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वार्षिक रिपोर्ट
Annual Report
2022 - 2023

भारतीय सुदूर संवेदन संस्थान
Indian Institute of Remote Sensing
देहरादून / Dehradun

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HIGHLIGHTS OF ACTIVITIES & ACHIEVEMENTS OF IIRS

The Indian Institute of Remote Sensing (IIRS), a Unit of Indian Space Research Organisation (ISRO), Govt. of India is striving continuously for the capacity building in the field of Remote Sensing (RS), Geographical Information System (GIS) and their applications through training, education and research. IIRS is playing a key role since five decades of its establishment in the country and Asian region in capacity building of various target groups, ranging from fresh graduates, and postgraduate students to policy makers. The Institute also hosts and conduct the training and educational programmes on RS & GIS offered by the Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations. As an integral part of capacity building, the Institute undertakes applied research in Remote Sensing & Geoinformation science, technology and applications and also participate in various research programmes of ISRO.

During FY: 2022-23, a total of 529 participants have benefited from regular training, educational programmes (PG Diploma, M.Tech., M.Sc., sponsored, certificate programme, etc.) and special courses as part of capacity building activities. In addition to regular training programmes, the customized special courses were organized for various target groups wherein around 325 participants have benefitted.

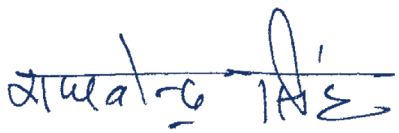
IIRS distance learning programmes - both Live and Interactive classroom (Edusat programme), and Online e-learning programme have significantly

contributed in the mass capacity building activity of the Institute. Under IIRS outreach programme, several modules of Learning Management Systems (LMS) for various certificate courses in geospatial technology were developed.

IIRS is involved in a number of research projects of ISRO/ DOS such as Earth Observation Application Mission, Disaster Management Support, Climate and Atmospheric Programme (ISRO-GBP) and other Mission Projects. In addition to these ISRO/ DOS projects, IIRS faculty have significantly contributed in the research activity through ongoing TDPs and other in-house research projects. Various research papers were published in peer reviewed international and national journals.

Third IIRS Academia Meet (IAM-2023) on theme 'Space Technology for Disaster Risk Reduction in Himalaya: Challenges and Opportunities' was held on March 28, 2023 at IIRS. There were more than 200 participants from various academic institutions, government departments, industries, Edusat-users from all over India besides faculty and student participants from IIRS.

I am thankful to Shri. S. Somanath, Chairman, ISRO for his continuous support and guidance on various initiatives and endeavours of IIRS.



Dr. Raghavendra Pratap Singh
Director, IIRS

IIRS PROFILE

Indian Institute of Remote Sensing (IIRS) is a constituent unit of Indian Space Research Organisation (ISRO), Department of Space, Government of India. Since its establishment in April 1966, IIRS has been a premier Institution and key player for capacity building in the field of Remote Sensing and geospatial technology, and its applications through training, education and research.

Considering enhanced capacity building needs, IIRS has been given the status of an independent Unit of ISRO with effect from April 30, 2011. Over the years, the Institute is playing a major role in capacity building activities which can be primarily grouped into the following three domains:

Formerly known as Indian Photo-interpretation Institute (IPI), the Institute is the first of its kind in entire South-East Asia. While nurturing its primary endeavour to build capacity amongst the user community by training mid-career professionals, the Institute has enhanced its capability and evolved many training and education programmes that are tuned to meet the requirements of various target groups, ranging from fresh graduates to policy makers including academia. IIRS is also one of the most sought after Institute for conducting specially designed courses for the officials of Central and State government ministries and stakeholder departments to make more effective utilization of Earth Observation (EO) data and use of Geographic Information System (GIS) tool. As a follow up of the National Meet held on September 07, 2015; IIRS is also given a special responsibility of Capacity Building needs for effective governance using space technology based tools in Ministries and Department under Central & State governments.

To widen its outreach, IIRS has started live and interactive distance learning programme (DLP) in 2007. Further, graduate and postgraduate students from universities spread across the country have also benefitted through EDUSAT-based distance learning programmes being offered by the Institute till date.

Efforts are underway to develop the e-learning content (also in Hindi) for various RS and GIS applications. The Institute campus also houses the headquarters of the Centre for Space Science and Technology Education in Asia and The Pacific (CSSTEAP), affiliated to the United Nations and first of its kind established in the region in November 1995.

IIRS, as host Institution provides support to conduct all its Remote Sensing and GIS training & education programmes at postgraduate level also. The headquarters of Indian Society of Remote Sensing (ISRS), one of the largest non-governmental scientific society in the country, is also located in the Institute's campus.

The Institute has a strong, multi-disciplinary and geospatial solution-oriented research agenda that focuses on developing improved methods/ techniques for processing, visualization and dissemination of EO data & geo-information for various societal applications and better understanding of Earth's system processes.

Currently, microwave, hyperspectral and high-resolution EO data processing and their applications is the main research focus. Various state-of the-art laboratories, field-based instrumentations and observatories networks help meeting the research goals and objectives.

For further details please visit IIRS website at https://www.iirs.gov.in

ACADEMIC AND CAPACITY BUILDING PROGRAMMES

Highlights

The Institute organises about 35-40 courses every year and it has trained 13,910 professionals (till March, 2023), including 1,491 professionals from abroad representing 110 countries mainly from the Asia, Africa and South America. In addition to regular academic programmes, IIRS is one of the most sought after Institute for conducting specially designed courses for the officials of Central & State government ministries and stakeholder departments for the effective utilization of earth observation (EO) data.

Special/ Tailor-made courses were also designed and conducted at IIRS for various user organizations; such as Basic Course on Remote Sensing, GIS and GNSS (25), Ground-based Subsurface Imaging for Enhanced Earth Observation Application in Geosciences (16), Summer school on usefulness of Remote Sensing and GIS for Environmental Studies (82), Crime GIS (17), Geospatial Inputs for Enabling Master Plan Formulation (25), Basic Course on Remote Sensing, GIS and GNSS (25), Geospatial Inputs for Enabling Master Plan Formulation (25), SAR Data Processing for Land Deformation Studies (19), RS&GIS in Predictive Soil Mapping (19), Remote Sensing and GIS Applications in Hydrological modelling and Data Assimilation (12), Microwave Remote Sensing Applications in Agriculture (13), Geospatial Inputs for Enabling Master Plan Formulation (19), Advance Remote Sensing & GIS and its Application in Water Resource (20), Applications of Remote Sensing and GIS for Disaster Risk Management (08).

To widen its outreach, IIRS has started live and interactive distance learning programme (DLP) in 2007. Further, graduate and PG students from universities spread across the country have also benefited through EDUSAT-based DLP being offered by Institute. IIRS has also launched e-learning course on RS&GIS which is running successfully. The Institute campus also houses headquarters of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations and first of its kind established in the region in 1995. IIRS provides support to CSSTEAP.

Till date CSSTEAP has conducted 67 PG Courses: 25 in RS&GIS, 12 in SATCOM, 12 each SATMET and SAS and 03 in Global Navigation Satellite System. Currently 26th RS&GIS course at Dehradun, 13th SATCOM and 04th GNSS course at SAC Ahmedabad are in progress. In addition, the Centre has conducted 79 short courses including webinar and workshops in the past 27 years. These programmes have benefited 3255 participants from a total of 38 countries in the Asia-Pacific region and 61 participants from 24 countries outside Asia Pacific region. Till date 191 participants from 17 countries have been awarded M. Tech. Degree in the 5 disciplines (85 participants in RS & GIS; 52 in SATCOM; 22 in SATMET; 27 participants in SAS and 05 in GNSS).

Students passed-out in the year 2022-23

Year	Regular Programme							Special Programmes	Total
	PG Diploma*	NNRMS	ITEC	M. Tech.**	M.Sc.***	Decision Makers	Certificate		
2022 - 23	29	37	63	39	9	10	17	325	529

*Completion batch: * PG Diploma (2021-22) ** M.Tech (2020-22) *** M.Sc. (2020-22)*

Details of the Special Course organised in year 2022-2023

S.No	Course Title	Course Duration	Course Period		No. of Participants
			From	To	
1.	Basic Course on Remote Sensing, GIS and GNSS	2 Week	23-05-2022	03-06-2022	25
2.	Ground-based Subsurface Imaging for Enhanced Earth Observation Application in Geosciences	1 Week	13-06-2022	17-06-2022	16
3.	Summer school on usefulness of Remote Sensing and GIS for Environmental Studies	1 Week	20-06-2022	24-06-2022	82
4.	Crime GIS	1 Week	25-07-2022	29-07-2022	17
5.	Geospatial Inputs for Enabling Master Plan Formulation	2 Week	04-07-2022	15-07-2022	25
6.	Basic Course on Remote Sensing, GIS and GNSS	2 Week	25-07-2022	05-08-2022	25
7.	Geospatial Inputs for Enabling Master Plan Formulation	4 Week	05-09-2022	30-09-2022	25
8.	SAR Data Processing for Land Deformation Studies	2 Week	14-11-2022	25-11-2022	19
9.	RS&GIS in Predictive Soil Mapping	2 Week	14-11-2022	25-11-2022	19
10.	Remote Sensing and GIS Applications in Hydrological modelling and Data Assimilation	2 Week	21-11-2022	02-12-2022	12
11.	Microwave Remote Sensing Applications in Agriculture	2 Week	28-11-2022	09-12-2022	13
12.	Geospatial Inputs for Enabling Master Plan Formulation	2 Week	05-12-2022	16-12-2022	19
13.	Advance Remote Sensing & GIS and its Application in Water Resource	1 Week	13-03-2023	17-03-2023	20
14.	Applications of Remote Sensing and GIS for Disaster Risk Management	1 Week	20-03-2023	24-03-2023	8
				Total	**325**

EDUCATION PROGRAMMES

Highlights

M.Tech in Remote Sensing & Geographical Information System (RS&GIS) is a two years course and forty one participants joined for the course. The participants distribution across discipline were as follows - Agriculture and Soils (4), Forest Resources & Ecosystem Analysis (3) Geoinformatics (5), Geosciences (4) Marine and Atmospheric Science (5) Natural Hazards & Disaster Risk Management (5) Satellite Image Analysis & Photogrammetry (4), Urban & Regional Studies (5) and Water Resources (4). Orientation programme for the batch happened on October 01, 2020 in online mode. The batch has five Government sponsored students.

Project Topics:

- Mango orchard phenology monitoring using optical and SAR data
- Improvising the yield prediction of sugarcane using field-scale evapotranspiration estimates
- Geospatial modelling for soil quality assessment in a watershed of hilly and mountainous landscape using machine learning techniques
- Spatio-temporal modelling of forest carbon dynamics in a shifting cultivation landscape of Northeast India
- Study of fuzzy machine learning models for specific crop mapping using dual sensor temporal remote sensing data
- Machine learning based spatiotemporal multi-sensor data fusion for surface coalmine fire detection
- Inter-calibration of nighttime lights using conditional generative adversarial networks
- An application of GPS based PWV for rainfall detection and monitoring
- Machine learning based long term cropland and cropping pattern change analysis using time series data
- Assimilation impact of INSAT-3DR sounder data in the simulation of recent tropical cyclones Tauktae and Yaas
- Study the Indian ocean dipole induced variability in the upper ocean dynamics and thermodynamics: an investigation using numerical ocean modelling, in-situ and satellite data
- Response of the Indian Summer Monsoon System to the Variable Warming Scenarios
- Development of an improved emission inventory over Indian region using satellite data and WRF-Chem model
- CNN based deep learning vs fuzzy machine learning models for medicinal plant mapping using dual-sensor temporal remote sensing data

- Analysis of speckle noise characteristics in SAR Images and its removal through advanced speckle filters
- Polarmetric modeling for lunar surface characterization using Chandrayaan-2 L- and S-band DFSAR Data
- Improving SAR interferometry based Digital Elevation Models using DEM fusion approaches
- Investigation of spinel bearing exposures on the moon for their nature of Occurrences, associated mineralogy and morphological characteristics
- Estimation of urban energy fluxes using Earth Observation data and modelling approaches
- Downscaling of land surface temperature using machine learning algorithms for urban areas
- Investigating the Polarimetric and Interferometric characteristics of SAR data to assess the flood dynamics of Kaziranga National park, Assam
- Mesoscale spatio-temporal modeling of heatwave and heat stress across agro-climatic regions of India
- Land subsidence mapping and monitoring using advanced differential sar interferometry in hasdeo area of Sohagpur coalfields, Madhya Pradesh and Chhattisgarh, India
- Determination of thermal and TEC anomalies as precursors of earthquakes
- Analysing the impact of temporal availability of remote sensing data and interpolation techniques on estimation of irrigation water requirement
- Spatio-temporal flood dynamics and its impact on Kosi river morphological changes
- Characterization of flood inundated paddy crop areas in Darbhanga District, Bihar using multi-temporal SAR and optical images for paddy crop vulnerability assessment
- Assessment of groundwater depletion, its impacts on aquifer-system compaction and land subsidence in Luni-Ghaggar drainage basin by GRACE gravity and DInSAR techniques
- Urban flood risk modelling based on Vegetation-Impervious Surface-Soil (V-I-S) fraction analysis and bivariate techniques
- Understanding the role of biophysical and climatic variables in surface urban heat islands for Indian cities
- Understanding hydrological behavior of Ganga river basin
- Glacier change studies under changing climatic conditions: a geospatial approach
- Glacial-hazard susceptibility and dynamics study of Rishiganga basin, Chamoli using remote sensing techniques
- Assessing the potential of sun induced chlorophyll fluorescence in understanding natural vegetation dynamics
- Study of thermal and Ionospheric anomalies as a precursor of earthquake
- Soil moisture estimation using dual polarized Sentinel 1 SAR data underneath crop cover
- Exploration of space borne LiDAR data in conjunction with remote sensing image for urban feature extraction

IIRS-ITC JEP: M.Sc.

Master of Science in Geoinformation Science and Earth Observation

The Master of Science (M.Sc.) in Geo-information Science and Earth Observation (specialisation/domain: Geoinformatics) is offered within the framework of Joint Education Programme (JEP) of the Indian Institute of Remote Sensing (IIRS) and the Faculty of Geo-information Science and Earth Observation (ITC) of the University of Twente (UT), The Netherlands. Students follow part of the course at IIRS and a part at the Faculty ITC, The Netherlands. The first year will be taught at IIRS followed by some modules at ITC. Students undergo research work under joint supervision of IIRS & ITC scientist/faculties. Upon successful completion of the course, students receive a Master's degree from UT-ITC.

This course is targeted for those who are interested to learn remote sensing and GIS technologies and their applications. Both the working professionals and fresh graduates (including candidates in the final semester/ year of the qualifying degree) can apply for the course. Course is of two years duration.

Eight M.Sc. students joined for 2022-2024 batch and undergoing required course work for this programme at IIRS-ITC.

Nine M.Sc Students of (2021-2023) batch are about to complete dissertation under IIRS-ITC Joint Education Programme (JEP). MSc students of this batch worked on the following research topics:

- Scattering Based Classification of Man-Made and Natural Targets for Polarimetric Calibration of SAR images
- Deep Learning for Built-up Fractional Mapping using Multispectral dataset
- Estimation of spatially distributed change in groundwater storage over Mahanadi basin

- Deep learning based model to extract the Irrigation Canal network
- Spatiotemporal analysis for fire forecasting using Deep Learning techniques in Google Earth Engine – A case study for the Indian state of Uttarakhand
- Multimodal fusion of hyperspectral and fully polarimetric synthetic aperture radar data for improved land use land cover classification using deep neural network approach
- A framework for the development of web GIS-based 3D visualization of flood
- Characterisation of the Lunar Surface using Chandrayaan-2 DFSAR (Dual Frequency Synthetic Aperture Radar) data
- Kinematic modelling and prediction of landslides using InSAR

IIRS-ITC JEP: PG Diploma Course in Geoinformatics

The Postgraduate Diploma (PGD) in Geo-information Science and Earth Observation (specialisation/domain: Geoinformatics) is offered within the framework of Joint Education Programme (JEP) of the Indian Institute of Remote Sensing (IIRS) and the Faculty of Geo-information Science and Earth Observation (ITC) of the University of Twente (UT), The Netherlands. Students follow the course at IIRS. Upon successful completion of the course students receive a diploma certificate from UT-ITC. The UT-ITC certificate has the name 'Post Graduate Diploma in Geo-Information Science and Earth Observation'.

This course is targeted for those who are interested to learn geoinformatics and its various applications. Both the working professionals and fresh graduates (including candidates in the final semester/year of the qualifying degree) can apply for the course. The classes for PGD21-22 started from October 04, 2021 with 10 course participants.

Selection for admission to P.G Diploma course is generally based on merit considering the academic record. However, Institute may also decide conducting interviews of eligible/ shortlisted candidates for selection.

Project Topics

- Crop Health Assessment using Machine Learning
- Impact of snow cover on nighttime lights
- Inaccessibility in Uttarakhand: an exploration using nighttime light data
- Ingest, process, and Visualize LIDAR Data in Python
- Assessment of influence of DEM resolution & its accuracy on flood scenario in parts of NE Himalayas
- Lunar geomorphic feature detection using deep learning
- Creation of QGIS plugins for LULC change modeling
- Deploying python script to automate ingestion of KOBO Toolbox Data into Geoserver
- Geospatial Application for Dairy Supply Chain Management
- Geospatial analysis of energy losses in Andhrapradesh state Central Power Distribution Network

TRAINING PROGRAMMES

IIRS-ITEC Programme

The Indian Technical and Economic Cooperation (ITEC) Programme was instituted by a decision of the Indian Cabinet on September 15, 1964 as a bilateral programme of assistance of the Government of India. IIRS has been entrusted by Ministry of External Affairs, Govt. of India to organize training programmes each year under ITEC.

The ITEC Programme of the Ministry of External Affairs is an earnest attempt by India to share the fruits of its socio-economic development and technological achievement with other developing countries. Under ITEC two short-courses are conducted as follows:

IIRS-ITEC Course on Geoinformatics

eITEC (online) course on Overview of Geographic Information Science

The Indian Technical and Economic Cooperation (ITEC) Programme is a bilateral programme of assistance of the Government of India. It is focused on addressing the needs of developing countries. There are about 161 ITEC partner countries. Capacity Building is one of the major activities under ITEC. The professionals and people from developing countries are offered unique training courses.

This short course during October 3-28, 2022 was attended by 35 participants from 11 countries viz Algeria (10), Azerbaijan, Bangladesh, Brunei Darussalam (6), Ethiopia (5), Georgia, Kenya (7), Mauritius (2), Myanmar (3), Somalia, Tanzania. The training programme of 4 weeks duration was conducted in online mode in two live sessions.

The topics covered during the online sessions were: Introduction to GIS, Geographic Phenomena, Concepts and examples, Data Inputting and Editing in GIS, GIS Data Models (Spatial and Non spatial), Map Projection Concepts & Use in RS & GIS, Spatial Analysis - Introductory Concepts and Overview, Spatial Analysis - Functionality and Tools, Data Quality &Policies OGC, NSDI & GSDI initiatives. Discussion on Internet resources, Open Source Software Technology & Tools, Introduction to Remote Sensing, An overview of Remote Sensing Applications, Introduction to GPS and GNSS, GPS Receivers, Processing, Methods, Errors & Accuracy Satellite Based Augmentation Systems & GPS Aided & Geo Augmented Navigation (GAGAN), Indian Regional Navigation Satellite System (IRNSS)/ NaviC, Advanced Geospatial Modeling, Uncertainty in GIS and Error Propagation, 3D GIS, City Models and Applications.

ITEC MEA Sponsored 21st Short Course on Remote Sensing with special emphasis on Digital Image Processing (09-01-2023 – 03-03-2023)

The training programmes have contributed to capacity building and human resource development in many parts of the world.

This course during January 09, 2023 to March 03, 2023 was attended by 33 foreign nationals from 20 countries. There were 14 participants from Dominican republic and one each from Bhutan, Burundi, Cameroon, Ethiopia, Kenya Kingdom Of Eswatini (Formerly Swaziland), Kiribati, Malawi, Mongolia, Myanmar, Nigeria, Oman, Paraguay, Sri Lanka, Syria, Tajikistan, Tanzania, Uganda and Uzbekistan.

This combined course of 8 weeks duration was designed in such a way that it offered a blend of latest technology and conventional techniques. It covers the basic and advance concepts of Remote Sensing, Photogrammetry, Image interpretation, fundamentals of GIS & GPS, Digital Photogrammetry, Thermal and Microwave Remote Sensing, SAR interferometry and basic & advanced topics on Digital Image Processing and lectures in various thematic disciplines were delivered by Dean, Group Directors, group heads/ Heads of concerned departments. The above topics were covered in theory lecture classes followed up by practical demonstrations. A field visits to ASAN and Paonta areas and An educational and sightseeing tour to Delhi and Agra was organized for the ITEC participants. In the last two weeks the trainees carried out a small project/ Case.

Post Graduate Diploma (PGD)

The Post Graduate Diploma in Remote Sensing and Geographic Information System is an important programme of the Institute. Presently nine specializations are offered in PG Diploma course: one in technology area namely Satellite Image Analysis & Photogrammetry and eight in other application areas such as Agriculture and Soils, Forest Resources & Ecosystem Analysis, Geoinformatics, Geosciences, Marine & Atmospheric Sciences, Natural Hazards & Disaster Risk Management (NHDRM), Urban & Regional Studies and Water Resources.

The course is of 1 year duration, comprising of three modules. The first module is common to all the participants, which deals with Geospatial Technologies focusing on Fundamentals of Remote Sensing & Photogrammetry and Basics of GIS. In the second module, the participants will be exposed to application of geospatial technologies in their respective specialisations. Participants carry out a pilot project in the third module.

The course is designed for the mid-career working professionals, fresh university students with Engineering and science background interested in remote sensing and geospatial technology and its applications. Based on the academic performance of the students, five fellowships are offered to the students under the prestigious IIRS Golden Jubilee Fellowship programme.

The 65th PG Diploma course in RS and GIS commenced on with 19 participants commenced on October 01, 2021 and got completed on August 05, 2022. The participants distribution across discipline were as follows-

Agriculture and Soils (1), Forest Resources & Ecosystem Analysis (5), Geosciences (4), Natural Hazards & Disaster Risk Management (3), Photogrammetry & Remote Sensing (2), Spatial Data Science (3) and Urban & Regional Studies (1).

Project Topics:

- Quantum Computing based Machine Learning for Satellite Image Classification
- Lithological Discrimination of parts of the Bhukia Area, Banswara District, Rajasthan using Hyperspectral Data
- To study the importance of spectral bands for mapping edible oil seed crops from temporal data set
- Intra Seasonal Spatio Temporal Variation of Heat Waves in India
- Analysis of a vegetation cover changes in Himalayas using multi-temporal satellite data
- Spatial distribution of sediment yield from watershed– Geospatial approach
- Monitoring of Barren Island Volcano, India Using Earth Observation technologies
- Land evaluation in dehradun using fuzzy methodology using GIS techniques
- Backscattering Analysis of Archaeological Sites Using Space borne SAR Data
- Assessment of temporal variation of land surface temperature in and around Lamayuru region, Ladakh using multisensor remote sensing data, 2000-2020
- Landslide Hazard Assessment and Modeling in parts of Shimla-Kinnaur National Highway 05, Himachal Pradesh
- Dynamics of Urbanization for Ecological Environmental Quality assessment in Delhi Region
- An evaluation of ECOSTRESS products of North West Himalayan forest, Uttarakhand
- Automated approach for forest disturbance detection using Sentinel - 1 SAR and Sentinel - 2 Optical dataset
- Deformation Analysis in and around Open Cast Mining area in Jharia Coal Field
- Estimation of tree volume using Terrestrial Laser Scanning
- Detection of flowering phenology of Rhododendron using multisensor EO data in Western Himalaya
- Impact of Urbanization and Extreme Events on Urban Floods in Patna City, Bihar
- Identification of Carbonates on Mars using Machine Learning and CRISM Data

NNRMS-ISRO Sponsored Certificate Course in RS & GIS Technology & Applications

IIRS has been conducting ISRO-NNRMS sponsored training programme (8-weeks duration) primarily for the faculty members of the university (including affiliated colleges) since 1993 so as the benefits of the space technology reach the society at large. During 2022, the course was organized during May 9 - July 1, 2022 and 37 participants attended from 17 different states of the country out of which 26 participants were from academic institutions while 11 from scientific institutes. The course comprised of 4 modules, each one of two weeks duration. First three modules are devoted to common module of RS, GPS, GIS and specialized thematic subjects, whereas fourth module is exclusively devoted for carrying out a pilot project by each course participant for better understanding and execution of remote sensing and GIS applications in their respective field of specialization. Participants has opportunity to attend many expert lectures from distinguished scientists during the training period viz., Shri A. S. Kiran Kumar, Vikram Sarabhai Professor & Member, Space commission and Prof. S. P. Singh, renowned Educationalist and Environmentalist, Former Vice Chancellor of Garhwal University. They had also opportunity to participate and win prizes in Yoga competition organized at IIRS and also on International Yoga Day celebrations. Overall the participants were satisfied with

the organization of the course and interaction with IIRS faculty.

Remote Sensing: An Overview for Decision Makers

A four days in-person special training programme on 'Remote Sensing: An Overview for Decision Makers' for the officials of all India services, central Services and state services, was conducted during July 11-14, 2022. In this course, total 10 officer trainees from 10 different organizations of union government and state governments had actively participated. The overall aim of the training course was to instil an appreciation of benefits and constraints of remote sensing technology and geographic information system techniques to aid in planning and management of natural resources and disasters. The course also enabled participants for sharing their experiences and knowledge with the aim of further enhancing the use of geospatial technology and its applications. The entire course was focused on the principles and applications of geospatial technology in the field of governance, urban and regional planning, forestry and ecology, atmospheric science, geosciences, agriculture and food security, meteorology, watershed management, water security, product generation, various types of disasters and their management. Broadly the content covered during the course included following topics- Fundamentals of Remote Sensing, Satellite based Navigation: Principles and Applications, Principles of GIS, Applications of Space based Technology for Enhancing Governances and Development, Geospatial Applications in Urban and Regional Planning, Geospatial Applications in Forestry, Ecology and Environment Security, EO for Air quality monitoring and Atmospheric Pollution, Ground based Geospatial tool for 3D Modelling and Application, Geospatial Applications for Geosciences, Geospatial Applications for Drought Assessment and Food Security, Geo-portal for Meteorological and scientific products. (MOSDAC/VEDAS/Extreme rainfall), Geospatial Applications in Disaster Management, Geospatial Applications for Watershed Management & Rural Development Planning, Geospatial Applications in Marine Studies with Emphasis on Potential Fishing Zone Mapping, Geospatial Applications in Water Security and a case-study on Bhuvan-ISRO's Geoportal Gateway to Indian Earth Observation Data Products and Services.

In general, the feedback has been very good to excellent. Nearly all the participants found the course to be meeting the objectives, relevant, well-structured, nicely organized and very useful to their current nature of job. The participants have mentioned that the course material provided will be very beneficial for help in future. Few participants did feel that the course duration can be increased for better understanding on specific topics.

SPECIAL & CUSTOMISED TRAINING PROGRAMMES

Basic course on Remote Sensing, GIS and GNSS

A Special Course titled "Basic Course on Remote Sensing, GIS and GNSS" was conducted for Central Armed Police Forces (BSF, CRPF, ITBP, SSB) and IB officials during May 23, to June 03, 2022. Total 25 candidates has joined the course from different Central Armed Police Forces from all across the country.

The course was designed to provide the exposure on Remote Sensing, GIS and GNSS technology and its applications, with major focus on strategic feature extraction. The course included both theory lectures and hands on practical exercises. The major topics covered in the courses includes the Principles of Remote Sensing, Platforms and Sensors, Digital Image Processing, Image Interpretation with respect to Strategic targets, Microwave Remote Sensing, Thermal Remote Sensing, Hyperspectral Remote Sensing, Terrain Analysis, GNSS, Basics of GIS and Spatial data formats, Map Coordinate system & Projections and Web geoportals. Special lectures were organized on SAR data interpretation for snow and Glacier areas and geological interpretation in mountainous terrain using remote sensing data.

