) and their integration into spatial GIS layer. e.g. details on ownership, type, category, etc. will be linked.

- Collection & integration of socio economic data essentially covering health, education, woman & child welfare, social justice and availability of basic minimum services at village or block level, administrative boundaries and information on various central/state scheme.



Drainage Layer (Cartosat-1) of Gangtok and Surrounding Area

Status

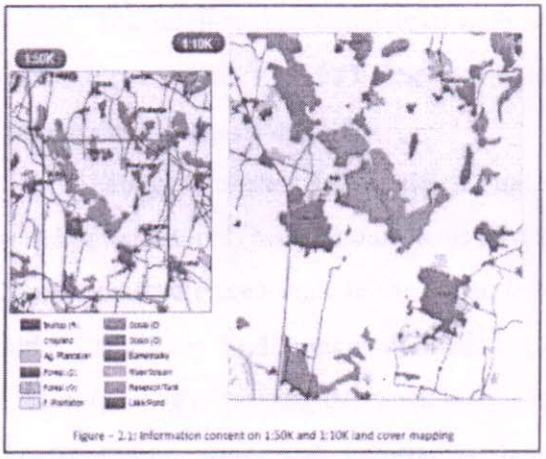


Figure - 2.1: Information content on 1:50K and 1:10K land cover mapping

The Cartosat data and LISS IV data for Space Based Information Support for Decentralized Planning project has been received from NESAC, Shillong. So far the cartosat 1 and LISS IV ortho rectified data from RRSC- Kolkata has also been received and pan sharpening is being done.

The following layers Roads, Drainage, Village Cadastral, Slope, Soil and Ground Water Prospect Layer generation will be started soon.

VII. NUIS (National Urban Information System) (Funded by NESAC, Shillong)

The major objective of NUIS project is to design, organize and establish a comprehensive information system in the urban local bodies for planning, management and decentralized governance listed in the 12th schedule in the context of implementation of the 74th Constitution Amendment Act (CAA).

The thematic layers like Landuse, road, drainage, geology and soil layer classification for 9 towns (Mangan, Pakyong, Rongli, Rangpo, Singtam, Namchi, Jorthang, Gyalzing-Pelling and Soreng) has been completed. The layers generation for remaining 1 town i.e Ravongla is under progress.

The specific objectives of NUIS project are:

- Develop spatial and non spatial (attribute) database for various levels of planning and decision support to meet requirements of urban planning and management.

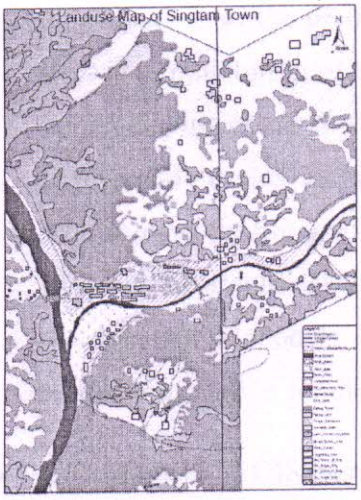
- Develop a model Utility mapping using Ground Penetrating Radar technology.
- Integrate convention data sources with modern data sources to develop Geographical Information System database.
- Develop design standards for Urban Spatial Information System and National Urban Data Bank & Indicators on methodology, database, data exchange format and protocols.
- Develop suitable applications/automated integration techniques in GIS to provide inputs to Master/Development/Zonal Planning and Utilities management.
- Create a town level repository of urban database through National Urban Databank and Indicators, which would also enable to assist development of urban indicators and urban indices by the Local Urban Observatory for National Urban Observatory.
- Build capacity among town planning professionals at State and Local Body level the use of modern data sources and GIS.
- Decentralize data generation, storage analysis and various levels of urban planning.

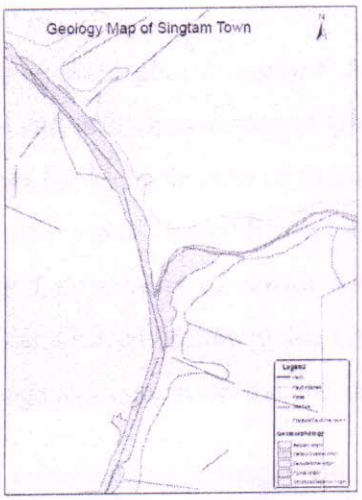
Input Database for NUIS:

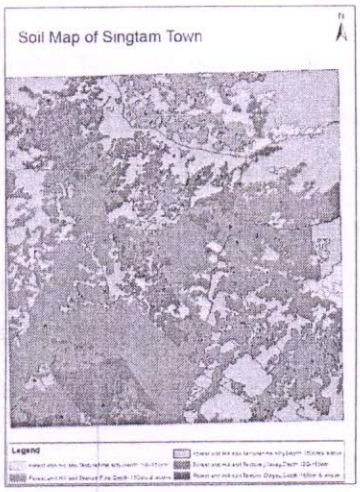
The satellite data consists of high resolution Cartosat-1(Panchromatic) Spatial resolution of 2.5m, Resourcesat-1(LISSIV) Spatial resolution of 5.8m and Fused (PAN + LISSIV) Spatial resolution of 2.5m of 2006-07.

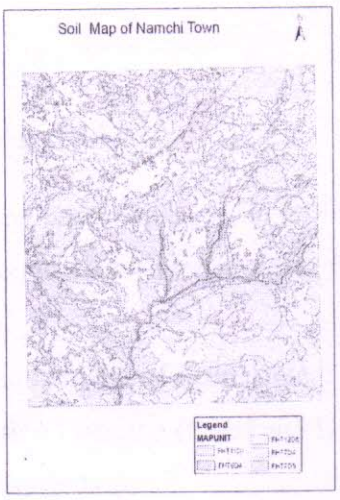
The geo-reference and rectified satellite imagery after displayed as a raster in ArcGIS with the Administrative (town) boundaries as a vector overlay, 2D based onscreen interpretation should be limited to the area outside the urban core and within the Urbanisable area boundary depending upon the theme to be matched which are primary layers are Urban land use, Physiography, Geomorphology, Geological Structure, Lithology, Soils, Drainage, Surface Waterbodies, Road, Transportation nodes and incorporate layer like Administrative boundaries, Forest boundaries, Settlement and Village Locations/Names, City/Town boundaries, to be mapped. Out of the twelve themes to be interpreted Physiography, Geomorphology, Geological Structure, Lithology and Soils themes would be mapped outside the city core/build up area whereas urban landuse, Drainage, Surface Water bodies, Road, Transportation nodes are mapped covering the total administrative area of the town.

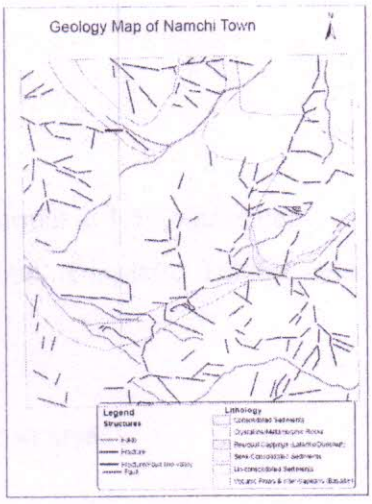
The Sample of the different thematic maps of NUIS project as under:











VIII. Mapping of Glacier Lakes and development of GIS based Glacier Lake Management Information System (GLAMINFORS) for the State of Sikkim(Collaborative project with CDAC, Pune) (Funded by Ministry of information Technology GOI)

The glaciers are nature's valuable source of fresh water for drinking water supply, agricultural, industrial and hydropower developments for present and future needs of millions of people living in the downstream. These frozen reservoirs release large amounts of ice melt water to many of the major rivers of this region. Sikkim State Council of Science and Technology is currently engaged in monitoring of glaciers and glacier lakes of Sikkim. However, the proposed **Glacier Lake Management Information System** for the state of Sikkim would prove to be very useful whereby the users/decision makers would be able to get information on any glacier lake, their nature, origin, location and identify the area likely to be affected due to GLOFs (Glacial Lake Outburst Floods).

Major objectives of the project are:

- Real time monitoring of the selected glacier/moraine dammed lakes in the Himalayan Region for developing preparedness and resilience in case of Glacier Lake Outburst Floods **(GLOFs).**
- Design and develop a system for identification of moraine dammed lakes, their classification, river channel profiling with the help of Digital Elevation Models, installation of field sensors at potential hazardous lakes and processing of sensor data along with remote sensing data for development of models under GIS environment for GLOFs/Flash floods, and deriving flood related information for damage assessment for the end user in real response time.
- Development of GIS based Glacier Lake Management Information System **(GLAMINFORS)** for the state of Sikkim.

Progress of the Project

Following work has been completed till now:

1. Preparation of following base map layers in GIS format at 1:50,000 scale:
   - Administrative boundaries (International, State, Districts, Taluka, and Available Village boundary).
   - Road/transportation network of entire state.
   - Settlement/Habitation Location (Rural and Urban areas).
   - Drainage/streams/water bodies.
   - Location of Hydel projects and industrial setup.
   - Forest Boundaries, Forest roads and Forest village locations.
2. Geo-referencing/Orthorectification, Edge Matching and mosaicking of Satellite Data
3. Preparation of various Thematic Maps such as Slope map and Glacier Inventory maps.

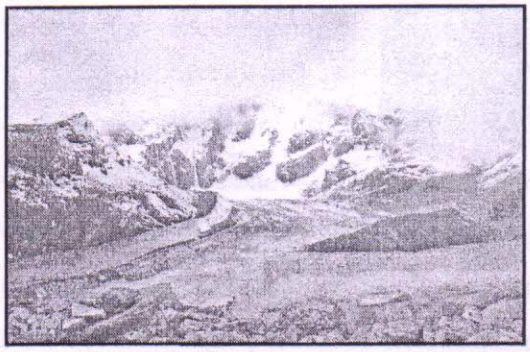
The team of scientists Lead by Shri Binay Kumar Project leader CDAC-Pune has conducted the field expedition in different glacier lakes of Sikkim

Team Member are:

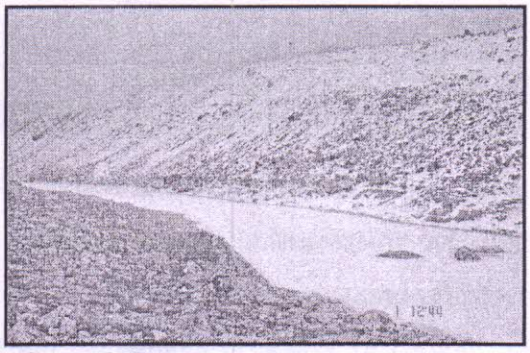
1.	Shri Binay Kumar	CDAC, -Pune
2.	Shri Narpati Sharma	DST, Sikkim
3.	Shri Safal Pradhan	DST, Sikkim
4.	Shri. Radha Krishna Sharma	DST, Sikkim
5.	Srhri. Pranay Pradhan	DST, Sikkim
6.	Shri. Deo Kumar Tamang	DST, Sikkim
7.	Shri Swapnil Awagadey	CDAC, -Pune
8.	Shri Murgesh Prabu	CDAC, -Pune
9.	Shri Sunil Hedge	CDAC, -Pune

Different Glaciers visited

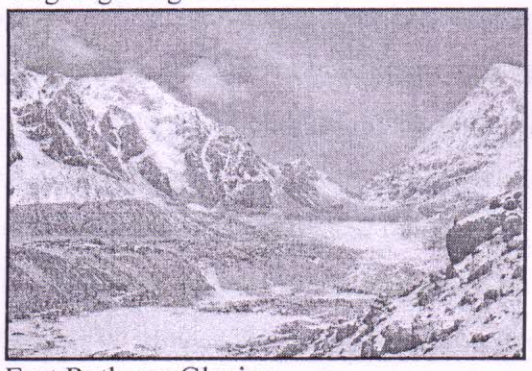
1. From 11th – 20th November 2010, the team visited Gurudongmar Lake, Chho Lhamu Lake near to Kerang Post, north-eastern part (behind the Tista Khangse glacier and Gurudongmar Lake) in the North Sikkim district and Changme Khangpu glacier.
2. From April 30th – May 11th 2011, the team visited East Rathong Glacier, Onglangthang Glaciers and its surrounding lakes like Green lake, Doodh Pokhari, Bahley Pokhari and unknown lake.
3. From 13th – 22nd April 2012, Lhonak Glacier was visited along with its surrounding lakes. Based on this study and field visits the detail study of some of the Glacial lakes is required.



