# ANNUAL REPORT
# (2020-21)

*Submitted to:*

SSTP DIVISION,
DEPARTMENT OF SCIENCE AND TECHNOLOGY
GOVERNMENT OF INDIA
TECHNOLOGY BHAWAN
NEW MEHRAULI ROAD, NEW DELHI – 110016

*Submitted by:*

SIKKIM STATE COUNCIL OF SCIENCE & TECHNOLOGY
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P.O. DEORALI, GANGTOK, EAST SIKKIM - 737102

Annexure-I

# Progress Report 2020-21

## SIKKIM STATE COUNCIL OF SCIENCE & TECHNOLOGY.

1. NAME OF SECRETARY
CUM-MEMBER SECRETARY- **Shri B. P. Pradhan, IFS**


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-CUM-
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Science & Technology,
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# INTRODUCTION

The Department of Science & Technology was created in year 1996. Major activities of the department constitute for promotion of Science & Technology relevant to the State, generation of awareness, Research, Development and Transfer of Technologies through public interface, Research Scholars, Educational Institutions (Schools/colleges/Universities/R&D institutions), Government and non-Government agencies involve in the various fields of Science & Technology.

As per Government of India mandate, the Sikkim State Council for Science & Technology was created during 1997 as an autonomous body with the primary objective on expediting decision making process through reduction of time consuming decision making process and cutting the administrative procedures being followed under Government Departments.

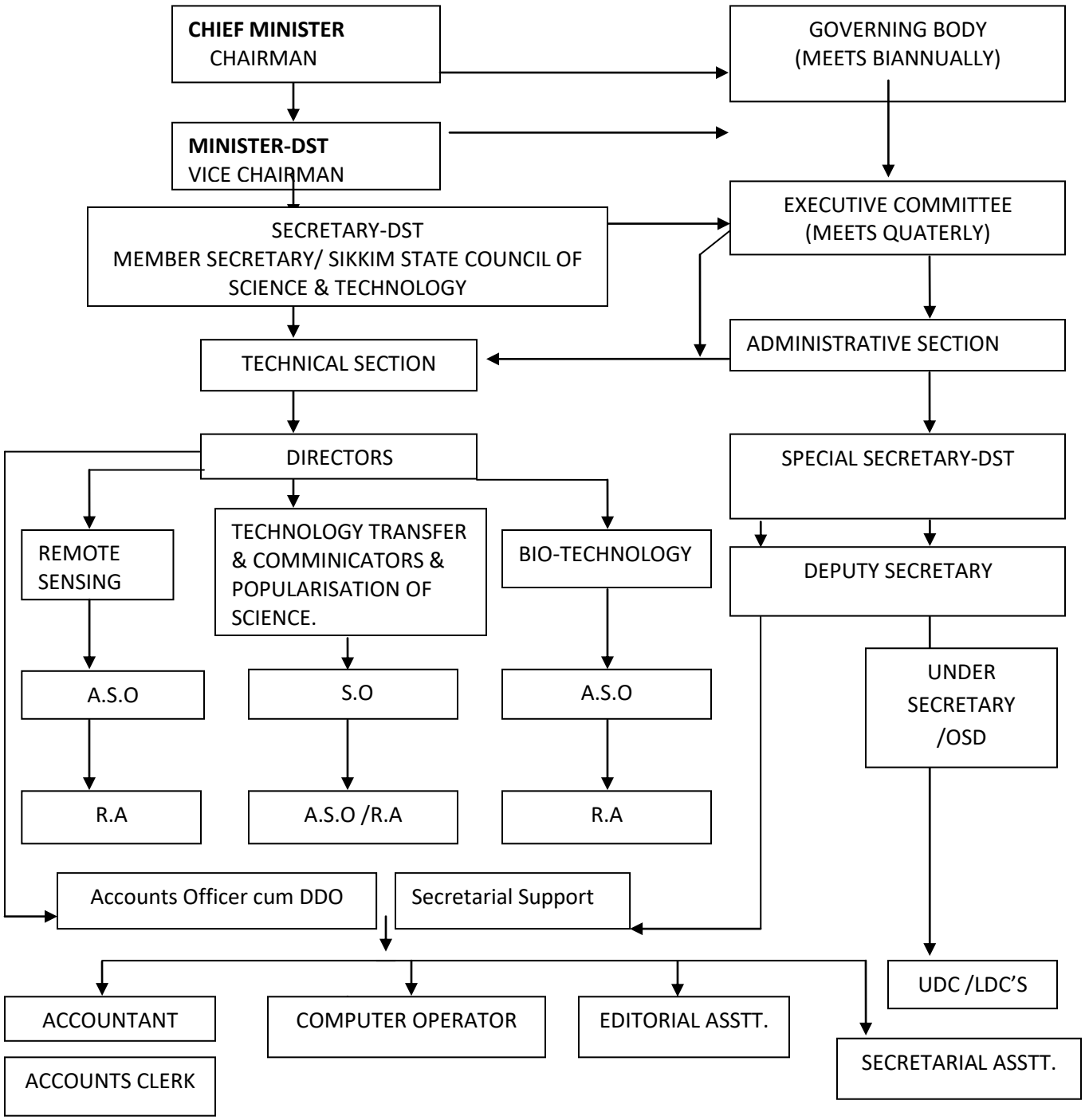
The State Council is an autonomous body registered under society act and managed by Governing Body with the Hon'ble Chief Minister as its Chairman and Hon'ble Minister for Science & Technology as Vice- Chairman and Secretary, DST&CC as Member Secretary. Apart from this line Department like Agriculture, Horticulture, Animal Husbandry/ Mines, Mineral and Geology/ Forest, Environment and Wildlife Management/Rural Management Department members are also drown from various scientific agencies of the Government of India

All major activities on promotion of Science & Technology are being undertaken by the Sikkim State Council. The DST&CC is administrative department to supervise the activities of the Council including implementing the programme/ Schemes/Policies of the both Central and State Governments.

Keeping in view the importance of Science & Technology for overall development of the state and with a view to provide sufficient autonomy for implementation of various scientific programmes, The department has taken up through the Council various scientific programmes related to (i) Bio-Technology (Bioinformatics & Tissue Culture, Medicinal Plants, Scientific programme on Planting Stock Improvement; Establishment of Sikkim Biotechnology Research and Application Centre) (ii) Glaciers and Climate Studies (iii) Environmental Information System; (iv) Patent Information Centre; (v) Remote Sensing and GIS; and (vi) Technology Transfer and Scientific Awareness, Capacity Building and Skill Development programmes. A full fledged Climate Change wing was added to the mandate of the Council in the year 2009.

1. **Structure of the Council:**
   a. **Date of Establishment: November 1997.**
   b. **Organization Structure**

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



**© Strength of approved Manpower (Both Central (DST) & State Support.**

**CORE MANPOWER OF SIKKIM STATE COUNCIL OF SCIENCE & TECHNOLOGY-2020-2021.**

| Name | Designation | Pay scale Upto June 2020 (Rs) | Pay scale from July 2020 (Rs) | Approximate monthly emoluments (Rs.) |
|---|---|---|---|---|
| Shri B. P. Pradhan, IFS | Member Secretary | | | |
| **Supported by DST,GOI Grants-in-Aid** | | | | |
| Shri Suman Thapa | Scientific Officer | 77700 | 80000 | 1,09,600.00 |
| Shri Nabeen Sharma | Research Assistant | 35200 | 36300 | 50,231.00 |
| Shri Dadul Lepcha | Accounts Clerk | 31300 | 32200 | 44,614.00 |
| Shri Rajdeep Gurung | Sr. Research Asst. | 37,100 | 37,100 | 51,327.00 |
| Shri Laydong Lepcha | Sr. Research Asst. | 37,100 | 37,100 | 51,327.00 |
| Dr. Sushan Pradhan | Sr. Research Asst. | 37,100 | 37,100 | 51,327.00 |
| Shri Radha Kri. Sharma | Sr. Research Asst. | 37,100 | 37,100 | 51,327.00 |
| Shri Pranay Pradhan | Sr. Research Asst. | 37,100 | 37,100 | 51,327.00 |
| Shri Tseten Pradhan | Sr. Research Asst. | 37,100 | 37,100 | 51,327.00 |
| Mr Pravakar Gurung | Research Assistant | 33,700 | 33,700 | 46,669.00 |
| Mrs Binita Shrestha | Research Assistant | 33,700 | 33,700 | 46,669.00 |
| Ms P. Pradhan | Research Assistant | 33,700 | 33,700 | 46,669.00 |
| Ms. Ongkit Lepcha | Editorial Assistant | 25,400 | 25,400 | 35,750.00 |
| Ms Pema Z. Lepcha | ASO | 20000 | 20000 | 240000.00 |
| **Supported by State Grants-in-Aid** | | | | |
| Shri Bhasker Gurung | Peon | Fixed | - | 9,300.00 |
| Mrs Yden Bhutia | Peon | Fixed | - | 9,300.00 |
| Ms Bashanti Rai | Peon | Fixed | - | 9,300.00 |
| Shri Shrep P.Dong | Peon | Fixed | | 9,300.00 |
| Ms Puja Pradhan | Peon | Fixed | | 9,300.00 |
| Shri Arpan Lepcha | Peon | Fixed | | 9,300.00 |

## LIST OF PROJECT STAFFS

| Sl. No | Name of Officials | Designation |
|---|---|---|
| 1 | Ms. Zamyang P. Bhutia | Scientist 'B' |
| 2 | Dr. Bhusan Gurung | Research Assistant |
| 3 | Ms. Bhawana Chetrri | Project Scientist |
| 4 | Ms.Yangchenla Bhutia | Project Assistant |
| 5 | Ms. Priya Darshini Gurung | Project Scientific |
| 6 | Mr. Sarauv Ghimery | Field Supervisor |
| 7 | Mr. Niraj Sharma | Information Officer (ENVIS) |
| 8 | Mr. Arpana Thapa | Project Assistant |
| 9 | Ms. Tseten Chung Lachungpa | D.E.O (ENVIS) |
| 10 | Ms. Palmu Bhutia | I. T. Officer/GIS (ENVIS) |
| 11 | Mrs. Deepa Rupa Sharma | Project Assistant |
| 12 | Mr. Sundeep Chettri | Research Assistant |
| 13 | Ms Rinkila Bhutia | Project Asst. |
| 14 | Mr. Yuwa Raj Century | Field Asst. |
| 15 | Dr. Smriti Subba | Project Coordinator |
| 16 | Ms. Sushnim Golay | Field Worker |
| 17 | Mr. Kishore Psd. Sharma | Project Asst. |
| 18 | Mr. Dup Wangyal Tamang | Project Asst. |
| 19 | Mr. Udai Biswakarma | Field Worker. |

2. **Budget allocation to your State S&T Council for last five financial years including central government, State government & any other sources.**

**(Amount in lakhs)**

| Sl. No | Financial Year | State Govt. Grants in Aid | Central Govt. Allocation | Other programmes (State) | Remarks |
|---|---|---|---|---|---|
| 1 | 2019-20 | 35.00 | 104.63 | a) Technology Transfer: 20.00<br>b) India Skillpedia: 20.00 | Received |
| 2 | 2020-21 | 15.00 | 78.00 | a)Science Awareness: 15.00<br>b)Sikkim Science Centre: 10.00<br>c)State Remote Sensing Center: 15.00<br>d)Technology Transfer: 5.00<br>e)Biotechnology App. Center: 5.00<br>f)Sikkim Himalayas Study: 50.00<br>g)Intellectual Property Right: 10.00 | Fund not released due to COVID related austerity measures. |
| 3. | 2021-22 | | Proposed for salaries | | |

3. Key activities under taken during the last two years in the area of :

**a) BIO-TECHNOLOGY-DIVISION:**

**Virus indexing for production of virus free large cardamom planting material**

Large cardamom in infested with two viral diseases namely 'Chirkey' and 'Foorkey' from the time immemorial. The practice of plant propagation and cultivation through division of plant further multiplied the virus to the newer locations. The viruses are further transmitted to uninfected plants by aphids. During such courses, it is assumed that more than 70%-80% of large cardamom plantations are already infected by these two viruses. The recent study also revealed that more plantations are already infected by these viruses as it was found that the asymptomatic and healthy plants are virus infected. The virus remains in the latent or dormant phase but can show symptoms anytime in future due to various physiological and environmental factors. Normally, there are two methods of detection of plant viruses, one is ELISA and another is by RTPCR. In case of large cardamom, no ELISA testing kit has been developed commercially. Further, viral load at very minimal, as in the above case, cannot be detected with this method. RTPCR is another method of viral detection. The development of RTPCR method for detection of each specific virus involves long and tedious process. Whole genome sequencing, identification of highly conserved region, primer designing, RNA extraction, cDNA synthesis, standardization of RTPCR conditions, sequencing, BLASTn etc. are some of the major process needs to be developed. Some of the previous scientists have worked on these viruses at molecular level to develop such protocol. Scientists at molecular biology laboratory, Department of Science and Technology, Government of Sikkim have standardized the protocol for detection of both 'Chirkey' and 'Foorkey' virus even at very low viral infection. Significant findings have been made in which healthy and asymptomatic plants also showed virus positive result. The isolation of viral RNA and PCR plays an important role in detection of low viral load which has been developed indigenously.

**Barcode study of large cardamom:**Barcoding of plants have its own significance which may be resolving the morphologically controversial species or application in the development of new breed having higher vigor. Barcoding of large cardamom at the intra-specific level not only helps to resolve the cultivars at molecular level but also helps to understand the genetic distance between them. Two bacode loci recommended by world barcode organization for plant have been used to resolve the cultivars and understand the genetic relatedness between them. It will be helpful to combine the distantly related cultivars to get the new variety having higher vigor. Ten(10) gene sequence of large cardamom popular cultivars namely, *Seremna, Varlangey, Dzongu, Green Golsey, Sawney* is sequenced and submitted to

NCBI GenBank. Two barcode gene region i.e. matk and rbcL gene of five cultivar is submitted. The diversity study at molecular level enables us to understand the genetic distance amongst the cultivars. It gives insight into how these cultivars are closely or distantly related to each other. This not only helps us to know the evolutionary relationship but also helps in combining the genetic traits of distantly related cultivars to produce of hybrid with hybrid vigor. Like, for example, it was presumed that a new cultivar, Seremna, originated at Hee-goan, West Sikkim is closely related to Dzongu or Green-Golsey on morphological observation. But, genetically, it was found to be closely related with Varlangey cultivar. In such a case a cross between Seremna with Green-Golsey or Dzongu may results in hybrid with higher hybrid vigor as they are distantly related genetically. Publication of this finding is made.

**Molecular characterization of fungi associated with blight disease of large cardamom**

Large cardamom is infested with fungal disease and is responsible for decline in production and degrading the quality of the finished product. Molecular characterization of these associated fungi is needed to find the new associated fungus which may be responsible for causing the devastating disease. The gene sequence of two fungus associated with large cardamom were sequenced and submitted to NCBI GenBank. The gene sequence of *Collectotrichum gloeosporiodes* and *Phyllosticta capitalensis* were submitted. The former is considered as main causal organism of large cardamom blight disease whereas later is the new finding associated with the same disease. The findings are published in Journal of Research in Agriculture and Animal Sciences, USA.

**Intellectual Property Rights**

Sikkim State Council of Science and Technology is notified as state nodal agency for Intellectual Property Rights of Sikkim.

- Registered a rice variety under Protection of plant variety and farmer's right developed by a local farmer.
- The GI filing works a large cardamom variety and Sikkim Temi Tea through GI attorney was done.
- 08 (eight) IP cells established in various universities and colleges. Asked to generate awareness and patent through micro-financing of projects.
- Notified Sikkim State Council of Science & Technology as Nodal Agency of IPR in the state through Government Gazette notification.

**Future plans:**

- Develop an ecosystem of inventions, innovations, patenting through the support of State Government and funding agencies.
- Create success stories of inventors through successful transfer of technologies/licensing, to encourage more innovations and inventions leading to patent, licensing.
- Encourage and facilitate design, logo, copyright, trademark, GI registration, farmer's variety of all identified potential products in the state, to protect their intellectual property.
- Generate good amount of awareness among the masses on protection of intellectual property rights through publications, workshops, outreach programms, digital and print media.

**Molecular docking study of potential inhibitors to bind spike (S) proteins 2AJF of SARS CoV and 7A93 of SARS CoV-2**

Outbreak and spread of COVID-19 viral disease has escalated severe health issue globally. With no specific medicines being recommended till time, the analysis and discovery of potential pre-drug molecules available in the line is very important. For a successful discovery of drug medicines, identification of potential ligands interacting to the binding site of catalytic pocket of receptorenzyme is very important. The study selected 34-drug molecules associated with Asthma and Pneumonia ailments and docked with spike (S) proteins 2AJF of SARS CoV and 7A93 (Glycoprotein) of SARS CoV-2. As per the results of computational analysis, the study found that two of the inhibitors molecules, Ciclesonide and Unii-yxv28V1B07 (Ceftobiprole medocaril) are showing good binding interaction with the spike proteins 2AJF of SARS CoV and 7A93 (Glycoprotein) of SARS CoV-2.

**Research publications:**


1. Subba, K. B.*, Prof (Dr.) Mitra, P.K. and Dr. Basistha, B.C. Molecular characterization of large cardamom cultivars using *mat*K and *rbc*L genes. Journal of Biotech Research, 2021: 12:106-113.
2. Laydong Lepcha* and Bharat Chandra Basistha (2021) Molecular docking study of potential inhibitors to bind Spike (S) proteins 2AJF of SARS CoV and 7A93 of SARS CoV-2. Journal of Computational Intelligence in Bioinformatics (JCIB). Research India Publication. Volume 14, Number 1 (2021) pp. 1-20.

3. Subba, K. B.*, Prof (Dr.) Mitra, P.K. and Dr. Basistha, B.C. First report of *Phyllosticta capitalensis* as one of the associated fungus of blight disease of large cardamom. Journal of Research in Agriculture and Animal Sciences. Vol. 8-Issue 6 (2021) pp: 50-52.

***Conducted three days hands on training on Agro technique of large cardamom to progressive farmers of Sikkim***

Three days hands on training ***on Agro technique of large cardamom*** was organized to 30 progressive farmers of Sikkim. Fifteen large cardamom progressive farmers were from Dzongu, North Sikkim, followed by ten and five farmers were from Dalapchand and Rumtek, East Sikkim. Hon'ble Minister Department of Science and Technology (DST), Shri Karma Loday Bhutia was the chief guest of three days training programme. Shri K.C. Lepcha, Secretary, DST, Shri D.G. Shrestha, Director, DST, Shri Dorjee Bhutia, Director, DST and Shri Suman Thapa, Joint Secretary, Sikkim State Council of Science and Technology also attended the training programme. Hon'ble minister interacted with the trainee farmers, and inquire them what they have learnt during the three days training programme. Hon'ble minister visited all large cardamom fields and nurseries. In his speech he said such types of training will help in solving lot of technical problems of farmers, which will help in cultivation of large cardamom scientifically.

**Phytchemical analysis large cardamom seed:**

Large cardamom has lot of therapeutic properties and cured lot of human diseases traditionally. Actually, it is highly potential medicinal plants having lot of bio-active chemical constituents which cured human diseases. To know about the phytochemical components of large cardamom cultivars of Sikkim Himalaya. A phytochemical analysis investigation work is started of all cultivars found in Sikkim.

**Academic achievement:**

I. Ms. Januka Pradhan from Sikkim Manipal University under the Guidance Dr. Joshna Chettri and Dr. Sushen Pradhan, Sikkim State Council of Science and Technology.
II. One B.Sc. student from Sikkim University completed project on large cardamom under the supervision of Dr. Sushen Pradhan, Sikkim State Council of Science and Technology.

## 4. Key activities& Success Story:

### b) TECHNOLOGY TRANSFER DIVISION:

**Green Skill Development Programme – Wild Beekeeping and Processing**Organized by ENVIS RP Sikkim on Ecotourism, State Council of Science and Technology, Sikkim

**No. of Candidates:** 25

**Duration:** 200hrs

**NSQF level** **:**04

**4th March – 25th March 2021**

- Organised in Kaluk, West Sikkim for the duration of 1 month
- Training on Honey Beekeeping and Bee Hive like scientific bee box, clay Hive was taught with hands on training in the each and every trainee's village.
- Transfer of Bees from Traditional Beebox to Scientific Hive was taught during the training programme.






- Field visit to Tadong, Karthok, Ringchenpong and nearby GPUs were conducted to build clay hive in trainees houses.
- Out of 25 trainees 13 are already self employed in the field of Wild Beekeeping and Processing.



*Hon'ble Minister distributing Scientific Bee box to Trainees with Secretaries&Officials, DST*

*Group photo with Hon'ble Minister Shri. Karma Loday Bhutia, DST, Government of Sikkim*

**3.Key Activities:**

**c). REMOTE SENSING & CLIMATE CHANGE CELL:**

**Development of Forest Fire Spread Model using Satellite Remote Sensing Computational Fluid Dynamics (CFD), and Non-CFD models in Sikkim Himalayas using High Performance Computing (HPC) System**

This project is in collaboration with Indian Institute of Technology, Kharagpur and Centre for Development of Advanced Computing (C-DAC), Pune. Sikkim state council of Science and technology has key role for collection of field date for forest fire modeling.

**Characterizing Patterns and Processes of Alpine Ecosystem in Indian Himalaya, Studies on Harnessing Remote Sensing for Environment and Climate (SHRESTI)**

Due to lack of long term data available for alpine area in Indian Himalaya, Space Application Centre (SAC), Ahmadabad Department of Space, Government of India in collaboration with the Sikkim State Council of Science and Technology, jointly undertake the programme on Studies on Harnessing Remote Sensing for Environment and Climate (SHRESTI) in Sikkim. uner this programme Sikkim State council of Science Technology collecting the vegetation data of alpine area of Sikkim.

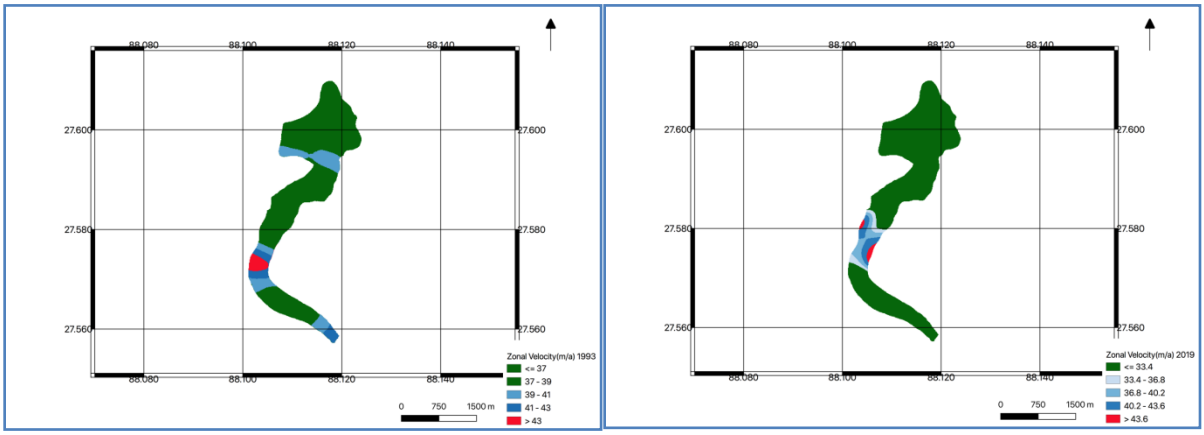
**Long-Term Monitoring on "Glacier Dynamics of East Rathong Glacier- Sikkim Phase II**

The project long term monitoring of " study on glacier dynamics of East Rathong Glacier" was sanctioned by SERB, DST-GoI in the year 2016 with the approved objectives viz. temperature indexed modelling, geodetic mass balance using DEMs, glacier hydrology, ablation measurements and vertical thinning, glacier surface velocity, snout monitoring etc. During this year following work was conducted;-

Estimation of Geodetic Mass balance of East Rathong Glacier using DEM Differencing: In the preliminary analysis the mean change in elevation was found to be 90m with average retreat of 1.9m per year in the period of 47 years from 1962-2009. It was also observed that in some areas of accumulation zone and near Equilibrium Line Altitude (ELA) zone there is increase in mass. The upper part of accumulation zone has higher mass gain with increase in elevation up to 102m.

However, the ELA areas had mass gain in an average of around 16m. Further, the statistical parameters are to be assessed to interpret the results accurately.

Study of Surface Velocity using Microwave Remote sensing based method: In Microwave Remote Sensing method the velocities have been estimated using the pairs of data for the year 1993 and 2019.




Zonal Velocity Distribution of East Rathong Glacier in 1993

Zonal Velocity Distribution of East Rathong Glacier in 2019

The velocity pixel profile has suggested that the average velocity in 1993 was around 37 ma $a^{-1}$ with standard deviation of 3.60 $ma^{-1}$ for the whole, area and in 2019, it was around 39$ma^{-1}$ with a standard deviation of 4.5 $ma^{-1}$. There is variation in frequency of pixels mostly due to two reasons, first being difference in pixel size i.e. for 1993 data from ERS 1 was used and for 2019 data from Sentinel 1 was used. The other is due to denser peak values for different range of pixel values.

**Technology Demonstration**

**1.Monitoring of Integrated Watershed Management Programme(IWMP)**

IWMP is a major project taken up by NESAC for entire North East India for the Department of Land Resources. The main objective of this project is to monitor and evaluate IWMP watersheds using Bhuvan Application (Srishti) involving high resolution IRS satellite. Watershed management is one of the key interventions for improving water resources and conserving soil in the rain fed areas of the country. Space technology with high spatial and temporal resolution satellite data is envisaged for effectively monitoring and evaluating activities under watershed management.

**2. National Wetland Inventory and Assessment (NWIA), Phase-II**

National Wetland Inventory and Assessment (NWIA), is a remote sensing based project, which catalogues wetland of India. The project was primarily started with the increasing importance of wetlands, for sustainable development.

Sikkim State Council of Science and Technology, handles the NWIA project for Sikkim, at the behest of the Space Application Centre (SAC), with the instruction from the Ministry of Environment, Forests & Climate Change, Govt. of India.

1. Wetland mapping and inventory on 1:25K scale using LISS-III for 2006-7 &, 2017-18 data.
2. Decadal wetland change analyses by comparing 2006-07 and 2017-18 LISS-III data.
3. Mapping of wetlands <2.25ha as point layer
4. Mapping and inventory of wetlands >0.1ha on 1:10K scale using LISS-IV data of Nov2016.

**3.Site suitability analysis under Coordinated Horticulture Assessment and Management using geoNformatics (CHAMAN) project (Phase-II)**

The Site Suitability analysis and mapping of potential areas for cultivation of **Kiwi fruit**s in **East District** of Sikkim under the guidance of Mahalanobis National Crop Forecast Centre.

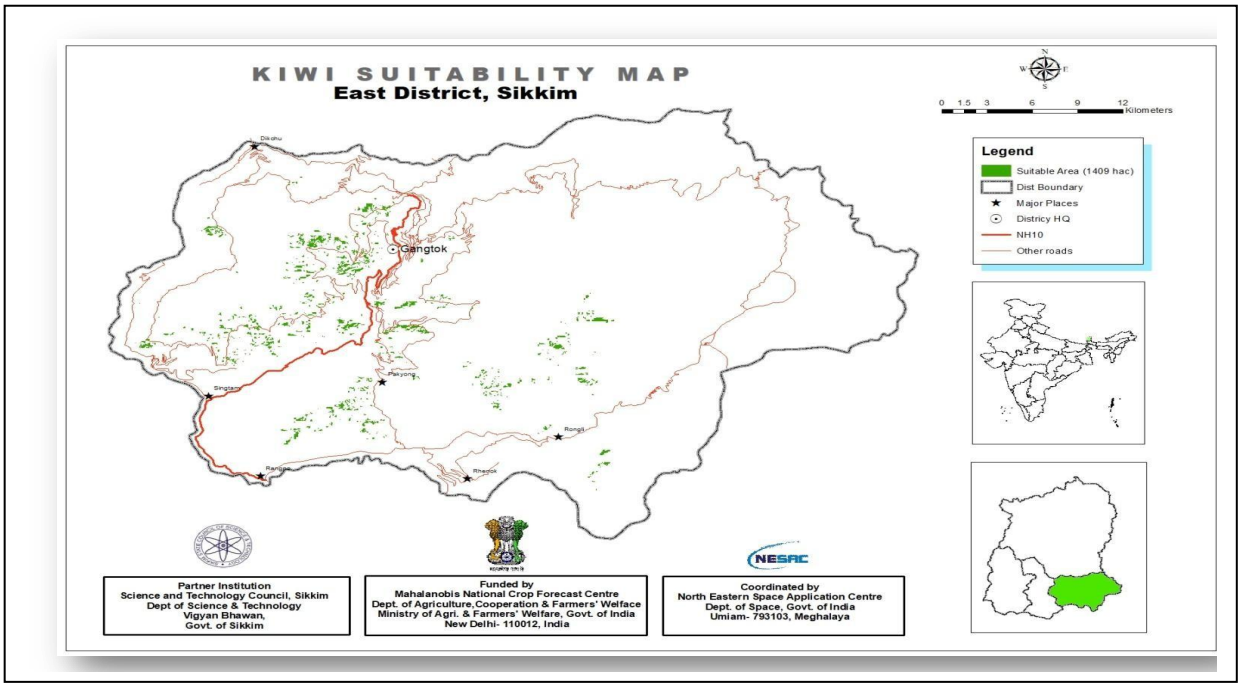



***Figure 3: Suitability map of KIWI Plantation, East District-Sikkim***

Total 1409 ha are identify for the suitable area for the cultivation of KiWi fruit in East Sikkim.

