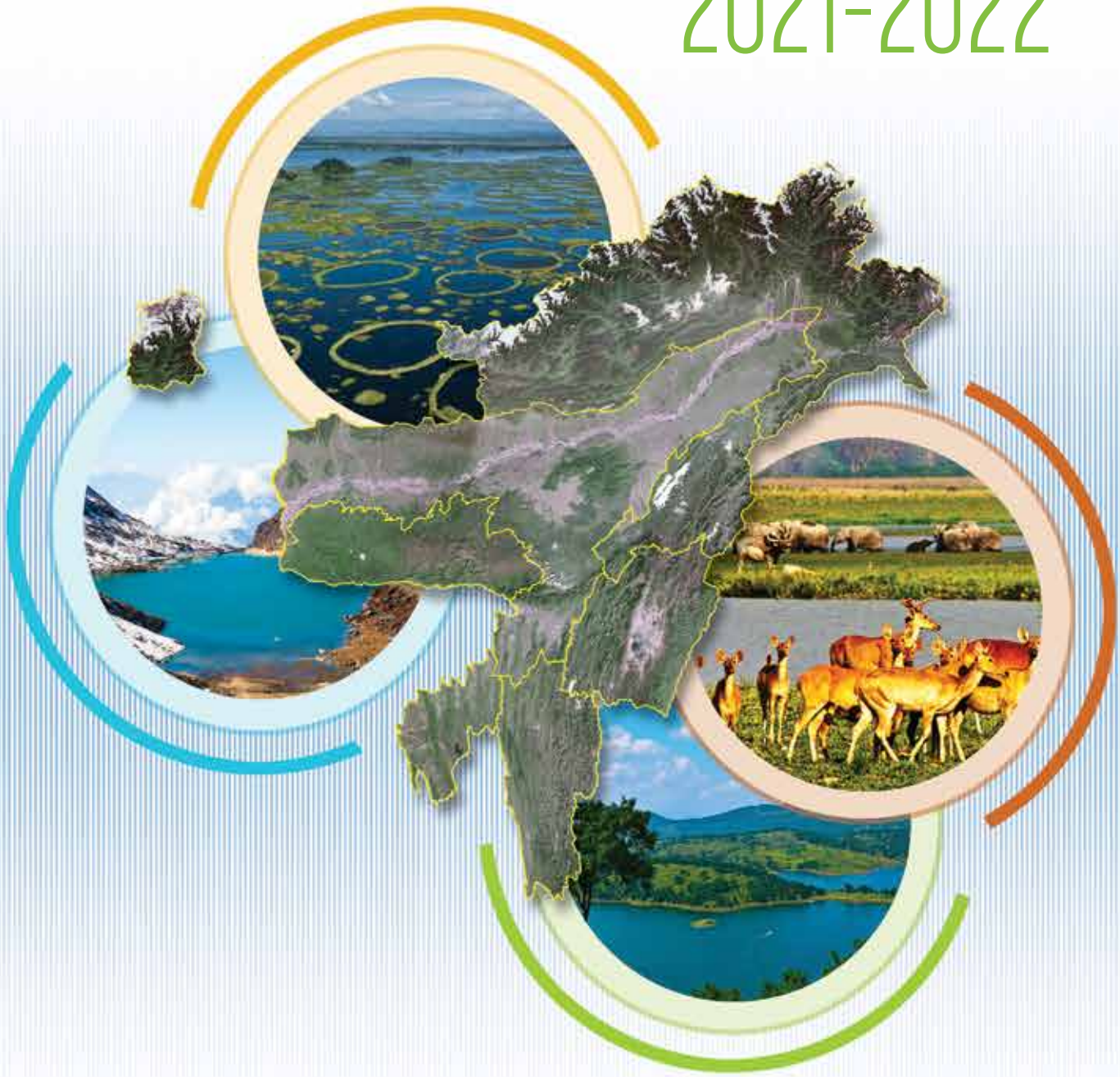
ANNUAL REPORT

वार्षिक रिपोर्ट

2021-2022



North Eastern Space Applications Centre

Department of Space, Government of India

Umiam, Shillong, Meghalaya

www.nesac.gov.in

Annual Report
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North Eastern Space Applications Centre
Department of Space, Government of India
Umiam, Shillong, Meghalaya

Annual Report 2021-22

Compiled and Edited by

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Reviewed by

Dr. S.P. Aggarwal, Director, NESAC

Vision

To play catalytic role in holistic development of North Eastern Region of India by providing Space Science and Technology support at all possible levels.

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Organisation: North Eastern Space Applications Centre

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Standard: ISO 9001:2015

Scope: Providing Value Added Services for Natural Resource Management and Disaster Management Support using Space Technology

Certificate No.: IRQS/200100548

Original Certification Date: 05/04/2017

Continuation Granting Date: 20/04/2020

Current Date of Granting: 23/09/2020

Expiry Date: 03/04/2023

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Head Office: 52A, Adi Shankaracharya Marg, Opp.Powai Lake, Powai, Mumbai - 400 072, India.

Mission

To provide data, information, knowledge, and services to the society, industry, and government by scientific and systematic studies on natural resource management, infrastructure planning, healthcare, education, satellite communication, and disaster management support, and to set up a space and atmospheric science research hub.

Director's preface

North Eastern Space Applications Centre (NESAC), under the aegis of the Department of Space, Government of India has made significant progress in taking the benefits of space technology to the development support activities for different key areas like natural resources management, infrastructure planning, disaster management support, etc. in the North Eastern Region (NER) of India.

The Hon'ble Union Home Minster of India, who is also the President of NESAC Society, chaired a special meeting of the NESAC Society on 24th July, 2021. The meeting was also attended by Hon'ble Chief Ministers of eight NE states, Hon'ble Union Minister of State for Space, Hon'ble Union Minister for Ministry for Development of NE Region (MDoNER) along with Chief Secretaries of all NE states and several secretaries to the Government of India. Activities of NESAC along with the Proposed Plan of Action (PoA) on use of space technology by various user departments of NE states were reviewed during the meeting.

The 16th meeting of NESAC Governing Council (GC) was held on 12th January, 2022 under the Chairmanship of Secretary, Department of Space & Chairman, ISRO. The council expressed satisfaction over the quantity and quality of work carried out by NESAC and provided required guidelines for new initiatives and assignments for the Centre.

During the year 2021-22, NESAC has witnessed exciting growth in multiple areas of its activity. The Centre took up and completed several new and innovative projects cutting across different thematic areas. Scientific and academic collaboration with different institutes and the user base has increased while the number of ongoing projects also increased to more than 70 projects, excluding the 110 projects being taken up as part of the PoA. Outreach and capacity building activities have also been accelerated after improvement in the Covid-19 pandemic scenario.

In the area of remote sensing applications in Agriculture and Soils, NESAC has developed an integrated system for planning and monitoring of Crop Cutting Experiments (CCE) in Meghalaya. A Mobile application and a dashboard system have been developed and handed over to Directorate of Economics and Statistics (DES), Govt. of Meghalaya. More than 40000 Sericulture assets have been geotagged using GAGAN based 'SILKS' mobile app as per the requirement of Central Silk Borad (CSB), Ministry of Textiles. An agro-climatic atlas covering eight districts of Nagaland and four districts of Mizoram has also been prepared under the FOCUS project of the FAO.

In the field of Forestry and Ecology, NESAC is executing a major project for providing geospatial inputs for the preparation of Forest Working Plan for the state of Arunachal Pradesh. Identification of the degraded forests/ forest gap areas within the reserve forests of different NE states is being carried out as a part of the PoA projects funded by NEC. A web application has been developed for continuous monitoring of deforestation. Mapping of bamboo growing areas for the state of Meghalaya has been completed for 9 districts of Meghalaya.

In the area of Hydrology and Water Resources, NESAC has taken up the expansion of Flood Early Warning (FLEWS) services to other flood prone rivers of North East India, after the successful

implementation of FLEWS in Assam. The river configuration of the Brahmaputra main channel has been undertaken to map the changes and present status in order to assess the stability/ instability of the chars using temporal satellite data. Identification of suitable water bodies/ wetlands in the state of Assam for flood water diversion has been taken up by NESAC.

As part of Urban and Regional Planning, the centre has been actively involved in urban and regional projects funded by different users. Generation of GIS database layers for the Shillong Planning Area was carried out under the AMRUT sub-scheme. A draft GIS based master plan for the Shillong Planning area was prepared under the AMRUT. A rural development plan for the model villages (Kaho, Kibithoo and Meshai) of Arunachal Pradesh has been prepared.

In the area of Geosciences, NESAC has taken up a project for the assessment of Land cover changes in two mining areas located in West Garo Hills and East Khasi Hills. NESAC carried out DGPS survey of the Mining Lease boundary pillars of the Star Cement Mines, Meghalaya. Space based inputs for planning and restoration of coal mining affected areas of South West Khasi Hill District, Meghalaya have been prepared.

