Biotechnology Division

Background

Biotechnology division was created with the objective to undertake research and development work on biotechnology, its promotion in the state and sustainable utilization of biological resources with its application. Biotechnology in the state made its beginning with the establishment of tissue culture laboratory in 1994 as then under the state forest department which was later transferred to Science and Technology along with existing manpower in 1998.

Achievements:

A. Established state-of-art molecular biology laboratory at Vigyan Bhawan:

With the humble beginning with a tissue culture laboratory, the division has made significant

progress and established state of art biotechnology laboratory in the state. With its establishment a solid foundation of biotechnology in the state is laid. The exploration and sustainable utilization of state's rich bioresources and their sustainable utilization through the application of biotechnological tools has now become possible. This is considered as our biggest achievement. The facilities is being utilized for research and training by the researcher, students and professors. Number of training on molecular biology has been conducted and is a first such training started in the state. Many research papers has been published in national and international journals.

B. Establishment of Biotechnology Research and Application centre at Sajong, Rumtek

Established state-of-art biotechnology laboratory including plant tissue culture laboratory at Sajong, Rumtek with the experimental field in 5 acre of land. The centre has main laboratory

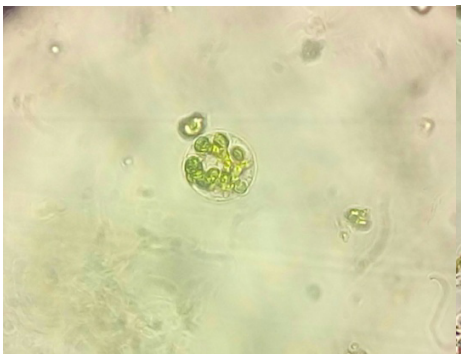
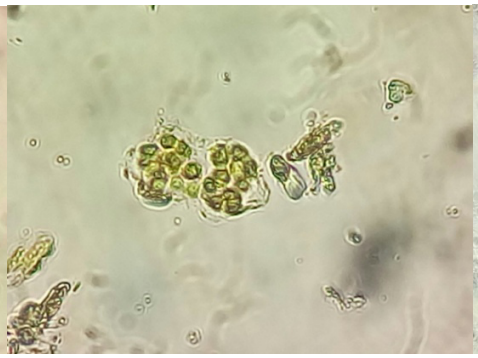
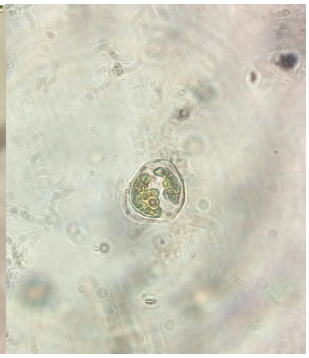
building with offices, hi-tech greenhouse, poly-house, shed-house chowkidar quarters and field. The laboratory and the field is used for research and training. The centre has multiplied some rare orchids of Sikkim like *Cymbidium whitae*, *Cymbidium eburneum* and also commercial orchids, medicinal plants etc. The laboratory has developed an intermediate flowering vanda by crossing cool growing vanda with warm growing vanda. The orchid is under multiplication in the laboratory. The centre has maintained germplasm of large cardamom with most of the available cultivars for research and training. The experimental field is used for research on Azolla cultivation and its application, improvisation of large cardamom cultivation method, SRI method of rice cultivation, natural farming etc.

The pioneer work of plant tissue culture in the state was carried out in our laboratory and successful initiation and multiplication protocols of economically important plant species such as

orchids, cardamom, medicinal plants has been developed. The establishments of government and private labs are the direct or indirect results of our successful laboratory. Such venture was an unsuccessful both in the private and public sector before in the state. Now, number of successful private as well as government laboratory has been established and producing quite a good number of plants. This, it is considered as a positive impact made by the laboratory. The laboratory has imparted number of training on plant tissue culture and nursery techniques to the entrepreneurs. Some of them have established laboratory and nurseries. The tissue culture protocol for the following plant species has been developed:

1. Cymbidium orchids of both species and hybrids
2. Phalaenopsis orchids
3. Vanda orchids
4. Dendrobium orchids
5. Lyscaste orchids
6. Large cardamom of all cultivars
7. Banana species/hybrids
8. Cane
9. Ginger
10. Citrus
11. Stevia
12. Asparagus

The laboratory is working on the development of resistant variety of large cardamom through protoplast fusion, cell culture and some significant progress has been made.

Isolated protoplast from large cardamom Protoplast fusion After fusion

Besides laboratory work, the centre has developed and maintained germplasm of large cardamom, ginger and herbal garden for research and educational purpose. The centre has maintained 7 cultivars of large cardamom and 6 cultivars of ginger and numbers of medicinal plants are being planted in the herbal garden. The centre is also working on the new type of farming method which may give a strong support to the organic mission of the state.


New method of farming Germplasm of large cardamom maintained at Sajong farm

C. Projects implemented

Ongoing projects:

Under the Biotechnology Division, there are two Government of India funded established centres.

I. Bioinformatics centre

Background

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

Research Area: Biodiversity, Biotechnology and Bioinformatics

Activities

Bioinformatics centre since its establishment conducted number of trainings, workshops and seminar and actively involved in the promotion of bioinformatics in the state. Some of the highlights are as under: Following trainings, workshops and seminars were conducted:

The centre has conducted a training programme on Introduction to Bioinformatics w.e.f. 28th to 29th November 2003.

A new Executive Committee consisting of seven members has been formed to streamline the activites of the Bioinformatics Centre as per the guidelines of Department of Biotechnology, Government of India.

A project on Sexually Transmitted Diseases (STD) and its rate of growth in Sikkim was completed by the Bioinformatics Sub-DISC.

Training on Computational Biology and Introduction to Biogrid was successfully conducted on 22nd to 23rd November 2005, by the Bioinformatics Sub-DISC, among the scientists, research scholars, MSc students etc.

The second Executive Committee Meeting of Bioinformatics Sub-DISC, Sikkim State Council of Science & Technology, was held on 18th February 2005, which was also attended by Shri. U.N. Behera, Joint Secretary, Department of Biotechnology, Government of India, New Delhi.

Two days training on Creation and Management of Biological Database was held from 7th to 8th November 2006. Scientists, lecturers and researchers were benefited from this training program.

Bioinformatics Sub-DISC, Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change, has organized three days training programme on Introduction and Scope of Computational Bilology, w.e.f. 3rd to 5th December 2007. Science graduates, research scholars, lecturers have attended this training.

First Sikkim Bioinformatics News Letter, Volume 1 was released in December 2006.

Bioinformatics Sub-DISC, Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change, has successfully organized XVIIIth All India Biotechnology Information System Network Coordinators' Meeting (BTISnet), at Chintan Bhawan, Gangtok, held from 3rd to 4th February 2007.

The Bioinformatics Sub-DISC, has developed a Flash animation CDs on life processes for the Biological students and teachers to understand the processes in a pragmatic approach.

BIOGYAN News Letter, Volume 2 was released in a month of August 2007.

Bioinformatics Sub-DISC, Sikkim State Council of Science & Technology, Department of Science & Technology and Climate Change, has organized a training programme on Environmental Genomics and Biodiversity, w.e.f. 25th March to 26th March 2008.

An Interactive Meet for establishing Bioinformatics infrastructure facilities and on line access library facility of library resources by higher secondary and higher senior secondary schools of Sikkim was organized on 19th June 2009 at Sikkim Science Centre, Marchak with the support of Department of Biotechnology, Government of India.

Dr .B.C.Basistha presented an International talk on 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.

The centre has initiated and supported to established Bioinformatics Infrastructure Facility project (BIF) in Science Centre, Marchak, East Sikkim.

Two days training on accessing of DELCON consortium online e-journal, gene sequence alignment and Phylogenetic analysis was organized from 21st to 22nd March 2011. The scientists and research scholars have been benefited by this crucial training.

Training on Biodiversity and Biological database development, its retrieval and used in research & conservation was successfully conducted on 27th – 28th September, 2011. Scientists, Senior Research Fellows, Junior Research Fellows, Research Assistants have participated in the training.

The Bioinformatics Sub-DISC, has successfully conducted training on Documentation of Ethno-traditional Knowledge by using Bioinformatics tools on 7th December 2012. The scientists,research scholars have attended this training.

On 9th August, 2012, the Bioinformatics Centre conducted training on DELCON Science Direct research Journals, which was attended by Scientists, Research Scholars, Research Assistants working in Sikkim State Council of Science & Technology.

BIOGYAN News Letter, Volume 5, was released in April 2012

The Bioinformatics Sub-DISC, has prepared a database on economically important Agro-horticultural crops diseases of Sikkim.

The centre has prepared an important first list database of rare, endangered and threatened plant species from Sikkim Himalaya. The same is uploaded in centre's website www.bioinformaticssikkim.gov.in.

The center has prepared animation software of Plant Physiology and Life Science quiz, which will be distributed to the colleges and schools. The software will be very useful for the students to understand Biology.

Bioinformatics Sub-DISC, published BIOGYAN News Letter, Volume 6, in February 2013.

The Bioinformatics Sub-DISC, has released BIOGYAN News Letter, Volume 7, in December 2013.

The Bioinformatics Sub-DISC, has started free Department of Biotechnology E-Library Consortium (DeLCON) online access of research journals, with the support of DBT, Govt. of India.

The Bioinformatics Sub-DISC, has published a compiled book Volume 3rd and 4th of publish research paper on Bioresources of Sikkim, which have been very helpful for the researchers of Sikkim.

Prepared an Animation using flash on Human Immuno Deficiency Virus for sensitizing the youth and students on Acquired Immuno Deficiency Syndrome.

4th Volume of BIOGYAN News Letter was published in December 2010.

The Bioinformatics Centre has published *Compendium on Ethno-Medicinal Plant Research of Sikkim Himalaya.* The book was released by the **Hon'ble Chief Minister of Sikkim, Shri. Pawan Chamling, on 22nd February, 2014,** during the inauguration of the Vigyan Bhawan, Department of Science & Technology. The book is of its first type in Sikkim, which was published in various peer reviewed national and international journals.

Fig. Compendium on Ethno-Medicinal Plant Research of Sikkim Himalaya.

The Bioinformatics Sub-DISC, successfully conducted a training on Bioinformatics and Applications in Biological Researches, on 13th March, 2014. The scientists, research scholars and MSc students were the benefited from this training.

A training on Phylogenetics Analysis in Molecular Biology was organized by Bioinformatics Sub-DISC, on 31st March 2014, which was attended by Scientists, Research Scholars, Msc students etc.

Bioinformatics Sub-DISC, has successfully conducted Bioinformatics Education Programme (BEP) in various colleges and schools of Sikkim w.e.f. 19th August to 22nd September 2014.

The Bioinformatics Centre has published and released its Quarterly based Bioinformatics News Letter, Biogyan Volum 7, on 13th March 2014. The news letter has been playing a vital role for the development of Biological Researches in the state.

The Bioinformatics Sub-DISC, has completed web database of all *Rhododendron sp. of Sikkim*. The same has been launched in Bioinformatics website: www.bioinformaticssikkim.gov.in.

The Bioinformatics Sub-DISC, has released its BIOGYAN News Letter, Volume 8, in March 2015.

The Bioinformatics Sub-DISC, conducted training programme on *Bioinformatics in Microbial Vesicular Arbuscular Mycorrhiza (VAM) Research,* on 31st March, 2015. Scientists, Research Scholars, Research Assistants, Science Students have been benefited from this training.

On 14th March 2015, Bioinformatics Sub-DISC, organized a Training on Bioinformatics in Plant Genomics Researches. Scientists, Research Scholars, Research Assistants, Science Students, have attended this training programme.

On 18th November, 2014, Bioinformatics Sub-DISC, organized a training programme on NATURE journals on-site research publication. The Scientists, Research Scholars, Research Assistants, from various research institutes have attended this training.

Bioinformatics Sub-DISC, successfully organized a month long Bioinformatics Education Programme (BEP) 2015, in various senior secondary schools of Sikkim, w.e.f. 16th September to 12th October 2015.

Research Publication of the centre:

Basistha, B.C., Sharma,N.P. **Lepcha,L.** Arrawatia, M.L. Sen,A.(2009). Ecology of *Hippophae salcifolia* D.Don of temperate and sub-alpine forests of North Sikkim Himalayas- a case study.Journal of Symbiosis, Springer Science, Published online: 04 December 2009.

Laydong Lepcha,Misra,T.K. and Mandal,P. (2009). Relative distribution pattern of Tree Biodiversity in Landslide prone areas of east Sikkim, India. *Research in Environment and Life Science (RELS).* Volume 2(4), pp.201-206.

Laydong Lepcha, Misra,T.K. and Mandal,P. (2009). Relationship of Biodiversity with soil parameters and vegetation buffers at Landslide prone areas of Sikkim. Journal of Hill Research, 22(1): 43-49,2009.

Laydong Lepcha, Roy,S.G. Sarkar,A. Basistha,B.C. and Arrawatia,M.L. (2011). Documentation of Medicinally important plants from the Landslide prone areas of East Sikkim, India: A survey Report. International Journal of Phytology. 3(7): Pp.01-07.

Laydong Lepcha, Misra,T.K. Mandal,P. and Ansari, A.A. (2010). Plant Biodiversity and soil erodibility of landslide prone areas of east Sikkim. *Journal of Ecobiology*. Volume 26, No.2. pp101-112.

Lepcha,L., Roy,S.G. Sarkar,A. Basistha,B.C. and Arrawatia,M.L. (2011). Documentation of Medicinally important plants from the Landslide prone areas of East Sikkim, India: A survey Report. International Journal of Phytology. 3(7): Pp.01-07

Laydong Lepccha, B.C. Basistha, K.B. Subba, Rajdeep Gurung and N.P. Sharma (2012). A reckon on the conservation and sustainability of *Abroma augusta* Linn in Sikkim Himalaya. Journal of Medical Science and Research. (JMSR). Indian Journals. Vol.3,Issue 2, p35-39.

S.Pradhan, B.C Basistha,R.Basnett &A.Banerjee (2012). Chromatographic Techniques used for Investigation of Basic Bio-active Constituents of Highly Potent Species –*Hippophae salicifolia* from Hidden Forest of Sikkim. Sikkim Biodiversity Significance and Sustainability, pp. 80-91.

Laydong Lepcha, B.C. Basistha, K.B. Subba, Rajdeep Gurung, N.P. Sharma (2013). . Medicinal value and microbial VAM incidence analysis of Bischofia javanica Blume in Sikkim Himalaya, India. The Journal of Ethnobiology and Traditional Medicine. Photon 120, pp650-655.

Laydong Lepcha, Basistha BC, Subba KB, Pradhan S, Gurung R, Sharma NP (2014). Understanding the Significance value of *Rhododendron arboreum* Smith Scarleti of Sikkim, India. *International Journal of Engineering Science and Innovative Technology (IJESIT).*Volume 3, Issue 4, July, p554-559.

II. Patent Information Centre

Patent Information Centre (PIC) is established in the year 2001 under the aegis Sikkim State Council of Science & Technology (SSCS&T), Department of Science Technology & Climate Change (DST&CC), Govt. of Sikkim. PIC, SSCS&T is funded and supported by Department of Science and Technology (DST).

Objective:

To create awareness about Intellectual Property Rights (IPR) especially Patents, Geographical Indication (GI), Copyright, Trademark, Protection of Plant Variety & Farmers Right (PPV&FR), Integrated Circuit & Layout, etc. To facilitate filing and searches of related IPR to the universities, industry, government departments & R&D institutions, students and teachers. Sensitization on IPR to the rural innovator, block level officers.

Awareness and sensitization activities were conducted through opening IPR cells in the state Govt. colleges, writing article in daily local paper, radio talk, workshop, seminar, IPR camps, brochure, palm plates, flex display, hoardings etc.

Summary of the progress:

PIC, SSCS&T has organized many workshops, seminars and camps on IPR (GVK, school, college and village level/community level). The centre is also actively involved in filing and Registration of different IPR like Geographical indication (GI), Patent, Copyright, Protection of Plant Variety & Farmers Right (PPV&FRA), Trademark and Logo, etc. PIC has published many articles on IPR in the local newspaper of the state, Research Journal and Books. The centre has opened eight IPR cells in the different colleges and universities with the objective to create awareness and sensitization on IPR. PIC has also broadcast Radio talk on IPR in the All India Radio Gangtok. The centre provides Patent search facilities to the researcher, scholar and visitors free of cost. The centre has maintained hoarding and Flex display on IPR at Vigyan Bhawan, Deorali, Gangtok and Sikkim Science Centre, Marchak.

Sensitization and awareness programs on IPR:

1. **Sensitization & awareness program on IPR in the "Kharif Kishan Mela" organized by Department of Food Security & Agriculture Development Department, Govt. of Sikkim from 12th – 14th June 2008 by the PIC, Sikkim**

Fig. Presentation on IPR to the visitors

2. **Sensitization and awareness on IPR in nthe "Regional Agricultural Fair & Rabi Kishan Mela" held at Saramsa, Ranipool, East Sikkim organized by ICAR Research complex NEH regionin collaboration with Agriculture Department, Govt. of Sikkim on 1st-3rd December 2008.**

Fig. Display of IPR materials during program with special reference to Patent & Geographical Indication (GI)

3. **Intellectual Property Rights (IPR) awareness program at National Science Day Program at different schools. (Gayzing,W. Sikkim, Chakung, W. Sikkim & Rangpo, E. Sikkim) (21st to 23th July, 2009)**

Fig 1. Presentation on IPRs to the students of Kyongsa Sec. School, Gayzing West Sikkim.

Fig 2. Lecture on Geographical indication (GI) to the students of Gayzing, West Sikkim.

2. IPR awareness program at "Women Empowerment through Capacity Building program on Backyard Poultry Production & Mushroom Cultivation at ICAR, Tadong" (29/07/2009)

Fig. Lecture and presentation on GI to the different self help group of south & west Sikkim, Women Empowerment program at ICAR Tadong.

3. Awareness and sensitization program on Intellectual property Rights (IPRs) with special reference to "Geographical Indication" (GI) and "Trademark" on "Capacity Building cum Entrepreneurship Development Program of Food & Fruit Processing"

Fig. Lecture on GI and Trademark to the participants of the Program.

4. Patent Information Centre (PIC) has also provides information and deliver lecture and presentation about different forms of IPR to the students and visitors in Science Exhibition at White Hall, Gangtok.

5. PIC, SSCS&T identified six potential local items for Geographical Indication (GI) registration from Sikkim.

1. Sikkim Mandarin *(Sikkim Soontala),*
2. Sikkim Dzongu Lepcha Hat *(Sumok Thyaktuk),*
3. Sikkim Dzongu Lepcha Darri *(Thokro/Darrey),*
4. Sikkim Temi Tea *(Sikkim Temi Chiyapatti)*
5. Sikkim Chilly Pickle, *(Dalley khorsani ko acchar)*
6. Sikkim Ginger, *(*var; *Bhaisey, Majauley)*

6. The centre has done Radio talk on "Importance of IPR & potential of GI & its importance" in local language of Sikkim which has been broadcast in the All India Radio Gangtok. The program on IPR was conducted during the All India Radio Science talk scheme.

7. State level workshops on Patent and other form of Intellectual Property Rights (IPR) in collaboration with Micro Small Medium Enterprises (MSME) held on 23rd February 2011 at Gangtok.

Pic: Presentation during the program

8. State level workshop on GI supported by TIFAC held on 11th March 2011 at Sikkim Science Centre, Gangtok.

Pic: Technical session of the program

9. Awareness about GI and other forms of IPR at Sikkim Science Centre to the visitors through lecture presentation and flex display.

10. Geographical Indication Registration filed to TIFAC and following two items were accepted by Technology Information Forecasting Assessment Council (TIFAC), New Delhi.

The centre has applied for four items to the TIFAC for providing support for GI registration. Among four which includes Sikkim Temi Tea, Sikkim Mandarin, Sikkim Dzongu Lepcha Hat (*Sumok Thyaktuk*) & Sikkim Dzongu Lepcha Darri (*Thkro*), two items has been accepted for the process GI registration. They are Sikkim Temi Tea & Sikkim Mandarin. (Registration under process)

Pic 1: Sikkim Mandarin

Pic. 2: Sikkim Temi Tea

Sikkim Mandarin: Applicant address

Sikkim Temi Tea: Applicant address

Horticulture & Cash crop Development Department,
Krishi Bhawan, Tadong.
P.O Tadong, Dist-Gangtok, East Sikkim
Pincode: 737102

Tea Board of Sikkim
Temi Tea Estate
P.O Temi, Dist- Namchi,
South Sikkim
Pincode: 737134

11. PIC provides Patent Search Activity to the visitors, researcher and scholars free of cost. (Both online and through patent CD RoM database)

12. PIC has established eight IPR cells in the school, colleges and universities in Sikkim with the objective to create awareness and sensitization on IPR and related issues.

The name of IPR cells opened in the colleges and universities were:-

i. Sikkim Sr. Sec. School, Mangan, North Sikkim
ii. Sikkim Government College (SGC), Gaylshing, West Sikkim
iii. Sikkim University (SU), 5th Mile, East Sikkim
iv. Sikkim Manipal University (SMU), Gangtok, East Sikkim
v. Sikkim Government College (SGC), Namchi, South Sikkim
vi. Sikkim Government College (SGC), Rhenock, East Sikkim
vii. Sikkim Government Law College (SGLC), Burtuk, East Sikkim
viii. Sikkim Govt. B. Ed College, Soreng, West Sikkim

13. PIC has published brochure on IPR, articles in the local newspaper of the state, Research Journal and Books.

The lists are as follows:

1) Brochure of PIC on IPR
2) "Sikkim Biodiversity - Significance and sustainability" with title "A Future Prospective; Intellectual Property Rights (IPR) in Sikkim Himalaya.
3) Published research paper in the Indian Journal of Traditional Knowledge (IJTK) with title "Traditional *Lepcha* craft *Sumok-thyaktuk* (*Lepcha* Hat) and its conservation in Dzongu Tribal Reserved Area (DTRA), Sikkim, India.
4) "Patent an Intellectual Property Rights" has been published in the local paper of the state 'The Himalayas'
5) "Trade of Intellectual Property (IP) in the world" has published in the 'Sikkim Mail' & 'Sikkim Express'.
6) "Traditional Knowledge, Folklore, Biodiversity and Intellectual Property" has published in the local paper of the state Sikkim Express.
7) Patent- an Intellectual Property Rights (IPR)
8) Intellectual Property Rights (IPR)- Importance of Patent
9) First GMO (Genetically Modified Organism) to be subject to a Patent
10) Concept of Geographical Indication (GI)
11) Protection of local products through GI
12) Intellectual Property Rights (IPR)- Protection of Plant Variety & Farmers Right (PPV&FR) PART-I
13) Intellectual Property Rights (IPR)- Protection Genome, Savior, Rewards & Recognitions (PPV&FR) PART-II

4. The PIC has organized four workshops on IPR in the following different colleges during the Financial Year 2012-2013.

The lists of the awareness program organised are as follows:-

i. Sikkim Govt. College Gayzing, West Sikkim
ii. Sikkim Govt. College Tadong, Gangtok.
iii. Sikkim Govt College Rhenock.
iv. Sikkim University, 5th Mile, Samdur.

Pic. Intellectual Property Rights (IPR) awareness program on Sikkim Govt College Tadong


Pic. View of IPR awareness program at Sikkim Govt. College, Gyalshing (20/02/2013)

View of IPR awareness program at Sikkim Govt. College, Rhenock

16. Copyright filing.

The following two copyright has been filled by the centre:-

i. Gyapo (A story)
ii. Kathaa (A story)

Both literary items are of Shri. Prashant Rasailey, a young enterprising film Director from Sikkim.

17. Plant Protection Variety & Farmers Right (PPV& FR) Filing

One local variety of rice, *Kalo Nunia* has been applied for the registration of Farmers Variety as a *Kailash Rana Manger* under Plant Protection Variety & Farmers Right has (PPV & FR) Act, 2001 and Plant Protection Variety & Farmers Right, Rule 2003.

18. PIC, SSCS&T Notified as a IPR Nodal Agency of Sikkim

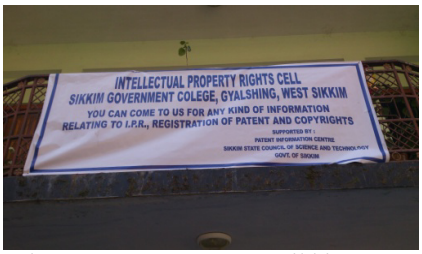
PIC,SSCS&T has been notified as a Nodal Agency for IPR in the state of Sikkim Vide Notification No. 15/DST/2013 Dated 20/03/2013

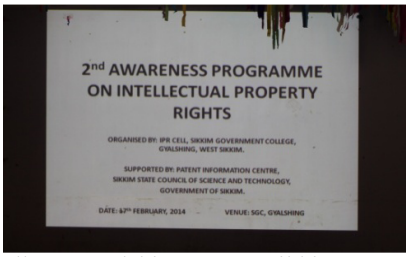
19. Five IPR Workshop organized by PIC during the Financial year 2013-2014

The centre has organized IPR workshop in the following colleges and schools:-

i. Sikkim Govt. Sr. Sec. School, Rhenock, East Sikkim - 20/03/2014
ii. Sikkim Govt. College (SGC), Gyalshing, West Sikkim- 17/02/2014
iii. Sikkim Govt. College (SGC), Namchi, South Sikkim- 28/03/2014
iv. Sikkim Govt. College(SGC), Tadong, East Sikkim- 14/03/2014
v. Sikkim Govt. Law College (SGLC), Burtuk, East Sikkim-28/03/2014

Picture:- IPR program at Govt. Sr. Sec. School, Rhenock, East Sikkim



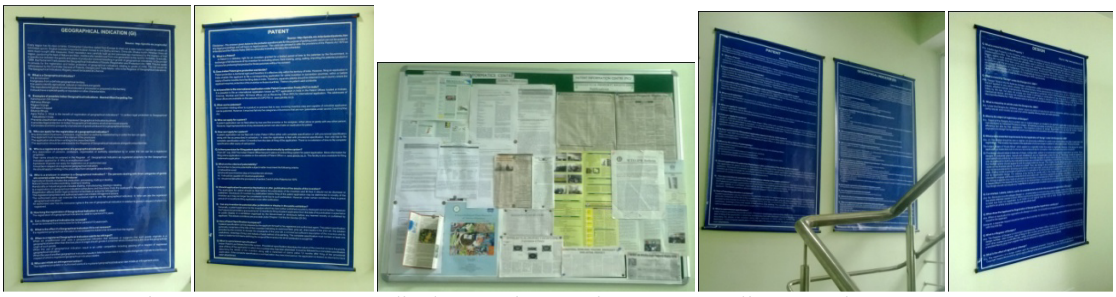


Picture:- IPR program at Sikkim Govt. college, Gyalshing, West Sikkim

Picture:- Sikkim Govt. Law College (SGLC), Burtuk, East Sikkim

Picture:- Sikkim Govt. College (SGC), Namchi, South Sikkim

20. IPR hoardings and Flex display for awareness



Picture:- IPR awareness display at Vigyan Bhawan, Deorali, Gangtok

21. PIC, SSCS&T has organized Four IPR workshop during the financial year 2014-2015

The centre has organized IPR workshop in the following four colleges and School:-

i. Sikkim Govt. College (SGC), Gyalshing, West Sikkim (14/03/2015)
ii. Govt. Sr. Sec. School, Tadong, Gangtok. (13/03/2015)
iii. Sikkim Govt. Sr. Sec. School, Rhenock, East Sikkim (16/03/2015)
iv. Sikkim Manipal University of Medical Science (SMIMS), 5th Mile. (18/03/2015)


Picture:- IPR Programs in different school and colleges

22. During the F.Y 205-2016, PIC has organized 16 workshop covering School level, college level, Gram Vikash Adhikari Kendra and Village and Community Level.

The list of the IPR conducted in different venues are as follows:

1) Outreach program on IPR at Khamdong GVK on 06/02/2016
2) IPR awareness program at Pakyong GVK on 11/02/2016
3) Awareness program on IPR at Ravangla GVK 16/02/2016
4) IPR sensitization program at Yangyang GVK on 17/02/2016
5) Outreach program on IPR at Namthang GVK on 18/02/2016
6) Awareness program on IPR at Sumbuk GVK on 19/02/2016
7) IPR awareness program at Dentam GVK, West Sikkim on 25/02/2016
8) IPR awareness program at Hee-Yangthang Sr. Sec. School, West Sikkim on 25/02/2016
9) IPR awareness program at PNGSS School, Gangtok. East Sikkim on 18/03/2016:
10) IPR awareness program at Government Senior Secondary School, Mangan, North Sikkim on 26/03 2016
11) Outreach programme on IPR at Government Girls' Senior Secondary School, Deorali, East Sikkim on 28/03/2016
12) Outreach program on IPR at Government Senior Secondary School, Tadong, East Sikkim on 29/03/2016
13) Sensitization program on IPR at Government Sr. Sec. School, Bojoghari, East Sikkim 18/03/2016
14) IPR awareness workshop at Sikkim Govt. College Namchi, South Sikkim 11/03/2016
15) IPR Awareness program at Lingdem, Dzongu, North Sikkim 12/03/2016
16) IPR Awareness program at Passingdang, Dzongu, North Sikkim 13/03/2016

Picture: IPR program at school, BAC and Community level

23. On 8th April 2016 A day long workshop on Intellectual Property Rights (IPR) was organized at Vigyan Bhawan, Department of Science Technology & Climate Change, Deorali, Gangtok.

Picture: Principal Secretary, DST&CC addressing the audience

Picture: Technical session during the program

24. PIC has published three more article in the local newspaper of the state "SIKKIM EXPRESS" with the objective to inform facilities of Department of Science, technology & Climate Change (DST&CC) regarding IPR.

The lists of the articles are as follows:

1.	Traditional Culture & Intellectual Property Rights	24/09/2015
2.	Trademark as a tool for strengthening services sector	28/01/2016
3.	World Intellectual Property Day	26/04/2016

25. Registration of GI (status)

1. Sikkim Temi Tea & Sikkim Orange

A Meeting on status of GI registration regarding Sikkim Temi Tea & Sikkim Orange was held on 5th January 2016 in the chamber of Principal Secretary, DST&CC at Vigyan Bhawan, Deorali Gangtok, between assigned Kolkata based legal Attorney S.Majumdar & Co. and stake holder of SikkimTemi Tea & Sikkim Oange/Mandarin. Shri. Monosij

Mukherjee was representing from S.Majumdar & Co. from Kolkata, Shri. Ravi Kumar, IFS, Managing Director and Shri.Mohan Chamling were representing from Sikkim Tea Estate, Shri. H.C Pradhan, Additional Director (Fruits) representing from Horticulture & Cash Crop Development Department (HC&CCDD), Govt. of Sikkim were present during the meeting.

2. Sikkim Dzongu Lepcha Hat *(Sumuk thyaktuk)* & Sikkim Dzongu Lepcha Darri *(thokro)* PIC is seeking additional financial support for this case.

26. Patent filing

PIC received two cases for Patent filing. After examination and patent search repot, one case invention (A device use to pick object from a distance) has been filed to TIFAC (Technology Information Forecasting & Assessment Council). TIFAC suggests modifying few claims on his inventive steps. Currently PIC is supporting in developing strong claims in his invention.

Regarding another invention after PIC examination, it is found that it does not fall under patentable invention under section of Indian Patent Act, 1970 but PIC is in touch with them for encouraging other patentable invention in future.

27. Protection of Plant Variety & Farmers Right (PPV&FR) Act

Recently PIC, SSCS&T has received a letter from Protection of Plant Variety & Farmers Right Authority (PPV&FRA), New Delhi regarding the local rice farmer's variety filed by PIC. The PPV&FR Authority has send the format of authorization letter and requested to fill and send authorization letter from applicant mentioning the PIC, SSCS&T will be authorized agency for filing Farmers variety on his behalf. The authorization has been made and sent to the authority, New Delhi. Registration is under process and certificate is awaited.

28. World Intellectual Property Day 26th April Celebration by PIC in the DST&CC.

PIC, SSCS&T has observed 26th April as a World Intellectual Property Day in the Department of Science Technology & Climate Change (DST&CC), Govt. of Sikkim. An awareness program on IPR was organized in the conference hall of Vigyan Bhawan, DST&CC, Gangtok. The program was chaired by Dr.Anil Mainra, IFS, Principal Secretary.

Picture: Dr. Anil Mainra Principal Secretary on the left and Dr. B.C Basistha, Additional Director –cum coordinator, PIC addressing the audience during IP day celebration program at Vigyan Bhawan.