**Establishment of Sikkim State Climate Change Cell under NMSHE: Published Scientific Papers from State Climate Change Cell -Sikkim (under NMSHE) for period 2020-2021**

The NMSHE has provided the valuable support to the states in the development of vulnerability maps, awareness generation on the climate change, institutional capacity buildings and training of the officers. Most of the core objectives of the NMSHE project has been achieved however few needs to be carried out in the upcoming years. As the NMSHE focus on the building resilience to the climatic abnormalities and risks and development of field based knowledge on mountain ecosystem, the following recommendations has been made that can be useful in field the gaps and minimize the uncertainties and limitations of climate change adaptation.

i. In this project, vulnerability assessment is one of the important objectives of NMSHE programmes. Further sectoral vulnerability needs to be carried out to know the impacts and vulnerability in the key sectors like Forests, Water, and Agriculture etc. In course of time, assessment of Risk due to climate change is still required to have in-depth understanding of the Himalayan region.
ii. In Sikkim Himalaya, the limited high altitude observatories and inadequate research capacities on glaciers further add to the glacio-hydrological uncertainties followed by difficult terrain and harsh weather conditions. Therefore, it is necessary to build associations among the knowledge organizations to further enhance and strengthen capacity.
iii. Sikkim Himalaya an integral part of IHR that has many glaciers and snow dominated zones that have contributed to the Teesta river system. However the region falls under data deficit zone of eastern IHR. Therefore a dedicated 'Regional Centre for Glaciology' is felt necessary for detail understanding the response of glaciers and prediction of future changes in the glaciers and river flow.
iv. Awareness and sensitization programmes on climate change still need to strengthen with latest innovative programmes like street play, online awareness programme through Essay writings, quizzes etc.
v. The studies pertaining to East Rathong glaciers and South Lhonak glacial lake can be effectively used for the hydrological modelling of freshwater resources (Glaciers) and hydrodynamic modelling of glacial lakes respectively. This in-situ based result of data-deficient zone of Sikkim Himalaya is required to the hydrologists, scientists and policymakers for high altitude freshwater management under a changing climate. However comprehensive

understanding of glaciers and glacial lake dynamics at different climatic zones very crucial for the entire Himalayan region.

**Outcome**

- Kumar R, Sharma RK, Pradhan P, Sharma N, Shrestha DG (2020) Melt Runoff Characteristics and Hydro-Meteorological Assessmentof East Rathong Glacier in Sikkim Himalaya, India. *Earth Systems and Environment* 4:567-582. https://doi.org/10.1007/s41748-020-00168-4
- Sharma RK, Kumar R, Shrestha DG (2021) Suspended sediment dynamics and associated hydro-meteorological interrelations in East Rathong Glacier, Eastern Himalaya, India. *Material Today Proceedings*. http://doi.org/10.1016/j.matpr.2021.01.082

**Himalayan Aerosol Experiment @ SIKKIM**

The Himalayan Aerosol Experiment @ SIKKIM was started on august 2019 jointly by Space Physics Laboratory, VSSC, Trivandrum, North Eastern Space Application Centre (NESAC), Shillong and State Remote Sensing Application Centre & Climate Change Cell, Sikkim State council of Science and Technology. The laboratory for monitoring the aerosol properties is set up lachung (27.6891°N, 88.7430°E, 2700m a.s.l.).

**Space based Information Support for Decentralized Planning (SISDP) Phase II**

The SISDP phase II is in the collaboration with NESAC Shillong and NRSC Hyderabad the creation of LULD from the Cartosat imagery is under progress.

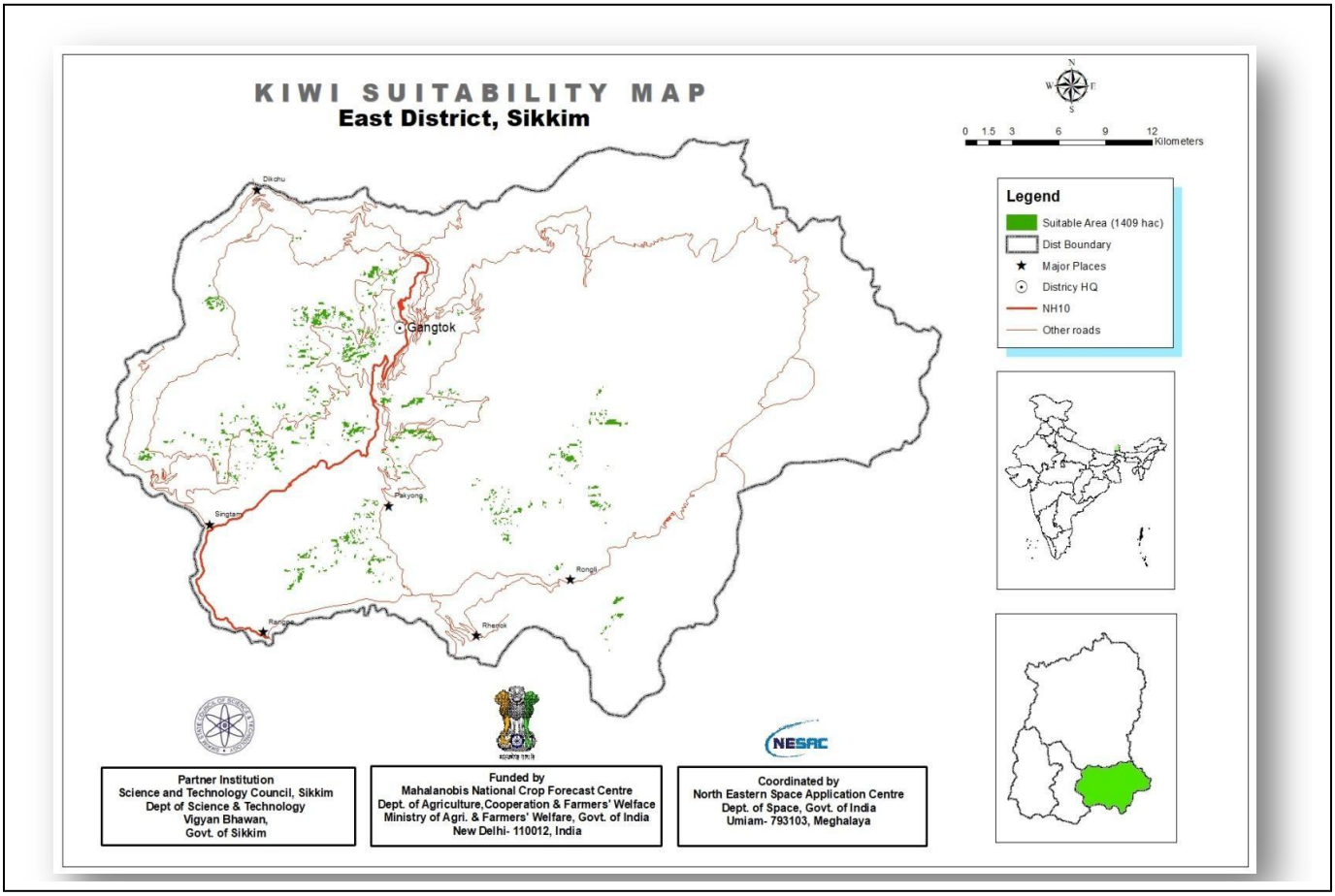
**Trainings:**

1. Training provided in collaboration with SIRD and National ,Institute of Rural Development & Panchayati Raj, NERC Khanapara, Guwahati **:** at KVK Namthang on " Integrating DDR & CCR into Rural Development Policies and Programmes" Climate Change Adaptation Strategies- Sikkim Adaptation Initiative". This training was conducted for all the staffs and officials of Panchayat institution and Hort. and Agri staff.
2. Online Certification Course on " **Remote Sensing & GIS Technology and Application for University Teachers & Government Officials**": Four officials from Remote Sensing Division attended online training during 13th June 2020 to 1st July 2020
3. Capacity building workshop on vulnerability profiles for India: State and district level using a common framework organized by IIT Mandi, IIT Guwahati and IISc Banglore at New Delhi in 2020

## 4. Success Story:

### a. Site suitability analysis under Coordinated Horticulture Assessment and Management using geoNformatics (CHAMAN) project (Phase-II)

The Site suitability analysis and mapping of potential areas for cultivation of **Kiwi fruit**s in **East District** of Sikkim under the guidance of Mahalanobis National Crop Forecast Centre.




| SL No. | Suitable Map Area, in ha | Indicator |
|---|---|---|
| 1. | 1409 | Green patches |

This study helps in identifying the suitable areas for kiwi plantation. The better understanding about the climatic conditions and physical factors on the suitable areas has been identified. If more materials or more research can be taken up by concern department or more documentation is done then the methodology can be redefined to include more parameters or criteria so that better and more accurate suitability sites can be identified.

Therefore, from the study and the availability of maps the concerned stakeholders can advise the farmers to which area expansion of the cultivation areas can be done or selection of new plantation areas can be taken up based on suitability map. This map of great use for any governmental projects to be taken because these maps will serve the purpose in identifying suitable areas. Workshop and sensitization programs with the stakeholders and farmers are the need of the hour where the use and importance of the suitability maps are made known to them. Furthermore future project plans needs to include the socioeconomic factors and the marketing systemof the crop where the use of these maps will greatly help in improving the ec onomic status of both the farmer and the stakeholder.

## 2. Published Scientific Papers from State Climate Change Cell -Sikkim (under NMSHE) for period 2020-2021

This year State Climate Change Cell submitted the Project Completion Report of NMSHE Phase-I project to DST, GOI. As the NMSHE focus on the building resilience to the climatic abnormalities and risks and development of field-based knowledge on mountain ecosystem, the following recommendations has been made that can be useful in field the gaps and minimize the uncertainties and limitations of climate change adaptation. The studies pertaining to East Rathong glaciers and South Lhonak glacial lake can be effectively used for the hydrological modeling of freshwater resources (Glaciers) and hydrodynamic modeling of glacial lakes respectively. These in-situ based results of data-deficient zone of Sikkim Himalaya is required to the hydrologists, scientists and policymakers for high altitude freshwater management under a changing climate. However comprehensive understanding of glaciers and glacial lake dynamics at different climatic zones very crucial for the entire Himalayan region.

**Following are the published papers :**

- Kumar R, Sharma RK, Pradhan P, Sharma N, Shrestha DG (2020) Melt Runoff Characteristics and Hydro-Meteorological Assessmentof East Rathong

Glacier in Sikkim Himalaya, India. *Earth Systems and Environment* 4:567-582. https://doi.org/10.1007/s41748-020-00168-4

- Sharma RK, Kumar R, Shrestha DG (2021) Suspended sediment dynamics and associated hydro-meteorological interrelations in East Rathong Glacier, Eastern Himalaya, India. *Material Today Proceedings*. http://doi.org/10.1016/j.matpr.2021.01.082

**Geo-Tagging and Monitoring of NEC funded Projects/schemes in NE region using Geospatial Technology and Tools**

The North Eastern Council (NEC), Government of India, Shillong is the nodal agency for the economic and social development of the North Eastern Region which consists of eight states of Arunachal Pradesh, Assam, Mizoram, Manipur, Meghalaya, Nagaland, Sikkim and Tripura. Being a regional planning body under Government of India, NEC has been playing a vital role for formulating sector wise outline of the development plans and project with a view to accelerating the pace of development with adequate funding provision to the state departments and other Central agencies.

In the continuous guidance, NESAC Shillong, Sikkim State council of Science and Technology is also one of the collaborative partner of the Geo-Tagging and Monitoring of NEC funded Projects/schemes in NE region using Geo-spatial Technology and Tools, for the State of Sikkim

Accordingly, Sikkim State Council of Science and Technology collected data from the different location of Sikkim where the NEC funded projects were being carried out. We covered maximum locations of East, West and South Sikkim. Geo-tagging of Thirty Nine project site has been completed and approved in the project. The work was done using NGMA NEC GEOMONITORING APP developed by NESAC.

## b. Green Skill Development Programme – <u>BAMBOO CRAFTS:</u>

Training-cum-skilled development programme organized by ENVIS RP Sikkim on Ecotourism, State Council of Science and Technology, Sikkim from 10th Feb.-25th March 2021.

**No. of Candidates:** 25

**Duration:** 400hrs

**NSQF level** **:**05

**10thFebruary – 25th March 2021**

- Organized in Khechuperi, Rimbi, West Sikkim for the duration of 2 months.
- Training on Bamboo products like Bamboo mug, Bamboo Sofa, Bamboo Dining Set and other handicraft product were taught with hands on training in the lab of Khechuperi Bamboo House with sophistication lab machine.

**Field Visit to Thingling,West Sikkim was conducted were trainees were interrelated on different types of bamboo varies and its plantation process.**

- Shri. D.T. Bhutia, Director cum ENVIS Coordinator, DST and Shri. Suman Thapa Joint Director SSCST visited the training site to review the bamboo products made by trainees.
- Two months long programme had a successful outcome were 9 out of 25 trainees are already placed as bamboo craftsmen in Khechuperi Bamboo House, West Sikkim.


*Picture: 1* *Picture : 2*

*Picture: 3*

- Picture 1 &2 : Distribution of Certificates and Bamboo Crafting tools to trainees by Shri. Karma Loday Bhutia, Hon'ble Minister, Department of Science and Technology, Government of Sikkim.
- Picture 3: Hon'ble Minister along with Secretaries and Director cum ENVIS Coordinator, DST
- *In Picture(Left): Shri. D.T. Bhutia Director cum ENVIS Coordinator*
- *Second from (Left): Shri. Karma Loday Bhutia, Hon'ble Minister, Department of Science and Technology*
- *Third From (Left) : Shri. M.L. Srivastava, IFS, ACS, Department of Science and Technology*
- *Fourth From (Left): Shri. A.B. Rai, Secretary, Cooperation Department.*

**FORM GFR 12A**

**GENERAL FINANCIAL RULES 2017**
**Ministry of Finance**
**Department of Expenditure**

# GFR 12 – A

**[(See Rule 238(1)]**

## FORM OF UTILIZATION CERTIFICATE FOR AUTONOMOUS BODIES OF THE GRANTEE ORGANIZATION

**UTILIZATION CERTIFICATE FOR THE YEAR 2020- 21 in respect Of recurring/non-recurring GRANT-IN-AID/SALARIES/CREATION OF CAPITAL ASSETS**

1. Name of the Scheme **State Science & Technology Programme**
2. Whether recurring non-recurring grants: Recurring Grant 2020-21
3. Grant position of the beginning of the financial year
   (i) Cash in Hand/Bank: NIL
   (ii) Unadjusted advances: NIL
   (iii) Total: Nil
4. Details of grants received, expenditure incurred and closing balances: (Actuals)

| Unspent Balances of Grants received years [figure as of Sl.No.3 (iii)] | Interest Earned thereon | Interest deposited back to the Government | Grant received during the year | | | Total Available funds (1+2+3+4) | Expenditure incurred | Closing Balance (5-6) |
|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | | | 5 | 6 | 7 |
| | | | Sanction No.(i) | Date (ii) | Amount (iii) | | | |
| 11,72,423/- | 13,973/- | 13,973/- (UBINJ 20330648179) | DST/SSTP/CoreGrant/Sikkm/2020-21 E-31048 | 31/12/2020 | 78,24,000/- | 89,96,423/- | 94,79,805/- | (-) 4,83,382/- |

5. Component wise utilization of grants:

| Grant-in-aid-General | Grant-in-id-salary | Grant-in-aid-creation of capital assets | Total |
|---|---|---|---|
| NIL | 78,24,000/- | Nil | 78,24,000/- |

Details of grants position of the end of the year

(i) Cash in Hand/Bank NIL
(ii) Unadjusted advances NIL
(iii) Total NIL

Secretary
Science & Technology Deptt.
Government of Sikkim
Gangtok, Sikkim

Manisha Basnett
Sr Accounts Officer-cum-DDO
Sikkim State Council of
Science & Technology
Deorali

Tapan Thapa
Additional Director cum
Resource Controlling Officer
Sikkim State Council of
Science and Technology

**GENERAL FINANCIAL RULES 2017** **FORM GFR 12A**

**Ministry of Finance**
**Department of Expenditure**

**Certified that I have satisfied myself that the conditions on which grants were sanctioned have been duly fulfilled/are being fulfilled and that I have exercised following checks to see that the money has been actually utilized for the purpose for which it was sanctioned:**

**(i)** The main accounts and other subsidiary accounts and registers (including assets registers) are maintained as prescribed in the relevant Act/Rules/Standing instructions (mention the Act/Rules) and have been duly audited by designated auditors. The figures depicted above tally with the audited figures mentioned in financial statements/accounts.

**(ii)** There exist internal controls for safeguarding public funds/assets, watching outcomes and achievements of physical targets against the financial inputs, ensuring quality in asset creation etc. & the periodic evaluation of internal controls is exercised to ensure their effectiveness.

**(iii)** To the best of our knowledge and belief, no transactions have been entered that are in violation of relevant Act/Rules/standing instructions and scheme guidelines.

**(iv)** The responsibilities among the key functionaries for execution of the scheme have been assigned in clear terms and are not general in nature.

**(v)** The benefits were extended to the intended beneficiaries and only such areas/districts were covered where the scheme was intended to operate.

**(vi)** The expenditure on various components of the scheme was in the proportions authorized as per the scheme guidelines and terms and conditions of the grants-in-aid.

**(vii)** It has been ensured that the physical and financial performance under the State Science & Technology Programme has been according to the requirements, as prescribed in the guidelines issued by Govt. of India and the performance/targets achieved statement for the year to which the utilization of the funds resulted in outcomes given at Annexure-I duly enclosed.

**(viii)** The utilization of the funds resulted in outcomes given at Annexure-II duly enclosed (to be formulated by the Ministry/Department concerned as per their requirements/specifications.)

**(ix)** Details of various schemes executed by the agency through grants-in-aid received from the same Ministry or from other Ministries is enclosed at Annexure-III (to be formulated by the Ministry/Department concerned as per their requirements/specifications).

**(x)** The UC has been uploaded on PFMS portal with ID NO. ..... dt....

Date: 07/10/2021
Place: Gangtok

Signature
Name.....
Chief Finance Officer
(Head of the Finance)

Manisha Basnett
Sr Accounts Officer-cum-DDO
Sikkim State Council of
Science & Technology
Deorali

Signature
Name.....
Head of the Organisation

Secretary
Science & Technology Deptt.
Government of Sikkim
Gangtok, Sikkim

Sikkim Thapa
Additional Director cum
Resource Controlling Officer
Sikkim State Council of
Science and Technology

**FORM GFR 12B**

**GENERAL FINANCIAL RULES 2017**
**Ministry of Finance**
**Department of Expenditure**

## GFR 12 – B

**[(See Rule 256(2)]**

**FORM OF UTILIZATION CERTIFICATE**

(1) Certified that out of the grant of **Rs. 78.24 lakh** SANCTIONED under **DST/SSTP/Core Grant/Sikkim/2021-21 E-31048** Dated: **31/12/2020**, in favor of Sikkim State Coucil of Science & Technology during the year 2020- 21 an amount of **Rs 94,79,805/-** has been utilized for the purpose for which it was sanctioned, and that the balance of Rs. **NIL** remaining unutilized at the end of the year 2020-21 has been surrendered to the Government (vide No.....dated.....)/ will be adjusted towards the loan payable during The next financial year.

(2) Certified that I have satisfied myself that the conditions on which the loan was sanctioned have been duly fulfilled/are being fulfilled and that I have exercised the following checks to see that the money was actually spent for the purpose for which the loan was mode.

**Kinds of checks exercised**

1. **CASH BOOK**
2.

**Signature**.....
**Designation**.....
**Date**.....

Manisha Basnett
Sr Accounts Officer-cum-DDO
Sikkim State Council of
Science & Technology
Deorali

Secretary
Science & Technology Deptt.
Government of Sikkim
Gangtok, Sikkim

Additional Director cum
Resource Controlling Officer
Sikkim State Council of
Science and Technology

**Annexure- A**

## REQUEST FOR ANNUAL INSTALMENT WITH UP—TO—DATE STATEMENT OF EXPENDITURE

(Year Means **Financial Year i.e. 1st April 2020 to 31st March 2021**

| | |
|---|---|
| 1. Sanction Letter No. | DST/SSTP/Core Grant/Sikkim/2020-21 E-31048 |
| 2. Total Project Cost | Rs. |
| 3. Sanctioned/Revised Project cost (if applicable) | Rs. 78,24,000/- |
| 4. Date of Commencement of Project | 1st April 2020 to 31st March 2021 |
| 5. Duration | 12 months |
| 6. Grant Received in each year | |
| a. I Year | Rs78.24 lakhs |
| b. II Year | Rs NIL |
| c. III Year | Rs. NIL |
| d. Bank Interest received on grant (mandatory) | Rs. NIL |
| e. Total | Rs. NIL |
| 7. Total expenditure | Rs. 94,79,805/- (Recurring) |
| 8. Funds required for next year | Rs. 103.21 lakhs |

Sulman Thapa
Additional Director cum
Resource Controlling Officer
Sikkim State Council of
Science and Technology

Contd./-

Manisha Basnett
Sr Accounts Officer-cum-DDO
Sikkim State Council of
Science & Technology
Deorali

Annexure – A*(Contd.)*

## STATEMENT OF EXPENDITURE

***(Period 1st April 2020 to 31st March 2021)***

| Sl No | Sanctioned Heads | Funds Allocated (*) | Expenditure Incurred I Yr II Yr III Yr Total | | Balance as on date | Requirement of funds upto 31 March 2022_ | Remarks (if any) |
|---|---|---|---|---|---|---|---|
| 1 | II | III | IV | V | III – V | | The total requirement of fund for the financial year 2021-22 Rs **103.21 lakhs** |
| 1 | Manpower | 89.96 | | 94.80 | (-)4.84 | 103.21 | |
| 2 | **Total** | **89.96** | | **94.80** | **(-)4.84** | **103.21** | |

Name & Signature
Principal Investigator : .....

Additional Director cum
Resource Controlling Officer
Sikkim State Council of
Science and Technology

Signature of Competent
Financial authority .....
Date: 07/10/2021

Sr Accounts Officer-cum-DDO
Sikkim State Council of
Science & Technology

* Indicate sanctioned /revised allocation as applicable.

a) Expenditure under the sanctioned heads, at –any point of time, should not exceed funds allocated under that head , without prior approval of DST i.e. Figures in Column (V) should not exceed corresponding figure in Column (III).

b) Utilisation Certificate for each financial year ending 31st March has to be enclosed , along with request for carry-forward permission to next year.

**Sikkim State Council of Science & Technology, Vigyan Bhawan, Deorali**
**Projected Salary from 1st April 2021 to 31st March 2022**

*(Figures in Rupees)*

| Sl. No. | NAME OF THE EMPLOYEES | DESIG-NATION | PAY IN THE PAY MATRIX AS ON 1.4. 2021 | NP A IF A N Y S | TOTAL (5+6) x 4 MONT HS | PAY IN THE PAY MATRIX after Increment AS ON 01/07/ 2021 | TOTAL (6+8) x 8 MONT HS | TOTAL (7+9) | D.A. @28% (on Col 10) | S.B.C.A @ 8% (on col 10) | H.R.A. @ 12% (on col 10 (-) NPA) | OTHER ALLOW-ANCES PER ANNUM S | TOTAL PER YEAR (col 10+11+12+13 +14) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| 1 | Suman Thapa | Addl Director | 83700 | | 334800 | 86200 | 689600 | 1024400 | 286832 | 81952 | 122928 | | 1516112 |
| 2 | Nabeen Sharma | Research Assistant | 35200 | | 140800 | 36300 | 290400 | 431200 | 120736 | 34496 | 51744 | | 638176 |
| 3 | Dadul Lepcha | Jr.Acctt. | 31300 | | 125200 | 32200 | 257600 | 382800 | 107184 | 30624 | 45936 | | 566544 |
| 4 | Laydong Lepcha | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |
| 5 | Radha Krishna Sharma | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |
| 6 | Pranay Pradhan | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |
| 7 | Rinzing Namgyal | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |
| 8 | Sushen Pradhan | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |
| 9 | Rajdeep Gurung | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |

Manisha Basnett
Sr Accounts Officer-cum-DDO
Sikkim State Council of Science & Technology
Deorali

| Sl. No. | NAME OF THE EMPLOYEES | DESIG-NATION | PAY IN THE PAY MATRIX AS ON 1.4. 2021 | NP A IF A N Y $ | TOTAL (5+6) x 4 MONT HS | PAY IN THE PAY MATRI X after Increme nt AS ON 01/07/ 2021 | TOTAL (6+8) x 8 MONT HS | TOTAL (7+9) | D.A. @28% (on Col 10) | S.B.C.A @ 8% (on col 10) | H.R.A. @ 12% (on col 10 (-) NPA) | OTHE R ALLO W-ANCES PER ANNU M $ | TOTAL PER YEAR (col 10+11+12+13 +14) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *1* | *2* | *3* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* |
| 10 | Tseten.Pradhan | Sr.RA | 37100 | | 148400 | 38200 | 305600 | 454000 | 127120 | 36320 | 54480 | | 671920 |
| 11 | Prabhakar Gurung | RA | 33700 | | 134800 | 34700 | 277600 | 412400 | 115472 | 32992 | 49488 | | 610352 |
| 12 | Binita Pradhan | RA | 33700 | | 134800 | 34700 | 277600 | 412400 | 115472 | 32992 | 49488 | | 610352 |
| 13 | Prena Pradhan | RA | 33700 | | 134800 | 34700 | 277600 | 412400 | 115472 | 32992 | 49488 | | 610352 |
| 14 | Ongkit Lepcha | CO | 25400 | | 101600 | 26200 | 209600 | 311200 | 87136 | 24896 | 42000 | | 465232 |
| 15 | Pema Zangmu Lepcha | ASO | 25000 | | 100000 | | 200000 | 300000 | | | | | 300000 |
| 16 | Jay Narayan Karki | ASO | 25000 | | 100000 | | 200000 | 300000 | | | | | 300000 |
| | | | | | | | Total | 7164800 | 1838144 | 525184 | 792432 | 0 | 10320560 |

(Rupees One Crores, Three lakhs, Twenty thousand, Five hundred and Sixty) only

Manisha Basnett
Sr Accounts Officer-cum-DDO
Sikkim State Council of
Science & Technology
Deorali