North Eastern Spatial Data Repository (NeSDR) system has emerged as the single window data visualization and sharing gateway pertaining to the spatial data of the NER. More than 1250 vector datasets under different thematic categories. NESAC has successfully developed the Tripura Banadhikar App as per the request of Directorate of Land Records and Settlements, Government of Tripura for demarcation of Forest Pattas lands which is integrated with GAGAN/ NaVIC technology.

NESAC has been providing operational UAV services in the NE region as well other parts of the country. The centre has conducted more than 20 UAV surveys in the year 2021-22 for different user departments and ongoing research projects in the centre. A pilot project was taken up to explore the feasibilities of using UAV technology to assist the authorities of Garo Hills Autonomous District Council (GHADC), Meghalaya to demarcate the village boundaries.

Under the SATCOM operational programs, NESAC is implementing ISRO's societal development programs like Tele-Education, Tele-Medicine and Emergency Communication Services. NESAC has been entrusted with responsibilities for local coordination for many ISRO projects like support to ISTRAC CDMR, Operational management of GSAT-29 Ground Station, the establishment of Radar under NETRA Project and Commissioning and local coordination for Ground Station under MCF, Hassan at NESAC.

Space and Atmospheric Science group at NESAC has been working to improve short and medium range weather forecast, particularly the severe weather forecast over the region. In addition, the group provides support and critical input in the management of major disasters like floods, severe storms, lightning, etc. The group continues to work on the impact of atmospheric boundary layer on ground level absorbing aerosols, impact of satellite based geographical data on simulation of rainfall over NER, impact of different initial conditions on rainfall simulation over NER etc.

NESAC has been proactive in implementation of official language policies of government of India. As a recognition to the sincere efforts of NESAC, the centre was awarded the first prize for implementing Official Language Policy of the Union for the year 2017-18 during the Official language conference for East and Northeast region, held on 18th Dec 2021, at Dibrugarh, Assam.

I convey my sincere appreciation for all the Scientists/Engineers and other staff of the Centre for their commendable work and earning laurels for the centre. I also convey my appreciation to the Editorial team for bringing out the Annual Report in time.

(S.P. Aggarwal)

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Director, S&T, North Eastern Council, Shillong

Invitee
Joint Secretary (F), DOS, Bangalore

Member Secretary
Director, North Eastern Space Applications Centre, Umiam

Contents

ABOUT THE CENTRE

North Eastern Space Applications Centre (NESAC), a joint initiative of the Department of Space (DOS) and the North Eastern Council (NEC), is a society registered under the Meghalaya Societies Registration Act, 1983. The centre has provided more than 21 years of dedicated service to the eight states of the North Eastern Region (NER) of India using space science and technology. The major objectives of the centre are: 1) To provide an operational remote sensing and geographic information system aided natural resource information base to support activities on development/management of natural resources and infrastructure planning in the region. 2) To provide operational satellite communication application services in the region in education, health care, disaster management support, and developmental communication. 3) To take up research in space and atmospheric science area and establish an instrumentation hub and networking with various academic institutions of NER. 4) To enable single window delivery of all possible space based support for disaster management. 5) To set up a regional level infrastructure for capacity building in the field of geospatial technology.

Management of the Centre

All policies, affairs, and business of NESAC are decided by the NESAC Society. Chairman, NEC presides over the NESAC Society and the Secretary, DOS/Chairman, ISRO is the Vice President. Other members of the Society are - Secretary, NEC; Chief Secretaries of the eight NE states, senior scientists from DOS and NEC and academia of NER. A Governing Council (GC), under the advice of the Society, manages the activities of the Society/Centre. Secretary, DOS/Chairman ISRO is the chairman of the GC and Secretary, NEC is the Alternate Chairman. Chief Secretary, Meghalaya; representatives of the governments of the NER States and representatives of central government agencies in the region are the other members of the GC.

Scientific Programs

The scientific programs of the centre are guided by the needs of the region and are reviewed yearly by the NESAC Society and GC. During the current year, NESAC has taken up and completed several projects covering the NER states in the areas of natural resources management, infrastructure planning, health, education, satellite communication and atmospheric science research. The centre has implemented a number of application projects sponsored by user agencies in the region, National/regional projects funded/coordinated by ISRO-DOS Centres, research and developmental projects under Earth Observation Applications (EO-A), Satellite Communications (SATCOM) programs, Disaster Management Support (DMS) program under the North Eastern Regional node for Disaster Risk Reduction (NER-DRR) and Space & Atmospheric Science Research under the Atmospheric Science Program (ASP).

Facilities

NESAC is located at Umiam about 20 km from Shillong, Meghalaya State. NESAC Guest House and the residential complex are located about 1 km from the office complex. The centre is well equipped with state of the art facilities in the areas of Remote Sensing (RS) and Geographical Information System (GIS), Disaster Management, Satellite communication and Space & Atmospheric Science Research.

Remote Sensing (RS) and Geographical Information System (GIS)

The centre has got state of the art servers and workstations for geospatial analysis and digital image processing, very high-end systems for photogrammetry, hydrological modelling, etc., GIS and GNSS equipment, Echo sounder, high quality output devices, etc. The centre has a rich collection of satellite data from Indian and foreign remote sensing satellites, covering the entire NER, reference maps and other ancillary

data of the region. NESAC is well equipped to process data from a wide variety of platforms to enable digital image processing, geospatial analysis and location based services. Capabilities and expertise do exist from both Commercial off-the-shelf (COTS) and open source software for data analysis. The centre also has in its possession the Digital Plant Canopy Analyzer to measure leaf area index, Spectro-radiometer to measure spectral reflectance at the close narrower interval for the creation of a spectral library.

Information Technology and Computing facilities

NESAC has state-of-the-art IT facilities comprised of high-end workstations and servers for providing the computing needs of various scientific/technical staff and academic outreach programmes. The robust web hosting infrastructure available at the centre is being actively used for providing IT operational services in NER for different user groups. The Local Area Network (LAN) with 1 Gbps Ethernet backbone is used to connect all the scientific groups and laboratories, administrative departments and other facilities in a secure way. The Internet connectivity having 1 Gbps bandwidth availed through National Knowledge Network Optical Fiber Cable (OFC) is being used to provide internet services to NESAC office and Outreach buildings, including 24x7 operational services for providing data and applications. Apart from providing internet services, the NKN with 1 Gbps bandwidth is being used extensively for conducting online meetings, discussions and short courses. ISRO's private Space-net connectivity is used for attending official meetings and secure streaming applications within the ISRO/DOS network.

The centre is well equipped with all relevant GIS and Remote Sensing tools such as high end systems and software for performing remote sensing information retrieval and data analysis, large scale mapping and ground truthing activities. Latest map plotters, printers, GPS systems and cameras including GAGAN, NAVIC and DGPS for professional grade surveys and ground truthing are part of the IT infrastructure that supports mapping activities by various groups in the centre. Sufficient numbers of software, both in the form of proprietary and open source, for carrying out image processing and GIS projects have been procured and are being upgraded as necessary.

The centre now houses multiple high-end servers including redundant servers, storage and sophisticated communication networks guarded by application-aware firewalls for the live hosting of numerous user-centric applications and data sharing gateway in a secure manner. Important data-centric applications such as North Eastern Spatial Data Repository (NeSDR) for centralized repository and delivery of standardized quality geospatial data to multiple users across NER, Geo-tagging and Geo-monitoring based applications for project monitoring of all physical projects and Geotagging of assets in India and other critical applications for disaster management are some of the major applications, which has been successfully made operational from the centre. NESAC also maintains a separate hosting infrastructure exclusively for disaster risk reduction activities in the region. All data delivery and dissemination pertaining to all forms of disaster mitigation are being hosted from this infrastructure. The infrastructure also has a High Performace Computing Cluster (HPCC) configured to run process-intensive activities such as weather forecasting, flood prediction models and numerous other R&D models. It has one master node (20 cores) and ten compute nodes (152 cores) with 20 TB storage (SAN). The system is interconnected with high bandwidth InfiniBand swtich. The HPCC is further being augmented with additional 50TB storage to accommodate the parallel running of multiple data-intensive applications.

