Annual Report 2010-11

Department of Science & Technology and Climate Change
Government of Sikkim, Gangtok
&
Sikkim State Council of Science and Technology
Development area ,Gangtok

Science & Technology Department in the State was created in the year 1996 mainly for generation of scientific awareness and for transfer of appropriate technologies for economic up-liftment of weaker sections of the society.

Keeping in view the importance of Science & Technology for overall development of the State and to provide sufficient autonomy for implementation of various scientific programmes, the Sikkim State Council of Science & Technology was also created.

The Department of Science & Technology through Sikkim State Council of Science & Technology has implemented various scientific programmes related to (i) Bio-Technology (Bioinformatics & Tissue Culture, Medicinal Plants, Scientific programmes on bio-fertilizers and biopesticides related to Organic farming; 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 details of work carried out under the different projects are as under:

Science Awareness, Communication and Science Popularization Programme:

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 was organized on 22.10.2010 at Sikkim Science Centre, Marchak, Ranipool, 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.

Accordingly 22 schools have submitted the name of their student for the award and the list was sent to the Ministry of Science & Technology, Government of India, New Delhi. DST, Sikkim received the Cheques for INSPIRE Award programme. The cheques were distributed by the Honble' Minister –Science & Technology, Government of Sikkim on 28th of July 2010 to students. Further, nominations of 136 students from various schools have also been forwarded during January 2011 to DST, Government of India for issue of INSPIRE Award.

Training Workshop on Telescope Assembling at Sikkim Science Centre

The Sikkim State Council of Science & Technology has organized a three days training workshop at Sikkim Science Center from 21st to 23rd April 2010 regarding **Telescope Assembling.** The training Workshop has been organized jointly with the Vigyan Prasar which is an autonomous organization under the Department 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.

Dr. B. K Tayagi, Senior Scientist, Vigyan Prasar, Department of Science and Technology, Government of India and Shri. Sandeep Bhattacharya, Director, Birla Planetarium, Jaipur, Rajasthan were the resource persons for the workshop. During the workshop documentary films on 'Eyes *On The Sky', 'The Expanding Universe' and 'Cosmic Collision'* were also shown.

The resource persons have given the elaborate presentations on "Telescope – A Light Bucket"/ "Stars and Constellations"/ "Brightness and Colours of Stars" and "Working of Human Eye" during 1st day. During 2nd Day, presentation on "How to navigate through the stars"/ "Determination of resolution of the telescope"/ "Phases of Moon, How to observe the Moon using the telescope"/

"Celestial Coordination", Skylores – local/Indian/western" and "How a sun dial works" were made by experts and on 3rd day, presentation on "Motion of Venus in the sky and phases of Venus" and "Meteor Showers" were given.

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.

Training Workshop on Biodiversity and Observing Nature held at Sikkim Science Center from 23rd to 25th April 2010:

A training workshop on **Biodiversity and observing nature** has been organized by Sikkim State Council of Science & Technology at Sikkim Science Center, Marchak from 23rd to 25th April 2010. 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.

Sikkim is very rich in biodiversity and **Year 2010 is the International Day of Biodiversity** and through this training programme, focus has been given for living together with nature and protection of natural habitat and eco system as a whole.

The main objective of this workshop was to understand the dynamics of nature and to promote the habit of learning by doing, using the immediate surrounding as open laboratory. The resource persons for this workshop were Shri Jayanta Sharma, Science Communicator from Assam, Shri Javed Alam from Nature Club of India, Patna and Dr. B.K. Tayagi, Senior Scientist from Vigyan Prasar, Department of Science & Technology, Government of India.

During the workshop practical demonstrations were held through nature walk. The identification and classification of plants, animals and birds has been carried out. The observation and studies regarding nocturnal animals were also taken up. The lectures and demonstrations were also carried out for study of habitat and eco system and how we can live together with nature without disturbing the ecological balance. The importance of soil, air and water as essential components for sustaining the life has also been emphasized.

The **Activity Kits on Biodiversity** prepared by Vigyan Prasar has also been distributed to the participants. The kits contain details of 51 hands on activities illustrating scientific principles and nature of phenomena and processes relating to biodiversity in a self explanatory manner. The students can learn various scientific concepts through the hands on activities given in the kits.

A Nature Kit consisting of magnifying microscope, three magnifier glasses of different powers and size and a thermometer and a book on Exploring Nature has also been given to each participant. In addition to this a Weather Activity Kit comprising of hands on activities illustrating scientific nature and phenomena about the Weather in a self explanatory manner has been provided to each participant. Using this Weather kits a mini weather station can be established in the schools using the locally available bottles and other used waste materials. This will provide an excellent hands on experiment facility at the school level to understand various natural phenomena related to weather.

This training workshop will help in promoting activity based learning for inculcating scientific and technical temperament among students in Sikkim. The Science Clubs will also be set up in the schools with the support of Vigyan Prasar for initiating new activities through this Clubs and to be a part of the national programmes like campaign on understanding and conserving biodiversity as part of **International Year of Biodiversity 2010 and International Year of Chemistry 2011.** To facilitate the teachers and science clubs, an Information and Resource Centre having all the softwares and details of forthcoming programmes and activities of Vigyan Prasar will also be established at Sikkim Science Centre. The association of Sikkim State Council of Science & Technology and Viagan Prasar through long term collaboration will promote the movement of science clubs in various schools of Sikkim.

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 on 24th and 25th April 2010. 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.

During the training workshop, in addition to organising technical session regarding innovative experiments in physics, demonstration was also given by the experts regarding use of personal computer for carrying out various experiments related to physics.

During the training the teachers were also explained about modalities for formation of Science Clubs in the schools and emphasis has been made to all teachers to participate in various programmes and activities of Sikkim State Council of Science & Technology as well as of Vigyan Prasar, which is a part of the Department of Science & Technology, Government of India.

This workshop will help in promoting activity based learning for inculcating scientific and technical temperament among the students in Sikkim. The Sikkim State Council of Science & Technology is also planning to organize a series of 25 one day training workshop for teachers and students of various schools for Learning Science through Fun in near future at Sikkim Science Centre.

Training on Green School programme:

From 27th – 28th June 2010 in Science centre,Marchak,Ranipool, a training on green school programme was conducted by Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change in collaboration with ENVIS centre,Department of Forest, Environment and Wildlife management and Centre for Science and Environment (CSE),New Delhi.

Symposium on Frontier in Biology:

From 1st - 2nd May 2010,two days Symposium on 'Frontier in Biology' was conducted in Sikkim Government College, Gangtok. The symposium engulfed talks on the current ideas and new directions in Biology. Mixtures of Plenary talks were conducted by leading Biologists along with more handson and interactive workshop session in specific areas. The programme was supported by Sikkim State Council of Science & Technology,Department of Science & Technology and Climate Change and National centre for Biological Sciences (NCBS),Bangalore.

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.

Conference of the Heads of Science Museum Centers:

10th All India Conference of the Heads of Science Museum Centres was held from 17th – 19th December 2010 at Science Centre, Marchak, Sikkim. The programme was organized by the Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change in collaboration with National Council of Science Museums, Government of India. The conference was attended by the Heads of the Science Museum and Science Centres from different parts of the country. The Hon'ble Minister for Science and Technology, Sikkim Mr. Bhim Dhugel announced the construction of a planetarium and three additional science galleries at Science Centre, Marchak.

The Minister while addressing the inauguration session of the 10th All India Conference of the Heads of Science Museum Centers at the conference hall of the Science Centre said that the centre should not only act as an information hub but also as a house of many research and innovative works.

Expressing concern on the brain drain from science stream to other professions he said that the science subject should be made more attractive. He also said that the centers should also work on the issues of climate change, melting of glaciers and global warming.

The conference had brain storming sessions and discussed about the improvement of the science centers. The issues being faced by the North East Science Centers have also discussed in the conference. Mr G.S. Rautela, Director General of National Council of Sciences Museums said that the science centres should be developed in such a way that it can attract more students and visitors.

Appreciating the way Sikkim Science Centre is functioning he also said that the proposal for performance based grant in aid is also under consideration at National Council of Science Museum level to the science centers by the Ministry from next year. He also suggested that the Sikkim Science Center should have more trained man power with more scientific temperament.

Workshop on Biodiversity and Climate Change:

A Workshop on Biodiversity and Climate Change to celebrate International year for Biodiversity was held on 13th May 2010 at Forest Conference Hall. During the workshop discussions were held regarding action plans of Climate Change in reference to biodiversity conservation in Sikkim. The programme was conducted by Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change in collaboration with The Mountain Institute in India (TMI) State Biodiversity board and German Technical Corporation (GTZ).

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

As a part of National Science Day celebration 2010, 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.

Mr. Ivan D Lepcha, PGT(Physics), PNG Schools who is very enthusiast teacher has conducted the programme as Resource Person. The programme was conducted among class IX students of PNG Schools in two batches and two batches of the students of Class IX, Biraspati Govt. Sr. Sec. School, Marchak during weekend in April 2010 to June 2010

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.

State Level National Children Science Congress 2010

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 October 22, 2010 at Sikkim Science Centre and attended by 41 Science Teachers from various schools of the state. The given theme for this year and 2010 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 on December 1, 2010, at Sikkim Science Centre, Marchak. There were total of 15 schools participated along with 16 Projects in state level competition. 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, Dr. Sunil S. Thorat, Scientist, Distributed Information Sub-Center, IBSD, Dept. of Biotechnology, GOI, Imphal, Manipur were the judges during the programme.

The selection was made by various experts and first position was awarded to Miss Anjali Gupta and her team of Paljor Namgyal Girls'' School on the project titled "**Land Albedo increase its**

Corelation with Ambient Temperature". Similarly second position went to Miss. Kunzang Lepcha & the team of Paljor Namgyal Girls' School on the project tilted **"To Study the Effective Measures in order to Prevent Litter"**. Third position was secured by Master Sujan Pradhan & the team of Govt. Sr. Secondary School, Temi, South Sikkim on the project titled **"Population Dynamics, distributional pattern and altitudinal variation of earthworm species at Temi-Tarku.** Finally the forth position was taken by Miss Pema Deeki Bhutia of Govt. Sr. Secondary School, Pelling, West Sikkim on the project titled **"To Study the Soil Quality"**. During the valedictory programme Shri. M. L Arrawatia, IFS, Secretary, Department of Science & Technology in his speech congratulated the participants for their effort and participation in the programme. He also informed the students to come up with innovative ideas and bring out more projects that can compete in the national level. Finally all the participants were awarded with a certificates.

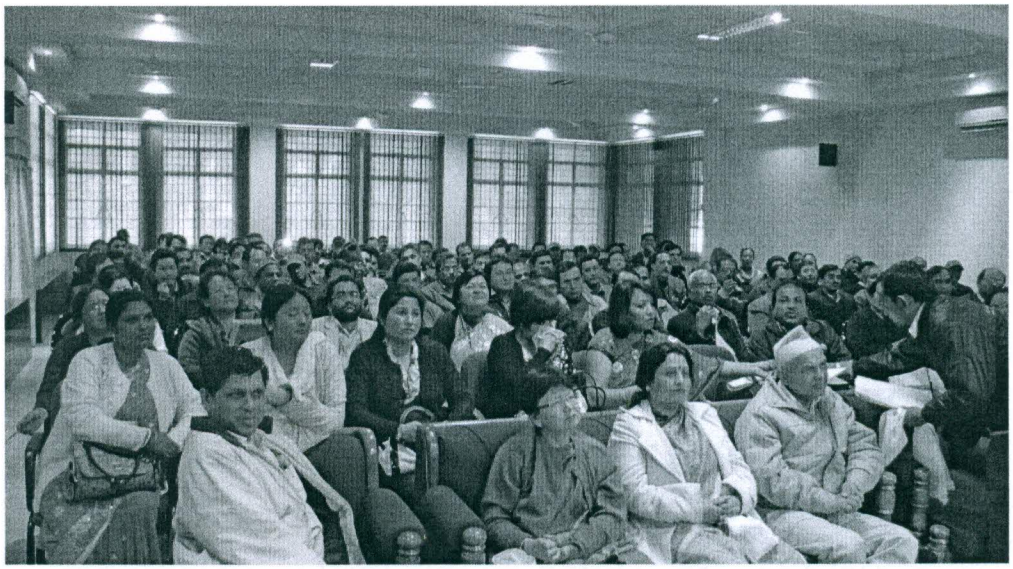
The students from these teams has also participated in the forth coming 18TH National Children Science Congress which was held in Vels University, Pallavaram, Chennai,, Tamil Nadu.

State Level National Children Science Congress 2010 programme at Sikkim Science Centre, Marchak.

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

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 Center 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.

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Activity Report of the ENVIS Centre Sikkim on Ecotourism for 2010-2011:

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.

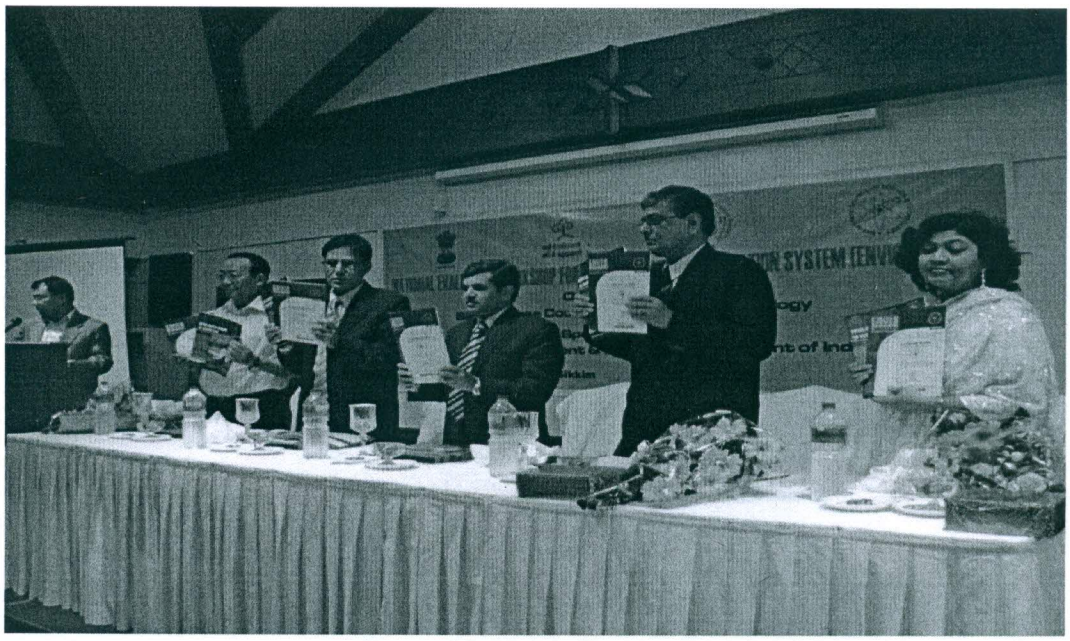
8. The infrastructure of the Centre has been upgraded rendering benefits on the usage of facilities to the visitors and various research papers on Eco-tourism have been collected for reference.