Annexure-I

# Specific Achievements/outcome of the project (Projects no. With Title)

**Restricted to one page only**.

| Approved Objective/ Activities | Achievements/ Deliverable till date | Achievements/ Outcomes (Specific to utilization of funds for a period Reported upon | Challenges shortcoming , If any |
|---|---|---|---|
| **Green Skill Development Programme:**<br>Green skills contribute to preserving or restoring environmental quality for sustainable future and include jobs that protect ecosystems and biodiversity, reduce energy and minimize waste and pollution. **In line with the Skill India Mission of Hon'ble Prime Minister, Ministry of Environment, Forest & Climate Change (MoEF&CC) utilising the vast network and expertise of ENVIS Hubs/RPs, has taken up an initiative for skill development** in the environment and forest sector to enable India's youth to get gainful employment and/or self-employment, called the Green Skill Development Programme (GSDP). The programme endeavours to develop green skilled workers having technical knowledge and commitment to sustainable development, which will help in the attainment of the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), National Biodiversity Targets (NBTs), as well as Waste Management Rules (2016). | **Wild Beekeeping and Processing F.Y. 2019-20-21**<br><br>Total Trainees trained: **50**<br>Total Self Employed:**37** | Distribution of Scientific Bee-box : 50 with 12 Ferma for Clay hive till date | NIL |
| | **Bamboo Crafts FY. 2020-21**<br><br>Total Trainees trained: **25**<br>Total Self Employed :**13** | Distribution of Bamboo Crafting tools like Drilling Machine, 8-Inch Cutter Machine, Dryer machine, Angle Grinder and other crafting tools. | |
| Project title: - "Mass production and propagation of large cardamom for livelihood sustainability of rural people in Sikkim using biotechnological intervention".<br>Funding agency: DBT, GOI<br>Objectives:<br>• Development/standardization of virus indexing protocol of two viral disease of large cardamom.<br>• Production of virus free planting material through tissue culture.<br>• Morphological studies of large cardamom cultivars.<br>Comparative studies on phyto-chemicals present in large cardamom cultivars. | a.The virus indexing protocol of two large cardamom virus namely, Chirkey and Foorkey is developed through RTPCR/PCR method.<br>b.Multiplied virus free planting material through tissue culture done.<br>Morphological studies of 10 large cardamom cultivars are completed. | Virus indexing protocol of two large cardamom viruses has been developed successfully at Molecular biology lab, Vigyan bhawan, Gangtok.<br>Morphological studies of 10 large cardamom cultivars is done and completed. | Large scale multiplication of virus free planting material could not be done due to non-receipt of fund from funding agency. |

| | | | |
|---|---|---|---|
| Project title: **Patent Information Centre**<br>Funding agency: DST, GOI<br>Objectives:<br>• To create awareness on Intellectual Property Rights in Sikkim.<br>• To guide and assist in patent, copyright, trademark etc filing and registration.<br>• To create an ecosystem of patent generation, filing and licensing.<br>• To assist in GI filing of local products. | a.Successfully registered a new rice variety "Kailash Rana" developed by a farmer under Protection of Plant Variety & Farmer's Right, Act, 2001.<br>b.Filed two local products for Geographical Indication registration namely, Temi-Tea and Hee-goan Seremna (Large Cardamom).<br>c.Opened 8 IPR cell in different colleges and universities. | Registered a new rice variety under Protection of Plant Variety & Farmer's Right, Act, 2001. | |
| Gene sequence submission | Submitted 13 gene sequence of large cardamom cultivars and fungal disease associated with it to NCBI GenBank. | | |
| **Long-Term Monitoring on "Glacier Dynamics of East Rathong Glacier-Sikkim Phase II**<br><br>**Objectives**<br>• Glacier secular Movement studies<br>• Glacier Hydrometry<br>• Glacier vertical thinning and ablation Glacier Meteorology | Successfully carried out glacier studies including snout monitoring, glacier hydrology study including discharge measurement and suspended sediment analysis, glacier velocity study, Glacier surface thinning studies and glacier meteorological studies from the year 2013. In Eastern Himalaya, East Rathong Glacier is the only glacier considered for long term study. So it provides an important window for comparative study of glacier between Eastern and Western Himalaya. | • Almost 36 meters of snout retreat has been recorded in between 2013 to 2018.<br>• The average thinning of 3.8 meters recorded during the year 2018.<br>Comparatively, the year 2018 recorded higher melting/thinning of East Rathong glacier.<br>The average daily discharge in the year 2017 in East Rathong melt water stream was 5.02 $m^3s^{-1}$, 4.69$m^3s^{-1}$ in 2018, and 5.37$m^3s^{-1}$ in 2019. | Between 2013 and till date, the study in some years hampered due to bad weather condition and failure of instruments like DGPS. |
| Monitoring of Integrated Watershed Management Programme (IWMP)<br>**Objectives:** The main objective of Integrated Watershed Management Programme (IWMP) is to restore ecological balance by harnessing, conserving and developing degraded natural resources such as soil, vegetative cover and water. | **North district (11167.21 ha.):** 249 Drishti points were uploaded in the Bhuvan application showing agriculture (57), check dams (64), checks & plugs (16) and others (112). Analysis for North IWMP-I/2009-10 is done for 2009-10(T0), 2014-15(T1), 2016-17(T2), and 2017-18(T3) periods. Changes in the land use and land cover of the study area for the time period from T0 (2009-10) – T2 | **North district:**Forest has increased T0 (2009-10) to T1 (2014-15) and decreased in T1 (2014-15) to T2 (2016-17).<br><br>**East district:** Forest decrease in T0 (2009-10) to T1 | |

| | | | |
|---|---|---|---|
| | (2016-17) were analyzed in terms of Agriculture, Built up, Forest, Wastelands and Waterbodies .<br>**East district(6528.03 ha):** Analysis for East IWMP-II/2009-10 is done for 2009-10(T0), 2014-15(T1), 2016-17(T2), and 2017-18(T3) periods. Changes in the land use and land cover of the study area for the time period from T0 (2009-10) – T2 (2016-17) were analyzed in terms of Agriculture, Built up, Forest, Snow/Glacial area, Wastelands and Waterbodies<br>**South district (4969.10 ha):** Changes in land use and land cover of the study area for time period from T0 (2010-11), T1 (2015-16) and T2 (2017-18) periods were analyzed in terms of Agriculture, built-up, forest, wasteland and water bodies. | (2014-15), and increased, from T1 (2014-15) to T2 (2016-17), which is a positive change.<br><br>**South District:** Agriculture land has increased in both the monitoring cycles which are a positive change. Built up and water bodies has shown no change. Forest area has decreased because some of the forest area has been converted to wasteland. | |
| Site suitability analysis under Coordinated Horticulture Assessment and Management using geo informatics (CHAMAN) project (Phase-II)<br>**Objectives:** The main objective of the project to find out the suitable areas/location for the cultivation of KIWI fruit using geo informatics. | The potential area for KIWI has been prepared for East District of Sikkim. Here only suitability classes were considered, there is no highly suitable, moderately suitable and marginally suitable. | The final map of suitable area of 1409 ha in East Sikkim has been uploaded in Bhuvan portal | |
| National Wetland Inventory and Assessment (NWIA), Phase-II<br>**Objectives:**<br>• Conduct national level wetland inventory at 1:50K scale using 2017-18 time frame Resource sat LISS-III data ,<br>Conduct change analysis in comparison to the previous assessment, conducted using 2006-07 image (Decadal change analysis), | Wetland mapping and inventory on 1:25K scale using LISS-III for 2006-7 &, 2017-18 data.<br>Decadal wetland change analyses by comparing 2006-07 and 2017-18 LISS-III data.<br>Mapping of wetlands <2.25ha as point layer<br>Mapping and inventory of wetlands >0.1ha on 1:10K scale using LISS-IV data of Nov2016.<br>**Ongoing work**<br>• Point layer of wetlands <0.1ha, and<br>• Base layer of road, drainage and settlement etc. on 1:10K scale using LISS-IV Nov2016 data. | Decadal wetland analysis of LISS-III 2017-18 Vs. 2006-08 showed an overall increase in wetland area (from 6755.03ha to 7138.06ha, i.e. 380.03 ha), including the number of wetlands, from 244 to 258 wetlands.<br>Overall ~7138.06ha of wetlands using the LISS-III 2017-18 data has been calculated, adding | |

| | | | |
|---|---|---|---|
| | | around 1% of total geographical area of Sikkim. | |
| Characterizing Patterns and Processes of Alpine Ecosystem in Indian Himalaya, Studies on Harnessing Remote Sensing for Environment and Climate (SHRESTI)<br>**Objectives:**<br>The specific objective of the programme for Sikkim Himalaya is to establish the long-term ecological site in alpine ecosystem for monitoring tree-line shift, phonological changes and record changes in soil microbial community. | Long term ecological monitoring sites for tree-line shift was identified and established in Kyongnosla Alpine Sanctury, East Sikkim, which is a reserve forest in East district of Sikkim. Three summits were chosen where total 24 quadrates of 3x3m were established. | Total 56 species of plants (including tree, shrubs and herbaceous plants), were identified in the three summit belongs to approximately 20 families (identification of complete species list is under progress as our second field survey for one summit (HSP1) is still pending and will be completed by second week of September, 2021). | |
| **Establishment of State Climate Change Cell, Sikkim under NMSHE**<br>**Objectives:**<br>• Vulnerability and Risk Assessment at district level<br>• Institutional Capacity building and R&D for data base/Information generation as per the SAPCC and NMSHE requirements<br>• Training programmes for stakeholders including Govt officials, researchers, community based organizations, media, etc:<br>• Public awareness for community | • The manpower of the State Climate Change Cell trained in vulnerability assessment and now they are in position to carry out the work independently in the state.<br>• Completed the district level vulnerability which has been presented in National level workshop held in New Delhi.<br><br>• Completed Pan India District level vulnerability assessment comprising all Indian states and Union territories. State Climate Change Cell, Sikkim carried out the assessment of Sikkim.<br>• The State Climate Change Cell are in position to carry out further work in climate change including climate change awareness programme, capacity building, Vulnerability Assessment, glaciology and GLOF, climate change based project proposal formulation etc in the state. The awareness programme has been successfully conducted in different part of the state in the project period targeting Block Administrative Centers, Schools, monasteries etc. The participants were members of Panchyats, BAC officials, local people, students, teachers etc. More than 5000-6000 individuals are sensitized on climate change in the state. | • Completed Pan India District level vulnerability assessment comprising all Indian states and Union territories. State Climate Change Cell, Sikkim carried out the assessment of Sikkim. The assessment shows that in Sikkim, the East and South district falls under highly vulnerable due to the drivers like availability of low livestock, high marginal farmers and low forest area for the rural population. At the national level, Sikkim falls under low vulnerability with the vulnerability score of 0.48. Maharashtra falls under least vulnerable state with vulnerability score of 0.42 and Jharkhand falls under very high vulnerable zone with score of 0.67. | |

**Annexure-II**

**QUANTIFIABLE OUTCOMES: PPA PROGRAMME**

(Restricted to one page) only.

| | | |
|---|---|---|
| A | Technology Developed/Delivered | a. Bamboo Crafts Training.<br>b. Wild Beekeeping and Processing.<br>c. Nano-hydro-technology for Cardamom drying-cum-electricity. |
| B | Summary of Progress | All above three technologies have been demonstrated in the field- Completed. |
| C | Livelihood/Economic Benefits: | Bamboo Crafts & Wild Beekeeping & Processing was adopted by unemployed youth of local villages of Sikkim for their livelihood.<br>Nano-hydro-technology has been benefited to the local cardamom growers for easy drying & loss of damages. |
| D | New Innovations: | Cardamom Drying through Nano-hydro-technology. |
| E | Social Benefits | Bamboo Crafts & Wild Beekeeping & Processing was adopted by unemployed youth of local villages of Sikkim.<br>Nano-hydro-technology has been benefited to the local cardamom growers for easy drying & loss of damages. |
| F | Details of Paper Published/ Patents Filled: 01 | **Published 10 research papers:-**<br>a.Subba, K. B.*, Prof (Dr.) Mitra, P.K. and Dr. Basistha, B.C. Molecular characterization of large cardamom cultivars using *mat*K and *rbc*L genes. Journal of Biotech Research, 2021: 12:106-113.<br>b.Laydong Lepcha* and Bharat Chandra Basistha (2021) Molecular docking study of potential inhibitors to bind Spike (S) proteins 2AJF of SARS CoV and 7A93 of SARS CoV-2. Journal of Computational Intelligence in Bioinformatics (JCIB). Research India Publication. Volume 14, Number 1 (2021) pp. 1-20.<br>c.Subba, K. B.*, Prof (Dr.) Mitra, P.K. and Dr. Basistha, B.C. First report of *Phyllosticta capitalensis* as one of the associated fungus of blight disease of large cardamom. Journal of Research in Agriculture and Animal Sciences. Vol. 8-Issue 6 (2021) pp: 50-52. |
| G | Research work which remains to be done under the Project (For on-going Projects): | - |
| H | Any other items: | Nil |

Annexure-III

Details about Grants-in-Aid projects received from DST and other Ministry/ Departments:

**(For last five years & current financial year)**

| Sl.No. | Title of the Project with File No: | Name of Division & funding agency (DST/DBT…) | Date of Start & Completion/ Status | Amount ( Rs in lakh) | Whether final UC/SE & Project completion report has been submitted (If yes mention date). |
|---|---|---|---|---|---|
| 1 | Study on Nutritional Potential Sustainable Socio Economy Ecology & Conservation for Tribal Population of Sikkim | DST-GOI | 2020-21 **(on-going)** | 60.88 | Project started |
| 2 | Establishment of Sc/ST Cell in State Science & Technology Council of Sikkim. | DST-GOI | 2020-21 **(on-going)** | 98.90 | Project started |
| 3 | Science Communication/Popularization Activities in Tribal Areas of Sikkim. | DST-GOI | 2020-21 **(on-going)** | 13.37 | Project started |
| 4 | ENVIS Center on Ecotourism/GSDP | MoEF-DST-GOI | 20-21<br>2019-20<br>31/12/2019<br>31/12/2019<br>2019-20<br>15/03/2019<br>04/08/2018**(on-going)** | 14.22<br>13.00<br>25.50<br>12.58<br>17.09<br>14.86<br>10.84 | SE/UC Submitted |
| 5 | INSPIRE-Award-MANAK | DST-GOI | 28/06/2018<br>01/01/2020 **(on-going)** | 10.95<br>5.83 | Submitted |
| 6 | SCI-Connect | DST | 17/01/2018 | 1.32 | Submitted |
| 7 | i.Awareness on COVID-19/Low cost innovation inPhysis/Chemistry & Climate Change.<br>ii.Capacity Building and Awareness Programme on Climate Change | Vigyan Prasar<br>DST-GOI | 08/04/2021<br><br>11/01/2019<br>11/01/2019<br>14/01/2019<br>03/04/2018 | 15.36<br><br>4.40<br>2.28<br>1.19<br>9.84 | Ongoing<br><br>Submitted<br>Submitted<br>Submitted<br>Submitted |
| 8 | NANO-Hydel Power Project | DST-GOI | 31/03/2016 | 86.65 | Completed |
| 9 | Diffusion of Grass Roots Innovation & Documentation. | NIF | 28/03/2018 | 3.25 | Completed |
| 10 | Demonstration Rain Water Harvesting & Storage | UNDP | 03/05/2017 | 15.00 | Submitted. |
| 11 | MICRO-SMALL & MEDIUM | DST-GOI | 15/06/2018 | 25.00 | Completed |

| | | | | | |
|---|---|---|---|---|---|
| | ENTERPRISE (MSME) | | 16/03/2019 02/04/2019 | 31.00 12.00 | & Submitted . |
| 12 | India-Skill-Pedia | DST,GOI | 15/10/2018 | 27.68 | Completed |
| 13 | State Biotech hub of DBT under its special programme for NE states of India File No: BT/04/NE/2009 | Department of Biotechnology Government of India | 22.12.2010 | 265.34 | Submitted 2019 |
| 14 | Molecular and digital documentation of ethno-traditional knowledge with special reference to folk healing practices. | Department of Science and Technology, Government of India | 2016 | 33.99 | Submitted 2018 |
| 15 | Development of Agro-techniques in Ginseng in Sikkim File No. DBT-NER/Agri/20/2013 | DBT, GOI | 26.11.2015 Supposed to complete on 2018. | 68.00 | To be submitted |
| 16 | Bioinformatics Sub-DISC File No. BT/BI/04/054/2000 | DBT, GOI | 9/7/2001 | Yearly release | Submitted 31/8/2020 |
| 17 | Establishment of Sikkim State Climate Change Cell Under NHSHE | DST- CCP-Division | March 2014 March 2020 but extended up to December 2020 Completed | 384.00 | Submitted |
| 18 | Long Term Monitoring on Glacier Dynamics of East Rathong Glacier Phase II | DST-SERB | March 2020 but extended up to December 2020 Completed | 78.24 | Submitted |
| 19 | Coordinated Horticulture Assessment and Management using Geo-informatics (CHAMAN) Phase I &II | NESAC, IRSO DOS | July 2020 Completed | 3.00 | Submitted |
| 20 | Characterizing Patterns and Processes of Alpine Ecosystem in Indian Himalaya Studies on Harnessing Remote Sensing for Environment and Climate (**SHRESTI**) | SAC, IRSO DOS | April 2019 - April 2022 ongoing | 27.06 | On Going |
| 21 | National Wetland Inventory | SAC, IRSO | April 2019 - April 2021 extended up | 16.02 | On Going |

| | | | | | |
|---|---|---|---|---|---|
| | and Assessment (NWIA) Phase-II (under **SARITA** programme) | DOS | to September 2021 **(ongoing)** | | |
| 22 | Development of INSAR based techniques for high resolution surface topography and ice velocity *under* Microwave and hyper spectral techniques for earth resources **(MAHTRAM / मातरम्** | SAC, IRSO DOS | September 2019 - March 2022 (Need to extension till july2023) | 21.13 | On Going |
| 23 | Monitoring of Integrated Watershed Management Programme(IWMP**)** | NESAC-NRSC- IRSO DOS | March 2016-March 2021 Extended till March 2022 | 0.64 | On Going |
| 24 | Space based Information Support for Decentralized Planning (SISDP) Phase II | NESAC-NRSC- IRSO DOS | March 2021 to March 2023 | 7.03 | On Going |
| 25 | Development of Forest Fire Spread Model using Satellite Remote Sensing Computational Fluid Dynamics (CFD), and Non-CFD models in Sikkim Himalayas using High Performance Computing (HPC) System | CDAC-MeITY | April 2020 to March 2023 | 17.97 | On Going |
| 26 | Revision of State Action Plan on Climate Change (SAPCC)-II | MOF&CC | Till March 2022 | 20.00 | On Going |
| 27 | Himalayan Aerosol Experiment @ SIKKIM | NESAC-NRSC- IRSO DOS | August 2019 to March 2022 (extension annually) | 5.60 | On Going |
| 28 | North Eastern Spatial Data Repository (NeSDR) | NESAC - IRSO DOS | September 2017 to September 2020 | 5.00 | On Going |

**Annexure- A**

REQUEST FOR ANNUAL INSTALMENT WITH
UP—TO—DATE STATEMENT OF EXPENDITURE

(Year Means **Financial Year i.e. 1st April 2020 to 31st March 2021**

1. Sanction Letter No. : **DST/SSTP/CORE Grant-G/2020-21 (G)**
Dated:

2. Total Project Cost: Rs

3. Sanctioned/Revised
Project cost: Rs
(if applicable)

4. Date of Commencement
of Project: 1st April 2020-21

5. Duration: 01 Year.

6. Grant Received in each year:

a. I Year Rs

c. Bank Interest received on grant: Rs.NIL
(mandatory)

e. Total Rs.

7. Total expenditure: Rs.

8. Funds required for next year: Rs

**Contd./-**

**Annexure – A***(Contd.)*

**STATEMENT OF EXPENDITURE**
***(Period 2020 to 2021)***

| Sl No | Sanctioned Heads | Funds Allocated (* ) | Expenditure Incurred I Yr | II Yr | III Yr Total | Balance as on date | Requir-ement of funds upto 31 March 2022 | Remarks (if any ) |
|---|---|---|---|---|---|---|---|---|
| **1** | **II** | **III** | **IV** | | **V** | **III – V** | | |
| **1** | Manpower | | | | | | | |
| **2** | Permanent Equipments | | | | | | | |
| **3** | Other Costs | | | | | | | |
| **4** | Consumables | | | | | | | |
| **5** | Travel | | | | | | | |
| **6** | Contingencies | | | | | | | |
| **7** | Overhead Charges | | | | | | | |
| **9** | **Total** | | | | | | | |

Name & Signature
Principal Investigator: ……

**Signature of Competent Financial Authority**
**Date:**

*** Indicate sanctioned /revised allocation as applicable.**

a. Expenditure under the sanctioned heads, at –any point of time, should not exceed funds allocated under that head , without prior approval of DST i.e. Figures in Column (V) should not exceed corresponding figure in Column (III).
b. Utilization Certificate for each financial year ending 31st March has to be enclsed, along withrequest for carry-forward permission to next year.

## Nominal Roll of Council Staff:

# Transfer of Technology Division

**ENVIS 'Resource Partner' Sikkim on Ecotourism**

GREEN SKILL DEVELOPMENT PROGRAMME


**Programme organized by ENVIS Resource Partner Sikkim on Ecotourism.**

ENVIS RP Sikkim on Ecotourism team consists of -

| | | |
|---|---|---|
| **Shri. DorjeeThinlay Bhutia** | **:** | Director, Department of Science and Technology cum ENVIS Coordinator |
| **Mr. Prabhakar Gurung** | **:** | Research Assistant |
| **Mr. Niraj Sharma** | **:** | Information Officer |
| **MsPalmu Bhutia** | **:** | IT Officer/GIS Expert |
| **MsTsetenChung ChungLachungpa** | **:** | Data Entry Operator |

**No. of Candidates:** 25

**Duration:** 200 hrs **| NSQF lvl –** 4 **| 4th March – 25th March 2021**

## About

## Green Skill Development Programme

Most vocational training programmes focus on mechanical/technical skills rather than 'soft' or 'green' skills. Green skills contribute to preserving or restoring environmental quality for sustainable future and include jobs that protect ecosystems and biodiversity, reduce energy and minimize waste and pollution. In line with the Skill India Mission of Hon'ble Prime Minister, Ministry of Environment, Forest & Climate Change (MoEF&CC) utilising the vast network and expertise of ENVIS Hubs/RPs, has taken up an initiative for skill development in the environment and forest sector to enable India's youth to get gainful employment and/or self-employment, called the Green Skill Development Programme (GSDP). The programmeendeavours to develop green skilled workers having technical knowledge and commitment to sustainable development, which will help in the attainment of the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), National Biodiversity Targets (NBTs), as well as Waste Management Rules (2016). The first GSDP course was formulated for skilling Biodiversity Conservationists (Basic Course) and Para-taxonomists (Advance Course) of 3 months duration each, on a pilot basis in ten select districts of the country (covering nine bio-geographic regions). 94 Trainees successfully completed the basic course qualifying as skilled Biodiversity Conservationists and 152 Trainees completed the Advanced Course qualifying as skilled Para-taxonomists. BSI and ZSI were the nodal Centres for the pilot programme.

## Certificate Course on Value Addition and Marketing of NTFPs (Animal Origin): Wild Beekeeping and Processing (NSQF – Level 4)

Under Green Skill Development Programme, ENVIS Resource Partner Sikkim on Ecotourism, State Council of Science and Technology conducted Certificate Course on **Value Addition and Marketing of NTFPs (Animal Origin): Wild Beekeeping and Processing.**


On 4thMarch, 2021, SIKKIM ENVIS RP organized an Inauguration function of Certificate Course on Wild Beekeeping and Processing at Kaluk West Sikkim under Green Skill Development Programmewhere Shri. D.T. Bhutia Director cum ENVIS Coordinator, Department of Science and Technology, Shri. Suman Thapa, Joint Director, Sikkim State Council of Science and Technology along with Master Resource Person Shri. Yual Rai and Shri. Sushil Chettri, Gram Panchayats, Ward Panchayats, TT Division Staffs and ENVIS Staffs were present. Following the programme, Director cum ENVIS Coordinator explained how this course on Wild Beekeeping and Processing will change the aspects of sustainable livelihood in rural areas which in return brings a profitable income for sustainable livelihood. Further, Joint

Director, SSCST explained the marketing aspects of Wild Bee products after the training programme. Panchayats from different ward shared their view regarding the rural employability after this programme. The programme was also attended by the locals.

The Inaugural function was also attended by Trainees from Kaluk, Tadong, karthokand Rinchenpong were present where they questioned regarding the training programme. The programme was of 200 hrs where both theory and practical was incorporated for skill learning.

The programme was organized in the with all the SOPs of COVID-19 protocols.

First Theoretical class was conducted by Resource Person, Mr. Sushil Chettri from Horticulture department who interpreted trainees on various introductory aspects on Bee Farmimg and Bee Rearing using posters and presentation. Resource person-cum-Bee Farmer Mr. Yual Rai also gave his valuable inputs on advantages of Bee farming and how it can be self sustaining business. Trainees were full of energy and question and answer session were also witnessed.

The trainees were given hands-on-training and demonstration about scientific bee box and its various aspects after the theory class.

First hands on training was conducted where trainees were taught on how to make clay hive and what are the local resources they can use to make clay hive. Trainees where taught how to cut rug which will be used as one of the material during construction of clay hive. Rug which is widely available even in remote places is cost effective and ecofriendly material and is used as replacement for other non degradable resources.

Trainees were also taught on how to collect proper mud for the local area and what are the significances of using mud in clay hive. In this session trainees were taught on separation of mud from other non usable materials. Further trainees were taught to build foundation or base of clay hive where resources like woods, nails, cutter and measurement tapes was required. They were also

interpreted on proper dimension to be made for base of clay hive. Interpretation on frame/ferma/pharma which was used as a frame for mud during the making of clay hive. They were also taught on how to fill mud using frame inside the clay hive.


In this training session, 6 groups were made out of 25 trainees and each group was assigned a task to make clay hive using all the eco friendly resources. From collection of materials to crafting equipments, making of roof etc. As seen in the picture each group successfully made clay hive in each trainees house during the practical session.


Mr. Yual Rai, took practical classes on frames used in hives where he interpreted about types of frame and how to transfer hive in Frame using many techniques. Trainees in this session took each frame and analyzed how the bees make hives and what are the precautionary measures during tying hive in frames. Mr. Yual Rai also interpreted trainees on uses of old or used hives which can be used as wax. He explained how the bees live in this hive and what are the measures to be followed while cutting out the hive from trees and other places.

Trainees had a great experience in this certificate course on Wild BeeKeeping and Processing where they acknowledged about scientific technique taught by Resource Persons.

Trainees were very enthusiastic and every trainee are now well trained to make clay hives in their own village.


Some of the photos of Engagement of Trainees in Practical Classes





*Distribution of Scientific Beeboxs to trainees of Wild Beekeeping and Processing by Shri. Karma Loday Bhutia, Hon'ble Minister, Department of Science and Technology, Government of Sikkim.*

**Programme organized by ENVIS Resource Partner Sikkim on Ecotourism.**

ENVIS RP Sikkim on Ecotourism team consists of -

| | | |
|---|---|---|
| **Shri. DorjeeThinlay Bhutia** | : | Director, Department of Science and Technology cum ENVIS Coordinator |
| **Mr. Prabhakar Gurung** | : | Research Assistant |
| **Mr. Niraj Sharma** | : | Information Officer |
| **MsPalmu Bhutia** | : | IT Officer/GIS Expert |
| **MsTsetenChung ChungLachungpa** | : | Data Entry Operator |

**No. of Candidates:** 25

**Duration:** 400hrs **| NSQF lvl –** 5 **|10thFebruary – 25th March 2021**

## About

## Green Skill Development Programme

Most vocational training programmes focus on mechanical/technical skills rather than 'soft' or 'green' skills. Green skills contribute to preserving or restoring environmental quality for sustainable future and include jobs that protect ecosystems and biodiversity, reduce energy and minimize waste and pollution. In line with the Skill India Mission of Hon'ble Prime Minister, Ministry of Environment, Forest & Climate Change (MoEF&CC) utilising the vast network and expertise of ENVIS Hubs/RPs, has taken up an initiative for skill development in the environment and forest sector to enable India's youth to get gainful employment and/or self-employment, called the Green Skill Development Programme (GSDP). The programmeendeavours to develop green skilled workers having technical knowledge and commitment to sustainable development, which will help in the attainment of the Nationally Determined Contributions (NDCs), Sustainable Development Goals (SDGs), National Biodiversity Targets (NBTs), as well as Waste Management Rules (2016). The first GSDP course was formulated for skilling Biodiversity Conservationists (Basic Course) and Para-taxonomists (Advance Course) of 3 months duration each, on a pilot basis in ten select districts of the country (covering nine bio-geographic regions). 94 Trainees successfully completed the basic course qualifying as skilled Biodiversity Conservationists and 152 Trainees completed the Advanced Course qualifying as skilled Para-taxonomists. BSI and ZSI were the nodal Centres for the pilot programme.

## Certificate Course on Value Addition and Marketing of NTFPs (Plant Origin): Bamboo Crafts (NSQF – Level 5)

Under Green Skill Development Programme, ENVIS Resource Partner Sikkim on Ecotourism, State Council of Science and Technology conducted Certificate Course on **Value Addition and Marketing of NTFPs (Plant Origin): Bamboo Crafts.**

On 10th of February, 2021, SIKKIM ENVIS RP organized an Inauguration function at Khechuperi West Sikkim, Certificate Course on Bamboo Crafts under Green Skill Development Programmewhere Shri. D.T. Bhutia Director cum ENVIS Coordinator, Department of Science and Technology, Shri. Suman Thapa, Joint Director, Sikkim State Council of Science and Technology along with Master Resource Person from Khechuperi Shri. Indra Kari Subba and Shri. Dhan Man Limboo, Experts from Line departments, Gram Panchayats, Ward Panchayats, TT Division Staffs and ENVIS Staffs were present. Following the programme, Director cum ENVIS Coordinator explained how this course on Bamboo Crafts will change the aspects of sustainable livelihood in rural areas. How Bamboo crafts will change a normal bamboo to value added products which can in return bring a profitable income for sustainable livelihood. Further, Joint Director, SSCST explained the marketing aspects of Bamboo products after the training programme.Joint Director from Corporation Department shared his view regarding the rural employability after this programme. The programme was also attended by the villagers and elderly people of the Ward.

The Inaugural function was very fruitful with inputs given by all the line department officials.


Trainees from Gerethang, Tashiding and Thingling were present where they shared their ideas and questions regarding the training programme. The programme was of 400 hrs where both theory and practical was incorporated for skill learning.

The programme was organized in the Khechuperi Bamboo House owned by Mr. Indra Kari Subba one of our Master Trainer for the Bamboo Crafts programme. The Function was conducted with all the SOPs of COVID-19 protocols.

First Theoretical class was conducted by Resource Person, Mr. Indra Kari Subba who interpreted trainees onBamboo products and the basics of bamboo skills before starting the main course of the programme. Trainees were full of energy and question and answer session were also witnessed.

The trainees were given hands-on-training after the theory

class, where they were taught about various bamboo skills specially needed for beginners in Bamboo crafts training programme.

Next day Mr. Indra Kari Subbainteracted with the trainees and had a discussion about bamboo species and types of bamboos available in trainees area. The identification of Bamboo is must for which Master Trainer conducted a theoretical class on Identification of Bamboos and type of Bamboo used for Bamboo Products.Interaction session with Master Trainer on type of Bamboo used for Bamboo crafts in hilly areas and use of Local Bamboos and its efficient. Further, Master Trainer explained the aspects of Bamboos and Types of Bamboos of Sikkim.*In Photo : Mr. Indra Kari Limboo, Bamboo Master Trainer, Khechuperi, West Sikkim.*

*Interpretation on Bamboo Turning Machine by Mr. Indra Kari Subba, Master Trainer.*

Master Trainer Mr. Indra Kari Subba showing how to make a bamboo craft with bamboo turning efficiently. Trainees had a great exposure on Advance Machine and they have mastered it with a month. Some of the training programme products were made from these bamboo turning machine. Trainees were divided in groups to have a hands on training on these advance machine. Mr. Dhan Man Limboo, Master Trainer engaged all the trainees for faster outcome.

*First Bamboo Product made by trainees.*

*Trainees engaged in Bamboo products using Bamboo Turning Machine.*

The hands on training using Bamboo turning machine was becoming fruit as it was drawing

more attention of trainees because they had not seen such type of machinery products and were every curious to work in these.The very next day, trainees started getting used to the machine and made many more bamboo products like bamboo mugs.

*Hands on Training on various bamboo products.*

First bamboo products made by each groups of trainees during the Green Skill Development Programme.

*Theory classes : Lecture given by Mr. Indra Kari Subba.*

Theory classes were given by Master Trainer Mr. Indra kariSubba on Treatment process of Bamboo, uses of acid and type of chemical required for proper treatment of Bamboo without which the bamboo products will not last.

The class had a very interactive session where trainees interacted with the trainer on organic treatment processes and duration of treatment.

*Welcome of Master Resource Person Mr. Parag Gohain and Mr. MousamSonowal, from North East Cane and Bamboo Development Council, Assam.*

Master trainer from Assam had an interactive session with trainees in the class. Trainees

were very serious and promising. MTs also visited nearby places for types of bamboo species available in the local area.

Bamboo Furniture by Master Trainers from North East Cane & Bamboo Development Council, Assam.

Master trainer from Assam started with the training on furniture making. The bamboo has under gone a treatment process and now as seen in the photo it is being burned as a treatment procedure.

The Bamboo furniture has a great scope as it is first time in Sikkim that public are witnessing such a wonderful product with high profit margin for entrepreneurs.

Skilling on furniture items of Bamboo was taught

to trainees were they caught and made products by themselves.


Group photo taken after the completion of Bamboo Sofa with cane and treatment. Niraj Sharma, Information Officer, ENVIS Ecotourism and Mr. Jai Karki, Asst. Scientific Officer, SSCST were present. The furniture was made by trainees themselves and Master trainers from Assam were very happy to see such a brilliant trainees.

Co


*Field trip to Thingling, West Sikkim.*

Field trip was organized on 18th March to Thingling, West Sikkim were trainees were given an interpretation on type of bamboos that are available in the local area. The different type of Bamboo likes Mali Baas, Balu Baas, Katta Baas, Parang, Malingoetc were shown to trainees.

The Master trainer also explained how bamboo helps in prevention of landside and how it grows as one of the prime contributor of Oxygen. Trainees were also taught about plantation of bamboos during the field trip.