A formal feedback was taken at the end of the course and in general, the participants appreciated the course and found to be highly useful with relevant content in theory and practicals.

Ground-based subsurface imaging for Enhanced Earth Observation Applications in Geosciences

The one-week special course on "Ground-based Subsurface Imaging for Enhanced Earth Observation Applications in Geosciences" has been organized by Geosciences Department between June 13-17, 2022. The main objective of this course was to encourage enthusiastic scientists, aspiring faculty members, and the young blooming researchers working in geosciences or any related domains; to be familiar with and gain profound knowledge about the fundamentals of geospatial & geophysical techniques and their application in the field of geosciences. A total number of sixteen participants working in various fields in different Institutes and Universities of India has been selected for the course.

The course was designed to include topics like Fundamentals of ground based geophysical methods; Ground Penetrating Radar (GPR), Electrical Resistivity Tomography (ERT), Multichannel analysis of surface waves (MASW) and Time Domain Electro-Magnetic instrument which provide 1D, 2D and 3D subsurface information, Integration of remote sensing and geophysical techniques for value addition and enhanced EO based applications in geosciences, etc.,

Summer school on 'Usefulness of Remote Sensing and GIS for Environmental Studies'

Since last ten years, IIRS is conducting a special course on 'Usefulness of Remote Sensing & GIS for Environmental Studies' for school students of classes varying from 10th to 12th standards. The aim of the course is to create an awareness about remote sensing technology & its use for the study of earth and its environment among the school students. This year, the course was organized from June 20 - 24, 2022. Eighty-two students from 54 different schools of Dehradun and other parts of the country participated in the course. The focus of the course was on principles of Remote Sensing (RS) & GIS and its applications for environmental studies.

Broad subjects covered in the lectures included Overview of Indian Space Programme, basics of remote sensing, basics of GIS, Tsunami and its impact on coastal zones, RS & GIS applications in geological studies, water resources, agriculture, soils, forestry, atmosphere and urban studies. A talk on online learning platforms for geospatial technology and its applications was also organized. Practical demonstrations were also arranged to familiarize the students with satellite images for land & atmospheric studies; various satellite data portals for meteorological satellite images; GIS data collection & mapping and School Bhuvan. The visits to Edusat studio and Space Exhibition were also conducted.

Crime GIS

One week special course titled 'Crime GIS' was conducted during July 25-29, 2022 at IIRS.

The total number of registration received were 89, out of selected participants 9 participants from Academia/Industry attended the course.

Additionally, 8 police personnel nominated by DGP Uttarakhand also attended the course. The course delved into different aspects of Geospatial Technology that could be used for spatial analytics of crime incidents.

Course briefly covered introduction to GIS, coordinate/projection systems, creating and organizing geospatial data, spatial analysis of crime incidents and predictive aspects of crime analysis.

The course was concluded with valedictory function having Dr P.V.K. Prasasd, ADGP Uttarakhand as chief guest in presence of Dr. R P Singh, Director IIRS and team IIRS.

Basic Course on Remote Sensing, GIS and GNSS

A two week Special Course titled 'Basic Course on Remote Sensing, GIS and GNSS' was conducted for Central Armed Police Forces (BSF, CRPF, ITBP, SSB) and IB officials during July 25, 2022 to August 05, 2022. Total 25 candidates participated in the course from different Central Armed Police Forces (CAPFs) & Intelligence Bureau (IB) from all across the country.

The course was designed to provide the exposure on Remote Sensing, GIS and GNSS technology and its applications, with major focus on strategic feature extraction. The course included both theory lectures and hands on practical & hands on exercises. The major topics covered in the courses includes the Principles of Remote Sensing, Platforms and Sensors, Digital Image Processing, Image Interpretation with respect to Strategic targets, Microwave Remote Sensing, Thermal Remote Sensing, Hyperspectral Remote Sensing, Terrain Analysis, GNSS, Basics of GIS and Spatial data formats, Map Coordinate system & Projections and Web geoportals. Special lectures were organized on SAR data interpretation for snow and Glacier areas and geological interpretation in mountainous terrain using remote sensing data. There was also one lecture from Guest faculty, Sujata Ghosh from ADRIN. She has delivered the talk on High Resolution Image Analysis for Strategic Applications. A field visit on DGPS survey and GPS data collection is also done in Dehradun city. The Participants were provided hands on exercises in both COTS and open source softwares for processing Remote sensing & GIS data.

SAR Data Processing for land deformation studies

A Special Course entitled 'SAR Data Processing for Land Deformation Studies' of 02 weeks duration was conducted during November 14-25, 2022 wherein nineteen officials participated in the course including four government sponsored participants in the course.

The course had both theory lectures and practical exercises. Five projects were also carried out by participants. Four guest faculties were also invited in the course apart from internal faculty.

In general, the feedback has been very good to excellent. Nearly all the participants found the course to be meeting the objectives, relevant, well-structured and very useful to their current nature of job.

Few participants did feel that the duration of the course should be of four weeks as two weeks are not enough for such kind of training.

Few participants expressed the requirement of such more courses in future specially using the open source environment for time-series measurements using SAR data.

Remote Sensing & GIS in predictive soil mapping

A course of two weeks duration was conducted during November 14-25, 2022 where in 19 government sponsored candidates representing various research organisations as well as universities across the country attended the course. The major topics covered during lectures were: Introduction to RS, Data Analysis and GIS; Soil-landscape Analysis for Soil Mapping, Principal and Approaches of Predictive Soil Mapping, Environmental Covariates, Spectral Indices for soil studies, overview and application of machine learning techniques and geostatistical approaches for predictive soil mapping, role of spectroscopy for DSM as well as global soil web resources and databases available for soil mapping. Senior scientists from ICAR-IASRI, New Delhi and IIT Kharagpur delivered invited guest lectures on the topics "statistical measures for sampling and accuracy" and "proximal soil sensors for digital soil mapping" respectively for the benefit of the participants. Hands-on exercises were carried out on various aspects of geospatial data handling, spatial variability analysis using geostatistics, and application of machine learning techniques for digital soil mapping. One-day field visit was carried out in Bidholi, langha and surrounding area for identification of soils in the field and study of the soil- landscape relationship using RS data. Further the participants were divided into 05 groups and each group carried out mini-project on application of various techniques for predictive soil mapping.

Remote Sensing and GIS applications in Hydrological Modelling and Data Assimilation

Two weeks special course on 'Remote Sensing and GIS Applications in Hydrological Modelling and Data Assimilation' was organised in offline mode at IIRS, Dehradun during November 21, 2022 to December 02, 2022. Total 12 candidates including Research Scholars, Teachers, Professors and JRFs from various research and academic institutions as well as universities attended the course. 20 lectures and 8 practicals were conducted covering various methods and applications of RS & GIS in hydrological modelling and data assimilation including 4 guest lectures by eminent speakers from other organisations. The course provided an overview of advance earth observation data and modelling approaches for monitoring and quantitative assessment of hydro-meteorological studies. The main aim of this course was to spread awareness about importance of remote sensing data and hydrological modelling including data assimilation in assessment of the hydro-meteorological hazards such as floods, GLOFs, drought and avalanche. The major topics covered in the course were as: Remote sensing data formats and its processing using different tools and technology; Hydrological modelling with different geospatial inputs; Concept of Data Assimilation, Data Assimilation Techniques, Applications of Data Assimilation; Assimilation of Remote Sensing Derived Land Surface Parameters in Hydrological Model, etc.

Training & Capacity Building Initiatives under AMRUT Sub-scheme

The Govt. of India (GoI) has launched Atal Mission for Rejuvenation and Urban Transformation (AMRUT) which has a sub-scheme on 'Formulation of GIS Based Master Plan for AMRUT cities'. IIRS along with Town & Country Planning Organisation (TCPO), Ministry of Housing and Urban Affairs (MoHUA), GoI has developed the course contents for country-wide training and capacity building of personnel involved in sub-scheme at three-level [Tier-1: Decision Makers (three-day), Tier-2: Mid-level (two-week) and Tier-3: Junior-level Officials (four-week)]. The course contents are designed to build capacity among urban planning professionals for utilising geospatial data for Master Plan Formulation and for Utilities Management. Various achievements so far made under training & capacity building activities under AMRUT Sub-scheme are:

1. Three-tier training programmes: IIRS has so far conducted eleven face-to-face training programmes. 332 participants from 16 states (till December 2022) have benefitted from these programmes at IIRS.

2. Tier-2 Course (July 4-15, 2022): A 2-week, Tier-2 course for middle level officials (July 4-15, 2022) was organized by Urban and Regional Studies department, IIRS for TCPO officials from Maharashtra under the AMRUT sub-scheme. 25 officials attended the training programs. The training covered lectures and practicals, field visits and special guest lectures emphasizing facilitation of AMRUT database generation and analysis.

3. Tier-3 Course (September 5-30, 2022): A 4-week, Tier-3 course for junior level officials (September 5-30, 2022) was organized by Urban and Regional Studies department, IIRS for TCPO officials from Maharashtra under the AMRUT sub-scheme. 25 officials attended the training programs. The training covered lectures and practicals, field visits and special guest lectures emphasizing facilitation of AMRUT database generation and analysis. Special emphasis was given on open-source softwares for remote sensing and GIS data processing.

4. Tier-2 Course (December 5-16, 2022): The Urban and Regional Studies department at IIRS arranged a Tier-2 course intended for middle-level officials from the Government of Maharashtra. The course, which took place from December 5-16, 2022, was held under the AMRUT sub-scheme and was designed to help officials generate and analyze the AMRUT database. Nineteen officials attended the two-week program, which included lectures, practical sessions, field trips, and guest lectures.

Microwave Remote Sensing Applications in Agriculture

Two weeks short course was organized during November 28, 2022 to December 09, 2022 wherein thirteen number of participants comprising Scientist, Professors, Ph.D. scholars and JRFs from State and Central University, Government departments, NITs and IITs attended the course. 12 lectures and 6 practical including 4 Guest lectures by eminent speakers from other ISRO centres were conducted to cover various facets of SAR remote sensing in Agriculture. The major topics covered during the lecture were Introduction to Microwave Remote Sensing- an overview, Synergistic use of optical and microwave data for agricultural monitoring, Introduction to Microwave RS-SAR system with special reference to RISAT-1A SAR, Agricultural applications with SAR data with special reference to operational activities including RISAT-1A SAR, microwave remote sensing for crop growth monitoring and assessment including synergy of optical and Radar remote sensing for crop inventory and monitoring, Overview of Operational SAR Data Products- Special Reference to RISAT-1A SAR, Biophysical parameter retrieval from multi-parameter SAR data, SAR sensors parameters requirement for Agricultural applications- Past, present and future prospects in Microwave Remote sensing, SAR data processing, SAR Applications in Soil Moisture, SAR Polarimetry and Interferometry applications Agriculture and Passive Microwave RS applications. Apart from these one day field visit was carried out in Poanta and surrounding to have hands-on experience in field data collection using various instruments.

Short course on Remote Sensing and Image Analysis (CRS)

A Short Course on Remote Sensing and Image Analysis (CRS) was organized from January 9, 2023, to March 3, 2023 where in 17 Participants had participated in this short course. It had one Indian Government sponsored Trainee and 16 Self-Financed Indians.

The primary objective of these courses was to enhance the capacity of middle-level professionals in the field of remote sensing with special emphasis on the processing of remotely sensed data using digital image processing techniques.

This course of eight weeks duration was designed in such a way that it offered a blend of the latest technology and conventional techniques. It covers the basic and advanced concepts of Remote Sensing and Digital Image Processing.

These topics were covered in theory classes followed by practical demonstrations & field visits. An overview of various applications of RS and GIS Techniques in various thematic disciplines were also delivered.

Advance Remote Sensing & GIS and its Applications in Water Resources

IIRS received a request from Water Resources Department (WRD), Govt. of Rajasthan to organise a tailor made customised course for their 20 officials on 'Advance Remote Sensing & GIS and its Applications in Water Resources' under National Hydrology Project. The course syllabus and dates are decided mutually by IIRS and Govt. of Rajasthan. The course was organized during March 13-17, 2023.

As the course participants were already trained in Remote Sensing and GIS, the course focus was more on application of these techniques in water resources. The participants were taught surface water body mapping; reservoir sedimentation; quantification of hydrological components; DEM applications; hydrological modelling; soil erosion and sediment yield; site suitability analysis for water harvesting structures (WHS); floods and drought. Apart from these lectures, dedicated hands-on on water body mapping and reservoir sedimentation; command area mapping and estimation of irrigation water requirement; DEM hydro-processing and hydrological modelling; Site suitability for WHS were conducted. A demonstration on sources and portals for spatial and non-spatial data was also organized. Overall, the course was highly appreciated by the course participants and suggested duration of the course should have at least 02 weeks. The WRD, Govt. of Rajasthan shown their willingness to conduct such courses with IIRS in future, as well.

Applications of Remote Sensing and GIS for Disaster Risk Management

A one-week special course on 'Applications of RS and GIS for Disaster Risk Management' sponsored by National Disaster Management Authority (NDMA) was conducted by IIRS during March 20-24, 2023. In this course, total 25 participants were expected to join the course but due to personal and official engagements only 8 participants could join the course on March 20, 2023. Out of 8, there are 2 participants each from Himachal Pradesh, Uttarakhand; 1 each from Kolkata, West Bengal; IMD New Delhi; IMD Dehradun; DDMA Barabanki, Uttar Pradesh.

The faculty members of IIRS and one guest faculty from SAC Ahmedabad delivered the lectures and conducted practical sessions in this course. At the end of the course a formal feedback was collected, and in general the feedback was very good to excellent. Nearly all the participants found the course to be meeting the objectives, relevant, well-structured and very useful to their current nature of job. Few participants did feel that the duration of the course should be of 2 weeks as One week is not enough for such kind of training.

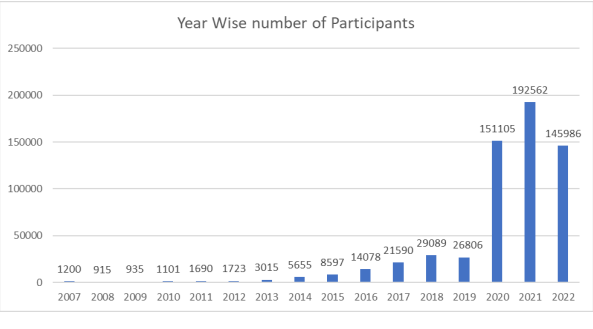
OUTREACH ACTIVITIES

With the rising trend and increasing popularity of online learning, especially after the emergence of a global pandemic, distance learning – along with new information technology, has been adopted extensively by educational and training institutes. Over the past few years, the government of India through its policy of Digital India, has been promoting such endeavors to popularize digital leaning environment. Distance Learning Program (DLP) offered by Indian Institute of Remote Sensing (IIRS), Indian Space Research Organisation (ISRO), is an innovative initiative for training students and professionals from academia and user departments in the field of geospatial technology & Earth Observation. IIRS DLP started in the year 2007 with 312 participants from twelve universities in India. Till December 2022, IIRS has successfully conducted 130 outreach programmes through live and interactive classroom mode (also known as EDUSAT programme) benefitted more than 5.73 lakh participants from 3034 network Institutions distributed across the country. The present outreach programme is being conducted through following two major modes:

- Live and Interactive classroom Programmes
- E-learning or Massive Open Online Courses (MOOC).

1. Live and Interactive classroom Programmes

IIRS uses internet based digital platform for conducting live and interactive online courses to primarily complement the educational programmes of the Indian Universities/Intuitions. In year 2022, IIRS has conducted total 28 online courses/full day workshops/webinar series benefiting 102989 participants from 1223 networked Institutions. IIRS has conducted 10 advanced topic courses, 7 basic courses, 6 full day workshops, 3 special MOOC courses 2 special customized courses. A total of 1.47 Lakh participants participated in IIRS online courses in 2022 from 1223 unique institutes across the country. The courses offered were covering a wide range of topics like Basics of Remote Sensing and GIS, Overview of Geoprocessing using Python, Satellite based Navigation, for Disaster Management, GIS for Supply Chain Management, Geospatial Technology for Archaeological Studies, Earth Observation for Carbon Cycle Studies. A one-day workshop on Space and Spatial Technology was conducted in Hindi on occasion of "VISHWA HINDI DIWAS". A special course on Fundamentals of Remote Sensing and GIS Technology was also conducted in Hindi language for the benefit of Hindi speaking participants. All the courses of IIRS DLP are made available through in-house developed Electronic Collaborative Learning and Knowledge Sharing System (E-CLASS) platform. The status of total benefiting participants is given in Table 1.



Details of courses conducted in 2022

Sl. No	Course	Institutions	Participants
1	Space Technology and its Applications	376	2695
2	Advances in Monitoring and Modeling of Hydro-Meteorological Hazards using Geospatial Technology and Process based Models	383	1719
3	Geo-data processing in Cloud computation platform- case studies using Google Earth Engine	357	1527
4	UAV Remote Sensing	300	1970
5	RS & GIS Applications in Natural Resource Management	441	3406
6	Overview of Geocomputation and Geo-web services	785	8910
7	Cryospheric and associated Mass Movements in the Himalaya: Recent Trends in Remote Sensing Techniques	396	440
8	Geo-data sharing and Cyber Security	716	5546
9	Applications of Geospatial Technology in Paleochannel Studies: Potential And Future Trends	295	1118
10	Overview of Geographical Information System	497	3835
11	Overview of Global Navigation Satellite System	681	5640
12	Fundamentals of Remote Sensing & GIS Technology (Course in Hindi)	610	4871
13	Basics of "Remote Sensing, Geographical Information System and Global Navigation Satellite System	745	8822
14	Remote Sensing and Digital Image Analysis	562	2449
15	Water Quality studies using Hyperspectral Remote Sensing for the Indian Coastal and Inland Waters	188	949
16	Remote Sensing & GIS Applications in Agriculture	322	1602
17	Flood monitoring using space based E arth Observation Systems	265	1331
18	Satellite Remote Sensing of Atmosphere	400	3148
19	Machine Learning to Deep Learning: A Journey for Remote Sensing Data Classification	810	9968
20	Geo-spatial Applications for Forest Ecosystem Analysis	423	1728
21	Space Technology & Applications	1	1999
22	Planetary Exploration of the Moon: Findings from Indian Remote Sensing Missions	390	2624
23	Status, Challenges and Opportunities for Geospatial Technology Applications in Irrigation Water Management	449	2061
24	Artificial Intelligence (AI) for Earth Observation (EO) and Geodata Handling and Processing	543	2610
25	Advanced Geospatial technologies for Disaster Risk Reduction (DRR)	355	1890
26	Hyperspectral And Microwave Remote Sensing Techniques For Geological Studies	538	2593
27	Global Navigation Satellite System and Location based services	716	4017
28	Overview of Geoprocessing using Python	1256	14873
29	Remote Sensing Technology and its Applications (Course in Hindi Language)	735	4641

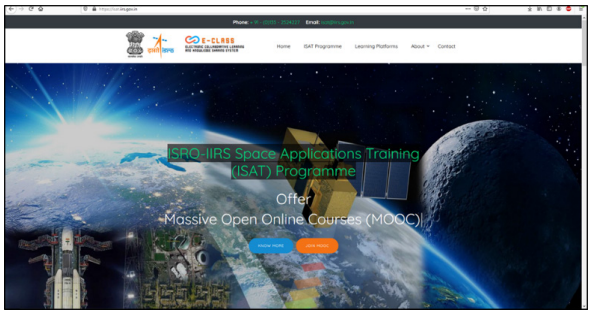
2. E-learning or Massive Open Online Courses (MOOC).

To enhance the outreach of geo-spatial science and technology, IIRS is also conducting e-Learning course in Remote Sensing and geo-spatial technology and its applications. In year 2022, the initiatives were taken to upgrade the contents of these courses by converting the existing content into user friendly html format and also with inclusion of new e-learning courses on thematic domains. Currently, more than 29,000 participants have registered for these courses out of which 4178 participants have opted for certificate until December 2022. The courses contents of RS&GIS technology are also available in Hindi language.

To expand the scope of E-Learning from technology to application of technology in thematic disciplines, e-Learning content for eight thematic disciplines demonstrating applications of geospatial technology were prepared. A total of 30.25-hours content covering RS and GIS applications in various disciplines such as urban and regional studies, agriculture, disaster mitigation and management, forestry, water resources and marine sciences were generated.

The developed thematic contents are being organized in form of e-Learning courses and will be made available to the learners through IIRS e-learning portal. A total of 11 courses on advanced topics are ready and will be soon available to users. IIRS eLearning course "Comprehensive course on Remote Sensing and GIS" was approved by All India Council for Technical Education (AICTE) as a 04 credit course and made available on SWAYAM portal of MHRD. In the year 2022, around 21,000 participants were registered for the course through SWAYAM portal. The examination was conducted by National Testing Agency and around 350 participants successfully completed the course and received certificate from AICTE.

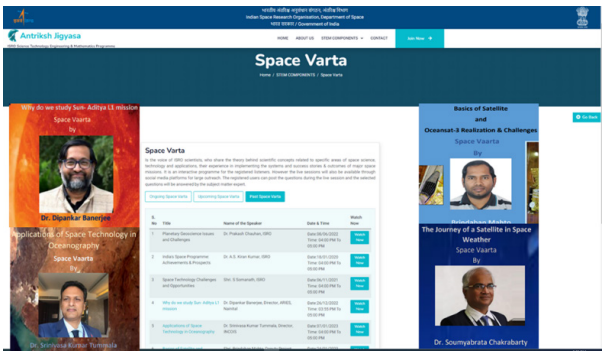
The ongoing outreach programme of IIRS-ISRO is targeted to the users from India. However, there are many requests from outside India to participate in IIRS-ISRO online courses. By considering the online training requirements of International users, IIRS is conducting International Distance learning programme under "ISRO-IIRS Space Application Training (ISAT)" programme since 2020. A dedicated portal, Learning Management System (LMS) and E-CLASS International platform was developed and deployed for International users in the Month of October 2020. A dedicated portal, Learning Management System (LMS) and E-CLASS International platform was developed and deployed for International users. This online training programme focusses on providing basic and advanced information in the field of Remote Sensing and Geospatial Technology and its applications; Satellite Navigation technology and Its applications; Planetary Science and applications;Weather and climate studies with focus on spatial data analytics and assimilations, SAR Data Processing and its Applications,Overview of Space Science & technology,Remote Sensing & GIS for Urban Studies and Environmental Modeling. The main focus of the programme is to popularize the technology, data products and services from Indian space programme. The International Outreach Programme is targeted to impart the training to Student community- Undergraduate, Post graduate and PhD scholars; Scientist and Researchers; and Governmental users from SAARC and Asia Pacific countries. Total 84742 participants from 115 countries have registered for the course. IIRS has developed online learning platforms and LMS for ISAT programme and made available to the learners through URL- https://isat.iirs.gov.in. The home page for ISAT LMS are shown underneath.



Details of Courses MOOC conducted for International Participants

	SAR data processing and applications	Overview of Space Science and Technology for School students	Remote Sensing & GIS for Urban Studies and Environmental Modeling
Course Start Date	April 04, 2022	June 06, 2022	July 06, 2022
Course Close Date	May 03, 2022	July 05, 2022	August 05, 2022
Total Registration	7477	34343	1177
Total Certificate Issued	1024	7026	156
No. of countries	36	115	47

During 2022, IIRS has designed and developed an Online Learning and Knowledge Sharing System "Antriksh Jigyasa" under ISRO STEM program. The portal is an active learning virtual platform which offers self-paced online courses to the learners on space science, technology, and its applications. It consist of six major verticals viz. Shiksha Gagan, Space Varta, Sky-Picks, Antariksh Navachar, Space Quiz and Space Park. Apart from this, the portal also contain educational material as lecture videos and documents along with reading material on various missions of ISRO. Figure 3 shows the registration page of Space Varta.



ISRO celebrated International Moon Day on July 20, 2022. As part of the celebration, an online Painting/ Drawing and Quiz competition was conducted for school students of Class 8th to 12th. Reading material and related videos were also hosted in the portal for the aiding of the student and making them aware about the moon and moon exploration by human being.

RESEARCH ACTIVITIES AND ACHIEVEMENTS

Earth Observation and Applications Mission

1. Retrieval of Geo-physical parameters using GNSS/IRNSS signals

ISRO - Geosphere Biosphere Programme (Climate and Atmospheric Programme)

2. Carbon Dynamics Assessment in Tropical Forests of Northeast India using Multi-sensor Data
3. Aerosol Radiative Forcing over India (ARFI)
4. IIRS-NCP - Soil Vegetation Atmosphere Fluxes
5. Spatio-temporal variations of gases air pollutants over the Indian subcontinent with a special emphasis on foothills of North Western Himalayas
6. Understanding the Impact of Climate & its variability on hydrological fluxes vis-a-vis water availability for sustainable development

Disaster Management Support Programme

7. IIRS- Advanced Studies (AS)
8. IIRS- Capacity Building (CB)

In-House R&Ds

9. Geospatial approach for Characterization of Agro-Ecological Zones for Diversification of Horticulture Crops in Himalayan Region
10. Estimating Soil Quality Parameters using Quantitative Colour Measurements
11. Continuation of Long Term Surface Energy Balance Studies for North-West Himalayan Agro-ecosystem using Large Aperture Scintillometry
12. UAV Applications in Characterization of Soil and Crop Variability related to Crop Stress and land management
13. Land Deformation Detection from Space: A Persistent Scatterer Interferometry and SBAS Approaches
14. Assessment of the Seasonal Water Level Variations Based on Hydrological Sensitivity Analysis of Time-Series SAR Backscattering Coefficients in conjunction with DEM and Gauge Data
15. Development of Array Database based system for EO applications
16. Strain modelling and seismic vulnerability assessment in NW Himalaya using space-based observations
17. Automated detection of rock glaciers in Western Himalaya, India

18. Effect of tropical cyclones on physical and biological processes in the North Indian Ocean
19. PolSAR-based modeling for scattering characterization of different components of forest vegetation
20. Development of the Terrain Corrections Algorithms for SAR data
21. Application Potential Assessment of UAV Data for Analysing Urban Environment and Hazards
22. Advanced Technique Development for River Discharge Estimation using Multi-Sensor Approach
23. Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II):
    (i) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – I:*** Geodynamics of Himalaya and Earthquake Precursor Studies
    (ii) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – II:*** Strengthening Vegetation Phenology-Productivity and Climate Linkages in North-West Himalaya
    (iii) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – III:*** Climate and Ecosystem Response Studies through Long Term Ecological Research Stations (LTERS)
    (iv) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – IV:*** Soil Erosion Estimation based on Radio Tracer Technique and Soil Quality Assessment in Mountainous Landscape of North-West Himalaya
    (v) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – V:*** Monitoring and Modeling of Hydrological Processes in Glaciated and Non-Glaciated Watersheds of North-West Himalaya
    (vi) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – VI:*** Modeling Temporal & Spatial Growth of North-West Himalayan Cities
    (vii) Monitoring and Assessment of Mountain Ecosystem and Services in North-West Himalaya (Phase-II): ***Sub Theme – VII:*** Observational and Simulation Study of Extreme Rainfall Over the North-West Himalayan Region

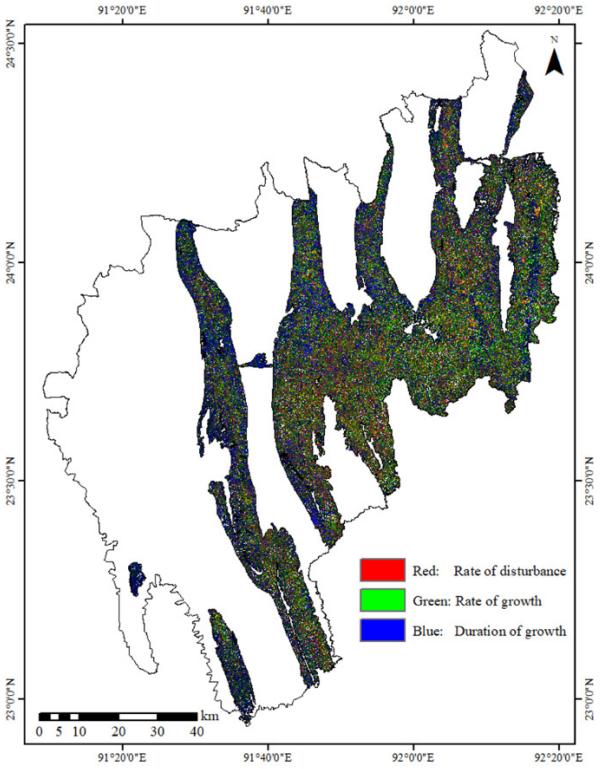
Other Projects

24. DBT: Indian Bioresource Information Network (IBIN) Project
25. NMHS: Himalayan Alpine Biodiversity Characterization and Information System-Network
26. Geo Ladakh: SDI for UT Ladakh
27. USDMA funded Satellite Based Mountain Hazard Assessment and Monitoring (MHAM) in Uttarakhand
28. NEEPCO Sponsored Project: Bathymetry Survey of Doyang Reservoir in Nagaland with NESAC

Carbon Dynamics Assessment in Tropical Forests of Northeast India using Multi-sensor Data (ISRO-CAP)

Forests sequester a large quantity of carbon and thus, play a significant role in the regional and global carbon cycle. Forest carbon dynamics, however, require accounting for the disturbances and recovery. The spatial extent and the magnitude of disturbance and regrowth determine the net carbon flux of a forest and the magnitude of carbon loss during and after disturbance. Long-term monitoring of forest carbon dynamics is gaining traction under increasing climate awareness, as well as programs such as the REDD+ framework. A significant portion of carbon emissions occurs due to land use changes, especially the conversion of forests to other land uses, particularly in northeast (NE) India, in a short period, and hence, monitoring forest carbon dynamics is required. The two main forest disturbance scenarios present in NE India are large-scale deforestation and shifting cultivation. Thus, assessing the spatial and temporal patterns of disturbances enables the determination of past and present degradation and recovery, their long-term trends, and their potential effect on the carbon balance. Hence, to address this issue, this project aims to assess forest carbon dynamics under two disturbance scenarios: large-scale deforestation and shifting cultivation. To fulfill the project objectives, the shifting cultivation landscape of Tripura has been selected initially.