Biotechnology division has executed number of R & D and extension projects. Some highlights of the projects are as under:

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

Funding agency:	Department of Biotechnology, Govt. of India
Yr. of commencement:	2010
Project duration:	3 year(initially, ongoing 6th year)
Total project cost:	Rs. 304.03 lakhs

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

Work done:

Some major work is being done under the project. The state of the art biotechnology infrastructure facility both at Vigyan Bhawan and cell and tissue culture laboratory, Sajong, Rumtek established under the project. The laboratory has 43 newly procured high end instruments and machineries and most consumables required for the molecular and biochemical studies.

Overview of the established molecular and biochemical laboratory and some of the instruments

Under the project, number of workshops, trainings and outreach programme has been conducted and published research papers in national and international journals. More than 20 workshops, seminars and trainings has been conducted. The outreach programme to inculcate interest on biotechnology amongst the students has been conducted in 21 senior secondary and secondary schools.

Hands on training on molecular Biology techniques

Outreach programme on biotechnology

2. **Molecular and digital documentation of ethno-traditional knowledge with special reference to folk healing practices for protection of intellectual property rights**

Funding agency: Department of Science & Technology, Govt. of India
Yr. of commencement: 2015
Project duration: 3 year
Total project cost: 33.99 lakhs

The main objective of the project is to document the ethno-traditional knowledge specially the folk healing practices by various practitioners in digital form as well as in written document form. Molecular documentation shall also be carried out of those plants used by the practitioners.

Work done:

Interview with the folk healers and documentation ethno-traditional practices of more than 100 folk healers has been done. Videographich documentation and DNA finger printing of plants is under progress.

3. **Mass production and propagation of large cardamom for livelihood sustainability of rural people in Sikkim using Biotechnological interventions**

Funding agency:	Department of Biotechnolgy, Govt. of India
Yr. of commencement:	2017
Project duration:	5 year
Total project cost:	126.27 lakhs

In the project, the following objectives will be met:-

(I) Identification of different large cardamom cultivars using morphological descriptors.
(II) *In vitro* propagation and hardening of micro propagated sapling.
(III) Improvement of Agri-technique for cultivation of large cardamom.
(IV) Standardization of protocol for virus detection in large cardamom using molecular technique.
(V) Establishment of large cardamom nursery, experimental-cum-demonstration site, training to farmers and distribution of quality planting materials.
(VI) Phytochemicals studies of seed from all cultivars of large cardamom.

Work done:

Initiated the work on procurement of instruments and construction of temporary net house at the premises of Sajong centre.

Completed projects:

4. **Distribution, habitat, protocol development and economic potential of seabuckthorn in Sikkim"**

Funding agency:	Department of Biotechnology, Ministry of Science & Technology, Government of India
Yr. of commencement:	1998
Project duration:	03 years.
Total project cost:	Rs. 20.04 lakhs

Works undertaken:

The Seabuckthorn plant considered to be a wonder plant of the fragile mountain ecosystem is found to be growing in the Lachen and Lachung valley of north Sikkim. The Scientific study of the plant in terms of its distribution, habitat protocol development for its propagation and economic potential is felt necessary to be carried as preliminary works.

In line with the project objective the work is being carried out. The study found that only one species i.e. *Hippophae salicifolia* is found in Sikkim mostly concentrated in

the flanks of Lachen and Lachung chu river in Lachen and Lachung valley of north Sikkim. The plant is found to be growing in newly exposed soils caused due to landslide and other natural calamities both in the riverine and non-riverine area. The plant add nutrient to the soil by fixing atmospheric nitrogen with the help of Frankia found in the root nodule. It is in fact, create the gateway to other plants to grow in the in-fertile area in the Himalayan bases. The plant loves sunny places devoid of obstruction due to other tree canopy or the hills. Due to its long root system, the plant is responsible for binding the fragile land in the region.

The study found that number of potent health products such as Jam, Jelly, Juice, marmalade, herbal tea etc can be developed from the plant. The study on its various propagation methods are also being carried out. The plant can be propagated through cuttings, tissue culture and seeds. The Frankia associated with root nodule of Hippophae and responsible for enriching of soil by atmospheric nitrogen fixation can be grown in artificial condition in the laboratory and the strain having good nitrogen fixing capability can be isolated.

5. **Training on propagation, cultivation and agro-techniques of orchids for rural women of Sikkim.**

Funding agency:	Department of Biotechnology, Ministry of Science & Technology, Government of India
Yr. of commencement:	1998
Project duration:	03 years.
Total project cost:	Rs. 24.20 lakhs

Works undertaken:

The orchids with its extraordinary and beautiful flower are the highly evolved family in the plant kingdom. The Sikkim blessed with the suitable agro-climatic condition for growing of orchids has the potential of developing a big orchid industry in the state. The state shall have the monopoly in orchid trade specially cymbidium in the national market. This potential is being realized and project proposal was forwarded to Govt. of India to carry out extensive training and provide post training technical support especially to the unemployed women to start with.

The orchid growing and their flowering were once a mania pursued by high privileged people is now affordable by most of the plant lovers, thanks to the discovery of tissue culture technique. The technique made possible to produce the desired clone in large number bringing down its costs. Further, the requirement of mycorrhizal fungal for orchid seed germination in nature is no more a necessity as same can be grown artificially in the laboratory. This eased in producing new hybrids in orchids. The training on tissue culture techniques is combined with the orchid cultivation as these are closely related and is helpful to the growers to expand the business. Batch wise training consisting of 20 per training in two months per batch were conducted at then the tissue culture laboratory at

metro point, tadong. The course included were practical hands on training on orchid potting mix preparation, hardening of orchid seedlings, transplanting to subsequent bigger pot, dividing of orchids, pasteurization of potting mix, tissue culture of orchids, seed culture of orchids, theoretical classes on nursery management, pest and disease control, nutrient application, vase life increase, cut-flower, post production management and marketing. The trainees were taken to nurseries at Kalimpong, nurseries in and around Gangtok. After the training programme, the trainees were provided with tissue culture grown orchid saplings to start with. Those intending to go for large scale orchid growing were assisted in project preparation and financing from the bank. About 140 trainees were provided training in 3 years duration. Some of the trainees have started their nursery and some have started recently with the government assistance.

6. **Training on propagation and cultivation of mushroom for rural women of Sikkim.**

Funding agency:	Department of Science & Technology, Ministry of Science & Technology, Government of India
Yr. of commencement:	1999
Project duration:	03 years.
Total project cost:	Rs. 7.08lakhs

Works undertaken:

Mushroom cultivation, it was thought, will help in improving the socio-economic condition of the unemployed women. The species chosen for training was oyster mushroom as it can be grown with ease if one has basic technical know-how. The button mushroom cultivation requires large installation and heavy financial in-put which is beyond the reach of the ordinary unemployed youth. The work is highly technical. In case of oyster mushroom cultivation, the investment is lower and affordable by most of the people. Taking all these considerations, the proposal was submitted to the Govt. of India for funding. Batch wise training was conducted with hands on training on substrate preparation, spawning, growing, pest management, harvesting, packing and marketing. About 120 rural women were given in-house training and trainings were also imparted in different places like, Rongli, Rhenock, Dentam etc.

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

Funding agency:	Department of Biotechnology, Govt. of India
Yr. of commencement:	2009
Project duration:	3 years
Total project cost:	Rs. 49.65 lakhs

Objectives:-

1. Survey of Hippophae growing Area in Sikkim.
2. Collection and maintenance of Hippophae germplasm from Sikkim.

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

Work done:

As per the objective of the project, the total survey of Hippophae growing areas in Sikkim was carried out. The cuttings from the selected accession have been sent to IHBT, Palampur for germplasm collection and maintenance. Ecological as well as morphological studies of hippophae plant were carried out using standard descriptors. The study on the *Frankia*, an organism responsible for nitrogen fixation in Hippophae was thoroughly carried out including in-vitro culture and genetic studies. Soil analysis of native Hippophae with reference of pH, moisture, organic carbon, nitrogen and other macro and micro nutrients was done.

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

Funding agency:	Department of Biotechnology, Govt. of India
Yr. of commencement:	2007
Project duration:	3 years
Total project cost:	Rs. 27.26 lakhs

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

Objectives of the Project:

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

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

Work done:

Under the project in line with the objective, quality planting material of large cardamom, ginger and citrus (mandarin) were distributed and demonstrated in the farmers' field. Total of 32 hector is being covered by these three crops under various locations.

Biotechnology Division

Remote Sensing Division

Sikkim State Remote Sensing Applications Centre (SSRSAC)

Background:

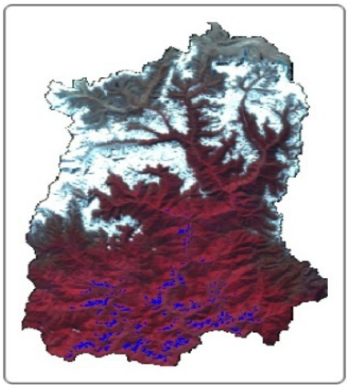
The Sikkim State Remote Sensing Applications Centre (SSRSAC) has started with the Department of Science and Technology in the year 1997. The Centre has one of the states of art-machineries and Software and Hardware like photogrammetry LPS-11, Arc Info-10 and ERDAS-9 with A0 size plotter and Scanner.

The SSRSAC has well trained manpower in the field of Remote Sensing and GIS. The Centre has provided different trainings in the field of Geo-informatics and also provide short term training to Student of different Colleges, in the field of RS and GIS. It has been undertaking various project funded by Central Government as well as State Government and also provides the necessary data to the user department for various developmental activities in the state. Sikkim State Remote Sensing Centre also coordinating the Climate Change programme with various department of State, Central and other agencies like GIZ UNDP etc.

1. **Integrated Missions on Horticulture Development**

This Project is carried out under the "Technology Mission for Integrated Development of Horticulture in North Eastern States including Sikkim" of Ministry of Agriculture, Govt. of India.

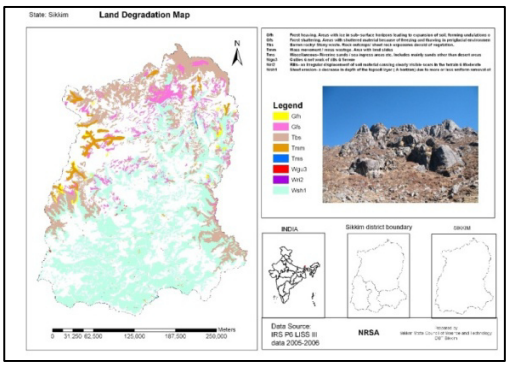
Under this project we highlights the suitable areas for the cultivation of Mandarin orange in the Sikkim that can be taken up for orchard expansion plan under the Technology Mission. Total 24,000 ha of land are fall under the suitable area for the cultivation of orange in Sikkim
The project duration was from 2001-2006 and was funded by**:** Ministry of Agriculture, Govt. of India through SAC, ISRO Ahmedabad.



FCC overlaps with Suitable Area for Orange

2. **National (Natural) Resources Information System (NRIS)**

The objectives of NRIS project is to create computer based natural resource information system that provides various sets of capabilities to handle geo-referenced data. This data set was create using the computer system works on Arc/info GIS software. The dataset includes the latest land use/cover from IRS IC/ID satellite data; creation and updating of village wise a spatial data as per the 2001 census records. Creation of the village wise location as per the latest data of Census. Digitization of land use/cover from latest satellite data at 1:50,000 scale. Digitization of other resources like drainage, Road, Village boundary, Soil layers, etc. this dataset was use for the other project as a base data set. The project duration was from 2001-2006 and was funded by**: Department of Space, GoI.**

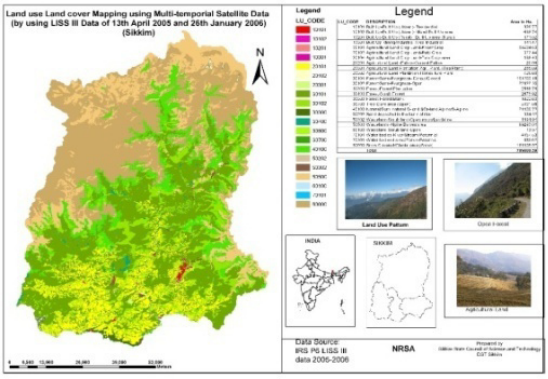


3. **Land Degradation mapping in Sikkim**

The objective of this project is to identify the degraded land of Sikkim, using the Satellite imagery. For delineation and mapping of land degradation classes, multi-temporal geo-rectified Resourcesat-1 LISS-III data was used for kharif, rabi and zaid seasons of 2005-2006. About 365sqkm of Sikkim was mapped in different classes of degraded area of Sikkim under this project.

The different classes of land degradation found in Sikkim are Gfh (frost heaving), Gfs (frost shattering), Tbs (barren rocky/ stony waste), Tmm (mass movement/mass wastage), Tms (miscellaneous-riverine sands/sea ingress areas), Wgu3 (gullies), Wri2 (rills), Wsh1 (sheet erosion). In accordance with the percentage of the state area North district contribute 28.4%, followed by 9.1%, 7.5%, 6.4% in West, East and South district respectively. The project duration was from 2008-2010 and was funded by**: Department of Space, GoI.**

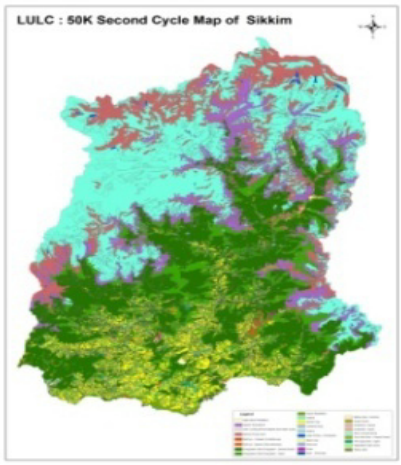
4. Land Use Land Cover mapping of Sikkim –Phase I



The objectives of the project are to generate land use/land cover data base on 2005-06 three seasons (Kharif, Rabi and Zaid) LISS III satellite data. Under this project we mapped the Landuse and Landcover map of Sikkim. This can be input for planning exercises at various levels. According to the data generated, 26.95% of total area of Sikkim is cover by semi evergreen forest which is the largest occupant in the state followed by snow cover and glacial area by 25.52%, followed by waste land (Alpine barren area) is 13.99%. Similarly 10.26% of total area is occupied by Forest/Semi-Evergreen-Open, 10.02% by Natural/Semi natural Grass-land & Grass-land Alpine/Sub-Alpine, 9.64% by Agricultural Land and 3.42% area occupied by other landuse and landcover classes in Sikkim. The project duration was from 2008-2010 and was funded by: Department of Space, GoI.

5. Land use and Land cover Change 2nd Cycle

The objectives of the project is to generate spatial database on land use / land cover for 2011-12, to generate land use / land cover change database along with change matrix with respect to 2005-06 and to identify areas of major change. Among all we have seen major change in forest cover area increase, a change has also observed in Agricultural area, wasteland area, and snow cover area. The project duration was from 2012-2013 and was funded by**: NRSC,** Indian Space Research Organization Hyderabad.



The Objective of the project are:

- ✓ To update the spatial information on landuse of 2005 – 06 with 2008-09.
- ✓ To identify and depict the areas with major land use / land cover change between 2005 – 06 with 2008-09
- ✓ To create the land use / land cover change geospatial database
- ✓ To prepare category-wise spatial change statistics of land use / land cover change

Outcome:

The Land use and Land cover change map was prepared and printed in the form of atlas

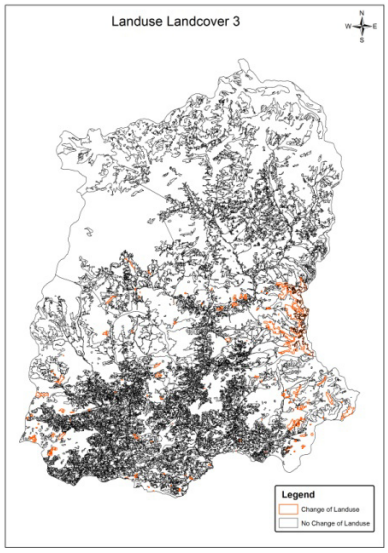
6. Land use and Land cover Change 3rd Cycle

National Remote Sensing Centre, Indian Space Research Organisation (ISRO), Department of Space, Government of India in collaboration with various State, Central Government Departments and Institutions has completed first and second cycle of LULC 50 K interpretation using Resourcesat LISS III data of 2005-06 and 2011-12 respectively using NNRMS Level-III classification system on 1 : 50,000 scale.

Establishing the Natural Resources Repository (NRR) is the overall goal under NNRMS. Reliable database on the spatial spread and monitoring the dynamics of the land use/land cover is the basic prerequisite for planning and implementing various developmental activities. Apart from this, nationwide land use information becomes important from the point of view of addressing changing pattern in land use/land cover in addition to overall reporting on the nation's land use/land cover scenario.

In the current exercise, existing spatial land use/land cover database will be modified to obtain LULC for 2015-16 for the entire country. This will be used as a base layer to arrive at land use/land cover changes from 2005-06 to 2011-12 to 2015-16.

Expected outcome: Detailed land use / land cover change database for the entire country for 2011-12 and 2015-16.



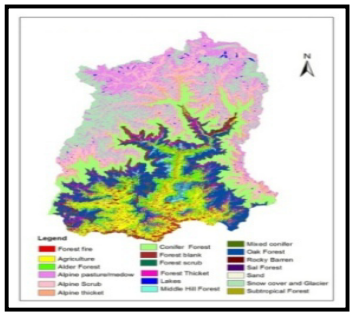
Objectives

- ✓ To update the spatial information on landuse of 2008 – 09 with 2015-16.
- ✓ To identify and depict the areas with major land use / land cover change between 2008 – 09 and 2015-16.
- ✓ To create the land use / land cover change geospatial database and disseminating through Bhuvan geo-portal.
- ✓ To prepare category-wise spatial change statistics of land use / land cover change and summation in the form of atlas

The updating of Land use and Land cover is under progress and almost 20% of the work has been completed

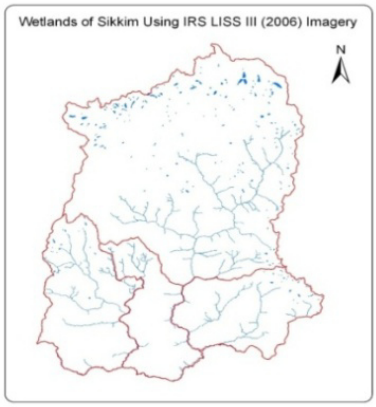
7. Forest Fire Mapping of Sikkim

In this project, an attempt has been made to prepare the database on forest fires in Sikkim using IRS LISS III imagery at 1:50,000 scale. For the study, three seasons' satellite imageries viz. 10th



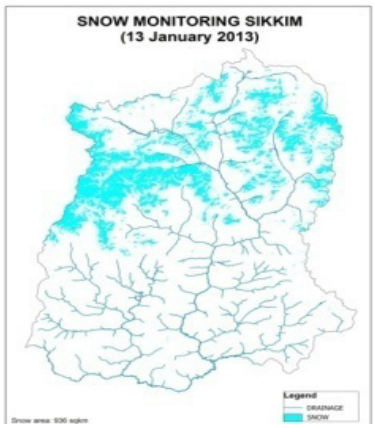
January 2009, 23rd March 2009 and 10th May 2009 of IRS P6 LISS III were used for the study. During the visual interpretation of 10th January 2009, 4 number of forest fires have been identified, while 23rd March 2009 imagery 201 forest fires have been identified and using10th May 2009 imagery, 82 additional 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 project duration was from 2009-2010 and it is under the climate change study in Sikkim.

8. Wetland mapping of Sikkim



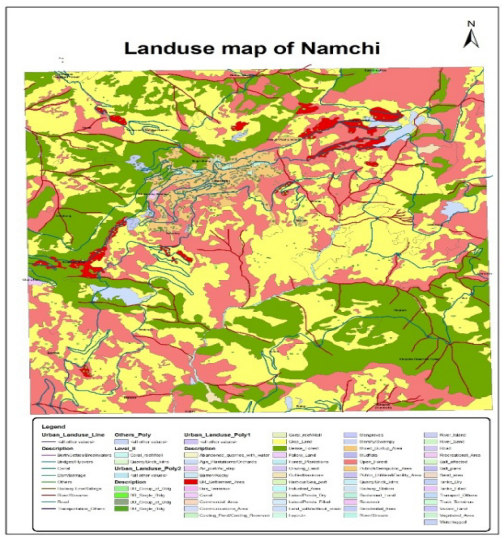
The objectives of the project are mapping the wetlands of Sikkim using IRS LISS III digital data following a standard wetland classification system. Total 553 wetland of Sikkim has been mapped including High altitude Lakes, low altitude lake and major rivers with the total area of 7196ha. Comparative study of wetland with 1998 atlas also done which seen the increase number and area of wetland of Sikkim. The project duration was from 2008-2010 and was funded by**:** Department of Space, GoI.

9. Snow monitoring of Sikkim Himalayas Phase -I



The project " Snow monitoring of Sikkim Himalayas Phase -I" was started by the Department of Science and Technology in the year 2008 in collaboration with Space Application Centre, Ahmedabad. Under this project the snow cover area of every 5daily and 10 daily were mapped using the Awifs satellite imagery. This project was funded by the Department of Space, Government of India.

10. NUIS (National Urban Information System)

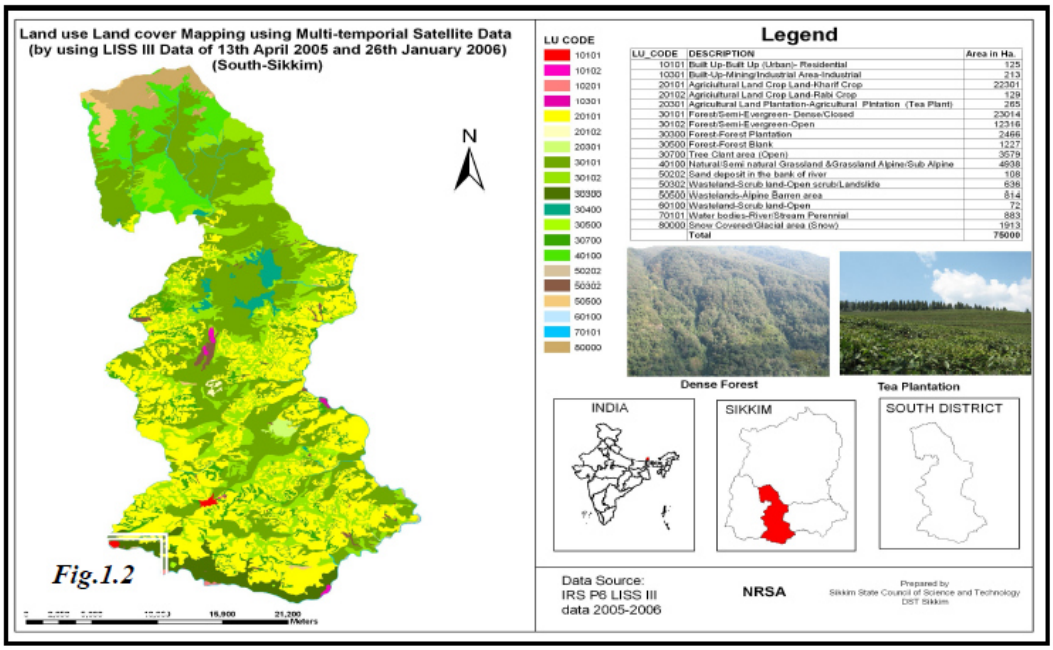


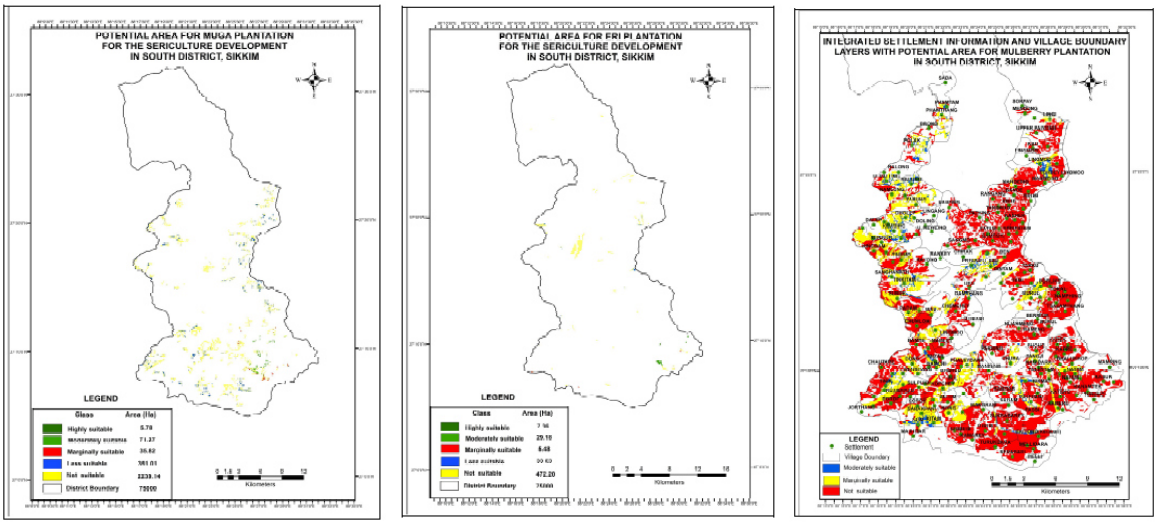
The major objective of NUIS project is to design, organize and establish a comprehensive information system in the urban local bodies for planning, management and decentralized governance. For Sikkim state it was assign 10 towns, for different

thematic mapping, and we have completed mapping of all 10 towns. The towns are Pakyong, Rabong, Rangpo-Singtam, Mangan, Jorethang, Rongli, Geyzing-Pelling, Soreng and Namchi. The required thematic layer was prepared and submitted to the NESAC. The project duration was from 2011-2013 and was funded by: Ministry of Urban Development, Govt. of India through NESAC, Dept. of Space GoI, Shillong.

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

This project covers application of Remote Sensing and GIS in sericulture development in south district of Sikkim. The suitable areas for the cultivation of Mulberry, Eri and Muga food plants in south district of Sikkim has been identified at the scale of 1: 50,000. The detail mapped and report is prepared and submitted to Central silk Board through NESAC, Shillong. The final suitable areas for the sericulture food plants (Eri and Muga) has been found to be very less as compare to Mulberry food plants. Therefore, other districts of Sikkim may also be taken for the study. Now the second phase of the project has been sanction for West district of Sikkim. The project duration was from 2008-2010 and was funded by: Central Silk Board, GoI, through NESAC, Dept. of Space GoI, Shillong.





12. **Application of Remote Sensing and GIS in Sericulture Development" Phase- II**

Sericulture is one of the important sectors of economy in India and plays an important role in programmes of poverty alleviation. Compared to agricultural crops, sericulture provides more employment all round the year and fetches higher income for rural farm families. Sericulture allows commercialization and diversification of farm enterprises. It is also an environmental friendly farm activity because the silkworm food plants like mulberry, som, etc are perennial crops protecting the soil from erosion.

Indian sericulture is an age old practice, producing all four types of natural silk namely *Mulberry, Tasar, Eri and Muga*. Our country is the second largest producer of mulberry silk accounting for about 15 percent of the of the global raw silk production. Mulberry sericulture is practiced in almost all states in the country but Karnataka, Andhra Pradesh, West Bengal and Tamil Nadu together account for about 98 percent of the total mulberry silk production in the country.

Space Technology inputs in sericulture related studies

Central Silk Board (CSB), Ministry of Textiles, Government of India has been pursuing the application of satellite remote sensing for sericulture development ever since the launch of the first operational remote sensing satellite, IRS-1A in 1988. CSB and ISRO in collaboration with the concerned States Sericulture/Textiles Departments applied the technology of remote sensing (RS) and geographical information system (GIS) for mulberry acreage estimation, garden condition assessment and for finding suitable areas for introducing sericulture in the non-traditional States. The "Manual of Satellite Remote Sensing Applications for Sericulture Development" brought out by CSB and ISRO

(CSB, 1994) gives more details. ISRO and CSB had carried out another large area project, called SPAARS, in which large scale application of the RS and GIS technologies were tried. CSB and North Eastern Space Applications Centre (NESAC) in collaboration with State Remote Sensing Centres have recently completed a national project entitled"Applications of Remote Sensing & GIS in Sericultural Development covering 108 districts from 24 states of the country (NESAC, 2015).

Objectives of the present project

i) To identify potential areas for *mulberry and non-mulberry* sericulture development in *west districts Sikkim* and
ii) To develop Sericulture Information *Linkage & Knowledge System* (SILKS) for the west districts.

Data collection of Mapping

Initially, all required layer for sericulture development were generate in Remote Sensing & GIS lab Sikkim. after generating the all required layers a field study was carried out by a scientific team from SSCS&T. Major aim of the field study was to collect soil PH values, texture, and corresponding field pictures.

With the field database and existing base layers the project prosonal were deputed to NESAC Shillong to mapping the suitable site foe Mulberry in west Sikkim.

Furthermore, The Scientists and Experts from NESAC, Shillong has asked to revisit the field to update the final suitability map or in other word, to do the accuracy assessment to all the reachable area in the final suitability map.

13. "**Strong motion seismometry, probabilistic seismic hazard, vulnerability and risk Microzonation of Darjeeling-Sikkim Himalaya (SHH)"**

The Microzonation of Sikkim region was started with an objective to assess the Seismic Hazard and Microzonation of Sikkim region through setting up of an array of strong motion observatories mostly covering lesser Sikkim Himalaya and a sparse distribution of the network in the Higher Sikkim Himalaya.

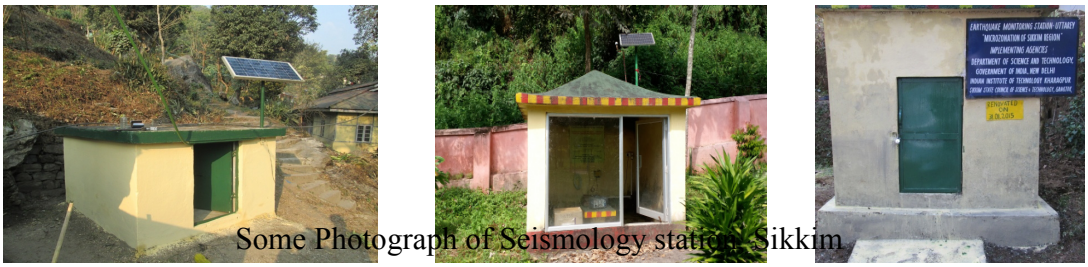
- It is a MoES, Govt. of India, funded project initiated by IIT, Kharagpur in the year 1996.
- It's been 25 years IIT, Kharagpur in collaboration with Sikkim State Council of Science and Technology has been monitoring seismic activities in Sikkim.
- Seismic Hazard and Microzonation Atlas of the Sikkim Himalaya has been released in 2011.

Locations of Earthquake Monitoring Station:

Science centre, Singtam and Phademchen in East Sikkim, Melli Dara in South Sikkim, Pelling and Uttarey in West Sikkim, Mangan and Chungthang in North Sikkim and Darjeeling in West Bengal.

Manpower and job profile:

One SPO/RA deputed on project basis at Sikkim State Council of Science, Technology & Climate Change is responsible maintenance of Seismometer located at different locations of Sikkim and Darjeeling and to collect Seismic data from all the station during an earthquake event and send the raw data to IIT, Kharagpur. Under Sponsored Research and Industrial Consultancy (SRIC), IIT, Kharagpur.



Some Photograph of Seismology station, Sikkim

14. Establishment of Landslide database Centre in Sikkim

Landslide is an important disaster of hilly areas like Sikkim and other mountainous regions of the world. Sikkim State council of Science and Technology is being carrying out the landslide studies with objectives to create the database on the landslides of Sikkim that not only help in understanding the spatial nature and characteristics of landslides but also help in monitoring the landslides. The landslide inventories from IRS LISS III 2006 image were used more than 300 landslides were mapped using the Remote Sensing and GIS software. We have also prepared the database of landslide of Sikkim with Location, and number. The project duration was from 2008-2010 and was funded by: Government of Sikkim.

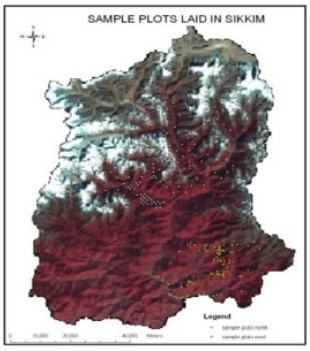
15. Programme on climate change research in terrestrial environment (PRACRITI)

Mapping of Glacial lake was conducted under this project. With the help of regression equations, the calculations of snow line altitude have been going on for both Tista and Ranit basins from 2005 to 2010. For the correlation of meteorological data with SLA, the IMD has been contacted, Using time series satellite data, the present study would be a great source of information in terms of change detection in the area of Glaciers and glacial lakes/ moraine dammed lakes. The study will provide the valuable information on the role of temperature when correlating with snow line altitude.