The trip was very fruitful as trainees were given a very detailed information about bamboos and its importance.

Further, Master Trainer from Assam also had an interactive session with the trainees were he talked about he type of bamboos available in Assam and difference between bamboos of Assam and Sikkim. He also explained some of the Sikkimese bamboo potential like Katta Baas.

**Some of the Products made by trainees during the Green Skill Development Programme on"Bamboo Crafts"**







*Mr. Indra Kari Subba, Master Trainer and Mr. Niraj Sharma, Information Officer, ENVIS RP Sikkim on Ecotourism, SCSTS, Gangtok.*

The final products made by trainees were examined by Master Trainers and ENVIS Staffs. The training had a very fruitful outcome as trainees learnt various skills of different types of Products. Bamboo Products made during the training programme by trainees were:-

1. Bamboo Mug
2. Bamboo Flask
3. Bamboo Steel Mug
4. Bamboo Flask with design
5. Bamboo tray set
6. Bamboo 3-seater sofa set
7. Bamboo 2-seater dining table
8. Bamboo Local Den T (Local Furniture)
9. Bamboo Center Table
10. Bamboo Center Table for Sofa
11. Bamboo flowers
12. Bamboo Spoon and dining set

*Soft Valedictory in presence of D.T. Bhutia, Director cum ENVIS Coordinator, DST, Shri. Suman Thapa, Joint Director, SSCST, Resource Persons Indra Kari Subba, Dhan Man Limboo, Parag Gohain, MousamSonowal and Mr. Niraj Sharma, IO, ENVIS Ecotourism, Shri Jai Karki, ASO SSCST.*

A soft valedictory was conducted on 25th of March, 2021 were trainees showcased the products made by them. Resource Persons and officials had an interaction on finished products made by trainees. Various bamboo products had a great finishing and trainees were well to start their entrepreneur.

Trainees interacted with the department officials and discussed about the post training activities and setting up of lab in Gerethang and Tashiding. Further, Owner of Khechuperi Bamboo House Mr. Indra Kari Subba has verbally promised to give placement to all the certified trainees of thingling under Green Skill Development Programme. The 400 hrs training concluded on 25th March, 2021.

*Distribution of Certificates and Bamboo Crafting tools to trainees by Shri. Karma Loday Bhutia, Hon'ble Minister, Department of Science and Technology.*





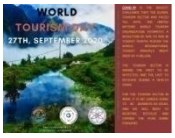
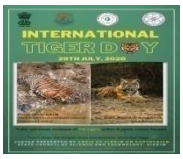
*Shri. Karma Loday Bhutia, Hon'ble Minister, Department of Science and Technology, Government of Sikkim, interpreting with trainees on success of Green Skill Development Programme on Bamboo Crafts.*

Hon'ble Minister along with Secretaries and Director cum ENVIS Coordinator, DST

*In Picture(Left): Shri. D.T. Bhutia Director cum ENVIS Coordinator*
*Second from (Left): Shri. Karma Loday Bhutia, Hon'ble Minister, Department of Science and Technology*
*Third From (Left) : Shri. M.L. Srivastava, IFS, ACS, Department of Science and Technology*

*Fourth From (Left): Shri. A.B. Rai, Secretary, Cooperation Department.*

**Information Products published/ released during 2020-21:**

| Publication / Product | Theme(s)/ Subject Area(s) | Year of Publication | URL of the PDF file in ENVIS website |
|---|---|---|---|
|  | **Best Practices of Ecotourism Amid COVID 19 Pandemic** | 2020 | http://scstsenvis.nic.in/indexx.aspx?langid=1&slid=5539&mid=2&sublinkid=1334 |
|  | **World Tourism Day 2020** | 2020 | http://scstsenvis.nic.in/indexx.aspx?langid=1&slid=5540&mid=2&sublinkid=1335 |
|  | **Short Video on World Environment Day 2020** | 2020 | http://scstsenvis.nic.in/index1.aspx?lid=4501&linkid=634&langid=1&mid=7 |
|  | **Poster Presentation on International Tiger Day 2020** | 2020 | http://scstsenvis.nic.in/index1.aspx?lid=4506&linkid=637&langid=1&mid=7 |
|  | **Short Video on World Ozone Day 2020** | 2020 | http://scstsenvis.nic.in/index1.aspx?lid=4539&linkid=639&langid=1&mid=7 |
|  | **Short Video - Awareness on World Wetlands Day 2021** | 2021 | http://scstsenvis.nic.in/index1.aspx?lid=5653&linkid=645&langid=1&mid=7 |

# PLACEMENT
## GREEN SKILL DEVELOPMENT PROGRAMME
VALUE ADDITION AND MARKETING OF NTFPs (Plant Origin): Bamboo Crafts F.Y. 2020-21
SCSTS, ENVIS RP SIKKIM ON ECOTOURISM



| SL | CANDIDATES | GENDER | ADDRESS | PLACEMENT IN | PLACED AS | CONTACT |
|---|---|---|---|---|---|---|
| 1. | Pranite Subba | M | Thingling-khechuperi, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 9747869795 |
| 2. | Nam Hang Limboo | M | Thingling-khechuperi, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 8768224951 |
| 3. | Susila Subba | F | Khichuperi,West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 7063244301 |
| 4. | Som Hangma Limboo | F | Thingling-khechuperi, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 7478432028 |
| 5. | Smita Limboo | F | Thingling-khechuperi, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 7872119041 |
| 6. | Suk Maya Subba | F | Thingling-khechuperi, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 8348145304 |
| 7. | Sandeep Limboo | M | Thingling, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 9083059084 |
| 8. | Jeekme Gurung | M | Thingling, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 7076258111 |
| 9. | Bimal Limboo | M | Thingling, West Sikkim | Khechuperi Bamboo House, Thingling, West Sikkim | Bamboo Craftsmen | 7479338564 |

## SIKKIM SCIENCE CENTER, MARCHAK.

The Sikkim Science Centre, located in Marchak, Gangtok, houses some interesting galleries such as the Unique Humankind gallery, Taramandal, Fun Science gallery, Gallery for Students' Activities and the science park.

In addition to these existing facilities, recently new facilities were inaugurated by Hon'ble Chief Minister of Sikkim on 20th November 2020. The new facilities include the 8m dia digital planetarium, 3D- Theatre, Biodiversity Gallery and Innovation Hub. The planetarium helps students grasp abstract astronomical concepts and can spark enjoyment and interests in science and offers magnetic experience every time with our Astronomy, shows unfolding their marvels and enhancing visitors' awareness and understanding of astronomy, not esoteric in nature, rather the kind one can enjoy in one's own backyard. Visitors enjoy a fast-paced, entertaining and immersive film with stunning 3D effects in a specially designed theatre meant to heighten the effect. Sikkim being the one of the richest biodiversity hotspot, the center houses a newly inaugurated Biodiversity gallery which displays the unique flora and fauna of Sikkim. In this Gallery one can know various activities of life through the interaction with exhibits. An Innovation Hub is place which provides facilities to nurture new ideas and help develop inquisitive perspective in youths of today. The Innovation hubs created by National Council of Science Museums engage youth in innovative and creative activities. These hubs serve as springboards for new ideas and innovation and thus helping the society and economy to face future challenges and meet rising aspirations of the growing population. Specifically, embedding such creative pedagogies in science education through Innovation 'Hubs' would have potential to retain talent in modern science.


**Inaugural Speech By Hon'ble Chief Minister.**

**Unveiling the Curtain By Chief Guest.**


**Ribbon Cutting Ceremony By the Chief Guest.**

**Newly constructed Digital Planetarium.**

**Visit to Biodiversity Gallery by the Chief Guest. Visit to Innovation Hub by Chief Guest.**


SIKKIM SCIENCE CENTRE, MARCHAK

Activities of Sikkim Science Center, Marchak-Ranipool:


**Facilities in Sikkim Science Center, Marchak- Ranipool.**

**<u>INSPIRE- Programme 2020-21</u>**:

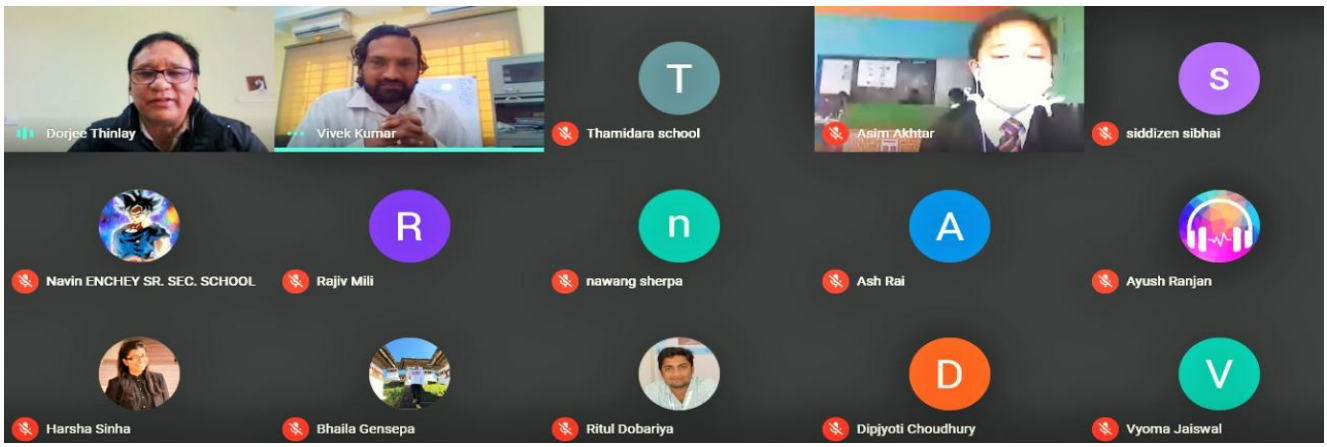
Department of Science & Technology (DST), Government of India flagship programme 'Innovation in Science Pursuit for Inspired Research (INSPIRE) is being implemented continuously since 2010. The scheme covers students in the age group of 10-32 years and has five components. The first component, INSPIRE Award aims to motivate students, in the age group of 10-15 years and studying in classes 6 to 10, to pursue Science and a career in Research. Ten (10) students from Sikkim already visited JAPAN through the programme. This year DST, GOI awarded 11 students from Sikkim. The districts and State level exhibition-cum project competition has yet to done through online mode all the project has been uploaded in site for evaluation of projects.

The INSPIRE Award Nomination 2020-21 has been closed. The total online nomination of students from Sikkim was 150 covering 87 schools for financial year 2020-21.

Out of 150 the 11 students have been short listed for INSPIRE, MANAK Awards 2020-21 for Districts Level exhibition-cum-project competition. The students from different districts have been awarded Rs 10000/- per student for preparation of projects by Government of India through INSPIRE programme. The State Level INSPIRE Exhibition and Districts Level Project Competition 2020-21 is organized online due COVID-Pendamic.

**List of selected Students who have been visited Japan through Sakura-Exchange Programme-INSPIRE-MANAK under DST-GOI from Sikkim.**

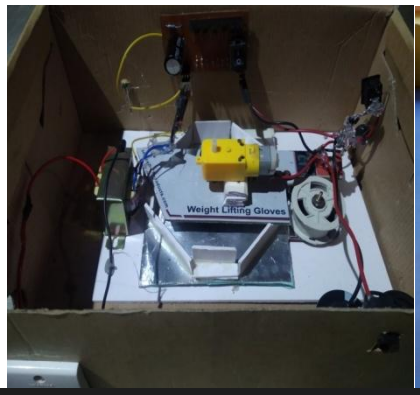
| SL. NO. | NAME OF STUDENTS | NAME OF SCHOOL | STD |
|---|---|---|---|
| 1 | Miss TSHERING DIKI BHUTIA | PALZOR NAMGYAL GIRLS SCHOOL (EAST) | 10 |
| 2 | Miss PRANITA SUBBA | YANGANG SR. SEC. SCHOOL (SOUTH) | 08 |
| 3 | Mr. SIMRAN PRADHAN | PALZOR NAMGYAL GIRLS SCHOOL (EAST) | 10 |
| 4 | Mr. ANAND RAI | LEGSHIP SR. SEC.SCHOOL (WEST) | 12 |
| 5 | Mr. GANDHI KARKI | PELLING SR. SEC. SCHOOL (WEST) | 12 |
| 6 | Mr. SUMAN SUBBA | SINGHIK SEC.SCHOOL (NORTH) | 09 |
| 7 | Mr. ABISHEK CHETTRI | LOWER SUMIN SEC.SCHOOL (EAST) | 10 |
| 8 | Mr. ASHISH DANGAL | RANGPO SR. SEC. SCHOOL (EAST) | 10 |
| 9 | Mr. AYUSH RANJAN (Selected) | RANGPO SR. SEC. SCHOOL (EAST) | 11 |

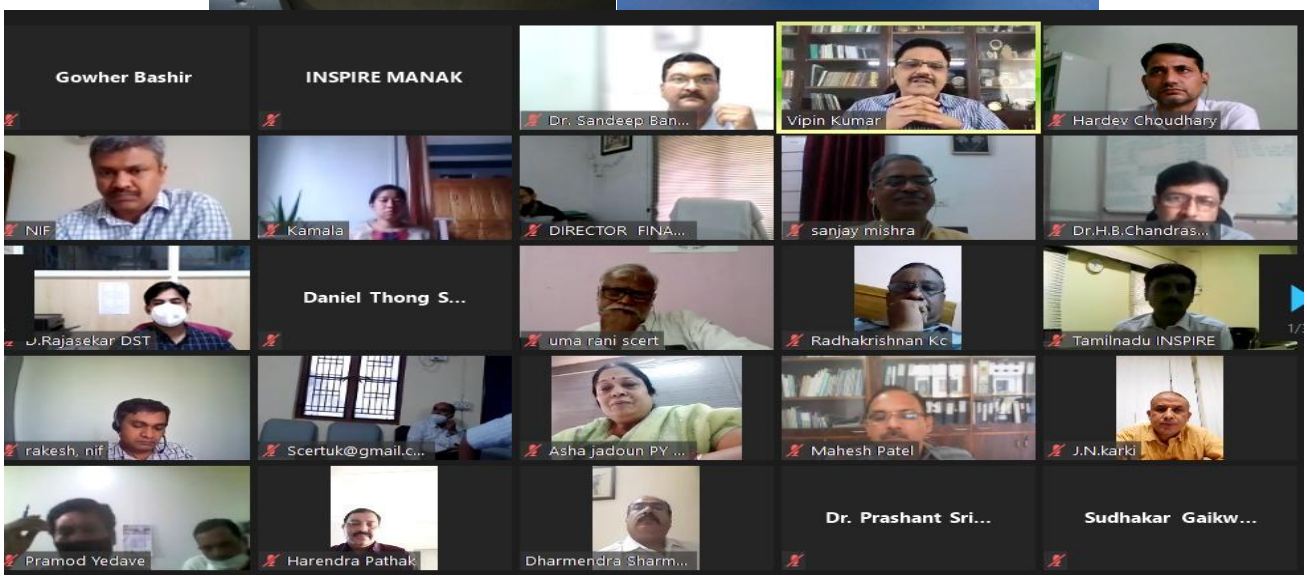



Virtual Meeting of INSPIRE-Award-MANAK

Online mentoring Workshop for NLEPC Selected Students under INSPIRE Awards-MANAK-Sikkim during COVID Pandemic.


**National selected projects from –SIKKIM -2020-21 (already uploaded by online mode)**




Meeting of INSPIRE AWARD-MANAK for Nodal Officer on **13th August 2021** Virtual mode organized by Department of Science & Technology, GOI & NIF.

**"Wild Edible fruits of Sikkim Himalaya: A study on the issues of their nutritional potential, Sustainable Socio Economy, Ecology and Conservation for Tribal Population of Sikkim".**

| | | |
|---|---|---|
| PROJECT DURATION | | 3 years |
| DATE OF START: | | 29th May 2020 |
| SCHEDULED DATE OF COMPLETION: | | 29th May 2023 |
| PROJECT COST | General | Capital |
| TOTAL SANCTIONED COST OF THE PROJECT: | 53, 14,120/- | 46, 60,000/- |
| TOTAL AMOUNT RECEIVED TILL DATE: | 14, 27,880/- | 46, 60,000/- |
| TOTAL EXPENDITURE TILL DATE: | 9,14,342/- | Nil |

**SUMMARY OF PROGRESS:**

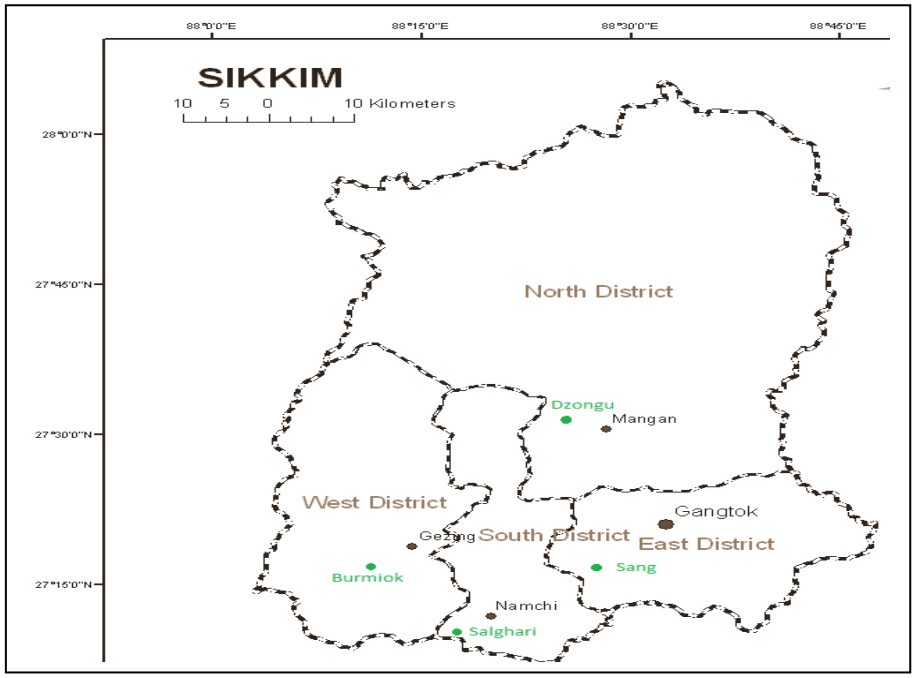
a) Review of literature going on

b) Field survey andSamples collection started from 5 major areas Dzongu, North Sikkim Kewzing, South Sikkim Tarku: South RumtekEast Bermiok: West District

c) 37 species of wild edible fruits were documented

d) Ash,moisture,protein,fat,carbohydrate content of five samples was analysed viz *Choerospondias axillaris* ; *Eriolobus indica* ; *Elaeagnus latifolia; Rubus ellipticusTerminalia chebula.*

**DETAILED PROGRESS REPORT** -Location map of the target area.




Target Beneficiaries (type of target beneficiaries' total size of target group(s), % of SC/ST of total population in project area etc.)

| Pilot site | District | SC | ST | Total Population |
|---|---|---|---|---|
| Dzongu | North | -- | -- | -- |
| Bermiok | West | 73 | 1617 | 2514 |
| Salghari | South | 9 | 126 | 850 |
| Sang | East | | | |

**Objectives:**

1. To document and delimit the wild edible fruits consumed in SikkimHimalaya
2. To study ecological distribution and socio-economy of common wild ediblefruits.
3. To determine nutritional composition such as moisture content, ash, protein, fat, carbohydrate, crude fibre, caloric content, vitamin c, beta - carotene, anti-oxidants andminerals.
4. To propose a model for domestication of wild edible fruits based on nutritivevalue.
5. To map and delimit the potential distributional areas of less-familiar wild edible fruits in Sikkim Himalaya.
6. To examine the microbiological safety of common and lesser known wild ediblefruits.

**Importance (relevance) of the proposed Interventions in the context of current identified problems (give in relation to livelihood systems (health, socioeconomic status etc)**

Relevance to state priorities: Sikkim is an organic state. Due to the steep terrain it has low agricultural and horticultural production which is not sufficient to meet the requirement within the state. Hence domestication of varieties of wild edible fruits with high nutritional value and their commercialization will further boost up the agricultural/Horticultural activity in thestate.

**Methodology**

(a) Mechanism for selection of beneficiaries and their involvement in project implementation processes. Through BDO office, Panchayat of tribal areas in four selected districts of Sikkim. West-Bermiok; South- Salghari; North- Dzongu; East- Sang.

(b) Technology Development, Dissemination and Deployment
Technical support from Knowledge Institutions/Research Labs

**Work Plan**

(a) Organisation of work elements

(b) Time schedule of activities giving milestones.

| Period of study | Achievable targets |
|---|---|
| 6 Months | Recruitment of manpower and activities pertaining to literature survey, documentation, pilot field survey, site selection covering all districts and procurement of equipments and consumables. |
| 12 Months | Field study and collection of samples;<br>Field surveys and sample collection of wild edible plants will be conducted phase wise in different regions. First phase will be targeted to cover East and North districts. First hand Information on ecology, socio economy, ethnobotany will be collected accordingly. Determination proximate composition and minerals estimation from the collected samples will also be conducted subsequently. |
| 18 Months | Second phase of surveys will be conducted in the west and south districts and collection of samples continues for analysis. Information from the ethnic people will be sought out. Sample analysis. |
| 24 Months | Collection of samples continues. Mapping and delimit the potential distributional areas of the wild edible fruits from all districts. |
| 30 Months | Final phase of survey, data collection, analysis, Model validation and fine tuning. |
| 36 Months | Compilation and analysis of data for Preparation of Final Report. |

**Science &Technology component/Innovativeness/Novelty of the project**

a. Documentation and compilation of data of wild edible fruits ofSikkim.

b. Study of ecological distribution of wild edible fruits of SikkimHimalayas.
c. Determination of Nutritional Composition of wild ediblefruits.
d. Developing model for domestication of wild edible fruits based on nutritivevalue.
e. Mapping and delimit the potential distributional areas of less-familiar wild edible fruits in Sikkim Himalaya.
f. Examination the microbiological safety of common and lesser known wild edible.**Comment on the possibilities of the activity becoming self-sustainable / marketing / buy back arrangements /Micro Enterprise Development etc** (give in terms of finite time including cost benefit analysis of the project) – Techno-economic viability of the project and its self-sustainability (for mid-term review).

i. The project will bring together people from different backgrounds and from different agencies to better understand their perception of wild ediblefruits.
ii. The project will enrich a full proof documentation of traditional knowledge and information on wild edible fruits of Sikkim and their scientific endorsement or suggestions, sodiscovered.
iii. The findings of this project will generate interest amongst the fellow researchers and will create avenues for further research andinvestigations.

## 10. OBJECTIVE WISE PROGRESS & OUTPUT/OUTCOME

**Objective 1:** To document and delimit the wild edible fruits consumed in SikkimHimalaya.

| **Proposed activities** | **Progress till date** | **output** | **Expected outcome** | **Challenges/ shortcomings** |
|---|---|---|---|---|
| Field survey | Review of literature Field survey started | Ongoing Survey of 5 watershed completed | | Information & literature of endemic species found to be limited. Survey is delayed due to state lockdown. |
| Sample collection | Samples are collected from 5 major areas viz, Dzongu, North Sikkim Kewzing , South Sikkim Tarku, South Sikkim Rumtek, East Sikkim Bermiok, West sikkim | 37 Wild edible fruit species are collected and samples have been preserved for further lab analysis. | | Ongoing |
| Documentation | 37 wild edible species are documented till date | Out of 37 wild edible species, 10 species were mostly used by the tribals for their food and | | Ongoing |

| | | | | |
|---|---|---|---|---|
| | | medicinal prupose | | |

**Table 1: List of documented wild edible fruits.**

| SL.NO | Botanical name | Local name | Habit | Family |
|---|---|---|---|---|
| 1 | *Choerospondias axillaris* | Lapsi | Tree | Anacardiaceae |
| 2 | *Elaeocarpus sikkimensis* | Bhadrase | Tree | Elaeocarpaceae |
| 3 | *Eriolobus indica* | Mehel | Tree | Rosaceae |
| 4 | *Juglans regia* | Okhar | Tree | Juglandaceae |
| 5 | *Machilus edulis* | Pumsi | Tree | Lauraceae |
| 6 | *Phyllanthus emblica* | Amala | Tree | Phyllanthaceae |
| 7 | *Rhus chinensis* | Bakhimlo | Tree | Anacardiaceae |
| 8 | *Rubus ellipticus* | Aiselu | Shrub | Rosaceae |
| 9 | *Terminalia bellirica* | Barra | Tree | Combretaceae |
| 10 | *Terminalia chebula* | Harra | Tree | Combretaceae |
| 11 | *Tetradium fraxinifolium* | Khanakpa | Tree | Rutaceae |
| 12 | *Trichosanthes tricuspida* | Indreyni | Climber | Cucurbitaceae |
| 13 | *Annona squamosa* | Sitaphal | | Annonaceae |
| 14 | *Baccaurea ramiflora* Lour. | Kusum | Tree | Phyllanthaceae |
| 15 | *Castanopsis lanceifolia* | Patle katus | Tree | Fagaceae |
| 16 | *Castanopsis indica* | Aulay katus | Tree | Fagaceae |
| 17 | *Castanopsis tribuloides* | Musure katus | Tree | Fagaceae |
| 18 | *Diploknema butyracea* | Chewri | Tree | Sapotaceae |
| 19 | *Litsea cubeba* | Siltimbur | Tree | Juglandaceae |
| 20 | *Ficus auriculata* | Nebara | Tree | Moraceae |
| 21 | *Ficus lacor* | Kabra | Tree | Moraceae |
| 21 | *Ficus subincisa* | Khasre khanew | Tree | Moraceae |
| 23 | *Ficus subincisa* | Lutay khanew | Tree | Moraceae |
| 24 | *Fragaria nubicola* | Bhuiu aiselu | Herb | Rosaceae |
| 25 | *Heracleum wallichii* | Chimping | Herb | Apiaceae |
| 26 | *Hodgsonia heteroclita* | Ghyu phal | | Cucurbitaceae |
| 27 | *Litsea cubeba* | Siltimbur | Tree | Juglandaceae |
| 28 | *Mangifera sylvatica* Roxb. | Chuche anp | Tree | Anacardiaceae |
| 29 | *Musa sikkimensis* Kurz | Bankera | Herb | Musaceae |
| 30 | *Nephrolepsis cordifolia* | Paniamala | Herb | Nephrolepidaceae |
| 31 | *Physalis minima* L. | Phakphakey | Herb | Solanaceae |
| 32 | *Rubus wardii* Merr. | Aiselu | Shrub | Rosaceae |
| 33 | *Ziziphus jujube* Mill. | Bayer | Tree | Rhamnaceae |

| | | | | |
|---|---|---|---|---|
| 34 | *Solanum nigrum* L. | Jangali bihi | Herb | Solanaceae |
| 35 | *Gyanocardia odorata* | Gante | Tree | Achariaceae |
| 36 | *Pyrus pashia* Buch.-Hamex Don | Naspati | Tree | Rosaceae |
| 37 | *Prunus cerasoides* | Paiyun | Tree | Ericaceae |

**Photographs of the some collected species:**

**Fig 1: *Juglans regia* L.**

**Fig 2: *Ficus auriculata* Lour.**

**Fig 3: *Mangifera sylvatica* Roxb.**

**Fig 4: *Choerospondias axillaris* (Roxb.)B. L. Burtt & A.W.Hill**

**Fig 5: *Gyanocardia odorata* Roxb.**

**Fig 6:*Nephrolepsis cordifolia* (L) C. Presl.**

**Fig 7: *Diploknema butyracea* (Roxb.)H.J.Lam**

**Fig 8:*Machilus edulis* King ex Hook.f.**

**Fig 9: *Terminalia bellirica* (Gaertn.) Roxb.**

**Fig 10: *Tetradium fraxinifolium* (Hook.f.) T.G. Hartley**

**Fig 11: *Trichosanthes tricuspida* Lour.**

**Fig 12: *Heracleum wallichii* DC.**

**Objective 2: To study ecological distribution and socio-economy of common wild ediblefruits.**

| Proposed activities | Progress till date | output | Expected outcome | Challenges/ shortcomings |
|---|---|---|---|---|
| Market survey | Market/haat survey started at Gangtok and namchi,singtam, Gyalsing | A total of 10 species of wild edible fruits from 9 genera and 9 families were documented till date which is mostly used by the Tribals of Sikkim Himalaya<br><br>8 species were found to have a good market and two species were still found to be unpopular.(Table:2) | | Ongoing |

**Table 2: List of 10 species used by the Tribals with its ecological distribution and marketable price.**

| Sl.no | Botanical name | Local name | Habitat | Market price |
|---|---|---|---|---|
| 1 | *Choerospondias axillaris* | Lapsi | Subtropical (900 – 2000 m) | 80-100/kg |
| 2 | *Elaeagnus latifolia* | Musleri | Subtropical/Temperate (1500 - 2600 m) | 70-80/kg |
| 3 | *Elaeocarpus sikkimensis* | Bhadrase | Temperate (1800 m) | - |
| 4 | *Eriolobus indica* | Mehel | Subtropical (300 – 900 m) | 80-100/kg |
| 5 | *Juglans regia* | Okhar | Temperate (300 – 1200 m) | 50-80/dozen |
| 6 | *Machilus edulis* | Pumsi | Temperate (1500 m amsl) | 60-120/kg |

| | | | | |
|---|---|---|---|---|
| 7 | *Phyllanthus emblica* | Amala | Subtropical (1450 m) | 80-100/kg |
| 8 | *Terminalia bellirica* | Barra | Subtropical (600 – 900 m) | 40-60/kg |
| 9 | *Terminalisa chebula* | Harra | Subtropical (600 – 900 m) | 40-60/kg |
| 10 | *Tetradium fraxinifolium* | Khanakpa | Temperate (1200 – 2100 m) | - |