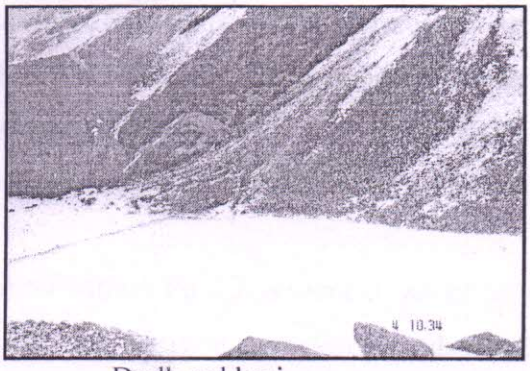
Onglangthang Glacier



Green Lake



East Rathong Glacier



Dudh pokhari

Unknown lake

Lonark Lake along with Lonark Glacier

IX. Vegetation Carbon Pool Assessment (VCP) (Funded by: DOS, GOI, Deharadun)

Human activities have increased the atmospheric CO_2 through burning of fossil fuel, landuse change and disturbance to the natural processes involved in the balanced cycling of carbon. CO2 is among the major greenhouse gases (GHG) contributing to the global warming and associated impacts. Over the years, landuse has been changing due to increase in population pressure which resulted in increased carbon emission from terrestrial ecosystem, forest sequesters atmospheric carbon and to limited extent by agricultural biomass by means of fundamental process of photosynthesis. But increasing anthropogenic pressure on the forest has resulted in clearing of forests and has led to decreased photosynthetic coverage. Depending upon the use, the biosphere can act as sink or source of carbon. Whether India is a net sink or source of carbon is poorly understood. Systemic studies therefore are required to assess the pools and fluxes of carbon to arrive at the country level carbon budget. However, due to large spatial extent and human impact purely field based estimations are inadequate. The main objective of the project is: To assess the terrestrial vegetation carbon in the country using satellite remote sensing, ground sampling and modeling.

In National Carbon Project (NCP)- Vegetation carbon Pool Assessment out of **30 plots**, field work of **30 plots** have been completed and the data and plant specimen is also collected according to the given field methodology. **Seven plots** of Tree Outside Forest area (TOF) are also completed. Completed the data entry of Tree species, Shrubs and Herbs, Dbh (D) m, basal area (m) and radius (m) is calculated for all the species. Find out the volume equation of all the tree species and also calculate the volume of 23 species.

Tree with cbh (circumference at breast height) more than 10cm has been taken for the estimation of

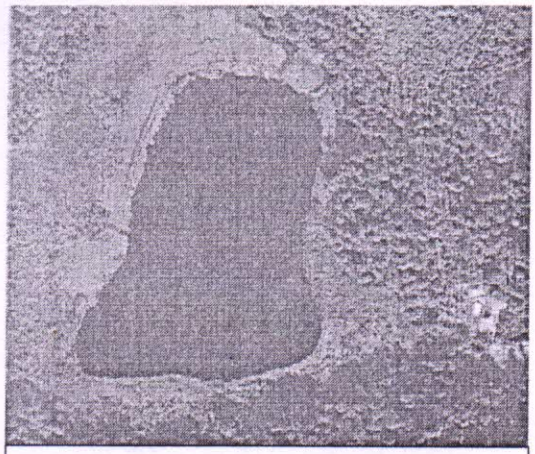
biomass and carbon. Volume and Biomass has been estimated using volume equations and specific gravity from the literature and other related parameters like height and cbh. As because the Volume equation formula was given only for the tree with the cbh>30cm, we first calculated the volume for the tree with the cbh>30cm, after which using regression equation between basal area Vs. Biomass, we finally calculated the biomass and carbon content of individual tree.

The collected data has been send to IRS- Dehradun for the analyses. The special dataset would be use for further research and also used as input in modeling for multiyear net carbon balance studies of India.

X. Wetland mapping of Sikkim (Funded by: DOS, GOI, SAC, Ahmedabad)

Remote Sensing or Satellite imagery plays a vital role for the mapping of lake in the Himalayan region. Keeping in view of above facts Sikkim State Remote Sensing Applications Centre in Collaboration with Space Applications Centre Ahmedabad mapping the lake of Sikkim using satellite imagery with Remote Sensing & GIS Technique, following result has been come up during the study.

Wetlands are one of the most important and reproductive ecosystems of earth and provides wide array of benefits to mankind. The state of Sikkim have many lakes which are snow fed, as well as river/spring fed, these lakes also form the source of many rivers of the state. Wetland mapping is done using satellite data of IRS P6 imagery on 1:50,000 scale. Such studies are first of its kind using IRS P6 and extensive ground truth assessment. The major wetland types in the state are High-altitude lakes (above 3000m), Low-altitude lakes (below 3000m), rivers and major streams. Ground truth data was collected for selected wetland sites and Standard Performa was adopted to record the field data. Field photographs were taken to record the water quality (subjective), status of aquatic vegetation and water spread. GPS was used for locating the features.



Khechodpalri lake (Google Earth Image)

Gurudogmar lake (Google Earth Image)

During the study, more **than 500 lakes** (including >2.25 ha and < 2.25 ha) were detected and total area of these wetlands (lakes and rivers/major

streams) was found increased in post-monsoon season (2006) from pre-monsoon (2005). High altitude lakes (above 3000m and more than 2.25ha) accounted for 40.79% (3050 ha) of total wetlands area, river/major streams accounting 55.25% (4131 ha) and Low-altitude lake (below 3000m and more than 2.25ha) was 0.20% (15 ha) of total wetland area.

The wetlands of Sikkim were found to be mostly with low and moderate turbidity and High turbidity wetlands were not detected. The state has four districts and North District has highest concentration of wetlands with 63.7% of total wetland area in state **and it covers 1.13% of total geographic area of state.** The other three districts i.e. West, East and South Districts have 14.3%, 12.1% and 9.88% area under wetlands respectively.

High Altitude Lakes were observed in three districts (North, West and East). The districts with very high concentration of small lakes (<2.25 ha) are North District with 221 followed by East and West Districts with 42 and 16 respectively, while south district has lowest with only 2 such wetlands.

Table: Area estimates of wetlands in Sikkim (Area in hectors)

Sr. No.	Wetland Category	No. of wetlands	Wetland Area (ha)	% of wetland area	Open water	
					Post-monsoon 2006 (ha)	Pre-monsoon 2005 (ha)
	Inland Wetlands - Natural					
1	Low altitude Lakes (below 3000m and more than 2.25ha)	1	15	0.20	8	8
2	High altitude Lakes (above 3000m and more than 2.25ha)	259	3050	40.79	3050	896
3	Major Rivers/Streams	12	4131	55.25	4131	4131
	Sub-total	**272**	**7196**	96.24	**7189**	**5035**
	Small Wetlands (<2.25 ha)	281	281#	3.76	281	281
	Total	**553**	**7477**	**100**	**7470**	**5316**

the average area of Small Wetlands (<2.25 ha) has been taken as 1 ha.

XI. Establishment of Landslide database Centre in Sikkim (Funded by: GOS)

Landslide is a major disaster of hilly areas like Sikkim and other mountainous regions of the world. Each year with the onset of monsoon, landslide in the form of mudslide, rockfall, debris fall etc. begins to appear in the hill slopes, causing huge damages to the life and properties. The frequent road blockages over the rainy seasons in all parts of the state are some of the serious issues of landslides that not only create troubles to the local residents but it also hampers the economic development of the area. Considering the fact, Sikkim State council of Science and Technology is carrying out the landslide studies with objectives to create the database on the landslides of Sikkim, that not only help in understanding the spatial nature and characteristics of landslides but also help in monitoring the landslides. Preparation of landslide inventories is one of the important parts of landslide studies that ultimately help in application of proper remedial measures and minimising losses. Remote sensing technology provides important platforms in the form of satellite images for the preparation of landslide inventories.

So far landslide inventories from IRS LISS III 2006 image is being completed and the output layers is being analysed in other important parameters of landslides like landuse, Slope, Aspect, altitudes and Forest type map of Sikkim. Likewise a landslide inventory is also prepared from Topographic Maps which is a key source of landslide of the past. It helps in identification of active landslides of the state and comparative studies of landslides. The coordinate of each landslides of Sikkim from high resolution Google Earth Pro images in the form of point locations is also recoded. The database of past landslide from the year 1976-2005 onwards covering Date, Location, and number of life losses is being made; same can be of great use for the researchers and planners in future.

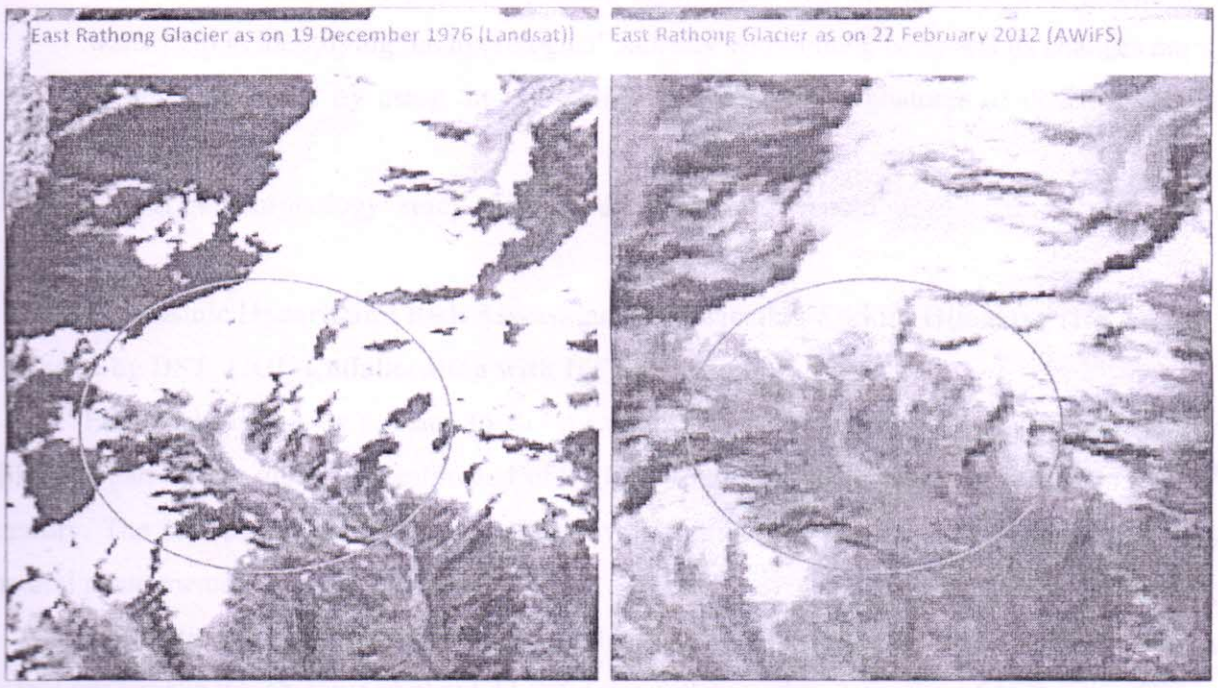
Landslide after 18th Sept Earthquake in North Sikkim (Source: *Dave Petley "The Landslide Blog",)*

XII. Study of Glacier Dynamic of East Rathong Glacier of Sikkim Himalayas:
(Funded by DST, GOI)

World has witnessed increase in global temperature with the dawn of industrial revolution in the early eighteenth century. With the rapid growth and development of industrial sector in the later period has accelerated the complex process of global warming which has created serious impact in the environment. Ice melting and glacial retreat is one of the main impact of global warming and climate change. Glaciers are the complex dynamic systems sensitive to their surrounding environment. They constantly change their shape and form to adopt the changes in the surrounding environment. Prolonged changes in the mean annual summer temperature of even less than 1 degree centigrade can change in glacier mass balance resulting in glacier advances or retreat hundreds of meters. In mountainous regions, glaciers form an important source of perennial water that fed the mighty rivers that supports life in various forms. So the study of Glacier is one of the main concerns in the present scenario.

Sikkim being a Himalayan region is also one of the glacier rich state of India. There are 84 glaciers feeding two mighty glacial river system including Tista and Rangit river basins with numerous streams. Likewise in other glaciers, the glaciers of Sikkim are also facing severe threat from the effect of global warming and climate change. Considering the fact, Sikkim State Council of Science and Technology with the support of Department of Science and Technology, Government of India and technical collaboration with the national experts in Glaciology is now undertaking the study of glacier dynamics of East Rathong Glacier of Sikkim Himalayas.

East Rathong Glacier, (Lat 27^0 34'E to 27^0 33'E and Long $88^0$07'E to $88^0$10'N) located in the West



East Rathong Glacier Photograph by: Pranay Pradhan.