Recently, the centre has been equipped with a state-of-art GPU facility to perform advanced big data analytics on remotely sensed imagery. Several AI/ML models have been built to automate general remote sensing pipelines for feature extractions. Operationalization of such

models is being undertaken for quicker yet precise delivery of user-centric data products for effective decision making

Satellite Communication

NESAC has got advanced satellite communication facilities to support various developmental programs in eight states of NER. The facilities available are: SATCOM studio for content generation in various subject matter; Spacenet system for video conferencing and data transfer activities amongst DOS/ISRO centres, ISRO DMS-VPN node, transportable VSAT system and satellite phones for communication support under disaster conditions. NESAC has hosted one of the four ground stations to have NAVIC/ data reception and monitoring facility on a 24X7 basis as part of the satellite navigation programme of ISRO. The centre also has various equipment like Beacon receiver, Radiometer, Laser Precipitation Monitor (LPM), rain gauge, etc. to conduct the Ka-band propagation experiment in collaboration with SAC, Ahmedabad and ONERA, France. The centre also has various equipment under the NAVIC SPS-GPS receiver experiment.

Space and Atmospheric Science Research

The centre has a dual-polarised S-band Doppler Weather Radar (DWR) installed at Sohra (erstwhile Cherrapunjee), Meghalaya, for studies in early warning of hydro-meteorological disasters, convective systems, cloud and precipitation physics, etc. A network of 17 automatic weather stations (AWS) has been set up to support flood forecasting activities. The group operates and manages three multi-instrumented aerosol observatories (at NESAC, Umiam; Tawang, Arunachal Pradesh; and Lachung, Sikkim) set up in collaboration with Space Physics Laboratory, Thiruvananthapuram, for Spatio-temporal characterization of aerosols and its impact on weather and climate over the Himalayan region.

The centre hosts a Multi-Wavelength Radiometer (MWR), Sunphotometer, Aethalometer, MicroAeth, Integrating Nephelometer, Electric Low Pressure Impactor (ELPI), etc. for physical and optical characterization of aerosols. To study the atmospheric boundary layer Physics and dynamics, the centre has Dr. Pisharoty sonde (GPS based) launching facility with hydrogen gas filled balloons and a 32 m tower with fast response 3D sonic anemometer and other meteorological instruments at four levels (at the heights of 6m, 10.5m, 18m, and 30m). A Cloud Condensation Nuclei (CCN) counter, Disdrometer, and one Ceilometer has been installed to study cloud microphysical properties and the aerosol-cloud interaction over the NE region. A tethered balloon launching facility is established for vertical profiling of aerosol using lightweight instruments.

Library

NESAC Library aims at providing "Anytime, Anywhere access" with state-of-the-art expertise, infrastructure and services, caters to the information requirements of the user community of the organisation and houses varied subject collections in both print and online formats.

During 2021-22, the library had added 2119 resources, including 1425 eBooks, 203 books, 167 e-Journals, 301 journal/magazine/ newsletter issues and 23 technical reports. The total catalogued records of the library are now increased to about 19 thousand including all items. The library continues to have access to IEEE Electronic Library, selected ebooks from IET, IOP, & T&F publishers, and e-journals from Wiley, Springer Nature & Scientific American through Antariksh Gyaan (ISRO Library Consortium) and 16 journals through the library subscription. Access to Elsevier e-journal, Taylor & Francis e-journals, Springer Engineering collection (2021) eBooks and Earth & Environmental Sciences Collection (2021) eBooks through Antariksh Gyaan were added to the existing collection during this period.

The library had registered 14 new members and a total number of 1252 circulation transactions were carried out during the period. The library

homepage continued to be the gateway to all kinds of information resources.

Unmanned Aerial Vehicle (UAV) Facility

NESAC has expanded the spectrum of activities in the field of UAV systems and its applications in the field of Remote Sensing, Disaster Management, Security & Surveillance, Payload delivery, etc. At present, more than ten different types of UAV platforms are operational & in the experimental stage, which include multi-rotors, fixed wings and VTOL Fixed wing UAV at NESAC. NESAC is also having a large no of payloads such as RGB cameras (12-42 Mps), multiband multispectral sensors (5/10 bands), thermal sensors, etc. The centre has been providing end-to-end UAV services for various user communities in the NE region and in the country. The centre is well equipped with state-of-art data processing facilities (both hardware and software with automated and semi-automated systems) for high-quality products like 3D Mesh, Point Clouds, Digital Surface Models, RGB/MX/Thermal Orthomosaics, etc. The centre has conducted more than 20 UAV surveys in the year 2021-22 for different user departments in NER. NESAC has also registered all its UAVs on the Digital sky portal and trained persons as RPAS pilots as per DGCA norms.

The centre is also extensively involved in research and development activities related to UAV systems, payload mechanisms, mission planning etc. and has an advanced UAV lab with different tools & equipment. With the advancement of 3D printing technology in NESAC, in-house mini UAVs for experimental purpose has also been developed. UAV R&D team has successfully developed and demonstrated the concept of tethered UAVs for continuous surveillance, drop mechanisms for dropping medicine, food and relief material at the time of the disaster, etc. The team has also integrated NAVIC based VTS (vehicle tracking system) for monitoring of UAVs and Post-Processed Kinematic (PPK) module for improving the accuracy of data.

Sports and Recreation Facilities

NESAC has well equipped Gymnasium, and Recreational facilities at its Residential Complex. The Gymnasium is having state of the art facilities like Treadmill, Elliptical Cross Trainer, Fitness Bike and other equipments. Badminton, Table Tennis, Squash and outdoor sports like Volley Ball and Cricket are regularly played at NESAC. Regular Staff of NESAC as well as students, trainees indulge in various sports and recreational activities. On the event of Republic Day, Independence Day and NESAC Foundation Day, various games and cultural programs are also organized by NESAC Recreation Committee for the staff of NESAC. NESAC has also set up full-fledged Gymnasium and Recreational facilities for its Outreach Facility.

AGRICULTURE AND ALLIED AREAS

NESAC has been carrying out various user-demanded as well as R&D projects in agriculture and allied areas using geospatial tools and techniques to provide synoptic, cost-effective, and timely information for effective crop planning and monitoring in the NE region.

In the face of changing climatic scenarios, accurate crop forecasting, irrigation scheduling, crop stress management and disaster preparedness, the need for precise Spatio-temporal information has become a critical need for the region. The use of advanced geospatial technology in agriculture supports towards the formulation of effective agricultural development plans.

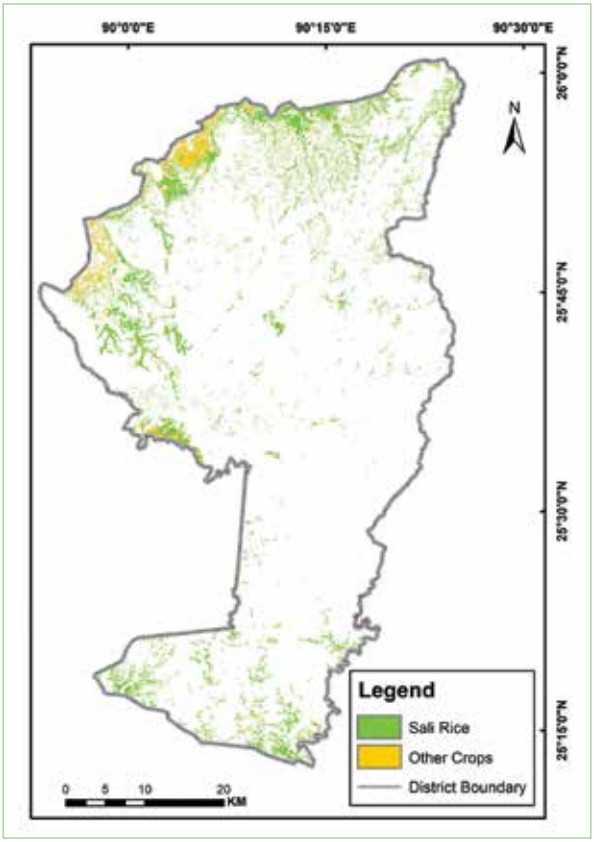
A brief summary of the wide range of projects in agriculture and allied areas undertaken by NESAC for the year 2021-22 has been discussed below.

Geospatial technology for acreage estimation of selected crops and development of a mobile app for planning and monitoring of CCE in Meghalaya

Meghalaya is an agrarian state with about 80% of the population engaged in agriculture, although only about 10% of the state's land is under cultivation. Directorate of Economics & Statistics (DES), Govt. of Meghalaya is the nodal agency for providing statistical information relevant to various socio-economic aspects of the state. The method of collecting, compiling, and evaluating agricultural statistics by DES is entirely reliant on time and cost intensive, laborious ground surveys by Crop Cutting Experiments (CCE). Owing to the fact that agricultural statistics provide important inputs for policy formulation, design and implementation, a feasibility study on satellite technology based area and production estimation of major crops of the state has been taken up. The study was implemented to support the SSS (Support for Statistical Strengthening) programme of the Ministry of Statistics and Programme Implementation (MOSPI), Govt. of India and intended to formulate an efficient and cost-effective solution to the existing challenge of rigorous field surveys as well as to provide remote sensing based crop acreage estimates.