**Table 3 : Ethno-medicinal value of collected species used by the Tribal's**

| Sl. no | Names of species | Ethnic perception | Ethno-medicinal value | Active principles | Remarks/ Community |
|---|---|---|---|---|---|
| 1. | *Choerospondias axillaris* | Ripe fruits consumed freshly, used as pickles | Effective against blood dysentery & good appetizer | Vitamin C, Vitamin E, beta- carotene, phenol & flavonoids | Bhutia & Lepcha |
| 2. | *Elaeagnus latifolia* | Ripe fruits consumed freshly, used as pickles & jams | Good for appetizer | Phenolic & flavonoids | General |
| 3. | *Elaeocarpus sikkimensis* | Ripe fruits consumed freshly | Good for appetizer | Alkaloids, glycosides, flavonoids, tannins | Lepcha |
| 4 | *Eriolobus indica* | mostly used for pickles | Cures blood dysentery | Vitamin C | General |
| 5 | *Juglans regia* | Kernel of the fruit is consumed after breaking the hard shell. | Good for cardiovascular diseases and asthma | Alkaloid, tannin, phenols | Bhutia, Lepcha |
| 6 | *Machilus edulis* | Ripe fruits are directly taken | Controls blood sugar level | Lignans, alkaloids | Genaral |
| 7 | *Phyllanthus emblica* | Mature fruits are eaten, also used to make pickle | Good for piles, constipation, gastritis, common cold | Ascorbic acid (vitamin C), carbohydrate, alkaloids, tannin | General |
| 8 | *Terminalia bellirica* | Fresh or dry fruits are eaten | Used in sore throat and coughs | Glycosides, flavonoids | Lepcha & Bhutia |
| 9 | *Terminalia chebula* | Fresh or dry fruits are eaten | Used in sore throat and coughs | Glycosides, flavonoids | Lepcha & Bhutia |
| 10 | *Tetradium fraxinifolium* | Used as pickle | Used to treat dysentery gastritis, food poisoning | Saponins, phenols, alkaloids, | All tribes |

**Objective 3: To determine nutritional composition such as moisture content, ash, protein, fat, carbohydrate, crude fibre, caloric content, vitamin c, beta - carotene, anti-oxidants andminerals.**

| Proposed activities | Progress till date | Output | Expected outcome | Challenges/ Shortcomings |
|---|---|---|---|---|
| Sample analysis in lab | Ash,moisture,protein,fat, carbohydrate content of five samples was analysed Namely:<br>▪ *Choerospondias axillaris*<br>▪ *Eriolobus indica*<br>▪ *Elaeagnus latifolia*<br>▪ *Rubus ellipticus*<br>▪ *Terminalia chebula* | *Choerospondias axillaris* with 54.18 % of carbohydrate found to be the highest.<br>*Eriolobus indica* with 78.26 % of moisture content found to be the highest<br>*Elaeagnus latifolia* with 82.23 % of moisture content found to be the highest<br><br>*Rubus ellipticus* with 79.68 % of carbohydtare found to be the highest<br>*Terminalia chebula with* 79.64 % found to be the highest. | | Nutritional analysis and chemical composition analysis is delayed to procurement process of the laboratory equipments and banned on transportation due to pandemic. Collection of seasonal matured fruits is awaited. |

**Table 4: Nutritional analysis of some collected species (As per AOAC 2019)**

| **Sl.no** | **Name of species** | **Ash (%)** | **Moisture (%)** | **Protein (%)** | **Fat (%)** | **Carbohydrate (%)** |
|---|---|---|---|---|---|---|
| 1 | *Choerospondias axillaris* | 2.45 | 64.50 | 3.98 | 0.04±0.005 | 54.18 |
| 2 | *Eriolobus indica* | 2.90 | 78.26 | 1.68 | 0.33±0.02 | 70.34 |
| 3 | *Elaeagnus latifolia* | 3.12 | 82.23 | 7.45 | 0.53±0.033 | 72.05 |
| 4 | *Rubus ellipticus* | 3.98 | 71.87 | 3.97 | 6.98±1.57 | 79.68 |
| 5 | *Terminalia chebula* | 3.86 | 52.56 | 1.22 | 3.87±0.55 | 79.64 |

**Objective 4: To propose a model for domestication of wild edible fruits based on nutritivevalue.**

| **Proposed Activities** | **Progress Till date** | **Output** | **Challenges/ Shortcomings** |
|---|---|---|---|
| Set up of poly house for nursery development in the four districts of Sikkim. | a. Pilot field sites identified -<br>▪ West – Bermiok<br>▪ South – Salghari<br>▪ North - Dzongu<br>▪ East - Sang<br>b. Identification of species for nurseries based on nutritive value and altitudinal variations undertaken in lab.<br>c. Agro technique for domestication of species under process | a. Setting p of poly houses under construction<br>b. Collection and identification of most economically viable species under way | Construction delayed due to state lockdown |
| | Total 71 household tribal beneficiaries are being involved. | | |
| | Targeted beneficiaries<br>▪ ST population<br>▪ Farmers | | |

# BIOTECHNOLOGY DIVISION

❖

**Background:** Biotechnology division under Sikkim State Council of Science and Technology, Department of Science and Technology, Government of Sikkim was established with the aim to promote and undertake research on biotechnology. State of art laboratory has been set-up at Vigyan Bhawan, Deorali, Gangtok with the financial and technical support of Department of Biotechnology, Government of India and State Government. Number of hands on training on molecular biology, biochemistry, biotechnology tools and techniques, bioinformatics has been conducted till date. More than 30 gene sequence has been submitted and published number of research papers in national and international journals.

**Major achievements in 2020-21:**

**Registration of new rice variety under Protection of Plant Variety & Farmer's Right, Act, 2001**

Sikkim State Council of Science & Technology (SSCS&T) Division, IPR (Intellectual Property Rights) has successfully registered a new rice variety developed by a local farmer of Sikkim. The new plant variety was registered for the first time from the state and as a matter of fact that, it is a matter of pride and big achievement too, of the SSCS&T, Sikkim. It was registered under the provision of Intellectual Property Rights vide Protection of Plant Variety & Farmer's Right, Act, 2001.


PLANT VARIETIES REGISTRY

Certificate of Registration

NEW PLANT VARIETY REGISTRATION CERTIFICATE RECEIVED FROM GOI, NEW DELHI

The said new rice variety was granted from the Protection of Plant Variety & Farmers Right Authority (FRA), New Delhi, Govt. of India. The new plant variety is developed by a progressive local farmer of Sikkim, Shri. Kailash Mangar, resident of Saramsa, Ranipool, East Sikkim. He has developed a new high yielding and scented variety of rice. Certificate of registration was received on 22th January 2020.

CERTIFICATE DISTRIBUTION PROGRAMME, TASHILING SECRETARIAT, GANGTOK, SIKKIM

The certificate distribution program was organized in the Gangtok, Tashiling Secretariat, Government of Sikkim. The certificate was handed over to the awardee from Hon'ble Minister, Department of Science & Technology, Forest Env. &W/L Management, Government of Sikkim Shri. Karma Loday Bhutia on 7th April 2021.

The entire research work, grooming, motivation, awareness about Intellectual Property Rights with special reference to Protection of Plant Variety & Farmer's Right Act, 2001 and entire supported was executed by IPR wing Biotechnology Division of SSCS&T. The technical part of drafting and filing including DUS testing was carried out by Shri. Rajdeep Gurung, Sr. RA, SSCS&T.

SSCS&T is currently working on Plant Genome Savior Reward & Recognition with coordination with Food Security & Agriculture Development Department, Government of Sikkim and ICAR (Indian Council of Agricultural Research), Tadong, Gangtok, East Sikkim.

**I. Research publications:**

5. Subba, K. B.*, Prof (Dr.) Mitra, P.K. and Dr. Basistha, B.C. Molecular characterization of large cardamom cultivars using *mat*K and *rbc*L genes. Journal of Biotech Research, 2021: 12:106-113.

6. Laydong Lepcha* and Bharat Chandra Basistha (2021) Molecular docking study of potential inhibitors to bind Spike (S) proteins 2AJF of SARS CoV and 7A93 of SARS CoV-2. Journal of Computational Intelligence in Bioinformatics (JCIB). Research India Publication. Volume 14, Number 1 (2021) pp. 1-20.
7. Subba, K. B.*, Prof (Dr.) Mitra, P.K. and Dr. Basistha, B.C. First report of *Phyllosticta capitalensis* as one of the associated fungus of blight disease of large cardamom. Journal of Research in Agriculture and Animal Sciences. Vol. 8-Issue 6 (2021) pp: 50-52.

**II. Submission of 13 gene sequences:**

- **Gene sequence submission**:

Ten (10) gene sequence of large cardamom popular cultivars namely, *Seremna, Varlangey, Dzongu, Green Golsey, Sawney* is sequenced and submitted to NCBI GenBank. Two barcode gene region i.e. matK and rbcL gene of five cultivar is submitted. The diversity study at molecular level enables us to understand the genetic distance amongst the cultivars. It gives insight into how these cultivars are closely or distantly related to each other. This not only helps us to know the evolutionary relationship but also helps in combining the genetic traits of distantly related cultivars to produce of hybrid with hybrid vigor. Like, for example, it was presumed that a new cultivar, Seremna, originated at Hee-goan, West Sikkim is closely related to Dzongu or Green-Golsey on morphological observation. But, genetically, it was found to be closely related with Varlangey cultivar. In such a case a cross between Seremna with Green-Golsey or Dzongu may results in hybrid with higher hybrid vigor as they are distantly related genetically. The findings were published in International Journal of Biotech Research, USA.

Table: The gene sequences with accession number submitted to NCBI GenBank and published

| | Mat k | | RbcL | |
|---|---|---|---|---|
| Cultivars | SeqID | Accession No. | SeqID | Accession No. |
| *A. subulatum* cultivar Dzongu | Seq1DZ_M | *MW086614* | Seq1DZ_R | *MW086619* |
| *A. subulatum* cultivar Green Golsey | Seq2GG_M | *MW086615* | Seq2GG_R | *MW086620* |
| *A. subulatum* cultivar Sawney | Seq3SW_M | *MW086616* | Seq3SW_R | *MW086621* |
| *A. subulatum* cultivar Seremna | Seq4SR_M | *MW086617* | Seq4SR_R | *MW086622* |

*A. subulatum* cultivar Varlangey | Seq5VAR_M | *MW086618* | Seq5VAR_R | *MW086623*

- **Gene sequence submission of fungus associated with large cardamom:**

The gene sequence of two fungus associated with large cardamom were sequenced and submitted to NCBI GenBank. The gene sequence of *Collectotrichum gloeosporiodes* and *Phyllosticta capitalensis* were submitted. The former is considered as main causal organism of large cardamom blight disease whereas later is the new finding associated with the same disease. The findings are published in Journal of Research in Agriculture and Animal Sciences, USA. In addition to these, one more fungus isolated from the infected sheath of large cardamom was isolated, amplified, sequenced and submitted in NCBI Gen-Bank.

| Organism | Accession no. |
|---|---|
| *Collectotrichum gloeosporiodes* | MZ148583 |
| *Phyllosticta capitalensis* | MZ076514 |
| *Arthrinium* sp. isolate LCF1OW | MW091027.1 |

**III. Viral indexing of large cardamom virus:**

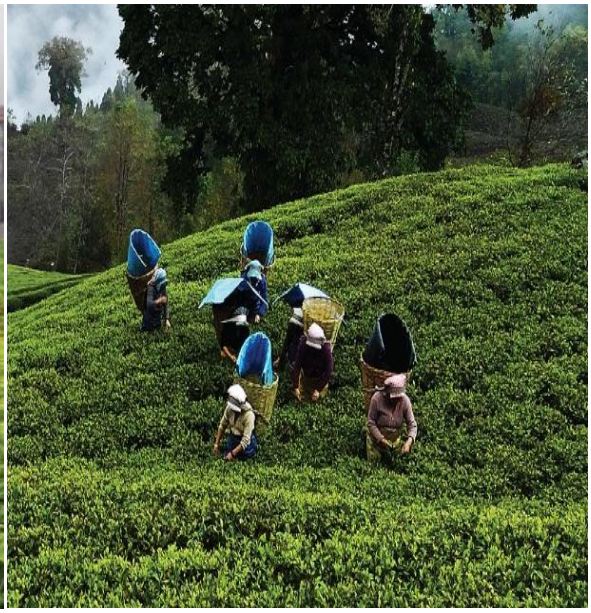
Large cardamom in infested with two viral diseases namely 'Chirkey' and 'Foorkey' from the time immemorial. The practice of plant propagation and cultivation through division of plant further multiplied the virus to the newer locations. The viruses are further transmitted to uninfected plants by aphids. During such courses, it is assumed that more than 70%-80% of large cardamom plantations are already infected by these two viruses. The recent study also revealed that more plantations are already infected by these viruses as it was found that the asymptomatic and healthy plants are virus infected. The virus remains in the latent or dormant phase but can show symptoms anytime in future due to various physiological and environmental factors. Normally, there are two methods of detection of plant viruses, one is ELISA and another is by RTPCR. In case of large cardamom, no ELISA testing kit has been developed commercially. Further, viral load at very minimal, as in the above case, cannot be detected with this method. RTPCR is another method of viral detection. The development of RTPCR method for detection of each specific virus involves long and tedious process. Whole genome sequencing, identification of highly conserved region, primer designing, RNA extraction, cDNA synthesis, standardization of RTPCR conditions, sequencing, BLASTn etc. are some of the major process needs to be developed. Some of the previous scientists have worked on these viruses at molecular level to develop such protocol. Scientists at molecular biology laboratory, Department of Science and Technology, Government of Sikkim have standardized the protocol for detection of both 'Chirkey' and 'Foorkey' virus even at very low viral infection. Significant findings have been made in which healthy and asymptomatic plants also showed virus positive result. The isolation of viral RNA and PCR plays

an important role in detection of low viral load which has been developed indigenously.

## IV. FILING OF TWO NEW LOCAL ITEM FOR GEOGRAPHICAL INDICATION (GI) REGISTRATION

IPR wing of SSCS&T has identified two new local items of Sikkim for Geographical Indication (GI) registration. As per Geographical Indication, Registration and Protection Act, 1999, required details are already furnished and drafting has also done.

SEREMNA, LARGE CARDAMOM



SIKKIM TEMI TEA

The two newly identified items for GI are *Sermena*, Large Cardamom of Hee Gao, West Sikkim and Lone orthodox item of Sikkim, Sikkim Temi Tea.

The GI attorney for these two items is also assigned and work order has also been issued.

## V. Morphological studies of large cardamom cultivars

The morphological studies of large cardamom using morphological descriptor of more than 10 cultivars are undertaken. The research study is likely to be published in reputed journals.

## Other activities

### Free access of research journals

Bioinformatics Centre, Biotechnology Division, has been providing free access of research journals among the scientists and researchers from various publishers with the support of DeLCON, Department of Biotechnology, Govt. of India.

**Project proposals submitted and their status:**

| Sl. No. | Title of the project (Submitted projects :) | Funding Agency | Amount in lakhs | File No. | Date of Submission | Status |
|---|---|---|---|---|---|---|
| **1.** | Identification of virus resistant cultivars in large cardamom and its wild relatives through molecular techniques and somatic hybridization for development of resistant variety | Department of Biotechnology, Government of India, Block-3-5 Floor, CGO Complex, Lodhi Road, New Delhi-110003 | 71,30,000.00 | | | **ISC approved** |
| 2. | Faculty Improvement Programme on Bioinformatics for the Professors, Assistant Professors, Post-graduate, Graduate & Undergraduate Science Faculty Working in Different Areas of Life Sciences in Sikkim. | Department of Biotechnology, Government of India, Block-3-5 Floor, CGO Complex, Lodhi Road, New Delhi-110003 | 90,06948.00 | 42148 | 28th January 2021 | Awaited |
| 3. | Skill Development Programmes on Bioinformatics for the PhD, Research Scholars and Post Graduate Students in different areas of Life Sciences. | Vigyan Acceleration, Department of Science & Technology, Government of India, New Delhi | 18,04000.00 | AV/KAR /2021/0 005 | 11th March 2021 | Awaited |
| 4. | DBT Skill Vigyan Programme under | Department of Biotechnology, | 28000000.00 | Contact person | 25th February | Awaited |

| | | | | | | |
|---|---|---|---|---|---|---|
| | State Partnership in Life Science and Biotechnology. | Government of India, Block-3-5 Floor, CGO Complex, Lodhi Road, New Delhi-110003 | | Dr. Manoj Singh Rohila | 2021 | |
| 5. | Setting up of Intellectual Property Facilitation Centre (IPFC) for MSME. | Micro Small and Medium Enterprises (MSME), New Delhi Government of India | 4,889000.00 | IPR/GFA/156 | 26th March 2021 | Awaited |
| 6. | Networking Programme on Rhododendron species of North Eastern Region. | Department of Biotechnology, Government of India, Block-3-5 Floor, CGO Complex, Lodhi Road, New Delhi-110003 | 14956590.00 | - | June 2020 | Awaited |
| 7. | Climate Change impacts on the Alpine ecosystem of Sikkim Himalaya. | Ministry of Environment Forest & Climate Change, Government of India | 26740000.00 | SSCS&T/859/202089/2021/RE | 23/03/2021 | Awaited |
| 8. | Mass production of ginseng (*P. sokpayensis)* for livelihood security and economic growth of rural people of Sikkim, North East India. | Department of Biotechnology, Ministry of Science and Technology, Block-3-5 Floor, CGO Complex, Lodhi Road, New Delhi-110003 Government of India | 34100000.00 | nerdiv@dbt.nic.in | 5.11.2020 | Awaited |

# Remote Sensing & Climate Change

## A. INTRODUCTION

Looking into the diverse natural resources and rich biodiversity in Sikkim Himalaya, the Sikkim State Remote Sensing Applications Centre (SSRSAC) established under Department of Science and Technology in the year 1997. The Centre now is well equipped with sophisticated Hardware and Remote Sensing and GIS software. The SSRSAC has well trained manpower in the field of Remote Sensing and GIS. The centre also provides short term training to Students of different colleges in the field of Remote Sensing (RS) and Geographical Information System (GIS) applications. It has been undertaking various projects funded by Central Government as well as State Government and also provides necessary data to the user departments for various developmental activities in the state. Sikkim State Remote Sensing Centre is also coordinating the Climate Change programmes with various department of State, Central and other international agencies like GIZ, UNDP etc.

**B. GOALS AND OBJECTIVES:**

1. Promoting research and development in various identified areas relevant to the state.
2. To generate scientific awareness and also to transfer appropriate technologies for economic uplift of the weaker section of the society.
3. To identify areas of long-term development of the state by ensuring application of science and technology.
4. To supplement the efforts of the State Government in implementing various projects whenever and wherever called for.
5. Mapping of natural resources especially in the remote and inaccessible areas of the state.
6. Providing essential data to the line departments for developmental activities in the state.

**C. OPERATIONS AND KEY ACTIVITIES:**

**I. Technology Development:**

**1. Long-Term Monitoring on "Glacier Dynamics of East Rathong Glacier- Sikkim Phase II**

The project long term monitoring of " study on glacier dynamics of East Rathong Glacier" was sanctioned by SERB, DST-GoI in the year 2016 and it will continue till March 2021. The approved objectives of the project are. temperature indexed modelling, geodetic mass balance using DEMs, glacier hydrology, ablation measurements and vertical thinning, glacier surface velocity, snout monitoring etc. The entire research work is completed by adapting the following methodology:

**a. Ablation measurements and vertical thinning:**

This includes the installation of bamboo stakes, seasonal measurement of installed stakes with DGPS and measurement of exposed height of the stakes to quantify the vertical thinning.

**b. Glacier velocity:**

Monitoring of stakes at the end of ablation session in the fields and calculating the displacement movement of stakes with DGPS coordinates in the lab.

**c. Snout monitoring:**

Snout monitoring by making permanent monitoring site with the help of Differential GPS (with X, Y and Z coordinates) near snout and also to generate retreat of the snout every year.

**d. Hydrology:**

Discharge Measurements/Hydrometry: We have constructed a Hydrological site at about 0.8 km downstream of the snout of East Rathong Glacier, where discharge measurements are being carried out of cross section of stream is being monitored thrice during the ablation session in the field. Float method is used for velocity measurements and

discharge Suspended Sediments: In the hydrological site, 500 ml water sample is taken 4 times a day for the suspended sediment analysis. The sample filtered through Whatman filter paper (ash less) and kept in incubator (Sci. oven) and left drying for 24 hours. The net weight is w considered as suspended sediment concentration (SSC) (in mg/liter). The SSC in terms of daily discharge is again considered as Suspended sediment load (SSL) expressed in tons per day.

**e. Mass balance estimation:**

Geodetic Mass balance was estimated using difference of Digital Elevation Model which was generated using digitized contours from toposheet of 1962 and ALOS PALSAR Global DEM of 2011.

**f.Suspended Sediment Analysis:**

Suspended Sediment Analysis was done by calculating Suspended Sediment Concentration (SSC) and Daily Suspended Sediment Load (SSL ) of the glacial stream.

**Major work accomplished:**

- Average annual ablation area ice thickness change using stake data 4.11m/per annum
- Average discharge of glacier melt water is 4.96$m^3$/sec
- Average daily sediment load is 50.80t/day (2019)
- Average daily Sediment concentration 75.05mg/liter (2019)
- Annual average snout position change 4.85m/annum
- Average surface velocity of ERG is 17.64m/annum
- Max. temperature 25.2$^{o}$C and Min Temp. 0.3$^{o}$C (June to Sept 2019)
- Preliminary results of geodetic mass balance estimates there is maximum upto 80-120m of ice thickness loss from 1962-2011 (49Yrs) using DEM.
- The Microwave data has been tested for the study area using 1993 and 2019 data. Total 23m ice loss in last 27 Yrs in an average 0.8m/annum). The present day average total ice thickness of East Rathong Glacier is 77m.
- Total area of Glacier 4.80sqkm and the debris covered area is 30.27 ha.

**Research outputs of the project**

- **Two candidate** has successfully **registered for PhD** under the project (one is with the co- guidance from the CO-PI).
- **Free data acquisition** of Very high resolution SAR satellite (Terra SAR-X) for both accumulation and ablation season was been granted to the Research Fellow by European Space Agency.
- **Communicated Paper:** Monitoring Ice Thickness change and Mass Balance Estimation of East Rathong Glacier, West Sikkim using SAR offset tracking, ice flow law, and slope information. Geocarto International

- **Published Paper:** Melt Runoff Characteristics and Hydro-Meteorological Assessment of East Rathong Glacier in Sikkim Himalaya, India, Published in Earth Systems and Environment.

*Fig :Drilling of glacial ice using stem drilling machine*

*Fig : Stake fixation in lower ablation zone of East Rathong Glacier*

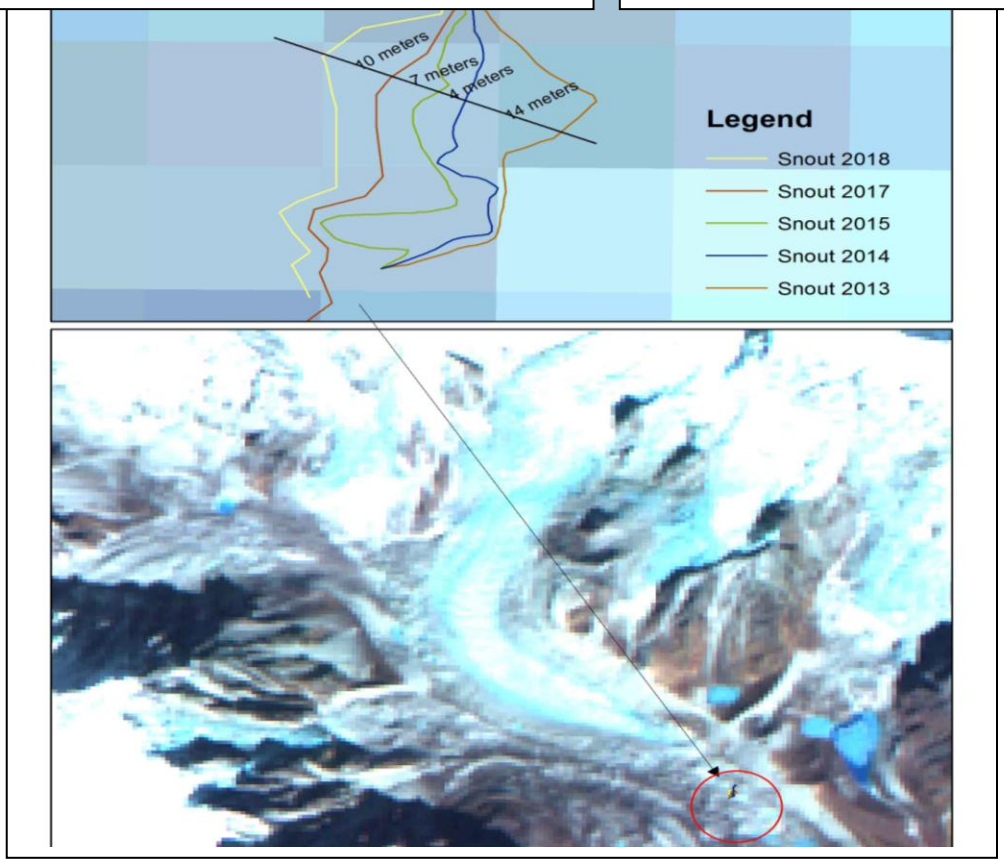


***Fig: Snout position 2013-2018, East Rathong Glacier***

***Fig: Residual dry analysis in the Laboratory in 2020***

**2. Himalayan Aerosol Experiment @ SIKKIM**

***Funded by:*** *North Eastern Space Application Centre (NESAC), ISRO, DOS, Shillong*

Aerosol are microscopic, solid, liquid or mixed particles that remain suspended in the air. Himalayas generate large quantities of natural aerosols that play an important role in cloud formation and Earth's climate. The Himalayas act as giant barrier to wind flow, facilitating the accumulation of aerosols that are then transported to high altitudes by mountain winds. Aerosol are airborne particles that are formed from both natural sources, such as gases released by plants, and pollutants emitted by human activities.

In this context, the highest mountain plateau system in the world- the Himalayas and the Tibetan Plateau are very sensitive to climate change. The Himalayas pose a key location and act as a background site to monitor the aerosols. But there is a gap in data. To bridge the gap in the chain of aerosol measurements over the Himalayas, eastern parts of Himalayas are suitable for examining the long-range transport of aerosols from South Asian region. The continuous measurements from this region will also contribute to the regional aerosol database and climate models.

Sikkim is highly suitable in order to understand the optical, physical and chemical properties of aerosols associated with the transport from the polluted Indian land mass, in addition to understanding the influence of local activities over the high altitude site. Moreover, there are several glaciers in the proximity of Sikkim, which will provide additional handle to look in to the aspects on aerosol-cryosphere interaction.

With the above mentioned justifications "Himalayan Aerosol Experiment @ SIKKIM" was started on august 2019 jointly by Space Physics Laboratory, VSSC, Trivandrum, North Eastern Space Application Centre, NESAC, Shillong and State Remote Sensing Application Centre & Climate Change Cell, Dept. of Science & Technology and Climate Change, Govt. Of Sikkim

**Details about the experiment site**

| SN | Place | Dist. | Lat | Long | Alt. (m), amsl | Accessibility | Address |
|---|---|---|---|---|---|---|---|
| 1 | Lachung | North Sikkim | 27 Deg<br>41 Min<br>27.5 Sec | 88 Deg<br>44 Min<br>35.6 Sec | 2700 | ~120 km from Gangtok. Takes 4.5 hour from Gangtok | Range Office, Lachung (T), Range<br>Dept. of FEWMGovt. of Sikkim |


***Fig: Geographical location and aerial view of the experiment site***

*a. Scientific aspects*

- To quantify the efficiency of aerosol radiation interaction at the eastern Himalayan site owing to their micro-physical and chemical properties
- To evaluate distinct source processes of aerosols (local and synoptic)
- To estimate the concentrations of Black Carbon/Dust/Water Insoluble Organic in Snow and quantify the impact on snow albedo

*b. Parameters to measure*

- ✓ Aerosol Scattering and Absorption coefficients
- ✓ Aerosol Optical Depth (AOD)
- ✓ Aerosol Mass Size Distribution (0.1 to 10 μm)
- ✓ Number concentration and number size distribution of aerosols (0.3 to 20 μm)
- ✓ Aerosol Chemical Composition
- ✓ Light Absorbing Impurities in snow.

***Finding:***

The PM10 filter paper is being sent to the respective authority through speed post from India Post and the same filter sample is being received through India Post at Lachung branch.

During the preliminary observations reveal that the columnar abundance of aerosols, which can be represented in terms of Aerosol Optical Depth (AOD) varies between 0.03 to 0.13 with an annual average of 0.08 ± 0.03.

The BC mass concentration varied from minimum values of ~830 ng $m^{-3}$ during the month of August to maximum values of BC ~ 2100ng $m^{-3}$ during the month of May.

**3. Development of Insar based techniques for high resolution surface topography and ice Velocity under Microwave and Hyper Spectral Techniques for Earth Resources Application and Management (MAHTRAM / मातरम्).**

*Funded by: Space Applications Centre, Indian Space Research Organization.*

Space borne interferometric synthetic aperture radar (InSAR) techniques for measuring ice flow velocity and topography have developed rapidly over the last decade and a half, revolutionizing the study of ice dynamics. Space borne interferometry has contributed to major progress in many areas of glaciological study by providing the first

comprehensive measurements of ice-stream flow velocity over the major outlets of Greenland and Antarctica; revealing that ice-stream and outlet-glacier flow can change rapidly (months to years); improving understanding of several ice-sheet and ice-shelf processes; providing velocity for flux-gate based mass-balance assessment; mapping flow of mountain glaciers; and capturing the geomorphic traces of past ice flow.

Generation of Digital elevation model (DEM) and glacier velocity mapping are the two most important applications of SAR interferometry or interferometric SAR (InSAR)used in cryosphere. Space- borne InSAR techniques for measuring ice flow velocity and topography have developed rapidly over the last decade. InSAR is capable of measuring ice motion that has radically changed the science of glaciers and ice sheets. Space-borne InSAR has contributed to major evolution in many research areas of glaciological study by measuring ice-stream flow velocity, improving understanding of ice-shelf processes, yielding velocity for flux-gate based mass- balance assessment, and mapping flow of mountain glaciers.

The project is in collaboration with Space Application Centre, ISRO. The objective of DST, Sikkim is mainly the validation of elevation and glacier velocity derived from the module in the Himalayan Glacier area. DST, Sikkim will also take the lead role in design and validation of surface elevation and ice velocity derived from satellite data along with the project team.

