

**STATE REMOTE SENSING
APPLICATION CENTRE**

REMOTE SENSING CENTRE

The Sikkim State Remote Sensing Applications Centre has started with the Department of Science and Technology in the year 1996. At present, the Centre has Seven Workstations and two PC along with 5Kv UPS. The Centre has one photogrammetry LPS-11, two Arc Info-10 and one ERDAS-9 software. The Centre also has A0 size plotter and A0 Size Scanner.

The SSRSAC has trained manpower in the field of Remote Sensing and GIS. The Centre has provided training to the Student of Sikkim Government College, Harkamaya college in the field of RS and GIS. The centre has been undertaking various project funded by Central Government as well as State Government. The Centre also provides the necessary data to the user department for various developmental activities in the state.

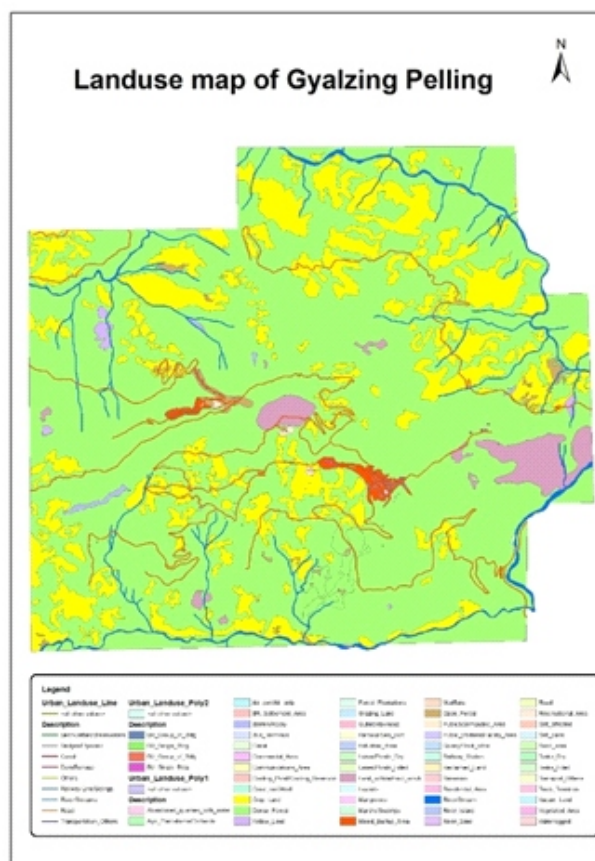
On Going Project

1. NUIS (National Urban Information System)

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 creation of database of towns Sikkim state on various themes using remote sensing and GIS has been done.

For Sikkim state 10 towns were identified, for different thematic mapping, namely, Pakyong, Rabong, Rangpo, Singtam, Mangan, Jorethang, Rongli, Geyzing-Pelling, Soreng and Namchi.

Finding: The required thematic layers (Landuse landcover, Soil, Geology, Structure, Physiography, Geomorphology, Lithology, Drainage, Road, administration boundary, etc) under NUIS project has been prepared and submitted to the North East Space Applications Centre, Shillong for further submission to the Ministry of Urban Development Government of India.



2. SIS-DP (Spatial Information Support System for Decentralization Planning)

The Space Based Information Support for Decentralized Planning project started in Sikkim from July 2011. The main objective of the project is mapping of various thematic layers of Sikkim in 1:10,000 scale for decentralized planning.