The project duration was from 2008-2013 and was funded by: Space Applications Centre (ISRO), Ahmedabad.

16. **Vegetation carbon pool assessment project in north Sikkim**

Under this North District of Sikkim was Selected as a project site. Tree with cbh (circumference at breast height) more than 10cm has been taken for the estimation of biomass and carbon. Volume and Biomass has been estimated using volume equations and specific gravity from the literature and other related parameters like height and cbh. The project duration was from 2008-2010 and was funded by**:** Indian Institute of Remote Sensing, Dehradun.



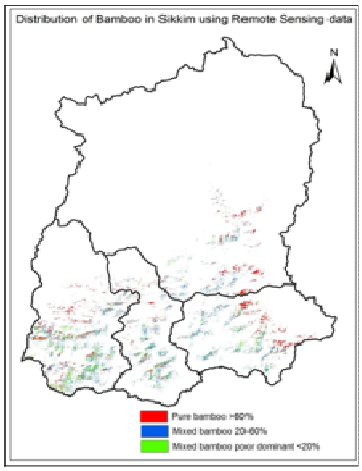
17. SIS-DP (Spatial Information Support System for Decentralization Planning)

The Space Based Information Support for Decentralized Planning project started in Sikkim from July 2011. The main objective of the project is mapping of various thematic layers of Sikkim at 1:10K scale for decentralized planning. Land Use and Land Cover (LULC), Roads, Drainage, Village, GPUs, Slope, Soil and Ground Water Prospect and other legacy data sets were prepared. The entire thematic layers were uploaded in bhuvan.nrsc.gov.in website. The project duration was from 2011-2015 and was funded by**:** NRSC, DoS, GoI, Hyderabad.

18. **Ground water prospects mapping for Rajiv Gandhi National Drinking Water Mission Phase-IV**

Under the Rajiv Gandhi National Drinking Water Mission (Phase-IV), ground water prospect mapping using Remote Sensing and Geographic Information System techniques in 1:50,000 scales needs to be undertaken. The final ground water prospect mapped has been prepared and submitted to NRSC Hyderabad to prepare the atlas. The project duration was from 2011-2013 and was funded by**:** NRSC Hyderabad, Department of Space.

19. **Identification of bamboos in Sikkim using RS and GIS technique**

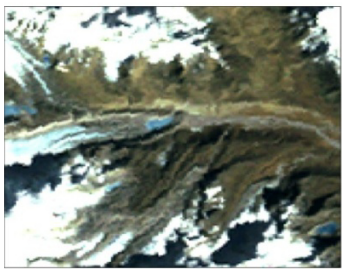


The area of bamboo available areas of Sikkim is estimated through remote sensing technique and field visits. Multi- spectral images from IRS P6 with 23.5 m resolution was used for mapping the areal extent of bamboos in Sikkim. West district has the maximum bamboo coverage, 14.41% followed by East district 8.76%, South district comes third with bamboo coverage about 8.37% and North district rank forth in terms of bamboo availability with the coverage about 1.42% of total geographical area.

The project duration was from 2011-2014 and was funded by: Horticulture and Cash Crops Development Department, GoS.

20. **Mapping of glacier lakes and development of GIS based glacier lake management information system (GLAMINFORS) for the state of Sikkim**

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



Lhonak Lake (1976)

Lhonak Lake (1997)

Lhonak Lake (2011)

The following lake has been prioritized as potential hazardous lakes in Sikkim.

1. South Lhonak Lake, 2. Sakho Cuu Lake, 3. Teesta Khangsey Lake, 4. Unnamed lake of West Sikkim, 5. Dodh Pokhari near East Rathong Glacier, 6. Gurudogmar Lake, 7. Chho Lhamu Lake, 8. North Lhonak Lake

Monitoring of lake provide an early indication of changes; early warning systems, to provide downstream residents and owners of infrastructure time to take avoidance action; and mitigation measures, to physically change the situation and thus reduce the risk.

Training on retrieving of lake level monitoring system

Two days training programme was imparted by scientist of CDAC Pune to retrieve the data of lake monitoring system in DST, Gangtok. The training was attended by staff of climate change Cell, Remote Sensing Application Centre of the department and the staff of Land Revenue and Disaster Management Department.

Training on installation of GLOF monitoring system

Training on installation of GLOF sensor were provided by scientists of CDAC Trivendrum on installation of GLOF sensor including integration of Antenna, installation of sensor in the antenna, installation of data transmitter and linking it with satellite for transmission of data etc. Based on this training programme the GLOF sensors were installed at South Lhonak Glacial lake in North Sikkim and Kupup Lake in East Sikkim by the manpower of State Climate Change Cell and others.

The particular sensor is in experimental phase. The high altitudinal lakes are prone to high velocity winds, extreme temperature and weak geologic structures due to the presence of moraines. The sensor equipment may not able to withstand in such climatic conditions. As such the functionality of the sensor needs to be monitor in high altitude areas which are easily

assessable. To fulfil that objective the GLOF sensor have been installed in Kupup lake in East Sikkim which is assessable by road ways.


I. Assembly of GLOF Antenna at Kupup Lake in East Sikkim & II. Antenna during the installation at Kupup Lake


I. Data Transmitter and AWS installed at Kupup Lake & II. Collection of depth point using raft boat

21. Monitoring of snow and glacier phase –II (2010-2014)

The analysis of snow cover of Sikkim in between October 2010-May 2014 revealed that the snow cover in Sikkim remains less than 25% in the months between September/October to December and maximum snow cover in months between January to May/June in Sikkim Himalaya. Occasional snowfall higher than 25% recorded in months between September/October to December in some years. However, the snow monitoring year of 2013-2014 revealed higher than 25% snow cover all through the season from October 2013 to May 2014.

In 5 Daily snow products, the maximum snow cover of 60% recorded on 18 February 2013 and minimum snow cover of 6%recorded in Sikkim on 10 October 2010 in the period in between October 2010 to May 2014. In 5 daily cloud free snow product, the maximum snow cover of 60% recorded on 18 February 2013 minimum 9% recorded in 9 October 2013. In 10 daily snow products minimum 7% and maximum 60% snow recorded in Sikkim.

In terms of average snow cover 22% average snow recorded in 2010-2011 which increased to 25% in 2011-2013 and maximum 33% snow recorded in 2013-2014.

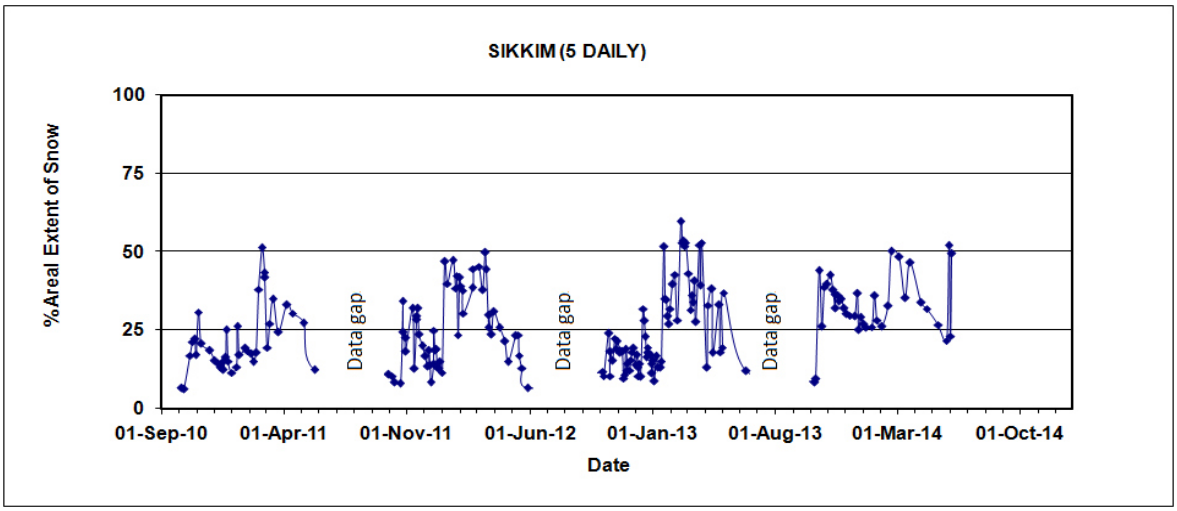


Figure. Daily snow cover in Sikkim between 2010-11 and 2013-14

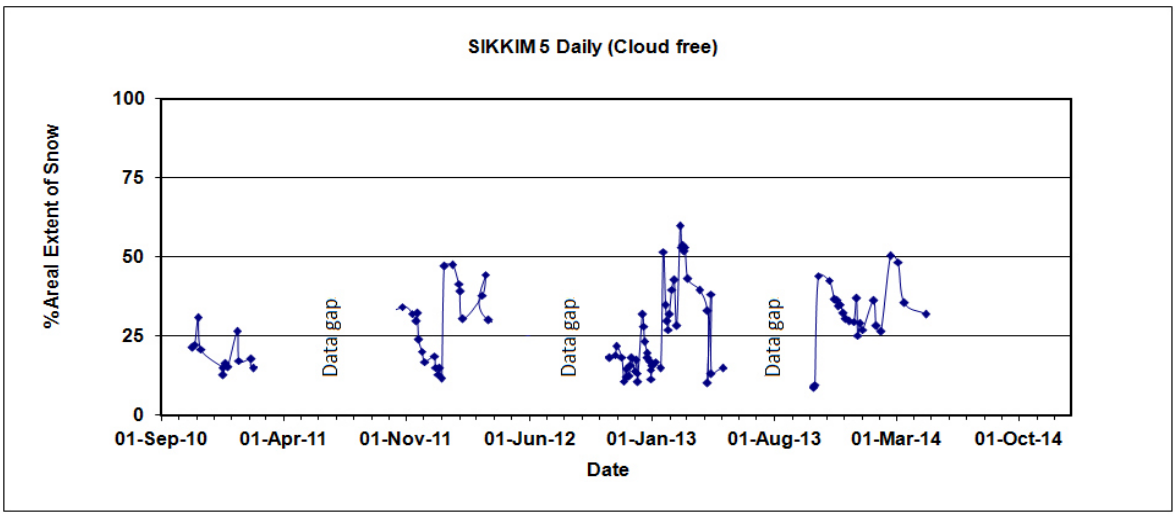


Figure. Daily cloud free snow cover in Sikkim between 2010-11 and 2013-14

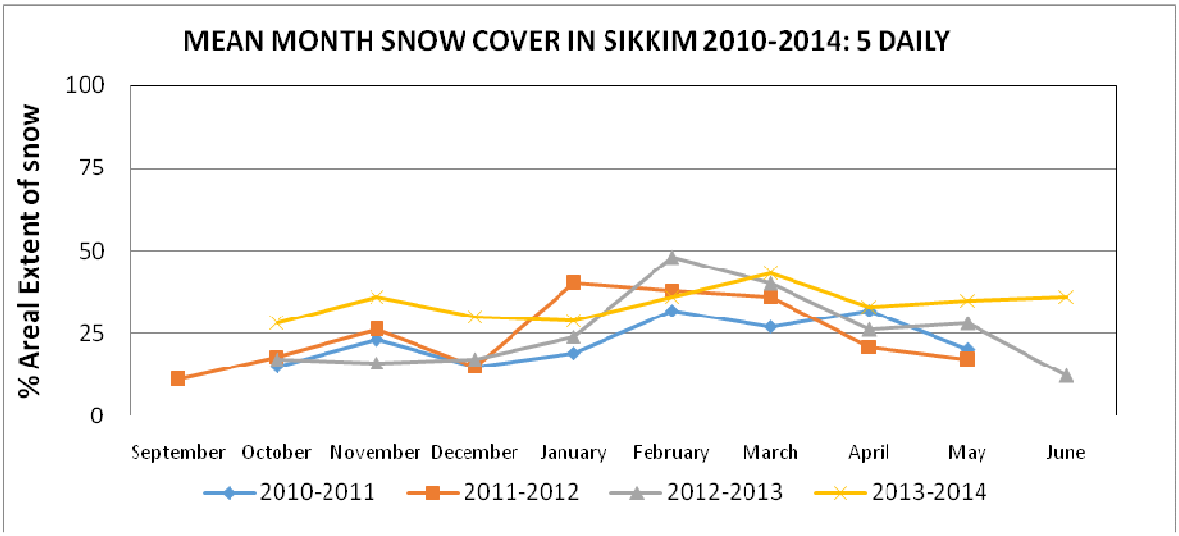


Figure. Daily Mean Month snow cover in Sikkim between 2010-11 and 2013-14

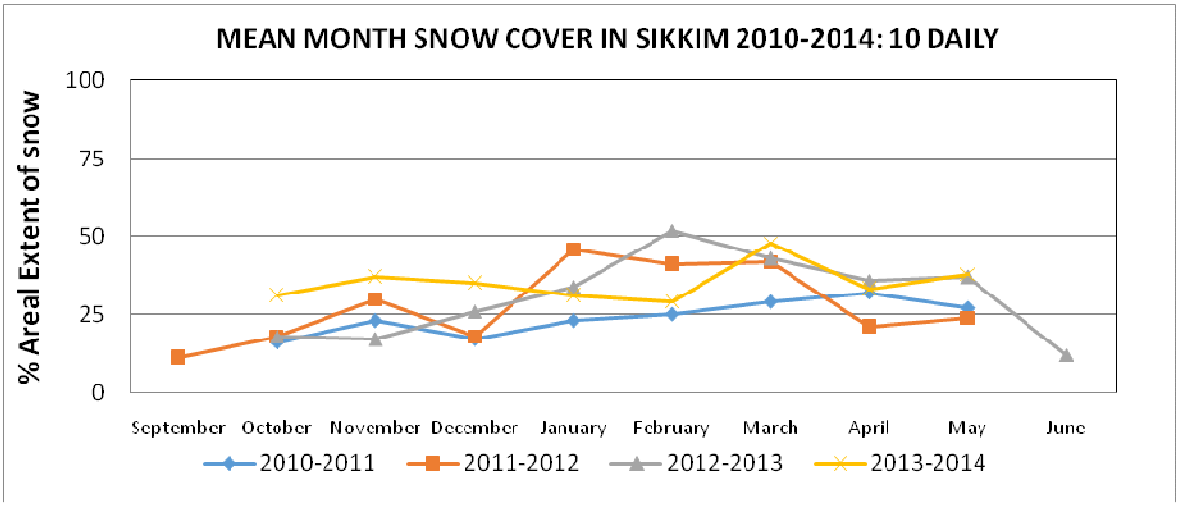


Figure. Daily Mean Month snow cover in Sikkim between 2010-11 and 2013-14

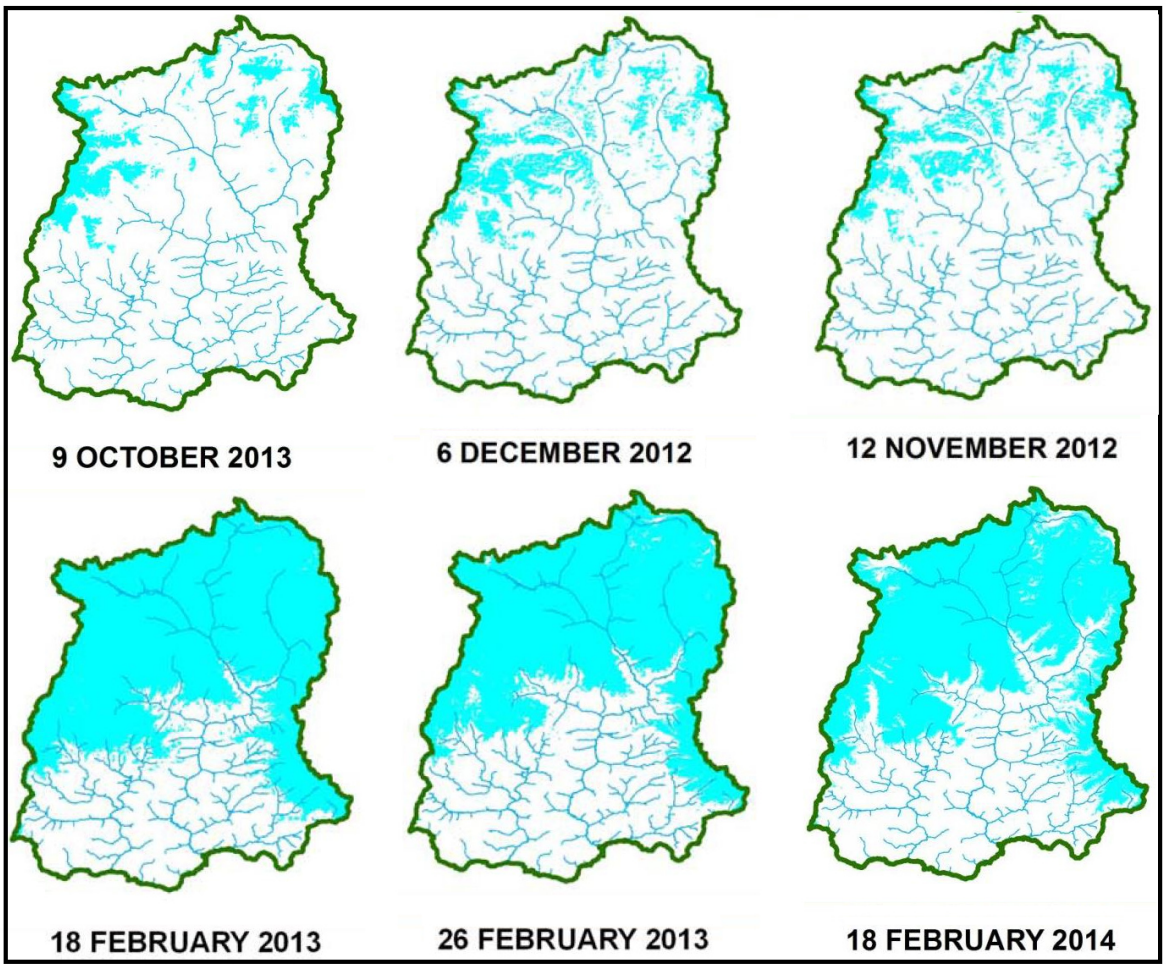


Figure. Snow cover in different dates in Sikkim

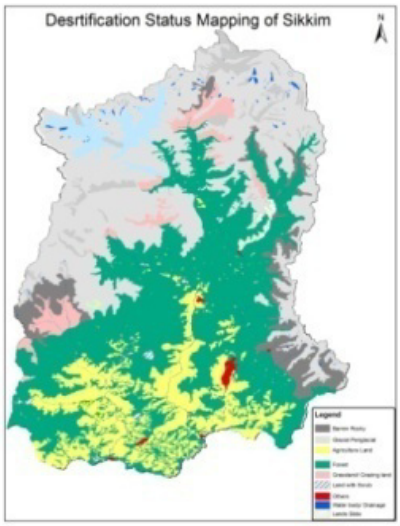
22. Glacier and Climate Change Studies

In Sikkim, a systematic inventory of Himalayan glacier was carried out in collaboration with the Space Applications Centre, Department of Space, GoI, Ahmedabad. As per the study Sikkim has 84 glaciers in Tista basin (Glacier Atlas of Tista Basin) in 2001. With the Constitution of the Sikkim Glacier and Climate Change Commission details inventory of Glaciers, snow mapping and related studies have been taken up under the chairmanship of Prof S.I Hasnain

Under this project study Glacier and climate change studies conducted in Sikkim on three glacier of Sikkim viz, East Rathong Glacier (West Sikkim), Zemu Glacier (North Sikkim), Changme Khangpu Glacier (North Sikkim). beside this Livelihood studies of Sikkimese people. Snow covers monitoring of Sikkim. Impact of Climate Change on Large Cardamom etc. The project duration was from 2008-2010 and was funded by**:** Government of Sikkim.

23. **Desertification status mapping-Sikkim**

Desertification is a continuous degradation of land under the influence of natural and anthropological causes in arid, semi-arid and dry-sub humid conditions. Desertification affects two third countries of the world and one third of the earth's surface, on which one billion people live (one sixth of world population). The causes for desertification are mainly improper management practices, over grazing, tree felling, over cultivation etc. The vegetal degradation, erosion processes, water logging and salinization leads to loss of soil fertility, soil compaction and soil crusting. In addition to this, urbanization, mining and recreation will also have adverse effects on the land leading to desertification. To assess the status of desertification for entire country is a herculean task and needs to be carried out using fast, accurate, cost effective and less laborious methods like satellite remote-sensing.



The main objectives of the project are:

- ✓ To map the desertification status of entire state (DSM) using AWiFS data (2012-13) on 1:500,000 scale.
- ✓ To map the desertification status of selected vulnerable districts of India using LISS III (2012-13) data at 1:50k scale.
- ✓ Desertification Vulnerability Modelling (DVM): To prepare Desertification Vulnerability Map on 1:50k for one district in each state.
- ✓ Development of methodology for preparation of desertification combating plans at larger scale for selected watersheds.

The causes of desertification are: change in frequency and amount of rainfall, reduction in vegetal cover, wrong agricultural management practices, cultivation on marginal lands, over-exploitation of the natural resources, excessive grazing, etc.

India occupies only 2.4% of the world's geographical area, yet supports about 16.7% of the world's human population; it has only 0.5% of the world's grazing land but supports 18% of the world's cattle population. Thus there is tremendous pressure on our land-based natural resources. India is endowed with a variety of soils, climate, biodiversity and ecological regions. About 50.8 mha land area (15.8% of the country's geographical area) is arid, 123.4 mha (37.6%) is semi-arid and 54.1 mha (16.5%) area falls in the dry sub humid region2. All put together, about 228 mha area, i.e. 69% of the geographic area of the country is dry land (arid, semiarid and dry sub humid). Appropriate action plan for arresting land degradation and desertification requires information on the area and the spatial distribution of the land undergoing different processes of degradation.

The classification system adopted is a three level hierarchical classification system. Which is given below:

Table 3: Comprehensive classification system

LEVEL 1: Land Use/ Land cover

The following categories have been identified as below -

Agriculture–Unirrigated	(D)	
Agriculture – Irrigated	(I	
Forest / Plantation	(F)/P*	
Grassland/ Grazing land	(G)	
Land with Scrub	(S)**	
Barren / Rocky Area	(B/R)#	B(Sc) indicating Scree areas in Cold Deserts
Dune / Sandy Area	(E)	
Water body / Drainage	(W)	
Glacial / Periglacial	C/L	
Others	(T)	

(* Rocky areas within forest can be annotated as only Fv3-R in the map)

(** Vegetal degradation in Land with Scrub around periphery of notified forests can be delineated as SV)

(Encroachment in forest area esp. agricultural practices, is FV3)

(# Barren and Rocky areas to be delineated separately as B or R and shown in others category of the legend)

(All settlements should be hatched)

LEVEL 2: Processes of Degradation –

Types of processes resulting in degradation:

Vegetation Degradation	(v)
Water Erosion	(w)*
Wind Erosion	(e)
Water Logging	(l)
Salinization/ Alkalinization	(s/a)**
Mass Movement [in cold areas]	(g)
Frost Heaving [in cold areas]	(h)
Frost Shattering [in cold areas]	(f)
Man made	(m)

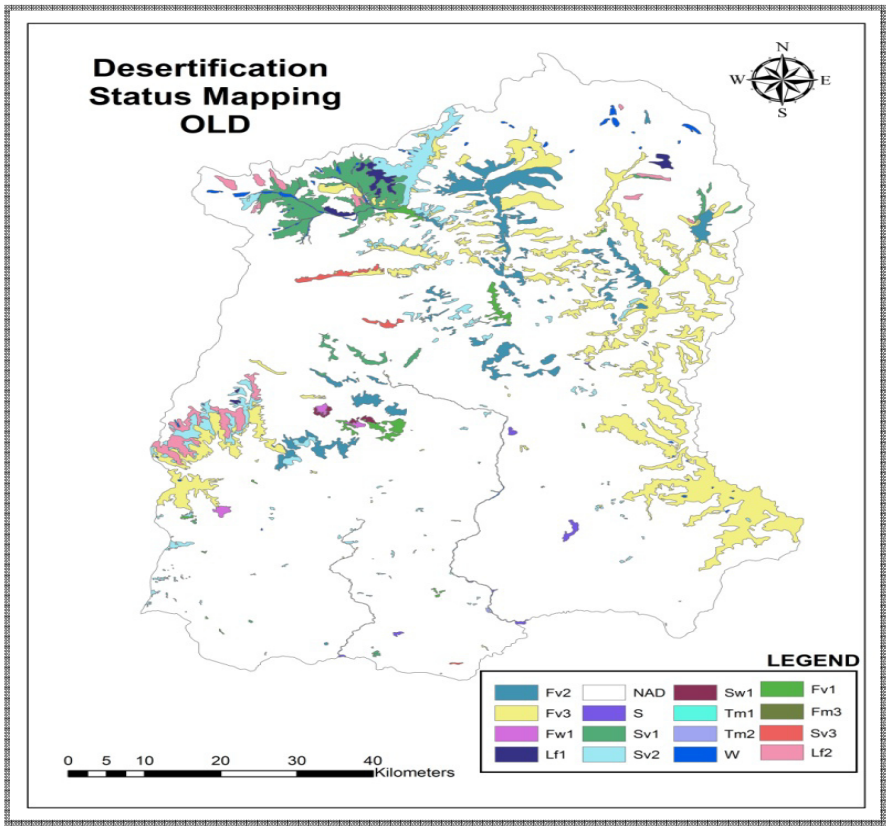
(*Gully/ ravines should be shown as Xw3, where x is the Land use/cover class of surrounding area.)

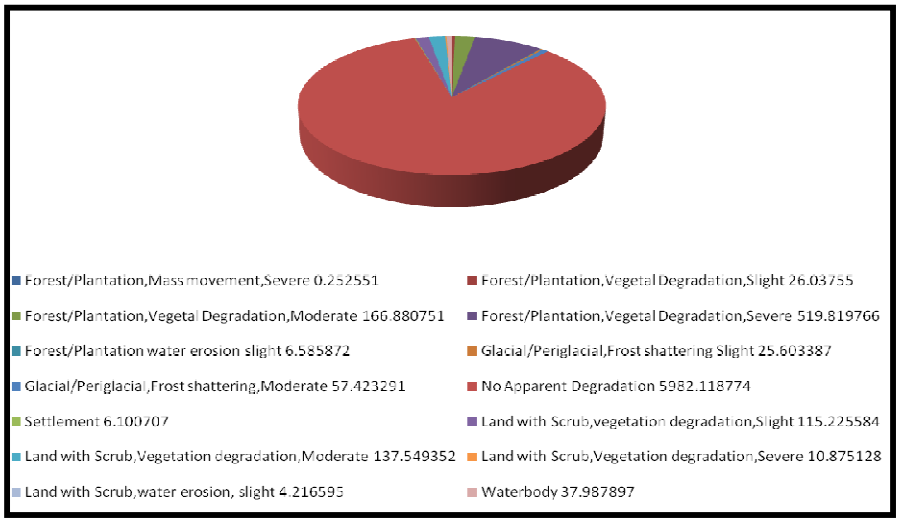
(** Salinization or Alkalinization should be shown as `s, or `a' separately. Where both occur, they should be shown together i.e. $\mathbf{s_x a_y}$, where **x** and **y** are respective degree of severities)

LEVEL 3: Severity of Degradation –

This level represents the degree and severity of the degradation:

Slight	1
Moderate	2
Severe	3



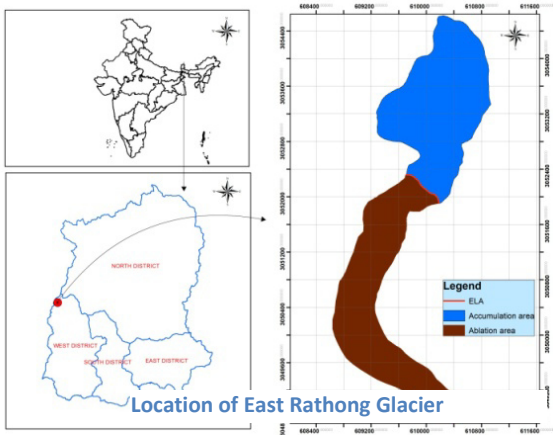


SL.No	**DSM_code**	**DISCRIBTION**	**Area**
1.	**Fm3**	Forest/Plantation, Mass movement, Severe	0.252551
2.	**Fv1**	Forest/Plantation, Vegetal Degradation, Slight	26.83755
3.	**Fv2**	Forest/Plantation, Vegetal Degradation, Moderate	167.0933
4.	**Fv3**	Forest/Plantation, Vegetal Degradation, Severe	**580.4582**
5.	**Fw1**	Forest/Plantation water erosion slight	6.585872
6.	**Lf1**	Glacial/Periglacial,Frost shattering Slight	17.60339
7.	**Lf2**	Glacial/Periglacial,Frost shattering, Moderate	50.42329
8.	**NAD**	No Apparent Degradation	**5940.407**
9.	**S**	Settlement	6.100707
10.	**Sv1**	Land with Scrub, vegetation degradation, Slight	110.2256
11.	**Sv2**	Land with Scrub, Vegetation degradation, Moderate	137.64
12.	**Sv3**	Land with Scrub, Vegetation degradation, Severe	10.87513
13.	**Sw1**	Land with Scrub, water erosion, slight	4.216595
14.	**W**	Water body	37.9879
		Total	**7096.677**

DSM1 LISS III (1999)	**DSM 2 LISS III (2013)**	**CHANGE**	**DSM_CODE**
0.252551	0.252551	0	**Fm3**
26.03755	26.83755	-0.8	**Fv1**
166.880751	167.0933	-0.212549	**Fv2**
519.819766	580.4582	-60.638434	**Fv3**
6.585872	6.585872	0	**Fw1**
25.603387	17.60339	+7.999997	**Lf1**
57.423291	50.42329	+7.000001	**Lf2**
5982.118774	5940.407	+41.711774	**NAD**
6.100707	6.100707	0	**S**
115.225584	110.2256	+4.999984	**Sv1**
137.549352	137.64	-0.090648	**Sv2**
10.875128	10.87513	0	**Sv3**
4.216595	4.216595	0	**Sw1**
37.987897	37.9879	0	**W**

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

Glacial Dynamics of East Rathong Glacier

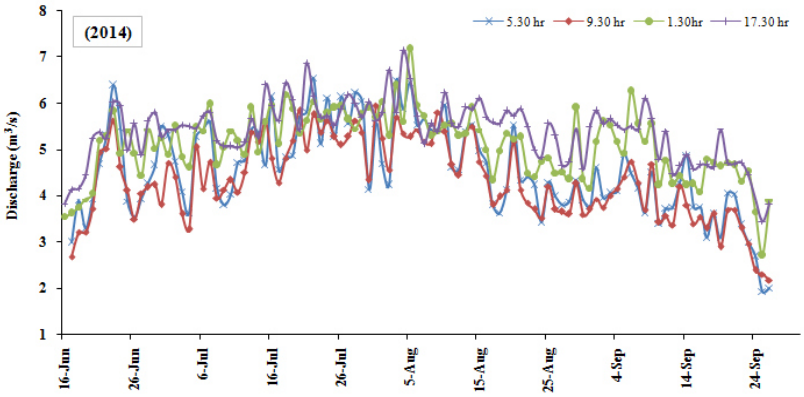


Study of Glacier Dynamic of East Rathong Glacier is project funded by Department of Science and Technology, Government of India. East Rathong glacier located in West District of Sikkim is selected as the benchmark glacier in Sikkim Himalaya for the study of glacial dynamics in order to know the health of glacier in this region. East Rathong Glacier is a valley type, debris cum clean, South- East facing glacier about 7 km with an average width of about 800 m. The flow of the trunk glacier (main body) is from North to South-East. It originates at an elevation between 4600- 6700m asl. From head of the glacier, it descends with a steep gradient and at ablation area, the gradient is moderately gentle. The glacier lies within a U-shaped valley. Around snout region is an Ice cave, on top of which is morainic materials lies. Two lateral moraines are well developed along the sides of the glacier.