**4. Development of Forest Fire Spread Model using Satellite Remote Sensing Computational Fluid Dynamics (CFD), and Non-CFD models in Sikkim Himalayas using High Performance Computing (HPC) System**

*Funded by:Centre for Development of Advanced Computing (C-DAC), Pune* Ministry of Electronics and Information Technology, Govt. of India

A CFD model will be developed for carrying out simulation studies of fire spread in forest area. As forest fires involve complex physical and chemical processes, all types of physical, chemical, thermal properties of components of the forest region in consideration need to be included into the model. The advantage of using Computational Fluid Dynamics (CFD) technique is its capability to simulate or capture the fire spread at micro level. All the complex processes involved i.e., combustion of vegetation and the resultant spread of gases can be captured or studied in detail. To solve CFD simulation for large size domain, HPC resources would be required. To simulate forest fires, we need terrain or hill data which will be obtained from Remote Sensing/GIS. In addition to that, wind profile of that forest region is also required which can be obtained from WRF model/MODIS data. The ground elevation plays a major role in spread of fires in forests, hence, obtaining relevant terrain data is important. The key objective of the project are:

1. To develop wildfire spread simulation model on High Performance Computing System based on computational fluid dynamics (CFD), Non-CFD models and Geomatics technologies
2. To simulate the model for wildfire spread for a sample test case

3. Testing the simulation model against the past fire occurrences in co-ordination with Sikkim Forest Department
4. To analyse the various scenario (weather conditions) of fire simulation using the model
5. Improvement of the model and developing a deployment ready framework at the level of forest division
6. Deployment of the forest fire spread simulation system at Sikkim Forest department

**Progress of the work:**

Research Permit has been obtained from the concerned **Forest Environment and Wildlife Management Department Govt. of Sikkim** for a period of one and it needs to be renewed each year.

**Collection of preliminary data from Forest Environment and Wildlife Management Department Govt. of Sikkim**

The preliminary data of Forest Fire has been collected from the department for the year 2014 to 2019. The occurrence of forest fire is observed mostly in Reserved Forest Area. The area in hectare of forest fire ranged from 2 to 35 hectare approximately. Tentative tour programme for visit to the location has been prepared.

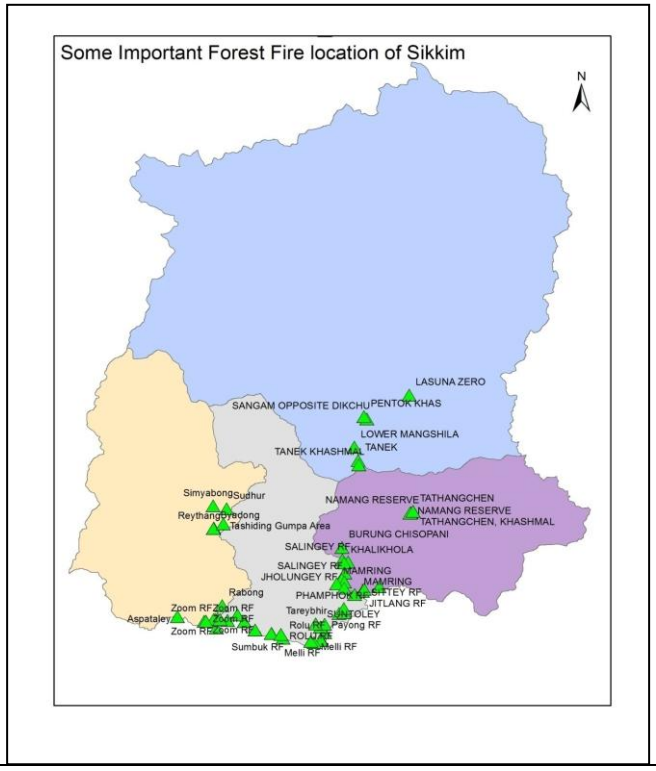


***Fig: Fire Location of Sikkim***

- **Field investigation of forest fires and provide burnt area polygon using GPS primarily for large forest fires.**
  Two field visits were conducted in the month of February 2021(one with the IIT team and other one with the CDAC team). Due to the lockdown burnt area polygon has not yet been collected.
- **Field investigation in selected sample plots and sample collection related to fuel load estimation on continuous basis in fire season (sampling scheme as proposed in Biodiversity characterization project at landscape level project need to be referred)**
  Sample collection related to fuel load estimation on continuous basis in fire season is not done due to lockdown during the fire seasons.
- **Implementation of QC comment by C-DAC.**
  Correction done as per the QC comment and is completed.
- **Provide all field Photograph/videos in uncompressed format.**
  Few Photographs and video have been sent to the C-DAC team.


**Fig: Photograph of forest fire in Sikkim.**

**Fig: Photograph of forest fire in Sikkim.**

**5. State Action Plan on Climate Change-II**

Subsequent to the introduction of National Action Plan on Climate Change (NAPCC) in 2008, State Governments were also encouraged to prepare their own State Action Plan on Climate Change (SAPCC) consistent with strategies in the NAPCC. Sikkim has formulated the State Action Plan on Climate Change (SAPCC)in 2014. Based on the study, Sikkim State Action Plan on Climate Change (SAPCC) was formulated with strategies identified to address the challenge faced by the state. with the main objectives being implementation for up gradation of SAPCC in the presence of stakeholders involved, Highlighting the methodology for Vulnerability Assessment, revision of present work on climate change adaptation program and making future adaptation program and policy for State on climate change The key areas of concern for Sikkim were identified as;

1. Water.
2. Agriculture, Horticulture and Livestock.
3. Forest, Wildlife and Eco-Tourism.
4. Promotion of Energy Efficiency.
5. Urban and Rural Habitats and Communities

Now the revision of existing SAPCC is under progress under Ministry of Environment, Forest and Climate Change the draft SAPCC is prepare, same need to update with the Sectoral Vulnerability Assessment and Climate projection.

**II. Technology Demonstration**

**1. Monitoring of Integrated Watershed Management Programme(IWMP)**

IWMP is a major project taken up by NESAC for entire North East India for the Department of Land Resources. The main objective of this project is to monitor and evaluate IWMP watersheds using Bhuvan Application (Srishti) involving high resolution IRS satellite. Watershed management is one of the key interventions for improving water

resources and conserving soil in the rain fed areas of the country. Space technology with high spatial and temporal resolution satellite data is envisaged for effectively monitoring and evaluating activities under watershed management. The major objective of the project are Correction of micro watershed project boundaries, land cover change analysis of watershed, change assessment with cross matrix table, map composition and vector layer showing changes, Analysis through Bhuvan portal, and base layer of roads ,settlement ,water bodies and drainage.

**North IWMP-I/ 2009-10:**

This site falls under the North district of Sikkim, and the year 2009-10 here represents the batch under which it was started. The total geographical area of the project is 11167.21 ha. It comprises of 10 micro watersheds. In the project area, 249 Drishti points were uploaded in the Bhuvan application showing agriculture (57), check dams (64), checks & plugs (16) and others (112). Analysis for North IWMP-I/2009-10 is done for 2009-10(T0), 2014-15(T1), 2016-17(T2), and 2017-18(T3) periods. Changes in the land use and land cover of the study area for the time period from T0 (2009-10) – T2 (2016-17) were analyzed in terms of Agriculture, Built up, Forest, Wastelands and Waterbodies

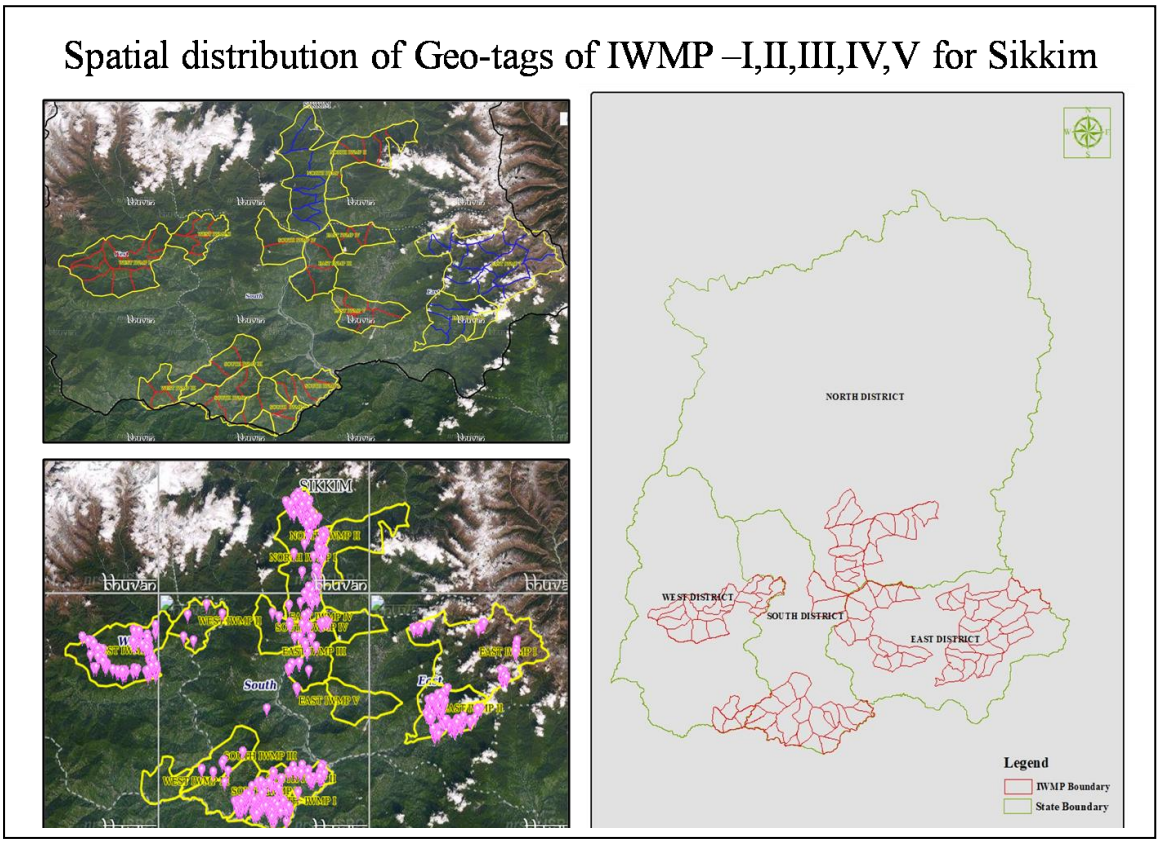



***Fig: IWMP sites distribution in the entire state***

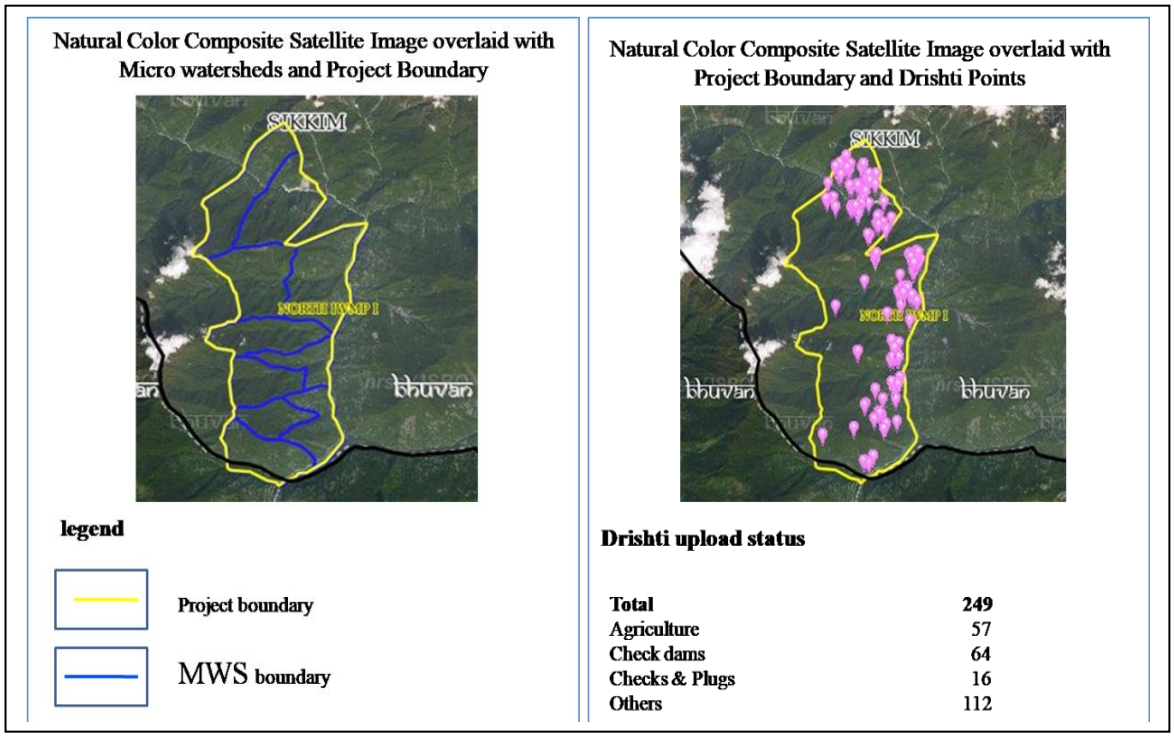
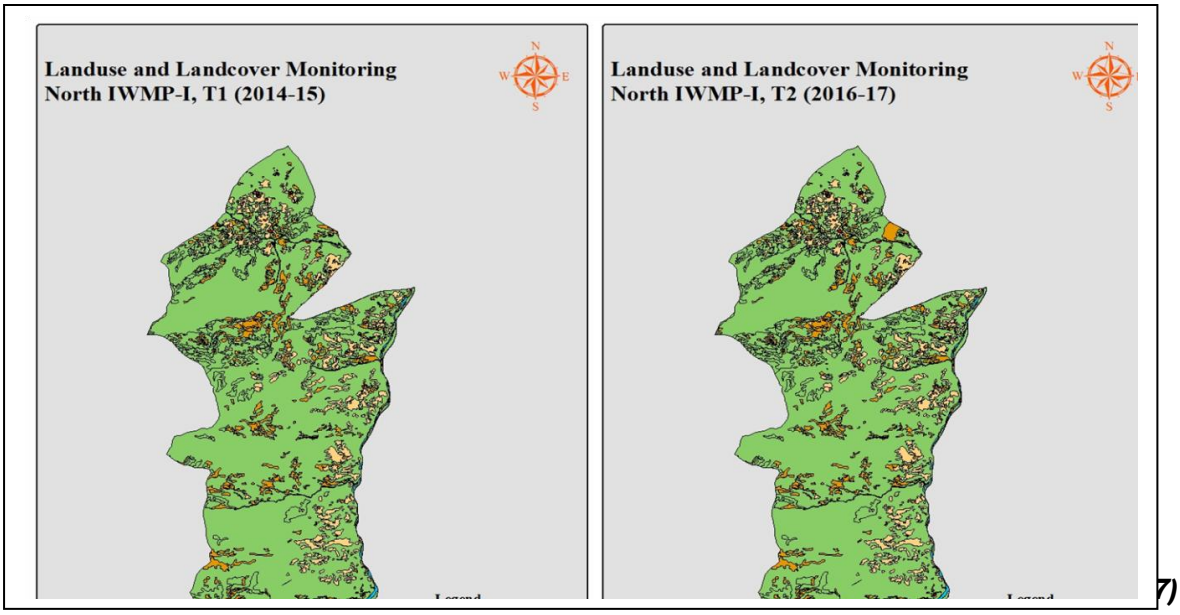



***Fig: Project boundary with distribution of IWMP Geo-tags for North IWMP-I***




***7)***

**Conclusions:**

- Forest has increased in the 1st monitoring period i.e, T0 (2009-10) to T1 (2014-15) but has decreased in the 2nd monitoring cycle i.e, from T1 (2014-15) to T2 (2016-17). Occurrence of landslides within the forest area which is now in wasteland is one reason.
- Wasteland has thus increased.
- Built up has increased in small portion and water bodies has not changed.

**East IWMP-II/ 2009-10:**

The study area falls in East district of Sikkim state, here the year 2009-10 represents the batch under which it was started. The total geographical area of the project is 6528.03 ha under IWMP scheme. It comprises of 7 micro watersheds. Analysis for East IWMP-II/2009-10 is done for 2009-10(T0), 2014-15(T1), 2016-17(T2), and 2017-18(T3) periods. Changes in the land use and land cover of the study area for the time period from T0 (2009-10) – T2 (2016-17) were analyzed in terms of Agriculture, Built up, Forest, Snow/Glacial area, Wastelands and Waterbodies .

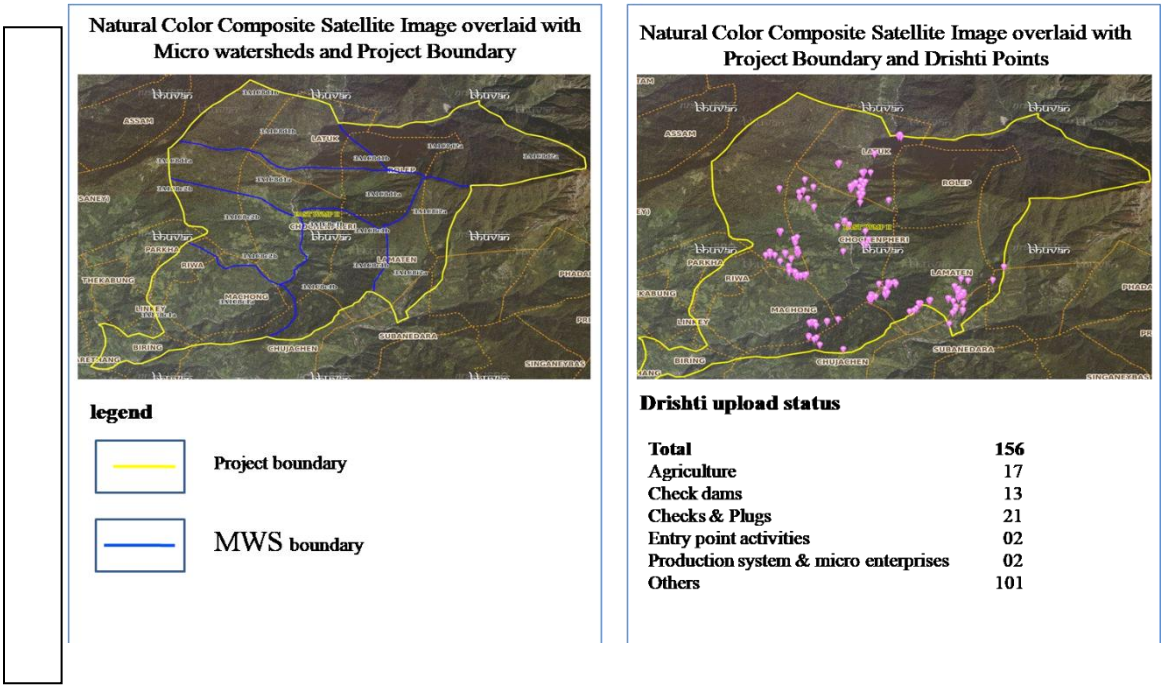



***Fig: Project boundary with distribution of IWMP Geo-tags for East IWMP-II***

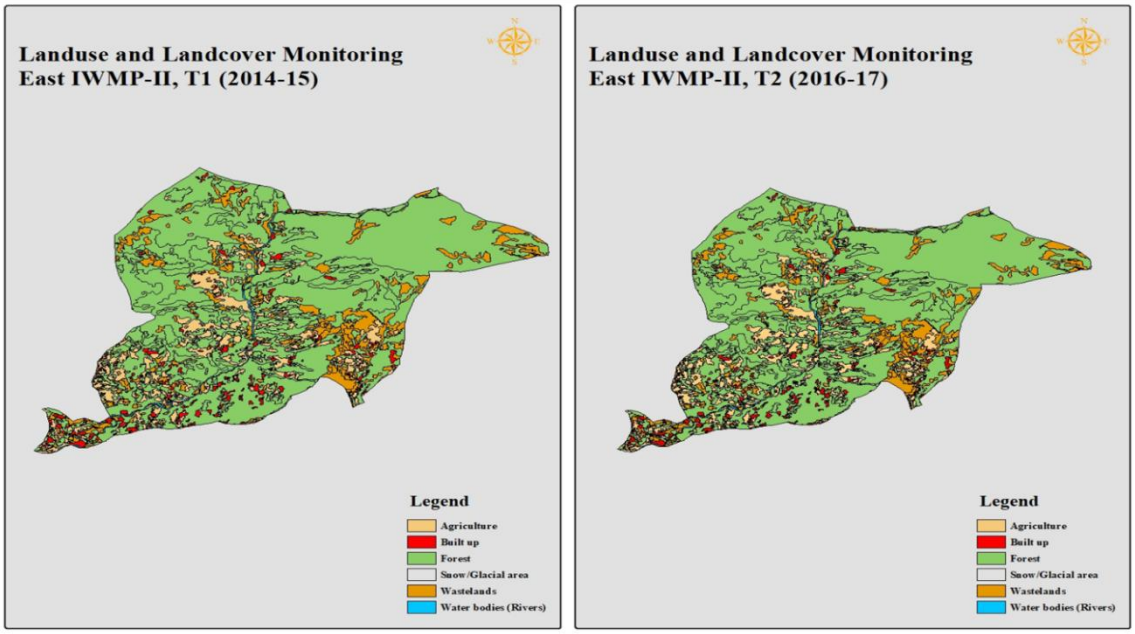



***Fig: Comparative assessment of LULC for T1 (2014-15) and T2 (2016-17)***

**Conclusions:** The Land use and Land cover changes for this project location are monitored for the period of T0 (2009-10), T1 (2014-15) and T2 (2016-17). Forest area was found to decrease in the first monitoring cycle i.e, T0 (2009-10) to T1 (2014-15), however it has increased in the second monitoring cycle i.e, from T1 (2014-15) to T2 (2016-17), which is a positive change. Overall wasteland has decreased and has been converted into forest and agriculture, which is also a positive change. Agriculture land has increased in the period T0 (2009-10) to T1 (2014-15) but has slightly decreased in the period between T1 (2014-15) to T2 (2016-17). Built up has remained the same.

**South IWMP-I/ 2010-11:**

The study area falls in South district of Sikkim state, here the year 2010-11 represents the batch under which it was started. The total geographical area of the project is 4969.10 ha under IWMP scheme. It comprises of 5 micro watersheds. Analysis for South IWMP-I/2010-11 is done for T0 (2010-11), T1 (2015-16), T2 (2017-18) and T3 (2018-19) periods. Changes in land use and land cover of the study area for time period from T0 (2010-11), T1 (2015-16) and T2 (2017-18) periods were analyzed in terms of Agriculture, built-up, forest, wasteland and water bodies.

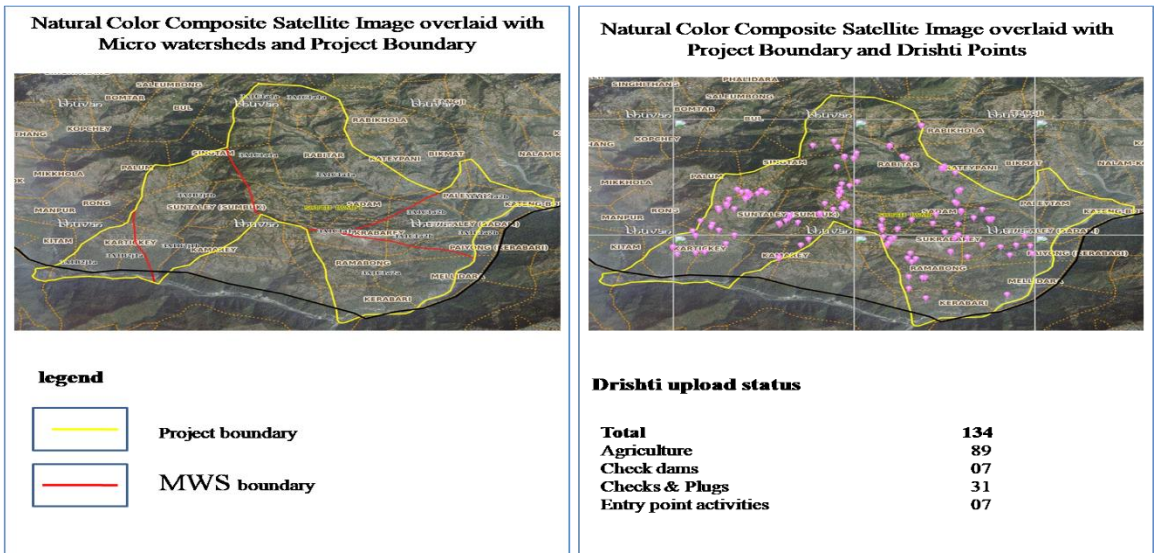



***Fig: Project boundary with distribution of IWMP Geo-tags for South IWMP-I***

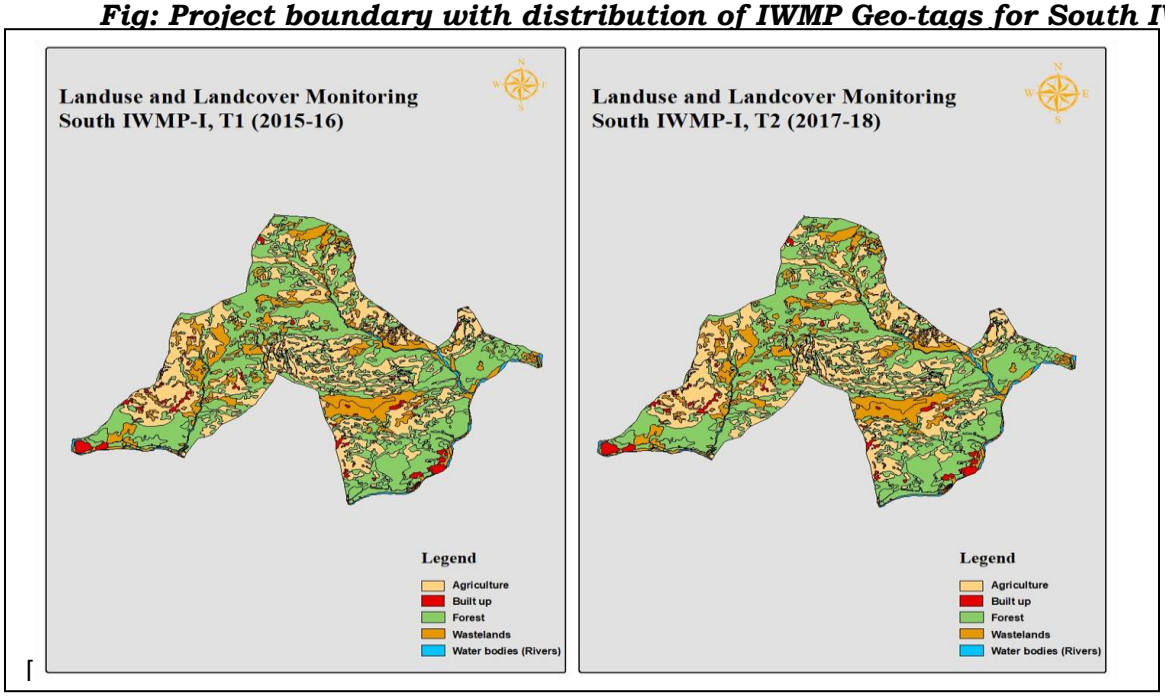



***Fig: Comparative assessment of LULC for T1 (2015-16) and T2 (2017-18)***

**Conclusions**

The Land use and Land cover changes for this project location are monitored for the period of T0 (2010-11), T1 (2015-16) and T2 (2017-18). Agriculture land has increased in both the monitoring cycles which are a positive change. Built up and water bodies has shown no change. Forest area has decreased because some of the forest area has been converted to wasteland.

**South IWMP-II/ 2010-11:**

The study area falls in South district of Sikkim state, here the year 2010-11 represents the batch under which it was started. The total geographical area of the project is 3985.29 ha under IWMP scheme. It comprises of 5 micro watersheds. Analysis for South IWMP-II/2010-11 is done for 2010-11(T0), 2015-16 (T1), 2017-18(T2) and 2018-19 (T3) periods. Changes in the land use and land cover of the study area for the time period from T0 (2010-11) – T2 (2017-18) were analyzed in terms of Agriculture, Built up, Forest, Wastelands and Waterbodies .