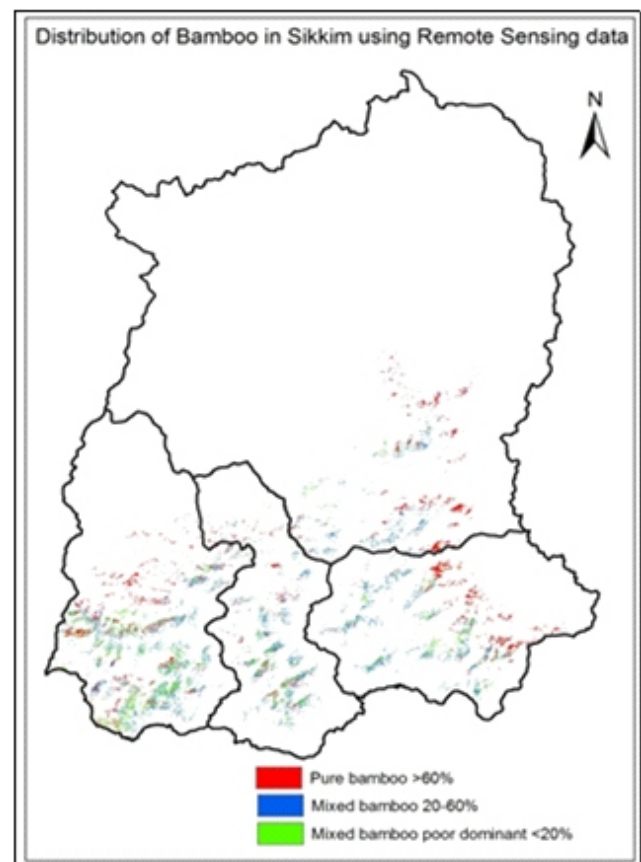
(SOI) sheet will cover the entire district of Sikkim in which 14 number of sheet are active sheets. The quality checking of the work has been done in National Remote Sensing Centre (NRSC) Hyderabad in December 2012. Further, quality checking of the work is carried out by NESAC scientist in March 2013. So far we have completed the generation of the layers for this project. The final Ground water prospect mapping will be completed by the end of next month.

The water quality testing is an important part of this project. The water quality testing of few different drinking water sources of all the district of Sikkim has also been undertaken. The testing was carried in both pre-monsoon period and post monsoon period. In Pre-monsoon period the testing was done in the month of May-June 2012 and in the month of September-November 2012 in post monsoon period.

4. Identification of Bamboos in Sikkim Using RS and GIS Technique

The Bamboos are classified into three categories depending on its coverage. Pure bamboo (bamboo covers more than 60%), Mixed Bamboo (Bamboo covers in between 30-60%) and Mixed Bamboo poor dominant (Bamboo cover less than 30%). Depending upon the Culm diameter pure bamboo is further divided into three groups. Small Bamboo with Culm diameter less than equal to 10 cm, Medium Bamboo with Culm Diameter 10-20 cm and Great Bamboo with Culm diameter greater than 20 cm. The area of bamboo available in the forest and non-forest areas of Sikkim is estimated through remote sensing technique and field visits. Multi- spectral images from IRS P6 with 23.5 m resolution was used for mapping the areal extent of bamboos in Sikkim. However, the species wise differentiation on the available dataset was not possible.

The West district has the maximum bamboo coverage, 14.41% of total geographical area of Sikkim. Most of the bamboo in this district are in south-west regions including Hilley and Barsey. This is followed by East district where bamboo coverage is about 8.76% of total geographical area, bamboo covers center and southern region of this district. The South district comes third with bamboo coverage about 8.37% of the total



geographical area and North district rank forth in terms of bamboo availability with the coverage about 1.42% of total geographical area.

Area wise the West district has 9856.4 ha. East district has 5592.27 ha. South district has 3651.9 ha and North district has 2395.64 ha of bamboo covered area Bamboo in the state are generally used only for domestic and social uses.



5. Land Use Land Cover 2nd Cycle

The Land use classification for 2nd cycle has been simplified from 79 classes to 54 classes based on the experience gained in 1st cycle of mapping. Onscreen visual interpretation technique is being used for land use mapping. The LISS III imagery of 2011-12 is being used for LULC classification and change detection over the previous cycle data. The LULC codes designed as per the manual will be used for codification of polygons and ground verification will be carried out for the areas where changes are observed. The finalization of the database is subject to quality assessment both at internal and external levels.

Objectives:

- To generate spatial database on land use / land cover for 2011-12

- To generate land use / land cover change database along with change matrix with respect to 2005-06 and
- To identify areas of major change.

End benefit to user

The potential users of LULC database include the, State Planning departments, Ministry of Rural Development, Environment and Forests, Earth Sciences, Central Water Commissions, Urban Development etc. Besides, it is also useful for various scientific research programmes like climate change studies, weather forecasting, growth trend analysis etc.

Finding: The change interpretation of north district and East District has been completed and submitted for final quality check to NRSC Hyderabad, and the change interpretation of other district is under progress.