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

The National Evaluation Workshop on ENVIS Centres 2010:

The National Evaluation Workshop on Environmental Information System (ENV*S*) Centres was held on 5th & 6th April, 2010. The event was organized by Sikkim State Council of Science & Technology and supported by the Ministry of Environment and Forests, Government of India at Mayfair Spa & Reports, Ranipool, Sikkim. More than hundred (100) participants from various National Institutions and State Government organisations participated in the workshop to discuss in detail the further strengthening of Environmental Information System in the country. The Hon'ble Minister-Science & Technology, Tourism, Forests, Mines and Minerals and Geology Department, Government of Sikkim has inaugurated the Workshop. Shri Neelkanth Ghosh, Statistical Advisor, and Smt. Madhumita Biswas, Joint Director, Ministry of Environment and Forests, Government of India has also participated in the Workshop.

Shri P.S. Rawat, Dy. Director, Ashok Bansal, Under Secretary, Amkit Kr. Bhandari, Programme officer and Ravi Goswami, Web Developer from the Ministry of Environmental & Forests, Government of India have also participated in the Workshop. Shri Sanjay Gahlout, DDG from the National Informatics Centre, Government of India, New Delhi has also participated in the Workshop.



The National Evaluation Workshop on ENVIS Centres 2010:

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.

On 22nd June 2010 a day long programme on video conferencing links SHG with peers and officials was conducted in Sikkim Science centre, Marchak. The programme was organized by Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change in collaboration with Sikkim Rural Development Agency (SRDA) under State Rural Management and Development Department.

An interactive programme on the formation of cooperatives through video conferencing was organized in all the four districts of Sikkim. 17th August,2010 (East Sikkim),19th August,2010 (South Sikkim), 21st August,2010 (West Sikkim) and 26th August,2010 (North Sikkim).

Remote Sensing and Geographical Information System (GIS):

Various activities under this sector are:

NUIS (National Urban Information System):

Creation of database of Sikkim state on thematic mapping of towns using remote sensing and GIS was done. 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.

Out of 10 towns of Sikkim, the mapping of 6 towns has been completed and remaining 4 towns are in progress which will be completed soon.

Mapping of Glacier Lakes and development of GIS based Glacier Lake Management Information System for the State of Sikkim:

The Sikkim State Council of Science & Technology jointly with Center for Development of Advanced Computing (C-DAC), Pune has taken up Mapping of Glacier Lakes and development of GIS based Glacier Lake Management Information System for the State of Sikkim.

The objectives of the Project are:

- Mapping of various Glacier lakes using High Resolution optical/microwave satellite data.
- Classification of lake types and identification of hazardous lakes.
- Generation of Digital Elevation Models (DEMs).
- Estimates of volume of water in the lakes.
- Development of model for river channel profiling.
- Development of model for prediction of Glacial Lake Outbrust Floods (GLOFs)/Flash Floods, areas likely to be inundated/affected by GLOF's, and Impact assessment of GLOF's.
- Developing preparedness and resilience in the event of GLOF's.
- Organizing important stake holders meet about the potential danger of GLOF's.
- Development of GIS based Glacier Lake Management Information System for the state of Sikkim.
- Installation and commissioning of the Glacier Lake Management information System at user site.
- Installation of sensors on potential hazardous lakes on pilot basis (may be taken up in the next phase of the project).

This project will be very helpful keeping in view the following aspects;

- Mapping of various Glacier lakes using High Resolution optical/microwave satellite data will provide us information regarding occurrence, distribution and aerial extent and classification of lake types and identification of hazardous lakes which will be very useful for monitoring of these lakes.
- The High resolution (Ikonos/QB/Cartosat data etc) are essential because size of the lakes will be very small many a times it may be fraction of a hectares. Sikkim being high rain

fall area and most of the time area will be covered with the clouds, so we propose to use Microwave data because area could be seen even during the cloudy weather.

- Sikkim being totally hilly state with steep slopes so, Digital Elevation Models (DEMs) of the area will be very useful in Development of model for river channel profiling and Estimation of volume of water in the lakes.
- The Development of model for prediction of Glacial Lake Outburst Floods (GLOFs)/Flash Floods, areas likely to be inundated/affected by GLOFs, and Impact assessment of GLOFs will be very useful and it will help in developing preparedness and resilience in the event of GLOFs and will also helpful in Disaster management at large scale.
- The Installation of sensors on potential hazardous lakes on pilot basis will be useful in case of lake breach/outburst and various types of information is expected from the proposed sensor network. Linking of Sensor data with GIS software and modeling will yield different type of information that will be very useful for disaster preparedness and management.
- Special tools/menus with the proposed GIS based Glacier Lake Management Information System for the state of Sikkim will be very useful for creation of data base for modeling/prevention of disaster etc.

The joint collaboration project has been started from January 2010 and the first meeting for finalizing the modalities for implementation of the project has been discussed during the meeting at CDAC on 1st & 2nd February 2010.

A six member team consisting of C-DAC scientists and scientists of Sikkim State Council of Science & Technology have carried out field expedition for high altitude alpine lakes covering Gurudogmar Lake, Cholahmu Lake, Teesta Khangpu Glacier and surrounding glacial lakes. The moraine status at the outlet of various lakes have been studied in detail. The work is in progress on digitization of various glacial lakes using the time series satellite data to know the rate of increase/ decrease in the glacial lake areas.

Seismic Hazard and Risk Assessment project for Sikkim Himalayas:

The Ministry of Earth Sciences sponsored this project in January 2010. The project is being taken up jointly by Geology & Geophysics Department, Indian Institute of Science, Kharagpur and Sikkim State Council of Science & Technology. In this project, a network of twelve strong motion stations are being maintained for earthquake monitoring on long term basis in Sikkim Himalayas.

Acquiring and monitoring earthquake related data by Earthquake Monitoring stations around Sikkim is in progress. 12 Earthquake Monitoring stations are located and are running smoothly at Lachen, Chungthang, Mangan, Lingza, Gangtok, Singtam, Padamchen, Melli dara, Jorethang, Pelling, Uttarey and Singtam. The analysis of data regarding earthquake events are being carried out jointly with Geology and Geophysics department, IIT, Kharagpur. One more station at Sikkim Science Center, Marchak is under construction.

Joint collaboration programme for assessment of vegetation and soil carbon pool assessment jointly with the Indian Institute of Remote Sensing under ISRO Geosphere Biosphere programme:

Carbon dioxide is among the major green house gases (GHG) contributing to global warming and associated impacts. Under the Kyoto protocol of United Nations Framework Convention on Climate Change (UNFCC) most of the countries have agreed to reduce the GHG emissions and also

report these emissions regularly. This reporting is necessary and is done as a National Communication to UNFCCC. The National Vegetation Carbon Pool assessment project aims to assess the phyto-mass and carbon in different ecosystem, e.g. forest ecosystem, forest strips, trees outside the forest, plantations, agricultural ecosystem, rural and urban ecosystems and other ecosystem. In India several studies have been carried out in different ecosystems, forests and some for out-side trees or forests. The data/information available on phyto-mass and carbon are based on different objectives and purposes. Therefore, this data/information has limitations while extrapolating in larger areas. Since data collection was not uniform hence not comparable. The present project attempts to collect data for phyto-mass and carbon pool assessment following uniform methodology. It is also envisaged that the data will be processed uniformly for mapping phyto-mass and carbon in country.

The main objective of the project are:

- Assessment of terrestrial vegetation biomass in the country using ground sampling and satellite remote sensing data;
- To generate geospatial data of the terrestrial phytomass carbon of India along with estimates of uncertainty.

In Sikkim the project is being implemented jointly by Forest Department and Sikkim State Council of Science & Technology to find out how much carbon per hector is sequestrated by the green forests of Sikkim. In addition to the taking the field plots for biomass carbon assessment. Soil samples are also being collected for soil carbon pool assessment in Sikkim.

Research papers related to Sikkim published in different journals and books is abstracted with title, authors, publication data, abstracts and keywords were collected from IIRS, Dehradun. There are total of **330 abstracts** from the year **1956 to 2009** on various topics related to Sikkim. A bibliography of abstracts regarding vegetation and climate change related research work has also being prepared from the year 1956 to 2009. The field work for collection of information by laying out field plots are in progress.

In National Carbon Project (NCP)- Vegetation carbon Pool Assessment of North District the field work of **19 plots** have been completed out of total **30 plots**, and the data and plant specimen is also collected according to the given field methodology. **Three 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 and also calculate the volume of various species.

In addition to this analysis of forest field inventory data of more than 200 plots has also been carried out for assessment of vegetation carbon pool in North and East districts.

Forest Fire Mapping:

The adverse impact of uncontrolled forest fire on the ecology and environments are well known. Due to erratic rainfall and extensive dry spells during winters and early summers in Sikkim in recent past due to climate change has increased incidence of forest fires. Besides the loss of precious flora and fauna, forest fire affects the regeneration of plants, soil moisture regime, nutrient balance and renders trees prone to insect and fungal attack. In the present study, an attempt has been made to prepare the database on forest fires in Sikkim using IRS LISS III imagery at 1:50,000 scale. During the study, date and time of forest fires in Sikkim were collected and near real-time monitoring using satellite imageries for forest fire were carried out. For the study, three seasons' satellite imageries viz. 10th January 2009, 23rd March 2009 and 10th May 2009 of IRS P6 LISS III were selected. During the visual interpretation of 10thJanuary 2009, 4 number of forest fires have been identified, while 23rd March 2009 imagery 201 forest fires have been identified and using10th May 2009 imagery, 82

additional fire incidences have been identified with the total burnt area of 0.2214 sq. km, 22.975 sq. km, and 9.995 sq km were recorded, respectively. The forest fires damage between January and May 2009 were identified using the time series satellite imageries in the different types of forests as well. Out of total agricultural area of 578.09 sq km of Sikkim state, the burnt area was found to be 10.47 sq km (1.81%). Similarly, from total Alder forest area of 445.83 sq.km, the burnt area was 3.94 sq km (0.88%). Regarding sub-tropical forest, which has the total area of 64 sq km, the burnt area covered 3.59 sq. km (5.61%). In Sikkim, the Sal forest area is only 19.02 sq km and burnt area was found to be 1.10 sq km (5.80%). Total Rocky Barren area of 64.00 sq km in Sikkim has burnt area of 2.92 sq km whereas the total area of Oak forest in Sikkim is 887.71 sq km in which burnt area was 0.30 sq km (0.03%). Under the Forest Blank category having area of 141.77 sq km, the burnt area is 1.68 sq km and in the Forest Scrubs of 15.95 sq. km, the burnt area is 0.19 sq km. Alpine forest, Conifer forest, forest thickets and snow and ice show no forest fire incidences as observed in the satellite imagery during the period. In contrast, Sub tropical forest and Sal forest shows the highest percentage of fire burnt area has been detected using the satellite imagery and this higher intensity of forest fire may lead to great impact on biodiversity.

Land Degradation in Sikkim Mapping using Remote Sensing and GIS:

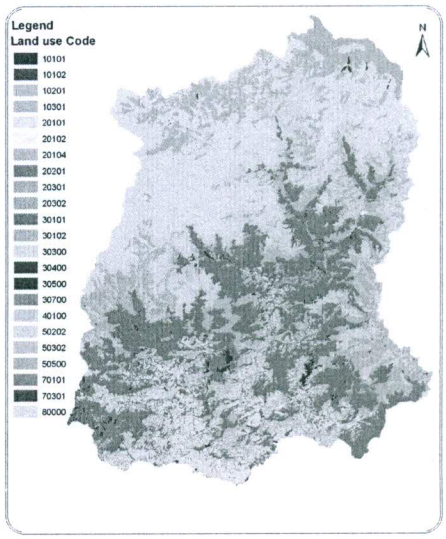
Degraded lands include those lands whose condition has deteriorated to such an extent that it cannot be put to any productive use as such, except current follows due to various constraints.

The main objective was to generate land degradation data base for the year 2005-06 using three seasons (kharif, rabi, zaid) IRS LISS- III satellite data based on NNRMS standards for easy query and retrieval of Geo database.

The classification system was adopted from NNRMS standards and broadly consists of Land degradation process, Land degradation type, Severity of the problem, Landform and Land use.

The study provides spatial database on land degradation on 1:50,000 scale for planning reclamation programmes at district level and can be monitored the same at 5 years time interval to see the impact of reclamation programmes. It also helps in identifying areas of rapid change (hot spots) and serves as a primary database for regional/ global environment studies etc. The mapping work has been completed in collaboration with NRSC. The field quality check assessment of satellite interpretation has also been carried out.

The final database and maps on 1:50,000 is being generated which will be very useful for different departments like Agriculture, Rural Development, Environment and Forests, Water resources to take up further measures for reclaiming degraded lands.



Land use land cover project:

Sikkim State council of Science and Technology with support of North Eastern Space Application Center has taken up Landuse and Land cover Mapping project using satellite data on 1:50,000 scale.

Sikkim is a state with variety of natural resources and the present project is a part of 'National Land Use Land Cover mapping' in which land use land cover is classified upto level three (3) classification scheme using multi-temporal satellite data.

Wetland mapping of Sikkim:

Wetlands are one of the most important and reproductive ecosystems of earth and provides wide array of benefits to mankind. Keeping this in view, in the present study, efforts has been made to study the different type of wetlands and their distribution in different geographical regions of Sikkim, a small state in the Himalayas in India with total geographical area as 7096 square kilometres, 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.

Table 1: 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.

Table-2: District-wise wetland highlights

Sl No	District	Geographic Area(ha)	Number of Wetland	Wetland Area(ha)	% of total wetland area	% of geographic area	Major wetland type (total types)
1	**North**	422600	432	4764	**63.72**	**1.13**	High Altitude Lake, River/stream, Small Wetlands (<2.25 ha)
2	**West**	116600	44	1069	**14.30**	**0.92**	River/stream, High Altitude Lake & Low Altitude Lake, Small Wetlands (<2.25ha)
3	**South**	75000	5	739	**9.88**	**0.99**	River/stream, Small Wetlands (<2.25ha)
4	**East**	95400	77	905	**12.10**	**0.95**	River/stream & High Altitude Lake, Small Wetlands (<2.25ha)
5	**Total**	709600	558*	7477	**100**	**1.05**	River/stream, High Altitude Lake & Low Altitude Lake, Small Wetlands (<2.25ha)

* The number of Wetlands may vary in the district-wise allocation because of the confluence of the River/Streams between districts, but the area remains same.