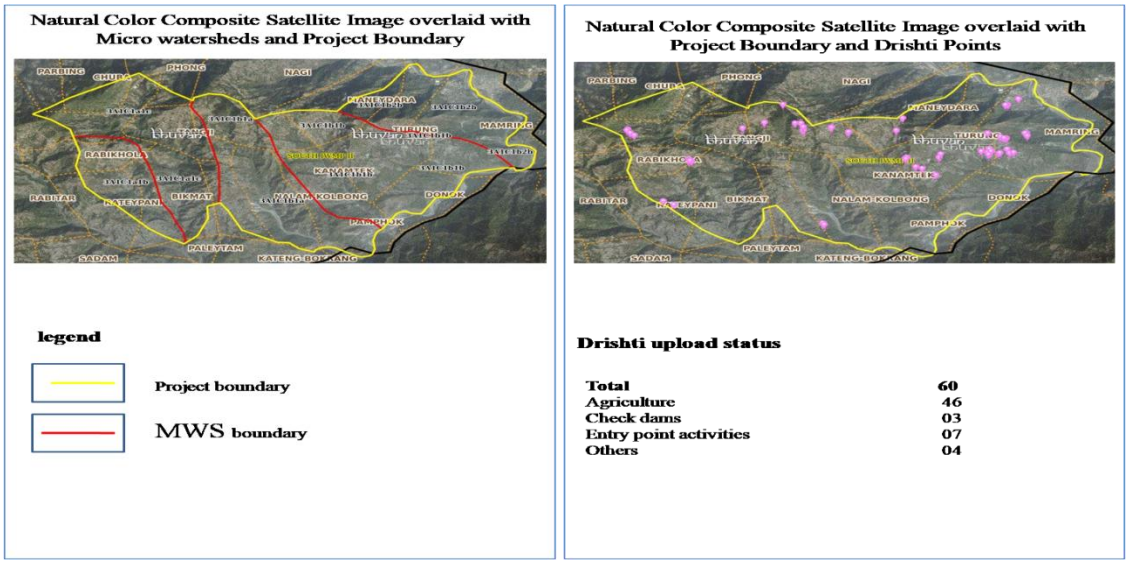



***Fig: Project boundary with distribution of IWMP Geo-tags for South IWMP-II***

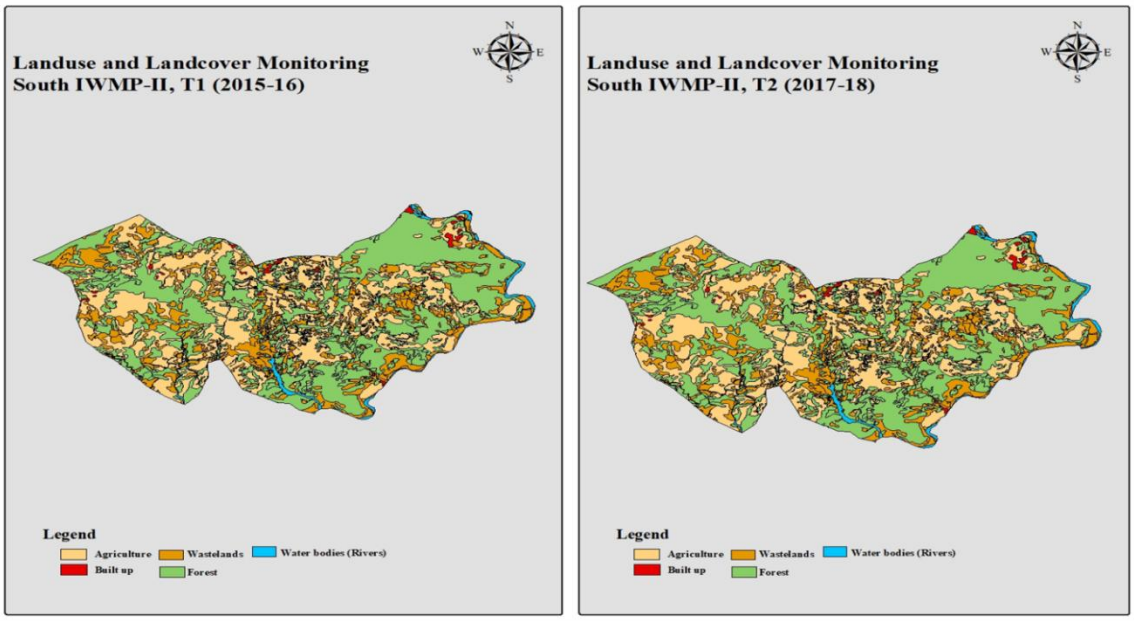



***Fig: Comparative assessment of LULC for T1 (2015-16) and T2 (2017-18)***

**Conclusions:**

The Land use and Land cover changes for this project location are monitored for the period of T0 (2010-11), T1 (2015-16) and T2 (2017-18). Agriculture land has decreased and some of its area has been converted into forest and also to wasteland. Built up has remained same over the years. Forest has increased during the period T1 (2015-16) to T2 (2017-18), which is a positive change. Also during the period T1 (2015-16) to T2 (2017-18) wasteland has decreased and converted into agriculture and forest area, which is also a positive change.

**5. Space based Information Support for Decentralized Planning (SISDP) Phase II**

This project was developed in order to help Panchayati Raj Institutions, the space based information support for decentralized Planning (SISDP) Phase I project was formulated by NRSAC and was implemented through the State Remote Sensing Application Centres in the country to provide basic planning inputs derived from space technology. The major deliverables viz. High Resolution Satellite Image (HRSI) of 2.5 m resolution for the entire country and thematic maps at 1:10000 scale. These products were generated for the first time in the country and are extremely useful in meeting the requirements for the developmental planning , implementation and monitoring of activities at panchayat level.

The SISDP Update is aimed at “Generation of value added geospatial products and services to meet Gram Panchayat Development Planning (GPDP) requirements by using

latest high resolution satellite data and updated thematic database through user friendly web GIS portal.

**Progress of Work:** preparation of Road and River line layer of East district of Sikkim has been completed so far.

6. **Strong Motion Seismometry in Darjeeling-Sikkim Himalaya : Comprehensive Maintenance for round the clock Seismic Monitoring by the 10Station DSSMA and Enriching Ground Motion Database for relooking into Seismic Source, Site and Path Characteristics from Hazard perspectives for a conservative Damage and Loss Estimate in SELENA and HAZUS Environment (SM 10)**

The Darjeeling-Sikkim Strong Motion Array (DSSMA) consists of 10 digital Strong Motion Accelerographs at Gangtok, Mangan, Singtam, Melli, Chungthang, Padamchen, Jorethang, Uttare, Pelling and Darjeeling. Mangan, Singtam, Padamchen, Chungthang, Pelling, Aritar, and Melli have housed 07 'ETNA' force balanced Accelerometer of Kinemetrics of high dynamic range of 108 dB @ 200 samples/sec and 18 bit resolution set at a trigger level of 0.02% of the full scale (2g) for earthquake monitoring and digital recording and three 'OBSEDIAN Accelerograph of Kinemetrics Inc. USA Make, of high dynamic range of 127 dB @ 200 samples/sec and 24 bit resolution set at a trigger level of 0.01% of the full scale (2g) recording are housed at Uttray, Darjeeling and Science Centre Gangtok as shown in **Figure 1.** The current status of the digital acceleographs at the above mentioned stations are given in **Table 1.** Photographs of some representative Darjeeling-Sikkim Strong Motion stations are shown in **Figure 2.** Some significant earthquakes including the 2015 Nepal Gorkha earthquake of Mw 7.9 that impacted this terrain are given in **Table 2** with sample recorded time history shown in

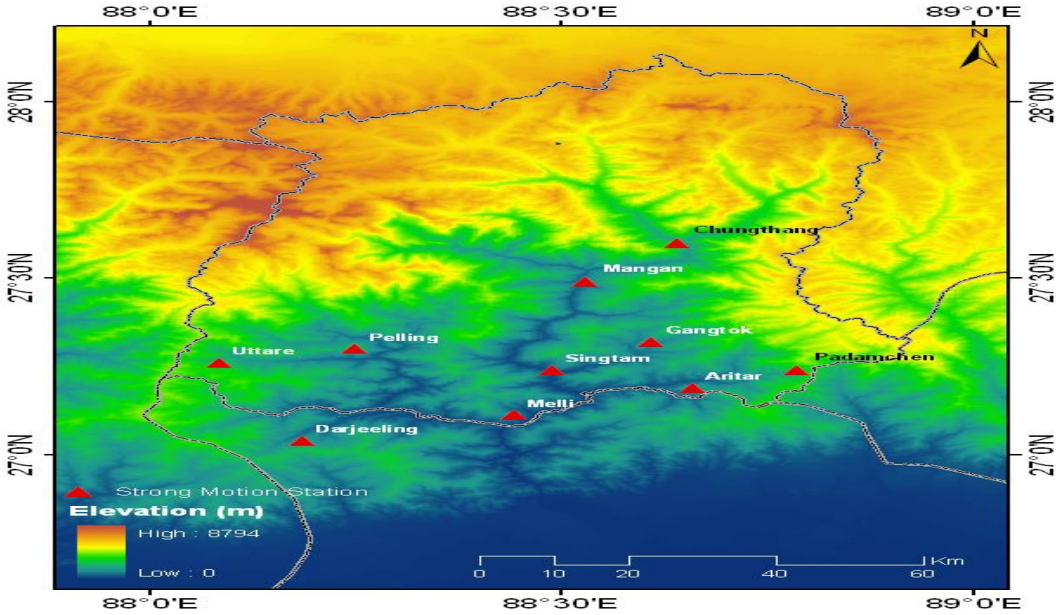



**Fig**: IIT Kharagpur Strong Motion Stations in Darjeeling-Sikkim Himalaya.

(a) (b) (c) (d)

**Fig**: Photographs of some representative Darjeeling-Sikkim Strong Motion stations at: (a) Science Centre, Gangtok, (b) Singtam, (c) Mangan, and (d) Padamchen**Table: Some recent earthquakes recorded by Darjeeling-Sikkim Strong Motion Array.**

| Date | Mw | Depth (Km) | Latitude(⁰E) | Longitude(⁰N) | Location |
|---|---|---|---|---|---|
| **2019/01/07** | **3.0** | 10 | 27.3 | 88.4 | South Sikkim |
| **2019/1/18** | **2.7** | 10 | 27.3 | 88.6 | East Sikkim |
| **2018/06/17** | **4.4** | 49.8 | 27.4 | 88.4 | Sikkim |
| **2018/06/26** | **3.9** | 10 | 27.3 | 88.6 | Gangtok, Sikkim |
| **2017/03/26** | **4.6** | 24.4 | 27.1 | 88.5 | East Sikkim |
| **2016/04/13** | **6.9** | 136 | 23.0 | 94.8 | North-West of Mandalay, Mayanmar |
| **2016/01/04** | **6.7** | 30 | 24.8 | 93.6 | Manipur, Imphal |
| **2015/04/25** | **7.9** | 8.2 | 28.2 | 84.7 | Barpak, Gorkha, Nepal |
| **2011/09/18** | **6.9** | 20 | 27.72 | 88.06 | Mangan |

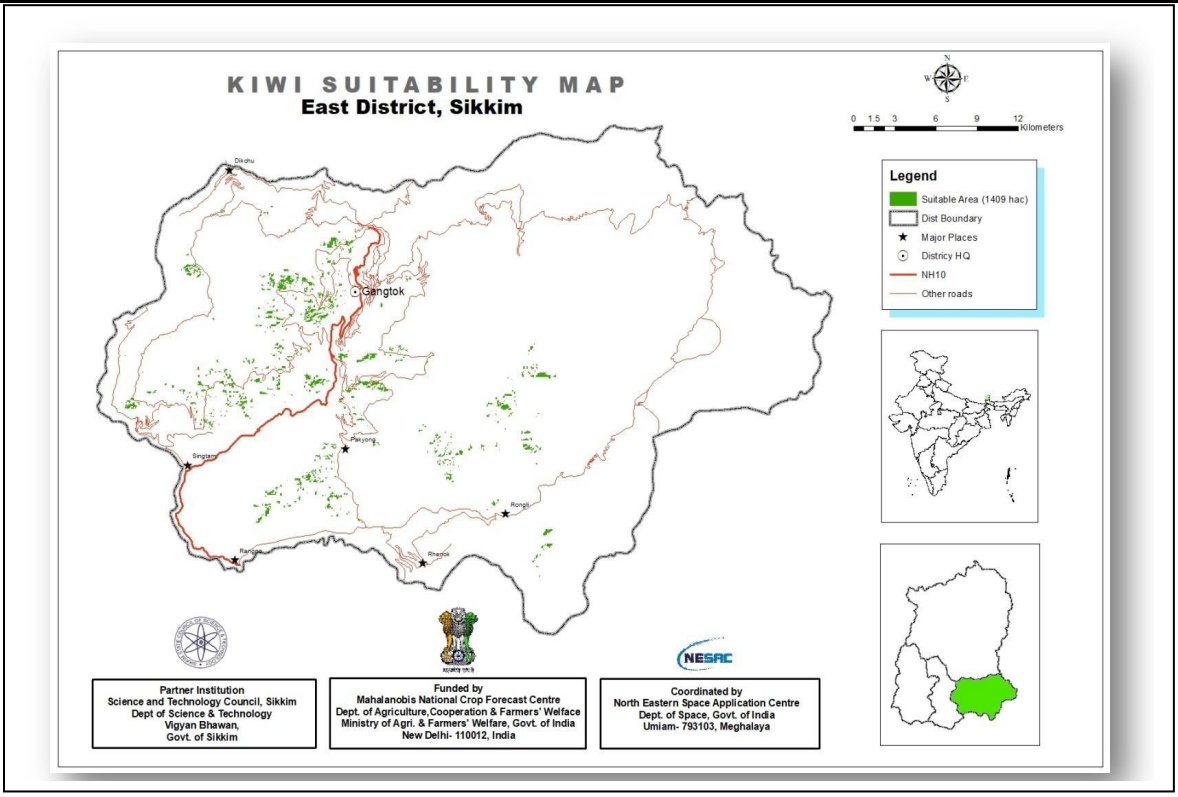
### 7. Site suitability analysis under Coordinated Horticulture Assessment and Management using geoNformatics (CHAMAN) project (Phase-II)

The Site Suitability analysis and mapping of potential areas for cultivation of **Kiwi fruit**s in **East District** of Sikkim under the guidance of Mahalanobis National Crop Forecast Centre.

**The following parameters were used for the analysis the data**.

| SL. No | Parameters/Layers | Data format | Data Source | Remarks if any |
|---|---|---|---|---|
| | LULC | Vector | SIS-DP | Wasteland is considered for analysis |
| | Soil map | Vector | NBSS & LUP | Drainage, Texture and Depth considered for analysis |

| | | | | |
|---|---|---|---|---|
| | Elevation Map | Raster | Carto-DEM NESAC | Extracted Aspect and Elevation. Reclassified According to |
| | Slope Map | Raster | Carto-DEM NESAC | |
| | Base | Vector | State Council-Sikkim | Admin boundary, Road, Block boundary and Settlement. |




| SL No. | Suitable map Area, in ha | Indicator |
|---|---|---|
| 1. | 1409 | Green patches |

**Conclusion and Future Scope**

This study helps in identifying the suitable areas for kiwi plantation. Also a better understanding about the climatic conditions and physical factors on the suitable areas has been identified. If more materials or more research can be taken up by concern department or more documentation is done then the methodology can be redefined to

include more parameters or criteria so that better and more accurate suitability sites can be identified.

Therefore, from the study and the availability of maps the concerned stakeholders can advise the farmers to which area expansion of the cultivation areas can be done or selection of new plantation areas can be taken up based on suitability map. This map is of great use for any governmental projects to be taken because these maps will serve the purpose in identifying suitable areas. Workshop and sensitization programs with the stakeholders and farmers are the need of the hour where the use and importance of the suitability maps are made known to them. Furthermore future project plans needs to include the socioeconomic factors and the marketing system of the crop where the use of these maps will greatly help in improving the economic status of both the farmer and the stakeholder.

**6. North Eastern Spatial Data Repository (NeSDR)**

The main goal of this project is to catalogue all the geospatial layers maintained by various Government Department and agencies of the region in a single window system with common database standard to enable maximum utilization of data for planning activities, effective data sharing mechanism and reduce duplication of geospatial efforts.

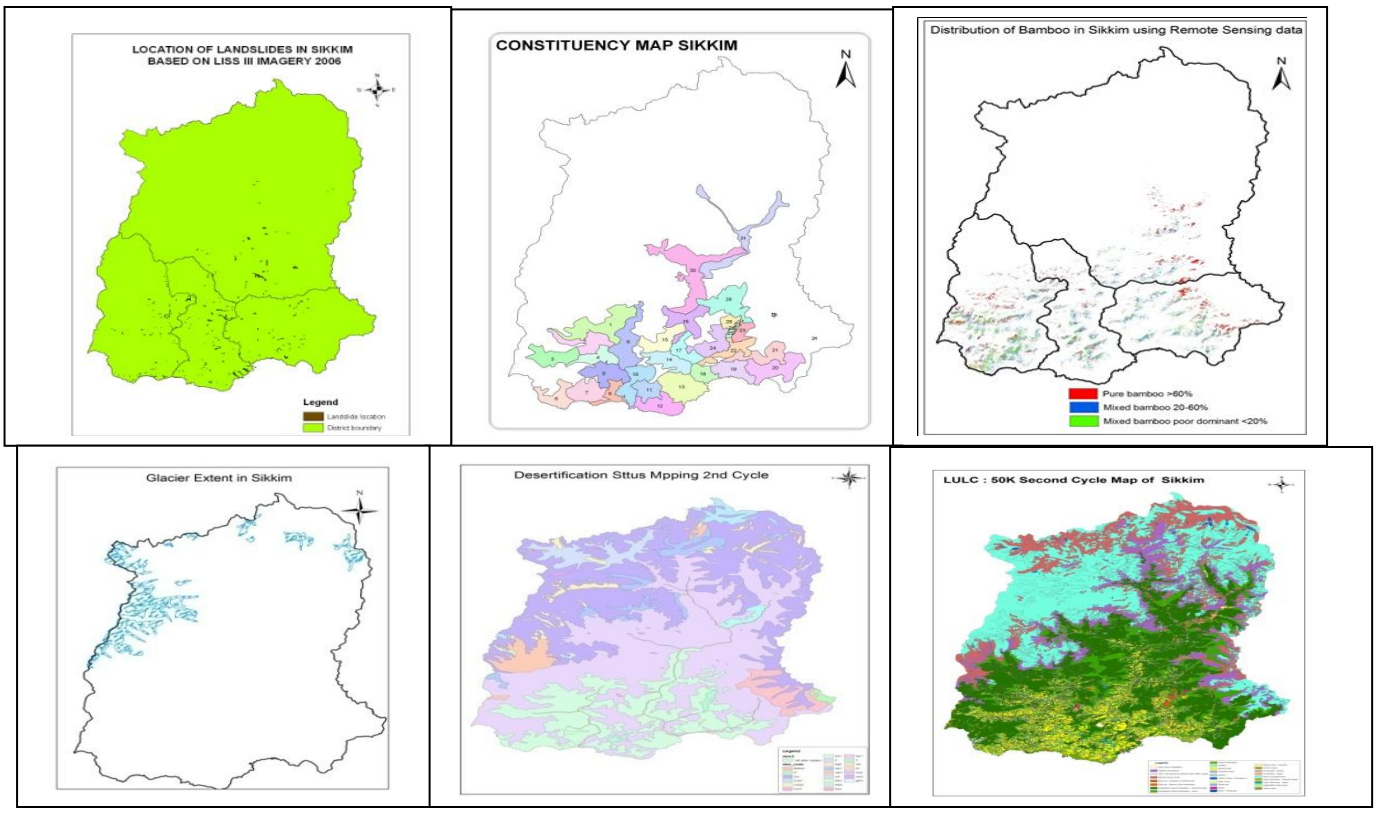



***Fig: The Maps of Sikkim Prepared by the State Remote Sensing Centre, Sikkim***

**7.GeoTagging and Monitoring of NEC funded Projects/schemes in NE region using Geospatial Technology and Tools**

The North Eastern Council (NEC), Government of India, Shillong is the nodal agency for the economic and social development of the North Eastern Region which consists of eight states of Arunachal Pradesh, Assam, Mizoram, Manipur, Meghalaya, Nagaland, Sikkim and Tripura. Being a regional planning body under Government of India, NEC has been playing a vital role for formulating sector wise outline of the development plans and project with a view to accelerating the pace of development with adequate funding provision to the state departments and other Central agencies.

Geotagging of existing projects sites in NE region using smart phone and GAGAN dongles in quarterly intervals as per the directive of NESAC. To carry out unmanned aerial vehicle (UAV) survey in certain project sites on case to case basis and to provide support and coordination during training and outreach phases on various version of mobile and dashboard applications developed by NESAC.So far the work was done using NGMA NEC GEOMONITORING APP developed by NESAC the 39 project site was already cover and uploaded in the Geotagging apps.

**8. National Wetland Inventory and Assessment (NWIA), Phase-II**

National Wetland Inventory and Assessment (NWIA), is a remote sensing based project, which catalogues wetland of India. The project was primarily started with the increasing importance of wetlands, for sustainable development. Department of Science and Technology, Govt. of Sikkim, handles the NWIA project for Sikkim, at the behest of the Space Application Centre (SAC), with the instruction from the Ministry of Environment, Forests & Climate Change, Govt. of India.

Wetlands are areas where water is the primary factor controlling the environment and the associated plant and animal life. They occur where the water table is at or near the surface of the land, or where the land is covered by water (www. ramsarg.site).

Under the text of the Convention of Wetlands, Ramsar, 1971(Article 1.1), wetlands are defined as: “areas of marsh, fen, peatland 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 the depth of which at low tide does not exceed six meters”.

Wetlands are globally important for survival of human and other living beings. They offer plethora of ecosystem services with countless benefits. The economic and biodiversity value of wetlands far outweighs many terrestrial ecosystems.The Himalayas, with its unique topography and climatic regimes, support diverse wetland habitats across a range of altitudes. However, like other wetlands, the Himalayan wetlands also face various threats.They are increasingly being threatened by rapid urbanization, pollution, developmental interventions, unsustainable management practices and encroachment.

Climate change is an emerging issue affecting wetland ecosystems significantly (Erwin 2009). The rapid degradation of wetlands directly and indirectly impacts the health and welfare of resident communities (MEA 2005).

Wetland inventory can be used widely used in developmental activities that require environmental clearance. Key objective of the project are**:**

- To carry out the wetland inventory at the national level on 1:25K scale using 2017-18 time frame Resource sat LISS-III data,
- Change analysis in comparison with the decade old LISS-III 2006-07data,
- Further, to conduct an inventory of wetland on 1:10K scale using LISS-IV 2017-18 data.

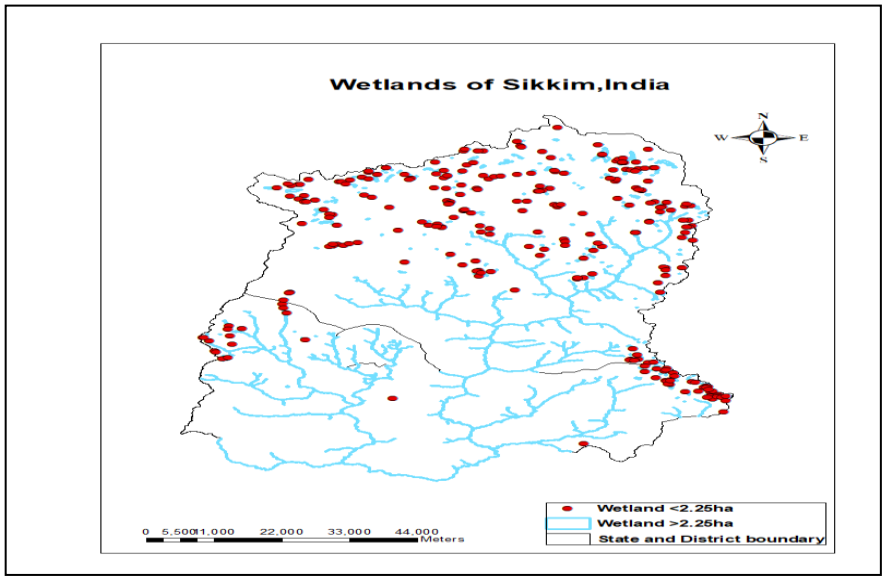



**Fig:** Wetlands of Sikkim, India. The blue line represents wetlands >2.25ha, and the red dots represents the wetlands <2.25ha.

**Facts and figures of the findings**

Table1. Showing category wise wetland distribution over the decades**Area in hectare (ha).**

| **Category wise wetland distribution in Sikkim** | | | | | | |
|---|---|---|---|---|---|---|
| | | 2017-18 | | 2006-07 | | Decadal change |
| **Sl.No.** | **Wetland type** | **Wetland area** | **Percentage of wetland area** | **Wetland area** | **Percentage of wetland area** | **Wetland area** |
| 1 | Inland natural | 7057.11 | 98.9 | 6749.82 | 99.92 | 307.29 |
| 2 | Inland - Manmade | 80.95 | 1.1 | 5.21 | 0.08 | 75.74 |
| | | **7138.06** | **100** | **6755.03** | **100** | **383.03** |

**Table**. Showing category wise wetland distribution and decadal change.

| | | | | 2017-18 | | | 2006-07 | | | Decadal Change | | New | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Sl. No.** | **Wetland type** | | | **No.** | **Area in ha.** | **Area(% of wetland area)** | **No.** | **Area in ha.** | **Area (% of wetland area)** | **No.** | **Area in ha.** | **No.** | **Area in ha.** |
| 1 | Inland | Natural | Lake/Pond | 1 | 15.08 | 0.21 | 1 | 15.08 | 0.223 | 0 | 0 | | |
| 2 | | | High altitude lake | 238 | 2978.59 | 41.73 | 230 | 2530.9 | 37.47 | 9 | 460.39 | 1 | 4.07 |
| 3 | | | River/Stream | 15 | 4063.44 | 56.92 | 12 | 4203.84 | 62.23 | 3 | -140.4 | | |
| 4 | | Man-made | Reservoir/Barrage | 4 | 80.95 | 1.13 | 1 | 5.21 | 0.077 | 3 | 75.74 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **258** | **7138.06** | **100** | **244** | **6755.03** | **100** | **15** | **395.73** | **1** | **4.07** |

**Work completed**

5. Wetland mapping and inventory on 1:25K scale using LISS-III for 2006-7 &, 2017-18 data.
6. Decadal wetland change analyses by comparing 2006-07 and 2017-18 LISS-III data.
7. Mapping of wetlands <2.25ha as point layer
8. Mapping and inventory of wetlands >0.1ha on 1:10K scale using LISS-IV data of Nov2016.

**Ongoing work**

1. Point layer of wetlands <0.1ha, and
2. Base layer of road, drainage and settlement etc. on 1:10K scale using LISS-IV Nov 2016 data.

**Important findings:**

- Decadal wetland analysis of LISS-III 2017-18 Vs. 2006-08 showed an overall increase in wetland area (from 6755.03ha to 7138.06ha, i.e. 380.03 ha), including the number of wetlands, from 244 to 258 wetlands. Refer Table 1&2, Figure 2.
- Increase in the number of wetland is majorly due to un-digitized high altitude wetlands (i.e. missed to digitized using 2006 data), and the construction of new wetland types (man-made as Dams and Barrage etc). Further, formation of a new wetland in higher altitude, with an area of 4.07ha.
- On the contrary to the overall increase in wetland number and area, wetland type: River/Stream showed a decrease of 140.4ha (Table 2.), we opine construction of dams after 2006-07, leading to drying of river and river beds as one of the major cause (Refer Picture 2).
- Overall we calculated ~7138.06ha of wetlands using the LISS-III 2017-18 data, adding around 1% of total geographical area of Sikkim.
- The HAW formed the dominant wetland types, accounting around 92.24% of total wetland area in the state.
- The wetland Tista River with area of 823.75ha (11.5% of the total wetland area) formed the primary contributor to the total wetland area.
- Wetland types such as, the man-made (River/streams and reservoir/Barrage) and natural high altitude wetlands (HAW, located at >3000m asl (above sea level)) wetlands showed major increase in their area.
- The Gurudongmar lakes A&B(5277m), The Khangchung Lake(5300m), The South Lhonak Lake, The Lhonak, The Changsang, The Khangchung Lake (5000m) were

some of the HAWs that showed growth in their area (Refer Figure 3.). Melting of glacier due to rise in temperature could be one of a primary reason.

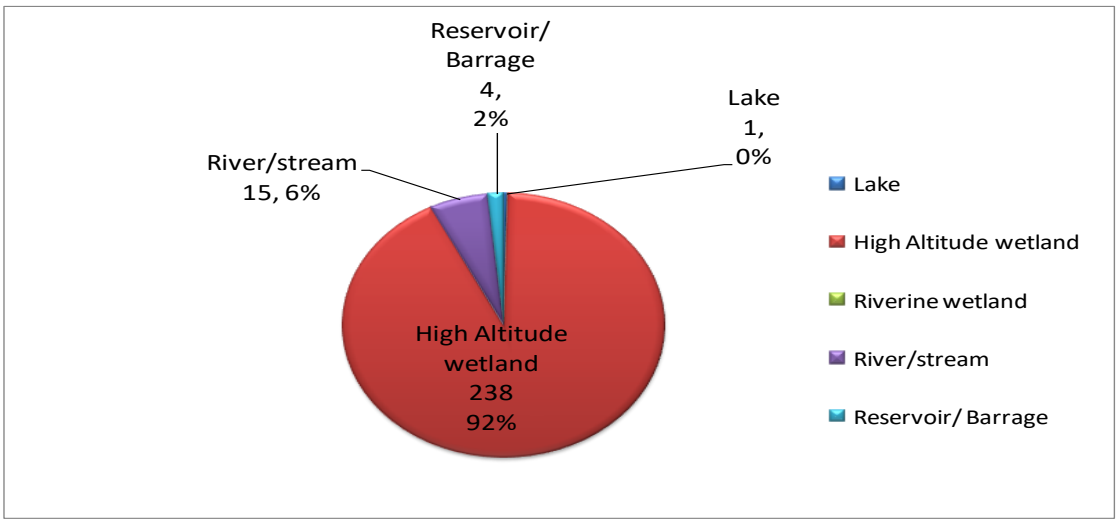



**Figure.2.** Pie chart showing distribution of varied wetland types (by area) in percent of the total wetland area assessed using LISS-III 2017-18 data, Sikkim, India.