Fig. 1- Agriculture Land with Tree Clad Area



Fig. 2- Agricultural land to Build Up and Scrub Land

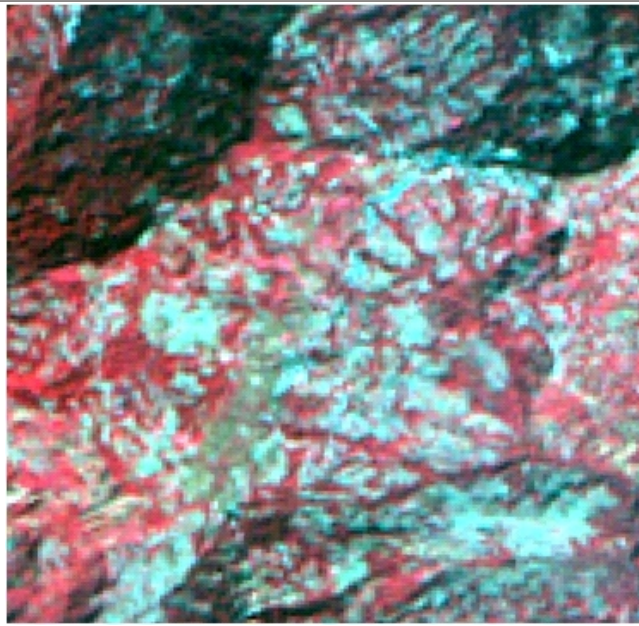


Fig. 3- Pakyong Airport area in IRS LISS III 2006

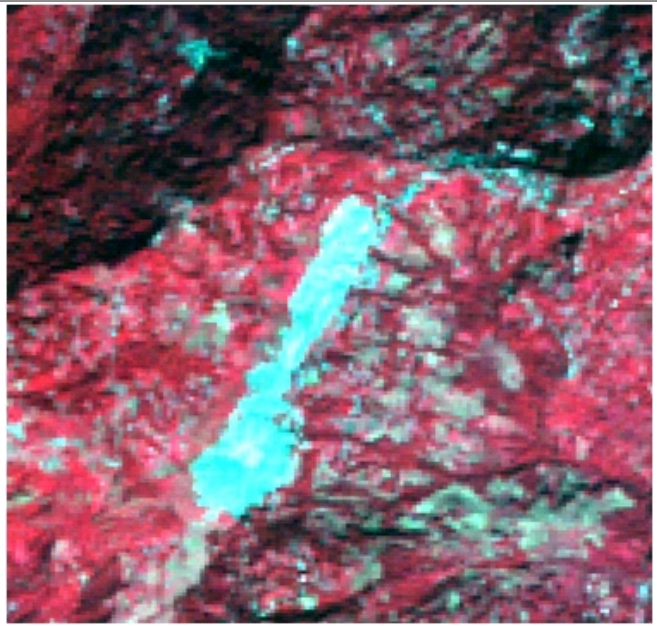


Fig. 4- - Pakyong Airport area in IRS P6 2011

6. Study of Glacier Dynamic of East Rathong Glacier of Sikkim Himalayas

The World has witnessed increase in global temperature with the dawn of industrial revolution in the twentieth 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.

The 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 forms 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

great importance in the present scenario.

Sikkim being a Himalayan state of India, is one of the glacier rich areas of India and the world. It has 84 glaciers feeding two mighty glacial river system including Tista and Rangit river basin with numerous streams. Likewise in other glaciers, the glacier of Sikkim is 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 the Department of Science and Technology, Government of India and with technical collaboration of the national experts in Glaciology, is undertaking the study of glacier dynamic of East Rathong Glacier of Sikkim Himalayas.

East Rathong Glacier, (Lat $27^{\circ} 34'E$ to $27^{\circ} 33'E$ and Long $88^{\circ}07'E$ to $88^{\circ}10'N$) located in the West Sikkim covers a basin area of 35.95 sq.km and total ice cover area of 8.49 sq.km. 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 in its phase wise studies:

- 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: glacier 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 cover monitoring of Sikkim Himalayas using AWiFS data.
- Snow ice physics: study of old/fresh snow, firm, 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.



In the month of October 2012 our team visited the East Rathong Glacier and fixed 13 stake in different elevation to study the glacier velocity of ERG. The team is expected to make such visits frequently to monitor the same.

7. Mapping of Glacier Lakes and development of GIS based Glacier Lake Management Information System (GLAMINFORS) for the State of Sikkim



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. The Sikkim State Council of Science and Technology is currently engaged in monitoring of glaciers and glacier lakes of Sikkim. Jointly with

the Centre for Developing Advanced Computing (CDAC), Pune **Glacier Lake Management and Information System** for the state of Sikkim is being prepared. The information would 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) etc.