Landslide Database Centre in Sikkim:

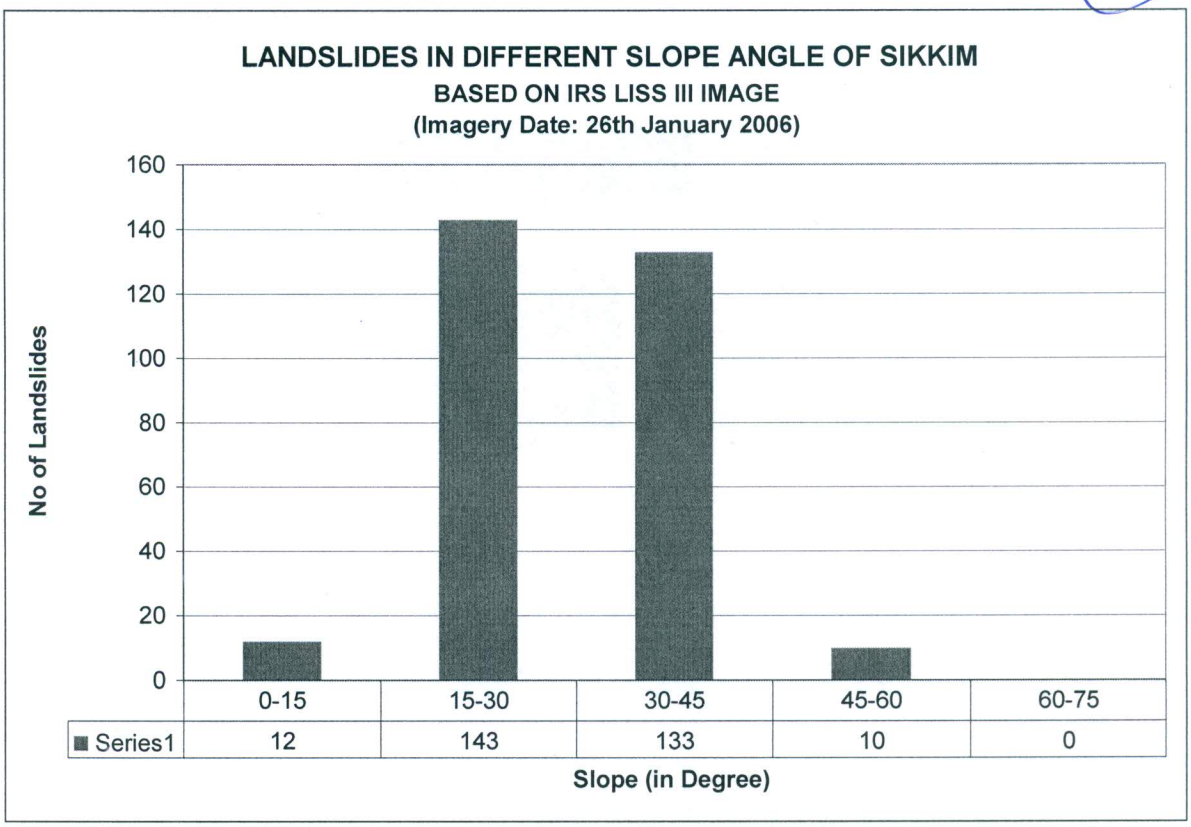
Landslide hazard is one of the important hazards of the state. The existing physical setting is one of the important causes of landslide hazard in the state. Weak geological formations, high rainfall, increasing population pressure, location in the seismic hazard zone and unplanned constructional activities are some of the important causes of landslides in Sikkim. The disaster brings the misery by damages to the roads, bridges, houses and the other communication facilities.

The increase in population accelerates the pressure between man and environment, which leads to the increase in the environmental hazards like landslides, which ultimately result in loss of

lives and properties. There has been number of cases where the landslides in Sikkim have taken number of human lives and huge losses of properties on annual basis. Almost every year landslides affects some part or the other of the State.

A study has been carried out to find out the spatial distribution of landslides in different parts of the mountainous state of Sikkim. It will help in understanding the nature and characteristics of landslide in the fragile topography of Sikkim and for taking precautionary measures in the state. In carrying out this study, the landslide inventory map was prepared through visual interpretation of IRS LISS III image dated 26 January, 2006. The location of landslides verified by using high resolution Google Earth Pro images of various dates such as Nov 24,2007, Feb 11,2006, Feb 6,2006, Nov 26,2005, Jan 1,2006,and Nov 8,2005 which enhanced the accuracy in preparing inventory map. Altogether 298 landslides were recorded in 2006 image, with total area coverage of active slide area as 961.68 hectares in Sikkim. Rangrang slide located in North District recorded as the largest landslide of Sikkim with 105.07 ha area as active slide coverage. District wise landslide distribution shows that 100 slides are recorded in West district, followed by 98 slides in South district, 60 slides in East district and 40 slides in North district respectively. The overlay analysis carried out in GIS platform by using landslide inventory layers over slope, altitude, aspect and forest type map of Sikkim. It was found that maximum landslides occurred at the slope angle in between 15°-45° with 143 landslides in 15°-30° slopes and 133 slides in 30°-45° slopes. Altitudinal wise maximum landslides were found up to 2000 meters above mean sea level with 93 slides up to 0-1000 meters and 144 slides up to 1000-2000 meters above mean sea level. Aspect wise maximum landslide falls on South facing slopes with 132 slides. Likewise 86 slides found in west facing slopes, 46 slides in East facing slope, and 36 slides in North facing slopes. The overlay analysis over forest type map and land use map revealed the maximum landslides in agricultural areas, followed by Alder forest and Oak forest.

District	**Number of Landslide**	**Active landslide Area in ha.**
West	100	153.66
South	98	326.66
East	60	145.22
North	40	332.94
Total	**298**	**958.48**


LANDSLIDES IN DIFFERENT SLOPE ANGLE OF SIKKIM
BASED ON IRS LISS III IMAGE
(Imagery Date: 26th January 2006)
No of Landslides
160
140
120
100
80
60
40
20
0
0-15
15-30
30-45
45-60
60-75
Series1
12
143
133
10
0
Slope (in Degree)

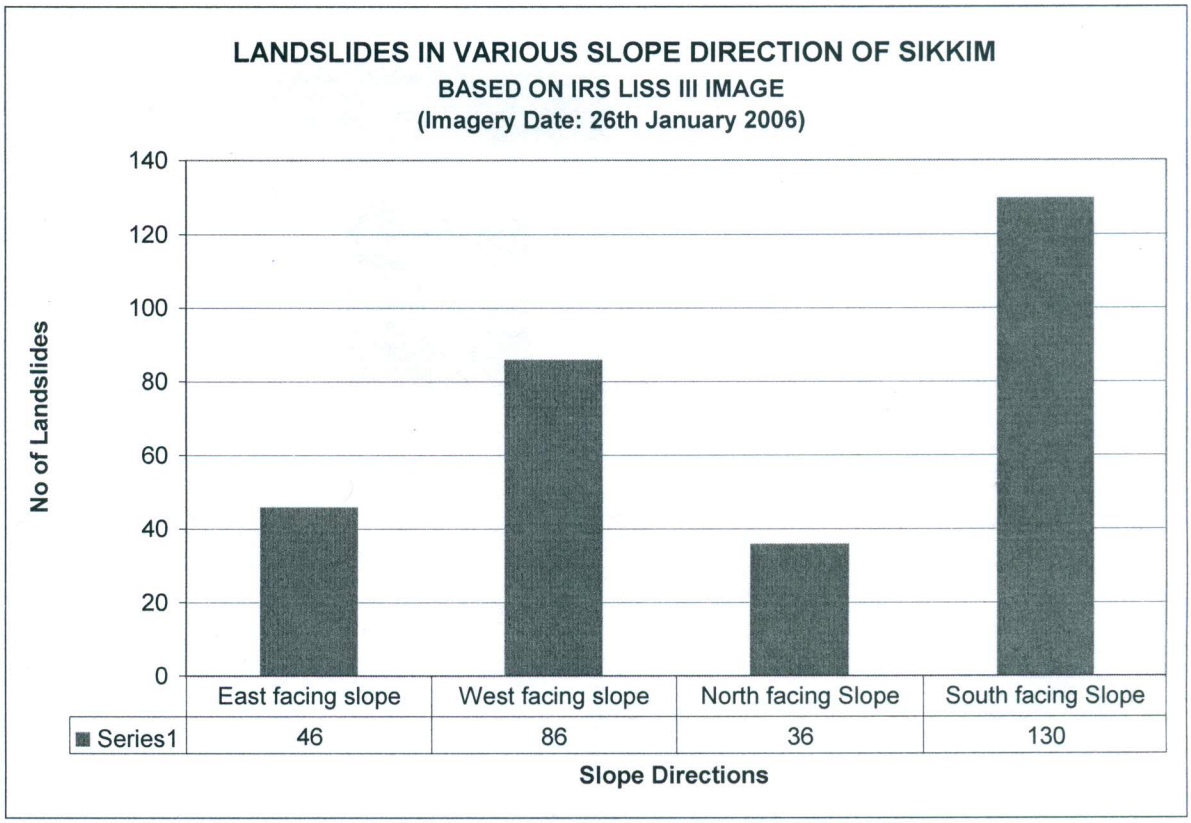
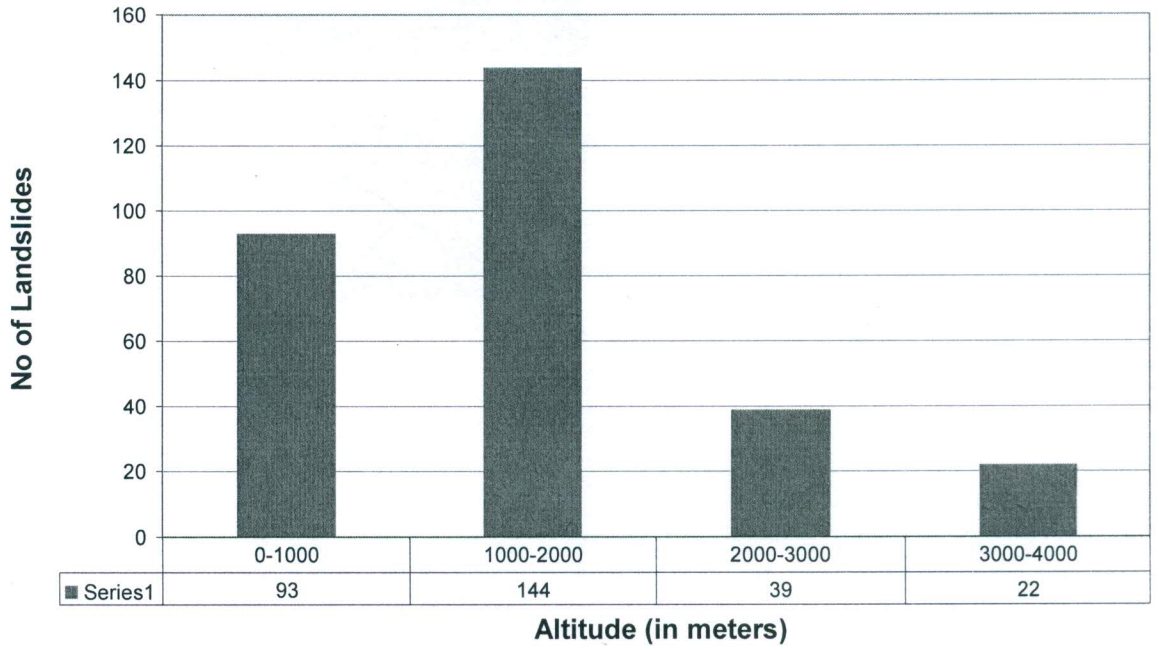

LANDSLIDES IN VARIOUS SLOPE DIRECTION OF SIKKIM
BASED ON IRS LISS III IMAGE
(Imagery Date: 26th January 2006)
No of Landslides
140
120
100
80
60
40
20
0
East facing slope
West facing slope
North facing Slope
South facing Slope
Series1
46
86
36
130
Slope Directions

Fig: 38 **LANDSLIDES IN DIFFERENT ALTITUDINAL LEVEL OF SIKKIM BASED ON IRS LISS III IMAGE (Imagery Date: 26th January 2006)**



An attempt has also been made to create the landslide hazard zonation map along the buffer of one km on the both side of National Highway 31-A, the road stretch of 44 km between Gangtok, the capital town of Sikkim and Rangpo, the border town in between West Bengal and Sikkim. The road serves as the lifeline to the people of Sikkim as well as is strategically important due to close proximity to the Chinese border. Out of total length of 114 km of NH 31-A, the portion of study area falls on Sikkim side of the border. The particular road stretch is one of the vulnerable areas that falls under few active slide locations. In carrying out the work IRS CARTOSAT image is used to generate road layer, landuse and the drainage map. Slope and aspect map prepared from SRTM image. Geological map of the particular stretch is prepared from Geological Survey of India map on the scale of 1:10000 maps. The landslide inventories map prepared from multi temporal data of CARTOSAT image, IRS LISS III image dated 26th January, 2006 and IRS LISS III images of 23rd March 2009. Additional extensive field visit was made to verify the landslide locations. All the layers are integrated in GIS software ARC GIS 9.2 version and came out with the hazard zonation as according to the Landslide Hazard Evaluation Factor (LHEF) suggested by the different scholars.

Applications of Remote Sensing and GIS in Sericulture Development:

The mulberry species as sericulture food plant for silkworm is perennial plant which protects the soil from erosion. India is the second largest producer of mulberry silk accounting for about 15% of the global raw silk production. The Sikkim State Council of Science & Technology and Sericulture wing for the State Forests Department in collaboration with the North Eastern Space Application Centre (NESAC), Shillong, Government of India, Department of Space had taken up a pilot project in May 2009 regarding "Applications of Remote Sensing and GIS in Sericulture Development" in South District of Sikkim. In this project potential areas for sericulture are being mapped on 1:50,000 scale using Remote Sensing and GIS.