Five crops, viz. winter rice (sali), boro rice, maize, rubber and potato have been selected for this study and acreage estimation of these field crops are made using high resolution satellite data supported by field surveys. Synthetic Aperture Radar (SAR) data have also been used to delineate the crop fields during the Kharif season when cloud free optical data was not available. Sali rice, which was grown over 78,257 ha of land, was found to be the state's largest growing crop. The majority of Meghalaya's sali rice is grown in the West Garo Hills district (14,859 ha). The same district also leads in the production of boro rice (8,231 ha) and rubber (5,602 ha). The study on maize in the Ri Bhoi district revealed that farmers cultivated the crop in 3,442 ha of land. Likewise, estimated areas under summer and winter potato have been found to be 9201 ha and 3362 ha, respectively in the East Khasi Hills district.

In different rice ecosystems, the selection of CCE villages was optimized through spatial stratification considering the agro-climatic conditions, soil type and elevation. UAV surveys were conducted with multispectral and RGB sensors in selected sample locations (27 villages in 8 districts) covering different strata of rice ecosystems. All the relevant CCE information was collected using GAGAN (GPS aided Geo-augmented Navigation) based mobile app (CCE app) developed at NESAC. The CCE app is designed to operate both in the online and offline mode, taking the poor internet connectivity in rural areas into consideration. Both the field and UAV data were utilised to delineate the area under sali rice in Meghalaya. To estimate the State's annual sali rice production, the yield from the driage CCE plots was modelled, which will require more trials and validation for operational use.



Sali rice acreage map of West Garo Hills, Meghalaya

A web-based spatial dashboard has also been developed for the visualization of the sampling plan and data collected during CCE. The dashboard has necessary features for interactive visualization, navigation, map query using filtering based approach and visualization of statistics via charting tools. The outcome of the project is expected to help the DES, Govt. of Meghalaya in optimising CCE samples, thereby reducing the cost, labour and time to a great extent. RS-based crop acreage estimates of the selected crops will be more accurate and reliable, which will serve as baseline information for agricultural planning in the state.

Geo-tagging of assets created under NERTPS programme of CSB in NER

Sericulture, an important sector of the Indian economy, contributes significantly to poverty alleviation. North East Region Textile Promotion Scheme (NERTPS) is an umbrella scheme of the Central Silk Board (CSB) under the Ministry of Textiles to promote the textile industry in NER by providing infrastructure, capacity building and marketing support to the industry (http://texmin.nic.in/schemes/). The scheme covers all sectors and subsectors of the value chain of textiles, handloom, handicrafts, sericulture, jute, etc. and is implemented in a project mode with region-specific flexibility in project design and implementation.

Following the implementation of the scheme, a large volume of assets, about 45000 have been created across 8 NE states. To monitor the effectiveness of the scheme, CSB entrusted the task to NESAC to geo-tag all the assets created under this umbrella scheme.

In the midst of the Covid-19 outbreak, NESAC took the challenge and geo-tagged the assets using GAGAN based 'SILKS' mobile app developed by the IT Team of NESAC. This app provided precise position of the assets and supported with offline collection of field data in areas having no internet connectivity.

116 Project Assistants were recruited from all the NE states and provided required hands-on training on the operation of the GAGAN-GPS dongle for geo-tagging of the assets. The exercise was carried out during the period from March 2020 to February 2022. To commemorate the successful completion of the project and to formally release the project outputs in the form of Project Atlas and 'SeriGeotag' dashboard (https://apps.nesdr.gov.in/silkdashboard/silks.php), a concluding workshop was organized jointly by NESAC and CSB at Assam Administrative Staff College, Guwahati on 19th April, 2022. About 60 Scientists and officials from CSB, State Directorates of Sericulture, State Remote Sensing Applications Centre and NESAC attended the workshop.

Shri R.R. Okhandiar, Member Secretary & CEO, CSB graced the inaugural function as the Chief Guest and released the Project Atlas. Special Guest of the workshop, Shri B.P Pradhan, IFS, Secretary (Science & Technology), Govt. of Sikkim launched the 'SeriGeotag' dashboard. A Central Sector Scheme viz., "Silk Samagra-2" was also

Releasing of Project Atlas of "Geo-tagging of Assets under NERTPS Program of CSB in NER"

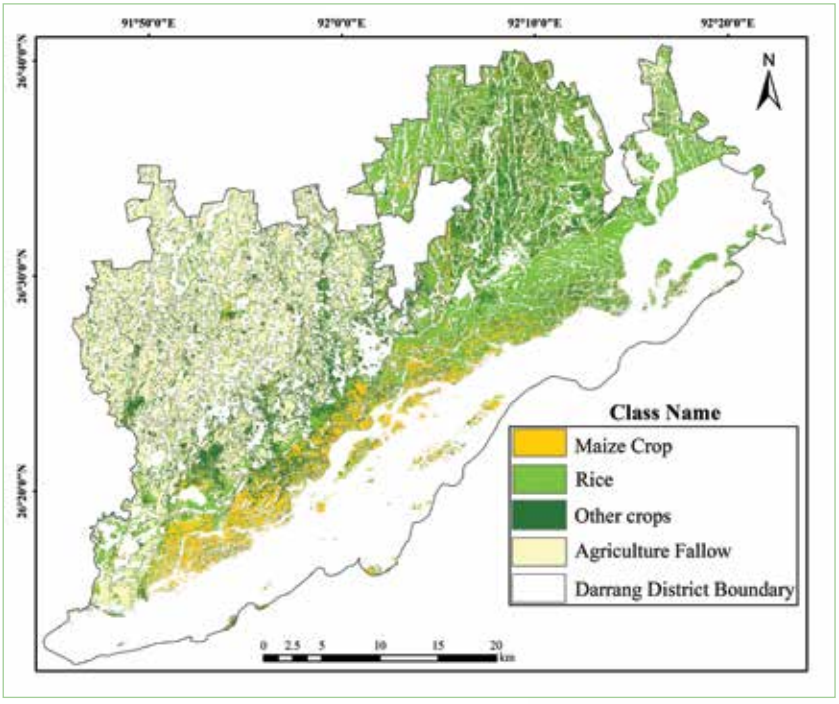
introduced during the inaugural function of the workshop. Member secretary, CSB emphasized that SILK SAMAGRA-2 is an integrated scheme for the growth of the Indian silk industry that combines the efforts of State Governments and other implementing organizations to improve the quality, productivity and production of raw silk, besides generating employment opportunities, particularly in the rural areas.

Maize acreage estimation in NER under SUFALAM

Under the SUFALAM (Space Technology Utilization for Food Security, AgricuLtural Assessment and Monitoring) Programme, coordinated by SAC, Ahmedabad, a pilot study on developing a remote sensing-based methodology for acreage estimation of maize crop has been carried out for Darrang (Assam) and Ri Bhoi (Meghalaya) districts representing valley and hilly areas respectively.

Both optical and microwave data from different seasons were used for the study and the training samples for the analysis were collected from various sites in the selected districts.

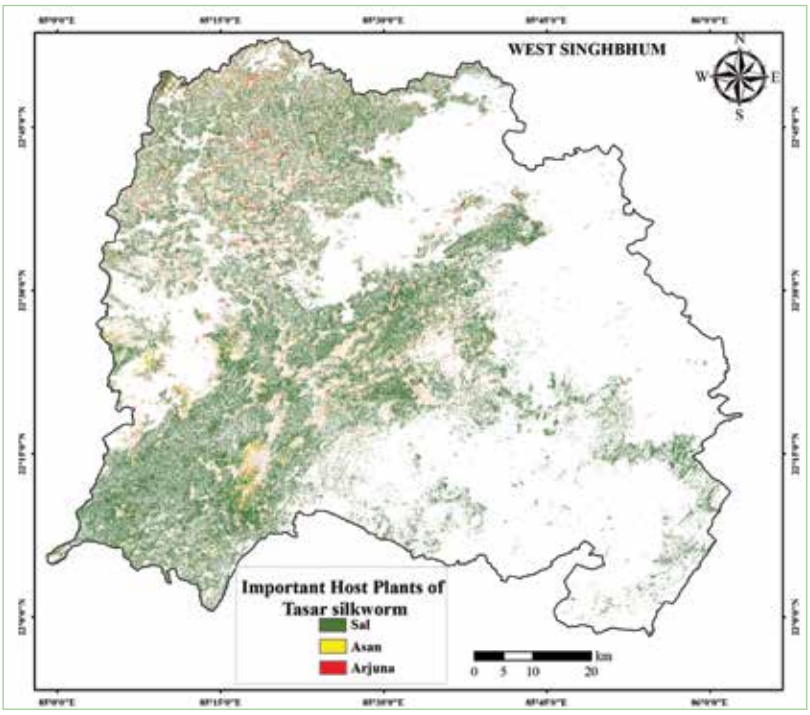
Six different types of classification algorithms viz. MLC (Maximum Likelihood Classifier), MDC (Mahalanobis Distance Classifier), SAM (Spectral Angle Mapper), SVM (Support Vector Machine), NN (Neural Network) and RF (Random Forest) were adopted for classification of maize. The data collected by UAV surveys were used to check the post classification accuracy and to study the phenological stages of maize. The NDVI and EVI vegetation indices were determined from the UAV-multispectral data in various growing stages of maize to compare the phenology with other crops. SVM classifier provided the highest overall accuracy (83.09%), highlighting the total maize area of Darrang to be 11762 ha against the government estimate of around 10000 ha. Maize acreage estimated using the SVM classifier in Ri Bhoi was 3442 ha.