Sikkim covers a basin area of 35.95 sqkm and total ice cover area of 8.49 sqkm. The snout is located at 4674mts (June 2008). It has length of 4.5km and breadth of 1.5km. The study is in its initial phase and it covers the following objectives:

- Glacier mass balance studies: Glacier Budget
- Glacier secular movement studies: snout monitoring and glacial movement
- Sub glacial studies: including internal structures of glacier ice/depth.
- Ice core studies and Dating: to study the age of the ice and study the trapped elements and gases for past and present environmental study.
- Glacial ecology: glaciers are the main indicators of climate change so the study of their long ecology is paramount.
- Meteorology: snow precipitation pattern, rainfall, evaporation rate etc are important meteorological parameters.
- Energy balance studies: albedo phenomena, sun inclination studies, illumination, light intensity etc.
- Glacier inventory of Sikkim in every five years using satellite imageries.
- Yearly snow covers monitoring of Sikkim Himalayas using AWiFS data.
- Snow ice physics: study of old/fresh snow, firn, ice crystal, reflectance, and wavelength fluctuations etc.
- Glacial chemistry: glacial chemistry study characterizes the water quality and the rate of chemical weathering of glaciated terrain. Hydro chemical characteristics of glacial melt water help in identifying the hydrological pathway within the glacier and its changes during an ablation period by using the variation in the chemical signatures of different run off components.
- Glacier geomorphology: study of glacier and landform orientation.

XIII. Seismic Hazard and Risk Assessment of Darjeeling-Sikkim Himalaya (HRA) (Funded by DST, GOI, Collaboration with IIT Kharagpur)

Earthquake is major menace to the mankind killing thousands of people every year in different part of the globe. An estimated of 17,000 persons per year has been killed in the 20th century. The studies are going on for prediction of earthquakes to save the mankind from such natural phenomema.

The State of Sikkim lies at the eastern edge of the rupture zone of the 1934 M = 8.4 Bihar Nepal earthquake which claimed about 11,000 lives and caused an intensity of VIII in the Sikkim

Himalaya (GSI, 1939). It was severely shaken again, more recently by the 1988 MS= 6.6 earthquake which ruptured a deeper part of the same zone, the isoseismic VII passing through its capital town of Gangtok in an approximately NE-SW direction. Several houses in the town were badly damaged, whilst power and other communication system installations suffered subsidence, besides a series of disrupting landslides.

The Ministry of Earth Sciences sanctioned "Microzonation of Sikkim region" project to Shri S.K. Nath, Professor, Geology and Geophysics Department, Indian Institute of Technology, Kharagpur and in Sikkim it is being coordinated by the Department of Science and Technology & Climate Change. The total no. of has eight Seismic Monitoring Stations in different part of Sikkim are constantly recording the vibrations.

Sl. No	Name of Station	Machine model Installed
1	Marchak (Science Center)	ETNA
2	Singtam	ETNA
3	Padamchen	ETNA
4	Melli	ETNA
5	Uttaray	ETNA
6	Pelling	ETNA
7	Mangan	ETNA
8	Chungthang	ETNA

On 7th November 2011 a day long workshop on **"Seismicity in Sikkim Himalayas: Current Scenario"** held at Sikkim Science Center at Marchak. The workshop was organized by Sikkim State council of Science and Technology. During the workshop Horn'ble Minister of Science and Technology Shri Bhim Dhungel inaugurated the new Strong motion and ETNA earthquake monitoring station at the vicinity of the Science Center.

Professor SK Nath, the Head of Geology and Geophysics of IIT, Kharagpur who has prepared a seismological investigation report after the September 18, quake also discarded the speculations of Hydel Power Projects (HEP) being the main cause of the earthquake and

the damages. "It should be understood that there are no direct or indirect relations between the HEP and the earthquake" Prof Nath said. He also said that not all the zones in Sikkim fall under seismic zone V but many parts of Sikkim also falls under the seismic zone II and III.

Prof Nath added "the rapid urbanization and the unprecedented population growth have compounded the risk of seismic zones" Stressing on the proper urbanization and the building codes Prof Nath said that the Government of Sikkim should make it mandatory to acquire the seismic clearance before going for any kind of constructions."The earthquake of September 18 which lasted for 18.2 sec had brought more devastations had the epicenter been somewhere in the urbanized areas" he said. He also stressed on the point that the seismic zonation map is needed to upgrade.

Shri A K Srivastava, the Principal Secretary of the Department of Science and Technology and Climate Change has also made a presentation on the topic.

List of Earthquake shock during the year 2011 and 2012 greater than 3 magnitude

2011						
Date	Time (UTC)	Lat	Long	Depth (Km)	Magnitude	Region
3/06/2011	00:53:21	27.5 Deg N	88.0 Deg E	26	4.9	Nepal-Sikkim (INDIA) Border Region
18/09/2011	12:40:47	27.7 Deg N	88.2 Deg E	10	6.9	Sikkim-Nepal Border Region
18/09/2011	13:11:59	27.6 Deg N	88.5 Deg E	16	5.0	Sikkim-Nepal Border Region
18/09/2011	13:54:17	27.5 Deg N	88.4 Deg E	9	4.5	Sikkim-Nepal Border Region
18/09/2011	21:51:52	27.6 Deg N	88.4 Deg E	28	4.2	Sikkim-Nepal Border Region
22/09/2011	16:44:43	27.6 Deg N	88.4 Deg E	30	3.9	Sikkim (INDIA)
17/10/2011	13:04:50	27.3 Deg N	88.4 Deg E	5	3.5	Sikkim (INDIA)
29/10/2011	00:43:41	27.4 Deg N	88.4 Deg E	5	3.5	Sikkim (INDIA)
09/12/2011	22:56:56	27.9 Deg N	88.2 Deg E	33	3.78	Sikkim-Nepal Border Region

13/12/2011	01:26:43	27.3 Deg N	88.6 Deg E	5	2.9	Gangtok Sikkim
14/12/2011	20:20:55	27.7 Deg N	88.0 Deg E	50	4.5	Sikkim-NepalBorder Region
18/12/2011	21:35:25	28.0 Deg N	88.2 Deg E	35	3.7	Sikkim-NepalBorder Region
2012						
18/01/2012	14:12:52	27.3 Deg N	88.5 Deg E	5	3.5	Sikkim INDIA
14/02/2012	13:48:43	27.3 Deg N	88.2 Deg E	5	3.6	Sikkim-Nepal Border Region
27/03/2012	23:40:08	26.1 Deg N	87.8 Deg E	12	4.9	INDIA- . NEPAL Border Region
30/05/2012	01:54:28	27.4 Deg N	88.0 Deg E	10	4.0	Sikkim-Nepal Border Region
11/06/2012	04:35:56	27.2 Deg N	88.3 Deg E	5	3.8	Sikkim-Nepal Border Region

Comparative study on frequency of occurrence of earthquake on 2011 and 2012 has found that the frequency of earthquake occurrence had tremendously increased after 18th September Earthquake of magnitude Mw 6.9 occurred at 6:10:48 PM near boundary between the Indian and Eurasian plates in proximity of Kanchenjunga Lineament hear the Sikkim- Nepal Border at 68 km NW of Gangtok, the Capital if Sikkim.

The graph below shows the frequency of occurrence of earthquake in 2011 and 2012 (Data taken from IMD).

Bio-Resources, Biotechnology Research and Tissue Culture Facilities:

The following programmes are being undertaken/initiated:

1. **Establishment of State Biotech Hub in Sikkim**

The project "Establishment of State Biotech Hubs (SBT hubs) in Sikkim" is funded by Department of Biotechnology (DBT), Govt. of India under special programme for North Eastern States of India. The project is being coordinated by Biotech Consortium India Limited (BCIL), a government of India enterprise promoted by Department of Biotechnology, Government of India. The project has the component of establishment of state of art biotechnology infrastructure facilities in the state, a nucleus research centre for biotechnological research. The total project cost is Rs. 304.03 lakhs and is of three years duration. The main objective of the project is the establishment of major biotechnology infrastructure facility in the state, to train the coordinators of the institutional hubs, to provide support for research and training and to have a linkage with other institutional hubs in the respective state.

Progress of the project:

1. **Appointment of manpower**: Three (03) Junior Research Fellow, one (01) Technical Assistant and three (03) lab attendants has been appointed in the project. The project is being headed by the coordinator Dr. B. C. Basistha, Additional Director and Co-coordinator, Shri. K. B. Subba, Assistant Scientific Officer, Deptt. of Science & Technology, Government of Sikkim.

2. Formation of Scientific Advisory Committee (SAC): Scientific Advisory Committee consisting members from different scientific institutions like North Bengal University, ICAR, G.B. Pant institute, Sikkim University, Government College, NRC Orchids was constituted with the Member Secretary, Sikkim State Council of Science & Technology as Chairman. The SAC was constituted to give advice suggestions and overall monitoring the progress of the project.

3. **Appointment of consultant**: Dr. Arnab Sen, Head of Department (botany), North Bengal University who is also a well known biotechnologist of the region has been appointed as consultant for a period of two years to guide, suggest and advice on the overall progress of the project.

4. **Preparation of list of instruments with specifications**: The list of equipments and machineries to be procured in the first phase has been prepared along with the detail specifications in consultations with the other institutes. The biotechnology laboratory has the following equipments at present procured from another project funded by DBT, Govt. of India: Gradiant PCR (Thermal Cycler), Applied Biosystem, Gel Documentation system, refrigerated centrifuge, gel electrophoresis unit, slab gel dryer, electrophoresis power pack, and basic infrastructure facility for plant tissue culture laboratory.

The following instruments have been finalized to be procured soon for Molecular and phyto-chemical studies under the State Biotech hub project. This includes; liquid N_2 canister (20 lit), liquid N_2 canister (11lit), water bath shaker, horizontal deep freezer (-20°C to -35°C) , vertical deep freezer (-20°C to – 30°C), -18°C deep freezer, UV Vis spectrophotometer, upright microscope with phase contrast attachment, ultra water purifier, BOD incubator, stackable incubator shaker, flake icemaker machine, vortex mixing machine, hot plate with stirrer, SLR camera, Hot air oven, Binocular CME compound microscope, Dissecting microscope, CO_2 incubator, Rotary shaker, Sonicator, Rotary evaporator, Weighing balance, Centrifuge, HPLC, Horizontal Laminar Air Flow Hood along with other experimental minor instruments and requisites.

5. **Meeting of the Scientific Advisory Committee**: The SAC meeting was conducted for finalization of the list of equipments as stated above with their specifications. The committee member gave valuable suggestions, guidance on the type and the appropriate specifications of the instruments to be procured soon.

6. **Construction of laboratory for instrumentation facility** : The laboratory to house the hi-tech instruments has been completed with modular furnishing, lab tables and other facilities.

7. **Tendering for procurement of instruments**: The tendering for the procurement of equipment has been done through global tender and publication of NIT in the local newspaper.

8. **Research activities**: The work carried out as of now is mainly based on plant tissue culture, biochemistry and applied activities. The following research activities have been undertaken:

Research activities	Status
• In vitro multiplication of two rare orchid species of Sikkim Himalaya (cymbidium whitae & C.eburneum) through meristem culture.	Completed
• Study of the use of creptomeria japonica (D.Don) leaves for growing of cymbidium orchids.	Completed
In vitro propagation of Zingiber officinale through shoot tip culture	Completed.
• Assessment of anti microbial activity of extract of the medicinal plants of Sikkim Himalayas.	Ongoing
• Assessment of anti-oxidant property of medicinal and aromatic plants of Sikkim Himalayas. Molecular studies of six cultivar varieties of zingiber officinale of Sikkim Himalaya using RAPD and other markers.	Ongoing

No. of papers published/presented: 01 presented in the National conference on biology and bioinformatics of economically important plants and microbes.

The newly appointed research scholars and the team are also engaged rigorously in doing literature review of their area of interest by retrieving research papers from free online journals facilities provided by Dept. of Biotechnology, Government of India through DBT e-Library Consortium (DeLCON).

9. **Signing of Memorandum of Agreement (MOA) with Kumaon University** and Department of Science & Technology, Govt. of Sikkim for affiliation of PhD scholars is under process.

10. **Hosting of 2nd Biotech hub Coordinators' Meet at Gangtok:** The project hosted 2nd Biotech hub interactive coordinators' meet.

II. Ecological Studies of Sea buckthorn and Genetic diversity of Frankia associated with it in Sikkim

The project is being funded by Department of Biotechnology, Ministry of Science & Technology, Government of India and is of three years duration. The main objectives of the project are as under:

Objectives:-

1. Survey of Hippophae growing Area in Sikkim.
2. Collection and maintenance of Hippophae germplasm from Sikkim.
3. Ecological and Taxonomical studies of native Hippophae and Frankia of Sikkim using descriptors.
4. Analysis of soil of native Hippophae with reference to pH, moisture, amount of organic carbon, available nitrogen, calcium, magnesium potassium and phosphorus.
5. Providing research materials, like fruits, leaves,etc of Hippophae to different institutes of the country under the DBT Network for biochemical research.
6. Isolation of Frankia associates with roots of Native Hippophae.
7. Genetic diversity studies of Frankia spp. Associated with native Hippophare root nodules.