The spatio-temporal patterns of vegetation disturbance and recovery due to shifting cultivation in Tripura state over three decades were studied. Using the LandTrendr temporal segmentation algorithm, areas with vegetation disturbance and recovery were identified and mapped based on the year of detection of the greatest disturbance and recovery, and the magnitude, duration, and rate of the same. Areas with a single instance of vegetation clearing from 1990 to 2020, multiple instances of vegetation clearing with fallow periods under 8 years, fallow periods exceeding 15 years, and relatively undisturbed areas were delineated. This study is the first attempt at long-term spatio-temporal monitoring of shifting cultivation patterns using temporal segmentation in India.

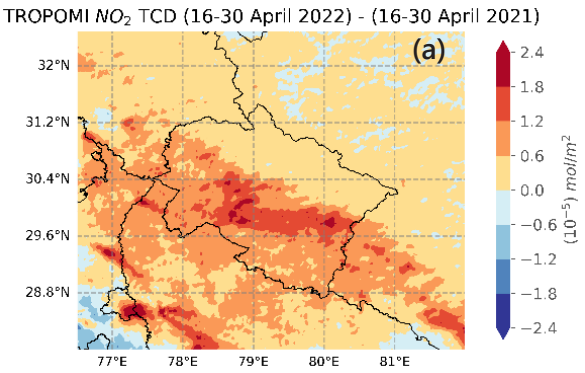


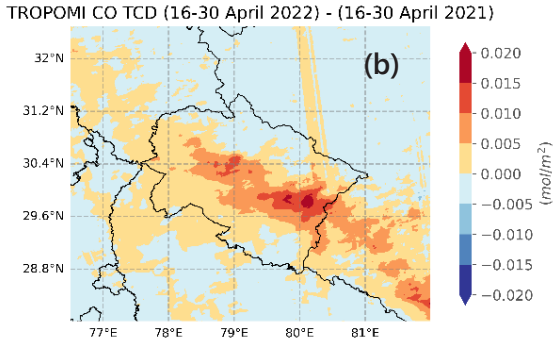
Overall vegetation disturbance and recovery patterns

Spatio-temporal variations of gaseous air pollutants over the Indian subcontinent with a special emphasis on foothills of North Western Himalayas (ISRO-CAP)

Under this Project increased concentration of air pollutants over Uttarakhand due to intense forest fire event in April 2022 were studied. Prevailing dry conditions and rainfall deficit during spring season in North India lead to heatwave conditions which resulted in widespread intense forest fire event in the Himalayan state of Uttarakhand during April 16-30, 2022. A total of 7589 active fires were detected by VIIRS during second half of April 2022 compared to 1558 during the first half. The TROPOMI observed total column values of CO and NO_2 increased by 4.4% and

11.7% respectively during April 16-30, 2022 with respect to April 1-15, 2022 (shown in Figure). A noticeable increase in surface level concentration of trace gases was also observed at Dehradun. In-situ measurements of CO, NO_x and O_3 compared to previous year observations during April 16-30, 2022 show an increase of 133%, 35%, and 6%. Weather Research and Forecasting model with chemistry (WRF-Chem) is utilized to quantitatively estimate the contribution of this event on the distribution of air pollutants over this state. A biomass burning emission inventory is developed using a bottom-up approach to represent the emissions occurring due to this forest fire event. The model results obtained using developed biomass burning emissions were evaluated against reanalysis and TROPOMI retrieved Total Column Density (TCD) of CO, NO_2, and O_3. Two simulations with (Fire) and without (NoFire) biomass emissions input were performed to quantify the contribution of forest fires to the concentration of trace gases and particulates. The CO, NO_2, and O_3 emitted/produced from forest fire over Uttarakhand during April 2022 contributed approximately 58.84%, 45.30%, and, 3.97% to the surface concentration of respective gas. In case of aerosols, it was around 66.4%, 58.01%, and 34.64% for $PM_{2.5}$, PM_{10}, and BC. The vertical profile analysis of pollutants revealed that extreme forest fire events can perturb distribution of air pollutants from surface up to 400 hPa.





Difference of TROPOMI retrieved Total Column Density of (a) CO and (b) NO_2 between April 16-30, 2022 and April 16-30, 2021

Soil-Vegetation- Atmosphere-Carbon Flux (Inter-disciplinary) Project (ISRO-CAP)

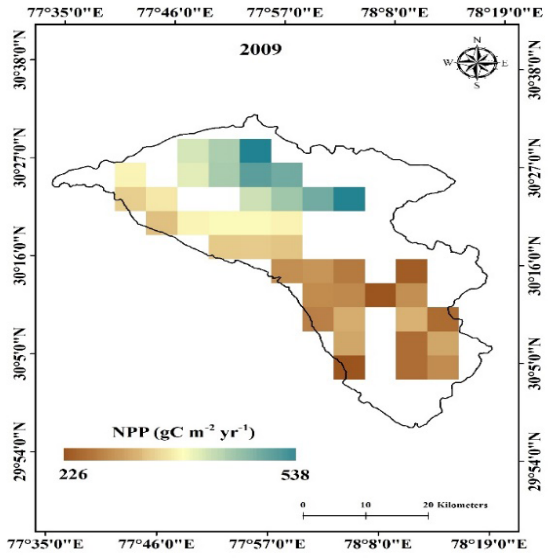
(i) Agricultural component

The project is part of Soil-Vegetation-Atmosphere Carbon Flux (SVAF) under ISRO-Geosphere-Biosphere programme and aims to use state of the art eddy co-variance (EC) flux-towers and remote sensing technique to measure and monitor carbon and water vapor exchange between vegetation systems and atmosphere. The flux towers observations are integrated with satellite observations for generating carbon exchange components and evapotranspiration estimates over large areas. The project is being extended for next 5-years till 2026 with an aim of Understanding Dynamics of Carbon and Water Vapor Fluxes over North-west Himalayan ecosystems. was envisage with objectives (i) Continuity of measurements from eddy covariance based flux-tower and other meteorological sensors for measuring energy, CO_2 and water vapor exchanges over diverse cropland and natural forest ecosystems (ii)To analyze seasonal and inter-annual variability of carbon and water fluxes of diverse North-western Himalayan ecosystems (iii) Multi-model (LUE based, process-based model and empirical) evaluation for gross primary production estimates of NWH region. Currently project operated in North western Himalayan foot hills with four eddy covariance sites namely Moist Deciduous Sal Forests (Barkot, UK),

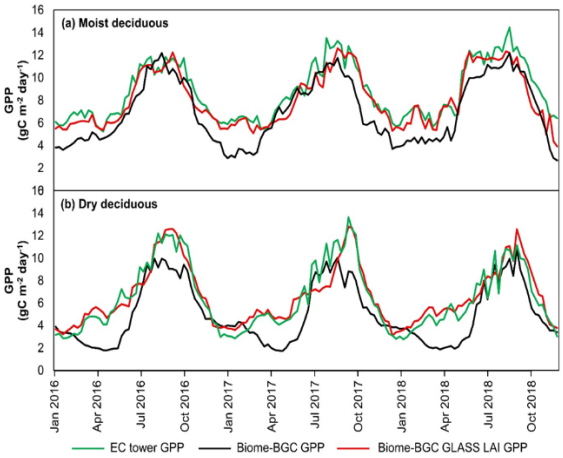
Mixed Dry Deciduous Plantation (Haldwani, UK), Sugarcane cropland (Saharanpur, UP) and Rice-wheat cropland (Palampur, HP).

The key achievement of the project comprises generation of long-term inter-annual and seasonal carbon balance over natural forests and cropland ecosystems at site and regional scale using flux-tower observations and modeling approaches. Processed-based Biome-BGC model was calibrated with the METRIC model output of Evapotranspiration (ET) to simulate water and carbon fluxes. Biome-BGC model execution on 0.05 x 0.05 grid has been performed using ERA 5 Land Reanalysis data (2000-2018) to simulate the gross primary productivity (GPP), net primary productivity (NPP) and ET over forested landscape in Doon valley. Average GPP for the Sal forest varies from 2701 gC m^{-2} year $^{-1}$ in dry year 2009 gC m^{-2} $year^{-1}$ to 3294 gC m^{-2} $year^{-1}$ in 2015. In Doon valley, the simulated mean NPP varies from 307 gC m^{-2} in 2009, the driest year in current century as compared to normal year 2000 with 785.90 gC m^{-2} $year^{-1}$ Further, we noticed significant negative correlation of vapor pressure deficit (VPD) and mean temperature with the forest NPP and ET in the Doon valley indicating prominent role of global warming on declining magnitude of these important forest ecosystem processes in changing climate. A process-based Biome-BGC model implemented with assimilation of time-series GLASS LAI data over two major plant functional types (PFTs) of northwest Himalayan (NWH) foothills of India in order to study the spatio-temporal variability of carbon fluxes. Integrating satellite based GLASS LAI into Biome-BGC model led to substantial improvement in GPP estimation for Moist deciduous forest (R^2 = 0.87, %RMSE = 11.12) and dry deciduous forest (R^2 = 0.86, %RMSE=10.38) while compared with EC tower based GPP for year 2018.

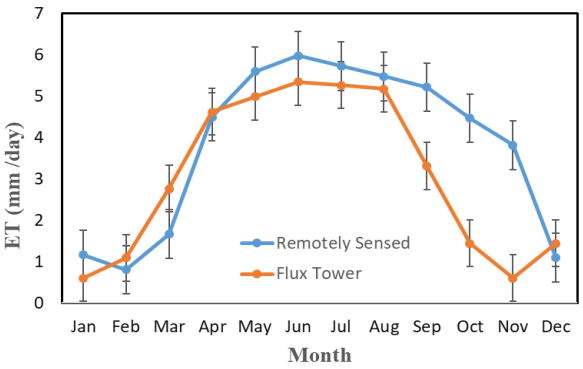
A study was carried out to demonstrate down-scaling of LST from LANDSAT OLI using fine resolution Sentinel-2 MSI images and estimating ET at field-scale for sugarcane crop in Saharanpur Districtc. Reasonably good agreement noticed between remotely sensed ET and eddy covariance based ET especially during actively growing stages of sugarcane crop canopy. We also evaluated the impact of 2022 heat wave on carbon, water vapour and energy cycles using half-hourly eddy covariance measurements from cropland site in Saharanpur. We found that net ecosystem exchange (NEE) decreased during the heat wave period, subsequently increasing the atmospheric carbon dioxide concentration in the atmosphere in comparison to the non-heat wave events. Latent heat flux (LE) was reduced by stomatal regulation during the heat-wave period.



NPP simulated by Biome-BGC in Doon Valley for drought year 2009



Performance of Biome-BGC model over forest flux-tower sites

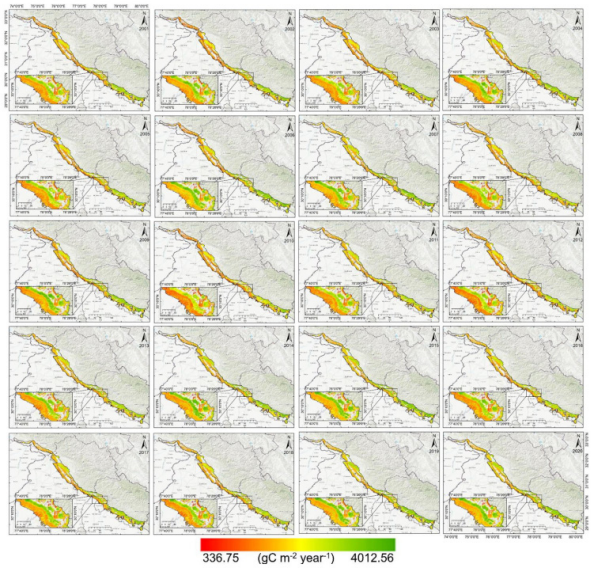


Seasonal variation in ET by flux-tower and remote sensing data

(ii) Forestry component

The project is part of the National Carbon Project and aims to use state-of-the-art eddy covariance (EC) flux tower and remote sensing (RS) techniques to measure and monitor carbon exchange between vegetation systems and the atmosphere. The project envisaged the objectives: (i) Continuity of measurements from EC-based flux tower and other meteorological sensors for measuring energy, CO_2, and water vapor exchanges over the diverse natural forest and cropland ecosystems (ii) Assessment and monitoring of carbon balance of natural forest and cropland sites (iii) Development of RS-based techniques for upscaling of carbon fluxes over large areas. Presently, the project is operated in northwest Himalayan (NWH) foothills with four EC sites: Moist Deciduous Sal Forests (BFS-Barkot, Uttarakhand), Mixed Dry Deciduous Plantation (HFS-Haldwani, Uttarakhand), Sugarcane cropland (SFS-Saharanpur, Uttar Pradesh), and Rice-wheat cropland (PFS-Palampur, Himachal Pradesh).

The key achievement of the project comprises determining maximum light use efficiency (LUEmax) values specific to the NWH foothills of India. The spatio-temporal variability of gross primary productivity (GPP) from 2001 to 2020 was estimated using remote sensing data in combination with eddy covariance data in the LUE-based model. The model was parameterized using different sets of default and calculated parameters. The study showed that the use of PFT-specific LUEmax and temperatures increased the accuracy of the model predictions. On validation, the LUE-based model predicted GPP showed R^2 = 0.82 for moist deciduous and R^2 = 0.83 for dry deciduous PFTs. The study revealed that with rigorous model parameterization, RS data can be used in an LUE-based model to achieve accurate spatio-temporal estimates of GPP.



Spatio-temporal variability of annual GPP (gC m^2 $year^{-1}$) in NWH foothills of India

Advanced Studies and Capacity Building in Disaster Management Science (DMSP)

Disaster Management Studies is one of the areas of National Importance as every year millions of rupees are spent in mitigating the effects of disaster in terms of rescue, relief and rehabilitation. India being one of the disaster prone countries of the world needs to be ever vigilant and prepared to handle the disasters as and when they occur. Space technology, which enables rapid and continuous monitoring of the earth, provides critical data to understand the cause as well as timely information for disaster risk reduction, rescue and relief operations. In this direction, there is national need for capacity building and

research in the area of Disaster Management Studies for fulfilling the priorities of action of Sendai Framework.

(i) Advanced Studies (AS) in Space based Disaster Management Support

DMS-Advance Studies program is effort funded by ISRO initiated to include the premier institutions in the country to develop advance research areas for application of in space technology for disaster management in the country. The program envisages to develop New methodologies, New algorithms for hazard detection, Application of AI and ML in DMR, Methodologies for Early warning systems and Multi-hazard and vulnerability assessment. The leading academic and research institutions of the country were involved in the programme. A total of 14 projects have been awarded after critical review and shortlisting among more than 80 proposals. Institutes which have been awarded the projects are: IIT-Roorkee, IIT Bombay, IIT Patna, IIT Ropar, IIT Mandi, GBPUAT, NIT Karnataka, Central University Jharkhand, IIRS; CBRI, IISER-Mohali. The areas in which the projects were awarded were:

- Avalanche Hazard and early warning – 02 projects
- Early warning system for landslides – 04 projects
- AI based Hailstorm Alerts – 01 project
- SAR based Algorithm for partially inundated vegetation – 01 project
- Landslide characterization and debris flow modelling – 02 projects
- Permafrost destabilization induced mass wasting – 01 project
- Extreme rainfall modelling – 01 project
- AI /ML modelling for crop disease – 01 project
- Multi-hazard analysis: Earthquake induced landslide – 01 project

(ii) Capacity Building (CB) in Space Based Disaster Management Support

DMS-CB program is effort funded by ISRO initiated to fulfil the CB requirements towards application of in space technology for disaster management in the country. The CB activities are categorised into Awareness Course, Basic Course, Advanced Course, Awareness Workshop and Brain-storming Workshop. The institutes which has been identified to provide the capacity building with the technical inputs of IIRS were:

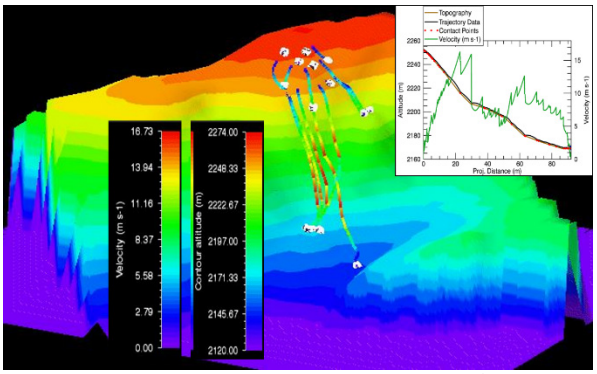
- IIT-Roorkee
- University of Burdwan, Burdwan
- Symbiosis International (Deemed University), Pune
- Punjab Engineering College, Chandigarh
- Punjab Remote Sensing Centre, Ludhiana

The following courses were organized by the above mentioned institutes:

- SAR Applications in Disaster Management (1-week)
- Space Technology Application for Compound Extremes (2-weeks)
- Space based Technologies for Flood Hazard (2-weeks)
- Hydro-meteorological Disaster Risk Reduction (2-weeks)
- Awareness Workshop on Open Source Geospatial Products in DMS (1-day)
- Monitoring of Environmental Hazards using Geospatial Technology (2-weeks)
- Brainstorming Workshop on Stubble Burning and Air Pollution: A Step towards DMS (1-day)
- Webinar on Application of Space Technology for DMS (1-week webinar series)

An Earth Observation based approach in characterization of selected landslides and debris flows in parts of the Uttarakhand and Himachal Himalaya (DMSP)

Assessment of Landslide Susceptibility and event based rockfall modelling in parts of Shimla and adjoining area was carried out in this study. Shimla and adjoining areas, off late, has remained one of the major hot spots in this regard and recurrent landslides including debris flows and rock falls/ topples in this area has aggravated since the monsoon of 2021. Available literature, albeit, indicates a dearth of reliable data to analyse and understand the landslide hazard potential of the area. This work, thus, grouts the knowledge gap by preparation of a susceptibility map taking cues mainly from satellite derived and ancillary products. The idea of utilization of Earth Observation based data is often fuelled by advancement in space technology and high resolution multispectral and panchromatic sensors which are able to provide tell-tale signatures of mass wasting at a substantially fine temporal gap. Analytical Hierarchy Process (AHP), a multi criteria decision making process of measurement through pair wise comparisons which relies on the judgements of the experts to derive priority scales has been utilized here for LHZ. The susceptibility map, thus produced, helps in locating potential zones of landslide occurrence. However, with the availability of advance technology in the field of landslides, stake holders find it intriguing to know about predictive aspects of landslides. To satisfy this issue, a numerical simulation was adopted to model one important rockfall event close to Shimla town on Dhalli bypass, which is precarious enough to pose substantial danger in terms of damage of property and blockade of the road. Maximum jump height of 3m, 400 kJ kinetic energy and up to 15m/s of maximum simulated velocity along the trajectory of the rockfall has been modeled for future rockfall at this location.



Numerically simulated velocity in ms^{-1} of the rockfall at Dhalli bypass, Shimla in perspective view obtained from ALOS PALSAR (12.5m) DEM (Inset: Graphical variation of altitude and velocity vis-à-vis projected distance of the runout/fall trajectory)

Geospatial Approach for Characterization of Agro-Ecological Zones for Diversification of Horticulture Crops in Himalayan Region

Horticulture is a science, as well as, an art of production, utilisation and improvement of horticultural crops, such as fruits and vegetables, spices and condiments, ornamental, plantation, medicinal and aromatic plants. The World Health Organization (WHO) recommends a daily intake of more than 400g of fruits and daily person. In 1994–1995, 14.5 million hectares of land were used for horticulture crops, yielding 119.2 million tonnes annually while As per National Horticulture Database (Second Advance Estimates) published by National Horticulture Board, during 2020-21, India produced 102.48 million metric tonnes of fruits and 200.45 million metric tonnes of vegetables. The area under cultivation of fruits stood at 9.6 million hectares while vegetables were cultivated at 10.86 million hectares. This define the progression in field of horticultural crop cultivation.

In the hilly areas, undulating landscape constitutes the most fragile elements of the ecosystem and the traditional economy rests on the terraced cultivation with extremely limited feasibility for expansion and modernization.

Consequently, low economic return remains the characteristic feature of the agrarian landscape in these regions. Horticulture crops have 296390 ha area, 1905830 MT production and 6.43 MT/ha productivity in 2012-13 of Uttarakhand state which shows the scope of identifying suitable area under horticulture crops in the state. Agro-ecological zonation map/ product of Uttarakhand state for horticulture crops is still a time required asset for betterment of farmer's livelihood and mountain agriculture, both.

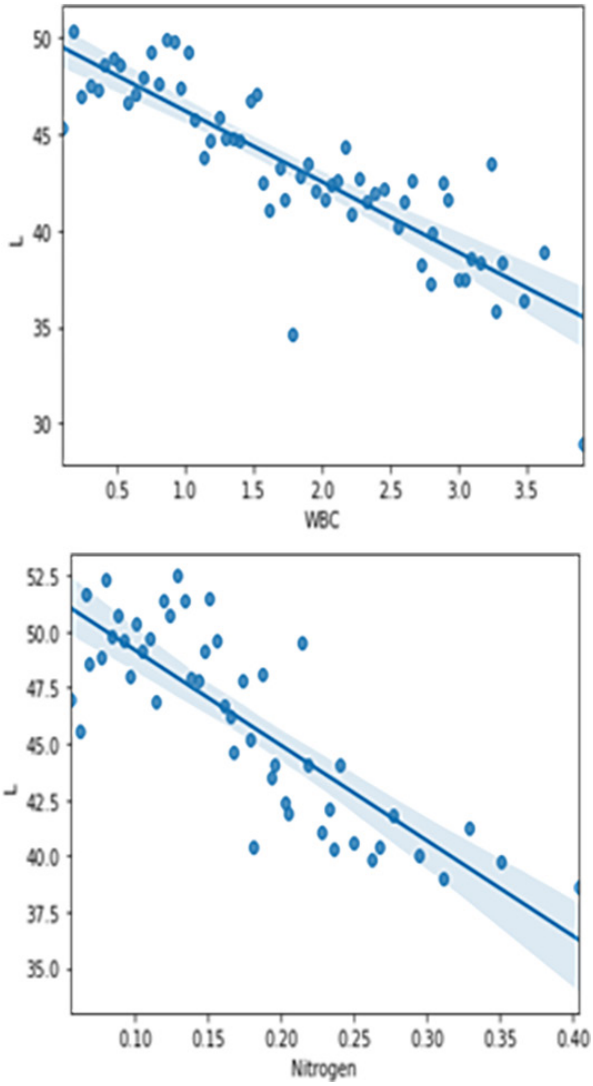
Weighted overlay analysis based crop suitability analysis for mango was done using physiographic, terrain and climatic factors in the geographic information system which divided into four classes i.e. high, moderate, marginal and not suitable. To define the level of limitation supplied by each component of each spatial dataset, these criteria were established based on review of literature and subject specialist for each of the composite spatial layers Weightage was assigned based on the variability of the considered parameters in the selected area. The potential zones was obtained by overlaying all the thematic maps via the weighted overlay analysis method. It was found that there are 161068, 152860, 37273 hectares are highly suitable, moderately suitable and marginal suitable, respectively for mango fruit crop.

Estimating Soil Quality Parameters using Quantitative Colour Measurements

Soil colour is an important property and is influenced by different soil quality parameters through their spectral response in the visible range of the electromagnetic spectrum. Traditionally it has widely been used by researchers for soil identification and classification with respect to soil taxonomy. Soil colour is influenced by various factors like mineral constituents, soil organic matter, particle size distribution, carbonates etc. of these different factors, soil organic matter has a very prominent influence on soil colour and is often related with fertility and consequently soil quality. Thus, measurement of soil colour/reflectance in the visible near infrared region would help in estimating different soil properties, which influence soil colour. Most common and widely adopted method for qualitative estimation of soil colour is using Munsell soil colour chart, which uniformly divides soil colour into hue, value and chroma notations. However munsell colour chart describes soil colour on qualitative aspects which is very much subjective and thus limits its use for quantitative prediction of various soil properties.

Various color space models capable of quantitatively estimating soil colour and thus overcoming the limitations of Munsell system exists and has been widely used in soil science. Nowadays various instruments like chromameters, color sensors; digital cameras etc are increasingly being used for quantitative estimation of soil colour. Such quantification of soil color using different color space models could be explored for developing various soil property prediction models. The project was formulated with the prime objective of developing soil color based models for prediction of various soil quality parameters. A mobile-based color sensor was used for quantitative color measurement of soil samples. Soil color database of nearly 2000 surface soil samples belonging to different textural classes from Himalayan region of Uttarakhand was developed by color measurements in different quantitative color space models. The samples were laboratory analyzed for the estimation of various properties including soil organic carbon, nitrogen, textural composition as well as various other soil quality parameters. Further, the soil property database was segregated based on depth and broad textural groups. Multiple linear regression technique using

analysis results of various soil properties and corresponding color measurements were used for the development of color based models for predicting major soil nutrients in various textural groups i.e., fine, medium and coarse textural groups. Among the various color spaces used, LAB color space was found to be the most suitable for prediction of soil properties. Lightness values of LAB color space were found to have a negative relationship with increase in organic carbon and nitrogen values in the used dataset. Prediction of soil organic carbon and total Nitrogen in medium and fine textured soils could be done with considerable accuracies using the color space based models. These models could be used for real time monitoring of soil nutrients at farmer's field level.