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 tasks has been accomplished;

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.
4. Intensive field data collection required for the project work.
5. Development of Sensor for its installation at vulnerable lakes by CDAC.

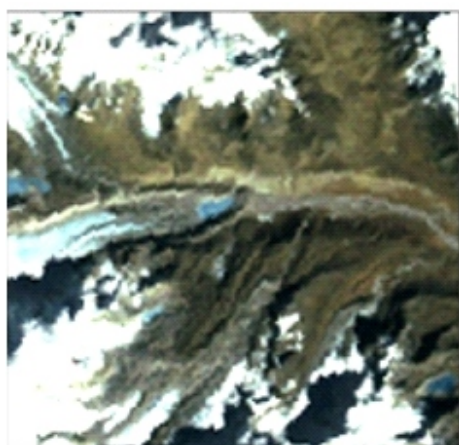


Figure 1. Lhonak lake (1976)

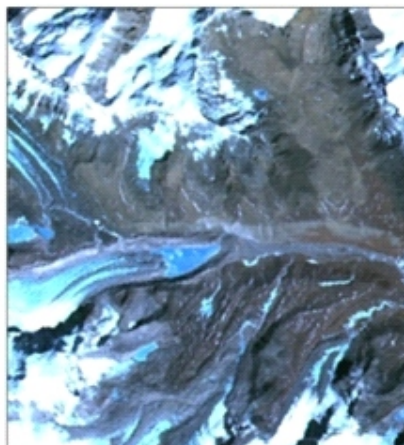


Figure 2. Lhonak Lake (1997)



Figure 3. Lhonak Lake (2011)



Findings:

Based on the study using the time series satellite data and field visits there are 25 glacial

lakes of Sikkim identified as the vulnerable lakes, out of which 8 glacial lake are identified as potential Hazardous lakes.

Sl. No	Potential Hazardous lakes
1	Lhonak Lake
2	Lake above the Lhasa Valley above Thangu village
3	Teesta Khangsey (Khangchung chho):
4	Unknown lake in West Sikkim
5	(Dod Pokhari): East Rathong Glacier
6	Gurudogmar Lake
7	Cholamu lake
8	Lake on North west of Lhonak valley

The immediate detailed study of these lakes is required and it is recommended to install the automatic sensor of the GLOF in these lakes

The Central Water Commission, Government of India has been communicated for regular monitoring of these lakes with the high resolution satellite data. A working group under the Chairmanship of Director, Snow and Avalanche Studies Establishment (SASE) Chandigarh has been constituted by DST, GoI. Field investigation by the experts is being planned for September 2013.

8. Programme on Climate change research in Terrestrial environment (PRACRITI):

The project has the following main objectives:

- Development of Models to access 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 extent of selected glaciers of Tista basin using Remote sensing data and snout validation.

The work elements identified for the state RS Centre:

- Extraction of snow line altitude for 2005-2010 using 10 daily snow cover products.
- Collection of meteorological data and discharge data
- Validation of snout and ELA.
- Updation of the extent of selected glaciers of

Tista Basin using RS data.

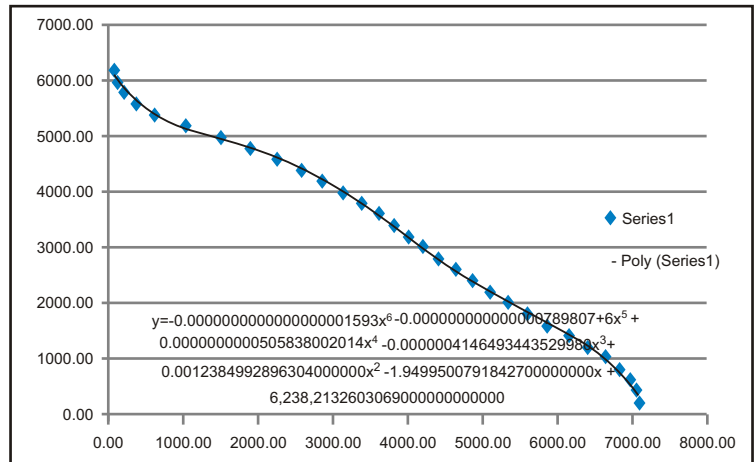
- Mapping and change detection of water spread of moraine dammed lakes using landsat Data.
- Development of model and report preparation.