1. ***Genetic diversity study of frankia associated with Hippophae in Sikkim***: The project PI is pursuing his PhD research work on the genetic diversity study as per the project proposal submitted to DBT, Govt. of India. He has undertaken the isolation work of DNA, PCR and the gene sequencing of the partial 16srRNA of uncultured *frankia* of 21 variations isolated from the root nodules of Hippophae salicifolia from the different area. He has submitted the sequence to NCBI and uploaded in NCBI website.

2. ***Work on isolation, in-vitro culture and DNA isolation, PCR***: The isolation and *in-vitro* culture of *frankia* from root nodule for pure culture and DNA isolation, PCR and gene sequencing has been carried out. Microscopic photography of *in-vitro* culture indicates the isolation of *frankia*. Koch postulate for confirmation of frankial presence has been done and the results are awaited. Once they are confirmed, DNA isolation, PCR and gene sequencing will be carried out.

3. ***Collaborative work with ICAR on PCR of frankia associated with Hippophae***: Joint collaboration work for isolation of DNA & PCR from *frankia* taken from pure culture has been started in the ICAR laboratory. Training on the preparation of reagents, isolation of DNA etc. has been started with some other materials. Isolation of DNA & PCR will be carried out from the pure culture once it is confirmed.

4. ***Morphological studies of Hippophae salicifolia using descriptor***: Morphological studies of *Hippophae salicifolia* using descriptor of 50 accessions has been carried out. These include location with parameter; altitude (m), longitude, latitude, aspect (using GPS), habitat, sex and species name, plant morphology; qualitative character (plant form, growth habit, branching, stem shape, stem color etc.), quantitative character (plant height, canopy etc.), leaf characters etc.

5. ***Collection of rhizospheric soil for soil analysis***: The soil around the roots of *Hippophae salicifolia* has been collected for analysis of the organic carbon content, available nitrogen, calcium, magnesium, potassium and phosphorus. The samples shall be sent to testing centre shortly. Soil Data in respect of soil pH, soil color, soil moisture and soil temperature has been collected from the periphery of the hippophae tree/shrub and the hippophae growing areas.

6. ***Collection and maintenance of germplasm from Sikkim***: Live cuttings of *Hippophae salicifolia* from Lachen and Lachung valley of North Sikkim has been collected and sent to IHBT, Palampur of about 10 accessions. About 100 cutting were sent for germplasm collection from Sikkim. Based on the success of rooting we shall be sending the additional cutting to the institute.

7. ***Bioactive principle analysis of leaves, fruits and seeds***: Basic Bioactive principal analysis of *Hippophae Salicifolia* was carried out in Amrita School of Biotechnology, Department of Phytochemistry, Kerela, under the guidance of Dr. Asoke Banerji, Distinguish Professor (Phytochemistry). Experiment was carried out for Analysis of Bioactive principle of different plant parts of Sea buckthorn (*Hippophae salicifolia)* of Sikkim . The plant part taken for the analysis dried leaves, dried Fruits and seeds. Extraction of compound was carried out using different techniques like, Thin Layer Chromatography, Column Chromatography, High Performance Liquid Chromatography, Chromatotron, Colour reactions, Hydrolysis. Soxhlet apparatus was used for extraction of compounds from plants parts. Significant preliminary findings have been made. The findings are likely to be published soon.

8. ***Nodulation and aerial nodulation study***: Study on the various correlating factors on nodulation in the natural orchard of Hippophae has been carried out. Significant findings have been made which shall be published soon. Study on the aerial nodulation on Hippophae tree has also been carried out. An attempt to induce nodulation in the polyhouse using different root media composition and the mixture of the rhizospheric soil was also carried out.

9. ***Rooting of cuttings of Hippophae salicifolia***: Cuttings of *Hippophae salicifolia* are planted for rooting and raising plants. The plant is giving positive result.

10. Study regarding association and migration of *Alnus nepaulensis* with *Hippophae salicifolia* D. Don, an indication of climate change

The study on the migration and close association of *Alnus nepaulensis* with Hippophae salicifolia is also carried out in the sidelines of the project and the signicants findings have been made.

III. Bioinformatics Centre

Sikkim State Council of Science and Technology is an autonomous non profit public funded research and training organization established under Department of Science and Technology, Government of Sikkim. With the of view of promoting and catalyzing Bioinformatics and Biotechnology works Sikkim Bioinformatics SubDISC Centre (Distributed Information Sub-Centre) was set up in the state in the year 2001 with the technical and financial support of Department of Biotechnology, Government of India.

OBJECTIVES:

The main objective of the center is to promote Biotechnology and Bioinformatics in the state through trainings, seminars and workshops, database preparation in various bio resources of the state, encouraging young researchers to take up research work in bioinformatics and biotechnology.

Research Area: Biodiversity, Biotechnology and Bioinformatics

INFRASTUCTURE FACILITY:

Hardware:-The Centre is equipped with a dual processor server, P-4 PCs, Laptops, Scanners, DeskJet and laser printers, digital camera and a Xerox machine.

Software: Geneious Pro Bioinformatics Software, Quick Heal Internet Security.

Internet facility: The centre has 24 hours internet connectivity provided by the State National Informatics Centre through RF Antenna.

FACILITIES PROVIDED:

- The center acts as an information retrieval center for providing information on various bioresources of the state and related fields, downloading bioinformatics tutors, lectures, literature.
- The center's library facility is provided free to the researchers and scholars working on various fields of science. The center has good volumes of books and magazines on bioinformatics, biotechnology, biochemistry, molecular biology, microbiology, etc.
- The center has compiled the published research papers on bio-resources of Sikkim which is very useful for researchers working on various bioresources of Sikkim.
- The on line journal facility is extended to all researchers and scholars of different institutes and colleges, government departments doctors and medical staffs of hospitals, etc.
- Free internet facility is provided for researchers and JRFs of different undergoing projects an centers housed in Sikkim State Council of Science and Technology, researchers and scholars of different institutes and colleges and schools.
- Provide facility to the young researchers to take up research in the field of Bioinformatics and Biotechnology through studentship and traineeships.
- The database prepared by the center is made online and is uploaded on the centers website www.bioinformaticssikkim.gov.in.

IMPORTANT ACTIVITIES (2011-2012)

- The Centre has conducted training on sequence alignment and phylogenetic analysis from 21st to 22nd March 2011. The scientists and research scholars have been benefited by the training.
- Training on Biodiversity and Biological database development, its retrieval and used in research & conservation was successfully conducted on 27th – 28th September, 2011. Scientists, Senior Research Fellows, Junior Research Fellows, Research Assistants have participated in the training.
- Fifth Volume of the news letter "BIOGYAN" has been published and is been made online at our website: http//www.bioinformaticssikkim.gov.in.
- Online Access of journals provided by Delcon consortium through Department of Biotechnology, Government of India is being used by the researchers and scholars.
- The Centre has prepared a database on economically important Agro-horticultural crops diseases of Sikkim.

WORKSHOP/ TRAINING/MEETS ATTENDED

- Attended All India Coordinator's Meet held at Jammu from 02nd to 04th February, 2012.
- Attended North East NEBInet meeting held at North Eastern Regional Institute of Science and Technology (NERIST), Nirjuli, Arunachal Pradesh from 10-11th November 2011.

PUBLICATIONS

- Laydong Lepcha,B.C.Basistha & M.L.Arrawatia (2012). Landslides: Athreat to Bio-resource of Sikkim Himalaya. Sikkim Biodiversity Significance and Sustainability, pp.80-91.
- S.Pradhan, B.C Basistha,R.Basnett &A.Banerjee (2012). Chromatographic Techniques used for Investigation of Basic Bio-active Constituents of Highly Potent Species – Hippophae salicifolia from Hidden Forest of Sikkim. Sikkim Biodiversity Significance and Sustainability, pp. 80-91.
- Sushen Pradhan,Manjila Sharma, K.B.Subba, Dhanraj Chhetri & B.C.Basistha (2012). Effect of growth regulators on in-vitro multiplication of Citrus jambhiri Lush. Sikkim Biodiversity Significance and Sustainability, pp.128-133.
- Manjila Sharma & Sushen Pradhan (2012). Comparative study of Fungitoxicity of Cymbopogon Citratus(DC)stape &Zanthoxylum armatum DC against Sour Rot Disease of Tomato causedby Geotrichum candidum link. Sikkim Biodiversity Significance and Sustainability, pp.134-141.
- Rajdeep Gurung,S.R. Lepcha & B.C. Basistha (2012). Intellectual Property Rights(IPR) in Sikkim Himalayas :Afuture Perspective. Sikkim Biodiversity Significance and Sustainability, pp. 193-198.

Recent Research publications

- L. Lepcha, S. Guha Roy, A. Sarkar, B. C. Basistha, M. L. Arrawatia. Documentation of Medicinally Important Plants from the Landslide Prone Areas of East Sikkim, India: A Survey Report. Journal of Phytology 2011, Vol.3(7): 01-07.

PROPOSED ACTIVITIES DURING THE YEAR 2012-2013.

a. Conducting trainings/seminars/workshops and sensitization programs on Bioinformatics and Biotechnology.
b. Publication of a Bioinformatics Sixth volume of newsletter "Biogyan" current bioinformatics advancements, biodiversity informatics and research activities.
c. Encouragement to young researchers to take up research in the field of Bioinformatics and Biotechnology through studentship and traineeships.
d. Collaboration with others research institutes of the state as well as other national institutes to take
research work in the field of Bioinformatics and Biotechnology.
e. Publication of Bioinformatics research papers on National/International Journals.
f. Preparation of animation software on Plant Physiology activities.
g. Preparation of programming software on Life Science quiz for School Bioinformatics.

FURTHER LINKS ON THE ACTIVITIES OF THE RESEARCHERS AT THE Sub-DIC

- http://www.sikenvis.nic.in
- http://www.dstsikkim.gov.in
- http://www.siikim.gov.in

IV. Patent Information Centre (PIC), Sikkim

- To create awareness among the people on Intellectual Property Rights
- To increase Intellectual Property Rights related activities in the state.
- To provide technical and legal assistance for Patent, Geographical Indication (GI) & other IPR related filing.
- To provide the detail information regarding query about IPR.

Benefit from the PIC, Sikkim.

Researchers will get detail support for filing patent. Local Horticulture and Agricultural products of the state will get GI registration, which provide benefit to the local community of the state in protection and commercialization of their products in the global market. Handicrafts and Handloom items of the state also get registration in GI and Trademarks. Traditional knowledge holders of the Sikkim may get opportunity to protect their knowledge and practices from different forms of IPR. Plant growers can get right to their new variety over the propagating material (including seed, cuttings, divisions, tissue culture) and harvested material (cut flowers, fruit, foliage) of a new variety through Plant Breeders Right (PBR) & Farmers Right under IPR. Intellectual Property (IP) of the people can be secured from elite infringement like bio-piracy, etc. All details regarding IP information and its registration can be retrieved from the centre.

Activities carried out in the year 2011-2012

1. ***Intellectual Property Rights Awareness.***
   Continuous awareness activities of IPR in the Science Centre through displaying of permanent flex.

2. ***Patent Search Activity.***
   Patent search activity is going on for proving support for patent filing from the state. PIC is providing patent search facilities to all the research institutes and the colleges and universities. The centre has also aware and sensitize about patent search, patent drafting and filing activities of the PIC during different programs of the Sikkim State Council of Science & Technology. The PIC, Sikkim has procured 30 years patent database with bimonthly renewable version from Patent Infos Chennai (ongoing activity).

3. ***Geographical indication (GI) activity.***
   GI filing of the two items i.e Sikkim Mandarin and Sikkim Temi Tea has been accepted by the Technology Information Forecasting and Assessment Council (TIFAC), New Delhi.

4. ***IPR cell created.***
   Total five no. of IPR cell created in the state by PIC, Sikkim State Council of science & Technology; they are Sikkim University, 6th Mile, Gangtok, College of Engineering & Post Harvest Technology (Central Agriculture University) Ranipool, Sikkim Government College, Tadong, East Sikkim, Sikkim Government College, Gayzing, West Sikkim, Sikkim Government College, Rhenock.