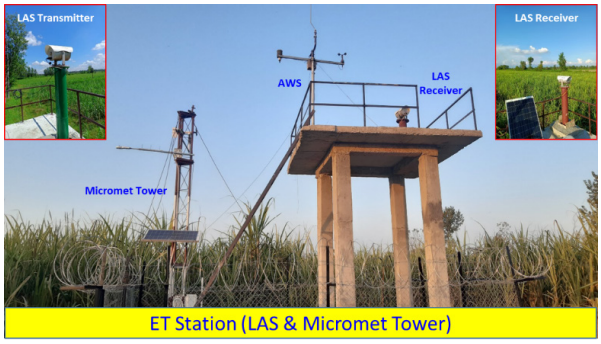
Relationship of Soil Organic Carbon / Nitrogen vs Lightness (L)

Continuation of Long Term Surface Energy Balance Studies for North-West Himalayan Agro-ecosystem using Large Aperture Scintillometry

Accurate measurement and estimation of surface energy fluxes are the essential keystone for understanding earth's climate system and further mass, heat and momentum between surface and atmospheric boundary layer. Precise estimation of evapotranspiration (ET), water use and water availability at local to regional scale are quite crucial for quantitative assessment of water resources. Estimation of turbulent heat fluxes (sensible and latent heat fluxes) with define accuracy is the most tedious task to be done at field scale, which is ultimately used for assessment of energy fluxes variation as well as for agricultural water management. To understand this process and functioning, augmentation of Large Aperture Scintillometer (LAS) and Micrometeorological Tower was done at crop research farm of GB Pant University of Agriculture & Technology, Pantnagar (Udham Singh Nagar, Uttarakhand). This site may develop as Super Site of Validation for ISRO-CNES Mission-Trishna as well as future upcoming satellites related to agricultural theme. LAS transmitter and receiver was installed at the height of 5 meter on the platforms, which are at the path length of 1020 meter with integration of Automatic Weather Station (AWS) on receiver end side within sugarcane cropland. Along this, micrometeorological tower was augmented at the receiver end integrated with two-height temperature-humidity probe, four components (CNR4) net radiometer instrument, soil heat flux plate, wind speed and direction sensors and atmospheric pressure sensor on 5 meter tower set-up. These all sensors are the fast response sensor working at 10 Hz frequency, which format the datasets in 5 min integrated files.

Sugarcane crop has the high water requirement as compare to other crops but it is classified as cash crop due to financial aspect. Terai

region of Uttarakhand is the significant region for production of sugarcane crop. Thus, the motivation of this research study to analyze and compute the crop water requirement and crop water use by sugarcane crop at seasonal and annual scale.

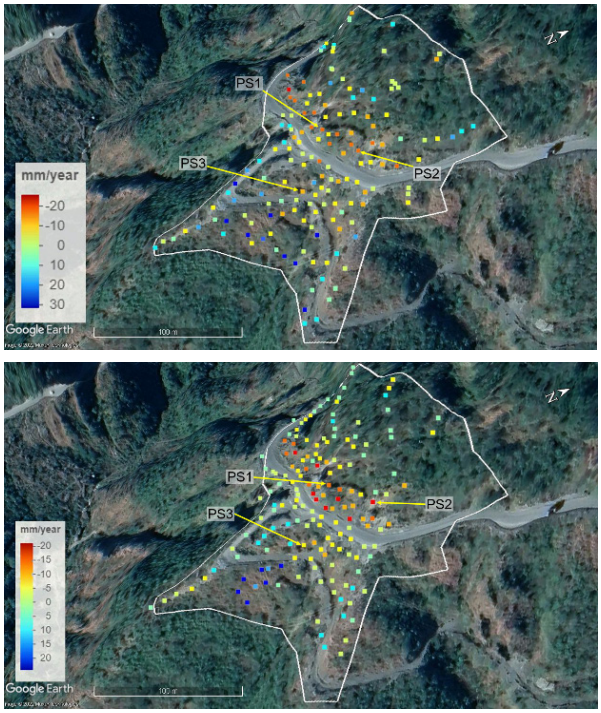


LAS and Micromet tower integrated ET Station at GBPUA&T, Pantnagar

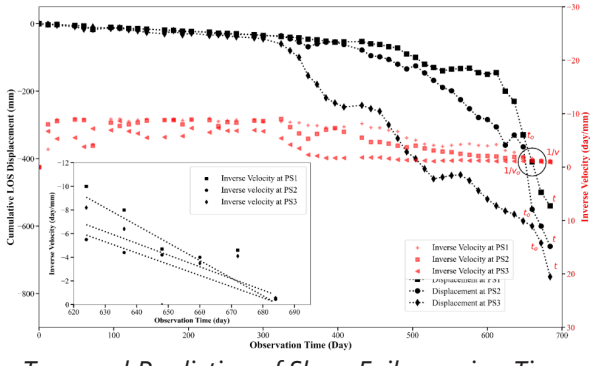
Land Deformation detection from Space: A persistent Scatter Interferometry and SBAS Approaches

A study on Landslide Deformation and Temporal Prediction of Slope Failure in Himalayan Terrain using PSInSAR was carried out for an event on July 30, 2021, wherein a massive landslide witnessed in Sirmaur district of Himachal Pradesh, India near Barwas and brought down around 180 m stretch of NH 707. In this study, we calculated time-series displacement of a landslide-affected area prior to its actual failure and temporal prediction of slope failure in a hilly terrain using persistent scatterer SAR interferometry (PSInSAR) technique and Sentinel-1 data in an open source computational environment. Total 52 images in ascending and 41 images in descending orbit, acquired for a period of almost two years (2019–2021) were used in the analysis.

Deformation was analyzed in terms of mean line of sight (LOS) velocity, horizontal and vertical components of velocity vector. Temporal prediction of slope failure was analyzed using two prediction methods i.e. inverse velocity (INV) and modified inverse velocity (T-INV) methods at three different accelerating and reliable PS locations using time-series displacement. Displacement time-series at selected PS points depict the initiation of slope instability from July 31, 2020 and July 03, 2020 using ascending and descending stacks respectively, which are almost one year before the actual failure. INV method predicted temporal windows of slope failure between July 27, 2021 to August 01, 2021 for ascending and July 24-29, 2021 using descending stack, while those of T-INV method lye between July 28, 2021 to August 01, 2021 for ascending data and between July 22-30, 2021 for descending data. Deformation-time series and predicted days of slope failure are in good agreement at different reliable PS locations.



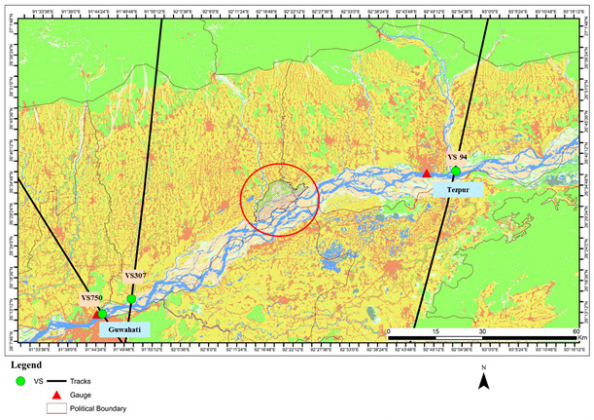
Mena LOS Velocity using ascending (Top) and descending (Bottom)



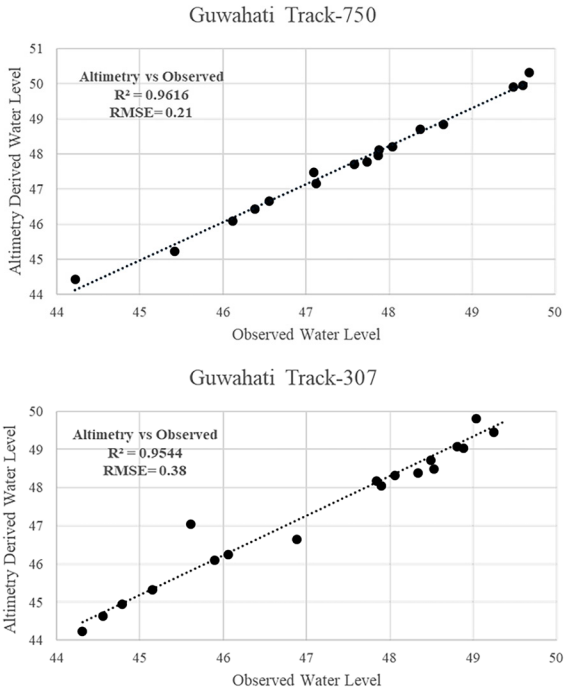
Temporal Prediction of Slope Failure using Time-Series Displacement measurement

Assessment of the Seasonal Water Level Variations Based on Hydrological Sensitivity Analysis of Time-Series SAR Backscattering Coefficients in conjunction with DEM and Gauge Data

Floods are the major source of damage to agricultural areas, human lives and infrastructure globally, including the Indian sub-continent. The Rajiv Gandhi Orang National Park is situated along the Brahmaputra River's flood plain is selected for the present study. The datasets used in this study include SAR, altimetry, optical and gauge data. It includes, Sentinel-1 SLC, Sentinel-1 GRD SAR datasets, Sentinel-3A altimetry dataset, Sentinel-2 and Landsat-8 optical images, IMD rainfall, and CWC river gauge station records. Sentinel-3A and 3B altimetry data for tracks 307, 750 and 94 for the year 2021 is processed for assessing the flood peaks in conjunction with in situ historic gauge data from CWC. Study shows the data from virtual stations can be used as a proxy for flood events. About 40 Sentinel-1 SLC datasets for 2021 have also been processed to study the backscattering behaviors for different land cover. Relationship of backscatter with changing hydrologic regime and polarimetric analysis is under progress.



Study area and virtual stations track

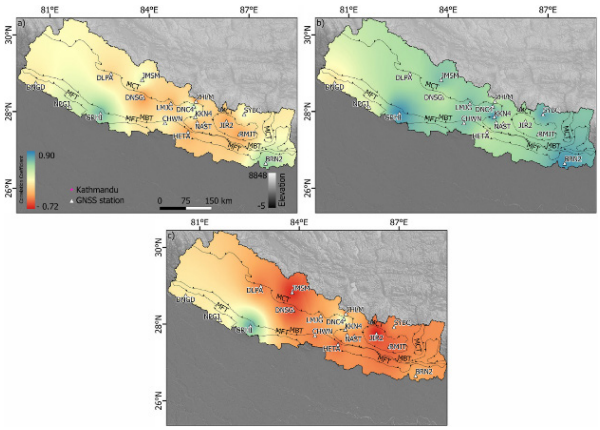


Correlation between altimetry derived water level and observed water level

Strain modelling and seismic vulnerability assessment in NW Himalaya using space-based observations

Impact assessment of the seasonal hydrological loading on geodetic movement and seismicity in Nepal Himalaya using GRACE and GNSS measurements were carried out in the Himalayan terrain is an epitome of ongoing convergence and geodetic deformation where both tectonic and non-tectonic forces prevail. In this study, the Gravity Recovery and Climate Experiment (GRACE) and Global Positioning System (GPS) datasets are used to assess the impact of seasonal loading on deformation with seismicity in Nepal. The recorded GPS data from 21 Global Navigation Satellite System (GNSS) stations during 2017-2020 are processed with respect to ITRF14 and the Indian reference frame, and the Center for Space Research (CSR) mascon RL06 during 2002-2020 is adopted to estimate the terrestrial water storage (TWS) change over the Ganga-Brahmaputra River basin. The results indicate that the hydrological loading effect or TWS

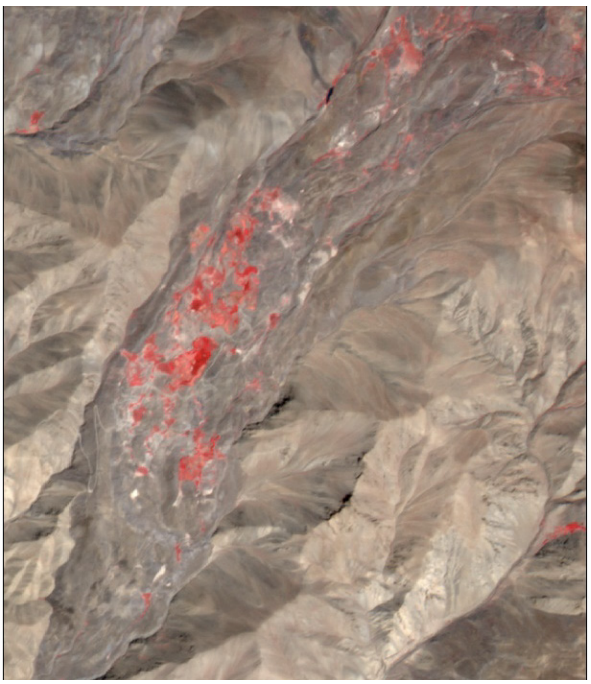
change shows high negative, high positive, and moderately positive values in pre-monsoon, co-monsoon, and post-monsoon months, respectively. The detrended GPS data of both horizontal and vertical components correlate with the seasonal TWS change using the Pearson correlation coefficient at each GNSS site. In addition, the correlation coefficient has been interpolated using inverse distance weighting to investigate the regional TWS influence on geodetic displacement. In the north component, the correlation coefficient ranges from -0.6 to 0.6. At the same time, the TWS is positively correlated with geodetic displacement (0.82) in the east component, and the correlation coefficient is negative (-0.69) in the vertical component. The negative correlation signifies an inverse relationship between seasonal TWS variation and geodetic displacements. The strain rate is estimated, which shows higher negative values in pre-monsoon than in post-monsoon. Similarly, the effect of seismicity is 47.90% for pre-monsoon, 15.97% for co-monsoon, and 17.56% for post-monsoon. Thus we can infer that the seismicity decreases with the increase of seasonal hydrological loading. Furthermore, the effect of strain is much higher in pre-monsoon than in post-monsoon since the impact of co-monsoon continues to persist on a small scale in the post-monsoon season.



The interpolated correlation coefficient between TWS and the (a) north, (b) east, and (c) vertical displacement components, respectively

Automated detection of rock glaciers in Western Himalaya, India

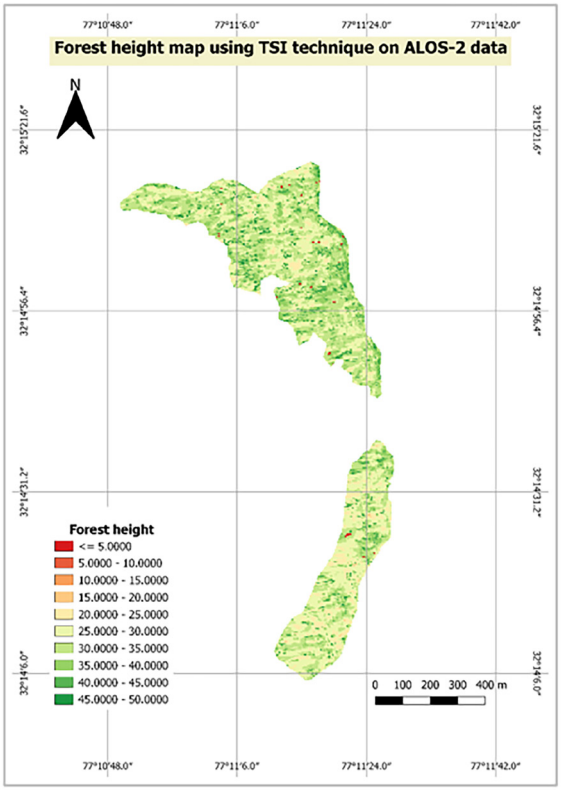
Rock glacier Oasis-An alternative for agro-pastoralism in a changing environment in the Himalayan cold desert: The present investigation is a unique account of evolving agriculture practices in the adverse climatic conditions of Ladakh with available sources. One such landform that is being used for housing and agriculture is an 'inactive rock glacier' present on the Ladakh range in the Union Territory of Ladakh. This rock glacier along with a number of other large and small active/inactive rock glaciers have been observed near Budhkharbu village. The inactive rock glacier used for habitation and agricultural activities is a gentle sloping, tongue shaped landform located at 34° 21′ 36.44″ N/76° 35′ 10.30″ E. The rock glacier is roughly 5 km long, 650 m broad, and covers an area of about 4.4 km^2. From north to south, the rock glacier spans an altitudinal range of 3558–4550 m above sea level (m asl). In the middle of this rock glacier (~3840 and 4024 m asl) a number of houses, a road and patterned cultivation can be seen on Google Earth images. The fact that there is little evidence of disturbances to the road and other infrastructure is further confirmation that the rock glacier is no longer actively creeping downslope.



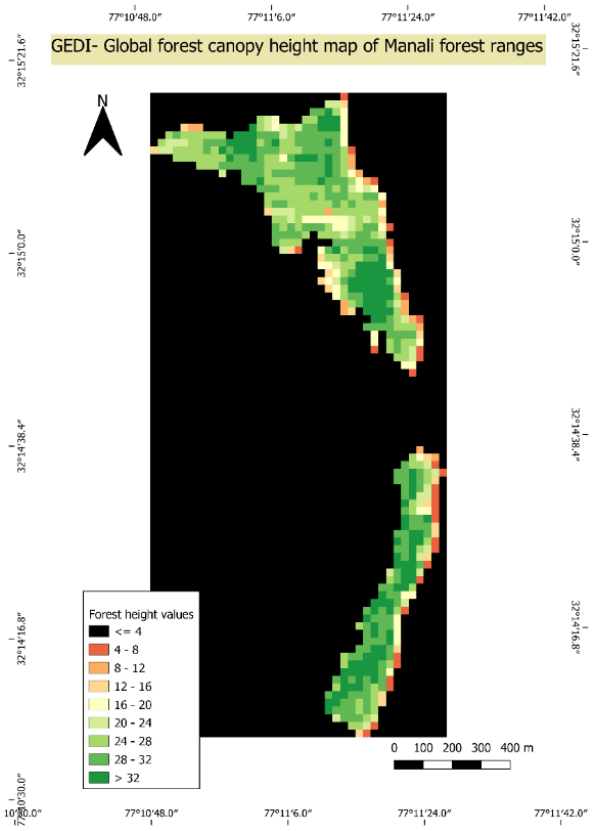
The inactive rock glacier in Ladakh showed on LISS IV image dated 29 August 2018

PolSAR-based modeling for scattering characterization of different components of forest vegetation

Forest height of the Manali forest range were obtained using three stage inversion and coherence amplitude inversion techniques and verified through field data. For the X band data, accuracy obtained was 95.66% with a correlation of 0.96 and an RMSE of 2.1 meters, when TSI technique was used. For the same data, the accuracy reduced to 90.02% with a correlation of 0.91, and the RMSE increased to 4.3 meters while using the CAI technique. For the C band data, when the TSI technique was used to estimate the forest height, 94.03% of accuracy was obtained with a correlation of 0.85 and an RMSE of 3.16 meters. The accuracy, correlation, and the RMSE changed to 84.52%, 0.64, and 6.75 meters, respectively, when the technique used was CAI. While, for the L band data, the accuracy of the maps generated was 91.14% and 92.22% upon using TSI and CAI techniques, respectively. The RMSE errors also were considerable in this data with errors being 5.6 meters in TSI technique and 4.3 meters in CAI technique. GEDI derived forest height map has underestimated the forest heights when compared with the field data.



Height map of the Manali forest using TSI technique



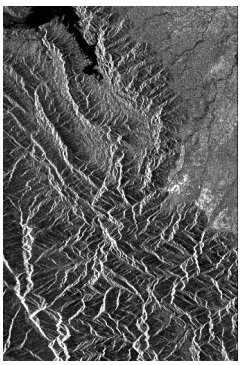
Height map of the Manali forest using GEDI derived forest canopy height map of the year 2019

Development of the Terrain Corrections Algorithms for SAR data

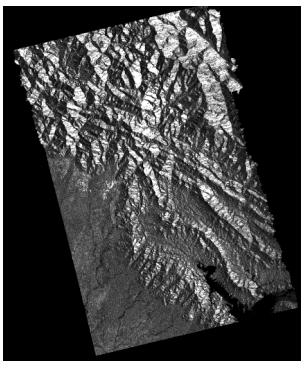
The prime focus of the present study is to develop SAR terrain corrections algorithms using various approaches which includes rational polynomial coefficient (RPC), RSM based approaches and terrain corrections through ascending & descending acquired SAR images. It mainly aims for the development of different SAR terrain correction algorithms & techniques which can be used for education, capacity building, research and application purposes. SAR has various geometric distortions due to terrain. These terrain induced geometric distortions significantly effects SAR geolocation accuracy. Generally, these distortions are corrected by geolocation and geocoding algorithms using SAR parameters, orbit and DEM. Terrain correction can be done through rigorous

sensor model (RSM) using pixel or grid-based methods. Terrain correction using pixel based Rigorous Sensor model are time consuming, however grid-based terrain correction algorithms based on RPC and RSM are fast. Since, terrain also effects the radiometry in the SAR images thus various radiometric terrain correction algorithms are developed to correct radiometry. Since SAR acquire data in both ascending and descending pass, thus geometric distortions can be corrected by using simultaneous ascending and descending data.

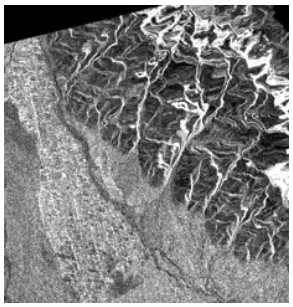
The methodology has been developed for Terrain correction of NovaSAR-1 data acquired through GPS orbit. The NovaSAR-1 Terrain Corrected products has been generated through Rigorous Sensor Model (RSM) Methodology using SAR parameters, orbit and DEM. The methodology is also developed to improve the geolocation accuracy for the NovaSAR-1 datasets acquired through TLE orbits. Due to orbit in accuracy, The ground range products are showing error from 200 m to 9000 m. After terrain correction using single GCP and Sensor model, the geolocation accuracy is reduced to less than 10 m. The figure below shows the terrain correction of NovaSAR-1 datasets.



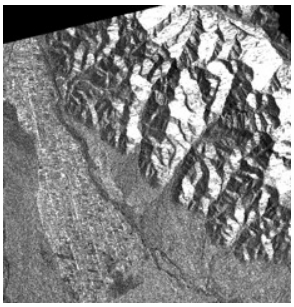
Ground Range product (GPS orbit)



Terrain Corrected product (GPS orbit)

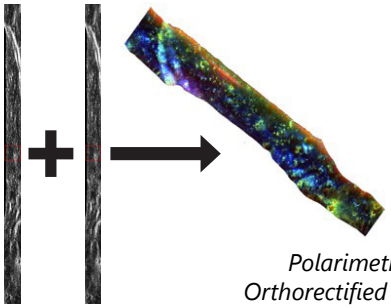


Terrain Correction without GCP (TLE orbit)



Terrain Correction with GCP (TLE orbit)

The Methodology has been developed for generation of polarimetric Terrain corrected products for DFSAR (Chandrayaan-2 datasets) & EOS-4/RISAT-1A. The figure below shows polarimetric Terrain corrected product for DFSAR data.



DFSAR SLC image

Polarimetric Orthorectified image

The methodology is also developed to correct the layover corrections in Sentinel-1 data by fusing ascending and descending data using RSM model, SAR parameters, SAR orbit and DEM.

Mountain Ecosystem Project-Strengthening Vegetation Phenology-Productivity and Climate Linkages in North West Himalaya

The northwest Himalayan (NWH) region is highly diverse in terms of topography and climatic conditions. The Himalayan region is significant in climate research due to its high biodiversity, high species endemism, and the great importance of its ecosystem services to adjacent plains. The study aims to gain insights into the phenological patterns, functional traits, productivity, and impact of climate change on the vegetation of the Himalayan

forest. The objectives of the project are to: (i) Assess the phenophase transitions between satellite and phenocam imagery, long-term changes in vegetation phenology and identify drivers of change; (ii) To generate plant functional traits database, plant functional types map and simulate intra-inter annual trends in vegetation productivity and (iii) To study the response of alpine vegetation to experimental warming.

PhenoCam was installed at Barkot forest range consisting of a tropical moist deciduous forest to understand the working of the camera and data generated through it. Sal and teak phenology were monitored from March to September 2022. Values were extracted from each band (red, green, blue, NIR) of the image to calculate reflectance and vegetation indices sensitive to phenological changes. Green Chromatic Coordinate (GCC) showed an increase from 1.2 to 3 for the sal canopy and 1.7 to 2.7 for the teak canopy. This indicated a gradual increase in canopy greenness from March to September with the occurrence of new leaves. For functional trait studies, leaf samples were collected from Sal and Chir pine forests in February and March 2022 respectively. The traits analysed include Leaf Area Index (LAI), Equivalent Water thickness (EWT), pigments, protein, sugar, and nitrogen content. Their estimation at the canopy level was done using partial least squares regression (PLSR) and PRISMA data. The wavelength regions sensitive to each trait were identified and their spatial variation mapping was done.

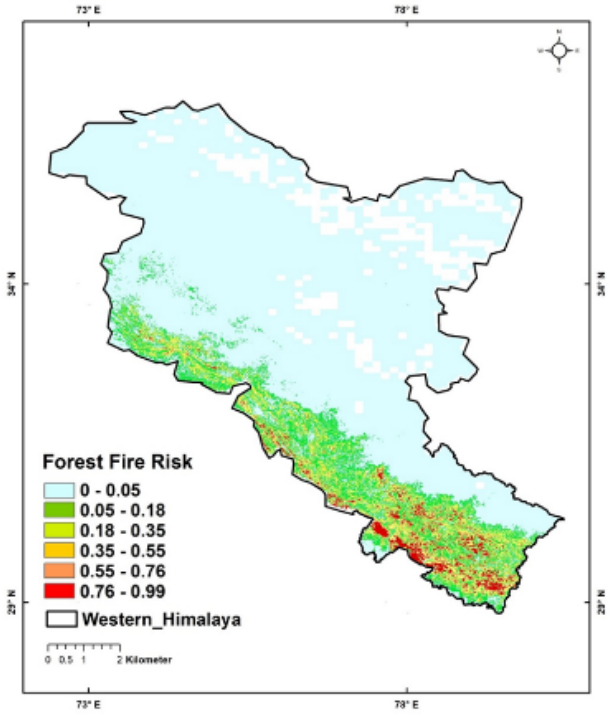
Fifteen OTCs and temperature and relative humidity data loggers were installed in the alpine region of Gangotri National Park comprising herbaceous meadows and sedge meadows in September 2022. The spatial cover of each species present within the OTC and control plot was recorded. The changes, if any, in species composition and its spatial cover will be monitored during fieldwork to be done in the next growing season. Additionally, differences in phenology, productivity, and nutrient composition of plants inside OTC and those present in the adjoining control plots will be monitored to assess responses of the alpine vegetation towards simulated warming conditions.

Open Top Chambers established at Gangotri National park for experimental warming studies

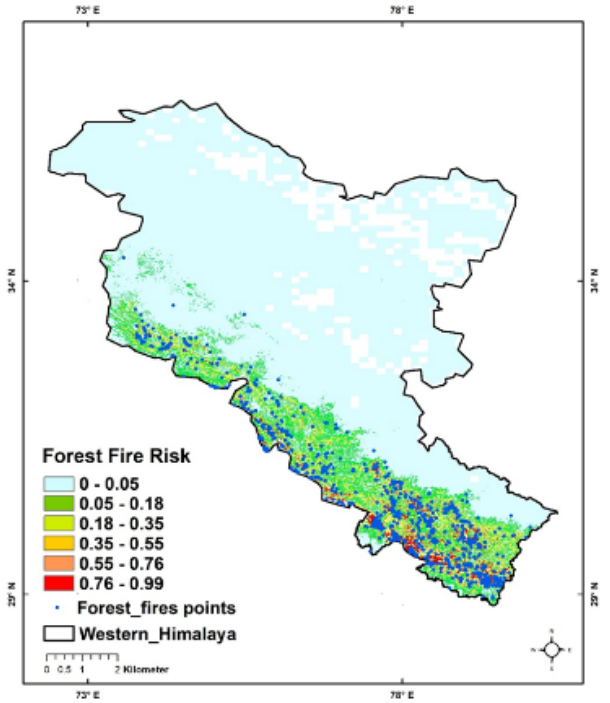
Mountain Ecosystem Project Phase II: Climate and Ecosystem Studies through LTERS

(i) Characterizing probability of Forest-fires in Western Himalaya along Vegetation gradient using Remote Sensing

Forest fire probability modelling was carried out for the western Himalaya using MODIS daily active fire data. It is observed from the maps that the proportion of area under forest fire in high & very high classes are 2.51% and 2.13%. The high probability classes are not distributed homogeneously in the study area but intensely clustered in lower region of south-east parts of the Western Himalaya which corresponds to the Uttarakhand state. It can be observed that >80% area is under very low and very - very low susceptibility zones comprising of 35 hectares of land. Among the six classes cyan colour of the map corresponds to no fire zone (VVL) and is part of upper most valley of the Himalayan region mostly covered with snow so chance of fire is negligible. The percent of area under this category is 78.72 % and total area correspond to 318184 km^2. The most influencing factor is vegetation type and NDVI and least one is aspect and population density in Himalayan region.