Maize crop and other crop areas delineated in Darrang district, Assam

Study on existence of tropical silkworm ecoraces and their subsist places with the help of geospatial technology

This project is executed jointly by Central Tasar Research and Training Institute (CTR&TI) and NESAC, which aims at complete documentation of available ecoraces of *Antheraea mylitta* Drury and implementation of appropriate in-situ conservation plan. Out of 44 ecoraces of tropical Tasar silkworm known so far, the current status of many is not known. The project aims to explore the current status of all the available ecoraces in tropical regions of India through systematic survey, phenotypic/morphological characterization, analysis of niches structure of the respective habitat areas and spatiotemporal distribution of various tropical Tasar silkworm ecoraces in our country through ground inventory and geospatial technology.



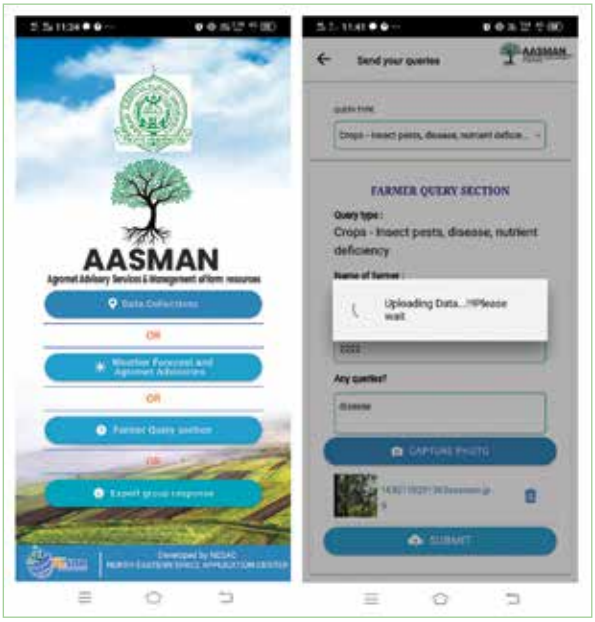
Distribution of Tasar host plants in West Singhbhum, Jharkhand

Delineation and mapping of Tasar host plants (primary) – Sal, Asan and Arjun has been completed for all the districts of Jharkhand. Random Forest algorithm was employed for digital classification of the study area and delineation of the host plants.

As per the requests from CTRTI, Ranchi, certain modifications have been introduced in the 'TasarGeotag' mobile app which was developed by the NESAC team to collect geo-tagged information about Tasar ecoraces. We now also have the feature to upload photographs of geo-tagged assets through the app. Apart from this, a web-based dashboard named 'TasarGeotag' has been newly built under this project. It provides users the ability to view the location, number and the field photographs of the geo-tagged information. Another notable feature is that the dashboard is linked with the mobile app, which facilitates near real-time visualization of the data collected on the field.

Geo surveillance of Agromet Field Units for effective delivery of Agromet Advisory Services

NESAC is executing this project jointly with Assam Agricultural University (AAU), Jorhat. An interactive mobile app (AASMAN- Agromet Advisory Services and MANagement of farm resources) is being

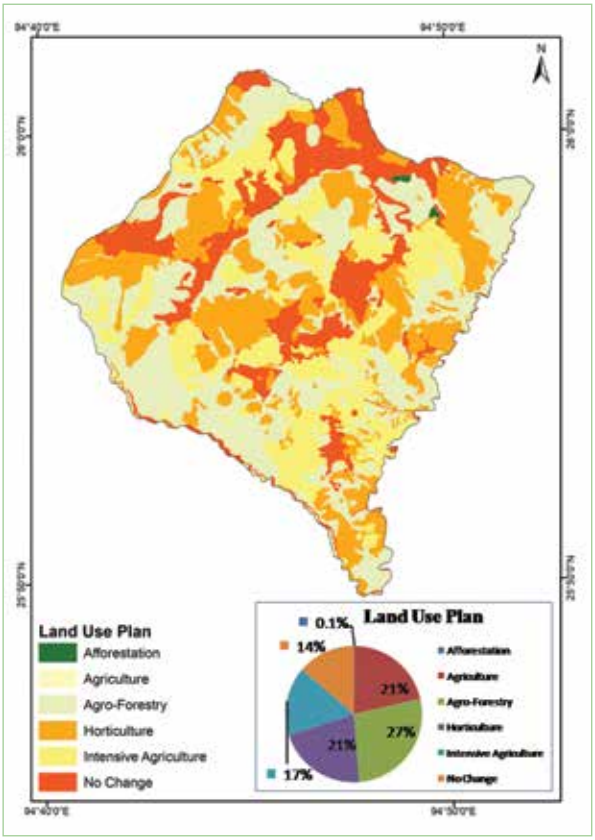


Home page of AASMAN mobile app

developed integrating IMD's weather forecast, extreme weather forecast (Lightning and heavy rainfall) and crop specific advisories. In addition to this, farmers query section and expert group response has also been integrated in AASMAN. The mobile app is available in English and Assamese languages.

Preparation of Agro-climatic Atlas under "Fostering Climate Resilient Upland Farming Systems (FOCUS)" Project for Nagaland and Mizoram

An agro-climatic atlas covering eight districts of Nagaland (Mon, Mokokchung, Longleng, Wokha, Zunheboto, Kohima, Kiphire, and Phek) and four districts of Mizoram (Kolasib, Champhai, Mamit, and Serchhip) has been prepared under the "Fostering Climate Resilient Upland Hill Eco Systems (FOCUS)" project of the Food and Agriculture Organization (FAO). Physiographic, soil, climate, and agroclimatic indices maps have been prepared at the block level to define the agroclimatic zones. Each zone illustrates the land use and land cover at different elevations, soil types with important climatic information for any developmental planning by careful assessment of agro-climatic resources. Training programs were also organized for the officers of Govt. of Nagaland and Mizoram on the use of agro-climatic atlas in land suitability studies and land use planning.



Land Use Plan (LUP) for Kiphire Sadar block of Kiphire district, Nagaland

Expansion of paddy in Umling block of Meghalaya using remote sensing and GIS

Rice is a major food crop of Meghalaya, occupying an average annual area of 110997 ha with a total production of 303476 Metric Tons. The productivity of rice in Meghalaya is much below the national productivity due to a number of constraints, such as the undulating topography, transport and communication problem, population dispersal pattern, inadequate credit support, poor marketing system, etc. The state is still in a deficit of about 2.63 lakh tons of rice grain annually. Govt. of Meghalaya has given emphasis on increasing the production of rice by bringing new areas under rice and requested NESAC to carry out a pilot project in the Ri Bhoi district. In response to the request, NESAC has taken up this project and completed the work for the Umling block of Ri Bhoi district to delineate the suitable areas for expansion of rice crop.

Suitable areas for expansion of rice in the non-agricultural, open tree clad (open forest) and culturable wastelands using LULC map of 1:10,000 scale were prepared from Resourcesat 2 LISS IV image of 2019 by using visual image interpretation technique. Soil samples were collected during the field visits and analysis results were used to generate soil fertility map along with Soil Health Card data collected from SHC web portal https//soilhealth.dac.gov.in. Soil map of 1:50,000 scale prepared by NESAC was used to generate soil depth, soil texture and soil drainage map. The slope map was derived from 10m Carto DEM generated from Cartosat-1 stereo data under the SISDIP project.

The study reveals that the soil of the study area is well-drained, deep, slightly to moderately acidic

in nature, non-saline, medium to high in organic carbon content, clay to loam in soil texture with medium available phosphorus and potassium and sufficient micronutrients. From soil site suitability evaluation for rice, it is found that 47% area is suitable for both ahu and sali rice, whereas 8% and 45% area is suitable only for ahu and sali rice, respectively. The highly suitable areas are found only for ahu rice which covers only about 0.56% of the suitable areas.