5. ***Publication***
   i. PIC has published latest brochure for the awareness generation of IPR in the state.
   ii. To create awareness about Intellectual Property Rights, the centre has published a booklet of IPR questionnaire in local language (Material is in press for printing).
   iii. Publication of IPR article in the Journal of "Sikkim Biodiversity- Significance and sustainability" with title A FUTURE PROSPECTIVE; INTELLECTUAL PROPERTY RIGHTS (IPR) IN SIKKIM HIMALAYA.
   iv. The centre has submitted research article to the Indian Journal of Traditional Knowledge (IJTK) which is publishing in upcoming edition of IJTK with title Traditional *Lepcha* craft *Sumok-thyaktuk* (*Lepcha* Hat) and its conservation in Dzongu Tribal Reserved Area (DTRA), Sikkim, INDIA.

6. ***New PIC website***
   Re-launching of the PIC website www.picsikkim.gov.in
   Digital certificate and VPN has been procured along with renewal of the domain gov.in website is also design and ready with latest updates only official approval is awaited for the launching.

7. ***Intellectual property Facilitating Centre (IPFC) setting up in the state***
   The PIC centre has prepared draft copy for setting up of the Intellectual property Facilitating Centre (IPFC) in collaboration with Micro, Small, Medium Enterprises (MSME).

8. *Copyright filing*
   One copyright has been filed by the PIC in the field of literature.

9. *Plant Breeders Right (PBR) & Farmers Right*
   The PIC centre is working on registration of one new variety of rice developed by the local farmers of Sikkim under Plant Breeders Right (PBR) & Farmers Right.

V. DBT's mission for the production of quality planting materials and utilization for the North East'

The project titled 'DBT's mission for the production of quality planting materials and utilization for the North East' is being funded by Department of Biotechnology, Ministry of Science and Technology, Government of India and is coordinated by The Energy Resources Institute (TERI), New Delhi. The project is of three years duration and commenced from 2008.The project is executed in almost all North East region of India including Sikkim through Sikkim State Council of Science & Technology, Gangtok.

Objectives of the Project:

- Production of Quality Planting Materials and their demonstration in the farmer's field.
- Conduct of training on the scientific methods of cultivation and their management.
- Demonstration of Quality Planting Materials in the farmer's field in a scientific manner.
- Setting up of quality farms for the identified products.
- Establishment of marketing linkages for value products.
- Upliftment of socio-economic condition of the farmers through employment and income generation.

Sikkim State Council of Science and Technology, Government of Sikkim is coordinating the implementation of the above project in the State of Sikkim. The production of Quality Planting Material of **Sikkim mandarin, Large Cardamom and Ginger** and their demonstration in the farmer's field is the main objective of the project. The project has taken up all the three crops and demonstrated in their farm with scientific cultivation methods.

In total 129 beneficiaries were provided with different cash crops as per the suitability in the area and now the plants are in fruiting stage and giving positive results. Some of the mandarin saplings provided under the project has attended about 13 ft. tall and started bearing fruits.

Future activities:

1. Setting up of the state of art biotechnology facilities.
2. Multiplication of rare and endangered plant species of Sikkim.
3. Study on the bioactive compounds of medicinal plants of Sikkim.
4. Development of biopesticide, biofungicide and biofertilizers using local plant extract, local microbe strains.
5. Molecular study of important plant species of Sikkim.
6. Development of digital database of important plant flora and fauna species of Sikkim Himalayas.
7. Geographical indication registration of Sikkim mandarin, Temi tea and lepcha hat from Sikkim.

The details of work carried out under the different projects are as under:
Science Awareness, Communication and Science Popularization Programme:

Communication and Popularisation of Science is one of the area of activity of the Council which pervades through all activities and initiatives of the council. This is a common platform where all divisions meet for popularization of extension work. The communication and information sharing is taken up at various levels and by identifying various location specific problems in which science & technology can play a manifested role for preparing young minds for future. Many planned activities are taken up every year which can be summarized as follows:

DBT-Natural Resources Awareness (DNA) Clubs programme in Sikkim State:

The Department of Biotechnology, Government of India has sanctioned a project DNA Clubs project in Sikkim as a part of major project for entire North Eastern States.

The objectives of the project are as follows:

- To enhance understanding among students about the immense value of biological diversity of our country, the importance of locally available bioresources, their sustainable use and conservation;
- To equip them with relevant skills for bioresource conservation;
- To familiarize students with scientific and technological issues related to biotechnology;
- To provide students with an experimental learning opportunity;
- To create opportunities for hands on experiments in the field at the school level;
- To organize field trips to National Institutes and National Biological parks of the country;
- To facilitate interaction with leading experts in the field including the core and visiting faculty at the Institutions.

In Sikkim 35 schools has been identified for taking up DNA club programme. The programme was formally launched by Hon'ble Chief Minister of Sikkim on 14th October 2009 during Platinum Jubilee celebration of Namchi Senior Secondary School at Namchi, South Sikkim.

The Sensitization Meeting of teachers of DNA CLUB of Sikkim and Vacation Traininng Programme for the club member students have been organized for fifteen days at Sikkim Science Centre, Marchak and Janata Bhavan, Gangtok

The Sikkim State Council of Science & Technology have identified 35 schools for DNA Club and invited all the schools. Out of which 25 schools attended the meeting. Mr. D.T.Bhutia, Senior Scientific Officer, State Coordinator of DNA Club had explained about the DNA Club, its terms & condition etc. He told about the details of equipment that the schools will be getting along with some cash money to organize the programmes. He also discussed about the various activities that the schools can organize in their respective school and to maintain the record of activity with date, types of activity, Resource Person invited etc. and also to maintain the expenditure details for submission of Statement of Expenditure and Utilization Certificate later(after taking the programme). The schools has also signed memorandum for taking up the DNA Club programme in the schools. The microscopes, computers and various essential lab equipments for biological experiments are also being provided to these schools.

Innovation in Science Pursuit for Inspired Research (INSPIRE):

INSPIRE Programme is centrally funded flagship programme of the Department of Science & Technology, Govt. of India which is being implemented through State Governments and UT administrations. The objective of this programme is to develop scientific temper amongst the young and to motivate them to take up scientific career for the scientific and technological advancement of the country. This programme has five components covering entire range of education and research from class VI to post doctoral stage of a student. The first component of this programme is INSPIRE Award which recognizes the talents among students at a very early stage. Each INSPIRE Awardee receives a onetime award of Rs.5000/- in his /her school carrier and with this money the awardee will be required to make a project / model which will subsequently be displayed at the exhibition organized at various level , including national level.

In the year 2010-11, Students from Sikkim bagged IInd and IIIrd position at the National Level Exhibition in Regional Category held at Pragati Maidan, New Delhi during 15-16th August, 2011. The winners received the awards from the President of India. . Accordingly a total of 631 INSPIRE AWARDS have been distributed to various schools all over the state so far. District level and State Level Exhibition is proposed to be held for these awardees to enable them to compete at National Level. It is now targeted to cover all schools within the state for INSPIRE Award in the year 2012-13

1. During the visit of Dr. Ajit Kembhavi, Director, IUCAA, Pune on April 25-28.2011 a Lecture/interaction programme was organized for the students/collegians as a part of Science Popularization programme at Sikkim Science Centre, Marchak on 27.04.2011. The progamme was attended by the students of Sikkim Government College, Bahai SSS, Saramsa and Biraspati Parsai SSS, Ranipool .
2. The programme**"THE WONDERFUL LABORATORY CALLED HOME & SCIENCE IN THE PLAY GROUND "**
   The programme"THE WONDERFUL LABORATORY CALLED HOME & SCIENCE IN THE PLAY GROUND "was a Interactive, demonstrations and was organized for two days on May 9-10,2011 at Sikkim Science Centre. Around 300 students of class –VIII-X from PNG school, Biraspati Parsia Govt. SSS, Ranipool, Lower Syari SS, Deorali Girls' SSS, Army Sec. School and Class VIII from Thumi Sambota (Tibetan School) and Indrakhil JHS, Ranipool. The programme attended the programme
   Arnab Bhattacharya, Resource Person from Tata Institute of Fundamental Research, Mumbai demonstrated and explained science behind every activity at home/ kitchen and in the play ground, such as breaking of eggs, testing of oil content in lemon/any citrus fruit, gooey insides of boiled eggs, refreshing scents of oranges, colourful magic of soap bubbles, sticky shampoos, squishy world of toothpaste and a lot more!
3. The Department of Science & Technology celebrated as **Green Mission Day** on 2.07.2011. The officers and staff planted tree sapling at Biotechnology Centre, Sajong.

4. **Training Workshop on Telescope Assembling at Sikkim Science Centre**
   During the visit of Dr. Ajit Kembhavi, Director, IUCAA, Pune on April 25-28.2011 a Lecture/interaction programme was organized for the students of schools and college as a part of Science Popularization programme at Sikkim Science Centre, Marchak on 27.04.2011. The progamme was attended by the students of Sikkim Government College, Bahai SSS, Saramsa and Biraspati Parsai SSS, Ranipool .
   The Sikkim State Council of Science & Technology has organized a three days training workshop at Sikkim Science Center from 21st to 23rd April 2011 regarding **Telescope Assembling.** The training Workshop has been organized jointly with the Vigyan Prasar

which is an autonomous organization under the Departament of Science & Technology, Government of India. The workshop was attended by science teachers from different schools from various parts of the state, along with the students.

During this workshop, **60 nos of telescopes were assembled** by the participants and these telescopes were handed over to participants for taking back by them to their respective schools to initiate astronomical activities like night sky watching in a regular way. All teachers were also been given a set of kit comprising about 30 activities for understanding the basics of astronomy along with a log book comprising about 30 observation based projects/activities on astronomy to keep the record of the activities undertaken by them.

The workshop has provided to the participants an excellent opportunity for getting recent advances in the field of astronomy and related subjects. An interaction session was also held with the Secretary, Science and Technology Shri M.L. Arrawatia. He has informed that construction of 8 meter dia planetarium will be taken up shortly at the Sikkim Science Center. The National Council of Science Museum, Government of India is helping us for setting up of the Planetarium at Sikkim Science Centre. He has also explained that overall objective of such workshop is to promote activity based learning for promoting scientific and technological temperament among the younger generation in the state. As a follow up of the training workshop nearly 150 science clubs will be made operational with the help of Vigyan Prasar in various schools of Sikkim. This will also facilitate the teachers and students to know about latest scientific development in various fields.

5. Training Workshop on Innovative Experiments in Physics held at Sikkim Science Center from 24th to 25th April 2010:

A Training Workshop on Innovative Experiments in Physics has been organized at Sikkim Science Centre. The workshop has been organized in joint collaboration with Vigyan Prasar which is an autonomous organization under the Department of Science & Technology, Government of India. The progrramme has been attended by science teachers and students from different schools from various of part of the state.

The resource persons for this workshop were Shri Man Mohan Singh Marwaha Prof. of Physics from Chandigarh and Shri R. Nath, Senior Scientist from Vigyan Prasar, Department of Science & Technology, Government of India. The objective of the workshop is to make the conceptual understanding of physics and physical phenomena through more interesting and enjoyable process by way of hands on approach. Vigyan Prasar and IIT, Kanpur has developed a series of such experiments. Such experiments and activities related to Fun with Physics may help in understanding the principles and concept in a lucid manner.

A CD comprising of about 70 such experiments has also given to each participant. The objective of this interactive CD is to illustrate and demonstrate a series of novel activities that may help enhance interest in physics amongst students and teachers. It is expected that students of class VIII to XII would be able to perform most of the experiments using commonly available objects/equipments. In addition to this a kit on Immergence of modern physics giving the details of fundamental discoveries from Classical Mechanics to Quantum Modern Physics has also been given to each participant.

6. Setting up of Sikkim Science Centre:

- The Sikkim Science Centre is one of the important facilities created for communication, popularization and outreach of Science and technology in the State. This Centre has been set up at Marchak, East Sikkim with the support of National Council of Science Museums, Government of India. It was inaugurated and dedicated to the people of Sikkim on 22nd February, 2008 by the Hon'ble Chief Minister of Sikkim.
- The Science Centre has a number of thematic galleries, outdoor science park and facilities for training and capacity building programme.
- Further extension of Sikkim Science Centre has also been taken up with the support of National Council of Science Museums, Government of India. This will include 8 meter diameter planetarium as well as thematic galleries on recent advances in science and learning science through fun, space & biotechnology gallery.

A Team of Engineers from NCSM has already visited the Sikkim Science Centre for marking layout on ground for the extension of Centre. The construction works for extension of centre has also started.

7. Hands on experiments and Demonstration in Physics as a part of National Science Day Celebration Programme:

As a part of National Science Day celebration 2012 the Sikkim State Council has conducted Demonstration and Experimentation in science (Physic) at Sikkim Science Centre. This activity is aimed to attract more students and general public to Sikkim Science Centre.