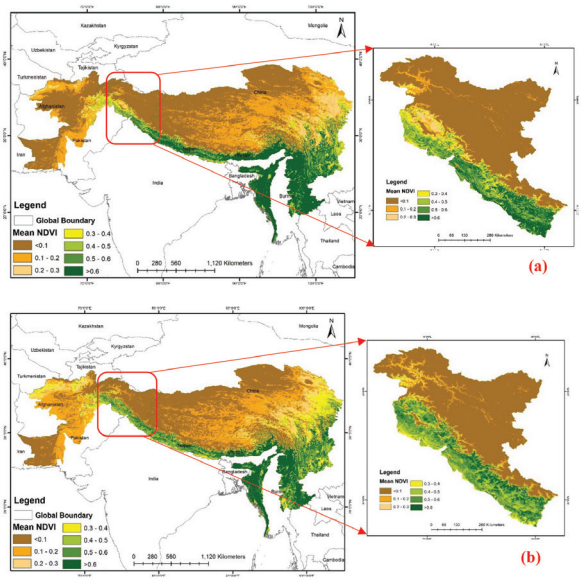
Fire Probability Distribution Map



Forest Fire Probability & Fire Incidences

(ii) Greening and browning trends in vegetation of Hindukush Himalaya (HKH) with focus on Indian Western Himalaya (IWH)

Ongoing research on the topic of "Greening and Browning trends in the vegetation of Hindukush Himalaya using Google Earth Engine". Hindukush Himalayan region covers parts of Afghanistan, Pakistan, India, China, Nepal, Bangladesh, Bhutan, and Myanmar. The study is conducted using MODIS NDVI products from 2001-2021 with the help of Google Earth Engine (GEE). The region shows an overall higher NDVI during the wet season in the Eastern part of HKH region whereas lower NDVI in the western part as compared to the dry season. Indian Western Himalayan (IWH) region has higher NDVI in the wet season as compared to the dry season in the Uttarakhand region of IWH. However, parts of J&K showed more green area in dry season as compared to that in wet season. The research is yet to be communicated for the publication.



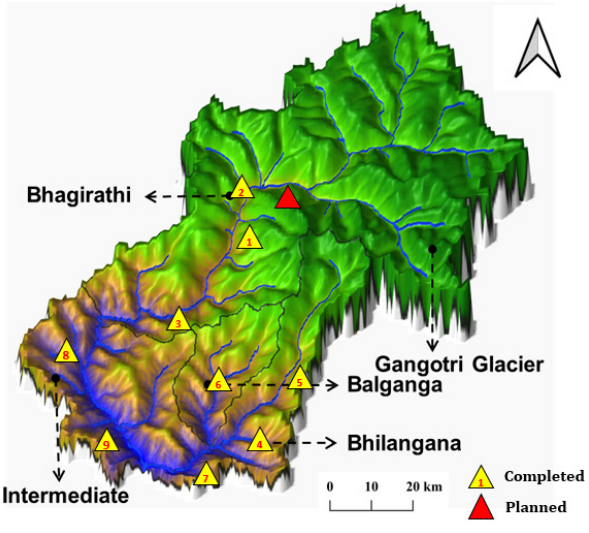
Images showing Mean NDVI during (a) Wet season, and (b) Dry season over Hindukush Himalayan region (HKH) from 2001-2021 with focus on Indian Western Himalaya (IWH)

Soil Erosion Estimation based on Radio Tracer Technique and Soil Quality Assessment in Mountainous Landscape of North-West Himalaya

Radio tracer technique is emerging as alternative to conventional method of estimating soil erosion rates of large area. Besides this, recent development in the technologies such as availability of high-resolution satellite data, terrain data, various software and increased computing power has enhanced data analysis capabilities over large spatial domains for reliable estimation. Radio

cesium (^{137}Cs) isotope is used for estimating long-term soil erosion rate of the study area. The present study aims to assess soil erosion rate and risk at pixel level using RUSLE model and to validate results with radiotracer technique. Soil quality will be assessed based environmental variables derived from remote sensing and climate data employing soft computing methods.

Satellite data/ product (CARTOSAT & IRS LISS IV) are purchased for the study area. For the generation of sampling plan for ^{137}Cs measurement, basic maps (geology, geomorphology, terrain, drainage, land use, soil-physiographic unit) are generated. A total 2 different sampling methodology was adapted. For understanding the soil erosion process over the lesser and higher Himalayan landscape hillslope based approach was adopted. Similarly, for the calibration of RUSLE model, stratified random sampling was designed. According to the soil sampling plan, approximately 660 soil profile samples are collected from the Tehri catchment area. Simultaneously, a pilot soil quality model developed for the intermediate catchment of Tehri using soil attributes and machine learning approach.



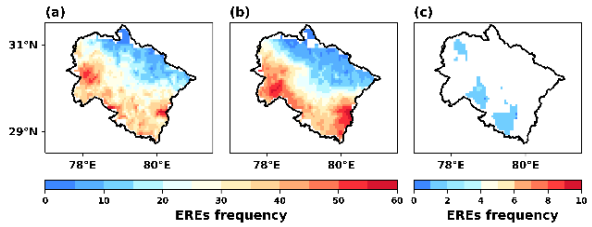
Hillslope sampling locations completed & planned

Soil sample analysis for soil physico-chemical properties are carrying on in Central Analytical Lab (CAL), Indian Institute of Remote Sensing, Dehradun. The collected soil samples were pre-processed and sent to Centre for Advanced Research in Environmental Radioactivity (CARER), Mangalore University for radio cesium analysis. Remaining, soil sample collection will carry out during March to June, 2023.

Observational and simulation study of extreme rainfall over the North-West Himalayan region

The state Uttarakhand is the most vulnerable state for extreme rainfall events (EREs). In order to examine the features of EREs over the Uttarakhand region, this study uses the most recent release of the Integrated Multi-Satellite Retrievals for Global Precipitation Measurement (GPM) (IMERG) dataset for the years 2000 to 2021 (June-September). The frequency and intensity of EREs has been estimated using three percentile distribution such as 98 (60.21 mm day^{-1}), 99 (78.51 mm day^{-1}, 99.99 (214.89 mm day^{-1}). The southern part of the study region receives highest number of extreme rainfall events (30-60 in last 21 years) compare to northern part (0-20 in last 21 years). Similarly, the southern part of study region receives the highest extreme rainfall intensity (greater than 90 mm day^{-1}) for the percentile distribution 98 and 99. EREs with elevation indicate that the maximum EREs frequency (20-60 in last 21 year) has been found in the elevation range 0-3000m across the study region. Additionally, strong negative correlation (~-0.82 and ~ -0.83) has been found between EREs frequency (in between 60.21 mm day^{-1} and 214.89 mm day^{-1}) and elevation. Similarly, strong negative correlation (~-0.87) has been found in between EREs intensity (98^{th} and 99^{th} percentile) and elevation. The highest rainfall intensity for all three percentiles has been found in the elevation range 0-3000m. The rainfall intensity associated with 5 year, 10 year and 15 year return level using Generalized

extreme value distribution has been found to be in the range of 80-120 mm day^{-1}, 100-160 mm day^{-1} and 140-200 mm day^{-1}.



The frequency of EREs having magnitude in between(a) ≥60.21 mm day^{-1} and < 78.51 mm day^{-1} (b) ≥78.51 mm day^{-1} and < 214.89 mm day^{-1} (c) ≥ 214.89 mm day^{-1} (colorbar represents the frequency of EREs).

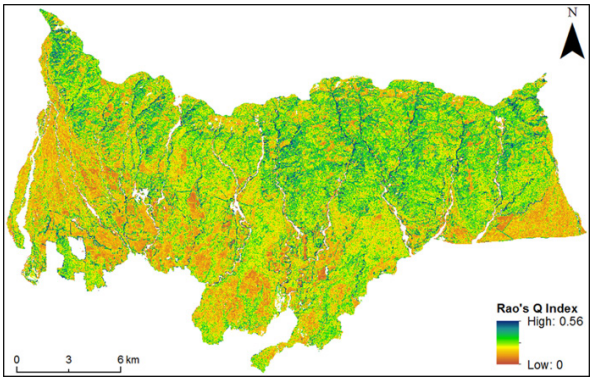
Biodiversity Characterisation at Community level in India using Earth Observation Data (DBT-DOS)

The project was targeted at spatially characterising the vegetation communities and generating various traits of vegetation using primary field data and multi-sensor remote sensing (RS) data for the Nandhaur landscape. The field data collected from 69 plots of 0.1 ha analysed for diversity pattern assessment. A total of 139 (72 trees, 26 shrubs, 33 herbs/grasses, and 9 climbers) species were recorded. Five tree species including Madhuca indica, Syzygium operculatum, and Holarrhena pubescens were found to be rare according to the field inventory, while Mallotus philippensis, Shorea robusta, and Syzygium cumini were most abundant. Two bamboo species i.e, Dendrocalamus strictus and Bambusa bambos were also recorded.

Eight tree communities were successfully classified with an overall accuracy (OA) of 92.60% with the Random Forest (RF) classification algorithm using multi-temporal Sentinel-2 data along with topographical variables and the canopy height model (CHM). Shorea robusta and Syzygium cumini communities constitute the tropical moist deciduous forest in both Terai and Bhabar regions. The greater richness and equitability in mixed deciduous communities complement greater diversity. Across the communities, Syzygium cumini, Shorea robusta, Mallotus philippensis, and Lagerstroemia parviflora were found to be the profusely regenerating species.

The Physicochemical analysis of soil was also carried out for 55 composite soil samples obtained from 0-30 cm depth. 4 soil samples were collected for each 0.1 plot. It was observed that the Organic Carbon, Potassium and Nitrogen content of moist deciduous communities is higher while the texture parameters of tree communities are almost uniform among the communities.

The spectral variation hypothesis (SVH) based on Rao's Q index derived from multi-temporal Sentinel-2 data was used to estimate tree species diversity patterns. The seasonal variation in spectra of vegetation due to phenology significantly affected the performance of Spectral diversity (Rao's Q) in estimating tree diversity. It was observed that the correlation was lower at the landscape level whereas higher for individual forest types. Among the forest types, the highest R^2 value was observed in the month of April (R^2 -0.69) for Dry deciduous forests. The use of multiple images increased the correlation between H' and Rao's Q index. The dry deciduous forest observed the highest R^2 of 0.77 between Rao's Q index and H' followed by that in the moist deciduous forest. The moist deciduous forest showed the lowest variation in R^2 over the year which may be because it is dominated by Sal (Shorea robusta), with the highest relative dominance up to 90%. A higher value of Rao's Q was observed for the upper mountainous region which is also part of the Nandhaur wildlife sanctuary while the lower foothills and flat areas outside the protected area showed lower tree diversity.



Composite Rao's Q index-based tree diversity patterns at 0.1 ha scale in the Nandhaur landscape

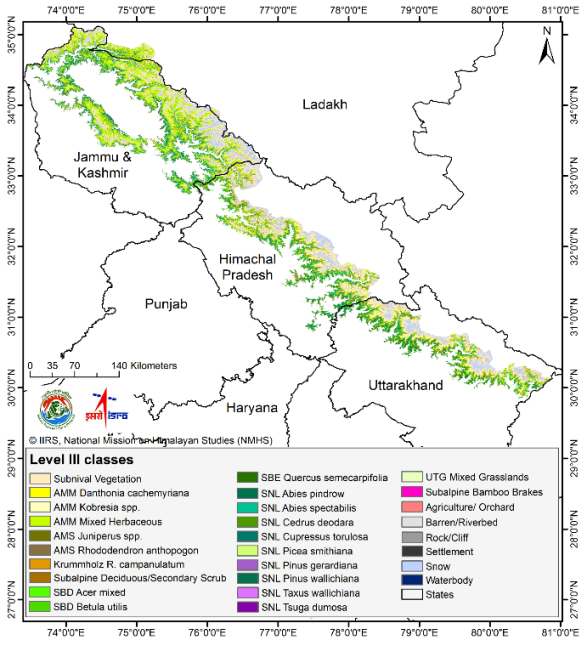
Himalayan Alpine Biodiversity Characterisation and Information System-Network (NMHS-MoEF&CC)

The project activities in 2022 were focused on: a) Refining the vegetation mapping for the Greater Himalayan region and generation of vegetation classification scheme and mapping for the trans-Himalayan region; b) intensifying field sampling for collection of vegetation data and soil samples as per project methodology, and analysis; c) testing of UAV-Hyperspectral imager for calibration and acquisition of the data; d) development of the web-portal.

The vegetation classification map at the community and species level is refined for the Greater Himalayan region and 23 vegetation classes were mapped with ~92% accuracy using the Random Forest machine learning algorithm on Sentinel-2 data. The relationship between vegetation distribution and environmental variables was analyzed and environment envelops of vegetation classes was revealed. Vegetation of the trans-Himalayan zone (Biogeographic zone-1) was classified into 31 vegetation classes and further refinement is undergoing to enhance classification accuracy. Field data was collected from 91 environmental grids, covering an elevation of ~3000-5200m asl. A total of ~8500 quadrats were laid so far to inventory alpine biodiversity across 755 1ha sites distributed along environmental gradient. A total of 699 species of plant have been recorded in the sample plots so far.

UAV parametrization and sensor calibration was done after conducting several test flights, training obtained from DGCA training institute and several round of discussion with sensor provider. Development of Himalayan Alpine Information System is undergoing with capabilities to visualize the spatial and non-spatial data and queries based search on different field of alpine plant diversity. The portal hosts spatial databases developed on environmental variables, topography, vegetation classified map, diversity maps as well as species information recorded in the sampling along with plot level information.

A field workshop was conducted at University of Kashmir and project manual was released.



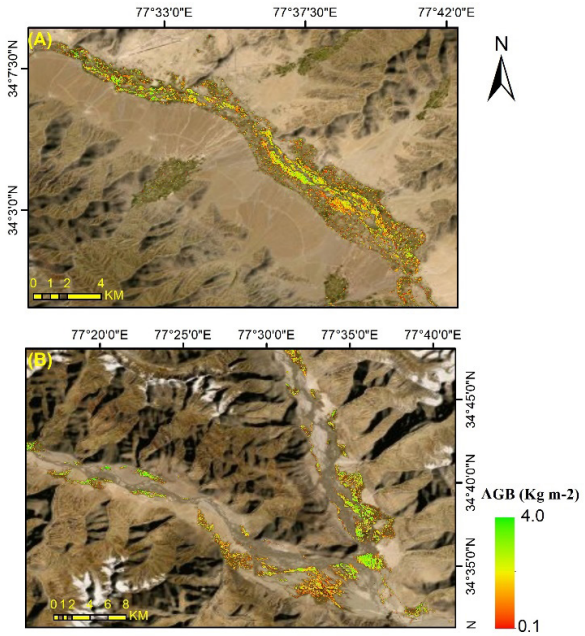
Vegetation community classified map (23 classes) for the subalpine-alpine region of the western Himalaya (Greater Himalaya)

Prioritizing Suitable Sites for Agroforestry Expansion and Conservation/ Restoration of Key Plant Species of Ecological and Livelihood Importance (Spatial Data Infrastructure (SDI) Geoportal with allied Database Development for UT-Ladakh)

The trans-Himalayas region of India creates the unique cold deserts of Ladakh, India. The region shows remarkable seasonal variation in climate creating a highly fragile ecosystem with limited natural resources. The project aims to conserve the unique ecosystem by mapping the key phytoresource species (Hippophae rhamnoides) and pastures for better management for improvement of the livelihood of the local people of UT-Ladakh. The objectives of the project are to (i) Mapping Sea Buckthorn to support bio-enterprise development and carbon trading; (ii) Assessing the status of rangelands and pastures for grazing management and eco-restoration; (iii) Assessing habitats of selected endangered and high-value plants for conservation planning.

For the fulfillment of project objectives, the mapping of Sea Buckthorn (SBT) for UT-Ladakh has been completed. The Site Suitability for agroforestry expansion of SBT is also completed for all valleys. The Above-ground biomass (AGB) and carbon stock of SBT are estimated using field and Radar satellite data. The estimated spatial AGB ranges from 0.1 kg m^{-2} to 4 kg m^{-2} in Ladakh. The maximum growth of SBT in Nubra Valley is supported by the large landmass formed by sand dunes near Lakzung. Nubra Valley contains the few largest patches of SBT along Lakzung, Summur, Tiggur, and Panamik villages. These major patches of SBT in Nubra are one of the major carbon reserves. In Leh Valley, SBT distributed on isolated landmass created by Indus river channels shows maximum AGB e.g. Shey, Chuchot, and Spituk village.

The study evaluates the spatial carbon sequestration potential (CSPI) of SBT in the different valleys for management and conservation or plantation. CSPI is a function of stored carbon, carbon assimilation rate, and the area occupied by vegetation. The result shows that SBT in Kargil and Nubra Valley needs conservation as they stored maximum carbon in form of biomass. SBT in Kargil and Nubra Valley showed carbon sequestration potential index (CSPI) average value is 0.14 and 0.15 respectively with high Aboveground Carbon Density (ACD) <0.7 gC m^{-2}.

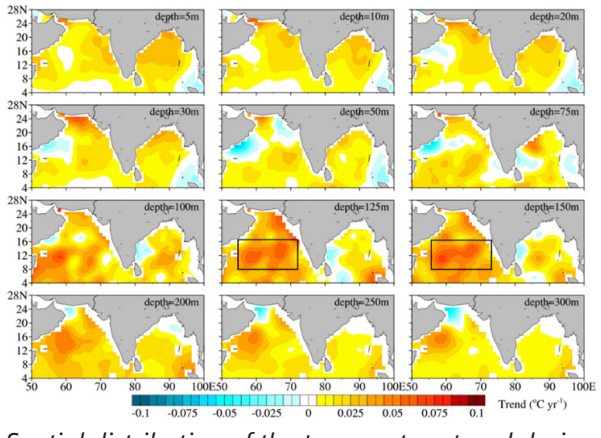


Spatial extent and above-ground biomass of H. rhamnoides in (A) Leh, (B) Nubra valley

Effect of tropical cyclones on physical and biological processes in the North Indian Ocean

Tropical cyclones have long been recognized as one of the most destructive natural phenomena which affect the tropical coastal

regions causing a huge loss of life and economic damage. India having an extensive coastal belt lying in tropical ocean is extremely vulnerable to these cyclones. Climate change induced global warming increases the strength and vulnerability of cyclonic events. The present work examines the links between the upper ocean warming over the northern Indian Ocean (NIO) and the increased frequency of cyclonic events, causes leading to the rapid intensification of cyclones and the response of physical and biogeochemical processes in the upper ocean during the crossing of cyclone. Using the ARGO gridded data of the spatial distribution of temperature, a trend analysis is carried out at various depths over the NIO for the period 2003-2020 which revealed that maximum warming trend of about 0.08 °C/ year is observed at depth 125 - 150 m over the southern Arabian Sea which is unique in the NIO and thus have important implications for the increased frequency and intensity of cyclones over this region. The presence of an anticyclonic eddy (warm core) in the proximity of the cyclone Tauktae track played a crucial role in the sudden increase in the intensity of the cyclone. An analysis on the impact of marine heat wave (MHW) on the occurrence of cyclone over the NIO showed that the presence of MHWs events on May 17, 2020 supports the sudden intensification of cyclone Amphan on May 18, 2020 from cyclonic storm to super cyclonic storm within 24 hrs.

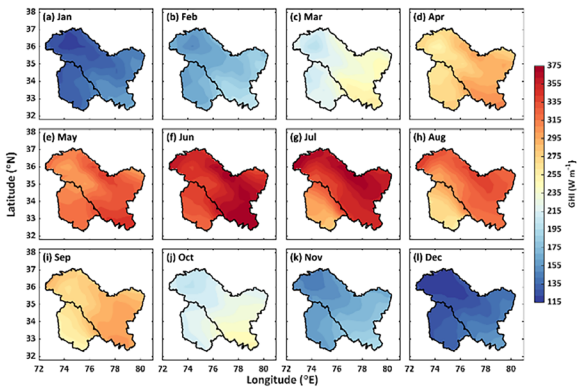


Spatial distribution of the temperature trend during 2004 - 2020 using ARGO at different depths

Numerical Modelling of Weather and Solar Parameters using WRF

(Spatial Data Infrastructure Geoportal with Allied Database Development of UT-Ladakh)

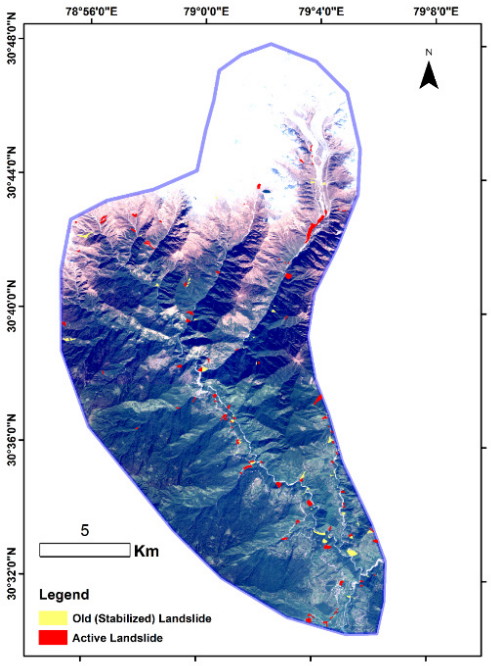
Solar technologies are viewed as feasible options for reducing greenhouse gas emissions and encouraging long-term adaptation in the context of climate change and rising energy demand. Solar energy is India's second-largest Renewable Energy (RE) source, and playing increasingly important role in the country's low-carbon energy portfolio. Jammu and Kashmir and Ladakh are the northernmost states of India, with elevations ranging from 205 to 8564 meters above the mean sea level. Both states are located just south of the Karakorum and have a subtropical and cold-arid environment with scarce renewable energy resources. This study is performed to identify the annual and monthly variation of solar energy potentials for the recent climatological future over the western Himalayan region. The long-term annual average demonstrated the high efficiency of GHI over Leh and Kargil and low over the Jammu and Kashmir region. The monthly variation shows greater GHI values between March and October, varying from 225 to 375 W m^{-2}, and lower from November to February, less than 220 W m^{-2}. The mean ambient 2-m temperature indicates December and January months are bad for solar energy installations, while June and July are excellent. Overall, the findings show that Ladakh has a remarkable solar energy potential and is recommendable for further investigation.



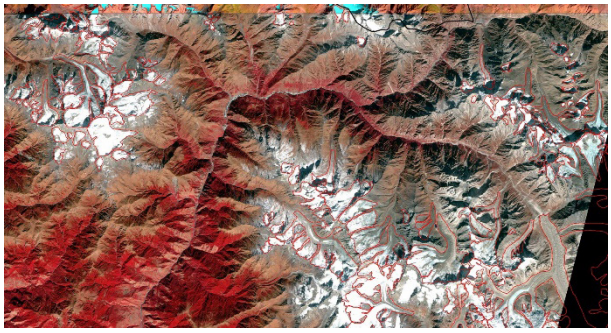
Spatial variation of monthly GHI from 1981 to 2020

Satellite Based Mountain Hazard Assessment and Monitoring (MHAM) in Uttarakhand

This work is part of project sponsored by Uttarakhand State Disaster Management Authority (USDMA) on glacial and landslide hazard components. Satellite based Inventory map (Pre-monsoon 2022) and Landslide hazard zonation by AHP method considering all causative/ triggering factors in Mandakini and Bhagirathi study area. Inventory map consists of active and old/ stabilized landslide locations at 1:25K scale. 149 Nos of old/stabilized landslides are detected in Mandakini valley. The map has been prepared by using Sentinel-2B images acquired in October 2021 and May 2022. Inventory of glaciers of Bhagirathi basin has been done using pan sharpened Landsat 8 data of the year 2021. The inventory of pro-glacial and per-glacial lakes were completed. For the avalanche activity around Kedarnath, joint field work has been conducted with USDMA and Wadia Institute of Himalayan Geology.



Satellite image (natural color composite) showing inventory of old (stabilized) and active landslides in parts of upper Mandakini valley. Data source: Mosaic of Sentinel 2B acquired on November 17, 2021 and April 06, 2022 displayed with RGB-432 band combination.



Satellite image (false color composite) showing inventory of Glacier mapping for Bhagirathi basin with RGB-321 band combination of LISS IV data

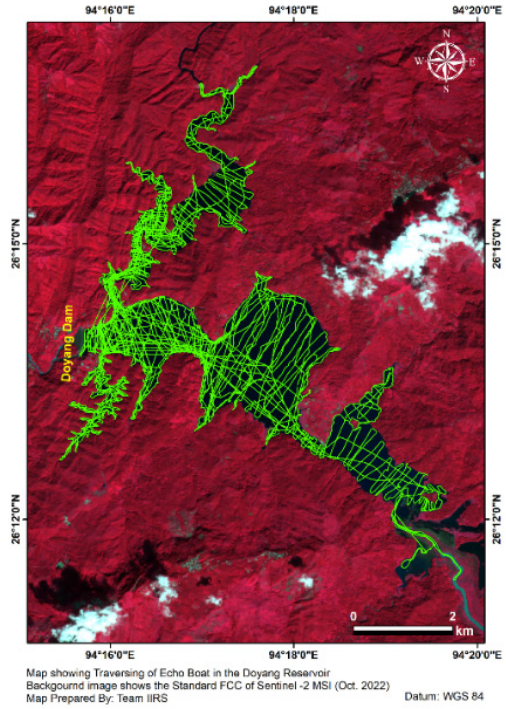
Bathymetry Survey of Doyang Reservoir in Nagaland

IIRS in collaboration with North Eastern Space Applications Centre (NESAC), Shillong is carrying out a project to access the present capacity of the Doyang Reservoir, Nagaland sponsored by North Eastern Electric Power Corporation Limited. In this project, IIRS has been given the responsibility of bathymetric survey of the reservoir. The team of IIRS carried out the preliminary survey during April 12-20, 2022. Whereas, the actual survey was conducted in phases: i.e., October 08-18, 2022 and November 10-14, 2022. The bathymetry survey was carried using the Seafloor Dual-beam echo sounder / echoboat of the IIRS. The echoboat was traversed in both longitudinal and latitudinal directions in the reservoir to collect the sounding data. The sounding data was pre-processed and spikes / outliers were removed. It was noticed that around 2500 sounding data points per hectare were collected correctly during the survey.

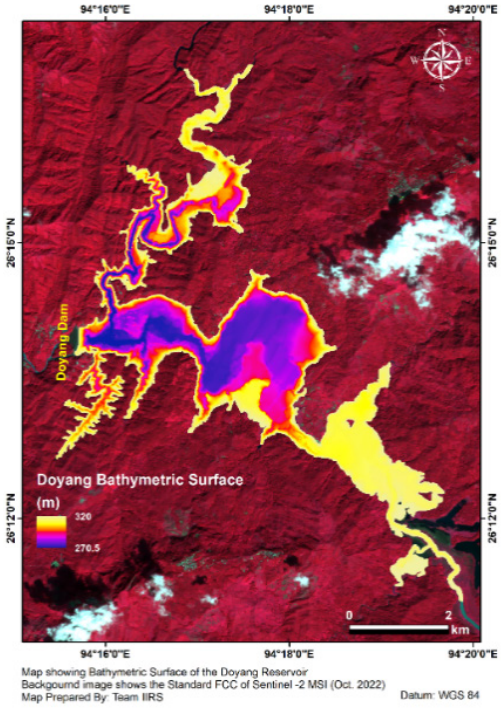
Using the sounding data collected at each point along the tracks and observed water level during the survey dates, the bathymetric surface was delineated as shown in the Figure. With the help of generated bathymetric surface, the contours at 1 m interval were delineated. Using the bathymetric surface, water spread area at every 1 m interval of elevation from 270 to 318 m was estimated. To

calculate the capacity between two elevations, the most widely used trapezoidal formula was used. In this way, the capacity estimated for the highest water level observed during the bathymetry survey days, i.e., 318 m, was 260.92 MCM against originally designed 300 MCM. However, the original capacity assessment method is at present unknown to team IIRS. There may be some level of methodological uncertainty in the present capacity assessment, as well.