The main objective of this study is to map and identify the potential areas for development of silkworm food plants for mulberry in South District of Sikkim. This study suggests the suitable areas for sericulture development (Mulberry) in south district of Sikkim through the application of Remote Sensing and GIS and taking help of suitable limitations criteria provided by Central Sericulture Board and North Eastern Space Applications Centre (NESAC). In consultation with the State Sericulture Wing under Department of Forests, Govt. of Sikkim, the suitable elevation zone for growing mulberry species was identified up to 1525 meters above mean sea level in the south district of Sikkim as per the local climate conditions. A carved out map of south district up to 1540 meters has been taken as base map for this study. From the Land Use Land Cover map on 1: 50,000 scale of South district jointly prepared by Sikkim State Council of Science and Technology and North Eastern Space Applications Centre, thematic layers on agriculture land and wasteland were prepared for the suitable elevation zone for mulberry species. From the soil map prepared by National Bureau of Soil Sampling and Land Use Planning (1996), the attributes like soil depth, soil drainage, soil texture, and soil erosion were given according to the degree of limitation. The slope map has been prepared for different class interval according to the suitable limitation for mulberry species with the altitude zone up to 1540 meters. The soil map, suitable elevation zone, layers on agriculture land and wasteland and suitable slope map has been intersected and the final suitability map for the mulberry cultivation has been prepared giving different classes as highly suitable, moderately suitable, marginally suitable and not suitable areas.

Project on setting up of Geo-informatics Centre in a phased manner:

The Geo-informatics Centre is being set up under the Sikkim State Council of Science & Technology by strengthening existing remote sensing facilities.

The aim for setting up of full fledged Geo-informatics Centre in a phased manner is for fully utilizing modern technology of Remote Sensing (GIS) and also Global Positioning System (GPS) for utilizing the facilities in the field of various natural resources of survey. This facility will also provide unique training opportunities to younger generation in the field of Geo-informatics. Three workstations, two desktop computers, 2 laptops, 1 GPS, 2 Range Finder and one Silver Range Compass has been procurred during this year. More equipments like GPS, Hypsometers, Silva ranger compass, workstation for digital analysis and latest version of ERDAS software for image analysis will also be procured.

Project on 1:10,000 scale thematic mapping (10K) & geospatial database generation for Project on 'Space Based Information Support for Decentralized Planning (SIS-DP):

The Sikkim State Council of Science & Technology in collaboration with the National Remote Sensing Centre, Department of Space, Government of India has started a project on thematic mapping and setting up of a geospatial data base for using at decentralized planning purposes. The MoU has been already signed with the National Remote Sensing Center.

GLACIER AND CLIMATE CHANGE STUDIES AND CLIMATE CHANGE ADAPTATION PROGRAMME :

Glacier and Climate Change Studies: Following programmes have been taken up for Glacier and Climate change studies.

- An Advisory Council viz. **'Sikkim State Council of Climate Change** for providing policy direction and institutional mechanism for effective implementation of various climate change adaptation programmes has been constituted by the State Government.
- The name of Science and Technology Department has been re-designated as **Department of Science and Technology and Climate Change" the State Government has also approved** for creation of full fledged **Climate Change Wing** by strengthening the facilities and manpower in a phased manner under this department with the mandate on climate change related issues to undertake detailed research and survey regarding impact of climate change in addition to already assigned mandate
- Sikkim may be the first Himalayan State who has carried out basin wise glacier inventory way back in 1999 by Science & Technology Department of the State Government with Space Application Centre, Department of Space, Government of India. The inventory of glaciers of Sikkim was carried out using satellite data of 1st January 1997. Based on this work, an atlas of the Glacier Inventory maps was also prepared. As per this study, Sikkim has 84 glaciers covering an area of 440 sq km. The total extent of permanent snowfields was measured as 251 sq.km. This makes total extent of an area under glaciers and permanent snowfields as 691 sq.km. Most of the glaciers have an area of less than 5 sq.km. There are onl above 5 sq.km. and only two glaciers are having an area of more than 20 sq.km. The total glacial and permanent snow cover-stored water is estimated at 145.05 cubic km. **The Department is again monitoring the status of glaciers of Sikkim jointly with the Space Application Center using satellite data of year 2004.**
- The glacier field studies for Zemu Glacier, which is largest glacier in Eastern Himalayas, has been taken up jointly with Prof. Milap Chand Sharma, Jawaharlal Nehru University, who is also a member of the Sikkim Glacier Commission. According to his observations Sikkim gets precipitation round the year from the south west monsoons, winter rains and Mediterranean westerlies due to its advantageous location in the eastern Himalayas. At higher altitudes, the precipitation is in the form of snow.
  The triple precipitation in Sikkim will always cater to better input for the glaciers compared to the Western Himalayas, Sharma, who carried out an extensive study of the state of glaciers said.
  Even the Zemu glacier, the largest in Sikkim, has retreated by only five to seven meters since 1977 despite its surface thining, he said.
  The condition of glaciers depended on factors beyond climate change and global warming like morphology of valley, its shape, size and slope, he said.

While there have been a number of glaciers which have retreated during the past several years, there have been other glaciers which have advanced during the same period.

- In order to broaden the scope of glacier research, that may represent all the micro-climatic settings across Sikkim Himalaya, and may ensure highly accurate predictions for the future flow patterns of Sikkim Himalayan rivers, leading to the development of regional stream flow models, more benchmark glaciers need to be included in network of Glacier Monitoring Observatories.
- Installation of Automatic Weather Stations at block levels with the support of the Department of Space, Government of India at each of the Block Development Centers in a phased manner has also been taken up. 10 Automatic Weather Stations are already established and are fully functioning.

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MONITORING GLACIER IN TISTA BASIN,SIKKIM

A JOINT PROJECT OF DEPARTMENT OF SPACE
AND MINISTRY OF ENVIRONMENT AND FORESTS, GOVT. OF INDIA

GLACIER MONITORING(1990,1997,2004)

TISTA BASIN, SIKKIM.

SPACE APPLICATION CENTRE (ISRO)
AHMEDABAD-380015

SIKKIM STATE COUNCIL OF SCIENCE AND TECHNOLOGY
GOVT. OF SIKKIM, GANGTOK-737101
&
G.B.PANT INSTITUTE OF HIMALAYAN ENVIRONMENT
AND DEVELOPMENT, SIKKIM.

STUDY OF GLACIER FLUCTUATIONS IN SIKKIM HIMALAYAS

The total number of the glaciers have been mapped using satellite data of 1990 , for the year 1997 , and for the year 2004 . Out of these, 34 glaciers are comparable and have been used for Glacier Monitoring and analysis. The total area of the glaciated region in Tista basin for these 34 glaciers is 300.8 sq. km. in 2004, 302.9 in 1997 and 304.34 sq km in 1990. the glaciers are distributed in the north, northwest, east and northeast part of the basin respectively (Fig. 2).

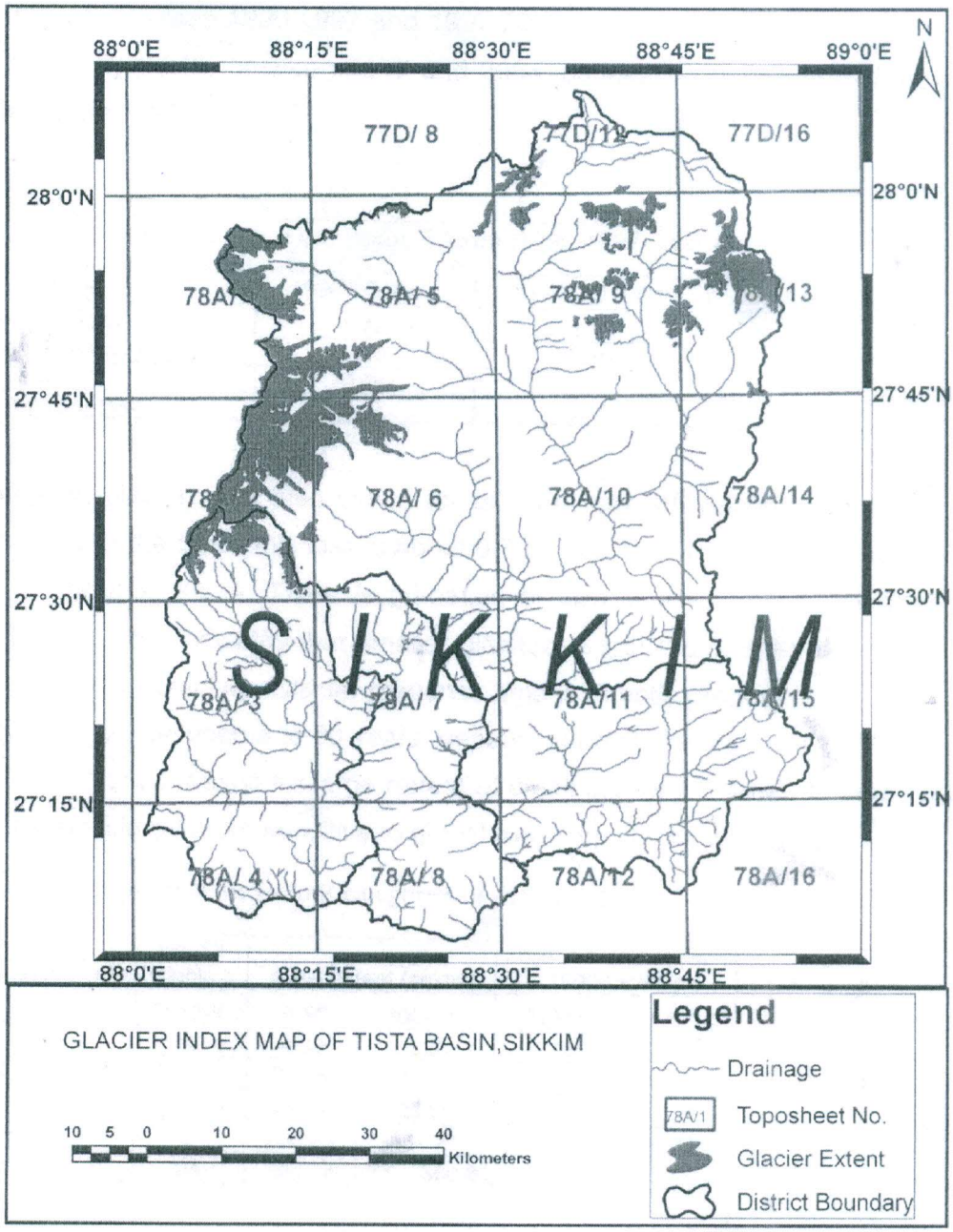
Glacier monitoring has been investigated amongst satellite imageries of 1990, 1997 and 2004. Out of the 112 Glaciers mapped, only 34 selected glaciers have been studied for comparision between 1990-1997, 1997-2004 and 1990-2004, due to presence of cloud, snow and shadow on the rest of the glaciers in either years. The total area of the 34 glaciers was 304.3 sq km in 1990 and reduced to 300.8 sq km in 2004 (Table 1).

Table 1: Area of glaciers in Tista basin in the year 1990, 1997 and 2004

Basin	No. of Glaciers	Area in 1990 (Sq. Km)	Area in 1997 (Sq. Km)	Area in 2004 (Sq. Km)
Tista	34	304.32	302.93	300.81

Most of the large glaciers in Tista basin are covered with rock fragments near the snout in the ablation zone and smaller glaciers have exposed ice on their ablation zone. The shape and the slope of the glaciers are mainly governed by the size and slope of the valleys. The orientation of ablation zones of most of the glaciers in Tista basin is towards south and southeast direction.

Figure 2: Glacier index map of Tista basin



Since 1990, the glaciated region reduced by 1.24 sq km in 1997 and 3.54 sq km in 2004 (Table 2). The investigation has shown overall 1.2% reduction in glacial area from 1990 to 2004. However, this change is not uniform in the time interval between 1997 and 2004, suggesting higher retreat in glaciers after 1997.

Table 2: Loss in area of glaciers, Tista basin, Sikkim (1990-1997-2004)

Year	1990 to 1997	1997 to 2004	1990 to 2004
Loss in area (sq km)	1.42	2.12	3.54
Annual loss in area (sq km)	0.20	0.30	0.25
% Loss in area	0.46	0.70	1.18
% Loss in area per year	0.07	0.10	0.08

- The change in glacier area also varies for different size of glaciers. For the largest glaciers of the basin this loss is about 0.72% and for the smaller glaciers this loss is about 26.45%. There is gradation of loss in area from larger to smaller glaciers. This indicates that smaller glaciers respond quickly to climatic variation then larger glaciers. Glacier response time is directly proportional to its depth; it could vary between 4 to 60 years, depending upon the glacial size. This could be fundamental reason for large retreat of small glaciers. Therefore, small glaciers are considered more sensitive to global warming (Table 3).
- Table 3: Loss in glacial area for various categories of the size glaciers

Glacier area(sq km)	No. of glacier	Area extent (sq km)		Loss in area between(1990 to 2004)	
	1990	1990	2004	Sq km	%
< 1 sq km	8	4.39	3.23	1.16	26.45
1 to 5 sq km	15	39.75	38.50	1.25	3.15
5 to 10 sq km	4	27.24	26.89	0.36	1.31
> 10 sq km	7	232.95	231.27	1.68	0.72
Total	34	304.34	300.81	3.53	1.16

Out of the 34 glaciers of tista basin, 8 glaciers have an area of less than 1 sq km. These glaciers cover about 4.39 sq km of the total glaciated region.

The glaciers having an area less than 10sqkm, makes most of the glaciers in the basin. There are 19 glaciers belonging to this category covering about 70sqkm. It has been observed that few glacier shows increase in area, which is in the order of few hectares. In view of spatial resolution of the data, this increase is negligible and can be attributed to the mismatching of the glacier boundaries of the three sources (The variation in the numbers, loss in area of each glaciers of tista basin is given in Table 4).

Remote sensing and GIS played a great role in the temporal analysis of the glaciers of tista basin. The status of glaciers and their retreats are very visible in different years. The overlaying of layers in different years gives a context from the terminus sides.