Further, demonstration and hands on experiment have helped students to understand the scientific principles and helped in creativity and innovative ideas.

The programme has also provided the opportunity to enhance student's knowledge and creativity with the support of the available infrastructure at Sikkim Science Centre.

Various resource persons conducted the programme. The programme was conducted among class IX students of various schools in batches.

8. Master Resource Person Resource Workshop on Understanding Weather and Climate

Rashtra Vigyan Pradyoghiki Sanchar Parishad (RVPSP), Department of Science & Technology, Government of India, New Delhi, has identified "Understanding of Climate and Weather" as worldwide concerns over issues of Global Warming and Climate Change. Recent phenomenon like global warming, depletion in ozone layer, forest, ground water, etc. are attributed to climate change. Rise in CFC in atmosphere, enhanced level of atmospheric pollution ; deforestation etc. directly or indirectly harm our environment and cause changes in the area specific climate and day to day weather. Some of these factors also directly or indirectly cause natural hazards like landslides, forest fires, floods, droughts and so on.

The programme is also supported by National Council of Science & Technology Communication, Dept. of Science & Technology, Govt. of India. Considering above stated concern The Sikkim State Council of Science & Technology as coordinating agency organized 3 days workshop on the subject to train State Resource Persons during September 6-8, 2010 at Sikkim Science Centre. The programme was attended by 31 teachers from various schools. The

programme comprised of lectures, demonstration and hands-on activity, etc. with the help of designed kits and experts from within the state.

The Director, Dr. K. Sitaram, Director, India Meteorological Department, GOI, Sikkim Unit was one of the Resource Person. Dr. Seetharam gave a power point presentation on perspective of climate change including the different types of classification on climate, various causes of Climate change and Impact of climate change in India He also discussed on various effect of climate change in a region or in a whole world.

Dr. M. Das, Scientist IMD, demonstrated the Weather Kit developed by Science Centre Gwalior, MP. Thereafter Dr. Bhoj Acharya, Lecturer, Zoology Department gave power point presentation on Food Webs, Food Chains and various natural cycles and their importance. A set of low cost kit was distributed to all the participants. Resource Person, Dr. M. Das demonstrated and made all the participant to learn the assembling, setting, observation and know how to take the reading and analysis and interpretation of data by understanding weather patterns with the help of the given kits. He also explained the recent trend in temperature and rainfall distribution in Gangtok. Dr. Ghanashyam Sharma, In charge, The Mountain Institute, Sikkim Unit gave power point presentation on role of pollution, fossil fuels, toxic wastewith regard to Global warming.

On the final day, a field trip to India Meteorological Department, Baluwakhani and Meteorological Observation Station at Raj Bhavan was organized. Dr. Das explained about how to study day to day weather condition, different types of clouds and the starting of monsoon and retardation of monsoon. Thereafter visit was taken to Weather station. Mr. Chettri and staffs of IMD showed different types of barometers, thermometer, rain gauge, wind vane- wind direction, theodometer, rate of evaporation tank, sun dial, etc. A film on climate change by Centre for Science & Environment was also shown.

9. State Level National Children Science Congress 2011

National Children Science Congress is the programme funded by National Council of Science & Technology Communication (NCSTC), DST, Govt. of India. The primary objective is to make a forum available to children of the age group of 10-17 years both from formal school system as well as from out of school to exhibit their creativity and innovative skills and more particularly their ability to solve a societal problem experience locally by using the method of science.

Resource Teachers Orientation Workshop was organized in July 4, 2011 at Sikkim Science Centre and attended by 41 Science Teachers from various schools of the state. The given theme for this year and 2011 is "Land Resources: Use for Prosperity, Save for Posterity "with six sub-theme based on focal theme. Mr. D. T. Bhutia, Sr. Scientific Officer, Sikkim State Council of Science & Technology and Dr. B. C. Kusre, Associate Professor, College of Agriculture Engineering & Post Harvest Technology, Marchak, Ranipool, Mr, Lalit Kumar Rai, Research Officer, G. B. Panth Institute of Environment & Himalayas, Pangthang, were the Master Resource Person during the Workshop.

The State Level 18th National Children Science Congress was organized by Sikkim State Council of Science & Technology in the month of October-November. Total of Fifteen Projects were selected from the entire four districts to present at State Level Children Science Congress. Four best project were selected viz. Akash Pradhan of Tashiding SSS, Pratima Tamang- Namchi Girls' SSS, Pratima Chettri-Temi SSS and Hee-Bermiok SSS to present at National Level Children Science Congress held at Jaipur, Rajasthan during December 27-31.

. Mrs. Usha Lachungpa, Sr. Research Officer, Forest Env. & WL Dept; Mr. L. K. Rai, Research Officer, G. B. Panth Env. & Himalaya, Pangthang, Mr. D.T.Bhutia, Sr. Scientific Officer

and Mr. D.G. Shrestha, Sr. Scientific Officer, Dr. B. C. Kusre, Associate professor, College of Agriculture Engineering & Post Harvest Technology were the judges during the programme.

State Level National Children Science Congress 2011 programme at Sikkim Science Centre, Marchak.

10. **Training programme on Low Cost Teaching Aids**

- The Sikkim State Council of Science & Technology in collaboration with Human Resource Development Department, Govt. of Sikkim and Sikkim Manipal Institute of Technology (SMIT) has successfully organized a two days training cum workshop on Low Cost Science Teaching Aid for Science Teachers of Sikkim on 12th & 13th January 2011 at SMIT, Majitar. The training was attended by 145 teachers representing various schools of the state. Dr. B.N. Das, Professor(Physics), Jadavpur University and Dr. A. Aryan, Professor (Chemistry) from Kolkata were the Resource Persons of the Programme.
- It was based on teaching the science on low cost experimentation, especially Physics and Chemistry. Theory along with practical demonstration on skill development for the low cost teaching science especially physics and chemistry was done separately by the resource persons. Methods to replace the costly chemicals with some minor locally available materials are also been taught during the training session. The main aim to organize this training to create interest in science and to inculcate the innovation among students especially those belonging to the schools located at very remote and far off from the established laboratories of the state.

Training programme on Low Cost Teaching Aids

11. **Environmental Information System (ENVIS) centre on Eco-tourism:**

The Ministry of Environment & Forests, Government of India has provided Environmental Information System (ENVIS) Centre on **Eco tourism theme for the whole country at Sikkim State Council of Science & Technology.** This Centre has taken up various activities for promotion of Eco-Tourism and also publishes ENVIS newsletter on Eco-Tourism regularly. A website www.scstsenvis.nic.in provides various information's on Eco-Tourism. The project is funded by the Ministry of Environment and Forests, Government of India. The Center is functioning since December 2000.

ENVIS is a decentralized system using the distributed network of data bases to ensure integration of national efforts in environmental information collection, storage, retrieval and dissemination to all concerned including policy planners, decision makers, research workers and the public.

The Objectives of the ENVIS Centre are as given below:

1. Long-term objectives:

- to build up a repository and dissemination centre in Environmental Science and Engineering.
- to gear up the modern technologies of acquisition, processing, storage, retrieval and dissemination of information of environmental nature; and
- to support and promote research, development and innovation in environmental information technology.

2. Short-term objectives:

- to provide national environmental information service relevant to present needs and capable of development to meet the future needs of the users, originators, processors and disseminators of information;
- to build up storage, retrieval and dissemination capabilities with the ultimate objectives of disseminating information speedily to the users;
- to promote, national and international cooperation and liaison for exchange of environment related information;
- to promote, support and assist education and personnel training programmes designed to enhance environmental information processing and utilisation capabilities;
- to promote exchange of information amongst developing countries.

3. The responsibilities of the ENVIS Centre on Ecotourism are:

- Establishment of linkages with all information sources, and creation of data bank on selected parameters in the subject area assigned.
- Identification of information gaps.
- Publish newsletters and Bulletins.
- Develop library facility and provide support to the focal point on the subject area.

Most importantly serve as interface for the users on the assigned subject.

Activity Report of the ENVIS Centre Sikkim on Ecotourism for 2011-2012:

1. Database on the parameters specified by the Ministry as Status of Eco-tourism, Flora and Fauna and Research and Literature has been worked upon and new information on these parameters updated regularly in our website www.scstsenvis.nic.in for proper dissemination.

2. Information also in the form of monthly news clippings collected from local and national dailies/internet/books and magazines, ecotourism events worldwide has been updated in the website with a linkage to their websites, case studies and articles on ecotourism and other issues pertaining to the ecotourism of the country.

3. Information pertaining to the tourism of the state is updated as and when available thus assisting the tourism of the state towards information dissemination on a national level.

4. The ENVIS homepage has been redesigned and made more dynamic with adding more photos on the photo gallery and bringing changes to make it more users friendly.

5. The Centre has brought out a newsletter addressing issues related to climate change and tourism and health tourism and also a compilation of abstracts from research papers on Ecotourism of India.

6. Important linkages to the tourism websites of the country and the state as well have been given in the ENVIS homepage.

7. The queries coming to the Centre in the form of emails, telephone, letters or personal visits has been effectively responded and books from the ENVIS library has been effectively made use of thus assisting the research workers, students and the general public in the area.

8. The infrastructure of the Centre has been upgraded rendering benefits on the usage of facilities to the visitors and various research papers on Eco-tourism have been collected for reference.

9. The Centre mainly focused on the village tourism and the tourism infrastructure in the national as well as state level during the year.

12. Setting up of Village Resource Centres in the State:

The Department of Science & Technology has taken up a joint collaboration project jointly with Indian Space Research Organization for setting up of Village Resource Centers (VRCs) which have the unique facility for societal application using satellite communication and remote sensing technology. The VRCs promote a need based single delivery system for the services in the areas of health care, education, agriculture, weather, environment disaster resilience and livelihood support to the rural population and empower them towards improvement of quality of life. 16 such centers have been established in various Block Administrative Centers and three Master Resource Centers have been set up at the Rural Management and Development Department, Sikkim Science Centre, Marchak as well as State Institute of Rural Development, Jorthang in South Sikkim. Numbers of training and awareness programmes have been conducted through VRC Network.

13. Construction of Technology Bhawan at Deorali, Gangtok:

For the development of Science & Technology in the State, construction of five storied building for Science & Technology Bhawan at Deorali, Gangtok with modern and state of the art facilities is in progress.

14. CANE/Rattan conservation and promotion of cane handicraft for sustainable livelihood.

1.) Under A DST, GOI funded project titled "*CANE/Rattan conservation and promotion of cane handicraft for sustainable livelihood*" under implementation completed the following activities:

(a.) Organised three days training to 35 participants from Dzongu representing NGOs, SHGs, Progressive farmers and artisans on propagation and value addition of Cane/Rattan at Hee-Gyathang, Dzongu w.e.f. 25-27 August,2011.

(b.) Conducted resource survey of cane and collected cane seeds of three different species viz. *Calamus acanthospathus, Calamus enermis* and *Plectocomia himaliaca* from Dzongu followed by collection of Cane species *Daemonorops jenkisiana* near Dikchu on the very same tour dated 3-7 January,2012 while *Calamus erectus* was collected from Sangkhola, Singtam.

(c.) Initiated Nursery development for propagation of Cane at Hee-Gyathang, Dzongu and Sajong, East Sikkim.

(d.) Initiated editing of data for publication of book titled "A Glimpse on the Fishes of Sikkim".

15. Mechanism for effective Coordination with the various Research Organizations:

In order to ensure continuous linkage, dissemination and outreach of technologies developed by various Research Institutions and Scientific Organizations located in Sikkim, for actual utilization of technologies by concerned user Departments for the benefit of people in the State, a High Level Coordination Committee under the Chairmanship of the Chief Secretary, Government of Sikkim is hereby constituted with the members from various research organizations, institutions and universities with the Secretary, Science & Technology and Climate Change as Member Secretary of the Committee.

Further, Secretary-Science & Technology and Climate Change has been nominated as a Nodal Officer to have interface with all the national S & T Departments on technology utilization related issues.

CLIMATE CHANGE INITIATIVES OF SIKKIM STATE COUNCIL OF SCIENCE & TECHNOLOGY (2009-1012)

Climate Change is one of the greatest challenges of our time. Various anthropogenic activities have caused rise in the atmospheric carbon dioxide and other green house gases resulting into global warming. Records of variability in temperature, rainfall and extreme weather events and rise in sea level provide collateral evidence of global climate change. The climate change has resulted in several changes in ecological, economic as well as social system.

Adaptation strategies are inevitable as both gradual climate change and extreme climate and monsoon events are expected to be more profound in future. The basic premise of any action on climate change , therefore, should now be to promote adaptive capacity in the context of concurrent provisioning for sustainable livelihoods of vulnerable populace and sustainable development. There is also a need for combining disaster reduction, natural resource management and climate change adaptation in a new approach to the reduction of vulnerability and poverty and enhancement of climate resilience.