Progress of the work

Generation of Regression Equations Models for Snow Line Altitude (SLA) for Tista and Rangit basins:

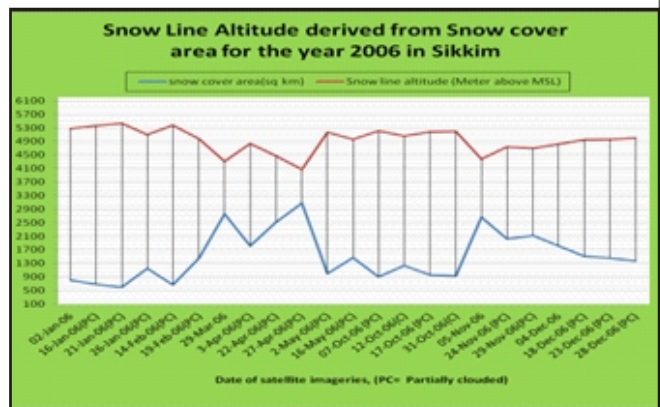
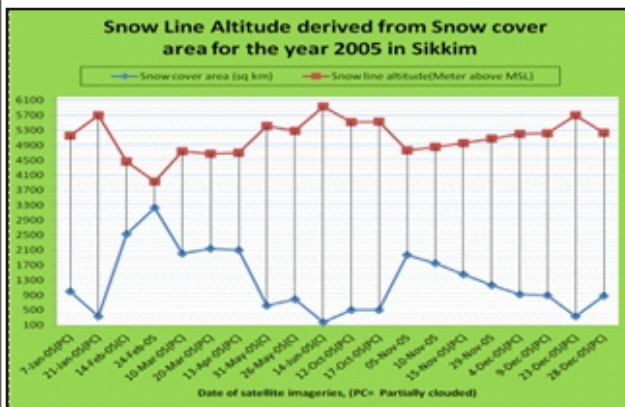
The regression equations for the both Tista and Rangit basins have been generated for the calculation of snow line altitude. For this, contour generation at the interval of 200m from ASTER DEM using ERDAS Software has been done. The error visible on the contour interval is rectified and generated the 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.

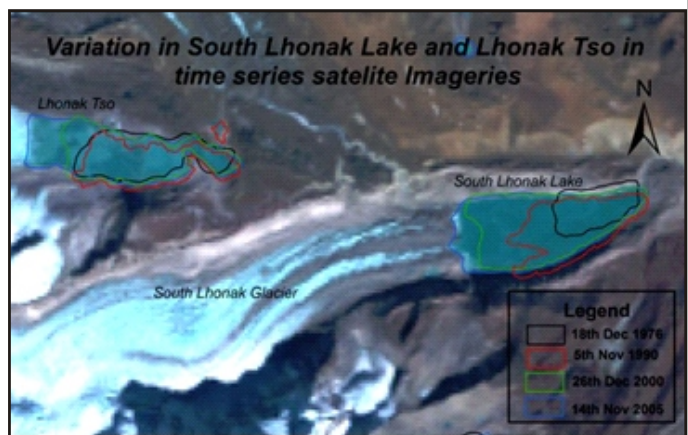
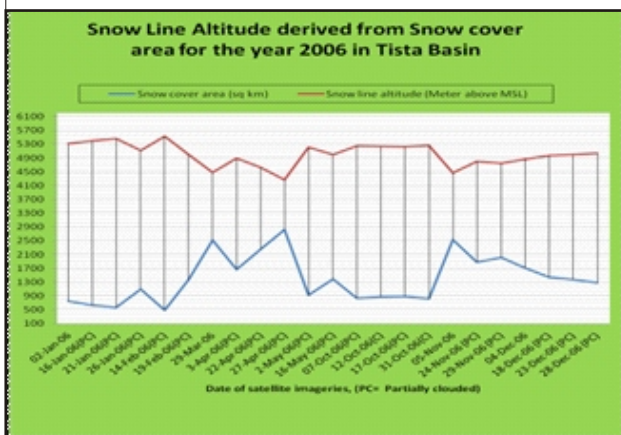
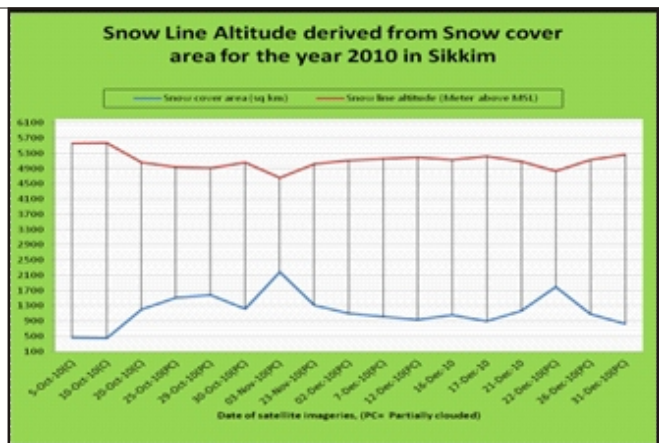
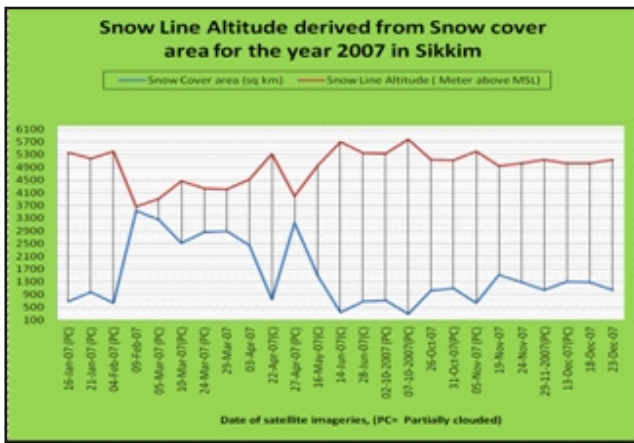
With the help of regression equations, the calculations of snow line altitude have been going on for both Tista and Rangit basins from 2005 to