Following are the major studies undertaken:

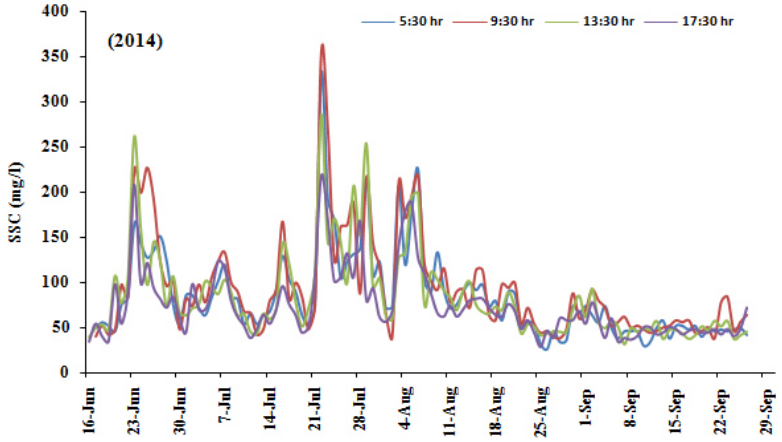
Snout Mapping and monitoring: Snout monitoring is one of the important parts of glaciology. Snout demarks the frontal part of glacier in the lower ablation area. In other words, snout is the particular area in the glacier from where the melt water starts flowing in the form of stream. From 2013, the snout has been monitored with the help of *Topcon DGPS*. The frontal faces of snout showed continuously changing on account of excessive melting in the ablation season of 2013 and 2014. The snout has retreated lengthwise at an average of 4.85 m in one year between September 2013- September 2014**.**

Glacier Hydrology covering Discharge measurement and suspended sediment load studies. Hydrological study is one of the important parts of glaciology, for which Rathong Chu was selected. The hydrological station was established below 1.5 km downstream of the glacier's snout. The average daily discharge in the year 2013 in East Rathong melt water stream was 5.07 m^3s^{-1}, which is comparatively higher than the average discharge of 2014 (4.84 m^3s^{-1}). Generally the maximum and minimum discharges were observed in 5:30 pm and 9:30 am for the year 2013-2014 respectively. Sometimes peak discharges were also observed at the end of the August at 13.30 hrs for both the years due to increased precipitation at that time.



Daily variation of discharge at East Rathong Chu from morning to evening collected for ablation season (2014)

Average daily sediment concentration in East Rathong glacier stream is 106.3 mg/l and 84.20 mg/l for the year 2013 and 2014 respectively. Average Sediment Load carried by Rathong Glacier stream is 49.94 td^{-1} and 37.11 td^{-1} in ablation season of 2013 and 2014 respectively.



Daily variation of Suspended Sediment Concentration(SSC) at East Rathong Chu from morning to evening collected for ablation season (2014)

Study of ablation and vertical thinning:

It was found that the glacier has retreated vertically on an **average of 3.849 m** in the ablation period of 2014 (June to September) along the centreline of the glacier, which is considerably higher than the last year melt record in the ablation season.

Team performing ablation stakes measurement in East Rathong Glacier

Meteorological studies

The data meteorological studies are collected by the manual equipments for the ablation period of 2013 -2014 in East Rathong Glacier.

Sl No	Observations	Instruments	Time of observation
1	Temperature	Thermo hygrometer	5:30 hr, 9:30 hr, 13:30 hr and 17:30
2	Rainfall	Ordinary Rain gauge	5:30 hr and 17:30 hr
3	Humidity	Thermo hygrometer	5:30 hr, 9:30 hr, 13:30 hr and 17:30
4	Water level	Manual Water level Gauge	5:30 hr, 9:30 hr, 13:30 hr and 17:30
5	Dry and wet Bulb Temperature	Dry and wet Bulb Thermometer	5:00 hrs to 18 :00 hrs
6	Wind Direction	Wind vane	5:30 hr, 9:30 hr, 13:30 hr and 17:30

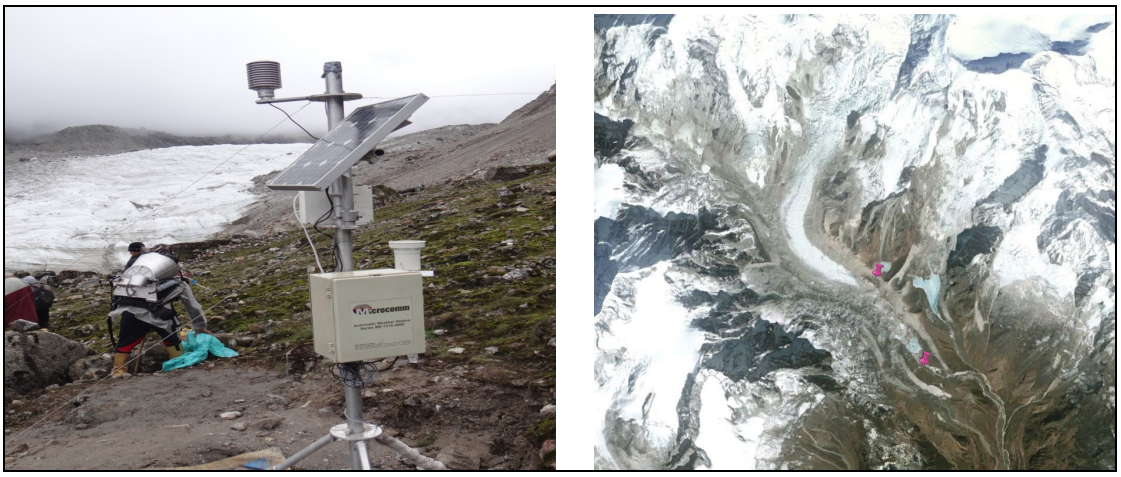
Other important studies are:

- Contour mapping of East Rathong Glacier
- Frontal area retreat of East Rathong Glacier using Remote Sensing Techniques
- Glacier Ice Velocity studies using Topcon DGPS.
- Snow cover Monitoring of East Rathong Glacier Catchment
- Study of Flora along the recessional moraines in semi Glaciated regions of East Rathong Glacier

Recently, the State Council submitted the status report on East Rathong Glacier to funding agency. The duration of the project is extended for another one year by DST, GOI.

Installation of Automatic Weather Station (AWS)

Sikkim State Council of Science and Technology had successfully installed Automatic Weather Station on the edge of elongated Right Lateral Moraine (RLM) at 4,700m to test the performance of it in the harsh environment of East Rathong valley and generate long term climatic data for the glacial accumulation studies. Recently installed AWS procured under NMSHE will generate data on several weather parameters including rainfall, temperature, humidity, sunshine hours, snow depth, snow temperature, wind direction and speed, respectively. The AWS will generate long term data for the detailed glaciological study in the days to come.



Installed Portable Microcomm Automatic Weather Station within the deglaciated valley of East Rathong at 4709m & its location

i. Data Retrieval through Microcrom Automatic Weather Station

Data has been downloaded from the previously installed AWS lying at old morainic ridge near the ever growing pro-glacial lake. It was installed in the month of September 2015 to generate long term data for the study of East Rathong glacier. It has provided data on several parameters of weather which include rainfall, temperature, humidity, sunshine hours, snow depth, snow temperature, wind direction and wind speed, respectively. It is a unique and first of its kind in the high altitude area of West Sikkim being installed by SCS&T. It consists of data logger, Yagi Antennae, solar panel, GPS, 12.5 Volt Battery etc.

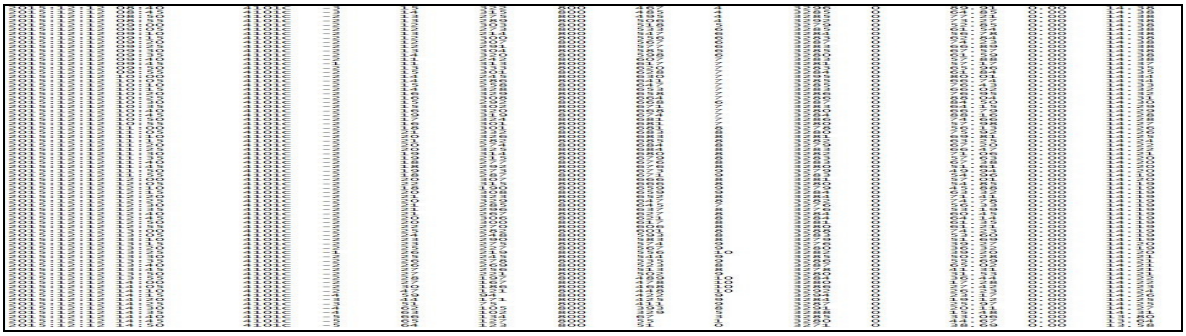


Figure. Data retrieved from data logger of Microcomm AWS

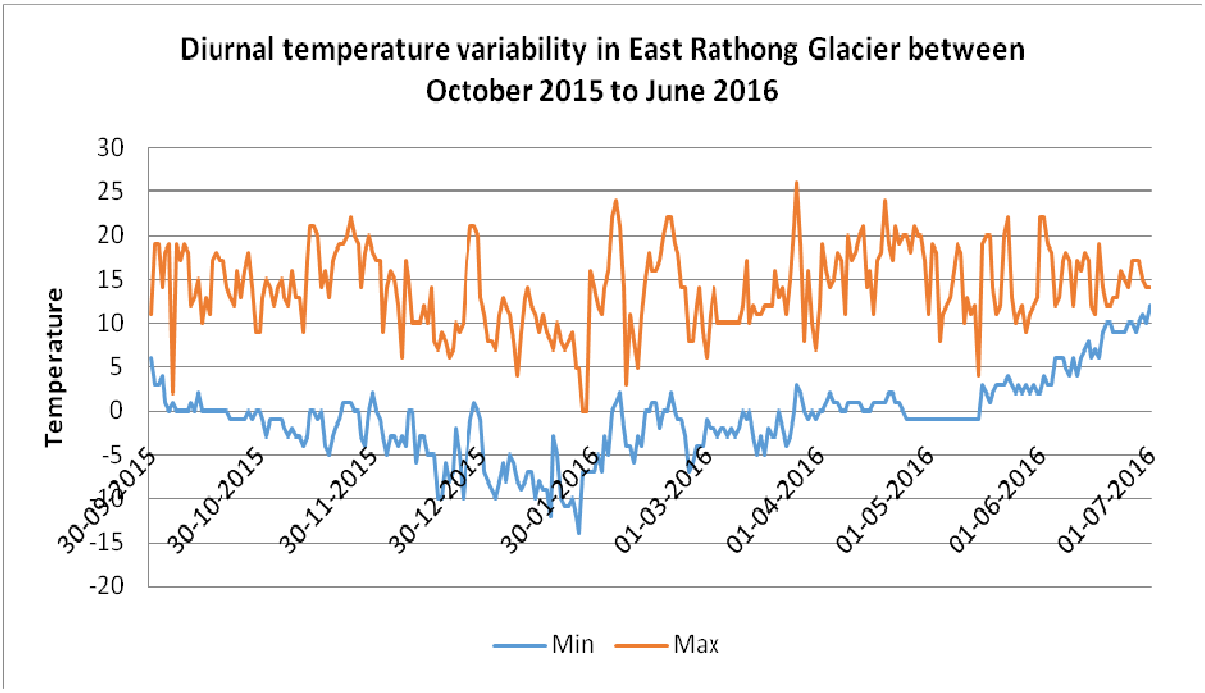


Figure. Diurnal temperature variability in East Rathong Glacier for the period in between October 2015 to June 2016

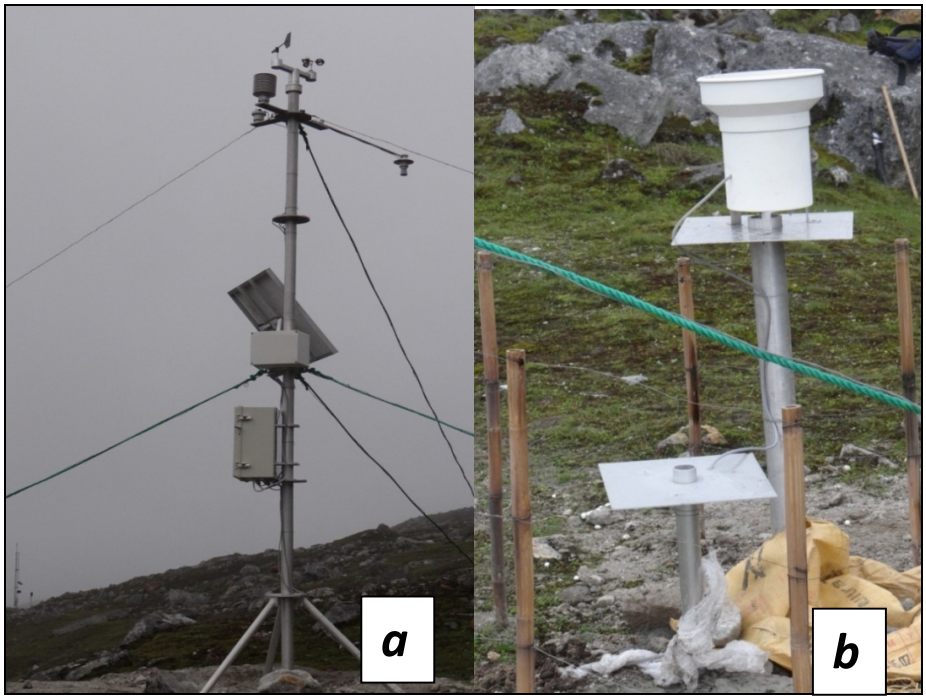


Plate. Automatic weather station with data logger ***(a)*** and rain gauge (***b***) lying in the vicinity of *Pro-glacial* lake

ii. Stake fixation for glacial ablation and velocity studies

For glacial ablation and velocity studies new bamboo stakes has been fixed at several altitudes targeting the ablation and accumulation area of East Rathong glacier. Besides, displacement of old bamboo stakes fixed last year has been monitored through DGPS by the scientific team. A total of 14 bamboo stakes has been monitored to calculate vertical thinning in the last nine months. Scientific team had found an average melting of 3.3meters in the last 9 months.

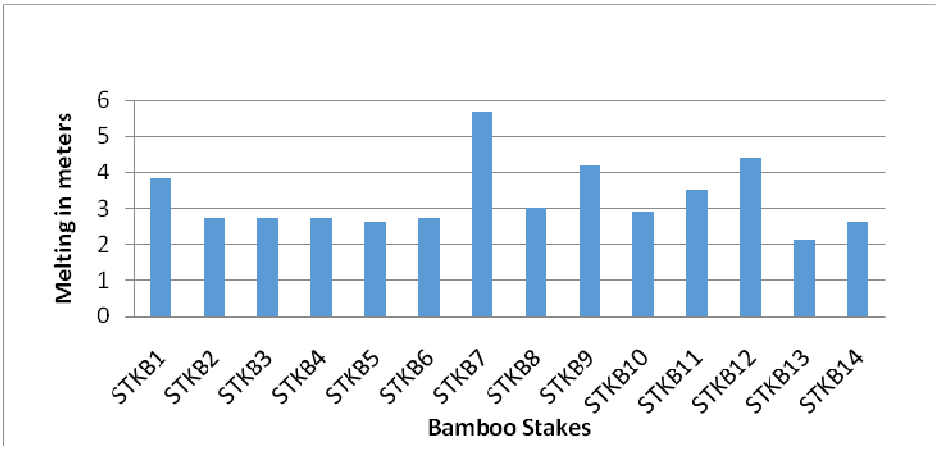


Figure: Melting of stakes in between October 2015 to June 2016

Figure. Stakes fixed on the surface of East Rathong glacier in September 2015

Plate. Bamboo stakes has been in East Rathong Glacier due to its eco friendly nature

iii. **Documentation of Glacial landforms**

The relict and contemporary landforms produced by the glaciers has been documented through photography and videography by the scientific team. The major glacial landforms documented are hummocky, left and right lateral moraines. The miniature glacial landforms documented includes glacial/ice *serrac* faces, transverse and longitudinal crevasses, Pro-glacial lakes and temporary ponds, Glacial Mills, Moulins, Dirt cones, Melt Water Channels, Talus cones, Glacial Sholes and *Mullin* lakes etc. Spatial and attribute data of the landforms has also been collected through hand held Global Positioning System. Field photos of a few glacial landforms are shown below.

Pro-glacial and temporary lakes

Glacial/sediment mounds

Moulin

Glacial Table

Melt water channel

Transverse glacial Crevasse

Plate. Documentation of glacial landforms

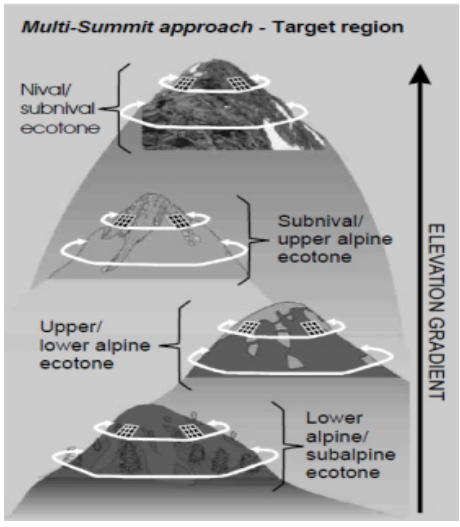
25. Long Term Monitoring on "Study of Glacier Dynamics of East Rathong Glacier-Sikkim"

The project "Glacier dynamics of East Rathong Glacier, Sikkim" aims at generating long term baseline data on glacier dynamics of East Rathong glacier. The main objectives of the project are Glacier secular Movement studies-snout monitoring and glacial movement, Snow covers monitoring of East Rathong Catchment yearly using AWiFs data, Glacier Hydrometry including discharge and suspended sediments of East Rathong melt water stream, etc. The State Council has already submitted the Status Report of East Rathong glacier to Department of Science and Technology, Government of India based on the work carried out during 2013-2014. Therefore present work confer the continuity of glacier dynamics project for establishment of long term glacier dynamics data on East Rathong Glacier.

Following are the progress work during the session 2017-18

1. Collection of AWS (Automatic weather Station) data from the field.(On last week of September)
2. Collection of DGPS (Differential Global Positioning System) data and field photograph.
3. Day to day sample collection of suspended river sediments and velocity data for three months i.e July - September.
4. Analysis of AWS data.

26. Alpine ecosystem dynamics and impact of climate change in Indian Himalaya



The primary objectives of the project are establishment of long term ecological records in alpine ecosystems of Indian Himalaya. Understanding alpine ecosystem response using remote sensing data, *in-situ* data and modeling. The long term study was started since 2013-14, previously we have selected the site at Gnathang for the long term study, but due to the anthropogenic activities we have sifted site at Kabi-Tingda. The three summits were selected at Kabi tingda reserve forest North Sikkim. The field data was collected continuously from every year from the site finally it was correlated with climate change data. This Project is sanctioned by Space Applications Centre, ISRO, Ahmadabad, under the Himalayan Alpine Dynamic Research Initiative (HIMADRI).

The primary objectives of the project:

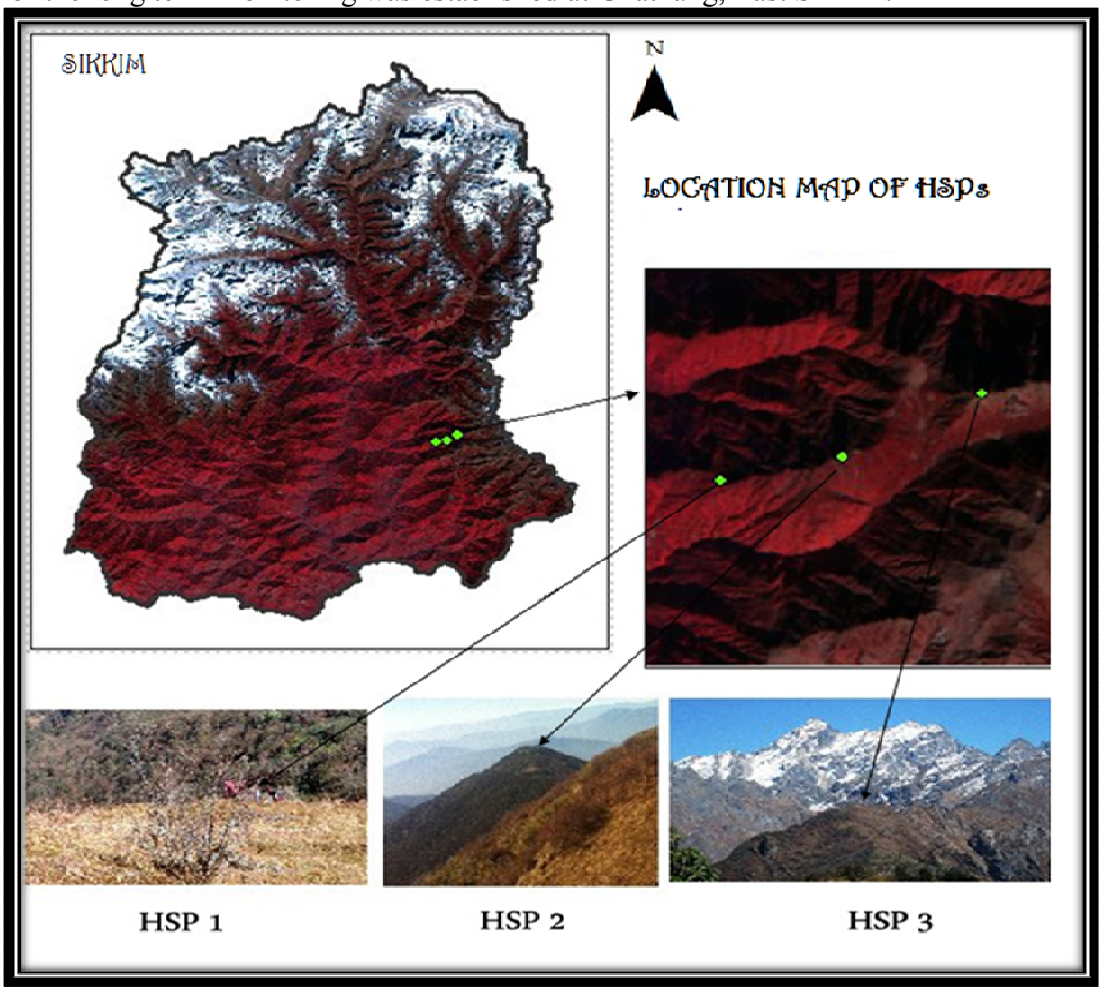
- Establishment of long term ecological records in alpine ecosystems of Indian Himalaya.
- Understanding alpine ecosystem response using remote sensing data, *in-situ* data and modelling.

The Secondary objectives:

- Remote sensing based seamless geospatial database development of the alpine ecosystem towards creation of baseline national data.
- Reconstruction of past alpine tree line with state-of-the-art techniques.
- Simulation of future climate change impact on alpine landscape.

Site selection and Site establishment

In 2014, the field work was conducted by scientific team from Sikkim State Council of Science and Technology; Space Applications centre (ISRO), Ahmedabad and CSIR-NBRI, Lucknow, and sit for the long term monitoring was established at Ghathang, East Sikkim.



In 2015, the team from Sikkim State Council of Science and Technology visit field Ghathang, East Sikkim; Survey was done at three summits GNT1, GNT2, and GNT3, but due to heavy human and animal's disturbances, these summits were not fulfilling the criteria given as per HIMADRI, So as discussed with scientific team of SAC Ahmedabad the, team from State Council of Science and

Technology had to search for new summits where this project would be done without any difficulty and disturbances.

So on 14th October 2015, team from Sikkim State Council of Science and Technology visited Kabi- Tingda, Reserve Forest near Tamzee, North Sikkim, in search of new summits for the project. There team was able to locate 3 summits where long term monitoring site could be established.

Elevation and Geographic coordinates of three summits are as follows: First Summit has been named as KB3 it's at elevation of 3926m, and coordinates are N 27˚25'30.4" E 088˚42'59.5".

Second Summit KB2 is at elevation of 3701m, Coordinates are N27˚24'54.4" E 088˚41'43.0".

Third Summit KB1 is at elevation of 3151m, Coordinates are N27˚24'41.5" E 088˚40'36.7".

Installation of Temperature Data Loggers

Temperature Data Loggers have been installed at all the three HSPs, by the side of 5m elevation; inside 3X3 meters quadrates. 5m elevation was taken using clinometers, at all the four Compass directions. Temperature from this data loggers will be will be acquired within this year

Summit code	Compass direction	Distance of 5m elevation, from HSP in meters
KBT 1	East	19.4
	West	28.2
	North	23.7
	South	17.9
KBT 2	East	36.7
	West	12.2
	North	14.6
	South	13.6
KBT 3	East	16.1
	West	28.2
	North	16.2
	South	50

Installation of Temperature Data Loggers

On the month November 2015 i.e. on 19/11/2015 Scientific team of "Sikkim state council of science and technology" revisited three summits to establish permanent sit for longterm monitoring as well as to install Wireless Temperature Data Loggers.

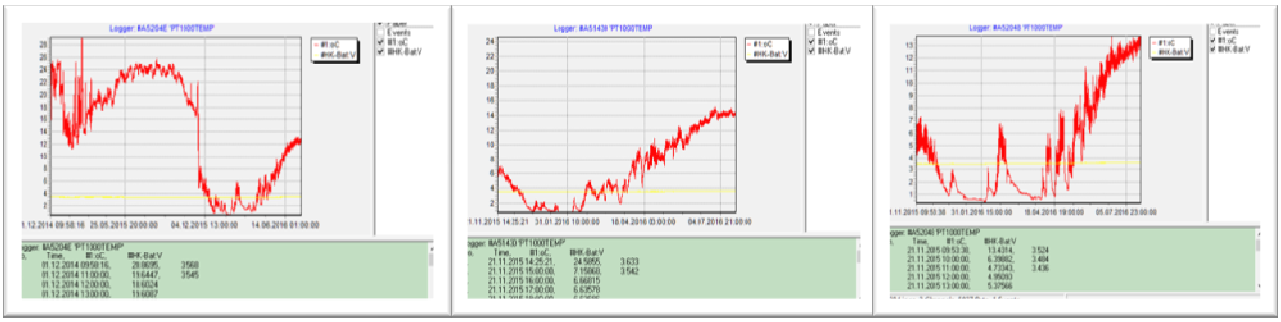
Temperature Data Loggers have been installed at all the three HSPs, by the side of 5m elevation; inside 3X3 meters quadrates. 5m elevation was taken using clinometers, at all the four Compass directions. Temperature from this data loggers will be will be acquired within this year.

B

C

D

Picture: A. Activating Data Loggers, **B.** Installing Data Loggers at KB1, **C.** Installing Data Loggers at KB2, **D.** Installing Data Loggers at KB3



Graph: showing maximum and minimum temperature collected from three summit

Vegetation sampling at selected Target region

Field visit was conducted on July 2016 bt the Scientific team from DST, SAC and NBRI visited Kabi-Tingda Reserve Forest, North Sikkim, for vegetation sampling at selected Target region, Plants identification, and Data Collection form installed Temperature Data Loggers.

Plot of 3X3meters quadrate at 5 meters elevation has been made from highest summit points (HSP) at all the four compass direction East, West, North and South, at all the three summits. Where vegetation sampling was done using grid frame of 1x1, for identification species name and codes were used.

Plants identification

Plants were identified following by lichen, bryophytes and vascular plants at all the three summits.

The dominant species of lichens *Dermatocarpon* Sp., *Umbilicaria* Sp., *Dermatocarpon* Sp, *Usnea* Sp and *Rhododendron* sp., *Aconogonum molle, Potentilla penduncularis, Senecio piversifolius Fragaria nubicola, Juncus thomsonii,* etc. were dominant vascular plant.

List of plant of all three summits:

	BOTNICAL NAME	GENUS	FAMILY	KB T1	KB T2	KB T3
1	*Aconitum ferox* Wall. ex Ser.	Aconitum	Ranunculaceae			✓
2	*Anaphalis busua* (Buch.-Ham.) DC.	Anaphalis	Compositae		✓	
3	*Anaphalis contorta* (D.Don) Hook.f	Anaphalis	Compositae	✓	✓	
4	*Athyrium filix-femina* f. strictum (Gilbert) J.T. Howell	Athyrium	Athyriaceae			✓
5	*Berberis darwinii* Hook.	Berberis	Berberidaceae	✓		
6	*Berberis jaeschkeana* C.K.Schneid.	Berberis	Berberidaceae	✓	✓	
7	*Berberis microphylla* G.Forst.	Berberis	Berberidaceae		✓	
8	*Bergenia purpurascens* (Hook.f. & Thomson) Engl.	Bergenia	Saxifragaceae		✓	✓

9	*Crepis sancta* (L.) Bornm.	Crepis	Compositae	✓	✓	
10	*Cynodon dactylon* (L.) Pers.	Cynodon	Poaceae	✓		
11	*Dryopteris borreri* V.I. Krecz.	Dryopteris	Dryopteridaceae	✓		
12	*Dryopteris dilatata* (Hoffm.) A. Gray	Dryopteris	Dryopteridaceae			✓
13	*Selinum wallichianum* (DC.) Raizada & H.O. Saxena	Selinum	Apiaceae	✓	✓	
14	*Euphorbia cognata* (Klotzsch) Boiss.	Euphorbia	Euphorbiaceae			✓
15	*Euphorbia helioscopia* L.	Euphorbia	Euphorbiaceae		✓	✓
16	*Fragaria nubicola* (Lindl. ex Hook.f.) Lacaita	Fragaria	Rosaceae	✓	✓	✓
17	*Gentiana triflora* Pall.	Gentiana	Gentianaceae		✓	
18	*Geranium molle* L.	Geranium	Geraniaceae		✓	
19	*Hydrocotyle nepalensis* Hook.	Hydrocotyle	Araliaceae	✓	✓	✓
20	*Impatiens brachycentra* Kar. & Kir.	Impatiens	Balsaminaceae	✓	✓	✓
21	*Impatiens sulcata* Wall.	Impatiens	Balsaminaceae		✓	
22	*Iris clarkei* Baker ex Hook.f.	Iris	Iridaceae	✓	✓	
23	*Iris milesii* Baker ex Foster	Iris	Iridaceae	✓		
24	*Juncus thomsonii* Buchenau	Juncus	Juncaceae	✓	✓	✓
25	*Juniperus indica* Bertol.	Juniperus	Cupressaceae		✓	
26	*Juniperus squamata* Buch.-Ham. ex D.Don	Juniperus	Cupressaceae		✓	
27	*Ligularia amplexicaulis* DC.	Ligularia	Compositae			✓
28	*Lilium nanum* Klotzsch	Lilium	Liliaceae		✓	✓
29	*Maianthemum purpureum* (Wall.) LaFrankie	Maianthemum	Asparagaceae		✓	
30	*Pedicularis siphonantha* D.Don	*Pedicularis*	*Orobanchaceae*			✓
31	*Onopordum acanthium* L.	Onopordum	Compositae			✓

32	*Paris polyphylla* Sm.	Paris	Melanthiaceae			✓
33	*Persicaria barbata* (L.) H.Hara	Persicaria	Polygonaceae		✓	
34	*Persicaria capitata* (Buch.-Ham. ex D.Don) H.Gross	Persicaria	Polygonaceae		✓	
35	*Plantago lanceolata* L.	Plantago	Plantaginaceae	✓		
36	*Plantago major* L.	Plantago	Plantaginaceae	✓		
37	*Pogonatherum crinitum* (Thunb.) Kunth	Pogonatherum	Poaceae	✓		
38	*Polygonum molle* D. Don	Polygonum	Polygonaceae	✓	✓	✓
39	*Potentilla peduncularis* D.Don	Potentilla	Rosaceae	✓	✓	✓
40	*Ranunculus hirtellus* Royle	Ranunculus	Ranunculaceae			✓
41	*Rhododendron anthopogon* D. Don	Rhododendron	Ericaceae			✓
42	*Rhododendron campanulatum* D. Don	Rhododendron	Ericaceae	✓		✓
43	*Rhododendron fulgens* Hook. f.	Rhododendron	Ericaceae	✓		
44	*Rhododendron thomsonii* Hook. f.	Rhododendron	Ericaceae	✓	✓	✓
45	*Rosa pendulina* L.	Rosa	Rosaceae	✓		
46	*Rosa sericea* Wall. ex Lindl.	Rosa	Rosaceae		✓	
47	*Rubus niveus* Thunb.	Rubus	Rosaceae	✓		
48	*Rumex obtusifolius* L.	Rumex	Polygonaceae	✓		
49	*Selinum tenuifolium* Salisb.	Selinum	Apiaceae	✓	✓	
50	*Senecio diversifolius* Harv.	Senecio	Compositae		✓	✓
51	*Strobilanthes tomentosa* (Nees) J.R.I.Wood	Strobilanthes	Acanthaceae		✓	
52	*Aechmanthera gossypina* (Wall.) Nees	*Aechmanthera*	Acanthaceae		✓	
53	*Swertia ciliata* (D. Don ex G. Don) B.L. Burtt	Swertia	Gentianaceae		✓	
54	*Swertia cuneata* Wall. ex D. Don	Swertia	Gentianaceae			✓

55	*Thalictrum foliolosum* DC.	Thalictrum	Ranunculaceae	✓		
56	*Valeriana hardwickii* Wall.	Valeriana	Caprifoliaceae		✓	
57	*Viola biflora* L.	Viola	Violaceae			✓
58	*Zephyranthes carinata* Herb.	Zephyranthes	Amaryllidaceae		✓	
59	*Cladonia Chatham*			✓		
60	*Everniastrum cirrhatum*			✓	✓	✓
61	*Lepraria thumbnail*				✓	✓
62	*Parmotrema perlatum*			✓	✓	
63	*Usnia orientalis*			✓	✓	
	Total Number of Species			30	37	26

Visit to BSI (Regional Center, Gangtok)

To know plant variety of Sikkim Himalaya and to monitor plant environment from earlier times, *Botanical Survey of India* (Regional Center, Gangtok), herbariums has been regularly visited. 1100 specimens were studies at BSI, which has been recorded by different botanist since 1934 to 2008. Botanical name, tag number, family, elevation and name of a place from where sample was collected, local name, collector name, date of collection were all noted. The 32 plant species were evaluated, and estimate the distribution of this species at various elevations

27. Pilot Demonstration' 2x100 KW micro hydel project in the North district of Sikkim

The 2x100 KW Thangu Micro-hydro 'Pilot Demonstration Project' (MHDP) is located at Thangu village in the Lachen sub-division, North Sikkim at an altitude of 14,000 feet. The Constructional and Power Generation Cooperative Society, Lachen executed the project with the technical support of the SPDCL.