Table4: Change in glacier area of the Tista Basin based on Satellite data (1997) and satellite data (2004)

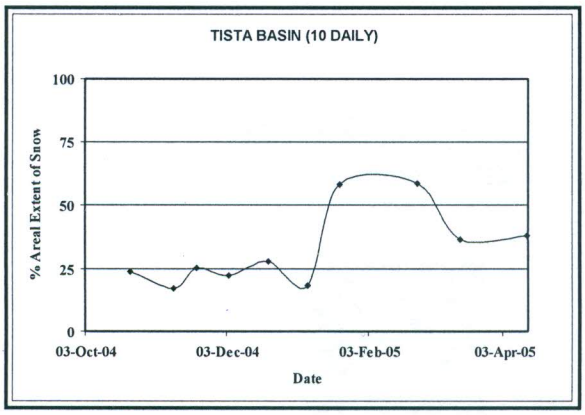
No. of Glaciers	Glacier ID	Area in 1997 (Sq Km)	Area in 2004 (Sq Km)	Change in Area (Sq Km)	Change in Area (%)
1	78A0101	1.383517	1.383517	0	0.00
2	78A0102	8.253387	8.118639	-0.134748	1.63
3	78A0103	7.9928	7.870604	-0.122197	1.53
4	78A0104	12.90115	12.73547	-0.165685	1.28
5	78A0105	12.74903	11.70983	-1.0392	8.15
6	78A0106	2.443135	2.442956	-0.000179	0.01
7	78A0107	6.165592	5.918544	-0.247048	4.01
8	78A0201	11.33501	11.02241	-0.312601	2.76
9	78A0202	43.62167	42.72194	-0.899736	2.06
10	78A0203	11.21858	10.19126	-1.027315	9.16
11	78A0204	10.99132	9.485723	-1.505599	13.70
12	78A0205	4.046941	3.657749	-0.389193	9.62
13	78A0206	1.349794	0.920484	-0.42931	31.81
14	78A0207	2.021594	2.021594	0	0.00
15	78A0208	2.883727	2.883727	0	0.00
16	78A0209	3.753983	3.753983	0	0.00

17	78A0210	2.4862	2.4862	0	0.00
18	78A0211	1.319169	1.225216	-0.093953	7.12
19	78A0501	1.328082	1.161125	-0.166957	12.57
20	78A0502	4.552952	3.687775	-0.865178	19.00
21	78A0503	1.888785	1.414236	-0.474549	25.12
22	78A0504	0.773979	0.610764	-0.163216	21.09
23	78A0505	4.026348	3.571554	-0.454794	11.30
24	78A0506	1.371463	1.371463	0	0.00
25	78A0507	4.009921	4.009921	0	0.00
26	78A0508	95.95237	95.86442	-0.087944	0.09
27	78A0509	6.131656	6.131656	0	0.00
28	78A0601	13.29274	13.29274	0	0.00
29	78A0602	10.0031	10.00317	+0.00007	+6.99
30	78A0603	5.477095	5.477031	-0.000064	0.00
31	78A0604	10.64638	10.56215	-0.084228	0.79
32	78A0605	0.942213	0.942213	0	0.00
33	78A0606	2.884477	2.884477	0	0.00
34	78A0901	4.303174	4.197088	-0.106086	2.47
35	78A0902	2.513153	2.971599	+0.45845	+18.24
36	78A0903	2.784423	1.81358	-0.970844	34.87
37	78A0904	1.81358	2.783632	+0.97005	+53.49
38	78A0905	8.563309	8.182575	-0.380735	4.45
39	78A0906	7.683443	7.656269	-0.027174	0.35
40	78A0907	3.442125	3.442125	0	0.00
41	78A0908	3.797822	3.797822	0	0.00
42	78A01301	6.987114	6.81122	-0.175894	2.52
43	78A01302	2.44999	2.447166	-0.002824	0.12
44	78A01303	2.816504	2.816504	0	0.00
45	78A01304	0.510297	0.476681	-0.033617	6.59
46	78A01305	1.010886	1.010886	0	0.00
47	78A01306	21.85591	20.58098	-1.274922	5.83
48	78A01307	3.780927	3.780609	-0.000318	0.01

49	78A01308	1.90866	1.90866	0	0.00
50	78A01309	3.731926	3.731926	0	0.00
51	77D01201	0.611947	0.611947	0	0.00
52	77D01202	1.691792	1.691792	0	0.00
53	77D01203	0.941959	0.426096	-0.515863	54.76
54	77D01204	1.367901	1.367901	0	0.00
55	77D01205	5.158331	4.74568	-0.412652	8.00
56	77D01206	2.959256	2.961097	+0.00184	
57	77D01207	0.321723	0.277405	-0.044318	13.78
	Total	**403.2043**	**392.0258**	**-11.17853**	**2.77**

Monitoring Sikkim Himalayan Cryosphere.

Sikkim has large concentration of snowfields and glaciers. Mapping and monitoring of seasonal snow cover and glaciers using field methods are very difficult in a mountainous terrain, like the Himalayas. Therefore remote sensing techniques have been used to monitor seasonal snow cover. The Sikkim Himalayan ranges feed river Tista of its fresh water, influencing the life pattern and economy of the Sikkimese and others in Eastern India. Seasonal snow cover is one of the important natural resources of the Himalayas. Snow Cover represents a major storage of fresh water, which is released during the spring-melt period. The high surface reflectivity of snow makes albedo and area study an important component of earths radiation balance. The study shows distribution of snow cover in Sikkim and two sub basins- Tista and Rangit for 4 years; from 2004 to 2008.Snow cover has been monitored using Advanced WiFS data of RESOURCESAT-I. The sensor is suitable due to high temporal frequency of 5-day intervals, better radiometric resolution and detection of snow under shadow has facilitated monitoring of snow in Sikkim Himalayas. Approximately 200 imageries have been monitored in the Tista Basin, in a fully automatic mode using Normalised Difference Snow Index (NDSI) algorithm. In the Tista basin of Sikkim, maximum extent was 50% in the month of February. Two peaks in the snow accumulation were observed in the months of November and February. Snow areal extent is comparatively high (35-40%) even in the summer months, indicating different snow accumulation and ablation pattern in Sikkim as Compared to Western Himalayas. Similar snow depletion curves has been observed in the sub-basins i.e, Tista and Rangit. Monthly mean and Yearly mean of Composite snow cover has been generated in this study. Data was not available from May onwards due to cloud cover.


TISTA BASIN (10 DAILY)
100
75
50
25
0
% Areal Extent of Snow
03-Oct-04
03-Dec-04
03-Feb-05
03-Apr-05
Date

5 DAILY SNOW COVER IMAGES: TISTA BASIN

DATA USED DECEMBER 2004

SNOW

40 20 0 40

Kilometers

Joint Collaboration Project on Climate Change Research in Terrestrial Environment (PRACRITI) with Space Application Center, Department of Space, Govt. of India:

The Sikkim State Council of S & T jointly with the Space Application Center, Department of Space, Govt. of India has undertaken a project on Climate Change Research in Terrestrial Environment (PRACRITI).

The objective of the project has the following components:

1. Mass balance of selected glaciers in Tista basin;
2. Retreat estimation of selected glaciers in Tista basin;
3. Glacier depth estimation using Ground Penetrating Radar.

The project duration is of three years starting from 2010. Work is in progress for mapping and model creation of snow and glacier extent in Sikkim Himalayas and its response to climate change. The work has following components:

- Development of models to assess response of snow and glacier extent to climate change.
- Development of snow and glacier melt runoff model and to assess future changes in stream runoff.
- Validation of models by field investigation.
- Mapping of moraine-dammed lakes in the Himalayan region.

Study regarding impact of Climate Change on Large Cardamom in Sikkim

Large Cardamom (*Amomum subulatum* Roxb.) is the most important cash crop of Sikkim. India has been the largest producer and exporter of large cardamom, however, the area and production of large cardamom has been decreasing in the recent years and in context of Sikkim, the production is rapidly decreasing at alarming rate.

In the present study, total of 141 cardamom fields were visited all over Sikkim, which comprises 56 fields in North, 69 Cardamom fields in East and 16 fields in West Sikkim. A standard Performa /Data collection Sheet was used for the collection of data which includes location, altitude, land and soil description, production and diseases, vegetation details in different cardamom fields and climatic study of different areas. Using GPS, the locations, Aspects and Elevation of the different areas were collected.

The work includes study of pollinators, temporal and environmental variations, distribution of rainfall, temperature, anthropogenic activities and water drainages etc.

The study indicates that not only the large cardamom but the other important crops like apples, ginger, potatoes etc are also affected. Furthermore, it is realized that elaborative and intensive studies is required to study the impact of climate change on livelihoods of the people at the community level.

Study regarding Climate change and perception of society in Sikkim:

A socio-economic survey was conducted in all the districts of Sikkim taking at least three villages in each of the district and interactions with inhabitants were carried out and data collection sheet were filled. Farmer perceptions on the related issues of climate change recorded. Impact of climate change on various fields like society, agriculture, economy, hydrology, environment, rainfall, temperature, rise in level of mosquitoes etc, were studied and correlated in the report.

A Standard Performa (Questionnaire) was prepared and survey was conducted. GPS (Global Positioning System) was used to determine location, altitude, Slope and aspects of the study areas of Sikkim.

Most of the respondents agreed that climatic, environmental and phonological changes are common nowadays in Sikkim. The work includes surveying of rainfall pattern, incidence of mosquitoes in winters, seasonal variation in temperature, drying of water springs, fluctuating spring season, production of large cardamom and phenology.

Programme regarding preparation StateAction 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:

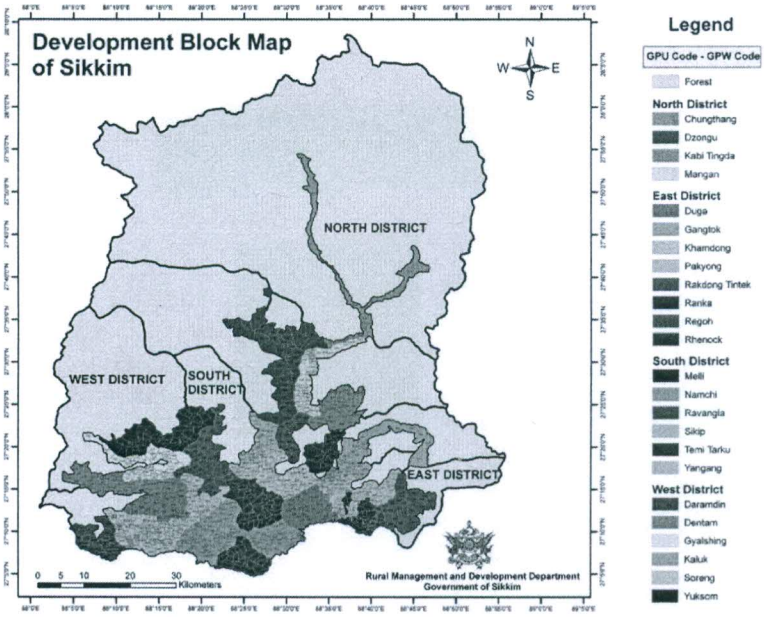
- Steps taken towards preparation of Sikkim State Climate Action Plan
- Focus on

- Water resources;

- Agriculture, horticulture, livestock;

- Forests, Wild life and biodiversity;

- Protection of environment through promotion of Renewable energy and climate friendly urban habitats.



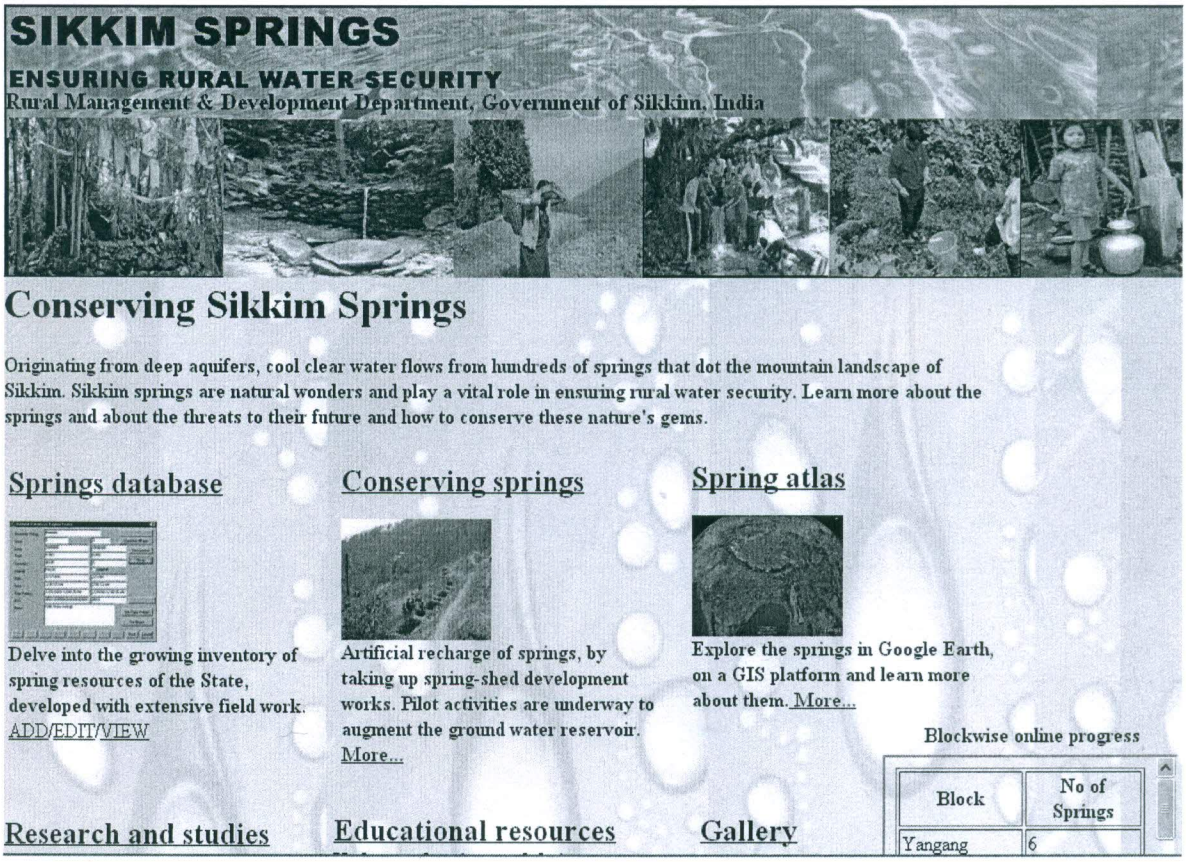
Percentage variation of monthly rainfall, maximum and minimum temperature averaged for the years 2006 to 2009, in comparison with long period average (LPA) for the period 1957-2005

Month	Rainfall	Max Temp	Min Temp
Jan	-73%	-0.1%	2.1%
Feb	-19%	0.3%	2.0%
Mar	-25%	-0.3%	1.5%
Apr	7%	-0.6%	1.4%
May	-26%	0.1%	1.4%
Jun	-8%	-0.4%	0.9%
Jul	-10%	-0.2%	1.4%
Aug	0%	-0.3%	1.0%
Sep	2%	-0.2%	1.0%