With an objective of assess the current climate variability, climate change, impacts of climate change, vulnerability of food, water and forests sectors, and suggest an approach to identify vulnerable sections and regions and incorporate adaptation strategies and practices, various initiatives have been started by Council in collaboration with various R&D institutions, national and international agencies working in the area of climate change.

Programme regarding preparation of State Action Plan for Climate Change

The Government of India released a National Action Plan on Climate Change (NAPCC) in 2008. In order to realize the implementation of NAPCC, The Government of India gives highest priority for supporting preparation of State level Action Plans.

Sikkim has taken lead in the growing issues like Climate Change. Under the framework of National Action Plan on Climate Change, the State Government has taken up initiatives to develop the State Action Plan on Climate Change (SAPCC) which is being coordinated by Ministry of Environment and Forest, Government of India at the National Level.

Climate Change - Sikkim Context:

- Sikkim is a high altitude mountain state located in the NE (27° 04' 46" to 28° 07' 48" N latitudes and 88° 00' 58" and 88° 55' 25" E longitudes), just above the state of West Bengal in India bordered by Bhutan in the east, Tibet in the north and Nepal in the west.
- It has regions that extend from temperate, sub Alpine to Alpine thereby making it one of the richest biodiversity hotspots with diverse indigenous flora and fauna having high commercial value.
- Sikkim has its water resources from monsoon rain and snow melt.
- As per 2001 census, the total population is 0.54 million, of which around 70% of population is rural and is thriving on livelihoods linked to natural resources such as agriculture and forest products that are vulnerable to vagaries of climate.

Observed changes in Climate:

- Like in other developing countries, there is a lack of spatially disaggregated meteorological records. Long term, reliable data is available only for one station - Gangtok.
- Climate change related studies based on the analysis of the data for this station month-wise, season wise and annually from 1957 to 2005 indicates a trend towards warmer nights and cooler days, with increased rainfall except in winter.
- The temperature in Gangtok has been rising at the rate of 0.2 ^{0}C per decade and the annual rainfall is increasing at the rate of nearly 50 mm per decade
- Comparison of long term meteorological data available for Gangtok station (1957 to 2005) with the trend over the last few years (2006-09), shows an acceleration of these patterns, with winters becoming increasingly warmer and drier now Winter rains is decreasingly becoming scarce. During the year 2008 and 2009, the state witnessed one of the driest winters in living memory
- Extreme climate events have become more frequent e.g. Cyclone Aila in 2009

Climate Change Concerns:

Availability of adequate natural resources for sustaining livelihoods thereby climate proofing

- Water resources
- Agriculture and Livestock
- Forests and Wild life
- Ecosystem biodiversity
- Renewable energy resources
- Protecting the environment from drivers of climate change (mitigation actions)

Addressing CC concerns:

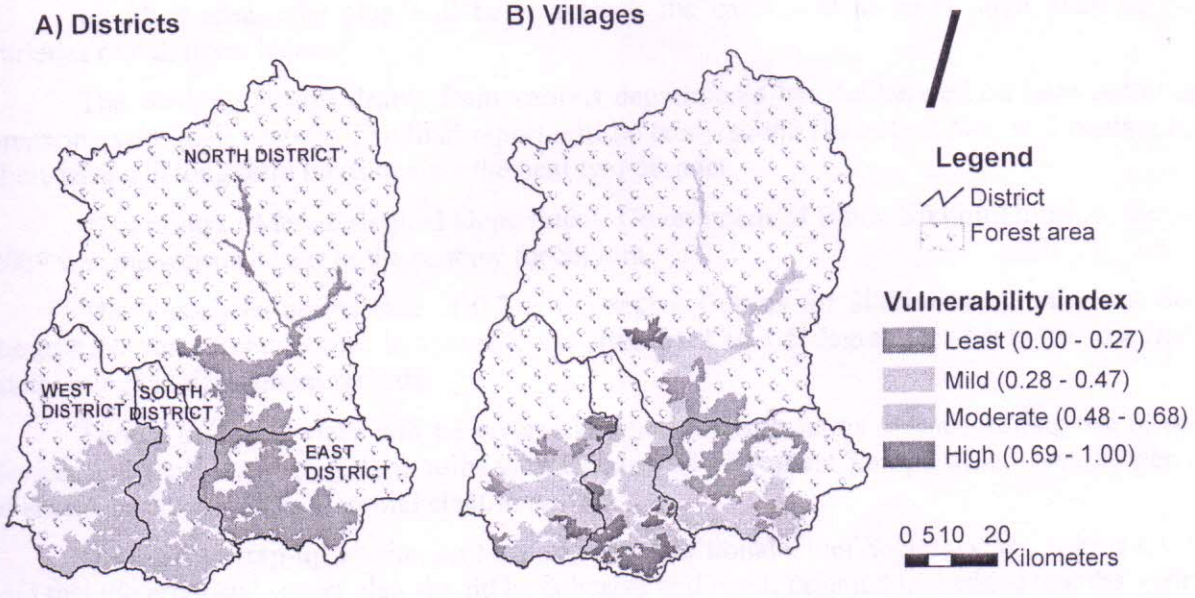
- Steps taken towards preparation of Sikkim State Climate Action Plan
- Focus on

- Water resources;
- Agriculture, horticulture, livestock;
- Forests, Wild life and biodiversity;
- Protection of environment through promotion of Renewable energy and climate friendly urban habitats.

Monitoring Framework:

14 Automatic Weather Stations functional as on 2012
Regular measurement of discharge of springs

Identification of climate-related vulnerabilities of rural communities of Sikkim, India



Towards Sikkim CC Action Plan:

- The Focal point, climate change has formulated working groups on the areas of concern in the CC context with members from related departments, NGOs, educational institutions and the private sector
- Outline of sectoral papers formulated and being written with inputs from the members of the working groups and with other concerned parties wherever required
- The sectoral papers, in line with the framework for SAPCC provided by MoEF, focus on:

- identification of Sectoral concerns due to CC
- Formulation of strategies for climate proofing the concerns and prioritize
- Identification of actions to implement the strategies in the next 5, 10 and 15 years
- Assess the cost of the implementation of this action at today's prices

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Brain storming workshop for identifying thrust areas for Climate Change Action Plan:

A two-day meeting was held under the chairmanship of the Chief Secretary, Mr T.T. Dorji, IAS on May 14 during inaugural session and Additional Chief Secretary Karma Gyatso, IAS on May 15, 2010 during wrap up session respectively for preparation of a State-level action plan on climate change with support from German Technical Cooperation (GTZ).

Eight thrust areas have also been identified for preparation of the State action plan for climate changes are forests, wildlife, eco-tourism, energy efficiency, urban habitats, water resources and communities vulnerable to climate change at gram panchayat level.

Water resources are being top priority for both urban and rural areas keeping in view of the vagaries of nature which has already seen reduction of winter rainfall to sizeable extent. This has affected many of our natural springs in rural areas. The action plan will give top priority to water resources in both urban and rural areas and those areas vulnerable to climate change up to gram panchayat levels.

For conserving the water resources, the action plan will include identification of water recharge zones and take measures for recharging the water resources by plantation and rain water harvesting, he said.

In urban areas, the plan will be to restock the catchment areas through planting local varieties of oak trees, he said.

The working groups drawn from various departments has deliberated on each sector and preparing with their reports. The final report will be ready soon. The action plan will contain both short-term and long term measures for the next two decades.

According to Meteorological Department, Government of India, Sikkim Division, the year 2009 was the warmest year in the century for Sikkim.

There has been an increase of 0.2 to 0.3 degree Celsius for Sikkim every ten years. So in the past 50 years, temperature in Gangtok has risen by 1 to 1.5 degree Celsius as per the Indian Meteorological department records.

Energy saving devices will be given additional focus in terms of encouraging use of solar devices and replace existing light bulbs with Condensed Florescent Lamps which save 80 percent of energy as compared to a normal electricity bulb.

During the wrap-up session on May 15, The Additional Chief Secretary Mr. Karma Gyatso said that the proposed action plan should be cohesive and result oriented and added that the various working groups should come out with innovative ideas and alternative solutions for taking appropriate measures for climate change adaptation and mitigation. Sikkim Government in the past two decades has taken several exemplary measures to protect ecology in the Himalayan State. The action plan will further strengthen our steps towards environment protection.

The State Government has already initiated various measures for protection and preservation of environment and sustainable development and said that the State government will give very high priority for climate change adaptation and mitigation programmes.

Ms. Verra Soltz, Project Director, Natural Resources Management and her team from German Technical Cooperation (GTZ) have assured of technical support regarding capacity building and training of the various working group members and also assured for providing services of experts and consultants to the working groups.

She has also said that the German Development Bank is already in touch with DONER Ministry to take up the pilot projects for the Northeastern region on the pilot basis. As a follow up

of the workshop the GTZ is helping in capacity building to our working groups and also providing consultants for preparation of action plan.

GTZ is supporting Sikkim in the preparation of state action plans that are aligned to the NAPCC using in-depth sectoral analysis as the building blocks.

CK.Rao Intercooperation, H.No.153/A/4 Sappers Lane, Balamrai, Secunderabad and his team, *Srinivas Krishnaswamy, CEO, Vasudha Foundation, 14 Jungpura B, Mathura Road, New Delhi and his team and* Dr. Himanshu Kulkarni Executive Director Advanced Center for Water Resources Development ... Management (ACWADAM) Plot 4 Lenyadri society, , Pune-411021 and his team

have been appointed as a consultant with by GTZ under its programme on Climate Change Adaptation in Rural Areas of India to assists the State Government for preparation of Climate change action plan.

Processes followed in facilitating the preparation of the Energy Component of the Sikkim State Climate Action Plan

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The Consultants, Mr Srinivas Krishnaswamy and his team comprising of Mr. Soumya Tripathy, Ms. Jarra Hicks and Mr. Nilesh Ekka (Initial period), all from Vasudha Foundation was contracted by GTZ to facilitate the preparation of the Energy Component of the Sikkim State Climate Action Plan and to work in close coordination with the Energy Working Group formed with representatives of the various nodal departments of Sikkim Government to ensure the final outcome of a comprehensive plan for the energy sector.

The working group consisted of members from the Department of Power, Sikkim Renewable Energy Development Agency (SREDA), Urban Development and Housing Department (UDHD) and Transport Department, with consultative roles for the Buildings Department, IT Department, Rural Development Department and the Forest Department.

The consultants made a total of 4 trips between the period of September 2010 and February 2011 and organized two workshops or group sessions along with detailed discussions with representatives and secretaries of the various above-mentioned departments. All official documents pertaining to data and information such as annual reports and vision documents of the concerned departments were studied.

The two workshops organized were:

a) Understanding the National Action Plan on Climate Change and linking National Policies and Programmes, relevant to the departments, titled "Training Workshop on Understanding Climate Change". This workshop had sessions on "science of climate change", "national action plan on Climate Change", "Overview of Policies and Programmes of the Central Government" relevant to the concerned Departments. This workshop was organized on the 27th and 28th January and the Energy group met once again to understand these issues in smaller group on the 29th January 2011.

The participants were also given a detailed framework on coming up with Action Plans and strategies for the sector and the consultants helped them in analyzing current situation concerning the various sectors and also on policy formulations.

As one of the outputs of the workshop, the various departments came up with a draft sector paper which was put in the perspective along with the consultants. The draft sectoral papers have been prepared for Power and Renewable Energy Sector, Transport Sector, Urban Development Sector and cross cutting issues on rural development, forestry, irrigation and tourism sectors.

b) "Brain Storming Workshop for finalization of the Sector Plans"

On the 17th February 2011, the energy group got together once again for a "Brain Storming and training workshop for finalization of the sector plans, where the "draft sector papers' were discussed in detail, gaps identified and the draft plans were also linked to national plans, programmes and policies. A detailed budget was also prepared.

Further, a road map for next steps with time lines was arrived at collectively by the group and it has been decided that the "draft sector papers" will now be finalized and submitted by the 27th February 2011 by all the departments as final documents and also keep ready presentations to be made before the key concerned officials for final approval.

Training programme for the members of working groups for preparation of State Action Plan on Climate Change:

The Department of Science and Technology & Climate Change, Government of Sikkim with technical support from German Technical Cooperation (GTZ) organized a three day programme on 27th, 28th & 29th January 2011 at the conference hall of Krishi Bhawan.

The program was attended by the members of the working group on Climate Change and officers from line departments like Agriculture, Horticulture, Animal Husbandry, Forest, UD&HD, Buildings, RMDD and Transport. The programme started with the inaugural address by the Secretary, DST & CC, Government of Sikkim who updated the house regarding progress of the State Action Plan.