The project has been inaugurated 14th November 2014 and taken over by the Lachen Dzumsha.

Photo: Inauguration of 2x100 KW MHDP, Thangu

28. Sikkim State Climate Change Cell

(established under National Mission for sustaining the Himalayan Ecosystem **(NMSHE)***)* **funded by;** Department of Science and Technology, Government of India.

Sikkim State Climate Change Cell established in October 2014 under Sikkim State Council of Science and Technology is being engaged in fulfilling the needs and objectives of National Mission for Sustaining the Himalayan Ecosystem in Sikkim.

Sikkim being located in the Himalayas is one of the vulnerable state in terms of climate change and its impact, there is an immense need to deal the climate change globally, at national level, state level and local level. There is a need to aware about climate change and global warming to the every individual so that there will be the participation of maximum individual in

fighting against the odds of climate change and its impacts. So the awareness generation of general public of the state on climate change is equally very important to minimize the impact of climate change.

Sikkim State Climate Change Cell is working in this direction since its establishment as according to the given mandate of the NMSHE. National Mission for Sustaining the Himalayan Eco-system (NMSHE), one of the missions under National Action Plan on Climate Change, supported by Department of Science and Technology, Government of India.

The **Objective of the project:**

- Vulnerability and Risk Assessment at Gram Panchyat Unit (GPU) and ward level: The state has total number of 176 GPU and 1001 wards in its four district of Sikkim. Vulnerability and risk assessment provides level of vulnerability within ward/GPU to prioritize the adaptation measures.
- Institutional Capacity building to attain the capability to handle climate change program and to find the solutions to address the problem of climate change in the state. To carry out Research and Development activities for data base generation as per the SAPCC and NMSHE requirements.
- Training programmes for stakeholders including Government officials, researchers, community based organizations, media etc in the state to work for the minimizing the affect of climate change in the state and to achieve the sustainable development.
- Involving masses to work for minimizing the impact of climate Change through awareness programme.

The Centre will also focus on Glaciological studies as well as various studies on Climate Change. Apart from that the Centre will also work on awareness programme on climate change. The Cell will work in close coordination with various stake holders based on the state in order to fulfill the goal of climate change adaptation programme.

Progress of Work

- Institutional capacity building: At present the State Climate Change Cell is fully functional in state with dedicated office space, manpower and equipment required for research and developmental activities. The two manpower of the Cell are trained at TERI Delhi on climate change initiatives and glaciological field based studies at Hamtah glacier by Geological Survey of India(GSI) and Chhota Shigri Glacier by Jawaharlal Nehru University(JNU). More training programmes of rest of the manpower is expected in coming years.

Glimpses of DST-SDC Workshop on Adaptation, Planning and Implementation in Indian Himalayan Region: Technical support for State Climate Change Cells

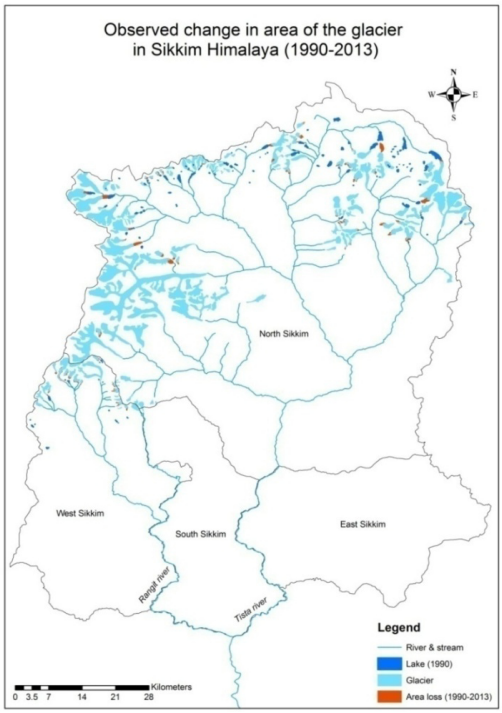
- Training programme of stakeholders including government officials, media etc: Preparation of training module is in progress based on Training Needs Assessment Report of Swiss Agency for Development and Cooperation(SDC). The mapping of the department engaged on management of identified key sectors is already completed. A consultation workshop of Stakeholders for the preparation of Action Plan for implementation of National Mission for Sustaining Himalayan Ecosystem (NMSHE), was held at Sikkim on 20th November 2015.

- Public Awareness: Public awareness programme on Climate Change is under progress. The awareness generation programme are carrying out through pamphlets, posters, newspaper, imparting lectures in schools, Block Administration Centre (BAC). Climate change awareness generation of Panchayat and other public under BACs in North and East districts is already completed. Climate change Awareness programme in South district is under progress.

- Database generation using recent satellite data to fulfill the needs of NMSHE and SAPCC is in progress.
- With the support of NMSHE, the State Cell installed Automatic Weather Station in East Rathong Glacier, Stakes fixed using Heucke stem drilling machine, established discharge sites for hydrological studies, procured weighing machine for measuring weight of suspended sediments etc.

Fixing of Stakes using Heucke Ice Drilling machine

- Completed snow cover monitoring report for the year 2013-2014. The report is submitted to SAC, Ahmadabad.
- Completed glacier inventory mapping of Sikkim using satellite imageries of 1990 and 2013.



- Study of Climate change induced natural hazards like landslides, study of GLOFs including South Lhonak Lake and Shako Tsho glacial lakes, study of vulnerable areas under major rivers and streams in Sikkim is in progress.
- Study of human health in terms of climate change is in progress.
- Study of high altitudinal lakes is in progress. Inventory mapping is completed, analysis of the data is in progress.

Climate Change Vulnerability mapping:

The Climate Change cell is engaged on the creation of database on the basic of three criteria the exposure, sensitivity and adaptive capacities required for the vulnerability assessment. The Cell has started the work of vulnerability mapping for the state of Sikkim using data from the census of India, 2005 and the data obtain from the DESME (Department of Economic Statistic and Monitoring Evaluation) Gangtok. DESME is the important department working on the collection and analysis of socio economic data at the state level. So apart from the Census of India the data collected through DESME are valid in nature and are considered as the main source of information. For the valid information on land use pattern of the state, Land use map prepared under Space based Information Support for decentralised Planning (SISDP) project has been used. The land use mapping was carried out at the scale of 1: 10000 which is considered as high resolution data prepared by using the mosaic of CARTOSAT and LISS IV imagery. So the land use information extracted is considered as high accuracy information on the existing land use pattern of the state.

In order to get the land use information at the GPU level, the land use map has been subset by all the individual GPU boundaries. The land use sub classes such as agricultural area, Built up area (Urban/Rural), cropland, forest, gullied /ravenous, lake/ponds, river stream, sandy areas, scrub land, transportation (pucca/kutcha) area has been extracted and area coverage by each of the classes is calculated in hectares. The ARC GIS software is being used for carrying out the entire analysis. So far the land use classification of all the four districts has been completed.

The socio economic data of Sikkim published by (Department of Economic Statistic and Monitoring Evaluation) Gangtok,2005 has been used to identify the vulnerability at each GPU level. The data were collected to fit the sensitivity and exposure parameters in the state in terms of climate change vulnerability mapping. The data covered at GPU level were total household, Below Poverty Line household, the types of house build in the area viz Pucca, Kutcha, and Semi

pucca, types and source of drinking water (Spring and River), the dependent population of the area, sex ratio, status of education. In addition the status of health, availability of PHC/Dispensary/PHSC, VLW Centre, and Veterinary Hospital of the area are also covered.

These information will be used to identify the degree of climate change vulnerability as well as the level of adaptive capacities available among the different GPU in the four district of Sikkim. The final vulnerability mapping will be done based on the standard format which could fit the needs and requirement of the mountainous topography of the state.

It is recommended that capacity building and more training to do the high resolution Vulnerability Assessment is required for the technical manpower and scientists of State Climate Change Cell.

(Note: The socio economic surveys in Sikkim were carried out at the interval of 10 years by DESME, Sikkim. The last survey was carried out in 2005 and as per Department of Economic Statistic and Monitoring Evaluation the present socio economic survey for the year 2015 is under process. The report may be available by next year. The result of 2015 survey will throw more light on existing real fact and figure of Sikkim. So it is hoping to get clearer picture of vulnerability mapping with 2015 survey report).

Table 1.Data and their status prepared for vulnerability Mapping sets

Sl. No	**Data**	**Types of data generated**	**Source**	**Status**
1	Land Use mapping	Agricultural area, Built up area (Urban/Rural), cropland, forest, gullied /ravenous, lake/ponds, river stream, sandy areas, scrub land, transportation (pucca/kutcha)	Cartosat and LISS IV Image	Entire district completed
2	The socio economic data of Sikkim	Total household, Below Poverty Line household, the types of house (Pucca, Kutcha and Semi pucca), types and source of drinking water (Spring and River), the dependent population of the area, Sex ratio, status of education, availability of PHC/Dispensary/ PHSC, VLW Centres, and Veterinary Hospital	DESME Report (2005)	70% completed
3	Population data of Sikkim	Total population, Rural Population, village wise population, male/female population etc	Census of India, Sikkim 2011	100% completed

1. Capacity building and training of the Officers

Prior to the training programme, it is being felt the need of carrying out Training Needs Assessment (TNA) in the state. The TNA which was done by SDC in Himachal Pradesh is a good report which focused on the needs and requirement of Himachal Pradesh. Each Himalayan state has its own unique characteristics and problems. So it is very important to focus on each state so that a concrete idea may be generated to work on this sector. The idea is also discussed in the last workshop held in Imphal, Manipur in April 2016. Training a huge number of officials in the state requires lots of things including Training module, training needs assessment, master trainers, training venue and other necessary arrangement. Despite of these hurdles, it is very important to build up the capacities of people engaged in implementation of plans and policies of the government to cope with climate change and its impact. So it will be taken up in serious manner in days to come by State Climate Change Cell.

Meanwhile UNDP is working on implementation of SAPCC covering water sector, Forest sector and Disaster management sector in Sikkim. The State Cell has requested UNDP based in Gangtok to assist for carrying out the Training Needs Assessment as well as capacity building and training of officials in the state. Meanwhile UNDP has engaged KPMG India as consultant for capacity building in Sikkim. The Klynveld, Peat Marwick, and Geordeler (KPMG) is working in close coordination with State Climate Cell and other line department for the Training Needs Assessment. Recently it has conducted SLD workshop in Department of Science and Technology and other line department. To move forward, the Sikkim State Climate Change Cell already working on the basic climate change modules as provided by IHCAP-ICCAP DST programme held at TERI Delhi and training modules available in different agencies working on climate change. In addition to that, the local module covering climate change concerns of the state are under preparation.

The State Climate Change Cell is fully dedicated to climate change concern in the state which is the most important part of establishment of Climate Change Cell under NMSHE. Prior to that, work on climate change was going on in isolation.

2. Climate Change awareness programme

The Sikkim State Climate Change Cell conducted Climate Change awareness programme in 22 Block Administrative Centres (BACs) in 4 districts of Sikkim. The programme was linked with National Science Day 2015 on the Theme of “Science for Nation Building” organized by Sikkim State Council of Science and Technology. Almost 500 people including Panchyat members, NGOs, Self Help groups, staffs of BAC and students and general public were sensitized on Climate Change. The response of the participants was very impressive and most of them suggested carrying out more programme in upcoming days. So far awareness programme are carried out in Educational institutions, State Science Centre and Block Administrative Centres.

Table 2. List of BAC (Sikkim) covered under awareness programme on climate change

S. No.	Name of BACs	Date	No. of Participants
1	Kabi, Noth Sikkim	27/01/2016	45
2	Passingthang, North Sikkim	29/01/2016	31
3	Mangan, North Sikkim	30/01/2016	34
4	Ranka, East Sikkim	01/02/2016	18
5	Rakdong, East Sikkim	05/02/2016	53
6	Khamdong, East Sikkim	06/02/2016	40
7	Duga, East Sikkim	08/02/2016	52
8	Rehgu, East Sikkim	10/02/2016	46
9	Pakyong, East Sikkim	11/02/2016	22
10	Nandok, East Sikkim	11/02/2016	36
11	Namthang, South Sikkim	18/02/2016	51
12	Sumbuk, South	19/02/2016	51
13	Sikip, South Sikkim	22/02/2016	52
14	Jorthang, South Sikkim	22/02/2016	56
15	Daramdin, West Sikkim	23/02/2016	54
16	Soreng, West Sikkim	23/02/2016	50
17	Kaluk, West Sikkim	24/02/2016	53
18	Martam, West Sikkim	24/02/2016	54
19	Dentam. West Sikkim	25/02/2016	51
20	Gayzing, West Sikkim	25/02/2016	56
21	Chograng, West Sikkim	26/02/2016	83
22	Chungthang, North Sikkim	29/02/2016	27

The photographs highlighting awareness programme in different BACs in Sikkim

Fig. Climate Change Pamphlet on Introduction to Global Climate Change: Concept, causes and evidences

Fig. Climate Change Pamphlet on Global Climate Change: Its impact in Sikkim

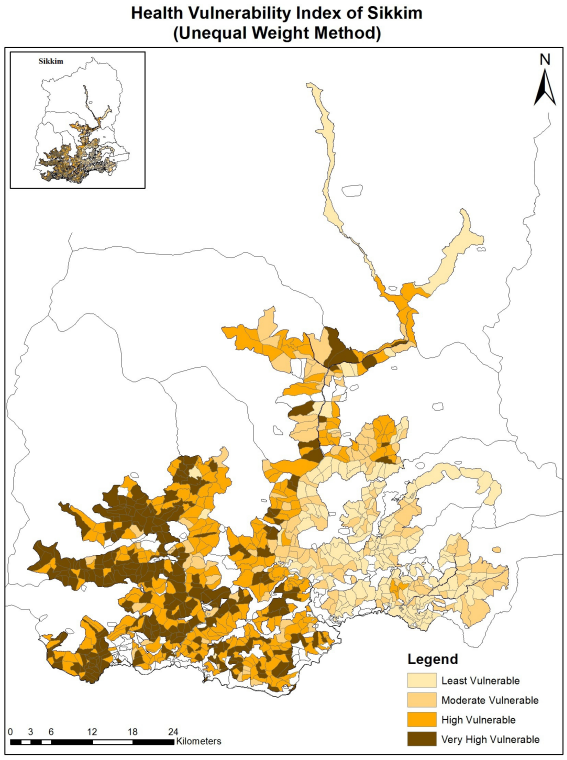
3. Study of Human Health in terms of Climate Change in Sikkim

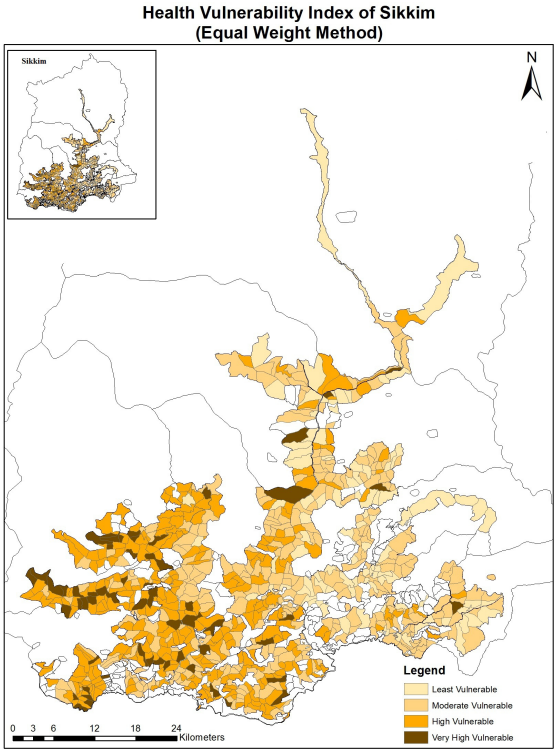
Climate change and associated phenomena are likely to impact on the human health directly and indirectly. Any increase in frequency of extreme events such as storms, floods, droughts and cyclones would harm human health in variety of ways in terms of loss of life, population displacement, loss of shelter, loss of food production, increase risk of infectious diseases etc. So at present State Cell is engaged in study of human health particularly focusing on various diseases prevail in the state. The information on study was compiled from Annual Report of 2013-2014 and Sikkim Health Information Bulletin 2014 from Planning, Monitoring and Evaluation (PME) Division, Health Department. The information included the demographic composition of Sikkim, Health infrastructure and various communicable and non-communicable diseases. Besides, statistical data was also collected from Meteorological Department showing year wise temperature (maximum and minimum) from 2009-2013. The various information and data available was analysed and correlation was made in relation to climate change and health issues. Geographic Information System was used to locate state hospitals, district hospitals, primary health centres and Primary Health Sub Centres existing in Sikkim.

The finding depicted the rising cases of vector borne disease (especially Malaria and Dengue) from 62 cases in 2005 to 160 cases in 2014. Similarly, the cases of death due to air borne disease viz. Acute Respiratory Infection (ARI) has been increasing in the recent years. The rises in these diseases cases are consistent with increase in temperature these days.

i. Mapping of health centres in Sikkim using GIS techniques

The district wise location of health centres in Sikkim has been mapped through GIS techniques. There are total one hundred seventy nine (179) health centres in Sikkim which includes One State Referral Hospital (Sir Thutob Namgyal Memorial Hospital) One (1) Central Referral Hospital, Manipal, four district hospitals *viz;* Singtam, Mangan, Gyalshing and Namchi. There are 24 Primary Health Centres, 146 Primary Health Sub-centres, Two Community Health Centre and One District Tuberculosis Centre, Namchi, which is under construction. A thematic map showing location of health centres in Sikkim have been prepared which is depicted in following page.





ii. Findings of the study on Climate Change and Health

The study has been made on health issues relating to climate change and looking on the trending scenario of Sikkim. As gathered from the available sources, Health Information Bulletin, Sikkim 2014.

Increase in the vector borne disease can be attributed to the altered weather pattern in the Himalayan State of Sikkim. The weather pattern has been kept as the key criteria for the survival of the mosquitoes and other vector-borne disease elsewhere. Other vector-borne disease has been also increasing partially. The data reveals the cases of malaria was maximum 160 on the year 2004 and the minimum number of cases was 38 on 2008 and 77 cases in 2012.

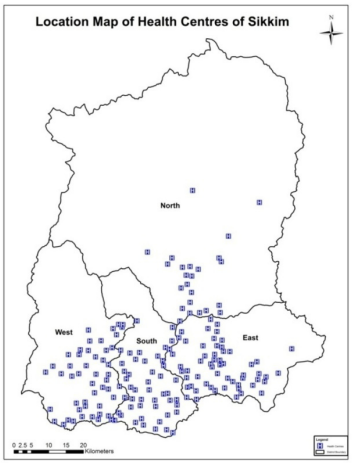


Figure: Location map of Health Centres in Sikkim

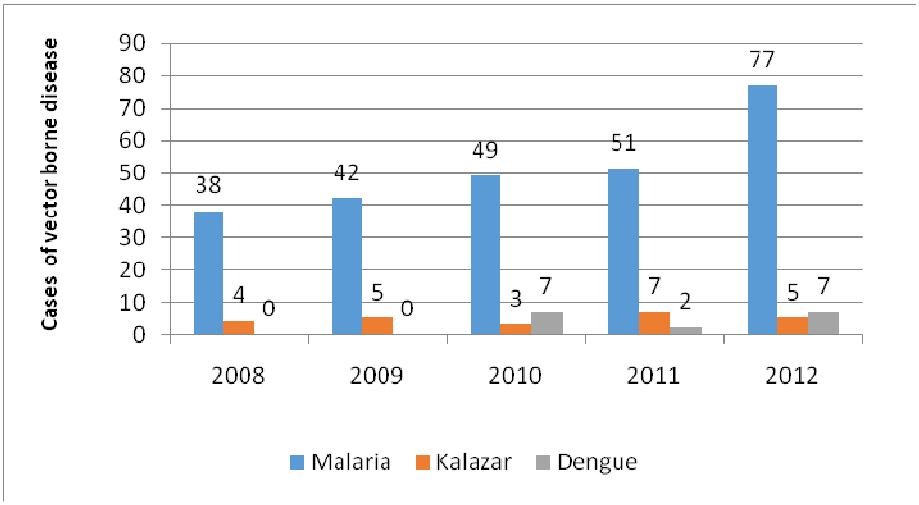


Figure: The trend of vector-borne disease in Sikkim from 2004 to 2012

The gathered data from Health Information Bulletin, Sikkim -2014, indicate an increasing pattern of skin disease as compared to other disease. The cases of skin disease in the year 2010 was 17947, which has been increasing in the upcoming year from 17947 in 2010 to 23174 cases in 2013. Eye infection cases have also been increased from 16538 on 2005 to 21344 on 2013.

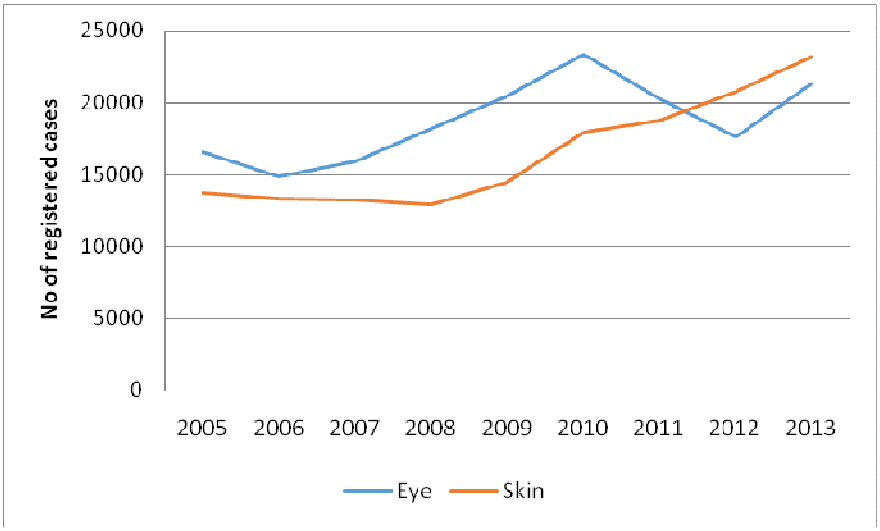


Figure: Trend showing the eye and skin diseases in Sikkim between 2005 and 2013

Air-borne and water-borne disease is partially growing over the upcoming years and the death tolls are being on the increasing trend. State health status are common in much being satisfied than other state but still there are cases of air –borne and water-borne diseases. Death rate is growing up in case of (Acute Respiratory Infection, (ARI) air -borne disease. The total death registered through Acute Respiratory Infection, (ARI) has been increasing over the years from 5 on 2003 to 23 on 2014.

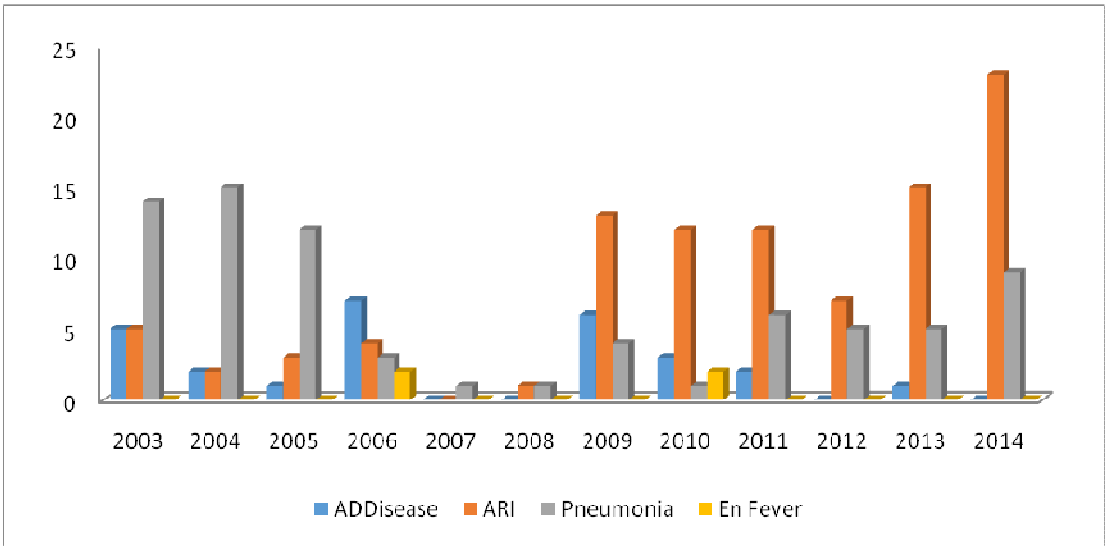


Figure: Showing death number by air-borne and water-borne disease cases in Sikkim, from 2003 to 2014

4. Satellite-based estimation of forest biomass of Sikkim forests between 1976 and 2011

Vegetation biomass is considered as one of the important source of CO^2 released in the atmosphere. So biomass estimation is one of the important area of study in climate change studies. One of the issues of major global concern today is the increase in atmospheric carbon dioxide by 15-25% over the past 100 years and its potential to change the world climate. Not only is additional CO^2 released to the atmosphere from the burning of fossil fuels, but CO^2 is also released by the clearing of forests. The use of remote sensing technology has become the most effective approach to biomass estimation. Vegetation indices (VIs) calculated from the reflectance measured by remote sensing can reflect the photosynthetic activity of the vegetation and are therefore increasingly used to monitor forest biomass. Forest biomass has been successfully estimated based on the normalized difference vegetation index (NDVI), which is a very widely used indicator, Soil adjusted vegetative index (SAVI) and Enhanced vegetative index (EV_{I2}). Satellite vegetation index (VI) products are commonly used in a wide variety of terrestrial science applications that aim to monitor and characterize the Earth's vegetation cover from space.

In the present study an effort has been made to estimate the biomass concentration in Sikkim Himalaya using three different estimating techniques such as NDVI, SAVI and EVI_2 . A 30-m resolution of Landsat images (LM1, LM2, Landsat-5 and Landsat-8) for the period between

1970 and 2011 has been used for the estimation process. These estimates are based on 210 sampling plot which is randomly selected in Google map of Sikkim. Following are the formula used for individual techniques.

NDVI= (NIR-RED)/ (NIR+RED)
SAVI = SAVI = {(NIR RED)/(NIR+RED+ L)} * (1+L)
EVI_2 = 2.5 * (NIR - RED) / (NIR + 2.4 * RED + 1.0)

The final result drawn using the above techniques were categorized into five parts such as non-forest, open forest, moderate forest, dense forest and very dense forest. The result showed that there has been an increase of vegetation biomass coverage from 1970 to 2011. NDVI value increased from 0.164 in 1970 to 0.755 in 2011. Similarly, SAVI value has been increased from 0.175 in 1970 to 0.750 in 2011 and EVI_2 value also increased from 0.665 in 1970 to 1.758 in 2011. The increased in value for all the estimation techniques shows that the forest cover and the bio mass concentration is increasing in Sikkim.

The statistics and visual observation of the NDVI images over the subsequent periods shows increments in vegetation biomass. As it can be visually compared the amount of green vegetation is rising. The maximum value increased from 0.14 (1976), 0.70 in (1987), 0.63 (1990), 0.76 (1996), 0.67 (2000), 0.73 (2005) and 0.75 in (2011). Due to this, the standard deviation value has been increased in 2011 data as compared to 1976.

Table 3. NDVI statistics of the study area.

Statistics	1976	1987	1990	1996	2000	2005	2011
Maximum	0.14	0.70	0.63	0.74	0.67	0.73	0.75
Mean	-0.82	-0.24	-0.24	-0.21	-0.35	-0.17	-0.13
Mean	-0.13	0.29	0.19	0.40	0.26	0.43	0.47
Standard Deviation	0.676	0.662	0.619	0.67	0.723	0.639	0.624

To understand the relationships between biomass and vegetative index i.e. $NDVI_{mean}$ value has been correlated between six forest types and NDVI value. The result indicates that the biomass and NDVI value exhibited significant correlations.

Table 4. Relation between biomass and $NDVI_{mean}$ value in different forest type.

Biomass *(n=210)*	**$NDVI_{mean}$**

I Very dense forest	0.66
II Dense forest	0.42
III Moderate forest	0.28
IV Less moderate forest	0.14
V Less forest	0.01
VI Non forest	-0.48

Change detection in the forest cover through NDVI studies depicted that out of total area of 7096 km^2, only 1094.1±457.8 km^2 of non-forest area has been observed, followed by less forest area of 1355.3±506.9 km^2 and so on (Table 3).

Table 5. Overall NDVI change detection of study area in between year (1976-2011)

Categories	**Area in km^2 (± = Standard deviation)**	**Change %**
Non-forest	1094.1±457.8	15.50
Less forest	1355.3±506.9	19.09
Less moderate forest	858.9±221.8	12.10
Moderate forest	984.6±291.6	13.90
Dense forest	1270.5±193.3	18.00
Very dense forest	1356.9±431.4	19.12

Features like river, lakes, ice, and glacier represented negative NDVI values.

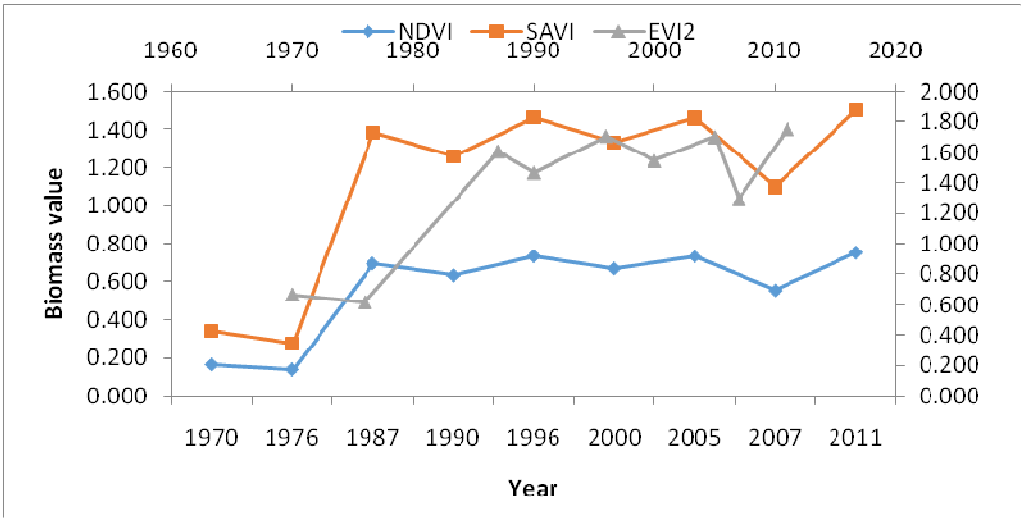


Figure. NDVI, SAVI and EVI of forest cover of Sikkim in between 1970-2011

5. Mapping of High Altitudinal Lakes of Sikkim Himalaya

In Sikkim large numbers of lakes of varying sizes were located in North, West and East district. These lakes plays an important role in conservation of ecosystem and biodiversity as it provide shelter to large number of living species of plants, animals and micro organisms. It also act as recharging point of springs located in lower elevation. These lakes are also present scenic beauty which attracts tourism in the region. In Sikkim these lakes are also very important from religious point of view. However in the recent years, the number and area of high altitudinal lakes are increasing in the glacial areas and decreasing gradually in non glacial areas. The change in weather and climatic parameters are seen as one of the important reason for this trend of the high altitudinal lakes. In both the cases, either increasing or decreasing in number of the lakes, it has put an adverse affect in the environment of the Himalayan state. In glacial area the number and area of the lake is increasing due to the formation of new lakes due to the melting of the glacier. In non glacial lakes the numbers of lakes are drying up due to the decrease in water in feeding streams of the lake or either due to the event of low snow accumulation. The drying of these lakes may affect the local ecosystem in the form of loss of precious plants and animals in conjunction with the drying of the lake. The formation of lakes in the fragile glacial area characterized by weak moronic strength and fast melting of the glacier specially during the ablation season has put the risk of Glacial Lake Outburst Floods (GLOFs) which may result in devastation in the downstream areas. So it is very necessary to monitor the high altitudinal lakes in order to understand the local environment.