Oct	-40%	-0.3%	1.5%
Nov	-24%	-1.0%	1.6%
Dec	-39%	-0.7%	2.1%

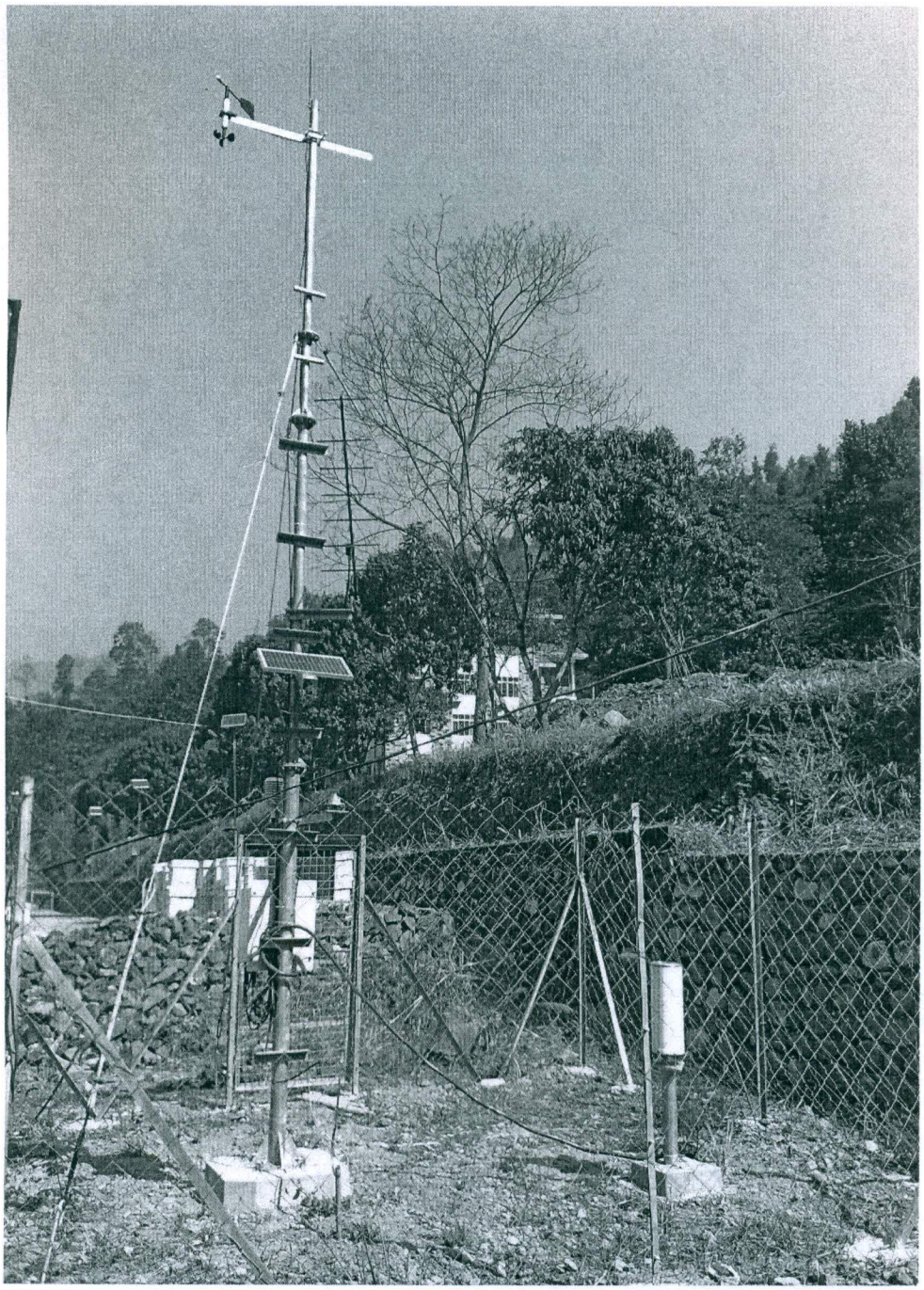
(Source Seetharaman K. pers. Communication, 2010)

www.sikkimsprings.org

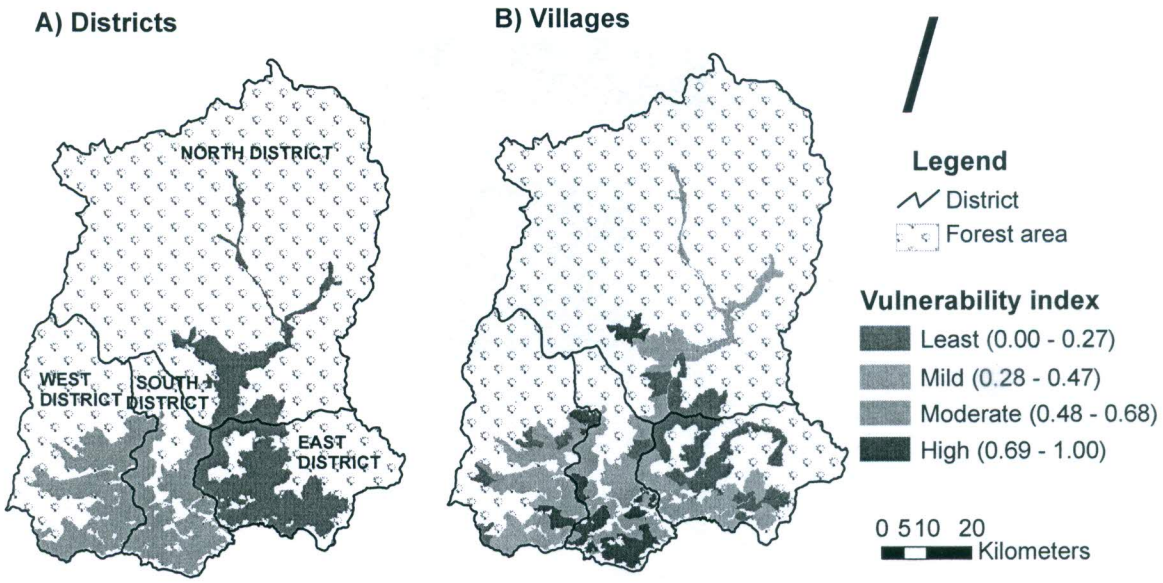


Monitoring Framework:

10 Automatic Weather Stations functional since 2009
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 todays prices

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.

Inter-cooperation Social Development, India has 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.

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).

Timelines for preparation of climate change action plan:

- Formulation of working groups - ……..2010
- Formulation of outlines of sectoral papers……Sept 2010
- Orientation programme for personnel of concerned departments, NGOs, educational institutions involved in the preparation of SAPCC……January 2011
- Draft sectoral papers prepared and reviewedMarch 10, 2011
- Transposing final sectoral paper material in the State action plan as per the format provided by the MoEF……March 20, 2011
- Circulate for comments to the state personnel and Finalization of SAPCC……..March 25, 2011
- Presentation to Chief secretary…… last of week of March 2010
- Communicate SAPCC to MoEF……..31st March 2011

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.

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.

Bio-Resources, Biotechnology Research and Tissue Culture Facilities:

Following programmes have been initiated:

Project on "Ecological studies of Sea buckthorn and Genetic Diversity of *Frankia* Associated with it in Sikkim:

The Department of Biotechnology (DBT), Ministry of Science & Technology, Government of India has sanctioned a Project titled '**Ecological studies of Sea buckthorn and Genetic Diversity of**

***Frankia* Associated with it in Sikkim'** to the Sikkim State Council of Science & Technology in January 2009.

The objectives of the project are:

- Collection and maintenance of *Hippophae* germplasm from Sikkim.
- Ecological and Taxonomical studies of native *Hippophae* and *Frankia* of Sikkim using descriptors.
- Analysis of soil of native *Hippophae* with reference to pH, moisture, amount of organic carbon, available nitrogen, calcium, magnesium potassium and phosphorus.
- Providing research materials like fruits, leaves, etc. of *Hippophae* to different institutes of the country under the DBT Network for biochemical research.
- Isolation of *Frankia* associates with roots of native *Hippophae.*
- Genetic diversity studies of *Frankia* spp. Associated with native *Hippophae* root nodules.

Details of various studies taken in the project are given below:

1. **Survey of Hippophae growing areas:**

The detail survey of the Hippophae growing areas of North Sikkim has been carried out and their distribution along with the density map has been prepared. This will enable to know the distribution pattern of the Hippophae plant and shall be a baseline to access the plant in different growing areas to carry further research. The Lachen and Lachung valley has the highest concentration of Hippophae in North Sikkim due to the favorable climatic and other geo-physico-chemical conditions. The survey to other similar places of the North Sikkim, East Sikkim and South Sikkim has been done. Few other places of North Sikkim has the sparingly distribution of Hippophae but not a single plant has been spotted in East Sikkim and South Sikkim by survey team.

2. **Collection and maintenance of Hippophae germplasm from Sikkim:**

An attempt to root the cuttings from the accessions of Hippophae to maintain the germplasm has been made but we are able to get the only the few rooted cuttings. We have already tied up with the State Forest Department and planning to establish a high altitude nursery. Forests Department has also maintained a Hippophae germplasm in their nursery without maintaining accession in the field and ready to provide to any research institutes within country for germplasm exchange.

3. **Ecological and taxonomical studies of native Hippophae and Frankia of Sikkim using descriptors:**

Ecological and taxonomical studies have been done using descriptor provided by DBT and total of about 40 plants has been accessed. 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.

4. **Analysis of soil of native Hippophae with reference to pH, moisture, amount of organic carbon, available nitrogen, calcium, magnesium, potassium and phosphorus.**

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 in order to

have a good understanding of the plants needs. The organic carbon content, available nitrogen, calcium, magnesium, potassium and phosphorus are yet to be done.

5. **Basic Bioactive Principal Study:**

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 has been made.

6. **Isolation of Frankia associated with roots of native Hippophae.**

Isolation of frankia from the root nodule of native Hippophae is being actively carried out at the laboratory using different frankia culture media and isolation techniques. The root nodules were collected from the Lachen, Lachung valley of North Sikkim and brought to the laboratory and cultured.

7. **Genetic diversity studies of Frankia spp. associated with native Hippophae root nodules.**

The genetic diversity study of Frankia is being carried out by the Principal Investigator of the project under his PhD programme with the support from the state government and the project.

8. **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. It was reported the occurrence of *Alnus nepaulensis* growing associated with H. salicifolia at an altitude of 7845 ft. at the Lachen valley of North Sikkim (Basistha et al, 2006). The study of the close area of the same place revealed that the A. nepaulensis has further migrated to higher altitude at 8438 ft. and found to be growing associated with H. salififolia in a ratio of 1.5:4. Comparative study of the other parameter of the same area in a particular time shows that the soil temperature, soil moisture, aerial temperature and humidity also increased over a period of time. ***The study also revealed that the A. nepalensis prefer to grow associated with the H. salicifolia.*** Since *A. nepalensis* is a temperate plant and is constantly migrating towards higher altitude with increase in temperature and is, therefore, considered a good indicator of climate change. A threat to the very survival of the *Hippophae* plant in the wild is also simultaneously sensed with the migration and close association of *A. nepalensis*. Since the *Hippophae* is a sun loving plant and needs high intensity light for the growth and development it is suspected that the fast growing *Alnus* may outgrow the *Hippophae* plant and come under the shade of it. Therefore, a further critical study is needed in order to save one of the wonder plant of the Himalayas. .

Patent Information Center:

Intellectual Property Rights (IPR) plays a key role in gaining an advantageous position in the competitive technological game for economic growth. India enjoys a large asset of R&D personnel and infrastructural facilities. Scientists and policy makers need more information orientation and facilities for protecting the products of intellectual prowess of Indian scientists. As a step in this direction, a single window Patent Information Center was created in 2002 under the Sikkim State

Council of Science & Technology, an autonomous body under DST, Government of Sikkim by the Department of Science & Technology, Government of India at the Technology Information, Forecasting and Assessment Council (TIFAC).

The objectives of this centre are:

- To create awareness about IPR, especially patents, in the neighbouring region of this centre and enable patent searches for the universities, industry, government departments and R&D institutions in the State and around;
- To analyze the patent information on a regular basis and suggest new programmes for R&D based on such information.
- Guide the inventors in respect of patenting their inventions.

Activities of Patent Information Centre, Sikkim. -2010-2011

- Article on Geographical Indication (GI), entitled "Concept of GI" has been published in the local paper of Sikkim "SIKKIM MAIL" dated 02/11/2010.
- *Awareness program and sensitization about Intellectual Property Rights has been organized* to the Science teachers during Jan 12th & 13th January 2011.
- Research article on A Lepcha Traditional Hat (*Sumok Thyaktuk*) in Dzongu Tribal Reserve Area, North Sikkim submitted and has been accepted for publication in Indian Journal of Traditional Knowledge (IJTK).
- A research article on IPR, "*A Future Prospective*; Intellectual Property Rights (IPR) in Sikkim Himalayas" has also been prepared for publication in the Research technical report of the Sikkim State Council of Science & Technology.
- An article on IPR with special reference to GI has been published in the local newspaper of the state, "Protecting local products through GI".
- A Radio talk on importance of IPR & potential of GI in Sikkim which was broadcast in the 'All India Radio Gangtok'.
- The draft proposal for registration of Geographical Indication has been prepared for following items and draft has been forwarded to the TIFAC, New Delhi for further suggestion and advice on technical part in the filing of GI for the first time from Sikkim Which includes:-

    1. **Sikkim Dzongu Lepcha Hat** *(Sumok Thyaktuk)* **&**
    2. **Sikkim Dzongu Lepcha Darri/ weave** *(Darrey/ Thokro)*
    3. **Sikkim Mandarin/Orange** *(Sikkim Soontala)*
    4. **Sikkim Temi Tea** *(Sikkim Temi Chiyaapati)*

► A draft Booklet on GI registration from Sikkim has been prepared for creating awareness.

► A questioners about IPR in local language of Sikkim for creating awareness on IPR among the peoples of the state has been prepared.

'DBT's mission for the production of Quality Planting Materials and utilization for the NE region' for the year 2009-2010.

The project titled 'DBT's mission for the production of Quality Planting materials and utilization for the NE region' was established on 31st December 2007. The project is being funded by Department of Biotechnology, Ministry of Science and Technology, Government of India and is coordinated by The Energy Research Institute(TERI), New Delhi.