The programme focused on the key sectors like Agriculture, Horticulture, Animal Husbandry, Forest and Water. Dr. C.K Rao from Inter-cooperation, Hyderabad introduced the three day program along with its key objective which was followed by the presentation on Science of Climate both at the global and local level. There was a presentation from another expert highlighting details of the National Action Plan (NAPCC) and proposed framework for the State Action Plan on Climate Change (SAPCC). Dr. Sandeep Tambe, IFS, Special Secretary, RMDD presented on the rural water security and also spoke on the Dhara Vikash concept as one of the major spring revival program in the State. He also shared the findings of the Climate Change Vulnerability Assessment which has been done at the Gram Panchayat Unit along with PRA in selected agro climatic village. This was then followed by a presentation on the Climate Change impact on Crops, Impacts on Livestock and Community perception of Climate Change Vulnerability, coping mechanism and their adaptive capacities.

On the second day the members of the working group provided their inputs to the sectoral paper and also prepared a draft Action Plan of the respective department. The sectoral paper of Forest sector was shared with the PCCF cum Secretary by the forestry working group at his chamber in the presence of the Secretary, DST, senior officials and consultants.

Similarly on 29th January 2011, Animal Husbandry and Agriculture, Horticulture department shared their draft action plan with their Secretary at the Krishi Bhawan Conference hall between his senior officials and consultants. In the post noon the draft sectoral paper and the action

plan of RMDD was presented at the RMDD conference hall. The draft sectoral paper and the draft action plan is expected to be finalized shortly which will further be refined and finalized with inputs for the Sikkim State Action Plan on Climate Change (SAPCC).

Climate Change Adaptation Project in Sikkim under the frame work of Indo-German Development Cooperation:

Since Sikkim State Government has taken pro active role on various issues related to Climate Change, the Government has approved Climate Change Adaptation Project in Sikkim under the framework of Indo-German Development Cooperation.

Some of the thrust areas where support could be taken up through this project are:

- Training, Awareness and Skill Development and Capacity Building as well as appropriate technology transfer related to Climate Change Adaptation programme. A Training and Skill Development Center could be set up with the help of this programme.
- Spring water recharge and rain water harvesting programmes in dry belt of Sikkim with the technological input.
- Vulnerability analysis both sectoral as well as on geographical pattern for identification most vulnerable areas due to climate change in Sikkim.
- Identification of best practices and replication on pilot basis for climate change adaptation programmes.
- Taking the pilot programmes on cardamom rejuvenation and ginger with technological input under climate change adaptation programme.
- Identification of indigenous crop varieties which are more resilient to climate change and its propagation on pilot demonstration.
- The pilot demonstration programmes for fuel wood and energy saving devices such as solar water heater, solar lighting system in temperate and alpine areas.

The proposed project will be mainly for reducing the adverse effect of the climate change by undertaking climate change adaptation field programmes in the areas of water security in rural areas, rural livelihood and income generation programmes through sustainable development and management of Natural Resources mainly in the field of Horticulture, Agriculture and Forestry. Through the project, awareness and capacity building programmes of rural people will also be taken.

In the last Indo German Negotiation held in 2009, the German Government has committed EUR 76 million (approx. Rs. 500 crores) for climate change adaptation programmes for North Eastern States including Sikkim. The proposed project as of now will be implemented in Sikkim, Meghalaya, Assam, Manipur and Nagaland. **Detailed mechanism for implementation of the project and preparation of detailed project report (DPR) will be taken up shortly through consultants identified by KFW and the Ministry of DoNER.**

Visit of Gtz appraisal mission to Sikkim during September 2010 for Technical Cooperation Programme between the Governments of India and Germany Climate Change Adaptation (CCA) Programme in the North Eastern Region –

An Appraisal mission for the programme has visited Sikkim in first week of September 2010.

Members of the appraisal mission were:

- Dr. Hans Helmrich (Consultant, team leader),
- Mr. Christoph Feldkötter, GTZ Headquarters, Planning and Development, Task Force for Climate Change,
- Dr. Neeraj Khera, Programme Coordinator for South Asia Regional Office of InWEnt, based in Delhi,
- Mr. Farhad Vania, Team Leader of a TC Programme on Support to Local Government in Himachal Pradesh,
- Mr. Satyan Chauhan, Technical Expert for GTZ, NRM India.

The Appraisal Mission held detailed discussions with officers of the various departments and also met the Chief Secretary of the Government of Sikkim.

The experts' team of the German Agency of Technical Cooperation Appraisal Mission on Climate Change Adaptation in the North Eastern region also met Sikkim Chief Minister Dr. Pawan Kumar Chamling. The team led by Hans Helmrich, expressed happiness over the awareness among the people of the state about the problem of climate change and the efforts made by the government to address the issue. The team also praised the Chief Minister for the efforts initiated by the government to protect the environment in the Himalayan state. The German Mission will be working with five NE states and giving technical support to Sikkim. The Chief Minister expressed his concern over climate change and global warming and asked the team to provide technical and expert support to the state and assured them of cooperation. State Minister for Science and Technology Bhim Dhungel also met the team.

Broad Areas of the technical co-operation with GTZ.

The project will deliver outputs in the following areas

1. Development, operationalisation and monitoring of the State Action Plan on CC
2. Promoting climate change adapted value chains
3. Creating awareness on climate change

This will include in the field:

- Long term on-site expertise
- Subject matter technical expertise as required
- Needs-based studies
- Facilitation to multi-stakeholder fora
- Workshops and training courses
- Selected demonstration pilots
- Exposure visits

Support for State Action Plan on Climate Change:

- Ensure that the State Action Plan is reflected in sectoral policies and missions
- Operationalise State Action Plan through mainstreaming climate change in selected centrally and state sponsored schemes and departmental operations
- Operationalise State Action Plan through attaching need-based technical expertise to implementation.
- Monitor implementation of the State Action Plan along agreed milestones
- Review implementation annually and adjust State Action Plan

Climate Change Adapted Value Chains:

- Establish fora of key value chain actors and supporters (from private sector and government)
- Select value chains that are (a) economically important, (b) pro-poor and (c) potentially adaptable to climate change and at risk due to climate change
- Analyse markets, technologies, actors, supporters
- Design interventions to e.g.: (a) connect producers with buyers, (b) promote appropriate technology, (c) select appropriate varieties, (d) enable producers to access finance, (e) connect actors to service providers …
- Support village clusters to plan for value chain promotion
- Monitor impact of value chain development on rural resilience to climate change

Awareness on Climate Change:

- Develop packages that address conceptual understanding of (a) climate change, its interlinkages with human communities and natural ecosystems, (b) biodiversity and traditional knowledge, etc
- Develop packages that present technical solutions for e.g. (a) watershed management, (b) natural springs conservation, (c) use of climate data and forecasts, etc
- Deliver training packages through e.g. (a) trainings, (b) workshops, (c) group discussions, (d) exposure visits, (e) multi-stakeholder dialogue forums

Knowledge Management

Knowledge management would include State specific programmes and regional programme packages. It is expected that each of the States (Sikkim, Nagaland, Meghalaya) would champion one or more particular topics relevant for regional Knowledge management.

Long-term, overarching, development-policy impact

Rural households in the North East Region will in turn use the services provided by these intermediary actors to adjust their farming strategies and diversify their income sources, thereby enhancing their livelihood resilience and adaptive capacity to the impacts of climate variability and change. This in turn will provide them with a larger number of options to adapt to climate change.

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Visit of KfW appraisal mission to Sikkim from 29 September to 2 October 2010 for Financial Cooperation Programme under Development Cooperation between the Governments of India and Germany Climate Change Adaptation (CCA) Programme in the North Eastern Region

A KfW mission comprising of Dr. Marcus Stewen, Senior Project Manager, Mr. Guenther Haase, Technical Expert, and Mr. Nand Kishor Agrawal, Project Manager (all from KfW Development Bank) visited Sikkim from 29 September – 02 October 2010 in order to appraise the feasibility of a CCA project in Sikkim as part of the Climate Change Adaptation (CCA) Programme in the North Eastern Region within the Development Cooperation between the Governments of India and Germany (Financial Cooperation [FC] Programme), and to discuss the institutional structure with the stakeholders in the state.

The mission discussed the Project with senior policy makers including the Chief Secretary, Mr. T.T. Dorji, the Additional Chief Secretary, Mr. Karma Gyatso, the Sikkim State Council for Climate Change (SSCCC) and heads of various involved line departments and their respective project teams.

The mission was appraised of potential climate change adaptation sub-projects for implementation within the framework of the FC Programme. The mission also visited Aho Yangtam village in Eastern District, and discussed observed climate changes, their impact on livelihood systems and possible coping strategies with the village communities.

During the mission, different proposed measures have been discussed. The discussions revealed that for the following measures the CCA linkage is evident:

- Springshed Development (100 springs proposed)
- Watershed development;
- Water resource development activities;
- Small water harvesting structures in water and erosion stressed areas;
- Rain water harvesting structures for improved domestic water supply;
- Promotion of climate change resistant crops and climate proofing of traditional crops;
- Securing and diversifying income sources and developing market linkages up to max. 15% of total investments.

In the villages where World Bank is supporting livelihood activities, FC funds shall not finance income diversification.

In addition, suitable technological interventions (investments) related to climate change adaptation (including early warning systems) will be explored.

For the other proposed measures, the CCA focus has to be established more strongly. Additionally, all proposals have to be strengthened in respect to technical and financial feasibility and sustainable operation. The mission further informed that the coverage of operational costs and of staff costs for government bodies / institutions is not permissible according to KfW regulations. This should be reflected during the fine-tuning of proposals.

During the mission, the issue of stand-alone projects (Oak plantations/restoration as integral part of watershed activities (overlap with JICA to be avoided); lake rehabilitation) was also discussed. The mission recommends considering this issue under the project only subject to a very clear CCA justifiable proposal.

Summary of progress for preparation of Project Design Document for submission to Kfw, Germany.

- Goal: Strengthen adaptive capacities of the target (rural) communities and reduce their vulnerability to climate change through sustainable Climate Change Adaptation (CCA) measures.
- Objectives:
  - Develop and implement an integrated and participatory community-based process for planning and implementation of sustainable CCA measures.
  - Improve the natural resource base to reduce vulnerabilities associated with water scarcity and agriculture-based livelihood in selected clusters
  - Improve livelihood security through climate proof, diversified agriculture and improved marketing infrastructure for farm products. .
  - Improve capacities for planning and implementation of CCA measures through capacity building and knowledge management.
- Detailed Planning & Project Design Document Drafting
  - Core Team Meetings (4)
  - Cluster level Stakeholder Consultations (2)
  - GPU level Community Consultations (4)
  - District Consultation Meetings (2)
  - Department level meetings to refine investment proposals wrt Climate Change Adaptation focus and design (15)
  - Collection and analysis of secondary data on clusters, proposed investments, and on-going development programmes.
- Programme Area: 5 States (Sikkim, Meghalaya, Assam, Mizoram, Nagaland)
- Total Financial Cooperation (FC): Euro 76 million (INR 456 Crore)
- Initial FC Commitment for State: Euro 5 million (INR 30 Crore)
- Programme Duration: 7 years
- Nodal Agency: Ministry of DONER (Central); Sikkim Council for Science & Technology FC by KfW supported with additional investment through Technical Cooperation (GIZ)
- Focus on sectors, regions and target groups which are most vulnerable to climate change
- Mixed Portfolio: Micro-plan based Interventions as well as Stand-alone Investments; CCA-proofed topping-up of ongoing government programmes
- Stakeholder Contribution: GoS – 15%, GoI / DoNER – 10%, Beneficiaries (5-30%)

PROJECT CLUSTER PROFILE

	Cluster 1: Seti-Kannam Khola	Cluster 2: Reshi Khola	Cluster 3: Tendong	Total
District	South	West	South	
Block	**Namthang**	**Kaluk**	**Namchi**	
No. of GPU	3	4	8	**15**
No. of Wards	21	22	45	**87**
No. of HH	1439	1921	6294	**9654**
% BPL	30%	36%	17%	**23%**
Area (ha.)	4279	4199	6445	**14923**
% Farm Land	41%	69%	71%	**62%**
% Culturable Waste	22%	22%	31%	**26%**
% of Population dependent on farming	65%	64%	46%	**53%**

I. 2X100 KW Microhydel project, Thangu

The Department of Science and Technology, GoI sanctioned a demonstration project at Thangu North Sikkim. The revised sanction has been obtained during the October 2010. There has been great delay in completion of the project. Despite the delay, efforts have been made to complete the project within the stipulated time frame of October 2012.