Regression Equation for Tista Basin

2010. Since, there is a data gap between May 2008 to Oct 2010, SAC is exploring to make these data available for further classification. For the correlation of meteorological data with SLA, the IMD 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.

Conclusion of the project

Using time series satellite data, the present study would be a great source of information in terms of change detection in the area of Glaciers and glacial lakes/ moraine dammed lakes. The study will provide the valuable information on the role of temperature when correlating with snow line altitude.

10. Snow monitoring of Sikkim Himalayas (Phase-II)

The 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. The 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 to Sikkim, the snow monitoring work is being carried out jointly with the Space Applications Centre (SAC), Ahmedabad from the year 2004-2005 onwards considering Tista and Rangit basin. At present the project is in its second phase. In its first phase snow monitoring of Sikkim has been completed upto the year 2007-2008. Remaining work for the year 2008-2009 and 2009-2010 is being carried out by SAC, Ahmedabad. The Snow monitoring of the year 2010-2011-2012 under second phase of project is being undertaken by the RS Centre.

Recently, the final Report for the year 2011-2012 has been submitted to SAC, Ahmedabad. It is observed that the maximum areal extent of 50% of total area of state in the month of March 2012 for Sikkim. The highest snow areal extent of 61% observed in Tista and 21% in Rangit basins, respectively in the same month. The lowest snow recorded in the month of September, October and December in 2011. In 2012, April and May are the months with least snow cover in Sikkim. In Tista basin, the least snow cover found in the same months.

Due to the unavailability of the cloud free images for the months of June to September the mapping of snow cover is possible only for the remaining months. The year wise snow cover atlas is being prepared on each monitoring dates of images. The snow monitoring for the year 2012-2013 would be started as soon as the data is



made available from SAC, Ahmadabad.

9. Thangu Microhydel project

The 2X100 KW microhydel project is being setup at Thangu village of North Sikkim. The project project work has resumed w.e.f May 2012. It is targeted to complete the project by August 2013.



Visit of Minister, Secretary DST at project site in August 2012.

11. Seismic Hazard and Risk Assessment of Darjeeling-Sikkim Himalaya (HRA)

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 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 Department of Science and Technology & Climate Change in collaboration with IIT Kharagpur have set up eight Seismic Monitoring Station in different part of Sikkim. The construction of Seismic Monitoring Station at Darjeeling and Siliguri is under progress.

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



Support to the user Agencies

- GPS data collection and mapping of the polling station of Sikkim for the Election Department.
- Post earthquake relief activities mapping for Land Revenue and Disaster Management Department.
- Catchment area mapping for various projects of Irrigation and Flood Control Department
- Hands on training on RS and GIS to the students of Sikkim University.