Table: Area under different suitability classes

	Sali rice		Ahu rice	
Suitability class	**Area (ha)**	**% area**	**Area (ha)**	**% area**
Highly suitable	-	-	52	0.56
Moderately suitable	415	2.65	1194	12.82
Marginally suitable	15268	97.35	8066	86.62

Expansion of Khasi Mandarin in Pynursla block of Meghalaya using Geospatial Technology

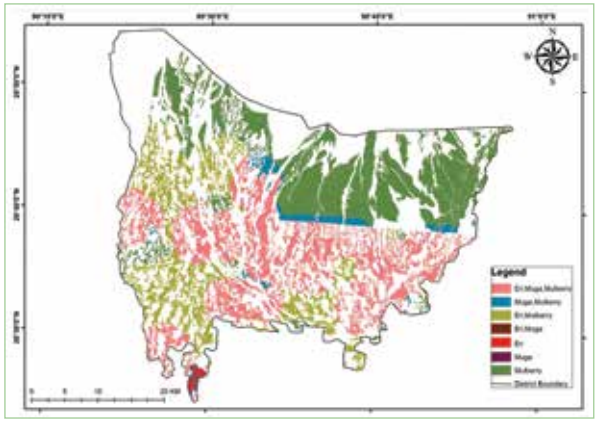
East Khasi hills district is the major producer of Khasi Mandarin in Meghalaya covering 4252 ha area (46% of total orange plantation), producing 23585 metric tons of fruits, which is 53% of the total state production. Pynursla block of East Khasi hills district is situated on the southern slope of Meghalaya and it is an important block which is producing good quality Khasi Mandarin. Department of Agriculture, Govt. of Meghalaya wants to increase areas under Khasi Mandarin plantations in the state. Based on a request from the user department, NESAC has taken up this pilot project to find out suitable areas for the crop in the Pynursla block and completed the work. Suitable areas for expansion of Khasi mandarin were identified based on soil site suitability for which soil map, soil fertility, slope and LULC map was used. The study reveals that soils of the study area are deep, non-saline, slightly to moderately acidic in reaction, sandy clay loam to clay in texture, rich in organic carbon, moderately well drained and contain medium available phosphorus and potassium and high Zinc. From the soil site suitability evaluation, it is found that 10,457 ha area covering 64% area is suitable for growing Khasi Mandarin in the Pynursla block. It is observed that 65% (i.e. 6784 ha) area is marginally suitable and 3672 ha (35%) area is moderately suitable.

Applications of Geospatial and Web Technology for Sericulture Development in Chirang district of Bodoland Territorial Council, Assam

The project was undertaken at the instance of Directorate of Sericulture, Bodoland Territorial Council, Government of Assam, with the objective of Identification of suitable areas for expansion of Mulberry, Eri and Muga sericulture and Integration of the database in the SILKS geo-portal.

The study revealed that the Chirang district is highly suitable for Eri and Muga sericulture that covers 56.3% and 46.3% of the study area. The remaining areas are moderately and marginally suitable because of the long distance from Eri and Muga sericulture practising communities. It is observed that mulberry sericulture is not highly suitable because of coarse soil texture, moderately acidic soils and steep slope. But moderately suitable areas can be used for expansion of mulberry sericulture with management practices like providing drainage facilities near plantations and using organic manure to improve soil texture and neutralising soil acidity. All the project outputs, namely Mulberry, Eri and Muga suitability maps, relevant inputs layers like slope, soil acidity, soil depth, soil texture, soil drainage, ground water prospect, road network, village, circle and sericulture practising village map and all other relevant non spatial information related to growing of food plants and rearing of silkworms, the occurrence of pest and diseases, different schemes for expanding the sericulture have been integrated in the SILKS portal developed by NESAC (http://silks.csb.gov.in). The content of SILKS is provided in English, Hindi, Assamese and Bodo

languages which will help all the stakeholders of the sericulture industry for better planning and expansion of sericulture in the Chirang district.



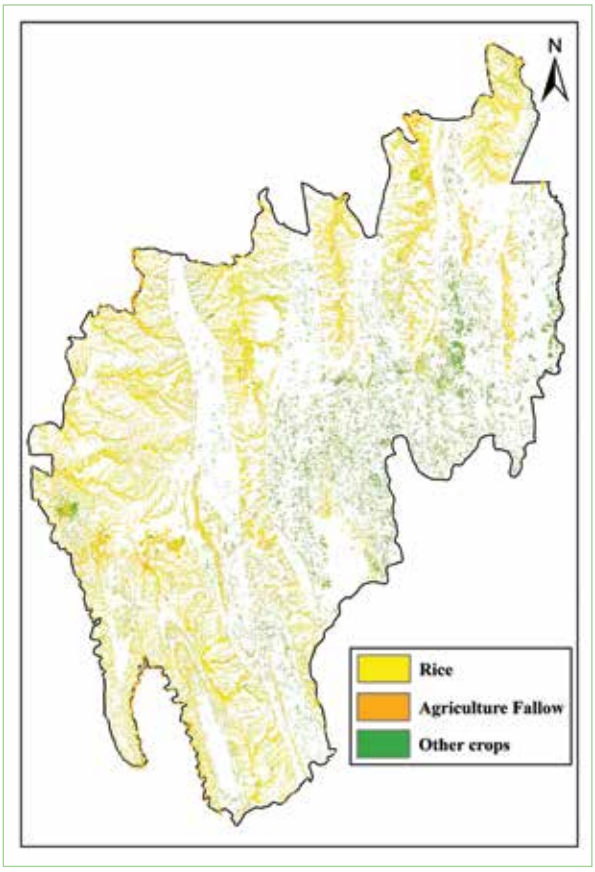
Areas suitable for Eri, Muga and Mulberry sericulture in Chirang district

Progress of Projects under Plan of Actions (PoA)

A total number of 24 projects in agriculture and allied sectors have been taken up as part of the PoA on the use of space technology applications in NER. The regional projects under the Plan of Actions (PoA) are focused on the use of space technology and applications to accelerate the development process in the NER. Two important regional level projects under PoA in agriculture and allied sector are "Applications of Space Techniques for Agricultural Assessment in NER (ASAAN)" and "Space-based Support for the Integrated Development of Horticulture in NER (SSIDH)".

Under ASAAN, delineation of agricultural areas has been completed for the state of Tripura.

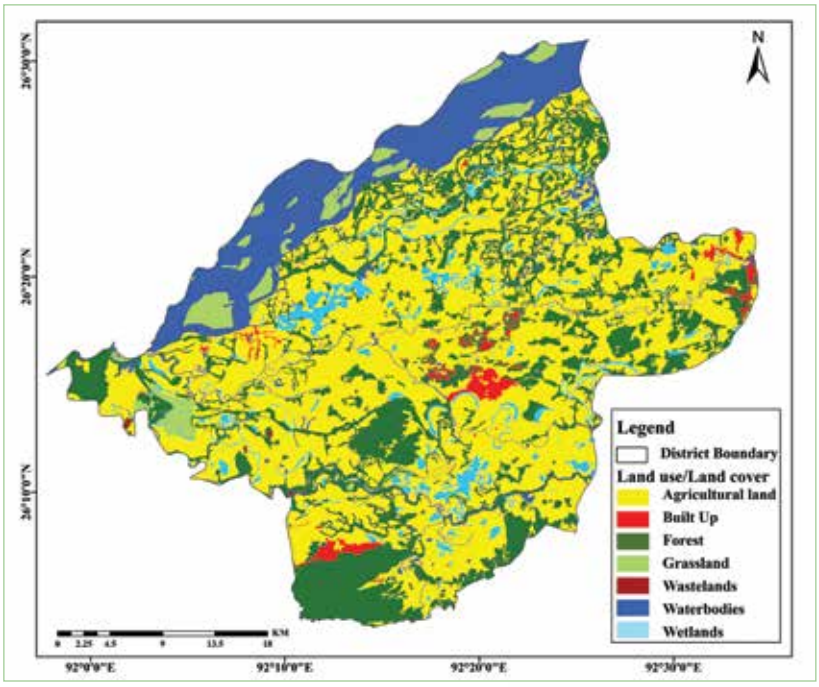
Under SSIDH, updation of Land use/Land Cover for site suitability analysis of selected horticultural crops in Arunachal Pradesh and Assam is in progress.



Delineation of agriculture area of Tripura under ASAAN

Apart from the regional projects, the work on state-specific PoA projects has been initiated.