In this study an effort has been made to map the high altitudinal lakes of Sikkim using multi temporal satellite data and topographic sheets. This is an ongoing studies under State Climate Change Cell.

Lakes have been digitized from Landsat imagery dated 3rd February 2009. Total numbers of 227 lakes have been identified covering total area of 2726 hectares which comprise of 86 glacial and 141 non- glacial lakes.

Monitoring changes of lake in terms of formation of new lakes, increase area of the lake, drying of lakes are important task that can be made through the interpretation of time series satellite imageries. To fulfil the task the State Cell is working on inventory mapping of lakes using old record of satellite imageries. However major problem faced are to get the cloud free and snow free satellite data of the high altitude areas. These area most of the time remain snow covered so it make difficult to identify specially the smaller lakes.

Table showing lake area greater than 25 hectares in Sikkim

FID	Name of Lake	Area(ha)	Altitude
4	khangchung Chho	173.0	5327
0	Gurudongmar A	114.2	5154
3	Chho Lamu	110.4	5100
2	Gurudongmar C	110.2	5215
5	South Lhonak	108.3	5219
120		95.2	5217
127		83.3	5006
1	Gurudongmar B	81.6	5243
6	North Lhonak	72.0	5447

9	Khora chhobuk	64.9	5046
72		60.5	5246
53	Changsang glacial	45.5	5446
129		45.0	5029
78		43.1	4605
125		42.8	4213
126		38.7	5432
7	Khora khang	36.3	5086
71		31.1	5126
152		31.0	4926
141		30.3	5007
50	La chho	28.5	5004
46	khora La	28.3	5360
15	Bithang Chho	26.4	3905
139		25.8	5084
210		25.7	5124

Area of the lake	**No of Lakes**
0-1	30
1-2	39
2-3	21
3-4	14
4-5	13
5-6	14
6-10	31
Above 10	65
Total	**227**

Table 6. Area wise different number of lakes in Sikkim

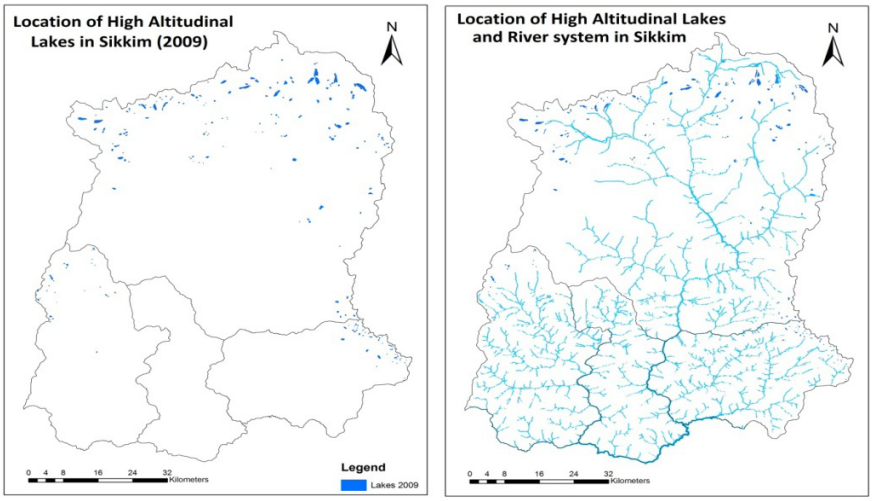


Figure. Map showing location of High Altitudinal Lake in Sikkim

OTHER ACTIVITIES:

Publications of Scientific papers "Climate perceptions of local communities validated through scientific signals in Sikkim Himalaya, India" in international journal

Recently in September 2016, Sikkim State Climate Change Cell has come up with a scientific publication on Climate change in Sikkim Himalaya. A research article entitled "Climate perceptions of local communities validated through scientific signals in Sikkim Himalaya, India" has been published in Journal *Environmental Monitoring and Assessment (*188:578) under Springer International Publishing, Switzerland. The article deals with the perceptions based ground information on climate change from the public responses and validation of this information with the observed climatic data. This study can help in planning specific adaptation strategies and to identify the priorities areas under climate change in Sikkim Himalaya and further to frame village-level action plan to implement the adaptation measures (https://link.springer.com/article/10.1007/s10661-016-5582-y).

Two Days Regional Workshop for North Eastern Region on Climate Adaptation

Two days regional workshop on North Eastern Region for climate Adaptation at Imphal, Shillong in April 2016 attended. The main focuses of the workshop were:

- Development human capacity on climate science and integration of adaptation planning on state specific issues,
- Understanding issues related for assessing vulnerability, risk and hazards in the IHR (Indian Himalayan Region) focusing on effective implementation of SAPCC, and
- Framing of modalities for implementation of training programme in the Himalayan states.

Shared Learning Dialogue (SLD) workshops International Council for Local Environmental Initiatives

International Council for Local Environmental Initiatives(ICLEI) South Asia is engaged in vulnerability assessment of Gangtok town due to the climate change which includes identification of the vulnerable places and people, understanding adaptive capacities of the urban systems. In this context ICLEI in collaboration with the Gangtok Municipal Corporation (GMC), organized three Shared Learning Dialogue (SLD) workshops. Sikkim State Climate Change actively participated in the particular workshop and give the valuable input for the activity.

Shared Learning Dialogue (SLD) workshops of World Wildlife Fund

World Wildlife Fund(WWF) India based in Gangtok is presently engaged in vulnerability mapping of high altitudinal areas of Sikkim in terms of Climate Change including Lachen and Lachung area. In this context WWF organized SLD workshop in December 2016. State Climate Change Cell participated in the particular workshop and provides valuable input for the task.

Workshop on "Building Climate Resilience and Mainstreaming DRR and Loss and Damage in the State of Sikkim Consultation to Facilitate Design of SAPCC Implementation Roadmap" co hosted by Department of Science and Technology and Climate Change, Sikkim State Disaster Management Authority (SSDMA), along with Indian Institute of Public Administration (IIPA) and Climate Action Network South Asia (CANSA).

The SAPCC was the first attempt aimed to identify the climate-impacts in the state and strategies to reduce these risks and vulnerabilities. While the implementation of the SAPCC is underway UNICEF India review of the Sikkim SAPCC found gaps that needed to be urgently addressed. To this effect, Sikkim state consultation was organized on May 5th & 6th, 2016 in Gangtok under the banner "Building Climate Resilience and Mainstreaming DRR and Loss and Damage in the State of Sikkim Consultation to Facilitate Design of SAPCC Implementation Roadmap" to highlight gaps in the Sikkim SAPCC, identify points of convergence amongst various state policies to build climate resilience in a comprehensive manner, and prepare a draft implementation roadmap to mainstream disaster risk reduction (DRR) and climate change adaptation (CCA) into state developmental planning. Sikkim State Disaster Management Authority (SSDMA), the nodal state agency for disaster risk reduction, and Department of Science, Technology & Climate Change (DST&CC) custodian of Sikkim SAPCC, co-hosted the workshop along with Indian Institute of Public Administration (IIPA) and Climate Action Network South Asia (CANSA). Various state departments participated in the consultation such as Department of Home, Land Revenue & Disaster Management (LR&DM), Panchayati Raj, Water Resources, Agriculture, Forest, Health, Rural Development and Power.

Preparation of Vision Document for attaining the sustainable Development Goals of Department of Science and Technology and Climate Change

The 13th Goal under Sustainable Development Goals cover "Take urgent action to combat climate change and its impact on Climate". In this context the vision document of Department of Science and Technology and Climate Change has been prepared to achieve the sustainable Development Goal.

Exposure visit to Leh Ladakh to understand the water conservation and management in the High Himalayas supported by UNDP

Recently officials from different department of Sikkim including State Climate Change cell under (Sikkim State Council of Science and Technology), Forest Wildlife and Environment Department, Mines mineral and Geology Department, Land Revenue and Disaster Management Department was on exposure visit to Leh Ladakh to understand the Ice Stupa Project(artificial glacier) which is conceptualized by Sonam Wangchuk, an engineer from Ladakh. The Ice Stupa (artificial glacier) is a unique techniques of conservation of water in the Himalaya. The exposure visit was organized by UNDP in the banner of "Conservation of Water in High Himalaya" under its climate change programme in Sikkim.

Field visit to Nathula area in East Sikkim for experimental Ice Stupa Project

Department of Science and Technology and Climate Change with the support of UNDP has been planning to carry out small scale experimental Ice Stupa Project in East Sikkim in the coming winter of 2016-17. Though the Ice Stupa is a proven technology in Trans Himalayan areas of Ladakh but it needs to be tested in the existing climatic condition in Sikkim. The major objective of the experimental Ice Stupa project will be to test the freezing condition of water in the prevailing climatic condition in the winter months in Sikkim. In this context the team from State Climate Change Cell visited Nathula area in the month of November 2016 to find out the possible site for the work.

Prepared web page of Sikkim Climate Change Cell

Web page on the activities of State Climate Change Cell have been prepared and it is

linked with the official web page of Department of Science and Technology and Climate Change. The link for the website is ***www.dstsikkim.gov.in/SIKKIM%20STATE%20CLIMATE%20CELL.html***.

Assist UNDP for the preparation of State Work Plan

UNDP under its climate change programme working in Sikkim from last one year covering Water, Forest and Disaster Management sector. The manpower of State Climate Change Cell engaged with UNDP officials for preparation of State Work Plan covering those sectors.

Awareness Programme on weather and climate change in different schools in Sikkim

Awareness programme on climate change is one of the important objectives of State Climate Change Cell and is one of the important mandate of National Mission for sustaining the Himalayan Ecosystem. To fulfill the objectives, an awareness program on weather and climate change was organized by Sikkim State Climate Change Cell under Department of Science and Technology and Climate Change in the months of March 2017. Fifteen Senior Secondary schools was selected from Sikkim covering East, North, South and West district. More than 2500 students and about 50 teachers were sensitized on climate change awareness programme commenced from 17th March to 31st March 2017.

The main motive of the program was to reached out to the students and to make them aware of the issue of climate change and to sensitize them about the current scenario and impact of climate change in the upcoming future. During the awareness program the students were familiarized with the term 'climate change' and 'global warming' with valid facts, figures, pictures and videos showcased from the global, national and local level validating the realness of the impact of climate change. The student were explained thoroughly about the main cause of climate change that the world are facing at current scenario.

Following important things were covered in the power point presentations:

- The term weather and climate, Climate Change and global warming
- Greenhouse gases and its role in maintaining life on earth
- Generation of CO2 after industrial revolution and its role in changing climate conditions
- Increasing CO2 level on earth atmosphere and increasing global temperature
- Glaciers and ice as an important indicator of climate change studies and impact of increasing global temperature on glacier around the world. The impact is well explained with the help of comparative photographs showing retreating glaciers.
- The impact of climate change in terms of increasing temperature, melting of glaciers, seal level rising, warming of sea and ocean and acidification due to warming and its impact in aquatic life,
- Increasing weather and climate related disaster including draught, floods, cloud burst, glacial lake outburst flood, cyclone due to climate change.
- Climate projections of further rise in temperature in next 50 to 100 years

- Organizations engaged in climate change studies, IPCC.
- Brief Initiatives taken up at global level by United Nations through Conference of Parties(COPs) and importance of COP 21.
- Brief Impact of climate change in India
- Measures taken up by Central government at National level, National Action Plan on Climate Change, National Missions for sustainable development etc.
- Impact of climate change in Sikkim with fact and figures
- Loss of glaciers in Sikkim with the help of comparative satellite imageries of past and present
- Threat of GLOF in Sikkim due to global warming with short presentation on South Lhonak Lake. Measures taken up by DST GOI and State Government in mitigation of GLOF in Lhonak Lake including Resistivity survey, Bathymetry survey, Installation of Early Warning System, Siphoning of lake water etc.
- Threat of loss of vulnerable plant and animal species in Sikkim
- Policy decision taken up by state government in Sikkim and need to follow those decision by us and general public.
- Adapting from impact of climate change
- Need to go for renewable energy and to conserve energy, role of LED bulbs in saving energy etc.
- Need to plant more and more trees
- Need to support the government decision in protection of environment.

The awareness program received huge attention and interest from the students in the school visited by the resource person of State Climate Change Cell. The videos clips on East Rathong Glacier and mitigation works in South Lhonak Glacier makes the program more meaningful as the students got an opportunity to have a glimpse of mighty glaciers of Sikkim which they only heard about in books. But at the same time they are quite worried about the shrinking glaciers and forming of huge glacial lake due to changing climatic conditions. The students also quarried with keen interest about the mitigation measures taken up at South Lhonak glacial lake.

The resource persons also requested them to aware others people including family members, neighbors and relatives about they learned from awareness program.

The main target of the awareness programme was the students from 9^{th} standard to 12^{th} standards, but due to lack of programme hall, all the targeted students were not accommodated in the space provided by the schools.

Details and schedule of the awareness progamme conducted on school date wise are listed:

Date	Senior Secondary School Venue	District	No of Participants
17th March 2017	BiraspatiParsi , Ranipool	East District	150
18th March 2017	KalzangGyatso, Kabi	North District	120
19th March 2017	Mamring&Dikling	East District	140, 180
20th March 2017	Rumtek	East District	250
21st March 2017	Yangyang	South District	140
22nd March 2017	Yuksom&Kechopaldri	West District	200, 180
23rd March 2017	Tashiding	West District	120
24th March 2017	Dentam	West District	80
25th March 2017	VCGL,Ravangla	West District	350
28/March/2017	HeeGyathang	North District	150
29/March/2017	Sadam	South District	140
30/March/2017	Sonamati Devi Memorial, Khamdong	East District	80
31/March/2017	Phodong	North District	200
Total			2480

Awareness Programme on Weather and Climate Change in different schools of Sikkim

State level Media Workshop on Climate change

A three days long State level Media Workshop on "Climate Change reporting in the Himalayas" jointly organized by Department of Science and Technology and Climate change, Govt of Sikkim and Centre for Media Studies New Delhi in collaboration with IHCAP-SDC and DST,GOI was held in Sikkim from March 25 to 27, 2017.

During the workshop, Ms. Janine Kuriger, Director, Swiss Agency for Development and Cooperation (SDC), Embassy of Switzerland and Dr. Mustafa Ali Khan, Team leader, IHCAP

werealso present. The senior Journalists, thematic experts, Scientists, policy makers, Students from many universities and Media persons across the Country have participated in the workshop.

Glimpses of the Media Workshop- Sikkim March 25-27, 2017

26. Study on South Lhonak Glacial Lake of Sikkim in terms of GLOF

Sikkim State Remote Sensing Applications Centre under Sikkim State Council of Science and Technology is being monitoring the South Lhonak glacial lake from the past few years. South Lhonak glacial lake, located in the extreme North-western parts of Sikkim, is one of the fastest growing lakes in Sikkim. The lake formed right at the snout of the glacier is located in the geographical coordinates of N 27^0 54' 56.7" and E 088^0 12' 33.7" at an altitude of 5201m. The analysis of satellite imagery revealed that the lake is growing very fast. The lake is dammed by loose moraines debris brought down by the glacier. The lake was a small glacial lake in 1960s, which grows to more than 2.10 km in length and 0.6 km in width at present. With this figure, the lake became one of the longest and largest lake within the territory of Sikkim. This enormous growth of lake on the loose moraines debris of the glacier, within a short period of time makes it one of the vulnerable lakes in Sikkim in terms of glacial hazard, in the form of glacial lake outburst flood (GLOF). The lake was around 18 ha in 1976 which increased to more than 126 ha

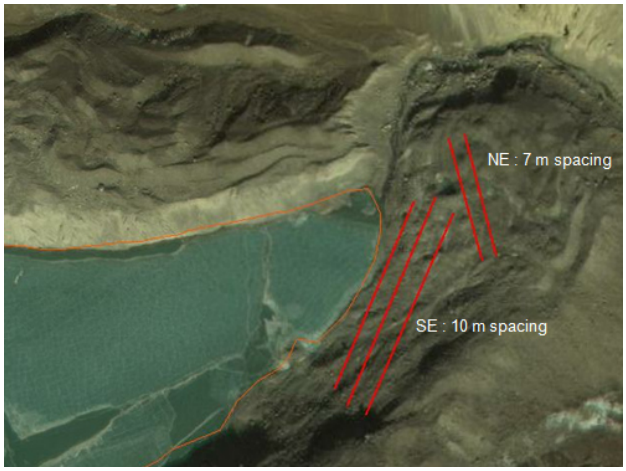
in 2013. The lake is purely a glacial moraine dammed lake which is vulnerable in terms of GLOFs. The lake if burst may cause devastation in the downstream.

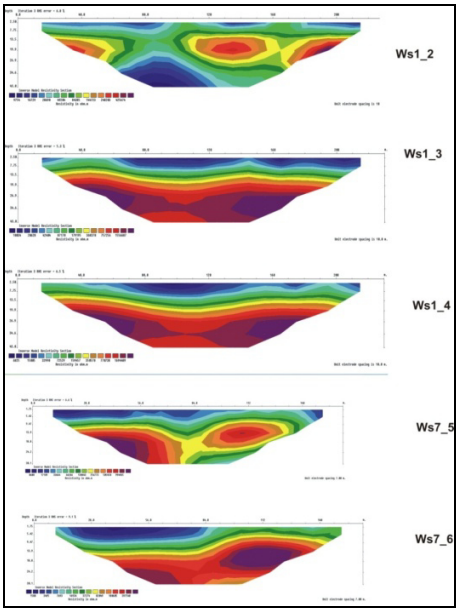
Keeping the threat in mind, Department of Science and Technology, Sikkim has already taken an initiative to study this particular lake. A working group committee has been formed in order to carry out the effective studies of the lake. Based on the suggestions made by the working group committee, a field study of the lake carried out in the end of August 2014. Following studies was conducted during this field visit:

Electrical Resistivity Survey of Moraine Damming the South Lhonak Lake

Electrical resistivity survey was carried out on the eastern direction in the moraines which are sensitive by visual interpretation. During the study, 2D Electrical Resistivity survey was performed in the moraines to get resistivity characteristics against GLOFs. The survey covering *5 longitudinal profiles* of the moraines were carried out during the survey. Among them, three profiles were drawn along the SW to NE directions with electrode spacing of 10 meters each covering the distance of 240 meters and two profiles were drawn from SE to NW directions with electrode spacing of 7 meters covering the distance of 168 meters. The distance between each profile was fixed around 50 to 60 feet.

Electrical Resistivity Survey of Moraines damming South Lhonak Lake

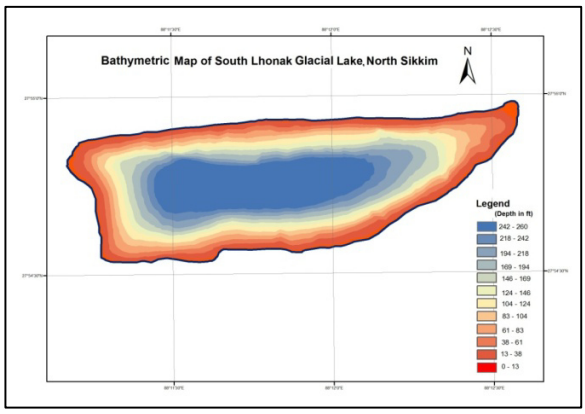


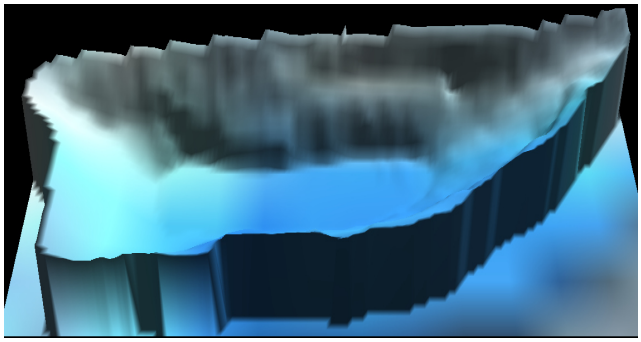


Location of Electrical resistivity survey site (5 longitudinal profiles)

Bathymetric Survey of South Lhonak Lake

Bathymetry is the study of underwater depth of lake or ocean floors. In other words, bathymetry is the underwater equivalent to hypsometry or topography. It is a crucial exercise for sustainable management of lake waters. Bathymetric data helps in evaluating the storage volume of lake, which is used to generate different potential reach models in GLOFs studies. The bathymetric study carried out in September 2014 in South Lhonak Glacier showed that the lake area is 126 hectare with a maximum depth of **260 feet**. The storage volume of the lake is 5, 36,38,863.54 m^3 (say **53 million m^3** = 536 billion litres of stored water) corresponding to the maximum depth of 260 feet.





Field Photographs of Bathymetry survey in South Lhonak Glacial Lake

South Lhonak Lake Mitigation

With support of Land Revenue and Disaster Management Department (LR&DM), a multi departmental expedition to South Lhonak Lake carried out this time (September 2016) most importantly for siphoning of lake and to install Glacier Lake monitoring system in the South Lhonak Lake. The expertise for the Siphoning has been engaged by LR&DM Department, Sikkim from SECMOL, Ladakh. Other line departmental officials were also the part of this expedition for the different, aspects of study pertaining to GLOFs.

i. First Siphoning of South Lhonak Lake

After the scientific interventions, Sikkim State Climate Change Cell together with the support of Disaster and land Revenue Department, Government of Sikkim and expert guidance from Dr. Sonam Wangchuk, SECMOL, Ladakh, initiated the first mitigation works for GLOF in

September 2016 at South Lhonak Lake. Siphoning of lake was done by using High Density Polyethylene (HDPE)quick clamp pipes during the expedition. The diameter of the pipe was 8 inches. A total of 140 pipes were used for the siphoning of lake for siphoning of water from three sets of pipelines. The team first measured the discharge of lake (say discharge after the peak melting season) by area velocity method. The approximate discharge measured near the outlet was about 4.5 m^3/s(160 cusec). The discharge from single pipeline is measured approximately 50 litres/second which ultimately gives a total of 150 -180 lit/s in three sets of pipelines. It is expected that lake would be lowered by about 2 meters at the end of winter season. This is the first of its kind, that HDPE pipes were used for siphoning the glacial lake in India and first approach towards the siphoning of such glacial lake in Indian Himalayan region.

I. GLOF sensor installed in South Lhonak Lake & II. Pipelines laid down for the siphoning of water from South Lhonak Lake


I. Photograph showing the outlet area of the lake and moraines dam & II. The photograph showing laying of pipelines with the help of rope in September 2016

ii. Updating the Bathymetric studies

Previously in 2014, the DST team studied the volume of the lake by ultrasonic depth sounder and estimated volume was about 53 million m^3. At the middle of the lake, it was expected that more depth could be there as the depth sounder crossed it threshold of 80 meters.

During this expedition, the team also calculated the actual depth at the middle of the lake using manual probe made up of rope and measuring tape. The depth was estimated to about 130 meter at the centre of the lake. This results would help us in updating the bathymetric volume of South lake.

Photo: Updating the Bathymetric survey and measuring the Water Depth in the lake in September 2016

iii. Installation of Lake Water monitoring system

As a part of project with Centre for Development and Advanced Computing (CDAC), Pune, the Department of Science and Technology, Sikkim has installed a Lake monitoring and information System (water level Sensor) at South Lhonak lake. The sensor gives the water level of the lake and also monitored the lake level when there is sudden fluctuation in water level. The sensor is developed by CDAC Trivandrum. The sensor provides the data to the CDAC-Pune and mobile information system is in process so that any alert message can be given at the local level. The sensor system is in experimental phase.

I. Assemble of Antenna of GLOF Sensor & II. Installation of Data Logger and Transmitter in South Lhonak Lake

27. National Wasteland Change Analysis 2nd Cycle

Previous cycles (2005-06 & 2008-09): The first exercise on National Wastelands Change Analysis has been executed at the behest of Dept. of Land Resources, Ministry of Rural Development.

Satellite data: IRS LISS-3 (2005-06 & 2008-09)

Outcome: Detailed wasteland change analysis and database for the entire country.

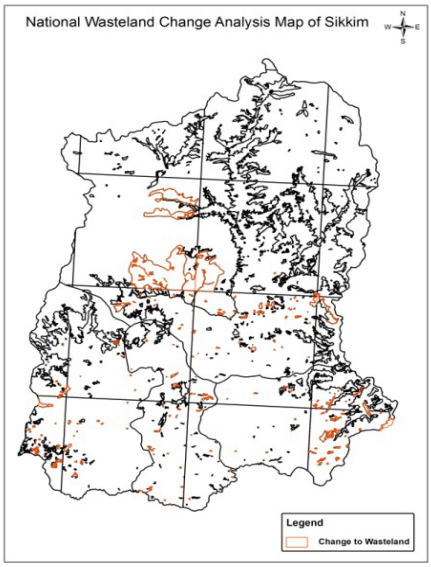
In order to report the spatial changes in wastelands between 2008-09 and 2015-16, study was undertaken for Department of Land Resources GOI.

Satellite data: IRS LISS-3 (2015-16)

Expected outcome: Detailed wasteland change analysis and database for the entire country.

Objectives

- ✓ To update the spatial information on wastelands of 2008 – 09 with 2015-16.
- ✓ To identify and depict the areas with major wastelands change between 2008 – 09 and 2015-16.
- ✓ To create the wastelands geospatial database and disseminating through Bhuvan geo-portal.
- ✓ To prepare category-wise spatial change statistics of wastelands and summation in the form of atlas.



Progress of the Project: The creation of required layer was completed and submitted to the funding agency after quality check.

28. Empowering Panchayati Raj Institutions Spatially (EPRIS)

Empowering Panchayati Raj Institutions Spatially (EPRIS) is a project with the goal to empower Panchayati Raj Institution for resource-based and integrated spatial developmental planning in a user friendly enabling environment. Panchayati Raj Institution (PRIs) refers to the participatory local self -government bodies at the three tiers of Panchayati Raj with a vision of attending administrative decentralization. Resource based development planning refers to the planning initiating at the gram panchayat level that considers information about resources as the knowledge base. Integrated spatial developmental planning refers to planning by the use of Bhuvan Panchayat Portal developed under SIS-DP Project. Under this project the outreach activities was take up the task for implementation under EPRIS, which aims for operational utilization of Bhivan Panchayat portal and the database prepared through Space based information support for decentralized planning activities in the three-tiers of Panchayati Raj system. Outreached activities refers to the capacity building of elected Panchayat representatives, their support functionaries and facillators, (ii) asset mapping and (iii) activity planning. Capacity building refers to conducting workshop/ training at State, District Panchayat and Intermidiate Panchayat levels.

29. Coordinated Horticulture Assessment and Management using Geoinformatics (CHAMAN)

Site Suitbaility Analyis under Coordinated Horticulture Assessment and Management using geoinformatics (CHAMAN) Project- Sikkim funded by Mahalanobis National Crop Forecast Centre (MNCFC), Department of Agriculture, Cooperation and Farmers' Welfare (DAC&FW), Ministry of Agriculture and Farmers' Welfare (MoA&FW), Govt. of India, New Delhi through NESAC Shillong, in collaboration with Space Applications Centre (SAC), Ahmedabad, NESAC and Sikkim State Remote Sensing Application Centre (SSRSAC).

Objective of the project

Identification of potential areas for cardamom plantation in West Sikkim district

Expected outcome

- ✓ District and Block-wise estimates of spatial location and extent of area suitable for cardamom plantation in West Sikkim district. This will be accompanied by potential area maps on GIS at 1:10,000 scale.
- ✓ Reports summarizing the area estimates and names of group of villages under each block suitable for cardamom plantation in West Sikkim district

The first phase of the project has been completed and final map

30. Vulnerability and Risk analysis of Geohazards in Himayan region

Project was funded by SAC, ISRO, Ahmedabad, Government of India, the main objective of the project is to mapping of the Vulnerable are for Landslide and GLOF in Sikkim Using the High resolution Satellite Imagery.

Activities of the project

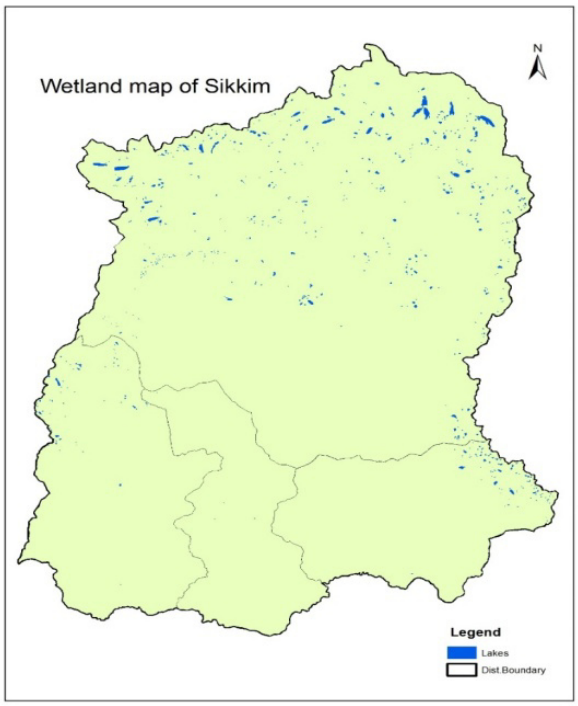
- ✓ Generation of database of geo technical parameters
- ✓ Analysis of data
- ✓ Ground truth of landslides
- ✓ Development of probabilistic model for bursting of lakes and landslides occurrence.
- ✓ Ground truth for landslides and potentially dangerous lake
- ✓ Risk analysis from vulnerable lakes and landslides
- ✓ Report preparation

Work Under Progress

- ✓ Inventory of glacial lakes and landslides using high resolution data/initially Google images in the form of maps.
- ✓ Browsing of Cartoset - 1/2 data covering landslides and lakes.
- ✓ Generation of database for each lake and landslide

31. **RS and GIS Mapping of Wetlands (Lakes & Rivers) of Sikkim**

Wetlands are one of the world's most productive environments that provides the basic necessities for numerous species of plants and animals to survive. Wetlands are "areas of marsh, fen, peat-land or water, whether natural or artificial, permanent or temporary, with water that is static or flowing fresh, brackish or salt, including areas of marine water depth of which at low tide does not exceed six meters", (Article 1.1, Ramsar Convention, 1975) Sikkim is very small, it has a very diverse physical feature that is naturally blessed with various types of wetlands. Using LISS-IV image of the year 2015-16 a total of **677** lakes have been identified, that covers an area of 3162 ha excluding rivers and small lakes below one hectare. The main objectives of the project is to **Mapping the wetlands of Sikkim** using IRS LISS IV Satellite imageries following a standard wetland classification system as per National Wetland Atlas: India, 2011, creation of a seamless wetlands database of the states in GIS environment, ect. In Sikkim there are a total of **671** high altitude lakes. The remaining **6** are low altitude lakes. There are **102** rivers and streams in the state. The North District has the highest number of wetland, having **501** lakes. The West District has around **70** lakes and the East District has **103** lakes. The South district has the lowest wetland area, consisting of only **3** lakes.