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.

Training on Sikkim mandarin cultivation at Gangtok:

Two batches of training on mandarin cultivation with scientific management practices have been conducted. The training was organized jointly with Indian Council of Agriculture Research (ICAR), Gangtok and Sikkim State Council of Science & Technology scientific expertise.

The selections of progressive farmers had been done by identifying the mandarin growing areas of Sikkim and consulting the concern panchayats and area MLA. In total 41 progressive farmers had been selected and trained on mandarin cultivation with scientific management practices in two batches. Two year old quality, disease free saplings of Sikkim mandarin have been provided by Indian Council of Agriculture Research (ICAR) Complex, Sikkim Centre, Tadong, Gangtok on payment. The number of saplings to be taken by the individual farmer was decided by the farmer himself depending upon the availability of his land for plantation. The plants have been growing well and upto the satisfaction of the team and the farmers.

Distribution and demonstration of mandarin sapling in the farmers' field:

The selected farmers were provided with mandarin saplings on successful completion of the training. Two year old quality, disease free saplings of Sikkim mandarin have been provided by Indian Council of Agriculture Research (ICAR) Complex, Sikkim Centre, Tadong, Gangtok on payment. In total, 4500 sapling raised from nucellar seedling provided by ICAR, Sikkim unit have been distributed to the selected progressive farmers, which have been transplanted in their field covering an area of 10 hectare.

Field Monitoring:

Field visits on regular basis are being carried out to monitor the growth and other aspect of the plants. The survey was undertaken to various mandarin distributed areas of Sikkim such as Zoom, Pandam, Pachak, Rhenock, Yangang and Sumin. All the distributed saplings were found to be growing satisfactorily except in few cases weeding was not taken up seriously so farmers were advised to clear the area surrounding the mandarin plant. Regular weeding and maintenance of the mandarin plantation was advised to the cultivators. The plantation was done as trained and scientifically with support of local horticulture inspector.

Training on mandarin cultivation at Yangang, South Sikkim:

Training on mandarin (*Citrus reticulata* Blanco) cultivation was conducted at Yangang, South Sikkim. Farmers were selected through Block Development Officer (B.D.O.) and plantation was done through NREGA from Rural and Management Development Department (RMD & D), Govt. of Sikkim. The training was imparted to 25 farmers. As done in the previous year, it was conducted prior to distribution of planting material for the plantation in the farmer's field. The training was attended by scientist, experts, and officers from ICAR, Sikkim, Sikkim State Council and Block Administrative Centre, Yangang. The experts explained and gave demonstration on scientific agro-techniques.

The agro-technique imparted to the progressive farmers has been experimented for many years and was found suitable for the terrain/soil conditions of Sikkim.

The officials of Sikkim State Council and the project staffs demonstrated the methods of Bordeaux mixture preparation and informed the gathering that is allowed to use in organic cultivation. Bordeaux mixture is a multipurpose insect and disease controlling preparation. They can be used to control various diseases including fungal and bacterial diseases.

On 12th June, 2010, a hands on agro-techniques for Citrus (Mandarin) cultivation was conducted by Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change in middle Tarku, south Sikkim. 22 progressive farmers from the middle Tarku participated in the training.

Distribution and demonstration of mandarin:

On completion of training the farmers were advised to do the pit digging and prepare the compost as per the technique imparted in the training. They were provided with mandarin saplings for the plantation in their field. The plantation was done under the supervision of local horticulture inspector and the scientists of Sikkim State Council. In total only 1500 saplings were provided to them covering 4 hectares.

Field Monitoring:

The survey was undertaken to Yangang where quality planting materials of mandarin was distributed. Saplings were found to be in satisfactory condition. Regular weeding, manuring and mulching of the mandarin plantation were advised to the cultivars.

Distribution and demonstration of large cardamom in the farmers' field:

Training on large Cardamom cultivation was conducted on 18th June 2010 in upper Lingmoo, south Sikkim by Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change. The training was part of Department of Biotechnology funded project Quality Planting Material and utilization for North East.Dr.Utpal Gupta from Sikkim Spices Board along with scientists of SikkimState Council of Science & Tecnology trained the farmers.

Total of 11 progressive farmers were provided with 5000 large cardamom suckers on successful completion of training. The plantation was done as per the instruction provided to them during the training. In total 6 hectares area was covered.

Field Monitoring:

Field visits was done to Raigaon, Pakyong to undertaken the survey of large cardamom cultivation which was done through NREGA programme.

Training on ginger cultivation:

A training program was organized by Sikkim State Council of Science and Technology in collaboration with Indian Council of Agricultural Research, Sikkim Centre, Tadong on agro-techniques of scientific ginger cultivation on 12th March 2010. The training was imparted to 12 progressive farmers of Lower Sumin (BAC Duga). The farmers were selected through Block Development Officer (B.D.O.) from Rural and Management Development Department (RMDD), Govt. of Sikkim. Demonstration and distribution of Ginger (*Zingiber officinale* Rose) was done with the help of concerned scientist of ICAR Gangtok. The Secretary, Department of Science & Technology, while addressing the gathering, urged the farmers to strictly follow the instructions given by the scientist during the training and observe the differences in production both in terms of quality and quantity. He also requested them to not to mingle the quality rhizome provided to them with the local rhizome. Dr. H. Rahman, Joint Director, ICAR also addressed the gathering and highlighted the programs undertaken by them for the benefits of this region.

Distribution and demonstration of ginger rhizome:

On completion of the training, the 12 farmers were provided with one quintal each quality rhizome produced by the farmers who has adopted the same methods. With this method the farmers can produce healthy, disease free rhizomes and increase the production up to eight folds.

Field Monitoring;

A field visit to Lower Sumin was done for monitoring of Ginger's field. The fields were in good conditions. Farmers have cultivated as being taught in the training held in ICAR.

Other activities:

Multiplication of large cardamom suckers:

Multiplication of large cardamom through suckers' development was carried out in the ICAR farm under joint supervision in 2008. In total 2000 suckers were planted in the ICAR farm for further multiplication.

Multiplication of nucellar seedlings of Sikkim mandarin (*Citrus reticulate* Blanco) and *C. jambhiri* through *in-vitro* culture:

In vitro cultures of nucellar seedlings of Sikkim mandarin is being done in the laboratory of Sikkim State Council from the selected mother trees, which are 20-30 years of age with superior accessions.

Root stocks of rough lemon (*Citrus jambhiri*) is also being produced through *in-vitro* culture for local root stock production, which is showing positive results even after transferring to the hardening shade.

Research publication on Sikkim mandarin:

"Effect of various cultural conditions on in-vitro germination of immature seeds of *Citrus reticulata* Blanco" in the Journal of Hill Research

"**Effect of growth regulators in *in-vitro* multiplication of nucellar seedling in Citrus reticulata Blanco**" in the journal of Hill Research

Development of hardening technology of Sikkim mandarin:

The hardening technology of in-vitro cultured seedling of *Citrus reticulata* and *Citrus jambhiri* has been developed with 98% survival rate.

In total 129 beneficiaries were benefited from the project funded by Department of Biotechnology, Government of India, which is being executed by Department of Science & Technology, Govt. of Sikkim. The project covered an area of about 30 hector of land for cultivation of large mandarin, large cardamom and ginger.

Sikkim Bioinformatics Center (Distributed Information Sub Center):

The Department of Biotechnology, Government of India has sanctioned a project entitled "Distributed Information Sub Center (DISC)" in the year 2001.

The objectives of the Project are:

- To provide a national bio-information network designed to bridge the inter-disciplinary gaps in biotechnology information and to establish link among scientists in organizations involved in R & D and manufacturing activities in biotechnology.
- To build up information resources, prepare database on biotechnology and to develop relevant information handling tools and techniques.
- To continuously assess information requirements, organize creation of necessary infrastructure and to provide information and computer support services to the national community of users.
- To establish linkages with international resources in Biotechnology Information (e.g. Databanks, published literature, patents and other information of scientific and commercial value).
- To evolve and implement programmes on education and training of information scientists responsible for having biotechnology information and its application to biotechnology, research and development.
- To develop, support and enhance public information resource for biotechnology e.g. Gene banks, molecular biology data and related research information resources.
- To undertake preparing and publishing survey, state–of–the- art reports and forecasts for several branches of the sector.

IMPORTANT ACTIVITIES:

- Fourth Volume of the news letter "BIOGYAN" has been published online at our website: http//www.bioinformaticssikkim.gov.in. Release of the fifth new paper is under progress.
- Online Access of journals provided by Delcon through Department of Biotechnology, Government of India has been activated and is being used by the researchers and scholars. Wide publicity amongst the scientific fraternities of different scientific institutes, colleges, government departments, doctors of hospitals, etc has been made through print media and information letters.
- The centre has prepared a scientific profile of more than 55 scientists and researchers working in Sikkim, which is helping the scientific mass to make a healthy interaction regarding their specific research works. The profile has been made online in centre's website www.bioinformaticssikkim.gov.in

- The centre has prepared a Bibliography of research articles on Bio-resources of Sikkim Himalayas.
- Reprints of animation CDs on life processes developed by the center which was released earlier was done as per the increasing demand by the teaching faculties. The CDs are being distributed to different schools and colleges after demonstration to be used as teaching aid to have a pragmatic approach of teaching.
- The Center has prepared a compiled book Volume 3rd and 4th of published research papers on Bio-resources of Sikkim which has been very helpful for the researcher throughout the world.
- Preparation of Animation using flash on Human Immuno Deficiency Virus for sensitizing the youth and students on Acquired Immuno Deficiency Syndrome has been developed final editing of the animation is under progress.
- Up gradation of the centers website is done on regular basis.

WORK SHOP/ TRAINING/MEETS ATTENDED:

- Centre's Technical Assistant has attended North East NEBInet meeting held from 11th – 12th November, 2010 in IBSD, Imphal, Manipur.
- Technical Assistant has attended the online e-Journal training conducted by DELCON with the support of Department of Biotechnology, Government of India on 13th November, 2010, at IBSD, Imphal, Manipur.
- Assistant Scientific Officer attended symposium and All India Coordinators' Meet at Pondicherry University on 2nd-4th February 2011.

PUBLICATIONS:

Articles

- Gurung. Priya Darshini; Gurung. Rabina; Basistha. B.C , Sharma. Prakash and Lepcha. Laydong. Bioinformatics an overview.Biogyan,vol-IV,3-7.
- Sharma.Manjila, Antifungal activity of *Cymbopogon citratus* (DC) Stapf. against sour rot disease of tomato caused by *Geotrichum candidum* Link.. Biogyan,vol-IV,8-12
- Lepcha. Laydong, Basistha. B.C, Gurung. Rabina, Gurung. Priya Darshini, Sharma. Prakash.H1N1 Influenza virus. Biogyan,vol-IV,13,14
- Lepcha, Laydong. Understanding Bioinformatics. 24th & 26th September, 2010, Daily News Bulletin, Sikkim Express.

Recent Research publications

- Sharma,M. Pradhan,S. Subba,K.B. & Basistha, B.C. Effect of Growth Regulators on the *in-vitro* Multiplication of Nucellar Seedlings of *Citrus reticulate* Blanco. Journal of Hill Research. Vol.22,No.2, 2009.pp.110-113
- Sushen Pradhan, Manjila Sharma, K.B.subba and B.C.Basistha. Effects of various cultural conditions on in-vitro germination of immature seeds of *citrus reticulata* Blanco. Journal of Hill Research.22(1):39-42,2009
- Basistha, B.C., Sharma, N. P., Lepcha. L; Arrawatia. M.L, and Sen, A. Ecology of *Hippophae salicifolia* D. Don of Temperate and Sub Alpine Forests of North Sikkim Himalayas – A case study- Paper accepted for Journal of Symbiosis, USA Inc.

- Shri.B.C.Basistha presented .Understanding agro- techniques of Sea buckthorn in Sikkim Himalayas. Proceedings of International Sea buckthorn Association Conference (ISA) 2009 at Belukuriha , Russia held from 1st-6th September 2009.

Documentation of traditional ethno-veterinary practices and its formulations:

The Department of Science & Technology, Government of India has approved a project in March 2010 entitled **'Documentation of traditional ethno-veterinary practices and its formulations'** to the Sikkim State Council of Science & Technology .The project will be started shortly.

The objectives of the project are:

- Resource survey and documentation of the ethno-veterinary and its formulation;
- Database creation on ethno-veterinary & its formulation;
- Awareness generation on ethno-veterinary amongst the tribal of rural areas;
- Creation of digital library for ethno-veterinary.
- The execution of the project is being initiated with the field survey cum documentation of ethno-veterinary practices and its formulations of Rongli Sub-Division, East Sikkim from 25th September 2010 to 10th September 2010. During research survey numerous ethno-veterinary practices and its formulation has been recorded from the three ethnic communities of Sikkim viz. *Lepcha*, *Bhutia Nepalese*. Total 50 traditional practitioners have been successfully interviewed and the informants audio visual record of these practitioners has been made accordingly. The traditional method for rearing cattles is also being documented simultaneously. The plants which is being used for the veterinary purposes is completely recorded with its basic formulations. The detail of the informants is also recorded for further studies and the GPS data of every place visited marked. A research paper entitled' *Ethno-veterinary practices and its formulations of some selected parts of East Sikkim with special reference to Rongli Sub-division'* of the survey is being appreciated by the peer reviewer and is already being accepted by National Institute of Science Communication and information Resource (NISCAIR) to publish in one of the leading journal on traditional knowledge the **'Indian Journal of Traditional Knowledge'**.

Mapping and Quantitative Assessment of Plant Resources of Sikkim as a part of Eastern Himalayan Region:

The Department of Biotechnology under the Ministry of Science & Technology, Government of India has sanctioned a project entitled 'Mapping and Quantitative Assessment of Plant Resources of Sikkim as a part of Eastern Himalayan Region' to Sikkim State Council of Science & Technology.

The main objectives of the project are:

- Quantitative assessment of the geographic distribution and population status of the plant resources of the Sikkim Himalaya.
    a. Enumerating the plant resources, their population levels and structure in the Sikkim Himalaya.
    b. Developing thematic maps of the density and distribution for Sikkim Himalaya.
    c. Quantitative estimation of available resource levels of plants of Sikkim Himalaya.
- Identifying the threats on plant resources and enlisting the threatened species.

a. Identifying the threats on the specific plant resources in Sikkim Himalaya.

b. Reviewing the existing opinion-based RED list and arriving at an objective and data-based RED list of the plant species of economic importance in Sikkim Himalaya.