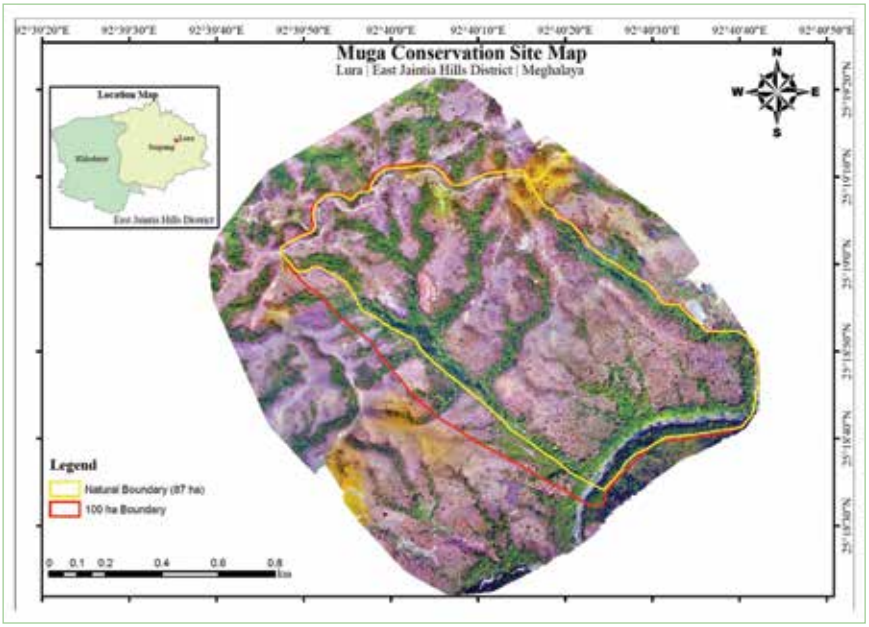
The PoA project "Applications of geospatial technology for in-situ conservation of Muga



Updated LULC map of Morigaon (Assam) under SSIDH

Silkworm in Jaintia Hills district, Meghalaya" has been initiated and UAV survey at Lura, East Jaintia Hills (EJH) was undertaken. Furthermore, the site for the setting of Automatic Weather Station (AWS) under the project has been surveyed.

At the request of the Chief Secretary of Arunachal Pradesh, NESAC took up the PoA project "Identification of suitable areas for kiwi & walnut cultivation in and around Kaho, Kibithoo & Mosai village of Arunachal Pradesh" and have completed the task for Kibithoo.



Muga conservation site map (Lura, East Jaintia Hills, Meghalaya)

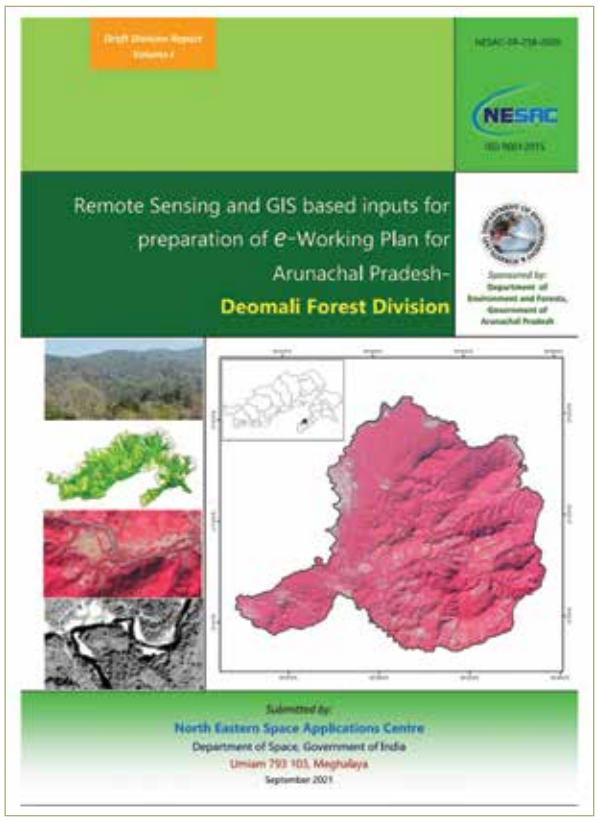
Multispectral and multi-temporal satellite imagery for the period of January-February, 2021 was used for updation of LULC map prepared at 1:50,000 (50K) scale for the period of 2015-16 by NRSC, Hyderabad, India. The visual image interpretation technique was used for updation of LULC. Culturable wastelands (grasslands) were extracted from the updated LULC. Soil map on a scale of 1:50,000, generated by the State Remote Sensing Application Centre (SRSAC), Itanagar has been used for extracting the required soil parameters viz., texture, depth, soil drainage and pH. Digital Elevation Model (DEM)-10m generated from IRS-P5 CARTOSAT-1 satellite imagery (CARTO-DEM) was used for delineating elevation, slope and aspect. Climatic data (rainfall & temperature) for the period 1990-2018 were used for the preparation of climatic spatial maps.

The GIS database pertaining to climate, physiography and soil parameters was categorized into 4 classes according to the level of suitability, i.e. highly suitable, moderately suitable, marginally suitable and not suitable, following standard criteria developed in consultation with the Horticulture Dept. of Arunachal Pradesh. However, for kiwi fruit, all the parameters were categorized into 2 classes only, i.e. suitable and not suitable due to the unavailability of detailed criteria. Suitable areas for growing kiwi and walnut have been identified in Kibithoo Circle of Anjaw district of Arunachal Pradesh using multi-criteria analysis in a GIS environment. An area of 3333 ha; 6.76 % of the Total Geographical Area (TGA) has been found to be suitable for the cultivation of kiwi fruit in the Kibithoo Circle. Again, 284 ha (0.57% of TGA), 6615 ha (13.41% of TGA) and 521 ha (1.05% of TGA) have been found to be highly, moderately and marginally suitable for growing walnut in Kibithoo Circle.

FORESTRY AND ECOLOGY

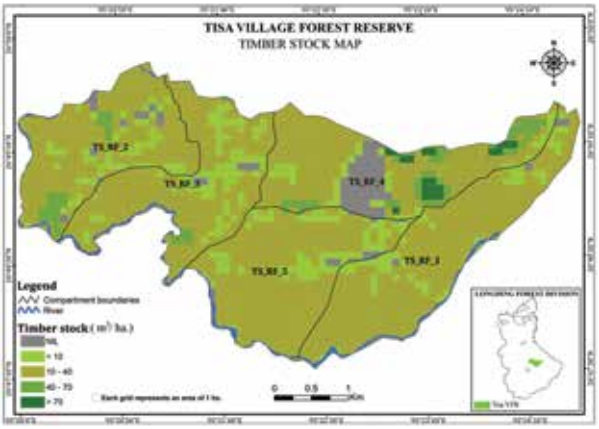
Preparation of Remote Sensing and GIS inputs for forest working plan preparation of Arunachal Pradesh

This project is being carried out to provide geospatial inputs for preparation of Forest Working Plan for the state of Arunachal Pradesh. Computation of growing stock estimates at compartment level have been done and provided to the Forest Department for different divisions. The detailed growing stocks and reports have been provided for the divisions of Deomali, Khonsa, Sagalee, Longding, Banderdewa and Dibang.



The information provided to the forest department includes area under different forest canopy densities based on maps prepared at 1:10,000 scale, The LULC maps of the VRFs/ARFs showing the different compartment boundaries, the growing stock maps indicating the spatial distribution of timber volume densities and carbon densities per unit area for all the VFRs/ AFRs computed based on the data provided by the Arunachal Pradesh Forest Department. The distribution of bamboo growing areas and estimated culm densities under different compartments for the 6 divisions have been completed. Apart from these the phyto-sociological analyses of trees and diversity indices derived from the field information have also been generated.

Longding division does not have any notified Reserve Forests but there are 7 Village Forest Reserve and 1 Community Reserve covering an area of 70.61 km^2.



Forest canopy density and other landuse map for different compartments of Tisa VFR

Mean timber volume density was found to be highest in Russa-Chopa VFR and least in Longding VFR. Apart from estimating the timber volume, biomass and carbon stock at compartment level, growing stocks have also been estimated in grids of 1 ha area to present the spatial distribution of the stock within the compartment.