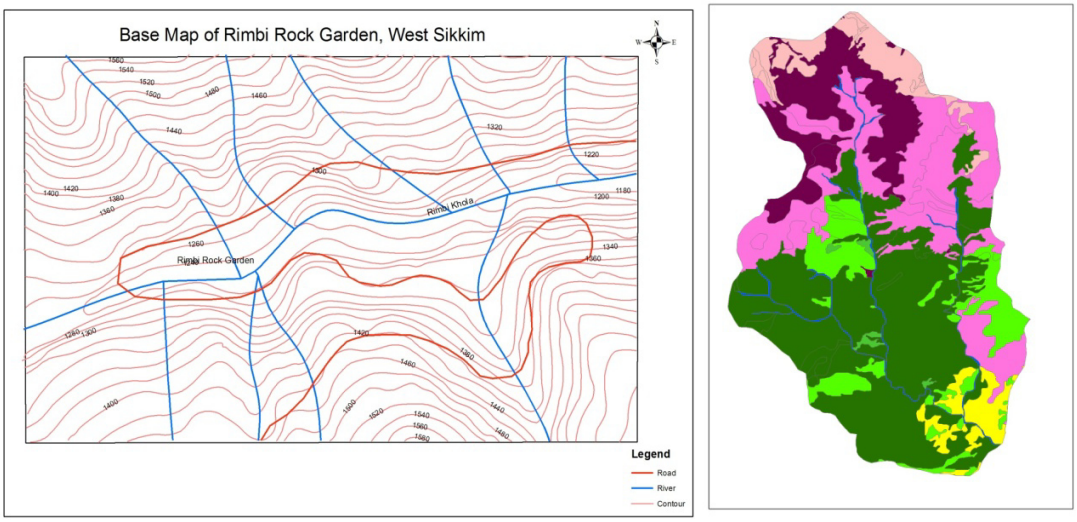


Sl. No	CLASSIFICATION OF LAKES ON THE BASIS OF SIZE (HA)	NO. OF LAKES AREA	AREA (HA)
1	BELOW 10	613	1072.19
2	10 – 50	53	1020.78
3	ABOVE 50	11	1068.63

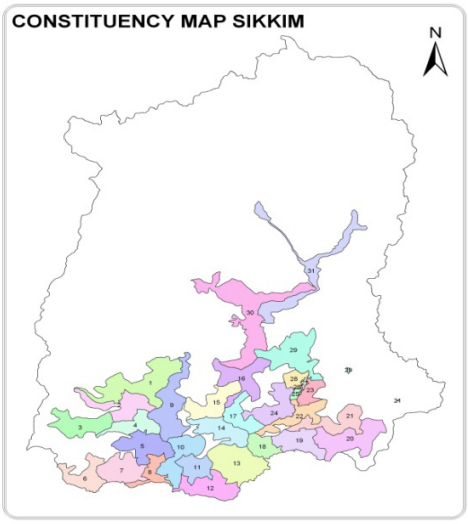
26. **SUPPORT TO THE USER DEPARTMENTS/AGENCIES**

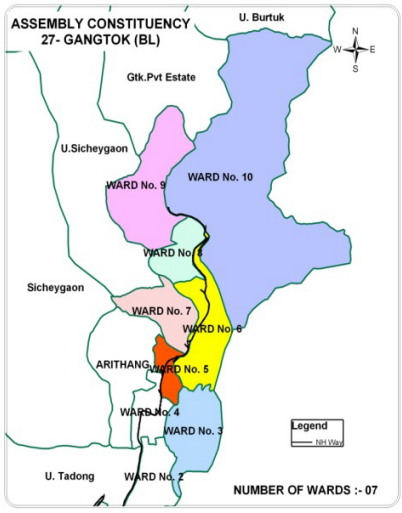
Centre, being nodal for Remote Sensing and GIS applications in Sikkim, has contributed handsome support to many user department and agencies in Sikkim. Some of the support includes-

- Preparation of various GIS map for General Election 2014
- GPS data collection and mapping of the polling station of Sikkim for the Election Department
- Catchment area mapping for the various projects of Irrigation and Flood Control Department.
- GIS maps provided for Agriculture Department, GoS to submit project proposal.
- Training on Remote Sensing and GIS application to the students of Sikkim



Sample catchment area for Irrigation and Flood control Department





Constituency Map of Sikkim.

Collaborative work on Climate Change:

The Department is actively coordinating the Climate Change programme with National and International agencies like MoEF&CC, DONER, GIZ, UNDP etc and facilitating various departments in the State.

The State Action Plan on Climate Change (SAPCC) for the state has been prepared and launched.

As the nodal Department for Climate Change in the State, a major project on "Addressing Climate Change vulnerability of water Sector at Gram Panchayat Level in drought prone areas of Sikkim" has been a mobilized through the National Adaptation Fund (NAF) to be implemented by the State Rural Management and Development Department.

Similarly, the support are being obtained from the GIZ and UNDP for Climate Change adaptation/mitigation programme which are being jointly carried out with the departments viz. Forest, LRDMD, RMDD, Horticulture etc.

TRANSFER OF TECHNOLOGY

AND

COMMUNICATION & POPULARISATION OF SCIENCE

(i) Establishment of Sikkim Science Centre, Marchak

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. The Science Centre has a number of thematic galleries, outdoor science park and facilities for training and capacity building programme.

Visit to Sikkim Science Centre by Students.

- The further extension of Sikkim Science Centre is being taken up with the support of National Council of Science Museums, Ministry of Culture, Government of India. This will include 8 metre dia Planetarium, 3D shows as well as thematic galleries on biotechnology and biodiversity. .

The Innovation Hub is proposed to be set up in Science Centre, Marchak, funded by Innovation Council under 'Scheme for Promoting Innovation, Creativity and Engagement in Science' (SPICE) to inspire young minds and to develop a culture of innovation in the country. The Innovation Hub will have following facilities for students/mentors:

- **Discovery Hall**
- **Innovation Resource Centre & Hall of Fame**
- **Idea Lab**
- **Design Studio**
- **Mentoring and guidance**

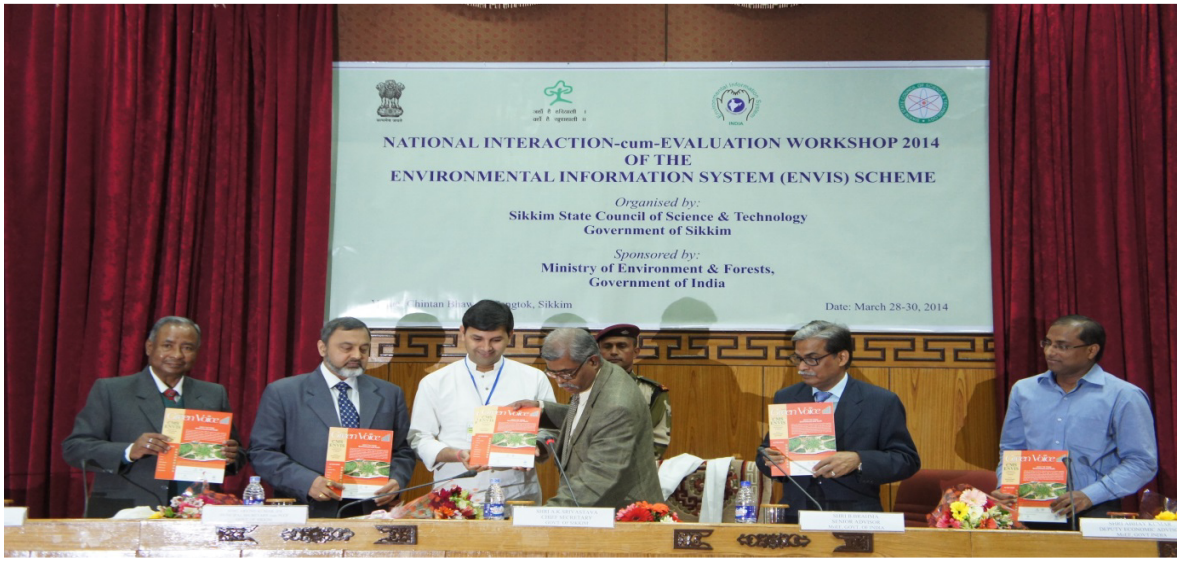
(ii) ENVIS Centre Sikkim on Eco-tourism:

ENVIS is a decentralized system with a network of distributed subject oriented centers ensuring integration of national efforts in environmental information collection, collation, storage, retrieval and dissemination to all concerned. The focus of ENVIS since inception has been on providing environmental information to decision makers, policy planners, scientists and engineers, research workers, etc. all over the country.

The Centre has been working on building up extensive information system on ecotourism in the country. The centre is continuously working on collection, collation and dissemination of information on Ecology, Environment and Ecotourism. The information system consists of state wise information on all parameters related to ecotourism. Information on National as well as state ecotourism policies of the country has been uploaded to bring it into a single platform for easy access and use by decision makers, planners as well as researchers. Parameters like Region wise Network of Eco-tourism sites, Wildlife and Avian Ecology and Endemicity in India, Wildlife sanctuaries & protected areas., Location wise distribution of threatened animals, Institutional Network of museums in India, State wise movement of Domestic and Foreign tourists, Situation of Agri-Tourism by region, Ecotourism travel infrastructure, Information system of eco-tourism, Economic benefits of birds and animals can be found in the website.

The website also gives comprehensive information on status of R&D in Eco-tourism, Documentation on Specie-wise details, habitat, food, human interaction, Educational, Research Institutions, Situation of wild life crime, misuse, Legal, regulatory network by region from all over the country

National Interaction-cum-Evaluation Workshop for ENVIS Centres held at Gangtok, Sikkim from 28th to 30th March, 2014



National Evaluation Workshop of ENVIS Centre-2014

A three-day National Interaction-cum-Evaluation Workshop for Environmental Information System (ENVIS) Centres was organized by the State Council of Science &

Technology for Sikkim (SCSTS), Gangtok on behalf of M/o of Environment & Forests (MoEF),Government of India, at ChintanBhavan, Gangtok, Sikkim on 28-30 March 2014.

The purpose of the Workshop was to evaluate the performance in 2013-14 of the 68 ENVIS Centres, 28 of which are hosted by State Governments/ UT Administrations. Around 125 delegates participated in the Workshop, including 90 representatives from 36 out of 40 Thematic ENVIS Centres and 21 out of 28 State/ UT ENVIS Centres.

Shri S.K. Shilal, Secretary, Department of Science, Technology and Climate Change(DST&CC), State Government of Sikkim, in his Address welcomed the dignitaries on the dais,Expert Members and delegates from various ENVIS Centres. Among the dignitaries were Shri A.K. Srivastava, Chief Secretary, State Government of Sikkim, who graced the function as the Chief Guest, delivered the Inaugural Address, ShriAbhay Kumar, (Deputy Economic Advisor, MoEF)Shri B. Brahma,(Senior Adviser, MoEF, and Guest of Honour), etc.

Review of performance in 2013-14 of ENVIS Centres was carried out in two parallel sessions by four Expert Members appointed by MoEF viz., (i) Prof. M.N.V. Prasad, Department of Plant Sciences, University of Hyderabad, (ii) Prof. Avinash Chandra, Professor (Retd.),Centre for Energy Studies, Indian Institute of Technology (IIT), Delhi, (iii) Dr. N. Ramaiah,Chief Scientist, National Institute of Oceanography (NIO), Goa, and (iv) Prof. Bharat H. Desai,Centre for International Legal Studies, Jawaharlal Nehru University, Delhi.

The participating Thematic and State/ UT ENVIS Centres made presentations on their activities in 2013-14, highlighting the collection, compilation, verification and updating of databases on the subject area by them, in particular bringing out the new databases developed and publications/ information products brought out. Dissemination of information, through various modes, such as user engagement based on statistics like visitor count on ENVIS Website and query-response were also depicted graphically.

The Experts evaluated the various Centers based on the criteria outlined in the Guidelines of the Scheme, as Category A: Very Good (≥80),B: Good (≥50 and <80) and C: Non-Performing (<50) prior to consideration of grant of fundsfor the next financial year 2014-15.A snapshot of the Grades for ENVIS Centre Sikkim on Ecotourism is below:

In the concluding remarks and summing up of the Workshop by Ms.Vandana Aggarwal, Economic Adviser, MoEF and Head, ENVIS Scheme, made some valuable points for the centres to deliver.

The Workshop concluded with a special vote of thanks for the hosting, organization and hospitality of the State Council of Science & Technology for Sikkim (SCSTS), and also other participating Departments, notably, the Forests, Environment & Wildlife Management Department, State Government of Sikkim, Gangtok.

The Grades of the ENVIS Centres have been put up on the ENVIS Portal, in the following link: http://envis.nic.in/grades.html.

(iii) Bio-Informatics infrastructure Facility (BIF) for the Biology Teaching through Bio-Informatics(BTBI) under BTISnet DBT at Sikkim Science Centre, Marchak

Activities of BIF at Sikkim Science Centre:

i. Developing the website to creating awareness of biotechnology through bioinformatics.
ii. Development of interactive information and interpretation kiosk with visuals on different facets of biodiversity of Sikkim
iii. Collection, collation, compilation & dissemination of biotechnology related Information to students.
iv. Nature interpretation facility about wild sanctuary and Nature Park.
v. Development of interactive computer based quizzes on bio resources of Sikkim.

(iv) Scientific evaluation of Water purification system in State of Sikkim.

The major objectives of the project are as follows:-

- To assess the performance of different types of water purification technology to provide safe drinking water in schools/institutions.
- To study the performance of the installed water purifier, quality and quantity of treated water produced and frequency of maintenance needed in school environment over a period of 12 months.
- To study the reliability of the product.

The filter selected works on various principles. It is a three staged filtration process consisting of pre filtration, Ultra-filtration and (UF) and ultraviolet (UV) filtration unit. The total output of this filtration system is 500 litres per hour per unit.

Installation of these three stage filtration system along with water tanks and drinking platform in 20 different institutions has been successfully completed in Sikkim.
The direct beneficiary of the project includes students and staff of twenty institutions across the state of Sikkim. The project is providing safe drinking water to an average of 1000 persons per school in different districts of the state which sums up to 20,000 persons per day. Hence, children in twenty different areas of the state are getting access to safe drinking water which ultimately indicates that they are safe and secure from common water borne diseases. Various

physical, chemical and biological parameters are being evaluated to ascertain the work performance of these filters.

iv) Cane / Rattan Conservation and promotion of cane handicraft through value addition for sustainable livelihood for the Dzongu Tribal Reserve Area, North Sikkim.

The project " **Cane / Rattan conservation and promotion of cane handicraft through value addition for sustainable livelihood for Dzongu Tribal Reserve Area, North Sikkim"** was initiated in the financial year 2010 - 2011 and completed in the year 2013-14. The project was executed at Dzongu, North Sikkim. One of the important objectives of the project is the capacity building of the farmers for propagation of rattan through seeds and also to promote rattan handicrafts through possible value addition.

While executing the project, a total of 9 species of rattan species have been recorded from Sikkim, viz. *Calamus acanthopathus, C. inermis, C. flagellum, C. latifolius, C. leptospadix, C. tenious, C. erectus, Plectocomia himalayana, Daemonorops jenkinsiana* etc. Whereas, 6 species of rattan have been relocated and redefined the distribution patterns of the species from the Dzongu valley. The rattan population in Dzongu are mostly confined to the inaccessible areas such as dense forests, undisturbed areas except *C. latifolius, C. flagellum, Daemonorops jenkinsinana* etc. The propagation of the *Calamus acanthopathus, C. inermis and Plectocomia himalayanahas* been successfully done under the project under at Hee- Gyathang, Lower Dzongu, North Sikkim. Morethan 2000 rattan saplings of different species has been generated from the seeds propagation methods. Such kind of trail propagation has never tried in Sikkim before. As an experimentation, some species are also being raised at the Sazong, Rumtek, East Sikkim near State Biotechnology Research & Application centre.

The rattans are identified as an important source of livelihoods for the people of Sikkim including Dzongu. Series of resource survey has been undertaken at Dzongu, in regards to its populations, habitat, traditional usages and for possible threats. The survey reveals that rattan has been part of the Lepcha tribal those who are leaving in the valley for many centuries. They have been using the rattan for various purposes and but due to indiscriminate usages the rattan population is this part of the Sikkim is also facing thread. Amongst all other rattan species *Calamus acanthospathus* has been used extensively for various purposes. Almost all the parts of the species are being used for various purposes. The prolong use of the species by the tribals the population of the *C. acanthospathus* imposes huge pressures on the wild forests. The conservation status of *C. acanthospathus* also has not been explicitly studied in the past. Therefore being a vulnerable and rare species the conservation approach has been made for the reclamation of the species. One of the reasons for such lost in the populations is due to combination of its slow growth and overexploitations. *C. acanthospathus* has a solitary habit which means that each plant comprises only one stem. This makes the species susceptible to over-exploitation, as wild harvesting necessarily kills the whole plant. In contrast, all other species of cane in Sikkim are multi-stemmed, so each plant continuously produces offsets that can be either harvested for cane, or used for vegetative propagation. Therefore, the propagation of the *C. acanthospathus* through the seed and adoption for the farming of the same may ease the pressure on the natural habitation of the forests.

The team members working under the project

Creation of Rattan polyhouse and nursery at DTRA

Plate (25); One polyhouse and two rattan nurseries has been created at Hee- Gyathang GPU at DTRA

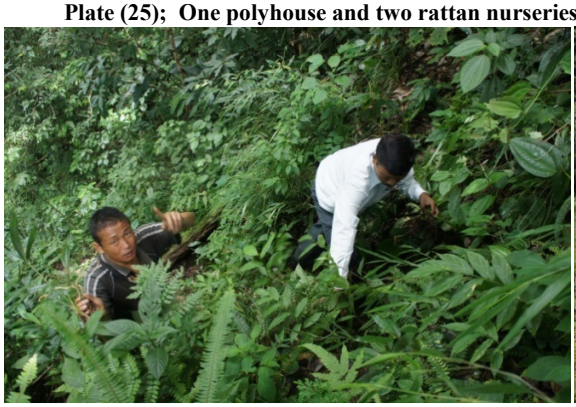


Plate (26) Field Survey by Dr. H.K. Bora and FA.

Plate 27) Rattan polyhouse at Hee-Gyathang, North Sikkim

Fig. (28) Training Programme on Cane Propagation and its Value Addition in collaboration with RFRI.

Plate (29) Trail propagation of Rattan at Sazong (Rumtek) and at Dzongu

Plate 30) Splitted rattan's stem for ready use .

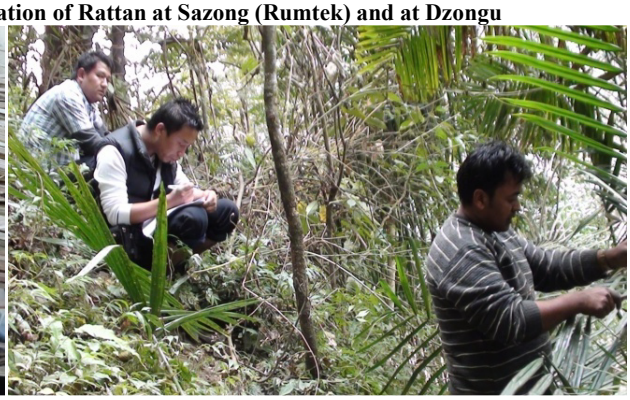


Plate (31) Filed investigation on Rattan diversity

v. Documentation of traditional ethno-veterinary practice and its formulation"

The project “Documentation of traditional ethno-veterinary practice and its formulation" was initiated in the year 2010 and completed in 2014. The project has been funded by SEED, Division, Department of Science & Technology , Govt. of India under Young scientist award. One of the key objectives of the project was to documentation of existing traditional practices and their formulations in cattle treatment. A total of 250 villages under 29 BACs, of Sikkim has been successfully explored for recording the datas associated with Ethno-veterinary practices

uphold by the local communities living in far flung areas. During the process, 180 folk healers (medicinal plant practitioners), 145 livestock herders (farmers), 98 senior citizens and other amateur traditional ethno-veterinary plant practitioner has been thoroughly consulted and taped the information as per the format created through the suggestions of Local Project Advisory Committee (LPAC) of the project. As a result, 200 plant species has been identified as important herbs being used in ethno-veterinary practice across the state. Approximately, 180 ethno veterinary formulations has been recorded which is being practiced for cattle treatment in Sikkim. Out of which, a total of 45 new and unreported traditional formulations have been recorded for the treatment of livestock in Sikkim through the project. The study also reveals that those formulations possesses strong basis in claiming intellectual property right of the farmers. During the exploration on ethno-veterinary practices in Sikkim, near about 250 villages in 4 districts of Sikkim (80 % in North district, 85% in East district, 95% in south district and almost 85% in West district) has been successfully covered. Due to the rocky terrains and due difficult landscapes some areas such as Tholung valleys (towards Kishong) , Dzongri, Green lake, Karch-Mangnam, Kongri, were not being able to explored during the survey. However part of some important Wildlife conservatories such as Pangolakha Wilife sanctuary and Fambong Lho Wilife Sanctuary in East Sikkim and few areas of buffer zone of Kanchendzonga National park (North & West Sikkim) has been successfully explored and identification of plants species being used in the ethno- veterinary purposes. The sample collection of the specimens to study the species in detail has been successful done. The plants are properly being identified in consultation of expert from Botanical Survey of India. The species are preserve at herbarium of Sikkim State Council of Science & Technology for future use and can be use as a source of reference materials for the schools, colleges and even for the universities of Sikkim.

While executing the project, more than 300 folk healers, plant practitioners, livestock herders has been successfully sensitize on importance of the folk medicinal plants and its conservations within their territories. With series of awareness programme, line departments, research institutions, NGOs (Non Governmental Organization), SHGs (Self Help Group), has been also sensitized in taking up necessary actions on conservation of ethno-veterinary plants and its practices for future use. In many remote areas of the Sikkim, the majority of farmers are still dependent on ethno-veterinary mode of treatment than modern allopathic medicine. One of the important achievements of the project is to create traditional knowledge digital library for 180 different formulations on ethno-veterinary practices of Sikkim. The digitization of the ethno-veterinary practices and their formulations was successfully done with the concept of facilitation to the farmers to protect their traditional knowledge from possible infringes (bio-piracy) in future. This digital library will be uploaded into public domain for general references for line departments, institutions, policy makers, Scientists etc. However, the main aim of digitization of this knowledge is for the future IPR related issues, protection of traditional knowledge, benefit sharing. The activities pertaining to creation of digital library has been done in collaboration of

IPR cell, Sikkim State Council of Science & Technology, Gangtok Sikkim. While analyzing the data collected, its reveals that 52 formulations recorded have strong potential in claiming for intellectual property right on ethno-veterinary formulations of folk healers of Sikkim for traditional livestock treatment.

vi. "PARTNERSHIP AWARD-2015" BY NATIONAL INNOVATION FOUNDATION (NIF) INDIA

The team led by Shri T.W. Lepcha , Hon'ble Minster with Principal Secretary and other officials of Department of Science, Technology and Climate Change called upon Hon'ble Chief Minister at Samman Bhawan on 19th March 2015 to apprise about the award being conferred by National Innovation Foundation (NIF- India).

The Sikkim State Council of Science & Technology has been conferred **"Partnership Award-2015"** by **National Innovation Foundation (NIF) India**,an autonomous body under the Department of Science and Technology, Government of India.This award has been *awarded for furthering the cause of grassroots innovation movement.* The award consisting of a trophy,a certificate and cash prize of Rs 50,000/- was received by Shri. D.T. Bhutia,Additional Director and Dr. S. R. Lepcha Deputy Director of the Department of Science and Technology,Govt.of Sikkim from Dr. R.N Mashelkar, Chairperson of NIF, the former Director General of Council of Scientific & Industrial Research (CSIR)and member of the Scientific Advisory Council to the Prime Minister during a function held in the Rashtrapati Bhawan, New Delhi on 7th March 2015.Only two States have been awarded such awards,the other State being Uttar Pradesh.

NIF- India is pursuing the cause of identifying and recognizing grassroots innovations and traditional knowledge practices from rural and urban areas with a mission of making India innovative and a global leader in sustainable technologies. The idea is to build upon and provide a nurturing platform to unsung heroes of our society who have solved technological problems through their own genius without any outside help. Established in the year 2000, **NIF-India** has been scouting, documenting, spawning, adding value, protecting intellectual property rights and

disseminating contemporary unaided technological innovations as well as outstanding examples of traditional knowledge of individuals and communities from across the country**.**

The Sikkim State Council of Science & Technology has been associated with **NIF-India** since 2010 and has been actively involved in the mission and trained many academicians, researchers, entrepreneurs and stake holders. *The Council* has also been one of the key partners in organizing the **" 34th Shodh Yatra – 2015 "** from 28th February to 3rd March 2015 during which a journey was taken through the villages of Lower and Upper Dzongu in search of knowledge, creativity and innovations at grassroots.The **60 Shodh Yatris** who undertook the journey comprised of scientists,innovators and students from all over India. During this Yatra, a series of meetings, discussions and documentations were conducted to promote grassroots innovation, traditional knowledge and value addition. Bio-diversity competitions were also held among the school children and recipe competitions for promotion of local cuisine were also organized.In the course of the Yatra, innovative students,local innovators, experimental farmers were identified and felicitated. Some of the innovative ideas from the students of Dzongu have been noted by visiting scientists including the well known IIM Ahmedabad Professor, Dr. Anil Kumar Gupta,who is also the Executive Vice Chairman of National Innovation Foundation. The **Shodh Yatra** initiative has turned out to be one of the major movements across the country in carrying the spirit of innovation to the doorstep of common man.

(vii) North East Climate Change Adaptation Programme (NECCAP)

The State Government has taken various programees on issue related to Climate Change in the State with an objective to axes to chain varnablity, Climate Change impact of food, water and Forest sector and suggested an approach to identify venerable section and region and incorporate adaptation strategy and practices. The various inceptive has been started by Council at National and International level. Government has approved frame work of Climate Change Adaptation Programme to strengthen adoptive capacity of the targeted community and reduce there varnablity to Climate Change through sustainable climate change adaptation majors. The German Development Bank (Kfw) has agreed to support 5 million URO (INB-30 Core) for seven years period as North –East Climate Change Adaptation Programme (NECCAP). The initial reimbursable State contribution is required amounting to Rs 5 Core as per the agreed minutes of the meeting between State Government and Kfw. Hence Rs 5 Core has to be age mark for NECCAP for the financial year 2012-13.

- Goal: Strengthen adaptive capacities of the target (rural) communities and reduce their vulnerability to climate change through sustainable Climate Change Adaptation (CCA) measures.

Background

- Following the Feasibility Study of the proposals presented by the five states including Sikkim, the KfW Mission and the State government agreed on the framework for implementation of NECCAP in Sikkim (Minutes of Meeting, October 2010), The MoM outlined the broad focus and the structure, and highlighted the need to elaborate the

feasible climate-change relevant proposals / measures in the form of Project Design Document (PDD). A team of consultant was appointed by KfW to assist the nodal agency in each state for the purpose.

- A multi-department core team constituted by the nodal agency (DSTCC) constituting representatives of DSTCC; RMDD; FSADD, HCCDD, FEWD, and SIMFED discussed and finalized the project design. For the purpose a series of core team meetings, department level meetings and district as well as cluster level stakeholder consultations were undertaken between Dec 11, 2011 and Feb 17, 2012 with the help of the KfW Consultant.

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

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

(i) a. National Childrens Science Congress Programme Annual Programme
b. National Science Day Annual Programme

National Level NCSC 2016 at Baramati, Maharastra.

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

Objectives:

- 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.

(iii) 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.

(iii) Eyes on Comet ISON (International Scientific Optical Network)":

The Sikkim Council of Science and Technology in association with the Paschim Banga Vigyan Munch (PBVM) is organizing two days state level workshop and observation programme on "Eyes on Comet ISON (International Scientific Optical Network)" from 18th to 19th November 2013 at Sikkim Science Centre, Marchak. The programme is catalyzed and supported by the National Council of Science and Technology Communication (NCSTC), Department of Science and Technology, Government of India. Vigyan Prasar, an autonomous organization of Department of Science & Technology, Govt of India was also part of the programme for academic content and resource material.

State level workshop during November 18-19, 2013

(iv) Organization of series of workshop in collaboration with Vigyan Prasar:

Three days consecutive workshop on Innovative Experiments on Chemistry and Observing Nature and Bio-Diversity for teachers and students of Sikkim was organized during October 24-26, 2013 in collaboration with Vigyan Prasar. The programme was funded by Vigyan Prasar, DST, GOI, New Delhi.

Dr. Arindam Rana, Associate Professor, Kolkata the Resource Person for Innovative Experiment on Chemistry, expressed his happiness for conducting such workshops for school teachers and gave a presentation on understanding the chemistry of life. He demonstrated how to use the kit. He explained the objectives of the workshops and how the workshop may help teachers in doing hand-on activities in classroom teaching for better appreciation and understanding of science by students and experiments with natural products and their comparable synthetic substitutes were performed. A number of activities based on chemistry in daily life were demonstrated. He demonstrated how to use the kits developed by Vigyan Prasar and also demonstrated a number of innovative activities related to qualitative analysis; fundamentals of pH metric titration, quantitative analysis, and acid-base chemistry were carried out by the participants. Many participating teachers demonstrated different innovative activities related to classroom teaching involving the hand-on activities. A module "Teaching chemistry- an acti9vity based approach", specially designed for the workshop, explained by Dr. Rana.

Md J. Alam, Resource Person, Patna, for observation of nature and bio-diversity explained the different parameters to observe in nature i.e. shape of leaves, wings of butterflies, insects, etc. he also explained the biodiversity kits distributed to participants. All the sessions were interactive and participants took part in interacting with the resource persons and did hands-on activities themselves. A few participants shared their views on the workshop and explained how it would help them in utilizing the resource materials provided by VP in doing hand-on experiments.

All the participants filled the feedback forms of the workshops. A few participants shared their views on the workshop and explained how it would help them in utilizing the resource materials provided by VP in doing hands-on experiments.

v. State level science and sanitation campaign- 2014

vi. Low cost science teaching aid in chemistry & physics for science teachers:

A series of Low cost Science Teaching Aid in Chemistry & Physics for the science teachers of the state has been successfully conducted during the month of March 2015 in support of Vigyan prasar, Department of Science & technology , Govt. of India. The training was held in two places one at Sikkim Science Centre on 26th & 27th February 2015 for teachers representative from South & west district. The another programme was being held at Zilla Bhawan at North Sikkim for East and North districts on 2nd & 3rd March 29015.

During the workshop the participants were given hands on training on methods to teach science by using a very minimal cost waste materials. The programme is mainly to supports schools that belong to tribal villages and schools without appropriate facilities for scientific experimentations.

During the workshop, a key lecture cum demonstration on phenomena on physics was conducted by Dr. B. N. Das, a retired Professor in Physics, and a Guest Faculty at the Presidency College, Kolkata He. demonstrated a number of phenomena in physics. His activities were mainly focused on light, in order to celebrate the International Year of Light, 2015. Experiments on presence of atmosphere and its pressure was demonstrated. Many experiment were shown to the gathering using soap, broken screen of mobile phones, etc. The participants were also given hands on training with innovative experiments.

Dr. Arindam Rana, Associate Professor, from City College, Kolkata also shared numerous principles of Chemistry through demonstration. He also demonstrated some experiments using low cost household materials such as displacement of chemicals, method to memorize the periodical tables, acid- base reactions, starch-iodine reaction, etc. which can be carried out even in schools in remote areas, where facilities to laboratories are yet to come up. Some experiments pertinent to the equations the children come across in their text books. Hand on activity was also conducted with help of the Chemistry experiment kits developed by Vigyan Prasar, New Delhi, which was one set each to all the participating schools and also requested them to apply the technique for better inculcation of Science and innovations among the school children.

The workshop ended with distribution of the certificates to the participants.

vii. **Workshop on Ham Radio (Natural Disaster Communication tool):** A week long workshop on Amateur (Ham Radio) was organized from 9th to 14th May 2017 in Sikkim Science Centre, Marchak, Sikkim .40 participants for various organizations, departments, volunteers, media personal had attended the work shop. Out of these 23 had appeared for Amateur Station Operators Certificate (ASOC) Examination and 11 have already received the license for operation of Amateur (Ham) Radio .

SIKKIM

Ham radio training for Sikkim concludes

SAMIR NUGO

GANGTOK, May 14: The weeklong State-level training on ham radio held at science centre at Marchak near Ranipool came to a close today.

The training programme was organized by Sikkim State Council of Science and Technology and supported by Vigyan Prasar, department of Science and Technology, government of India.

The training which started from May 9 had participants from across the districts comprising of Quick Response Team, members of SSDMA, media persons and NGOs members.

Sandeep Baruah, Scientist-E and the main resource person of the training, imparted technical knowledge on ham radio with the skill of theory and practical.

The valedictory function today had the State Science & Technology principal secretary Anil Mainra as the chief guest accompanied by former secretary Rajesh Verma as a guest of honour.

Mainra urged the participants to make ham radio a hobby as it is useful during the time of emergency. He further appealed all the participants to clear its first hurdle and possess the license after which the department will provide equipments.

The function also had a power point presentation by Verma, who is also a ham radio operator from Sikkim. He encouraged the participants to become ham operators and to help the people in the time of disasters.

Land Revenue joint secretary Ganesh Khanal urged the trainees to be more dedicated and keep the skill in track. He farther stated that the department in consultation with the Science & Technology department will soon start the amateur radio (ham radio) in Sikkim for emergency situations like natural disasters.

The trainees will have to appear and qualify a written exam which would make them eligible for a ham license to be issued by the Union Communication & IT ministry.

Amateur radio (ham radio) is a popular hobby and service that brings people, electronics and communication together. People use ham radio to talk across town, around the world, or even into space, all without the internet or cell phones. Ham radio plays a key role in the time of emergency like floods, earthquake, landslides etc when telecommunication network fails to work.

Participants using ham radio sets during the training. SE Pic

day certification training-cum-workshop on Ham Radio started today at Sikkim Science Centre, Marchak. The training programme is being organized by Sikkim State Council of Science & Technology with support from Vigyan Prasar, Department of Science & Technology, Government of India.

The Quick Response Team under State Disaster Management department, teachers, media persons, NGOs and volunteers are undergoing the training programme which will cover in-depth Ham Radio studies, informs a press release.

During the workshop, the participants will also get to know the advance applications of Ham Radio such as packet radio and data transfer using PSK31.

The training programme will be followed by an examination to become certified HAM user which will be conducted by Union Ministry of Communication.