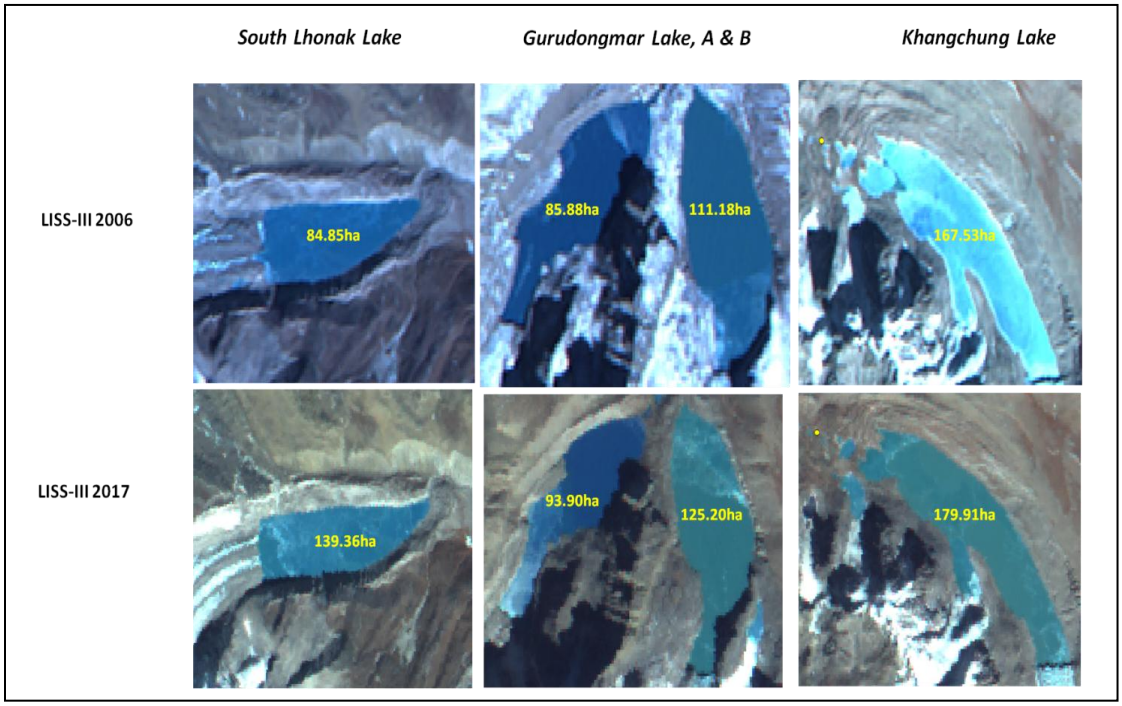


**Fig: Image showing decadal change in area of some of the high altitude wetlands of Sikkim, India.**

***Fig: Showing the side view of the Lhonak lake.***

***Fig: Showing drying river beds, causing decrease in wetland area.***

**III. Popularization of Science**

**1. Establishment of Sikkim State Climate Change Cell under NMSHE:**

Among the four major objectives, vulnerability assessment is one of the important objectives to be carried out under NMSHE project. A series of training programme on vulnerability assessment was done from the year 2017 under the guidance of IISc Bangalore, IIT Guwahati and IIT Mandi. Since NMSHE project basically focused on Himalayan states, in the year 2019, IIT Guwahati and IIT Mandi in collaboration with IISc Bangalore brought first vulnerability assessment report 'Climate vulnerability Assessment for the Indian Himalayan Region using a common framework'. The assessment for Sikkim carried out by Sikkim State Climate Change Cell. The details of the report available at DST GOI website (IHCAP_Climate Vulnerability Assessment _30 Nov2018_Final_aw.pdf in).

Likewise, vulnerability assessment being an important component to be considered for the revision of State Action Plan on Climate Change (SAPCC) of all the states and UTs of India, district wise Pan India vulnerability assessment carried out in February 2020 with the involvement of IIT Guwahati, IIT Mandi, IISc Banglore and representatives from states and UTs.

Sikkim State Climate Change Cell involved for the vulnerability assessment of Sikkim. In this exercise an effort has been made to bring a vulnerability assessment considering the common indicators for all states/UTs with few important state specific indicators. The details report entitled 'Climate Vulnerability Assessment for adaptation planning in India using common framework' released in April 2021 by DST, GOI. The detail report is available in DST GOI website. The indicators considered in the assessment are Livestock to rural population(no/pop), Marginal farmer + small farmer (%),Women work force (%), Unirrigated land (%), Forest Area (ha)/1000 rural pop, Average person days/household employed under MGNREGA (days), Doctors available in district towns (Number) and Yield variability. The assessment shows that in Sikkim, the East and South district falls under highly vulnerable due to the drivers like availability of low livestock, high marginal farmers and low forest area for the rural population. At the national level, Sikkim falls under low vulnerability with the vulnerability score of 0.48. Maharashtra falls under least vulnerable

state with vulnerability score of 0.42 and Jharkhand falls under very high vulnerable zone with score of 0.67. District wise vulnerability map and vulnerability ranking map of Sikkim given in following figures.

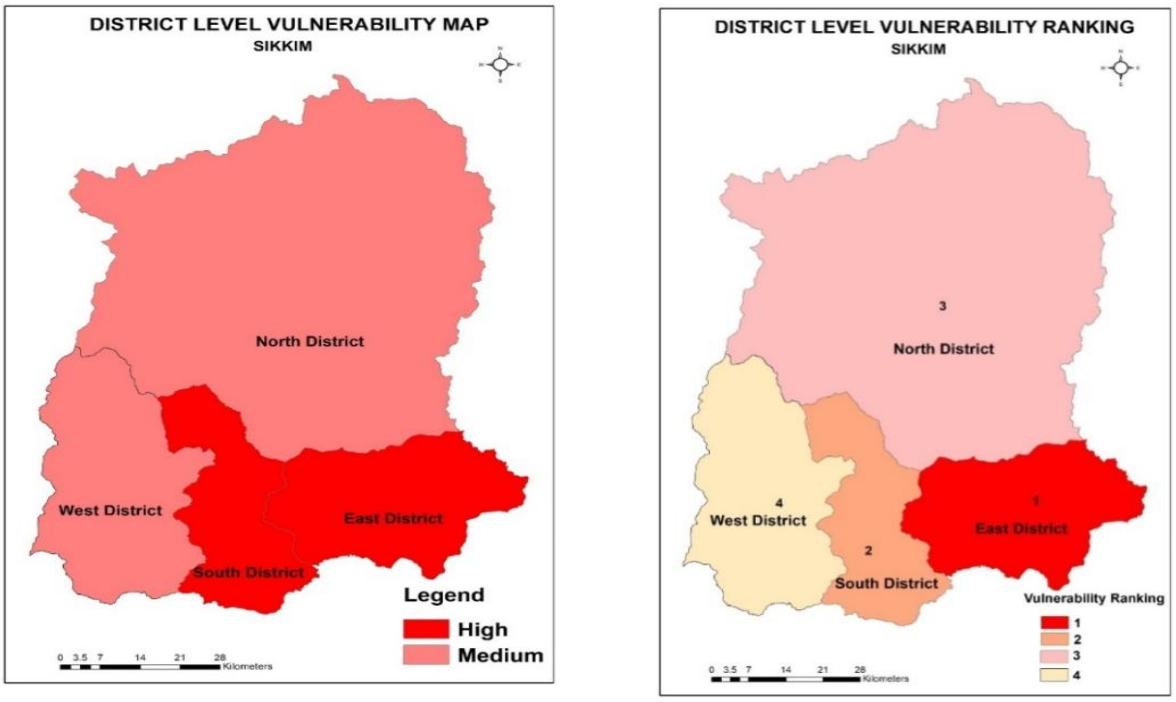



***Fig: District level vulnerability profiles (map and ranking) for Sikkim***

The district wise drivers of vulnerability in Sikkim are given in the following graph.

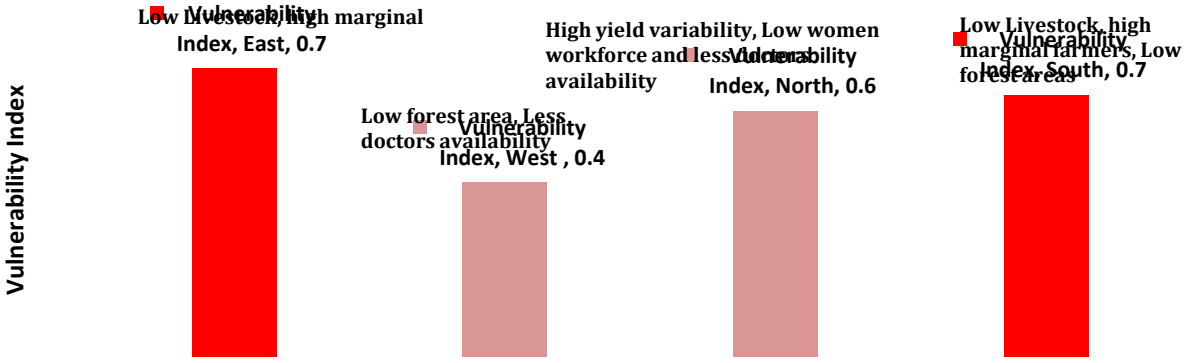



**Fig:** Drivers of vulnerability across the districts in Sikkim

The drivers of vulnerability throw light on areas where focus need to be done for improvement. However, it is not necessary to give a due importance to the divers of

vulnerability done at National level as those indicators are considered primarily to bring out the vulnerability assessment at the common framework. As such it is very important to carry out the vulnerability assessment at regional and local level so that the real indicators and divers of vulnerability can be identified to solve the problems specially considering the impact of climate change. In NMSHE phase-II project that kick started from July 2021, the State Climate Change Cell will focus on sectoral as well as local level vulnerability assessment.

Conclusions, Future aspects and policy recommendations of the NMSHE-Phase-I

This year State Climate Change Cell submitted the Project Completion Report of NMSHE Phase-I project to DST, GOI. As the NMSHE focus on the building resilience to the climatic abnormalities and risks and development of field-based knowledge on mountain ecosystem, the following recommendations has been made that can be useful in field the gaps and minimize the uncertainties and limitations of climate change adaptation.

vi. In this project, vulnerability assessment is one of the important objectives of NMSHE programmes. Further sectoral vulnerability needs to be carried out to know the impacts and vulnerability in the key sectors like Forests, Water, and Agriculture etc. In course of time, assessment of Risk due to climate change is still required to have in-depth understanding of the Himalayan region.

vii. In Sikkim Himalaya, the limited high-altitude observatories and inadequate research capacities on glaciers further add to the glacio-hydrological uncertainties followed by difficult terrain and harsh weather conditions. Therefore, it is necessary to build associations among the knowledge organizations to further enhance and strengthen capacity.

viii. Sikkim Himalaya an integral part of IHR that has many glaciers and snow dominated zones that has contributed to the Teesta river system. However, the region falls under data deficit zone of eastern IHR. Therefore, a dedicated 'Regional Centre for Glaciology' is felt necessary for detail understanding the response of glaciers and prediction of future changes in the glaciers and river flow.

ix. Awareness and sensitization programmes on climate change still need to strengthen with latest innovative programmes like street play, online awareness programme through Essay writings, quizzes etc.

x. The studies pertaining to East Rathong glaciers and South Lhonak glacial lake can be effectively used for the hydrological modelling of freshwater resources (Glaciers) and hydrodynamic modelling of glacial lakes respectively. These in-situ based results of data-deficient zone of Sikkim Himalaya is required to the hydrologists, scientists and policymakers for high altitude freshwater management under a changing climate. However comprehensive understanding of glaciers and glacial lake dynamics at different climatic zones very crucial for the entire Himalayan region.

**Research Paper Published from State Climate Change Cell -Sikkim (under NMSHE) for period 2020-2021**

- Kumar R, Sharma RK, Pradhan P, Sharma N, Shrestha DG (2020) Melt Runoff Characteristics and Hydro-Meteorological Assessmentof East Rathong Glacier in Sikkim Himalaya, India. *Earth Systems and Environment* 4:567-582. https://doi.org/10.1007/s41748-020-00168-4
- Sharma RK, Kumar R, Shrestha DG (2021) Suspended sediment dynamics and associated hydro-meteorological interrelations in East Rathong Glacier, Eastern Himalaya, India. *Material Today Proceedings*. http://doi.org/10.1016/j.matpr.2021.01.082

**2. Characterizing Patterns and Processes of Alpine Ecosystem in Indian Himalaya, Studies on Harnessing Remote Sensing for Environment and Climate (SHRESTI)**

The alpine ecosystem being exposed to low temperature conditions, are generally considered particularly sensitive to climate change (Beniston 1994, Prise and Barry 1997). Less influence by anthropogenic activities and comparatively low ecological complexity, the alpine ecosystems can be considered as "natural laboratories" where the impact of climate change are expected to be more pronounced than on biota at lower altitude. The transition zones like tree-line from where the alpine meadows starts are consider most sensitive and changes can be observed in minimum time. Various studies have reported a shift in tree-line due to climate warming (Walther et al. 2005; Hickling et al. 2006, Parmesan 2006, Chen et al. 2011; Schick off et al. 2015), but due to lack of long term data available for Himalaya, Space Application Centre (SAC), Ahmadabad Department of Space, Government of India in collaboration with the Sikkim State Council of Science and Technology, jointly undertake the programme in Sikkim.

**Overall Objective**

The objective of the programme for Sikkim Himalaya is to establish the long-term ecological site in alpine ecosystem for monitoring tree-line shift and study the plant species richness, vegetation cover and β-diversity (species turnover) across elevation gradient.

**Specific Objectives**

1. Identification of potential field side for the study. 2. Study vegetation dynamics (below vs. above tree-line)

Information for this report was soured from the primary records from the field sites established under the project, and from secondary sources (references listed). This report is not a comprehensive report of this project as the project is ongoing (2019 – 2022).


***Fig: Study area - Kyongnosla Alpine Sanctuary, East Sikkim. The three blue marked points represent the three summits chosen for laying vegetation plots.***

Three summits were selected using the GLORIA (Global Observation Research Initiative in Alpine Environments) protocol representing an elevation gradient. The selected summits covers the elevation gradient starting from subalpine (> 3000m a.s. l. (meters above sea level)) to highest summit point (4046 m asl). Standard GLORIA Multi-Summit approach was followed to set-up the monitoring sites at each summit. In each summit, starting from the highest summit point we established 5m and 10m boundaries of the summit areas. Further in each 5m and 10m boundary we recorded complete species list.

**Findings**

**1st High Summit Point (HSP):** First summit was at an altitudinal range of **4046m asl** (meters above sea level).

**2nd HSP:** The second summit was at an altitudinal range of **3923m asl**.

**3rd HSP:** The third summit was at an altitudinal range of **3811m asl.**

The Long term ecological monitoring sites for tree-line shift was identified and established in Kyongnosla Alpine Sanctury, East Sikkim. Three summits were chosen where total 24 quadrates of 3x3m were established. In each summit, starting from the highest summit point we will establish 5m and 10m boundaries of the summit areas and the summit area sections into east, west, north, and south. In every summit area section within the 5m boundaries, we establish 3m x 3m quadrat clusters and in the four corners of the four 3m x 3m quadrat clusters, 1m x 1m quadrats will be established (Fig. 2). In

each 1m x 1m quadrats we will record detailed vegetation records to detect changes in species composition and changes in vegetation cover. Further in every 5m and 10m boundary, we will record the complete species list and estimation of species percentage cover.

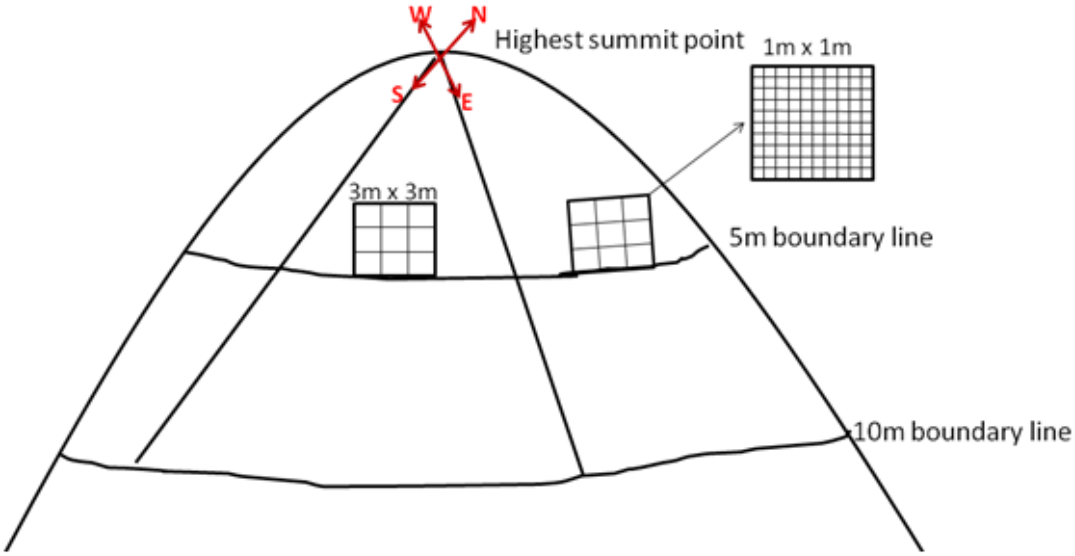



**Figure 2:** The multi summit sampling design shown on a hypothetical example summit.

- Total 56 species of plants (including tree, shrubs and herbaceous plants), were identified in the three summit belongs to approximately 20 families (identification of complete specie list is under progress as our second field survey for one summit (HSP1) is still pending and will be completed by second week of September, 2021).
- We observed a difference in the species composition along the summit within the 5m and 10m boundaries. Species like *Gentiana, Anaphalis busua, Rhodiola* etc. were found to be present in the 5m boundaries of HSP3 whereas shrub species like *Rhododendron anthopogon, Rhododendron campanulatum* etc. were found to be present only within 10m boundaries of HSP3. Similarly thre was differences in species composition in HSP2 as well where *Rhododendron campanulatum, Juniperus recurva, Arisaema* etc. were found to be present only in 10m boundaries of HSP2.
- Further analysis of the field data to be done after the completion of the field survey for the HSP1

**Future directions\Change in species richness, cover percentage**

We will be calculating the mean number of species, cover percentage of each species, mean soil temperature and mean soil moisture. For each species richness and cover, both summit area sections and 1m x 1m quadrat data will be used. Further to

determine the effect of variables like elevation, and aspect on species richness and cover percentage, variation partitioning was used ). Variation partitioning splots the total variation into factions and statistical significance was then evaluated using the Monte Carlo permutation test.

For β-diversity,. we will be calculating the turnover component of beta diversity to examine spatial patterning of turnover resultant dissimilarity among summits using the beta part package (Baselga and Orma 2012).

**Soil properties**

Dry mass will be determine by drying 5 g of the soil samples at 105°C overnight. The total carbon and total nitrogen contents of the soils were measured on a CN analyzer (Leco analyzer) using oven-dried soil. Soil pH was measured in a CaCl2 [0.01 M] solution at a soil: solution ratio of 1:2.5 at room temperature. All physical and chemical soil properties were carried out in triplicate.

***Fig: Photos taken during our field visit to Kyongnosla Alpine Sanctuary, East Sikkim July 20***

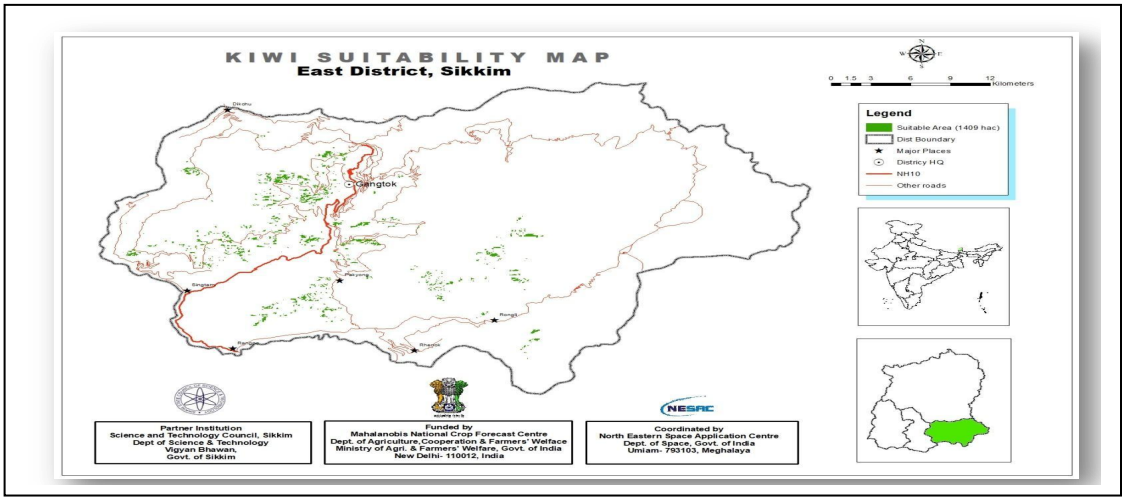
**IV. Trainings provided and attended:**

8. Training provided in collaboration with SIRD and National ,Institute of Rural Development & Panchayati Raj, NERC Khanapara, Guwahati **:** at KVK Namthang on " Integrating DDR & CCR into Rural Development Policies and Programmes" Climate Change Adaptation Strategies- Sikkim Adaptation Initiative". This training was conducted for all the staffs and officials of Panchayat institution and Hort. and Agri staff under South Sikkim.
9. Online Certification Course on " **Remote Sensing & GIS Technology and Application for University Teachers & Government Officials**": Four officials from Remote Sensing Division attended online training during 13th June 2020 to 1st July 2020
10. Capacity building workshop on vulnerability profiles for India: State and district level using a common framework organized by IIT Mandi, IIT Guwahati and IISc Banglore at New Delhi in 2020

**V. Success Story:**

1. **Site suitability analysis under Coordinated Horticulture Assessment and Management using geoNformatics (CHAMAN) project (Phase-II)**

The Site Suitability analysis and mapping of potential areas for cultivation of **Kiwi fruit**s in **East District** of Sikkim under the guidance of Mahalanobis National Crop Forecast Centre.




| **Suitable** map **Area, in ha** | **Indicator** |
|---|---|
| 1409 | Green patches |

This study helps in identifying the suitable areas for kiwi plantation. Also a better understanding about the climatic conditions and physical factors on the suitable areas has been identified. If more materials or more research can be taken up by concern department or more documentation is done then the methodology can be redefined to include more parameters or criteria so that better and more accurate suitability sites can be identified.

Therefore, from the study and the availability of maps the concerned stakeholders can advise the farmers to which area expansion of the cultivation areas can be done or selection of new plantation areas can be taken up based on suitability map. This map of great use for any governmental projects to be taken because these maps will serve the purpose in identifying suitable areas. Workshop and sensitization programs with the stakeholders and farmers are the need of the hour where the use and importance of the suitability maps are made known to them. Furthermore future project plans needs to include the socioeconomic factors and the marketing system of the crop where the use of these maps will greatly help in improving the economic status of both the farmer and the stakeholder.

**2. Published Scientific Papers from State Climate Change Cell -Sikkim (under NMSHE) for period 2020-2021**

This year State Climate Change Cell submitted the Project Completion Report of NMSHE Phase-I project to DST, GOI. As the NMSHE focus on the building resilience to the climatic abnormalities and risks and development of field-based knowledge on mountain ecosystem, the following recommendations has been made that can be useful in field the gaps and minimize the uncertainties and limitations of climate change adaptation. The studies pertaining to East Rathong glaciers and South Lhonak glacial lake can be effectively used for the hydrological modeling of freshwater resources (Glaciers) and hydrodynamic modeling of glacial lakes respectively. These in-situ based results of data-deficient zone of Sikkim Himalaya is required to the hydrologists, scientists and policymakers for high altitude freshwater management under a changing climate. However comprehensive understanding of glaciers and glacial lake dynamics at different climatic zones very crucial for the entire Himalayan region.

**Following are the published papers :**

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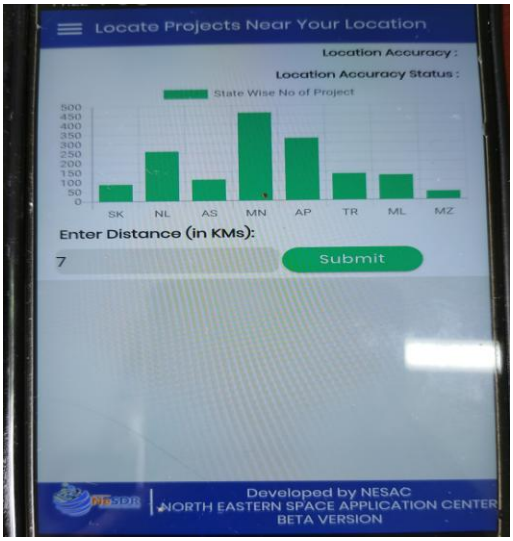
### 3. GeoTagging and Monitoring of NEC funded Projects/schemes in NE region using Geospatial Technology and Tools

The North Eastern Council (NEC), Government of India, Shillong is the nodal agency for the economic and social development of the North Eastern Region which consists of eight states of Arunachal Pradesh, Assam, Mizoram, Manipur, Meghalaya, Nagaland, Sikkim and Tripura. Being a regional planning body under Government of India, NEC has been playing a vital role for formulating sector wise outline of the development plans and project with a view to accelerating the pace of development with adequate funding provision to the state departments and other Central agencies.

A Memorandum Of Understanding has been made on 4th March 2020 with North Eastern Space Application Center (NESAC) as 'First Party' and Sikkim State Council of Science and Technology as 'Second Party' to execute this project.

We as "Second Party" went on a tour to 39 different locations in Sikkim where the NEC funded projects were being carried out. We covered maximum locations of East, West and South Sikkim

Geo-tagging of Thirty Nine project site has been completed and approved in the project. The work was done using NGMA NEC GEOMONITORING APP developed by NESAC.

**A. Project Proposal submitted to funding agency for 2020-2021.**

**1. Preparation of Tourist Guide Maps and Identification and development of potential site for Geo tourism at pilot scale in Sikkim**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

The rural tourism has been initiated in Sikkim through various schemes of state government to popularise the eco tourism in the state. The home stay tourism has been started in various locations and many people in the rural areas have been benefitted so far. However, still there is the need to work more on it as the numbers of beneficiary are very low than expected. There are many home stays constructed under government schemes lying non operational. The lack of training and awareness of the people engaged in the sector as well as the lacks of management to channelize the flow of tourist in those constructed home stays are the major reasons of the poor performance of the schemes. In addition, the scheme fairly lack the concept coined by the geo tourism towards the conservation of culture and tradition of the geographical location. During the peak flow of tourist, the local resident in town like Gangtok and Namchi faces severe problems which need to be resolved through Geo tourism.

**2. Deployment of Early Warning System for Minimizing the Floods Hazards in Potentially Vulnerable Glacial Lakes in Sikkim Using Space Based Technology**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

The disaster related to the glaciers has become frequent in the Himalaya during recent decades. The Kedarnath disaster in Central Himalaya, India, is the recent example of GLOF event, which claimed lives of many people and caused massive damages of infrastructure and property due to outbursts of Chorabari glacier in Uttarakhand (Dobhal et al. 2013; Allen et al. 2015). Sikkim Himalaya consists of 14 potentially dangerous glacial lakes. There are many developmental projects like hydropowers in the downstream of glacial lakes which are in potential threat due to floods. Many hydropower plants are already commissioned and operational since long along Teesta and Rangit rivers. Therefore, study and identification of potentially vulnerable glacial lakes is prime importance. However, it is a challenging task due to the limits imposed by high altitudes, the remoteness of locations and short accessible period of the extreme location. Therefore, the use of high resolution satellite based time series data allow us to identify and prioritise the lake in terms of their expansion over the time. Further, installation of Early warning system in the glacial lakes can be extremely important to save the human lives, infrastructure and property downstream. It is expected that effective and sustainable mitigation strategies could be developed from the present project which are significant inputs for glacial lake management plan in Sikkim Himalaya.

**3. Geotagging and Monitoring of project funded by Government in Sikkim using Geospatial Technology and Tools**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

Government of India as well as state government funded various project/Scheme to various Department in Government of Sikkim as well as other agencies. Due to the typical geographical position, difficult terrain and climatic condition, many times the programmes and schemes sanctioned get poorly implemented. Sometime it is duplicate the project in same location.

The evaluation and monitoring of the status of the projects in in-accessible areas are difficult due to insufficient technical inputs, infrastructure bottlenecks and lack of zeal and transparency in implementation and ineffective monitoring methods.

Considering the above, a project proposal is formulate a web-based platform using Geo-spatial technology for monitoring of the status of the progress of the projects running in various locations of Sikkim. The implementation of the project will help the funding agencies/government to release the fund based on the progress or performance of the project. A parallel project is already in place but that project is limited to the project funded under NEC. Since government fund need to be properly utilised and it requires monitoring through the available technology. So in this proposal, area of interest has been extended to state funded project as well.

The mobile app is already developed by NESAC for the NEC geo tag project and same will be customized for the present project. It is planned to execute the work in collaboration with NESAC.

**4. Developing a Medical Emergency mobile application for telemedicine support in linkage with nearest Health centre District Hospital as well as State Hospital**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

This project aims at **"developing a Medical Emergency mobile application for telemedicine support in linkage with nearest Health centre District Hospital as well as State Hospital".** This application will assist in diagnosing and treating patients with certain ailments during emergency especially in the rural and remote areas. It will also enable the consultations between the doctors and patients as if they are present in the same room. Another feature here is that it will enable the doctor to consult with specialists if they are unable to assist the patient. In many times it will be possible to monitor and treat patients at their homes especially during such pandemic (COVID'19), where it is not safe to step out of homes. Also that Telemedicine offers a low cost health care system for the poorer section of people in the rural and remote corners of the state (Sikkim). It will be an immediate solution to the urgent need of health infrastructure.

**5.Managing Human-Wildlife Conflicts in Sikkim, using Geographical Information System and Remote Sensing**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

Geographical Information System (GIS) and Remote Sensing have played a vital role in conservation and management of the natural resources and in enhancing our

understanding of human-wildlife conflicts. Recently, The Wildlife Institute of India in their study used GIS and RS to assess the level of ongoing human-leopard conflict in PauriGarhwal District of Uttaranchal in relation to landscape characteristics. Remote sensing and GIS have been used to estimate the severity of human-leopard conflicts in relation to vegetation categories. The study has given a better understanding of wildlife management and conservation issues in the area which would help mitigating planning of human-leopard conflicts. Also the utility of Remote Sensing and GIS technology in wildlife conservation planning has been demonstrated. This study can be used as reference and being a government entity, The Wildlife Institute of India can be the credible training partner for this study in Sikkim.

**6. Identification of agriculture current fallow land of Sikkim for establishment of community organic farming centres**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

The concept of community organic farming centres in cultivable fallow land will be more acceptable to farmers for production purposes on sustainable basis. The people of the state are involved in organic farming because of the organic market which is special because of the high premium prices which also has plenty of export opportunities. . The concept of community organic farming centres may offer small farmers and indigenous people, particularly those working in marginal areas, ways of increasing their income in an ecologically sound way.

**7.Mapping, restoration, and rehabilitation of degraded forest**

*Submitted to : North Eastern Space Application Center (NEC through NESAC)*

The proposed project being the first of its kind to work on forest degradation using satellite imagery, it is practically impossible to treat all degraded forests at once; because of the costs of treatment and success rate. Thus this project should be carried out as a model project. Priorities will be outlined, considering social, ecological, and financial factors. We suggest a small-scale pilot study as an effective proposal for a start. Once some initial success is achieved it will be logical and easy to expand a project over larger areas.

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