Along with the bathymetric surface, the revised Area-Elevation-Capacity Curve was also derived for the reservoir. It was observed that the there is a large loss of capacity at lower and higher elevations. Similarly, change in higher and lower elevation water spreads was observed.



Traversing of Echoboat in the Doyang Reservoir

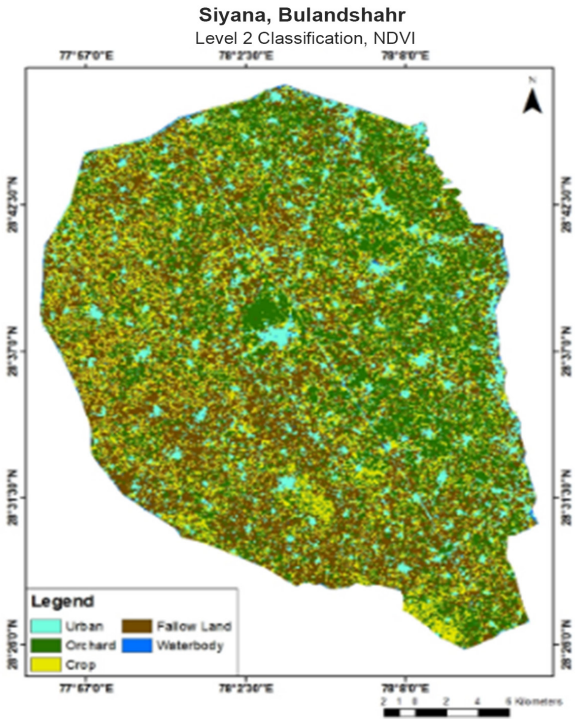


Bathymetric Surface of the Doyang Reservoir

ADDITIONAL R&Ds

JECAM: Joint Experiment for Crop Assessment and Monitoring

In collaboration with the MNCFC, orchard mapping at Siyana, Bulandshahr by pixel based methods and object based classification was demonstrated. SAR parameters and optical data derived Vegetation indices annual temporal profile used to identify the sensitive phenological stages. Mango orchard phenology and characterization was also studied.



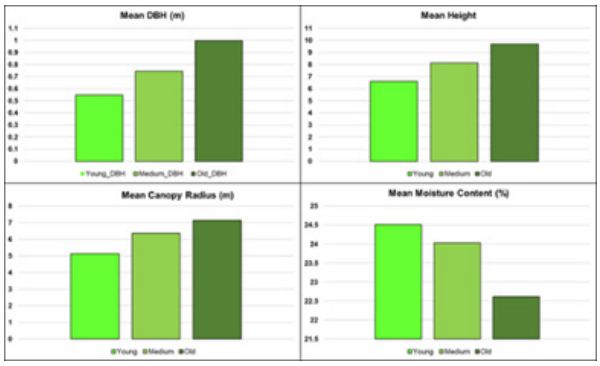
Orchard classification map vis a Vis other classes

RISAT-1A utilization of data

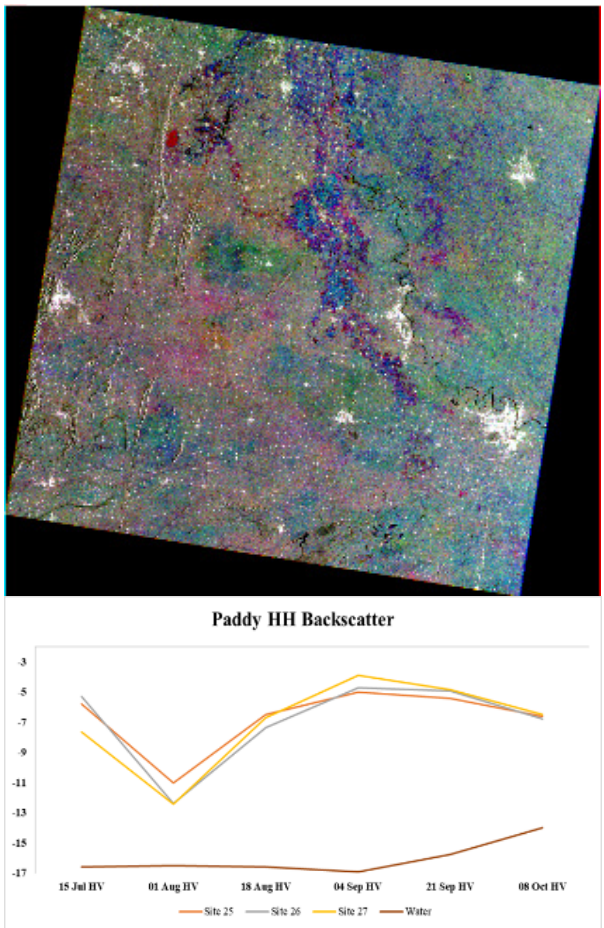
RISAT 1A MRS data (temporal) for Agra, Punjab and Palampur site analysed. RISAT FRS-1 and 2(compact-polarized/ full-pol) data preliminary analysis completed. Different transplantation date signature could be extracted from multitemporal RISAT-1A data.

Also the high resolution data (FRS) based analysis showed significant correlation with the orchard biophysical parameter.

RISAT-1A based analysis is planned. Various biophysical parameters were studied and estimated.



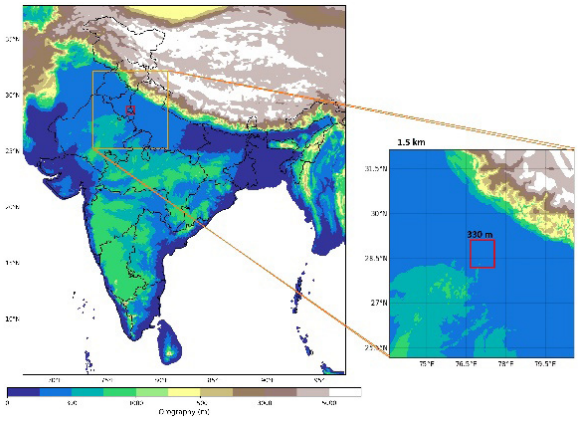
Orchard biophysical parameter of various Mango classes



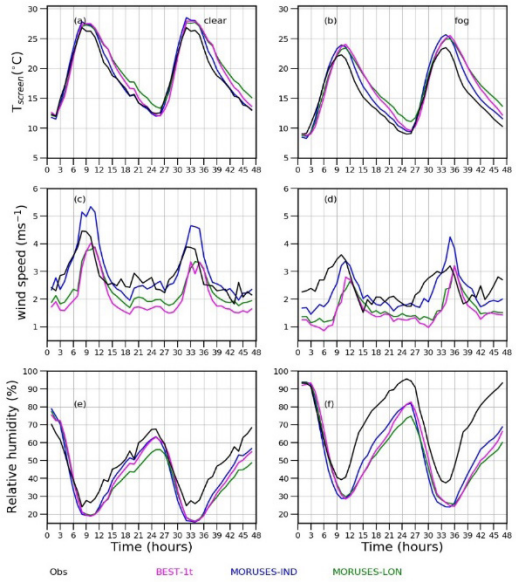
date RGB of Khari 2022 depicting paddy cultivation vs other landcover and temporal profile

Ingestion of detailed Urban Canopy Parameters in High Resolution Urban Climate model for improved near –surface weather prediction

The current study emphasizes the need for ingestion of accurate Urban Canopy Parameters (UCPs) information for improving the near-surface weather prediction over Delhi, a tropical Indian city. The Met Office Reading Urban Surface Exchange Scheme (MORUSES), a two-tile urban energy budget parameterization scheme, is introduced in a high-resolution (330 m) model of Delhi along with ingestion of detailed UCPs information (MORUSES-IND). Information on UCPs i.e. Mean building height, Frontal Area Index, Plan rea Index were derived using Very High resolution Optical stereo data (Pleiades - 0.5 m spatial resolution). It is found that ingestion of Urban Canopy Parameters (referred as MORUSES-IND) information in model reduce the warm bias in screen temperature (Tscreen) simulations, especially during the evening and night hours as compared to default UCPs information based on London morphology data (Referred as MORUSES –LON). The root-mean-square error of Tscreen is reduced up to 29 % and the diurnal cycle of surface energy fluxes is also reproduced well. The model with UCPs information represents the impact of urbanization more realistically which, is reflected in the reduction of urban heat island and UCI in both synoptic conditions. Wind speed simulated using MORUSES-IND shows an increase in magnitude (25%) and exhibits remarkable improvement in terms of magnitude and phase in day1 and day 2 during clear and foggy events.



Study area and nested Domain configurations



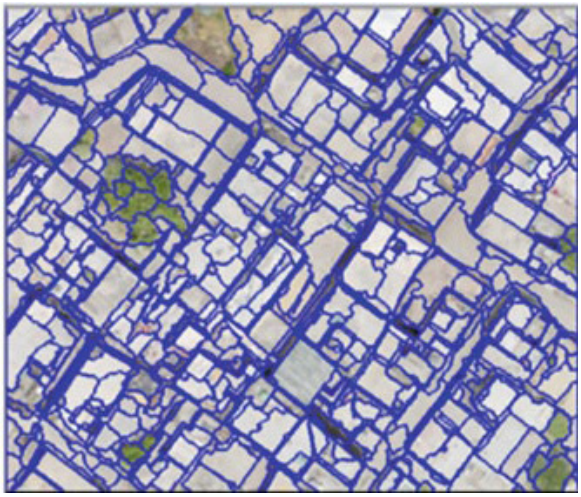
Ensemble mean diurnal cycle of observed (black) a-b screen temperature Tscreen (oC), c-d wind speed (ms^{-1}) and e-f relative humidity (%) are compared with the numerical simulations BEST-1t (magenta), MORUSES-IND (blue) and MORUSES-LON (green) at IGI, an urban site. Left and right columns show clear and fog cases respectively.

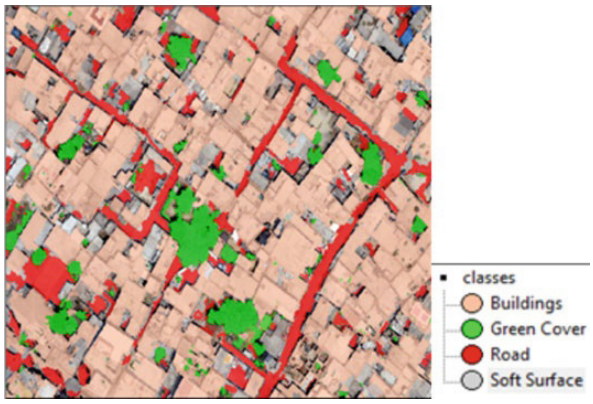
Urban Feature Extraction using UAV Data

The present study demonstrates the potential of Very High Resolution (VHR) orthoimage and Digital Surface Model (DSM) for urban classification using the OBIA techniques. This study uses highly dense urban area situated in the nearby Roorkee city of Uttarakhand, India. The geographical extent of the study area spans from 77° 54'19.49''E longitude to 77°

54'21.34''E longitude and from 29° 52'0.273''N latitude to 29° 51'56.86''N latitude. It comprises of densely packed buildings of varying heights and aerial coverage. The study area consists of both manmade features (buildings, roads, pavements and parking lots etc.) and natural features (bare soil, grasslands, shrubs and trees). The imagery was obtained using the UAV DJI Phantom-4 pro, which includes a non-metric camera with visible colour bands (red, green, and blue) having 12-megapixel resolution. OBIA analysis allows for the detection and extraction of numerous urban objects such as buildings, roads, and trees. The segmented roads are classified into categories based on width and connectivity. Buildings extracted are categorised based on their elevation and size. The main objective of the current study is to establish a methodology for extracting detailed land use with the sub-objectives of finding suitable segmentation algorithms for such VHR imagery. Various parameters (spectral, texture, context and elevation) were evaluated, and rules were formulated to extract and categorise urban features specifically for roads and buildings. Figure alongside shows the segmented image and extracted features using OBIA. The study aims to demonstrate the extraction of the finest of details captured by UAV can be effectively classified using the segmentation and classification approach. The combination of UAV with OBIA can provide a quick and effective method of updating maps, particularly in frequently changing urban areas. As a result, the study's findings provide new insight into the use of OBIA in information extraction from UAV data.

Orthoimage of the study area





Segmented image and extracted features

Water availability in Upper Indus Basin (Geo-Ladakh)

The high resolution, raster-based, fully distributed Spatial Processes in Hydrology (SPHY) cryospheric-hydrological model, which was applied to assess the water availability

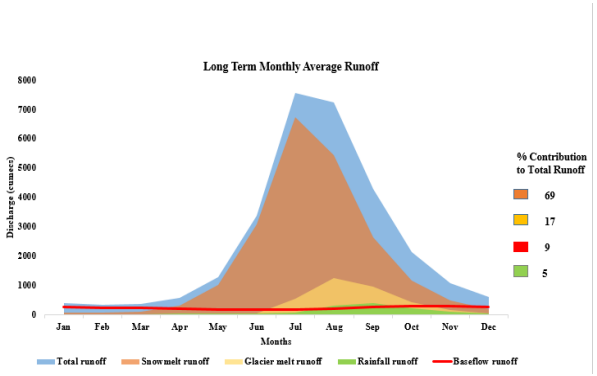
in the Upper Indus basin. Attempt was made to study the impacts of climate change on the water availability of the basin. The model was setup at 1 km^2 spatial resolution and run at daily time step. The actual runoff which is calculated for each grid cell consists of four possible contributing factors: rainfall-runoff, snowmelt, glacier melt, and base flow. For each grid cell the total runoff generated per time step (Q_{TOT}) is calculated as:

where Q_{GM} is runoff from glacier melt, Q_{SM} is runoff from snowmelt, Q_{RR} is rainfall-runoff and Q_{BF} is base flow. To determine the contribution of each of the four components to the total runoff within a grid cell, a sub grid parameterization is used in which for each cell the fractional ice cover (GF), ranging from 0 (no ice cover) to 1 (complete ice cover), is determined. Glacier melt is simulated using a degree-day modelling approach. A differentiation in debris covered and debris-free glaciers is made based on thresholds for elevation and terrain slope, and different degree day factors are used for both glacier types.

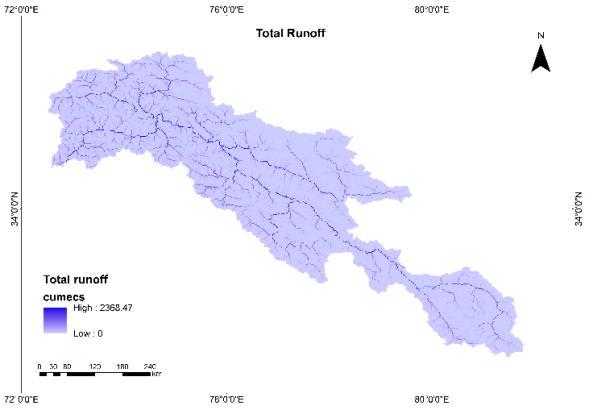
In the context of the Upper Indus Basin, the SPHY model has been used to assess water availability in the region. The Upper Indus Basin is a mountainous region that spans parts of Pakistan, India, Afghanistan, and China, and is a major source of water for the downstream regions. The SPHY model has been used to simulate the water cycle in the basin, including the dynamics of snow and glacier melt, which are important sources of water in the region.

The SPHY model is typically used in combination with satellite data and ground-based observations to improve the accuracy of the simulations. The model can also be used to evaluate the impact of climate change on water availability in the region, as well as to assess the potential benefits of water management strategies such as reservoirs, irrigation systems, and groundwater recharge.

Besham Quila station yielded an average annual runoff of 2368.67 cumecs. Analysis of the long-term monthly averages indicated that snowmelt accounted for 69% of the total runoff, glacial melt contributed 17%, base flow contributed 9%, and rainfall runoff contributed 5%. These findings highlight the dominant influence of snowmelt and glacial melt on the runoff dynamics at Besham Quila station, which is consistent with the hydrological characteristics of high-altitude mountainous regions.



Long term monthly average runoff



Spatial water availability

Monitoring of river flow at sparsely gauged basin using integration of space-based water level and hydrodynamic modelling

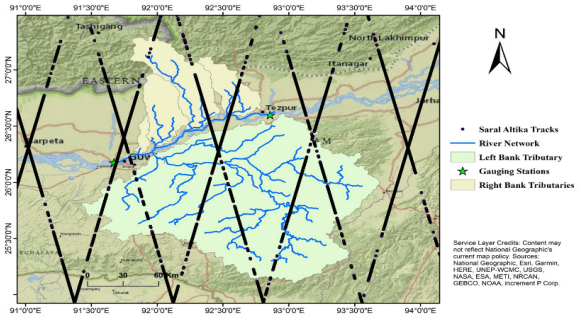
Remote sensing data provides an opportunity to monitor water level of transboundary river basins at fixed temporal resolution. It is possible

to estimate river discharge at ungagged river sites using altimeter observations and nearby gauging data. This approach provides the low-cost uniform monitoring of river flow in remote areas. Further, researchers dealing with flood hazard and risk assessment typically refer to stage/discharge data for the calibration and validation of hydrological and hydrodynamic models. However, gauging stations in many parts of the world are either unavailable or sparsely available and decreasing due to the high economical and temporal efforts required for their maintenance.

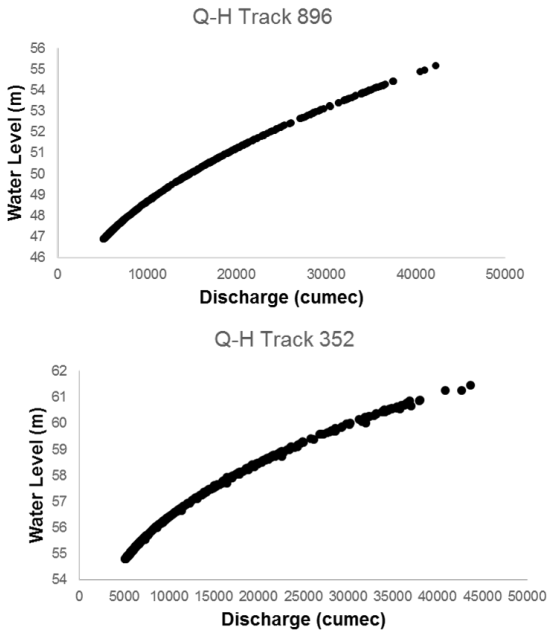
In this study, combined use of hydrodynamic model and satellite altimetry data has been exploited to estimate stage-discharge rating curves at virtual stations in flood-prone sparsely gauged river stretches of Brahmaputra (Tezpur to Guwahati) and Mahanadi (Boudh to Naraj). Here, results of Brahmaputra River only are shown.

The centimetre level agreement (RMSE: 15–88 cm) was observed between the modelled and altimetry-derived water level at all the virtual stations, indicating the potential of satellite altimetry for multi-site validation of the hydrodynamic model and validation of the constructed rating curves.

The availability of rating curves at virtual stations allows the expansion of the gauging network along the sparsely gauged river, thus enabling the estimation of the discharge at additional locations, possibility to improve prediction capability of large-scale hydrological models and evaluation of the contributions of lateral tributaries. At present the altimeters observations have low temporal resolution (e.g., 10 days) and methods to estimate discharge depends on the auxiliary data of the nearby station. However, availability of high computation facility, HD models in combination with the more detailed observations by the forthcoming satellite missions, can open up new aspects to enhance the study of the flow dynamics at the global scale.



Virtual stations in Brahmaputra River basin



Stage-discharge rating curves generated at virtual stations

Semi-automated Workflow for Mapping the Extent and Elevation Profile of Intertidal Zone of Parts of Gulf of Kutch, India, Using Landsat Time Series Data

Mapping the topography of intertidal zones through in situ methods has many challenges associated with it and airborne techniques for determining the elevation profile are expensive. High temporal and spatial coverage provided by satellite remote sensing makes

it highly efficient in assessing the extent and profile of intertidal zone even in remote and inaccessible areas. In this study, a semi-automated and scalable methodology is presented for generating the digital elevation model of the intertidal zone of Gulf of Kutch, India, thus bridging the existing gaps between terrestrial and marine elevation datasets.

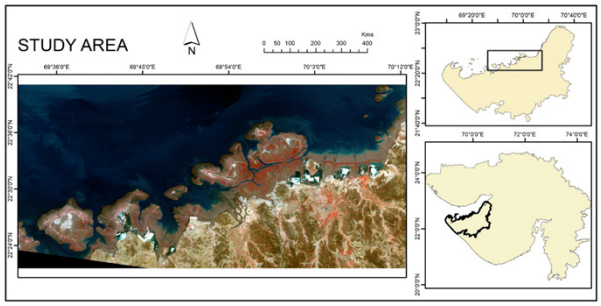
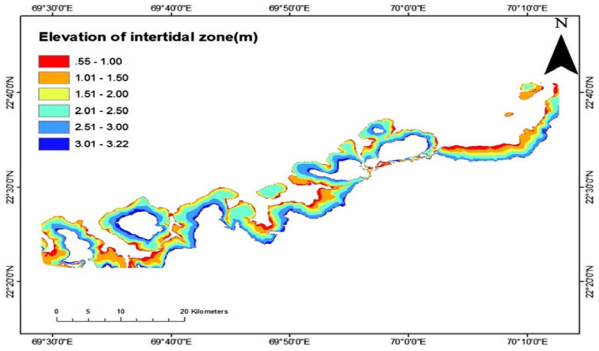
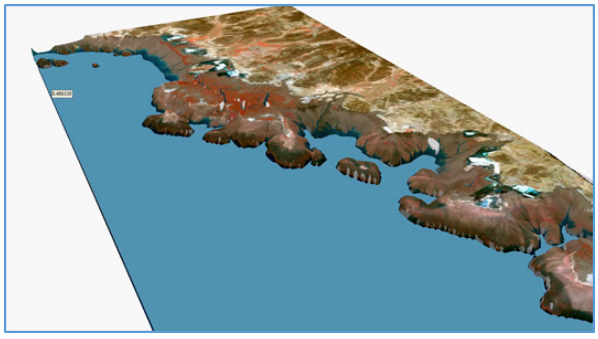


Image showing the study region

Image showing Land-water boundary



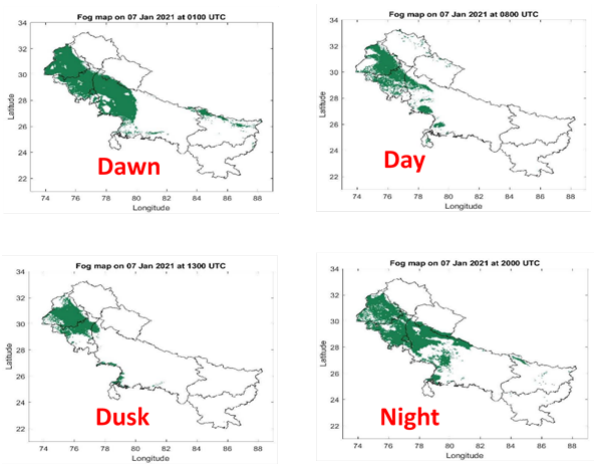
Extent of Intertidal zone



3D elevation of the Intertidal zone

Fog estimation using SEVIRI data

Fog is a cloud of tiny water droplets that forms at ground level and is thick enough to limit horizontal visibility to less than 1 kilometre. The presence of heavy and extended periods of fog in the Indo-Gangetic Plains is one of the major weather hazards, impacting road transportation, aviation, the economy and public life in general. So, it is essential to be able to detect the fog in time, in order to deal with a large number of influence factors. The ground observations are limited in spatial and temporal coverage. The satellite products especially from geostationary platforms have the advantage of temporally continuous data over a large spatial extent. The present work is on the retrieval of fog from geostationary satellite data over Indo-Gangetic Plains. The state-of-art fog products over IG plains are Fog/Low stratus clouds and that too doesn't have good accuracy during dawn and dusk. In this research, the emphasises is on the retrieval of pure foggy pixels during the whole day including dawn and dusk. The algorithm has been developed using Random forest machine learning techniques alongwith MSG (Meteosat second generation) SEVIRI (Spinning Enhanced Visible and Infrared Imager) data and ground visibility data. The algorithm developed has been proven capable of detecting fog irrespective of time i.e. day, night, dawn and dusk with high accuracy. Figure shows typical fog images retrieved during dawn, day, dusk and night on January 7, 2021.



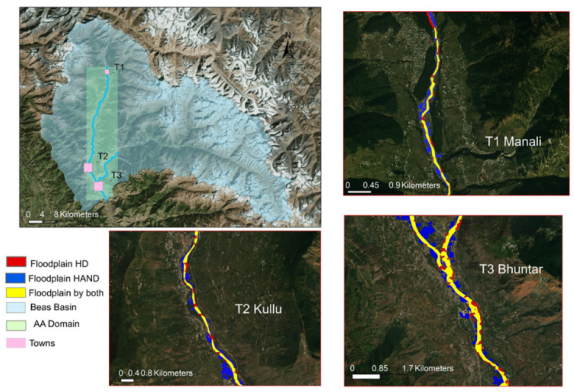
Fog images retrieved during Dawn, Day, Dusk and Night Time on January 7, 2021

Investigation of less complex topographic features based tools for fast floodplain delineation

Flood is one of the disaster which happens every year in North West Himalayan region. Floodplain varies from upland by their hydrologic features and functions. Delineation of floodplain is most important step in preparedness phase of relief management activities of flood related natural hazards. Identification of flood-prone areas facilitates defining critical source areas and planning rescue mission during extreme flood events.

Intensive work has been done towards comparison of 1D, 2D and 1D-2D coupled HD models and on impacts of variation in topography/roughness coefficient configuration within same models for flood inundation prediction. Previous study have compared less complex model AutoRoute and topographic index HAND with HEC-RAS 2D for flood mapping while other proven landscape classifier topographic indices such as TWI and SP are yet to be tested against HD model in complex terrain. The aim of this study is to investigate feasibility of three topographic indices (TWI, SP and HAND) as fast floodplain mapping tools and how they behave with respect to HD model based floodplain.

Topographical indices raster's (TWI, SP, HAND) were generated for ALOS PALSAR DEM using geospatial technique. Thresholding was done by conducting DGPS surveys at actual floodplains in Beas basin to create floodplain and upland classes. HAND floodplain was able to mimic the floodplain by physical based model in terms of extent, meandering and confluence points. HAND and SP both the methods have shown favourable results compared to TWI for delineation of floodplains in the mountainous basin. Results of this study indicate that floodplains can be delineated using fast less complex tools. Having said that, fast flood mapping tools can be used to generate primary flood inundation maps and will serve as base maps for the detailed flood disaster management plan. These tools can also be used for evacuation strategy during real-time flood situation in ungauged basins. In future, elements at flood risk will be mapped for identified flood prone areas.

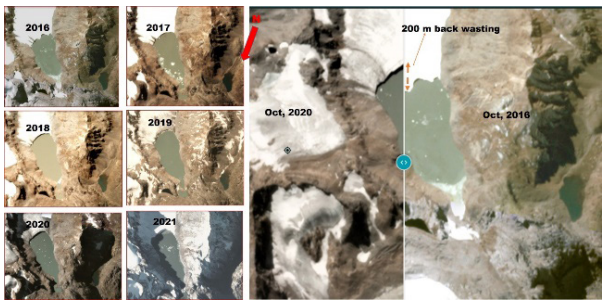


Evaluation of HAND floodplain against physically based floodplain

Assessment of Bhilangna Lake for potential glacial lake outburst Floods (GLOFs) central Himalaya, India

Catastrophic hyper-concentrated flow during the glacial lake outburst Floods (GLOFs) and its far-reaching consequences on life, property and infrastructure are the foremost concern throughout the high mountain areas. The present investigation focuses on a potentially dangerous moraine dammed proglacial lake in the Bhilangna Valley, central Himalaya, India,

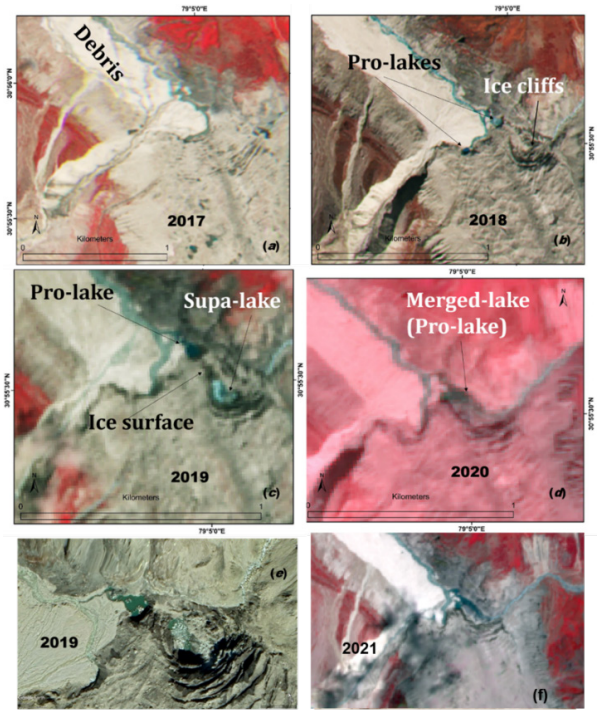
which has been expanding at an alarming rate during the last two decades. This lake has expanded from 0.15 to 0.35 km^2 during 1999–2020 at the cost of loss in the associated glacier area by 0.21 km^2 during the same time period. We have tried to understand the possible trigger and simulated the worst-case outburst scenario and its impact on the settlements and infrastructure in the downstream valley.