The inaugural session was chief guest.

While welcoming the resource persons and participants, Mainra explained the importance of alternative mode of communication during natural disaster and how it can save several lives if there are trained persons in remote areas to communicate with the help of such device.

He suggested all participants to be serious and take interest during the training so that the State's effort does not go waste.

Scientist Sandeep Baruah from Vigyan Prasar and former State Information Technology secretary Rajesh Verma are the resource persons.

During many of the past large scale disasters all over the world, Amateur Radio Service (Ham Radio) has proved its efficacy in quick dissemination of disaster management information like search and rescue, relief work, tracking of missing person, real-time plotting of vehicles and personnel involved in disaster management and transmission of weather telemetry data.

viii. **"Sci- Connect" Science quiz competition supported by Vigyan Prasar.**

ix. Science Awareness Programmes supported by State Government:

One day awareness programme on Traditional Knowledge with respect to Medicinal Plants of Sikkim for College Students.

Series of Awareness Programme on Organic Farming for farmers of Sikkim in 08 Subdivisions (02 sub divisions of each District) of State.

Workshop on Animation on Science using existing facilities at Science Centre for 15 days.

Workshop on low cost teaching aid in Science For three days for the graduate teachers of State.

2. **New Facilities:** Various new facilities have been added up which are all due for inauguration.

1. **8m dia Planetarium -** Planetarium is a facility for presenting educational and entertaining shows on celestial wonders and the magic of night sky, capturing the beauty and magnificence of celestial objects and phenomena. A dominant feature of most planetariums is a dome shaped projection screen onto which scenes of stars, planets and other celestial objects can be made to appear and move realistically to simulate the complex motions of the heavens. The celestial scenes can be created using a wide variety of technologies. The 8m dia planetarium has a seating capacity of 53 and daily 4 shows can be held.

2. **3D- Theatre** - A 3D/three-dimensional film is a motion picture that enhances the illusion of depth perception. In Science Centre ambience, short length scientific documentaries produce an immersive experience for the visitors and this element of surprise helps communicate science in a better way. Many modern science centres are now equipped with the 3D theatre facility. It creates immense curiosity among the visitors and simultaneously generates revenue.

3. **Innovation Hub** -The 'Innovation Hub' is a Science laboratory for high school (classes VI to XII) and College students where they are engaged in creative and innovative activities. The underlying ideas is to promote critical thinking and problem solving ability through hands on activity. The broad sections of Innovation Hub are 'Hall of Fame: Innovators and Inventors', 'Innovative Resource Centre', 'Innovation Laboratory' and 'Tech Lab: Robotics and Microprocessor Programming Facility'.

4. **Biodiversity gallery –** Different exhibits related to Sikkim Biodiversity has been displayed in this section which mostly aims in providing the information on biodiversity among the mass and thus helping the students in conserving the biodiversity of Himalayas by creating awareness at a glance.

3. Drinking Water and Building Water Security through In-situ Rainwater Harvesting at Suldung Kamling GPU, Soreng Block ,West Sikkim

25 households were benefitted with installation of in-situ rain water harvesting system in Kamling Suldung GPU under Mangalbaria Block. The beneficiaries were provided with 2000 ltrs Reno Sintex water tank 02 nos at each household with 01 no mineralized gravity jumbo housing water filter (1.5"), 01 no jumbo spun filter cartridge of 20" each with complete installation. The project was supported by United Nation Depelopment Programme.

4. "Dryer for Cardamom, ginger, mushroom and other herbs and vegetables energized by Nano Hydel Power generated by local water streams:

Two projects on **"Dryer for Cardamom, ginger, mushroom and other herbs and vegetables energized by Nano Hydel Power generated by local water streams" is going on one at Dentam, West Sikkim and other one at Rangoli. East Sikkim.** The main objectives of the project is to develop technology for drying of a large cardamom without compromising its quality in Sikkim and to generate power through local available water streams which will provide power these driers. The project is funded by DST, GOI for the period of three years.

India SkillPedia/ TechPedia

An Initiative of the State S&T Councils
and Skill Mission Teams of Sikkim and NE States

A Solution Framework & Collaboration / Transactional platform and Cyber Eco-System to empower and inspire Skilled Workers, Entrepreneurs & StartUps

Knowledge Repository with authoring systems, crowd sourcing features and service delivery is aimed at imparting know how for concepts, applications, competency development, prototyping, production, manufacturing and service delivery

With the

AIM of;

Sharing and harnessing knowledge and Innovation through collaboration.

Building individual and organizational competencies and capacities.

Ushering in technological and industrial competitiveness of the Indian Industries.

Department of Science and Technology
Government of Sikkim





1. Overview of indiaskillpedia/ indiatechpedia Portal

The indiaskillpedia.com / indiatechpedia.com portal serves as a collaboration and transactional platform/ ecosystem, for skill aspirants, entrepreneurs, start-ups and budding, ambitious professionals to develop competencies, acquire know-how, engage in purposive actions to develop technologies, product and services by facilitating in a number of ways as mentioned below;

Skill India
कौशल भारत - कुशल भारत

(i) providing access to knowledge and a facilitating authoring system for sharing and upgrading know-hows, skills & competencies,

(ii) engaging young persons, skill aspirants, entrepreneurs, startups and communities by providing adaptive, automated delivery of information and services for their empowerment and handholding

(iii) linking them to sources of knowledge, professionals, state agencies and enabling pursuits for sustainable livelihoods, pursuits to establish startups/ enterprises to engage in production, manufacturing or service delivery, sustain such entrepreneurial ventures and

(iv) keeping the target group updated and enrichedto enhance their capacities for innovations, building capacities and confidence for rapid execution of ideas and scale ups

"Nurturing Skill Aspirants, Entrepreneurs & StartUps;
Transforming them as legends"
Is the purported goal

Such outcomes as those above would be achieved through the sharing and harnessing knowledge and innovation through collaboration, building individual and organizational competencies and capacities and ushering in technological and industrial competitiveness of the Indian industries

As an ***Online Knowledge Repository***, the Portal serves the purpose of accessing, exchanging, sharing resources that can help in pursuits for augmenting capacities, competencies, acquiring know-hows, assimilating an understanding for planning/ performing tasks, producing, manufacturing, building, assembling, installing, setting up or managing processes.

Embedded features and functionality in the portal enables authoring of contents/ contributions, invoking process automation for review and approval for authentication, acknowledgement, validation of uploaded/ reviewed or modified contents for quality and acceptability, as also for the required organization, annotation, cross referencing and presentation of such knowledge resources intuitively adapted to the profile of the user.

The portal subscribes to the ***paradigm of Open innovation***, which is becoming increasingly relevant in the current scenario where collaboration, networking and partnerships play significant roles to determine success and outcomes.

2. Context

- Skill Aspirants, Entrepreneurs/ StartUps require handholding
- A platform that enables connect them to share knowledge and access useful material to sustain their interest would be useful
- There is abundant knowledge available in public domain and with public funded institutions . However, they are widely distributed, unorganized with limited access .
- Knowledge generated are often not available in a form that can inspire, motivate and be used by Skill aspirants, entrepreneurs and startups

3. The Requirement

- The Requirement is for a Solution framework which serves as a platform for creating/ compiling, sharing knowledge
- Authoring systems developed and deployed on a cyber platform can help organize and place knowledge resources within an intuitive structural framework for better understanding
- Past Experience has shown that Advocacy, Engagement and Adaptive presentation of content helps retain the interest of users
- Capturing browsing habits of users, profiling users on the basis of their interaction can be modest efforts at Cognitive modelling
-

4. The Approach

- Sourcing Knowledge in Public Domain
- Structuring the Portal Solution and underlying knowledge base to facilitate cognition
- Enabling and enhancing understanding of Career Choices and Pathways, methods to harness technology, productization through DIY Culture
- Promotion of habits for knowledge exploration and self-learning, prototyping, incubation, product development and improving service delivery
- Mobilizing Domain Experts to share knowledge & encourage Community involvement and participation for knowledge management and dissemination

5. Stakeholders & Target Audience

As an Open System, the users and stakeholders themselves are the champions who share their knowledge, resources, intellectual inputs in engaging, empowering and handholding others.

The portal envisages engagement of training providers, educational institutions, industries, researchers, technology aspirants, enthusiasts, experts, resource persons, community leaders, and students in development and strategic sectors, and R&D institutions, who are desirous of contributing knowledge to promote and empower the entrepreneurs, startups, technology enthusiasts, skilled professionals and manufacturing industries.

The platform enables dialogue for

(i) upgrading skills, knowledge, know-hows, develop competencies and capacities
(ii) disseminating awareness and encouraging entrepreneurs/ industries to pursue/patent acquisition, develop technologies, source solutions to technology and capacity problems
(iii) prospecting, sourcing technologies, exploring and leveraging opportunities for development of technologies or pursuing innovations for manufacture and marketing of products and solutions,
(iv) facilitating technology acquisition, transfer, negotiation of terms, understanding and positioning in the market, evolving strategies / approaches for exploitation of opportunities
(v) supporting the augmentation of capacities of industries to manufacture products and services which can meet the demands in the Indian and global marketplace and
(vi) facilitating effective management of operations and risks.

The portal serves as an institutional mechanism that would disseminate ideas, designs, challenges/ solutions, requirements/ pre-requisites, methods, mechanisms and systems for products and services in various development and manufacturing sectors, - which can be seen and harnessed by other individuals, industrial establishments and organisationsto leverage such inputs and scale up their capacities for production of such products, components and value added services.

The Portal is managed by Officers, Researchers of the Sikkim State Science and Technology Council and Skill MissionTeam members and professionals of the States of Sikkim and North East**.**

6. Envisaged Objectives & Outcomes

The indiaskillpedia / indiatechpedia portal envisages engagement of technology aspirants, enthusiasts, experts, resource persons, community leaders, researchers and students in strategic sectors, academic institutions and R&D institutions, who are desirous of contributing to promote and provide inputs to the manufacturing industries that are aimed at;

i. disseminating awareness and encourage industries to pursue/patent acquisition, develop technologies,
ii. prospecting, sourcing technologies, exploring and leveraging opportunities for development of technologies or pursuing innovations for manufacture and marketing of products and solutions,
iii. facilitating technology acquisition, transfer, negotiation of terms, understanding and positioning in the market, evolving strategies / approaches for exploitation of opportunities,

iv. supporting the augmentation of capacities of industries to manufacture products and services which can meet the demands in the Indian and Global Market
v. facilitating effective management of operations and risks.

The portal will serve as an institutional mechanism that would disseminate ideas, designs and requirements for products and services in the manufacturing sector, - which can be seen and responded to by manufacturing companies with capacities for production of such product components and value added services

The portal is a modest effort that attempts to facilitate the community of entrepreneurs, technology enthusiasts, skill aspirants and start ups to collaborate and contribute in a manner that ensures that knowledge is created, developed and shared with contributions being made through crowd sourcing, compiling, repurposing and reusing contributions of resource persons, experts, techno-preneurs, developers, consultants, state agencies and institutions engaged in training and development of skills, technologies, products and systems.

7. Challenges faced before deployment/implementation.

Engaging the stakeholder community to share information, knowledge is a challenge. Automated processes and authoring systems have been deployed coupled with editorial review mechanisms for validation and authentication for quality and acceptability.

However, incentivizing knowledge sharing evolves progressively through engagement, active messaging, face to face interactions, creating awareness on purpose, functionality and features of the portal and encouraging/ motivating the contributors.

An alternative form of ***crowd sourcing approach*** has also been adopted. This involves, constituting a close group of motivated researchers associated with the management of the portal, and entrusting them with the task of identifying and sourcing contents which are already in public domain. The content from its original source is anchored and reproduced/ repurposed with anchor images and key paragraphs and providing links to the original source.

The research group also proactively contacts the potential sources of knowledge, familiarizing them with the manner in which content can be uploaded and revised.

The other challenge is of Intellectual property rights. Giving credit to the contributors, authors, resource persons and acknowledging the source is done with due diligence.

Sometimes, authors and contributors are not very keen on identifying themselves or filling up forms or even loathe logging in before making any relevant changes to content using the authoring mechanisms provided to improve their quality.

Hence, in evolving the solution, even the requirement for logging in, before uploading or revising/ reviewing a knowledge resource or contribution has been dispensed with. Instead the system merely captures the IP address and maintains logs to keep track of changes done.

8. Salient Features of the Portal

- Wide range of Authoring Systems Variants

- Intelligence for User Profiling - leveraging models, mechanisms and tools for
  (a) capturing Cognitive Dimensions – researching on manifest behaviors of users and patterns of interactions/actions
  (b) underlying information seeking habits & motives
- Presenting Cross Reference Links
- Maintaining profile logs - Monitoring & Capturing Browsing habits during User Sessions
- Geo-location routines for customizing presentation of information
- Engagement Mechanisms and Tools to send communications to Users
- Analytics & Decision Support Routines

9. Process followed for deployment/implementation

The Portal has been deployed in Amazon Cloud to ensure reliable, robust, realtime, online experience with minimal latency and 24/7 availability. The infrastructure encompasses storage, computational resources scalability, security features and analytics which can be added seamlessly on the basis of transactional volumes, load balancing and demands for improved responses.

Messaging and solicitation of feedback, form based user inputs and content upload/changes features are made available extensively, adapted to the context with functionality and features that are easy to use.

Extensive online help, tool tips, mouse over dynamics enable ease of navigation and access to specific resources being searched. The layout structure, link labels are themselves intuitively organised and are provided under various labelled sections providing an insight to the underlying knowledge structure and organisation of content, in order to facilitate cognition, ease of comprehension and access.

The contents are also extensively cross referenced and indexed for navigation and ease of access, as also to give the user a comprehensive contextual understanding of the knowledge which is presented.

Both shelf view which enables views of files and knowledge resources in standard formats such as pdf/ jpeg etc, as also hyper media views with inbuilt hyper links, crosslinking other knowledge resources and content, are made available in the portal.

10. Innovative aspects of your project/activity.

The system uses intelligence for **Profiling of Users and Adaptive Presentation of Content**

Embedded system modules analyse and profile users visiting the portal on the basis of (a) the preferences and options entered by them in the course of interactions with the system, (b) their responses to the system generated messages and (c) on the basis of automated information capture relating to their browsing habits, relying on the pattern of interactions performed by the users in seeking and accessing information presented in the portal.

Such profiling is performed to (a) enable adapt the presentation of information and resources that can be of use to the user, during his sessions with the system as also to (b) engage him through messaging or emails to bring to his attention any content updations/ additions that could be of interest to him.

Secondly, on **Content Authoring - Upload and Revision,** the Portal is designed with an authoring system that enables any user, to upload and revise contents. An editorial review process that can be invoked takes care of validation and authentication of any uploads or revision of contents, to ensure that they are appropriate, relevant and of acceptable quality, prior to the publication of such uploaded or revised contents in public domain.

Appropriate acknowledgement is inbuilt in publishing content with the recognition, identification of sources of contents that are published. Authors or Users who revise or upload content have the option of identifying themselves. The default mechanism that is built in, is the capture of the IP address of the user/author as the case may be. Wherever possible, links are also given pointing to the original source of the content.

Authors and contributors are also given the option to identify themselves optionally while expressing providing their feedback or comments, in respect of any changes that are suggested or made to the content. Appropriate tracking, logs or recognition are maintained and published in the system in respect of any content that is presented in public domain.

The system maintains a log of revisions/ changes as also drafts of earlier versions of a knowledge resource or content in the portal in the transactional space or if it is older than a year in the archival space.

While the Indiaskillpedia Foundation comprising of members from the science and technology councils and skill mission teams subscribe to the principle that knowledge should be freely accessible, on several occasions there is a need to invest time and effort to ensure quality of content and also respect the intellectual property and ownership of original content of the author and acknowledge such intellectual property. Hence, contents are also tagged as free content, premium content, content under review or those shared and transacted only within the members community of Indiaskillpedia Foundation in the transactional domain until any issues related to such content are resolved prior to placement in the public domain.

On the m**otivation for Content Contributors and Authors, -** while contribution of knowledge resources is a voluntary act anchored on the principle of free access to knowledge and empowering others to leverage knowledge for livelihood, prosperity and progress, significant levels of contributions are recognized with Awards and Honorarium based on the recommendations of an expert panel from time to time. A list of exemplary and outstanding levels of contribution will also be publicized in the portal.

Other challenges relate to the development and evolution of the software solution and portal application with the required maturity encompassing aspects such as those undermentioned.

- Developing features/ functionality to handle multimedia data / knowledge resources
- Relying mostly on open source code for building functionality and features
- Leveraging technologies and methods to enable render content related to drawings, animations, videos, raster images/ graphics and vector models
- Presenting dynamic link layout, pages and content adapted to profile of the user
- Analysing usage pattern, predicts and presents relevant content employing appropriate pattern recognition and type casting of users
- Employing multiple presentation and navigation styles- a knowledge repository style of presentation as well as augmented presentations with a hyperlink based authoring and navigation style.

- Embedding Analytics and intelligence in the portal solution architecture and software application
- Employing mechanisms for triggering of communication through SMS besides webpage refresh and presentations, tool tips, context help, evidence based drill down/ traces, cross references, interactive content, leveraging enhanced and enriched cognitive techniques of compilation of resources and associated automated routines.
- Control command structure within the solution framework employing – SCADA (Supervisory Control and Data Acquisition) type mechanisms to ensure that every user is uniquely onboarded and engaged on the basis of his profile, navigation parameters and session stats to ensure that his experience with usage and access of contents is enriched.

11. Characteristics of the solution implemented - governance dimensions and practices

The idea that has been realized in indiaskillpedia Portal is guided by the objective that enriched knowledge resources should guide the technopreneurs in taking informed steps in establishing his startup, engage in production or service delivery, deal with ip issues and sustain in such endeavours.

It is a knowledge repository targeted to cater to technopreneurs, skill aspirants wanting to be self-employed.

- The system relies on distributed data uploads and crowd sourcing approach
- The portal solution leverages a black board architecture, which forms the broad guiding framework for decision support and actions
- Content validation process flows for editorial reviews prior to publishing in public domain is inbuilt as a mechanism to ensure quality assurance and authentication of content
- The application is geo- location sensitive for adaptive profile based info & link layout display
- The system leverages and evolves iterative advanced functionality and features such as those mentioned below, for augmenting user experience and pre-empting responses adapted to users expectations
    - embedded intelligence - cues, messaging, presentation of links, cross referencing & context help for users
    - evidence & context based data capture,
    - drill down traceability,
    - tool tips, navigation aids, bread crumbs etc
- Focus is on evolving a robust platform and application that presents an appealing and easy interface for motivating and imparting confidence to skillaspirants, jobseekers, techpreneurs and startups
- Provides users insights on concrete actionable pursuits for design, development of products & services, institute systems for operations and commencement of production of goods, products manufacturing or delivery of services
- Nature of Contents to be sourced, transacted and delivered on indiaskillpedia includes details of technologies, machinery, products, materials, - descriptions, drawings, specifications, operations, properties, functions , installation, calibration etc
- The target group for indiaskillpedia portal is well defined– startup guys, entrepreneurs, technology enthusiasts, IP practitioners, innovators, professional, young skill aspirants. Content will accordingly be sourced, compiled and deployed under appropriate links with

relevant cross references and navigation links for related topics presented alongside main topics

- Usage and functionality are intuitive and presented with clarity especially concerning disclaimers, rights, expectations, services etc
- Evidence & context based data capture, drill down traceability, tool tips, navigation aids, bread crumbs etc are built in the application
- GIS based schematic mapping – with location scenarios on maps and interactive features are integrated
- Dynamic analytics, feedback and system responses for closing the loop on actions performed is monitored
- Simplified two step process flows is adopted for online transactions and process automation routines
- Hyper dimensional –configuration module is built in and customized to needs of user groups
- Intelligent algorithm is employed – for the purpose of meta data capture and management, content invocations and management & association of contexts
- The application has inbuilt data retirement rules for archival of past data

Engaging Content Authors and Sourcing Resources

- Crowd sourcing model is employed
- Content sourced from wikipedia, public domain blogs, posts, and from resources shared in websites/ portals. Relevant contents are identified and sourced to be presented with relevant metadata and due acknowledgements
- For content which authors require some form of remuneration for enabling use of their intellectual property, appropriate mechanisms has been instituted /embedded in the portal which implements methods that provide such remuneration/compensation
- Ingenious methods require are adopted which incentivize content sharing, variants of models are experimented with and evolved with experience
- authors and contributors are presented with feedback on how their content is viewed or accessed to motivate them in contributing and sharing contents in public domain for the purpose of promoting Indian economic engine
- Repurposing existing content available with Govt. agencies are pursued with relevant agreements/ MOUs or understanding with such agencies
- Structuring the appeal, soliciting content contributions, conceptualizing incentives, recognition of contribution are undertaken by a back end team
- Facilitating content compilation, deploying authoring systems, mechanisms for validation/ refinement of content, indexing / cross referencing and knowledge capture routines are constantly improved on the basis of performance indicators and metrics
- Incorporating feedback on quality to enable improvements and employing closed loop contraptions to trigger content quality improvements are being attempted.

Extensive Outreach and Engaging Stakeholders

- Successful content sourcing, enrichment and its usage will require extensive outreach strategies and promotion
- Mechanisms that are embedded include and encompass;
    - *Messaging* - triggers on events for sending out messages, standardizing templates for messages, customizing and personalizing messages

    - *Embedding intelligence* - which profiles usage and improving user experiences through adaptive presentation of links, layouts and content
- Government agencies are encouraged to take ownership or be a strategic partner to ensure that existing content available in various MSME establishments, District Industry Centers and public funded organisations are placed in public domain.

Automation of Information and Services Delivery

- Progressively, depending on the consent or willingness of the collaborating partners, the platform can enable technology transfer, licensing, IP lease agreements in the form of some facilitated mediation.
- The Portal will help disseminate information relating to various technologies that are available, the manner in which technologies can be acquired or scaled up, - associating appropriate partners. The portal provides a directory of technology related service providers with their profiles and experiences, so that industries can choose to avail services of such firms in their efforts to acquire, sale, transfer or upscale IPs/technologies.
- Industries can also pose challenges concerning the problems that they face in various manufacturing operations or in their efforts to upscale technology, explore solutions or validate and verify whether a given technology can be adapted to serve their problems. Such challenges can be viewed by industries, R&D Organisations and Academic Institutions and responded to with appropriate suggestions, solutions, methods or actions pursued for partnering with stake holders for required problem solving.
- The system functionalities will be developed to facilitate the presentation of challenges faced by industries, while enabling academic/ research institutions and consultant organizations to support and provide solutions to such challenges leveraging technological innovations and progressive management strategies. Collaborations across academic, R&D institutions and industries would enable better sharing and exchange of know-how and leverage patents / technology for developing appropriate solutions.
- Organizations in strategic sectors like Space, Atomic Energy, Defense, Infrastructure, Energy, Ecology and Environment etc, as also industries can provide details of technologies that have been developed by them in the course of their operations and R&D efforts, in the form of a shelf of technologies.
- Such technologies as have been presented may be acted upon by industries seeking to source technologies to expand on business opportunities, or seeking solutions to their problems/ challenges to meet their requirements. Efforts can thereafter or concurrently be pursued in respect of the following;-
    - evolving technology solutions or landscaping of relevant technology
    - intensifying and converging efforts for indigenization, import substitution and development of technologies
    - pursuing strategies for augmenting capacity to design, manufacture, manage operations, mitigate risks and sustain business
    - accelerating efforts for the design and manufacturing of products and services

12. Details of coverage of the targeted population.

Indiaskillpedia portal is a companion to the skillyoungindia.com portal which engages skill aspirants and young entrepreneurs.

As could be seen from the dashboard / analytics presented in the home page of skillyoungindia, the system and associated database already has ~7500 skill aspirants, 41 training providers, 62 training courses, 1176 placements and 796 persons undergoing ongoing counselling

During registration of Skill trainees and counselling session, aspirants are introduced to the features of indiaskillpedia knowledge repository. All training providers are being directed to upload learning resources, knowledge content, lab and workshop exercises, as also associated manuals, handbooks etc.

During all workshops, events and meetings with industrial establishments, the need for more learning resources to enable skill aspirants and entrepreneurs acquire knowledge and be empowered is emphasised.

In the Science and Technology Councils, all researchers are encouraged to upload the nature of their research, its benefits to the community and demystify science and technology in a manner that they could be understood and made use of by community youth and elders.

In gram sabhas, nagar panchayat and gram panchayat meetings - brochures and pamphlets are being distributed on the use of skill pedia knowledge repository.

Integrating and presenting analytics dashboard and profiling information on users / visitors are being attempted.

13. Comparison of the pre-deployment with post-deployment scenario.

Knowledge resources available for young professionals, skill aspirants, entrepreneurs and startups are not available from a single source. Different Govt agencies, organisations who promote SMEs, incubation, start ups, entrepreneurs and provide skill training adopt different ways of engaging the target community.

Physical meetings, workshops, conferences involve excessive costs and bulk of the potential target population who require to be reached out to, do not get an opportunity to attend them and be benefitted.

With the internet, smart phone usage spreading fast and bandwidth/ connectivity being extended to even villages and rural areas, the internet based deployment is a feasible and potentially benefitting approach. Contents deployed online are now accessible on any device and computer system.

The State Goverment Departments have also put up internet kiosks, citizen facilitation centres, incubation centres, where computer systems with internet connectivity enable browsing and provide access to knowledge sources that are deployed in the internet cyber space.

While google and other search engines and online knowledge sources provide useful information, the difficulty with such public domain resources are that they are not organised. Effort is required to collate, compile, research and cull out the required information.

The intuitively designed layout structure and organisation of content in the online indiaskillpedia portal knowledge repository would facilitate ease of access to the required knowledge source.

Further extensive cross referencing and links to other relevant knowledge resources provided in the portal would be useful to the target community.

14. Benefits of the solution implemented.

The Portal would provide extensive resources in the form of learning and knowledge resources, case studies, videos, technology reports, training materials, feasibility reports, impact studies and such other reference material that would be of use to the individuals and organisational entities.

Various events relating to workshops, training, conferences and other events which would help in information dissemination and networking, while providing opportunities to industries for exchange of perspectives and partnering would also be made available on the Portal.

Information and details relating toschemes and programmes offered by multiple Government, Ministries and Departments are now seamlessly integrated in a contextual comprehensive framework or reorganised appropriately as a one stop destination for access to such details. This can significantly benefit entrepreneurs, industries to establish themselves, venture to implement their ideas, harness technology, enhance productivity, reinforce and augment their capacity or leverage such other forms of assistance to grow and contribute more effectively in the manufacturing sector.

The services provided in the portal is targeted at assisting indian industries (local, national & indigenous manufacturers, SMEs) identify, reach out, profile and augment their capability and capacities. Such services may be in the nature of strategies, opportunities, models, mechanisms and pathways that would facilitate meeting their requirements for technology development, indigenization etc leading to growth, prosperity and sustainability.

The portal would serve as a collaboration platform to engage Knowledge Management Partner Institutions (KMPIs) and service providers who facilitate the process of technology acquisition, licensing, transfer, intellectual property management, legal consultations/ negotiations, consulting for technology landscaping, evaluation of patents for freedom to operate, contracting, arbitration and dispute resolution etc

As part of an evolving paradigm, the indiatechpedia portal will progressively embrace a design to implement manufacturing focused ERP Solution on the Web which will serve as a mechanism to ;

- Engage R&D organisations, strategic sector, industries & academic institutions.

- Pose and address technology related problems and challenges that presents opportunities for manufacturing in various domains, o Evolve strategies, solutions, approaches, methodologies and pathways for development of technologies, o Engage and facilitate manufacturing companies, MSMEs in the production and manufacture of products and services leveraging technologies developed.

- Facilitate buyers to meet sellers of manufactured goods and services, o Avail consultancy/ advisory services related to patent evaluation, technology profiling, technology acquisition or legal assistance,

- Partner with other firms in system assisted, mediated negotiation and facilitation to reach agreement on sale or purchase of technology, technical / management services or support to build capacity for manufacturing.

- Whenever required, industries can search the portal, locate a suitable technology/an ideal R&D partner and forge a relationship. Companies can also keep feeding their current research focus areas and requirements for specific research resource from the Universities/Public Funded Research Institutions. Interested experts when coming across any specific industry requirement that matches their area of expertise and interest will then be able to contact the company directly and build the relationship.

- Such a measure is expected to benefit the Universities/Public Funded Research Institutions tremendously as existing IPs can be readily licensed to the industry, thus avoiding additional investment in time and associated risk.

15. Public Access

- As the portal is in public domain and hosted in the Cloud Infrastructure, it is accessible by any user who has an internet enabled computing system or device.
- Specifically, the critical success factor is the extent of onboarding, involvement, participation and contribution by the community of knowledge workers, researchers, industries, government agencies, consultancy establishments, training providers and technology enthusiasts to upload contents and be committed to improve the quality of content that is deployed to benefit the community of entrepreneurs, skill aspirants, startups, industries, village communities and professionals.
- Models like wikipedia have shown that individuals do come forward with a societal commitment and share knowledge that is useful to others.
- The network of Science and Technology Councils in the States and Skill Mission Teams can also actively partner to upload and update content that will be increasingly useful to communities at large.
- The skill india, make in india, women empowerment, SME focus, thrust to manufacturing and other initiatives are all aimed at making our Nation more progressive, prosperous, self-reliant, inclusive and empowered.
- With the demographic advantage of having a large youth population and extensive penetration of internet and mobile technology, the onboarding / usage and increased collaboration and networking would flow in its natural course. Such process can be further accelerated with the use of social media, advocacy, promotion etc.
- Mobile applications being developed to interface with the indiaskillpedia is another initiative being taken up along with the extensive use of social media like facebook, twitter to ensure better outreach, access, replicability in terms of onboarding and usage.

16. Services envisaged in IndiaTechPedia.com portal

I. Access to Knowledge& Sharing Expertise

Sharing Knowledge and Domain Expertise

Access to Learning Resources, Course Structure,

Support for Learning progression
Features and facilities for Knowledge Dissemination
Metadata specification
Search services to locate, access and preview, read or download knowledge resources

II. Training &Assessment of Competencies

Training Design
Lesson Plan & Outcomes
Training Partners
Tools and Techniques for Assessment of Knowledge and Competencies

III. Networking and Collaboration

Connecting with other experts and resource persons

IV. Consultancy & Directory Services

Opportunity to Promote consultancy services
Directory Services, Catalogs, Product & Service Guides
Offering Mentoring or Apprenticeship Services
Location aware services to connect with mentors, resource persons
Analytics and Decision support services

V. Products and Services

Online Sale of Products and Services

VI. Professional Development

Membership Application in Professional Bodies
Resume Building and References
Job References
Tools and facilities for practicing a profession
Know How to produce goods, manufacture products and deliver services
Consultancy for Career options, Pathways and proficiency upgradation

VII. Production, Processes, Product Design / Development& Manufacturing

Ideas, Incubation & Innovation
Iterative Product Design , Evolving specifications
Standardization of products and services
Methods for production, packaging, componentizing, modularity of design and packaging
Material specification, use of alternative materials,
Tests for meeting structural or functional specification
Standardization of Design, Products and Services
Drawings of parts, components, products, assemblies
Assembly or Dis-assembly of tools, fixtures, product assemblies
Working or operating principles of machinery, processes
Standard Operation Procedures for production/ manufacturing, testing, assembly,

VIII. IPR & IP Management

Processes for Patenting, TM, GeoIndication and Designs
Consultancy for IPR and IP Management

IX. Operation Management & Service Delivery
Lean and flexible Operations

X. Systems Design and ERP for Decision Support
Business Process Modelling
ERP Solution Architecture
Process Automation
Decision Support
Configuration Management
Interoperability
Manageability, Sustainability

17. Sustaining the Initiative

- Emphasizing focus on Open knowledge
- Need for empowering and handholding skill aspirants, potential entrepreneurs and start-Ups
- Clarity in Principles/ Policies for Operation and Management of the Knowledge Repository
- Continuous Innovation and Updation of features, content and behavior of the application
- Leveraging Promotional Events

18. Research Dimension

- The project initiative leverages a Research focus to make continuous improvements in mechanisms/ methods for- knowledge Capture/ Representation, Intelligent systems and Cognitive approaches for enriching learning experiences for skill promotion, entrepreneurship development and hand-holding with start-ups
- Embedded mechanisms, automated processes for content compilation, indexing & cross referencing knowledge elements, organization and structuring knowledge, characterizing content and extracting metadata.
- Evolutionary Algorithms to capture nuances and parameters which depict human-system dynamics
- Developing paradigms, mechanisms, algorithms with self-learning/ adaptation properties along transient temporal/spatial dimensions, - and evolve cognitive models of knowledge exploration habits of users for enriched presentation of contents
- Conceptualizing Contraptions for Embedding trigger events at various points of human engagement of the system during their interaction sessions and leveraging them for enriched learning experience in users