- Setting up Sikkim Himalayan Eco-Region specific database on plant resources.

a. Combining the database from the field survey of the project with the secondary data sources already available.

b. Setting up a suitable programme systems for updating the retrieving the datasets in spatial and digital forms by the end users.

c. Analyzing the spatial and temporal patterns of change in specific plant resources in Sikkim Himalaya.

The orientation training under the project has been completed with the support of Prof. Uma Shanker, Department of Botany, North Eastern Hill University, Shillong. More than 240 field sample plots are required to be carried out. The field work is in progress.

The first major survey for the mapping of the plant resources was successfully conducted from 13th April 2010 to 3rd with the laying of transect quadrate of 250 m to 350 m length and 10 m breadth. The second major exploration was from 3rd July to 21st July 2010. Altogether 19 grids (Sk00N1 to SKOON19) have been covered. During the survey many plant species and their population has been recorded including trees, herbs, climbers and others. Besides Angiospermic plants various species of *Pteridophytes*, *Gymnosperms*, *Mushrooms* and other grasses has been recorded. The processing and preservation of all specimens is being done at the herbarium of Botanical Survey of India (BSI), Gangtok. Majority of the plant species is being identified at the field level however some species needs to be identified with the help of BSI. The exploration tour was done by the team lead by Project P.I. Shri S.R. Lepcha and the field staff under Remote Sensing cell of DST, Sikkim. During the survey, the places covered as per the grid prepared from the GIS & Remote Sensing laboratory from Bakcha (Kabi) to Yumey Samdong (Lachung) including Dzongu Restricted area. The total length of the quadrate covered is not less than 100 m.

Cane (Rattan) Conservation and Promotion of cane Handicraft for sustainable livelihood of Dzongu Tribal Reserve Area.

The project entitled '***Cane (Rattan) Conservation and Promotion of cane Handicraft for sustainable livelihood of Dzongu Tribal Reserve Area'*** is being sponsored by the DST, GOI for the period of three years (2010 to 2013).

The objective of the project is:

1. Creation of cane propagation nursery
2. Introduction of improved technique for propagation of cane through seed.
3. Value addition and diversification of local traditional cane products for sustainable livelihood.
4. Awareness generation and conservation of cane species through training of farmer
5. Creation of '*Germplasm'* for rattan diversity of Sikkim.

The total 8 cane species exist in Sikkim. Out of which a local species *Calamus acanthopodius,* which is identified as most durable is certainly facing now a serious threat due to overexploitation and unsystematic collections for foods and others. The scientific propagation of C. *acanthopodious* shall be done through matured seeds to reclaim /aforestation of the cane population in the wild forest of Sikkim. A Local Project Advisory Committee has been framed to monitor the smooth progress of the project. The 2 sites has been located for nursery development at Hee Gyathang

lower Dzongu, North Sikkim and at Sazong, Rumtek Gangtok east Sikkim is being identified. The installation of the nursery is for propagation of cane and its demonstration to the farmers and the trainees if necessary.

Construction of Biotechnology Research and Application Center at Sajong:

Under the Biotechnology mission, initiatives have been taken by the Government of Sikkim for construction of Biotechnology Research and Application Centre at Sajong, Rumtek, East Sikkim. Further, sheds/green houses/polyhouses using state of the art technology are also being set up in this centre in addition to modern raised bed nursery. Emphasis is given to tissue culture/vegetative propagation of rare and endangered and economically important plants.

The main building of the centre has been completed. Setting up of various laboratories, greenhouses and polyhouses are being taken up. Experimental trial of lemon grass, mandarin and large cardamom has been taken up. On 24th June 2010 Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change observed 10 minutes to earth by conducting plantation in Sajong, Rumtek. Around 800 saplings were planted.

Establishment of State Biotech Hub (SBThubs) under Sikkim State Council of Science & Technology by DBT under special programme for North Eastern States of India:

The Department of Biotechnology, Government of India has recently sanctioned a three years project at a cost of Rs. 304 lakhs for establishment of State Biotech Hub (SBThubs) under Sikkim State Council of Science & Technology by DBT under special programme for North Eastern States of India.

The main objective of State Biotech Hub will be having major biotechnology infrastructure facilities for training as well as providing support to research and to develop linkages with all the institutional hubs on biotechnology in the state. The instruments worth Rs. 200 lakhs will be provided under the programme. The provision for traineeship and studentship and the JRS/SRF will also be provided in this project. The programme will be coordinated by North Eastern Region Biotechnology Programme Management Centre (NER-BPMC) Biotech Consortium India Limited (BCIL) at national level.

Setting up of a Bio-incubator in Sikkim

The matter has been pursued with the Department of Biotechnology, Government of India for setting up of Bio-incubator in Sikkim. Recently, the Department of Biotechnology, Government of India has provided funds to Biotech Consortium India Limited (BCIL) New Delhi for preparation Detail Project Report for setting up of Bio-incubator at Marchak near Science Centre, East Sikkim. Once the detail report is ready, the matter will be pursued with the DBT for providing funds for various facilities for setting up of Bio-incubator in Sikkim.

A pilot technology demonstration Micro Hydel Project in Alpine areas at 12,000 ft.

A revised sanction has been conveyed by the Department of Science & Technology, Government of India for a sum of Rs. 606.40 lakhs for the above said subject with guidelines of 90% Central share & 10% State share which entails Rs. 5,45,76,551/- and Rs. 60.64,061/- respectively. Out of the proposed amount, a sum of Rs. 3.00 crore have been released and work will be taken up in the field by the Energy and Power Department with coordination of Science & Technology Department.

In this project, a 2X100 KW micro hydel station will be set up in Thangu village of North Sikkim. This project has a huge potential in alpine area of North Sikkim.

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.

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.

List of Paper published or under publication:

Sl. No	List of paper	Status of Paper	Authors of paper
1.	*Frequency studies of different shade trees in large cardamom plantations of three districts of Sikkim together with shrubs, herbs and climbers*	Published in East Himalayan Society of Spermatophyte Taxonomy, PLEIONE, December 2010	Radha Krishna Sharma, Dharmendra Lamsal, Narpati Sharma, D.G.Shrestha, M.L. Arrawatia
2.	*Study of Forest Fires of Sikkim Himalayas using Remote Sensing and GIS Techniques*	Presented at International workshop on Biodiversity and Climate change at IIT Kharagpur w.e.f. December 19-22, 2010 (Abstract Volume published)	Narpati Sharma, Radha Krishna Sharma, Keshar Kr. Luitel, M. L. Arrawatia, D. G. Shrestha, Safal Pradhan
3.	*Study of Suitable Areas for Mulberry Food Plants for Sericulture Development in South Sikkim using Remote Sensing and GIS Techniques*	Accepted for the Geomatrix 2011 Conference at IIT Mumbai w.e.f. February 26-27, 2011	Radha Krishna Sharma, D.G. Shrestha, Narpati Sharma, M.L. Arrawatia, Pranay Pradhan
4	*Landslides hazard zonation along NH31A in between rangpo and Singtam in Sikkin:A RS and GIS based apprroach*	Accepted for the Geomatrix 2011 Conference at IIT Mumbai w.e.f. February 26-27, 2011	Pranay Pradhan, N.P. Sharma, Radha Krishna Sharma, D.G. Shrestha, M.L.Arrawatia
5	*Climate change and us: A Preliminary statistical report on Human health*	Send to: *Biodiversity: A sustainable use in Sikkim Himalaya,* SSCST.	Radha Krishna Sharma, M.L. Arrawatia, D.G. Shrestha
6	*Regeneration of Citrus reticulate.Blanco through nucellar culture from immature fruits*	Published in Journal of Hill Research.	Sushen Pradhan
7	*Comparative study of nodulation in Hippophae salicifolia D. Don in riverine and non-riverine areas in Lachen valley of north Sikkim*	Proceeding, National Conference on Sea buckthorn, Palampur, Emerging trends in Production to	Sushen Pradhan, B.C. Basistha, Srijana Chettri, Radha Basnet, K.B. Subba

8	*Association & Migration Studies of Alnus nepalensis D. Don and Hippophae salicifolia D. Don. Indicating Climate Change in Lachen valley of North Sikkim.*	Proceeding, National Conference on Sea buckthorn, Palampur, Emerging trends in Production to Consumption February 16- 18, 2010 page 19-20.	B.C. Basistha, Sushen Pradhan, Srijana Chettri, Radha Basnet, K.B. Subba
9	Effect of Growth Regulators on the *in-vitro* Multiplication of Nucellar Seedlings of *Citrus reticulate* Blanco	Journal of Hill Research. Vol.22,No.2, 2009.pp.110-113.	Sharma,M. Pradhan,S. Subba,K.B. & Basistha, B.C.
10	Effect of various cultural conditions on in-vitro germination of immature seeds of citrus reticulata Blanco.	Journal of Hill Research. Vol.22,No.1, 2009. Pp.39-42.	Pradhan, S., Sharma,M. Subba, K.B.& Basistha, B.C.
11	Study on Type and Distribution of Wetlands of Sikkim Himalayas using Satellite Imagery with Remote Sensing & GIS Technique	Paper presentation (Presented) International conference 'Lake 2010' at Indian Institute of Science (IISc), Bangalore on 23rd December 2010.	Narpati Sharma, Safal Pradhan*, M. L. Arrawatia and D.G. Shrestha
12	Traditional *Lepcha* craft *Sumok-thyaktuk* (*Lepcha* Hat) and its conservation in Dzongu Tribal Reserved Area (DTRA), Sikkim, INDIA	Indian Journal of Traditional Knowledge (NISCAIR) publication	S.R.Lepcha* R. Gurung & M.L. Arrawatia Accepted
13	"A future perspective"; An intellectual property rights in Sikkim Himalayas	Biodiversity Journal to be publish from Department of Science and Technology, Gangtok	Rajdeep Gurung, S. R. Lepcha, B. C. Basistha, M. L. Arrawatia Submitted

14	Ethno-veterinary practices and its formulations of some selected parts of East Sikkim with special reference to Rongli Sub-division.	Indian Journal of Traditional Knowledge (NISCAIR) publication	Dhanraj Chettri *, S. R. Lepcha & M.L. Arrawatia Accepted
15	The Genus Juncus (Tourn.) L. in East Sikkim (India) with special reference to Pangolakha Wildlife Sanctuary .	East Himalaya Society of Spermatophyte Taxonomy, NBU, W.B. (India)	S.R. Lepcha, G. chettri, A.P. Das Published in *Pleione* (Vol-1, No-2, 2007.
16	Diversity and Distribution of bamboos in Pangolakha WildLife Sanctuary in Sikkim, India	East Himalaya Society of Spermatophyte Taxonomy, NBU, W.B. (India)	Sonam R. Lepcha, Tika Prasad Sharma and A.P. Das Published in *Pleione*
17	Snow accumulation and ablation pattern in Sikkim Himalayas.	NATIONAL RESEARCH CONFERENCE ON CLIMATE CHANGE, IIT Delhi. 5-7th March 2010. Presented paper at the conference. (website publication:www.cseindia.org)	SMRITI BASNETT, A.V. KULKARNI B.P.RATHORE , M.L.ARRAWATIA, DHIREN .G. SHRESTHA .
18	Monitoring Sikkim Himalayan Cryosphere.	Paper presented at International Symposium 'Benefiting from Earth Observation',organized by ICIMOD, 4 - 6 October 2010, Kathmandu, Nepal. (to be published in the	SMRITI BASNETT, A.V. KULKARNI , B.P.RATHORE , M.L.ARRAWATIA, D .G. SHRESTHA .

		proceedings of ICIMOD journal)	
19	Comparative study of Plant Biodiversity and Physico-chemical parameters of soils of Landslide prone areas	International Jounal of Ecology and Development. Vol. 17,No.F10, February 2010	*Lepcha,L., Mandal,P. Misra,T.K. and Sharma, N.P.
20	Relative distribution pattern of Tree Biodiversity in Landslide prone areas of east Sikkim, India.	International Journal of Research in Environment and Life Science. Vol.2(4) 201-206(2009)	Laydong Lepcha*1, P. Mandal 2 and T.K. Misra3
21	Plant Biodiversity and soil erodibility of landslide prone areas of east Sikkim	Journal of Ecobiology	Lepcha,L., Misra,T.K. Mandal,P. and Ansari, A.A.
22	Relationship of Biodiversity with soil parameters and vegetation buffers at Landslide prone areas of Sikkim.	Journal of Hill Research, 22(1): 43-49,2009.	Lepcha,L., Misra,T.K. and Mandal,P.
23	Ecology of *Hippophae salcifolia* D.Don of temperate and sub-alpine forests of North Sikkim Himalayas- a case study.	Journal of Symbiosis, Srpinger Science, Published online: 04 December 2009.	Basistha, B.C., Sharma,N.P. Lepcha,L. Arrawatia, M.L. Sen,A.
24	Documentation of medicinally important plants from the Landslide prone areas of East Sikkim,India: A survey	*(SUBMITTED ON INVITATION: February 2011)* Journal of Phytology (Japan)	Laydong Lepcha [1*], Sanjoy Guha Roy [2], Abhijit Sarkar [3], Bharaat Chandra Basistha [4] and Murari Lal Arrawatia [4]

Name: Radha Krishna Sharma
Designation: Junior Research Fellow

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Training Attended in the year 2010

- Attended On- job training on application of Remote Sensing and GIS in Sericulture development in NESAC, Umiam, Meghalaya from 18th April – 05th May 2010.
- Attended *"International Workshop on Biodiversity and Climate Change 2010"* at IIT Kharagpur, West Bengal from 19th December – 22nd December 2010.

Name: Sushen Pradhan
Designation: Junior Research Fellow

Training Attended

1. Training on Bioactive analysis of *Hippophae salicifolia* for three weeks at Kerala, Amrita University, Kollam.

2. Six months training on Molecular Studies of *Frankia* in Botany Department of North Bengal University, Dist. Darjeeling, West Bengal.

3. One month training on molecular studies of *Zingiber officinale* of Sikkim in Biotechnology Department of Guwahati University, Guwahati ,Assam.

Name : Safal Pradhan
Designation: Junior Resarch Fellow

TRAINING UNDERGONE:

- Two weeks training program on Remote Sensing and GIS, sponsored by ISRO and conducted by Sikkim Manipal Institute of Technology, Majitar from 16th to 27th November 2009.
- Four day training on statistical software 'SPSS v16.0' at Rural Management Development Department, Govt. of Sikkim from 11th October 2010 to 14th October 2010.