Satellite images showing rapid expansion of Bhilangna Lake from 2016 to 2020

Assessment of Dynamics of Frontal Part of Gangotri Glacier, India, from 2017 to 2021 Using Remote Sensing Data

The current study employed multi-sensor data from 2017 to 2021 to demonstrate the rapid transformation of the Gomukh—the terminus of the Gangotri Glacier, Central Himalaya, India. Between 2017 and 2021, the Gangotri Glacier's frontal zone underwent rapid changes, including the formation and merging of ephemeral lakes, the development of ice cliffs, and a shift in the meeting of melt streams from Raktavarn Glacier. The analysis showed that the snout of the Gangotri Glacier has lost an area of 0.08 km^2 from its frontal part from 2017 to 2021. During the investigation period, the snout of the Gangotri Glacier has receded by around 270 m. These findings are significant because they demonstrate how the dynamic glacial front changes with glacier ice area loss and indicate that increasing glacier recession should be anticipated as the climate warms, which may occasionally result in the formation of ephemeral lakes and generate a negative feedback loop.



IRS LISS IV images showing snout condition of Gomukh after 2017 evens of debris flow

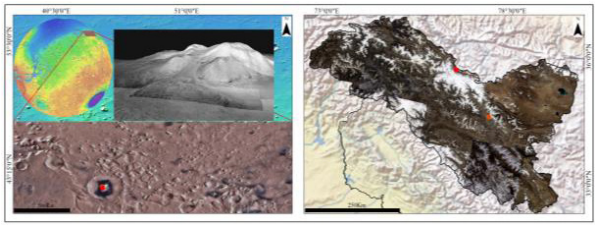
Level-2 processing of Imaging Infrared Spectrometer (IIRS) data from Chandrayaan-2 Mission:

Imaging Infrared Spectrometer (IIRS) is a hyperspectral imaging sensor onboard ISRO's Chandrayaan-2 orbiter is intended for mapping mineral composition and complete characterization of hydration feature on the lunar surface. With its extended spectral range (0.8-5mm), high-spatial resolution (80m) and high Signal to noise ratio, IIRS data is capable to measure surface composition based on diagnostic spectral absorption features of known/unknown characteristic mineral present on lunar surface. This study was conducted to derive the methodology for processing of Chandrayaan-2 IIRS data to generate photometrically corrected reflectance images. Spectrally and radio-metrically calibrated level-1 IIRS spectral radiance data were subjected to various data reductions techniques including thermal emission correction beyond 2.5µm, conversion to apparent reflectance and empirical line correction for smoothing the observed reflectance spectra. The thermally corrected IIRS reflectance data after correction for standard geometry were calibrated with

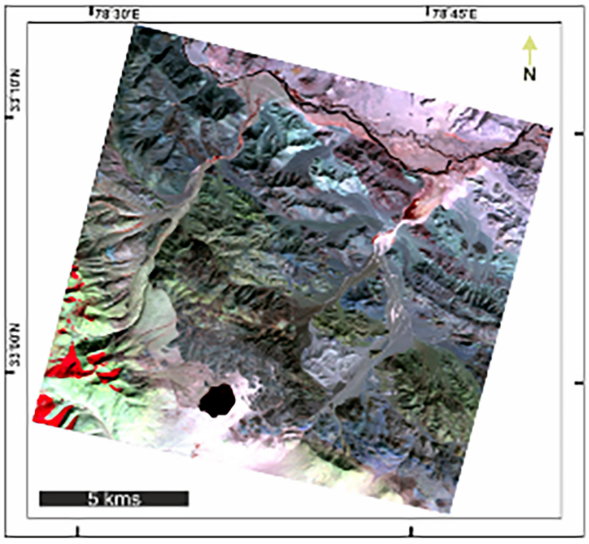
ground-based observations of the lunar surface from Apollo 16 site to generate Level-2 product. The results were compared with observations from Chandrayaan-1 Moon Mineralogy Mapper (M^3) data within the overlapping spectral range from the same region to validate the absolute reflectance of the IIRS.

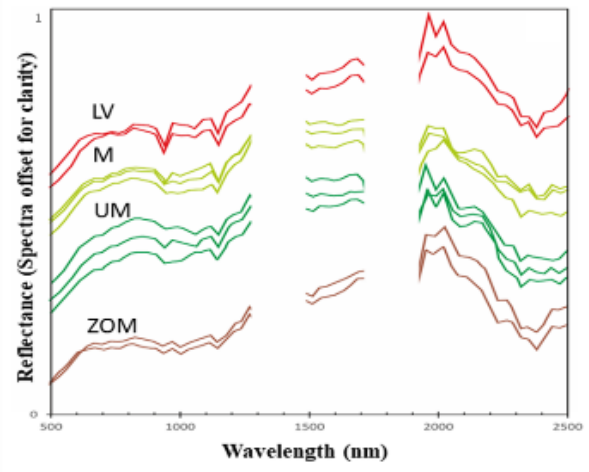
Nidar Ophiolites Complex of Ladakh: Martian Analogue Terrain

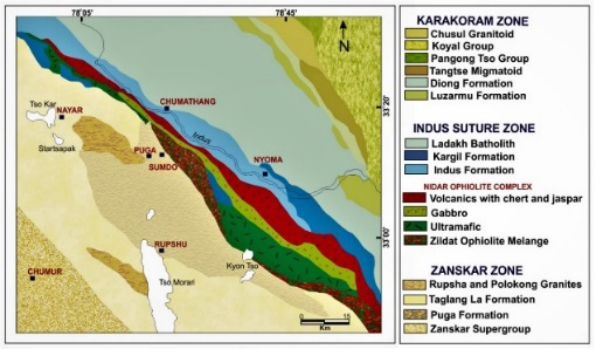
Nidar ophiolite complex is a volcano sedimentary terrain with ophiolites exposed well in the Indus Suture Zone, SE of Ladakh. It forms parts of Alpine-Himalayan ophiolites that represent oceanic crust and upper mantle of the Earth. Located between 32°45'N to 33° 35'N to and 78°E to 79°E this volcano sedimentary terrain with ophiolites consists of a wide range of lithologies with metamorphism, alteration, weathering that also contribute and effect the spectral signatures of different lithologies. Nidar ophiolites with characteristic mineralogy and associated low-temperature aqueous geochemistry can therefore can provide easily accessible areas that can serve as good analogs for planetary crustal rocks especially for martian crust. This study was undertaken keeping in view mainly to identify and observe the distribution of Nidar ophiolite using hyperspectral and multispectral imageries. Also, lithological mapping and spectral characterization of the endmembers obtained after data processing of hyperspectral data from PRISMA. The ophiolite exposures alongwith associated lithounits were analyzed systematically using available high-resolution multiple datasets (LANDSAT-8 OLI, ASTER-TIR and PRISMA).



Geological Map of Nidar Ophilite Complex, Ladakh (Source: Chauhan et al., LPSC, 2022)



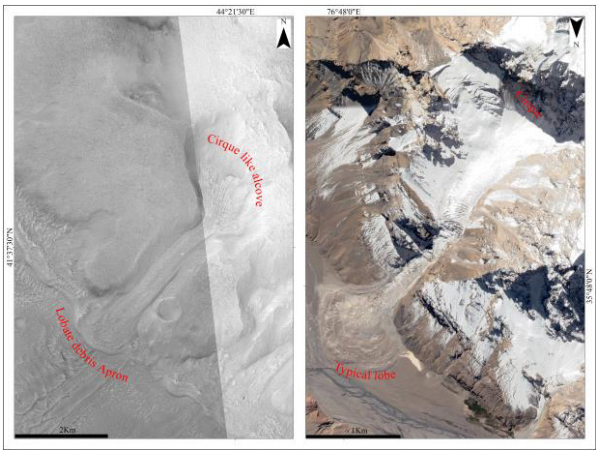




Colour composite image from hyperspectral data of PRISMA sensor, displaying various lithounits in the region distinctively; Reflectance spectra acquired from PRISMA data for the various lithounits of the study area (Source : Chauhan et al., LPSC, 2022)

Study of glacial features at Mars (Protonilus Mensae) and their analogues in Ladakh

This study was conducted to examine and compare the clusters of features believed to be of glacial or peri-glacial in origin present at Mars with those present at Ladakh, Himalaya. In the Protonilus Mensae present in northern Arabia terra region of Mars the region appears to be highly modified by glacial activity have been reworked multiple times in the recent geological past and preserves typical glacial and Periglacial landforms. The selection of Ladakh as analog site for Martian glacial features study was due to its barren landscape, high altitude arid cold desertic conditions somewhat similar to Mars and seclusion of the geomorphological features from anthropogenic activities. The comparative analysis of morphological properties of rock glaciers on Mars and earth can help to understand the paleoclimatic history of Mars and possible causes responsible for shift from warm to cold and dry conditions on Mars. High-resolution satellite images of earth and Mars have been utilized for the comparison and establish the similarities.



Left- a mosaic of HiRISE images ESP_060197_2220_RED and PSP_002098_2220_RED showing LDA at the base. Right- terrestrial tongue-shaped lobe.

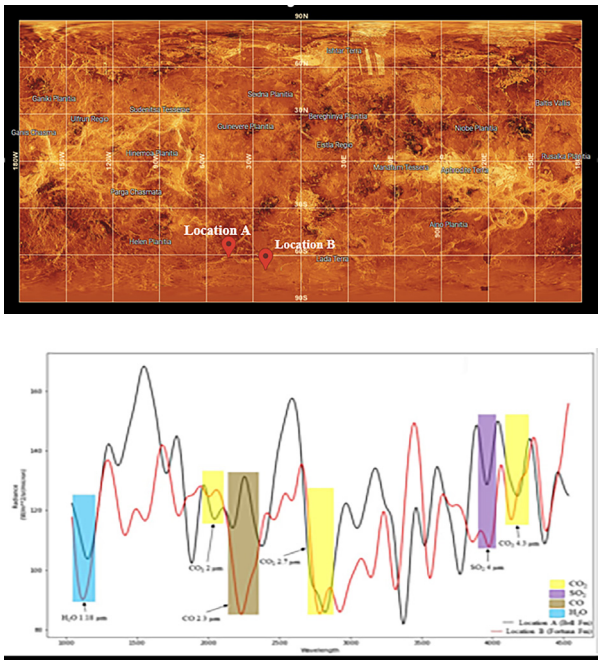
Location of the study areas from Mars (Protonilus Mensae) and Earth (Ladakh Himalayas) Source: Verma et al., LPSC, 2023.

Utilization for VIRTIS data to detect sites of active volcanism on Venus

The Venusian atmosphere consists of CO_2 (96.5%), and N_2 (3.5%), with few to a few hundred parts per million (ppm) of sulfur-bearing trace gases, chlorine and carbon compounds and water vapour. Any active volcanoes would cause an anomaly in the atmospheric concentration of volatile components due to outgassing.

This study conducted to analyze the spectral characteristics of gases present in the Venusian atmosphere at specific locations to detect their concentration anomalies that may indicate the possibility of active volcanism. Two specific sites (Bell and Fortuna Formation) were selected based on a geological to narrow down the regions of the youngest volcanic units and the deformed oldest units. The study utilized data from the Visible and Infrared Thermal Imaging Spectrometer (VIRTIS) instrument onboard Venus Express. It provides high-resolution hyperspectral spectra of the Venusian atmosphere in the 2-5 µm range and two channels that allow mapping of the minor constituents of the planet's deep atmosphere occurring in the region of the upper and lower clouds. The data has a low signal-to-noise ratio (SNR). So, several noise removal algorithms like PCA, Laplacian Filters, Butterworth filters etc. to enhance the spectral features. Since the availability of pure spectra from the VIRTIS datasets is limited, a transfer learning-based machine learning approach was utilized. The weights and biases of preliminary layers where low-level features such as peaks and dips can be extracted from the pre-trained models from spectral/signal-based data and transferred to the preliminary layers of the noise removal VIRTIS data-based neural networks. Once the noise is removed,

ANN-based architectures was performed to automate per-pixel-based classification. The results from the two locations were studied for observing the variability of absorption features (2-5 µm) for CO_2 and SO_2.

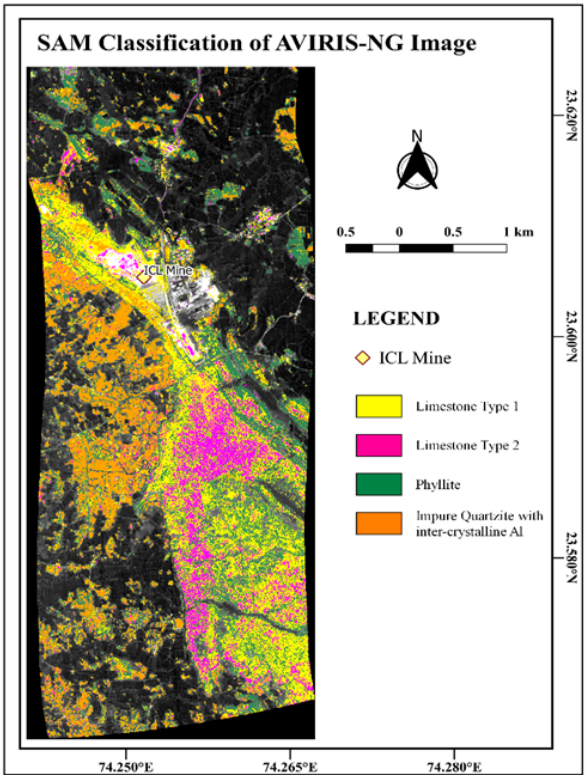


Study area location and VIRTIS spectra from the respective locations

Lithological Discrimination of parts of the Bhukia Area, Banswara District, Rajasthan using Hyperspectral Data

In a developing countries, exploration and exploitation of mineral resources help create the infrastructure that can sustain the population and economic growth. Remote sensing makes a brilliant tool to boost this growth. Hyperspectral Remote Sensing has been a key technology in mineral exploration and mapping for some time now. In this study, Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRIS-NG) data with high spatial and spectral resolution is deployed to map the metasedimentary rocks in parts of the Bhukia region of Banswara district, Rajasthan.

Similarly, PRecursore IperSpettrale della Missione Applicativa (PRISMA) data is also utilized to achieve the similar goal. The rock spectra obtained from both the surface reflectance hyperspectral datasets after applying the processing techniques were compared against USGS spectral library and the field/ laboratory spectra to identify the diagnostic spectral features. The processing techniques applied include minimum noise fraction, to reduce the dimensionality of the data, pixel purity index used to locate pure pixels and n-d visualizer to select endmembers. Spectral Angle Mapper algorithm was applied to both the datasets and detected limestone, dolomite, phyllite and quartzite rocks. Furthermore, absorption band parameters were estimated and interpreted to corroborate the chemistry of the rock which resulted in differentiation of limestone based upon Al^{3+}/ Mg^{2+} content.

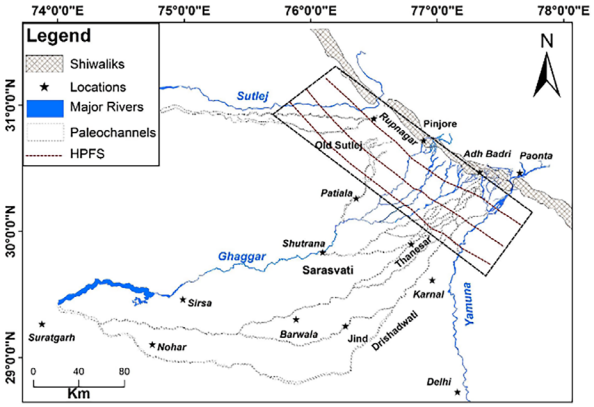


Classified image of AVIRIS data using Spectral Angle Mapper (SAM)

Implications of Geodynamics on Extinction of Vedic River Sarasvati

The geodynamic framework plays an important role to understand the cause of disappearance of once existed river Sarasvati during Neolithic and Harappan civilization in the northwest India. River migration and disappearance of channels in Himalayan front primarily involve geodynamic processes originated from the collision of Indian and Eurasian plates. Starting from the Himalayan mountain range, a number of tributaries were contributing to the Ghaggar-Hakra river system which earlier constituted the ancient Sarasvati river system. These channels of Sarasvati river in Frontal Himalaya have experienced continuous tectonic activity in geologic past due to ongoing movements of the Indian and the Eurasian Plates. Investigations in eastern interfluve of the Sutlej and the Yamuna reveal the eastward shift of rivers on LANDSAT 3 (1980) and IRS LISS IV (2016). Paleo-channels identified from satellite images were confirmed by geophysical investigations using Electrical Resistivity Tomography (ERT). Topographic and morphometric analysis using ALOS PALSAR DEM further aided to decipher the influence of tectonic activity on surface manifestation of paleochannels. A series of imbricate faults at almost parallel to the Main Frontal Thrust (MFT) or Himalayan Frontal Thrust (HFT) have been interpreted as the main cause and mechanism of active faulting in frontal Himalaya that has significantly influenced the migration and amalgamation of streams.

A unique trend of eastward stream migration with knee bends as observed on satellite images is attributed to the rotational component marked by anticlockwise movement (corroborated by GNSS observation) of under thrusting Indian plate. The series of imbricate faulting coupled with anticlockwise motion of the region has resulted in migration of the streams towards Yamuna which finally captured those including Drishadwati originally flowing towards west contributing to Sarasvati system. Therefore, geodynamics and tectonics play a crucial role in understanding river migration and water resource availability in many parts of thickly populated Indo-Gangetic alluvial plain.



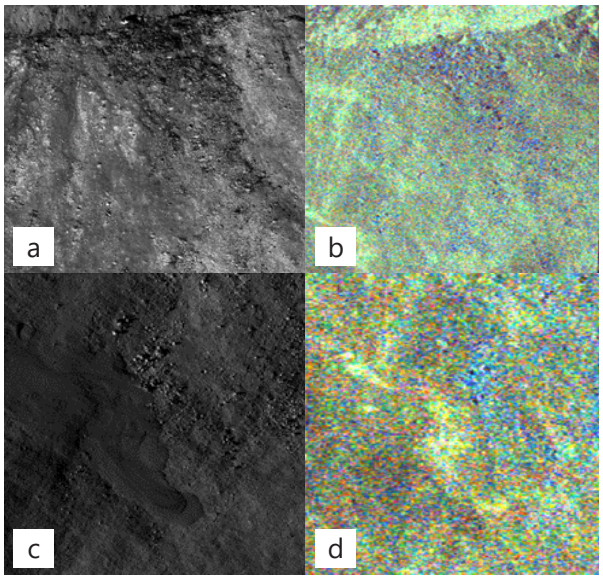
Course of Sarasvati river and other streams upto Suratgarh and its association with imbricate fault structure as interpreted from satellite based observation

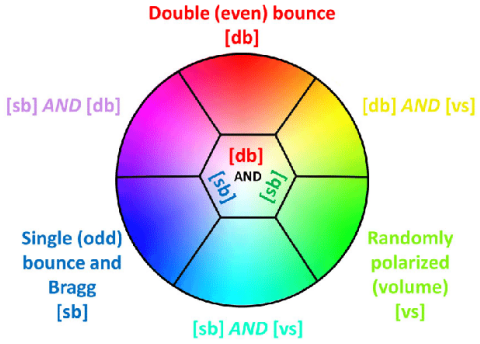
Multi-frequency and Polarimetric SAR data analysis for lunar surface/ sub-surface properties at selected locations

The use of radar remote sensing in lunar research has given us a better understanding of the physical properties of the lunar regolith. We have utilized Mini-RF and DFSAR radar

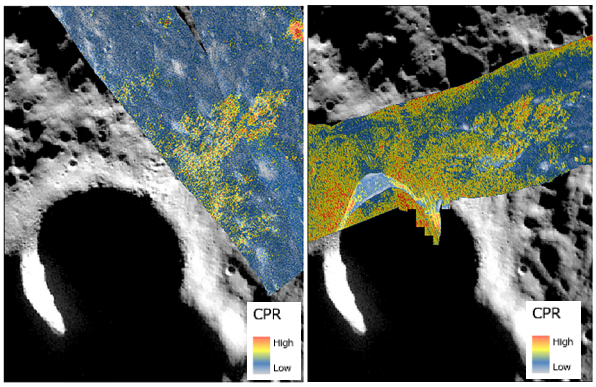
imagery to investigate the impact craters Whipple (89.1°N 118.2°E) (polar PSR) and Giordano Bruno (35.9°N 102.8°E) (non-polar) in depth, identifying and characterizing different crater facies units.

Both of the chosen craters have previously been reported showing presence of fascinating features, making them ideal candidates for our study. Large blocks or boulders of rock act as smooth reflectors on the lunar surface and thus exhibit a significant amount of odd bounce scattering appearing bluish in the case of the Giordano Bruno crater rim region. Although optical imagery shows the impact melts and flows to be smooth, they are highly rough particles, comparable to the rough proximal ejecta blanket just outside the crater rim. Impact melts and flow units exhibit significant volumetric scattering and high CPR values due to the abundance of rock particles and pieces in the lunar regolith. The reported impact melt flow near the Whipple crater was studied using DFSAR S&L bands to see variations, if any, in the physical properties. Both the S, L band show high CPR values with S showing approx. 1.4 and the L-band showing higher values than that (~1.9). This could be due to the greater penetration by the L band into the subsurface leading to higher scattering due to fragments and clasts present (higher CPR) or the roughness of the particles being more constrained to the L band wavelength (24cm).



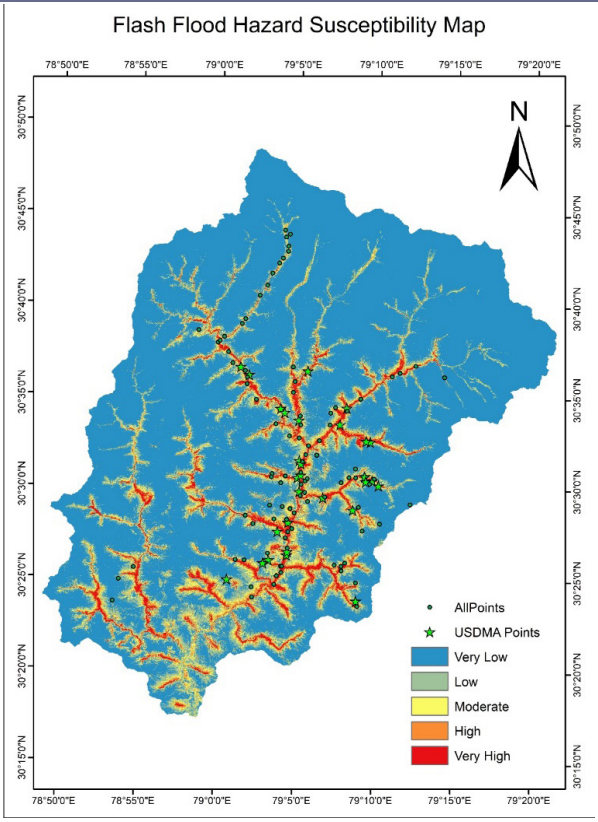


m-χ radar signatures showing characteristic features along with the corresponding NAC imagery. a-b) showing the southern portion of the Giordano Bruno crater rim and the bluish appearing rough boulder units. c-d) showing the rough impact melt flow appearing bright with the curved flow pattern visible.



CPR images overlain over total backscattered image with LROC WAC basemap. Left - DFSAR L band CPR image of the impact melt flow at Whipple. Right – DFSAR S band CPR for the same melt flow. White arrows mark the melt flow extent.

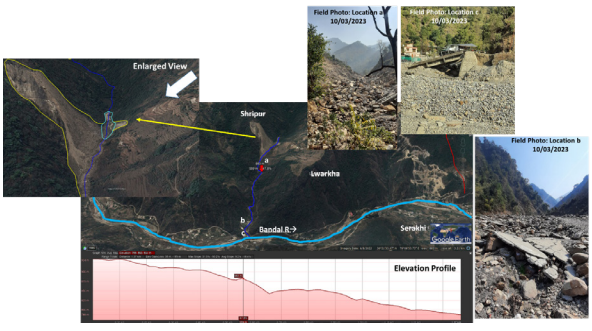
Flash Flood Hazard Susceptibility Mapping Using Entropy Based Modelling for Mandakini Basin, Uttarakhand, India



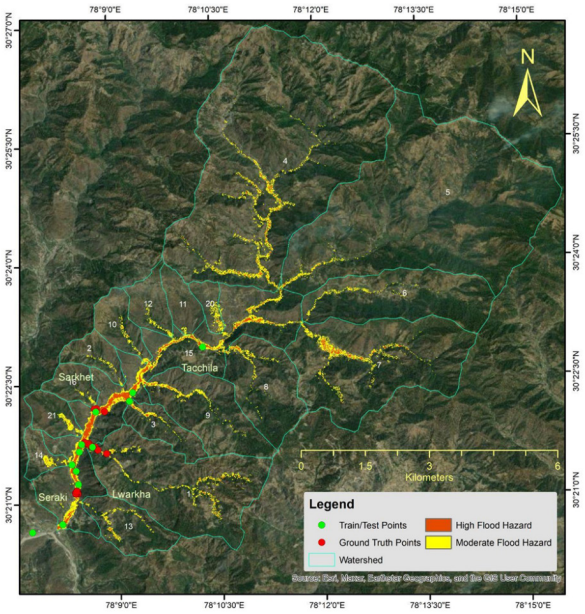
A inhouse methodology development effort for development of susceptibility mapping was attempted. Application of entropy (maxent) based machine learning technique for flash flood hazard susceptibility mapping. Most important conditional factors were found to be distance to river, distance to landslide, elevation and land use. The predictive capacity (AUC) of the model was determined to be 91%. About 80 km^2 (4.9%) of the study area, mostly along the main stem of the study area, is classified under high and very high classes of susceptibility to flash flood.

Support to Uttarakhand Government in DM Support - Maldevta (Dehradun), Uttarakhand Flash Flood Event of August, 2022: A Space and Ground Based Assessment

On August 19, 2022 late night and August 20, 2022 early morning hours Maldevta and surroundings were affected by flash floods triggered duet to cloudburst in causing large scale destruction within the Bandal River watershed. An integrated use of high resolution pre and post time series satellite images, digital elevation model (DEM), utilization of various geospatial and visualization tools in conjunction with ground based information was done to have more insights into the flash flood event. Factors like precipitation, changes in river morphology, normalized difference turbidity index (NDTI), development of Landslide Lake Outburst Flood (LLOF), damages to infrastructure were studied using time series satellite images. Information was shared with Uttarakhand Disaster Management Agency (USDMA). Villages like Sarkhet, Seraki, Tacchila, Tunetha, Tal, Bhainsiyan, Bhutsi, Rawali, Gheria, Khartijel, Bhorkhandi, Lwarkha, Silla, Shripur, and Chamroli were observed to be impacted by flash floods. Further Maxent entropy based model utilizing DEM derived terrain conditioning factors together with ground information was used to prepare a flash flood hazard zonation map. High flood probability is seen along the main Bandal River adjoining villages Sarkhet, Seraki, Lwarkha, Sarkhet and Tacchila.



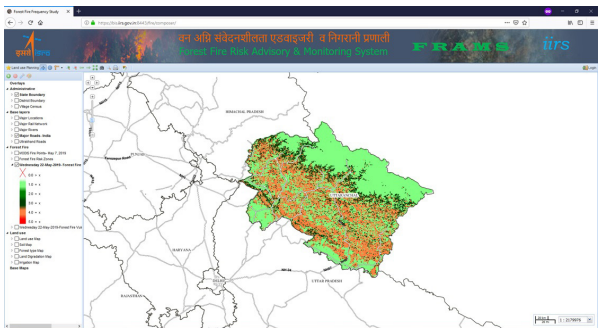
Satellite images showing the landslide (yellow colour line), tributary (blue colour line), location of LLOF and lake boundary (cyan polygon) and the Bandal River (cyan colour thick line) along with enlarged view and tributary profile.



Flash flood hazard probability map overlaid over satellite data

Support to Uttarakhand Government in DM Support - Forest Fire Risk Inputs for Government of Uttarakhand

IIRS has developed Forest Fire Risk Advisory and Monitoring System (FRAMS) for Uttarakhand State. The system is developed as an automated digital workflow, which generate the advisories on daily basis using space based inputs and ground information. Daily forest fire risk map is generated using a spatial model developed at IIRS for the western Himalayan region of India. The model takes Land surface temperature and other weather parameters such as rainfall, humidity, wind speed/direction, temperature etc. as inputs as dynamic factors and topography, vegetation and land use as well as distance from roads and settlements as static parameters for generating the forest fire danger index on a daily basis. The model accuracy ranges between 82-94% with the active fire locations from MODIS/SNPP-VIIRS (Bhuvan/FSI). The Geo-processing engine of FRMS has been developed as open system architecture using Python and GDAL/OGR library. The system automatically download the daily MODIS, Near Real Time (NRT) product and generate the fire risk map and danger index. The different forest administrative boundaries such as Circle, Range and Beat are overlaid on Fire Risk map and daily advisories are generated for field officials and decision makers. The advisories are sent to the forest officials of Uttarakhand State as SMS. The same input is also being sent to NDRF and USDMA. FRMS Geoportal has been developed for interactive map visualization, location based queries, data analysis and other user-defined services. The developed geo-portal is a responsive web application, which is compatible with desktop and mobile platforms. URL of the geo-portal is https://forestfire.iirs.gov.in/fire/



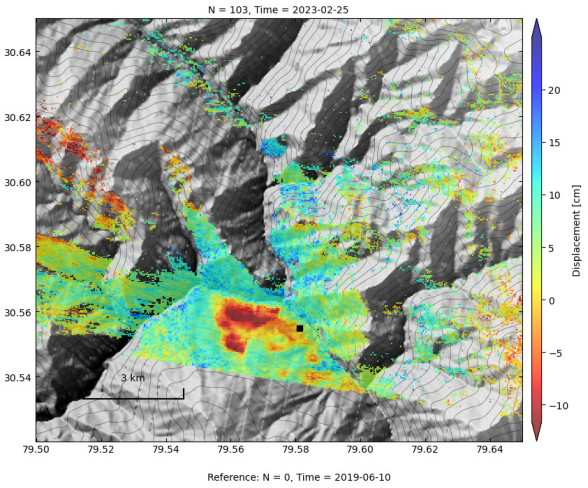
Forest Fire Risk Advisory & Monitoring System (FRMS) - Geoportal

Support to Uttarakhand Government in DM Support - Land Deformation Analysis of Joshimath Town using Small BAseline Subset (SBAS) Interferometry SAR Technique

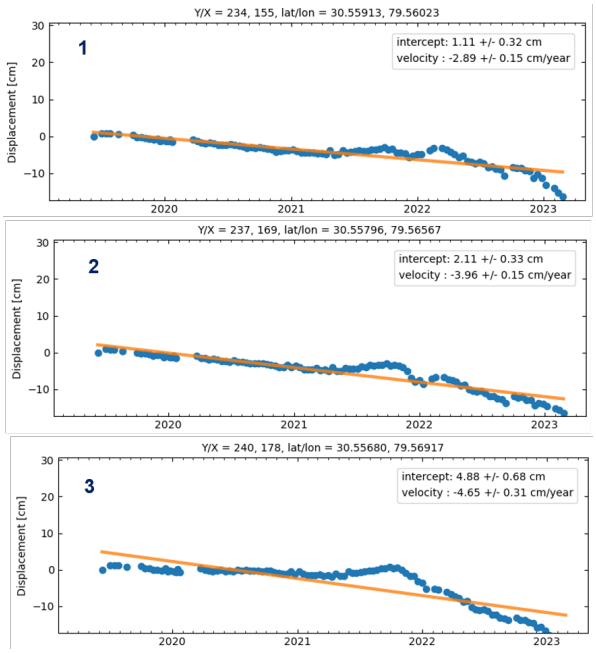
In this study, we used 102 Sentinel-1A space borne Synthetic Aperture Radar (SAR) images acquired from June 10, 2019 to February 25, 2023 with a revisit period of 12-day, were used to derive long time series deformation using Small BAseline Subset Interferometry SAR (SBAS-InSAR). SBAS-InSAR is an advanced version of Differential Interferometric SAR

technique, that analyzes targets (pixels) with stable phase, and moderate to high coherence throughout the investigation period and derive the displacement time-series along the radar line of sight (LOS). Total 290 interferograms were processed using 102 Sentinel-1 images to derive a time-series measurement of land deformation (displacement) along the radar line of sight (LOS).

Figure shows the radar line of sight (LOS) deformation and its rate of movement from June 2019 to February 2023. The yellow to red points (pixels) show the subsidence in increasing order of magnitude (away from satellite) and has been overlayed on the high resolution satellite DEM. The regions in the central part and few paches in the eastern part of the Joshimath town shows higher rate of subsidence (around 12 cm / year) compared to other areas of Joshimath town. Further the time-series LOS displacement was plotted over central and southern (at high altitude) numbered by 1, 2 and 3 to understand the LOS movement over entire investigation period (June 2019 – February 2023). Figure show the time-series graphs of radar LOS displacement (deformation) versus time at three locations 1, 2 and 3 is also shown. From SBAS-InSAR based analysis it was observed that there was an increase in the land deformation activity (around 12 cm/yr). The enhanced deformation activity was observed in the central, eastern, and southern (high altitude) parts of the Joshimath town in patched manner. The deformation over Joshimath town is not uniform and not over whole region. The major changes in the deformation started from February 2021 when Rainy flash flood occurred, and a sudden movement is observed during June 2022, October-November 2022, and January 2023, and continued till date. These satellite based observations are related to land surface motion only and needs to be correlated with the geophysical, geotechnical observations.



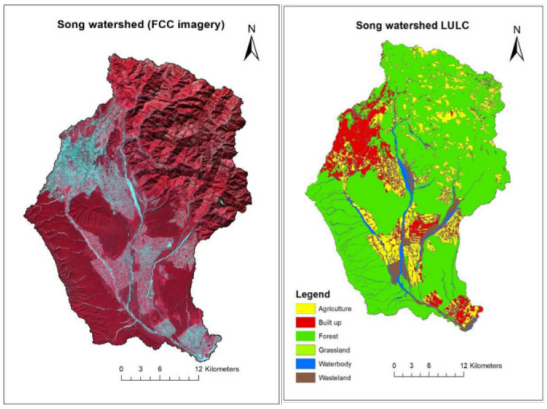
Radar line of sight (LOS) deformation movement between June 2019 and February 2023. The colored points (reddish) show the movement away from the satellite and represents land subsidence of different magnitude

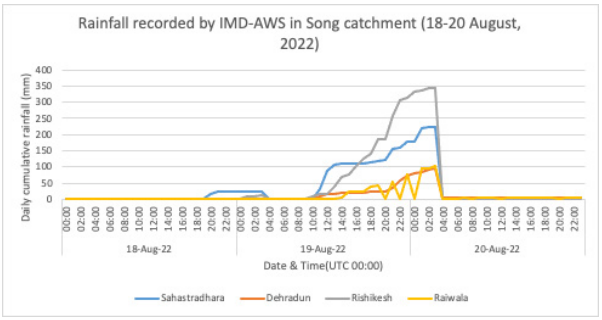


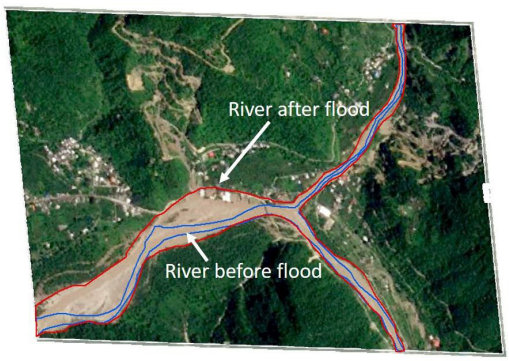
Radar LOS time-series deformation (displacement) between June 2019 and February 2023. The red circle shows the sudden change in movement of land surface. Locations 1, 2 and 3 are corresponding to locations as shown above.

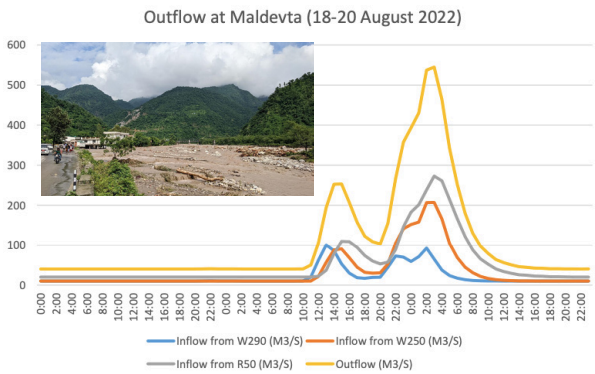
August 19-20, 2022 Flash flood simulation and inundation assessment in Song Watershed of Dun valley, Uttarakhand

Nowadays, increasing cloud burst events and unpredicted excessive rainfall has caused sudden havoc in many vulnerable places of Himalayan region. One such flash flood event occurred during 19-20 of August 2022, due to excessive rainfall in the Song River catchment (with area of 1043 sq km) of Uttarakhand. In the upper catchment, Maldevta village area faced heavy loss of infrastructure and some causalities. To assess the flood intensity, an event based HEC-HMS hydrological model has been setup for flash flood simulation. Pre and post disaster assessments have been done by analyzing Planet scope and Sentinel-1 synthetic aperture radar (SAR) imagery. Four AWS station data falling in the catchment was acquired and used for hydrological simulations. A maximum of 344mm and 225mm cumulative rainfall observed in Rishikesh and Sahastradhara area respectively on August 19-20, 2022. A field visit was conducted on August 20, 2022 for disaster site ground data observation. Planet scope satellite imagery acquired for pre and post disaster analysis of Maldevta area. At Maldevta, maximum increase of 170 m was observed in cross section of the river after flood. A flood water discharge of 2473 cubic meter/sec observed at Rishikesh outlet of the Song River at 5:00AM on August 20, 2022. The simulated peak flood flow in the song river was estimated as 544.8 m^3/sec at Maldevta at 3:00 AM on August 20, 2022 and an area of 18.11 Ha observed under flood inundation in planet scope image. An area of 5.36 Sq km. has been observed under flood by analyzing post disaster Sentinel-1 SAR imagery for the entire Song catchment. The catchment is found vulnerable and increasing unplanned settlements and human intervention coupled with changing climatic pattern makes catchment more sensitive to flooding disaster.









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Awards

Dr. Vaibhav Garg, Scientist/Engineer 'SF', Water Resources Department has been conferred with ***"Indian National Geospatial Award"*** for the year 2022 by Indian Society of Remote Sensing for his pioneering contributions in the field of geospatial technology applications in surface water resources and capacity building among the user community.

Dr. Vaibhav Garg, Scientist/Engineer 'SF', Water Resources Department has been awarded with ***"ISRS Asian Geospatial Award – 2022"*** for his research publication entitled "Monitoring Inland Waters of Asia using Saral AltiKa Satellite Altimeter Datasets" during Asian Conference on Remote Sensing held at Ulaanbaatar, Mongolia on October 05, 2022.

MAJOR EVENTS

Parliamentary Standing Committee (PSC) visit on April 12, 2022

The study visit of the Department related Parliamentary Standing Committee of the Ministry of Personnel, Public Grievances Law & Justice- Review of Vigilance administration of Ministries/ Depts. of Govt. of India & PSUs, to Dehradun took place in FRI, Dehradun on April 12, 2022. The Committee was Chaired by Honorable Shri Sushil Kumar Modi ji, (MP from Rajya Sabha). Meeting began with brief presentation delivered by Director, IIRS on 'Vigilance activities of IIRS'. The duly filled-in questionnaire was also submitted to the committee as per the desired format. Ms. Kamala Rajesh, Dy. Secretary, DOS (V&L) as ISRO HQ representative, was also present in the meeting besides team from the IIRS.

Ambedkar Jayanti

The Birth Anniversary of Dr. B.R. Ambedkar is celebrated each year on April 14. As the COVID-19 cases reduced, it was decided to organize a function to celebrate the Birth Anniversary of Dr. B.R. Ambedkar at IIRS on April 29, 2022. Short documentary on Dr. B.R. Ambedkar was showed to the gathering. Official lunch was offered to all the staff members of IIRS, CSSTEAP & CISF along with JRFs/ SRFs. The programme was celebrated under strict Covid-19 guidelines.

Environment Day

World Environment Day is celebrated on June 05 every year to remind people about the importance of nature. It is the biggest international day for the environment. Led by the United Nations Environment Programme (UNEP), and held annually since 1973. IIRS celebrated Enviroment Day on June 06, 2022 on theme "Only One Earth". Director, IIRS planted tree near Vikram Sarabhai Hostel.

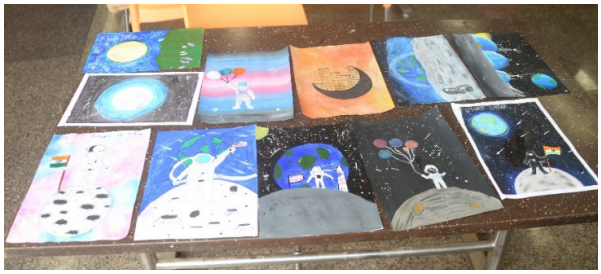
International Yoga day (IYD)

The Ministry of Ayush, the Nodal Ministry for observation of the IDY, planned several programs as countdown to IDY-2022. As part of the countdown, the Ministry designated date of June 02, 2022 to Dept. of Space for conducting Yoga Programmes (C.Y.P.) IIRS celebrated the event on June 02, 2022 where C.Y.P. under guidance of Expert Yoga Instructor was performed.

International Moon Day

UN General Assembly has declared July 20 as "International Moon Day". Subsequent to the successful launch of Lunar Missions by ISRO and continuing the Lunar Programme.

International Moon Day was celebrated in the Institute on July 20, 2022. Schools with students participated in a drawing and painting competition organized for school students.



Independence Day
Azadi Ka Amrit Mahotsav

On August 15, 2022, 75th Independence Day was celebrated at IIRS Campus with full zeal and patriotic fervour with active participation of all staff and family members of IIRS/CSSTEAP. The programme commenced with the greeting and Guard of Honour by CISF followed by hoisting of National Flag and address by Director IIRS. The event included march-past by CISF personnel, cultural performances, distribution of ISRO Annual Service Excellence Awards, awards to meritorious children of IIRS staff by Director IIRS and sweet distribution.

AKAM and Swachhata week- Event for school children

As a part of Swachhata week- drawing and painting and quiz competition was arranged for Government school students. Around 40 school children from class IX-XII participated in the event. Students visited the Vikram Sarabhai space exhibition also. Prizes were distributed in four categories to all the four classes (IX-XII) for the Quiz event. Overall three prizes were awarded for painting competition plus 5 consolation prizes.

Sadbhavana Diwas celebration

The birth anniversary of former Prime Minister Late Shri Rajiv Gandhi on August 20, is observed as 'Sadbhavana Diwas' every year. The theme of Sadbhavana Diwas is to promote National Integration and Communal Harmony among people of all religions, languages and regions. The idea behind observance of 'Sadbhavana Diwas' is to eschew violence and to promote goodwill among the people. A pledge was administered on August 18, 2022.

भारतीय सुदूर संवेदन संस्थान में हिन्दी दिवस/ पखवाड़ा का आयोजन

सरकारी कामकाज में राजभाषा हिन्दी के प्रति जागरूकता तथा उसके उत्तरोतर प्रयोग में गति लाने के उद्देश्य से केंद्र सरकार के कार्यालयों मे प्रति वर्ष हिन्दी दिवस पखवाड़ा का आयोजन किया जाता है। प्रत्येक वर्ष की भांति इस वर्ष भी भारतीय सुदूर संवेदन संस्थान मे 19-29 सितम्बर 2022 तक हिन्दी पखवाड़ा का आयोजन किया गया था। उद्घाटन समारोह 13 सितम्बर 2022 को सभागार में आयोजित किया गया । संस्थान के कार्मिकों तथा उनके परिवार के सदस्यों ने दिनांक 13 सितम्बर 2022 से 29 सितम्बर 2022 के दौरान विभिन्न प्रतियोगिताओं जैसे निबंध लेखन, हिन्दी टंकण (यूनिकोड में), हिन्दी टिप्पण व आलेखन, हिन्दी भाषा/व्याकरण ज्ञान, राजभाषा प्रश्नोत्तरी, वाद-विवाद, आशुभाषण, देशभक्ति गीत आदि प्रतियोगिताओं मे भाग लिया। समापन समारोह में विभिन्न प्रतियोगिताओं के विजेताओं को 30 सितम्बर 2022 को पुरस्कार वितरित किए गए।

Swatchhta Pakhwada

Swatch Bharat is a flagship program of Government of India and swatch pakhwada was observed in IIRS from October 02, 2022 to October 16, 2022 in connection with Azadi Ka Amrit Mahotsav.

Swachhta Pledge was administered on October 02, 2022 under standard operating procedures (SOPs) issued by Government of India regarding Covid-19.

A Khadi exhibition was arranged on October12, 2022 under the flagship program.

Cycling event on October 30, 2022

For celebrating the National Unity Day, IIRS organised a cycling event on October 30, 2022; with participation of IIRS staff including their family members, researchers, students & CISF staff.

Samvidhan Diwas (Constitution Day 2022)

November 26, 2022 was celebrated as Samvidhan Diwas (Constitution Day) on the theme "India-the mother of Democracy". Online quiz was administrated by NIC, Govt of India for IIRS employees.

CSSTEAP General Body (GB) Meeting

27th CSSTEAP General Body (GB) meeting was held on December 14, 2022 with participation of officials from ISRO, GB member countries and other important dignitaries including Director, IIRS, Director, CSSTEAP, Director, NRSC, Director, PRL wherein Chairman, ISRO & Secretary DOS chaired GB meeting.

Hindi Diwas

January 10, 2023 was celebrated as Hindi Diwas in the campus. M.Tech second year students were encouraged to present their research work in Hindi as a presentation.

Republic Day 2023

IIRS celebrated Republic Day with full zeal and enthusiasm on January 26, 2023. It was celebrated with active participation including family members of IIRS, CSSTEAP, CISF staff and students of various courses for IIRS & CSSTEAP. The cultural activity was performed

on this occasion and CISF presented a reflex shooting drill. Spot sports event for staff & students of IIRS & CSSTEAP were also organised.

Advocacy event in coordination with Competition Commission of India (CCI)

An 'Advocacy event' was organized successfully at IIRS on the request of Competition Commission of India on February 21, 2023 with active participation of 34 personnel including Director IIRS, Dean, GHs/ GDs, HBPMD, HPGA/ HIFA, etc wherein Sh. Rajiv Rautela, IAS and his team from CCI, N.Delhi delivered lectures.

Golden Jubilee Celebrations of ISRS

ISRS has successfully completed 53 years of its existence as one of the premier professional scientific societies in the country. Journal of the Indian Society of Remote Sensing (JISRS) the research journal of ISRS with its initiation as 'Photonirvachak' in 1973 has also completed its 50 years in 2023. For celebrating this remarkable achievement of the ISRS and JISRS, the executive council of ISRS along with the editorial board of JISRS organized the Golden Jubilee Celebration on February 24, 2023, at the IIRS Campus Dehradun.

Visit of six-member technical team delegation from Saudi Space Commission (National Space Agency of Saudi Arabia)

Director, IIRS chaired the briefing on 'Activities of IIRS & UN-CSSTEAP' during the visit of six-member technical team delegation from Saudi Space Commission (National Space Agency of Saudi Arabia), to IIRS Campus on March 07, 2023, as per the ISRO Headquarters' schedule.

National Safety week (NSW)

NSW was celebrated at IIRS between March 04-10, 2023. Pledge was administered as a part of event.

Birth anniversary of Shri Mahatma Gandhi ji & Shri Lal Bahadur Shastri ji, was celebrated on October 02, 2022 in IIRS and a cleanliness drive was organized in IIRS campus.

International Women Day (IWD)

International Women's Day (IWD) is marked on March 08th every year globally to celebrate the economic, political and social achievements of women. However, due to Holi festival on March 08, 2023, it was celebrated on March 16, 2023 at IIRS. Essay competition for all permanent employees of IIRS was also organized on March 14, 2023 as a part of event. Dr. (Smt.) Geeta Khanna, Chairperson, State Commission for Protection of Child Rights, Govt. of Uttarakhand was the chief guest and Dr. (Smt.) Brinda V., Director, Directorate of Safety Reliability and Quality, ISRO HQ, Bengaluru was the guest of honour. Recognising contributions of IIRS Women in its achievements, small token of appreciation was also distributed to IIRS ladies.

IIRS Academia Meet (IAM) – 2023

The IAM-2023 on theme 'Space Technology for Disaster Risk Reduction in Himalaya: Challenges and Opportunities' was held on March 28, 2023 at IIRS. Besides Scientist/ Engineers & staff from IIRS there were around 200 registered participants from various academic institutions, industries, government departments, JRFs, Students & Edusat-users from all over India and Scientist/ Engineers from IIRS. Dr. Ranjit K. Sinha, IAS, Secretary, Disaster Mgmt, Govt. of Uttarakhand was the Chief Guest; while Dr. Kalachand Sain, Director, WIHG and Dr. S.K. Srivastav, CGM, RRSC/ NRSC participated as Guest of Honour and released 'Placement brochure for 2023' and inaugurated the exhibition wherein posters on student research & departmental activities were displayed. The IAM comprised of three sessions- inaugural ceremony, a plenary session & a panel discussion wherein besides registered participants, the event was attended by Sc/ Engrs, JRFs/ SRFs, staff, students of IIRS. A feedback session was also organized on Mar 27, 2023 for outreach coordinators of DLP (~ 60 participants).

Other Infrastructural Improvements

Activities Accomplished in 2022-23 by CMD

- New Reception Building
- Major external & internal repairs and maintenance works in the Godavari hostel building
- Construction of new security gate at CSSTEAP building
- Establishment of a Space exhibition in the Golden jubilee hostel
- Establishment of a small Nursey for meeting seasonal flowering needs inside the campus

New reception building

New bituminous surface repair of approach road

New herbal garden

Renovation of ISRS building

Renovation of ISRS building

Major external and internal repair and maintenance works in Godavari Hostel building

Construction of new security gate at CSSTEAP building

Establishment of space exhibition in the Golden Jubilee Hostel

Establishment of space exhibition in the Golden Jubilee Hostel

Establishment of space exhibition in the Golden Jubilee Hostel

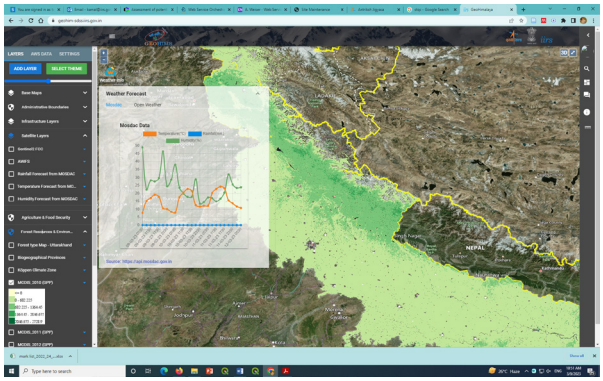
Establishment of a small nursery for meeting seasonal flowering needs inside the campus

New paver block road in front of International Hostel

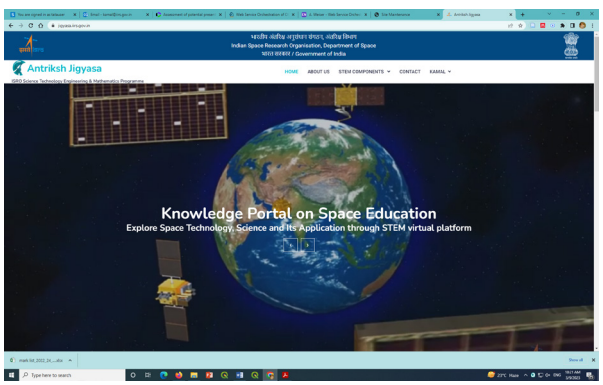
Software Development & Technical Infrastructure upgradation at IIRS: FY 2022-2023

The state-of-the-art technical infrastructure of IIRS is upgraded and scaled-up on regular basis with latest technologies advantages. Following are the major software development and technical infrastructure upgradation activities carried during FY 2022-23.

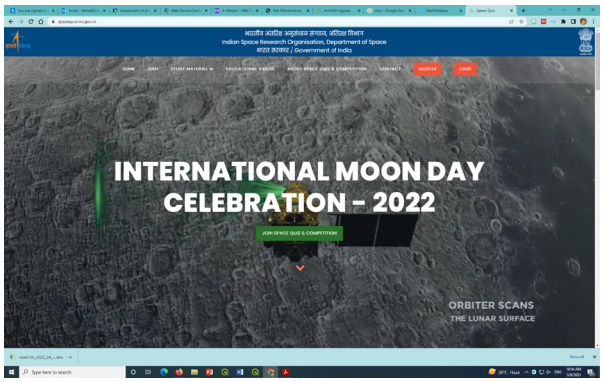
1. Geospatial Dasboard for Himalayan Region:
A webGIS based portal was designed and developed with 2D/3D visualization of the satellite data and other related geospatial datasets. The portal consists of 06 major geospatial themes along with related geospatial datasets. The weather data is integrated in the portal as APIs' from MOSDAC and Open Weather Map along with the Sensor Data from the AWS. The portal allows geo-visualization with various GIS tools of data analytics by integrating data from multiple sources.



2. Antriksh Jigyasa : Web Poral for Space Science Education (https://jigyasa.iirs.gov.in)
This website is designed and developed under ISRO STEM program to disseminate space education to the student fraternity of India. The portal consists of video lectures on various aspect of space technology along with various scientific documents published by ISRO. There are primarily 06 major components in this portal viz. Shiksha Gagan, Space Varta, Spark, Antriksh Navachar, Space Quiz and Sky Picks. As of now about 1300 particiapants have registered in the portal since November 2022.



3. Web Portal for ISRO Moon Day Celebration:
(https://spacequiz.iirs.gov.in) - based on request from CBPO ISRO HQ, a web portal for Space Quiz and painting competition for School student was deployed and made live for the students. About 22294 students from all over India participated in this event through this portal.



4. IT infrastructure as per GOI mandate:

- Standardisation Testing and Quality Certification (STQC) was obtained for the official website of IIRS and the website is now GIGW compliant
- Redundant NKN line is established at IIRS for safe and reliable transfer of data & knowledge with other ISRO centers
- Based upon the guidelines received from ISRO HQ and mandated by GOI, designed, developed and integrated the APIs' for JRF recruitment on GOI UMANG portal. Provided necessary technical support to IIST Trivandrum in the development and integration of their API

5. Automation of Admission Portal:
New modules for merit list preparation, course fee submission through epay API, waitlist operating and admission letter generation were designed, developed and deployed in the admission portal.

6. Software for advance research:
Campus License for the RS and GIS software has been deployed to meet the increasing need of students, specialized courses and research projects. Latest version of Advance Image Processing Software for Object based Image classification is deployed in central license server.

इसरो ISRO

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