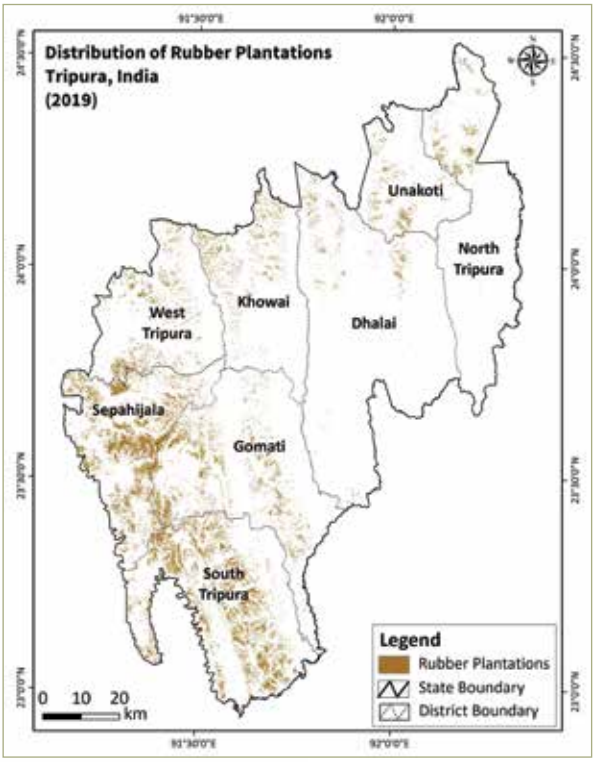
Mapping the distribution of rubber plantations in all the districts of Tripura state

A collaborative project with with ICMR-Regional Medical Research Centre, Dibrugarh on "Operational feasibility of additional intervention package for accelerated malaria control in areas with jhum cultivators in Tripura" is being undertaken in Dhalai district, Tripura to understand the relationship between jhumias

and the incidence of malaria infection. Spatial distribution of jhum fields have already been prepared, and to understand the influence of climatic parameters and forests types on malaria incidence, the area under rubber plantations have been mapped for the entire state of Tripura.

Using multispectral and multi-temporal images of Sentinel-2 data, composite images of Normalized Difference Vegetation Index (NDVI), Ratio Vegetation Index (RVI) and Normalized Difference Moisture Index (NDMI) of the study area were generated. Differencing of the indices were performed by subtracting the values of the indices in January 2019 from those of March 2019 to utilize the marked difference in the reflectance of rubber plants in two seasons. The resultant images were subjected to supervised classification.

The area under rubber plantations (3+ years old) was found to be 57,028 ha and the district-wise distribution is shown in the Table and the spatial distribution of rubber in Tripura is shown in the map.



Distribution of rubber plantations in Tripura

Table: Area under rubber plantations in different districts of Tripura (2019)

Districts	Area (ha)
Gomati	9,184
Dhalai	2,054
Khowai	3,292
North Tripura	1,834
Sepahijala	16,077
South Tripura	18,295
Unakoti	1,929
West Tripura	4,363
Total	**57,028**

A rubber plantation during leaf shedding

Assessment of socio-ecological vulnerability to climate change among agro-forestry managers along an altitudinal gradient in the eastern Himalayas

Household survey on agroforestry practice based on questionnaire survey and ecological data collection were conducted in the villages of Sumer and Byrwa in Umsning block, Kdonghulu, Mawbri and Mawtneng village in Umroi block of Ri Bhoi district and Shella village under Shella

An agroforestry farm in Ri Bhoi district

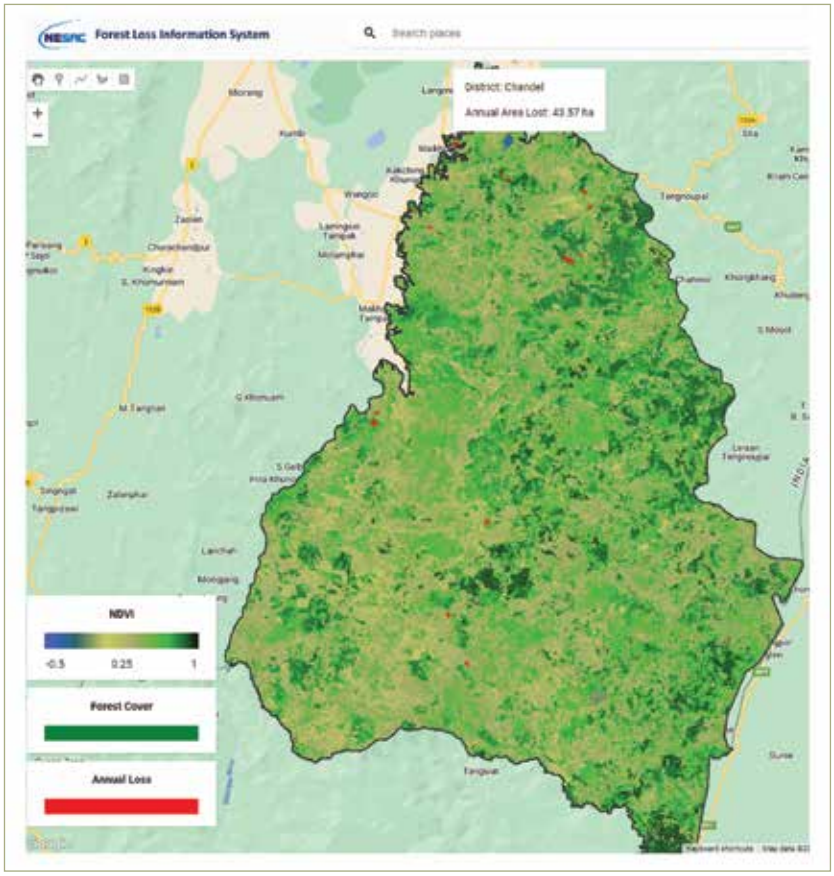
Bholaganj block in East Khasi Hills district of Meghalaya. From the field data, it was observed that the main agroforestry systems practiced in these villages were Silvihorticulture with major tree species like *Artocarpusheterophyllus, Schimawallichi, Mangiferaindica, Areca catechu* along with crops like black pepper, pineapple, beans, ginger, turmeric, etc. Questionnaire survey included response from the farmers on different aspects of exposure to changing climate, the sensitivity and the adaptive capacity.

Identification of degraded forests/ forest gap areas in Reserve Forest areas of NER

This project is being taken up to identify the degraded forests (forest gaps) within the reserve forests (RF) of different NE states as a part of the PoA projects funded by NEC. The RF boundaries have been obtained from the respective state forest departments and high resolution satellite data are being used to identify and delineate the forest gaps. The information thus generated will be provided to the state Forest Departments to aid in their management planning.

Development of Automated System for Monitoring of Deforestation

Forest loss in North Eastern Region (NER) has become a vital issue due to increasing demand of forest produces and other traditional practices. This is one of the PoA project funded by ISRO and aimed to develop an automated system for monitoring of deforestation. NDVI based image differencing technique was used to identify the area under forest cut. The images of pre and post time periods were taken from the same month to minimize the phenological variation. Forest type map from Forest Survey of India (FSI) was considered as base map of forest area. The consistency check of deforested area was carried out with consecutive months to increase the accuracy of the product. The entire process was developed on Google Earth Engine platform and web application has been developed for continuous monitoring. Annual forest loss product for year 2020 and 2021 can be generated and downloaded at district level using the web application. It is expected that many organizations including Forest Departments of the region will be benefited once the system is fully operational.

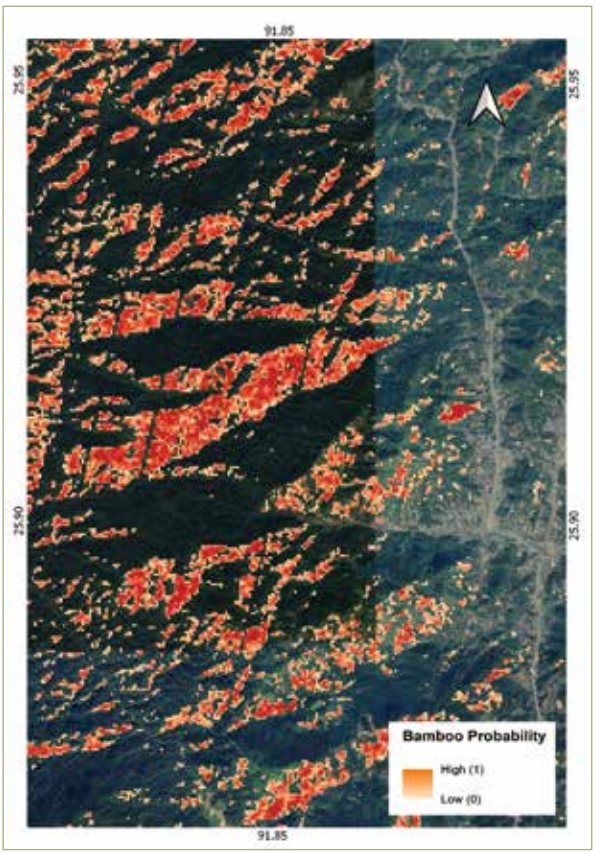


Web application of Forest Loss Information System portal (Forest loss in East Karbi Anglong, Assam for year 2021)

Development of methodology for delineation of bamboo growing areas

Bamboo is one of the important forest resources of north east India. Mapping and monitoring of these resources are essential for socioeconomic welfare of the society. Current project was initiated to develop a methodology for identification of bamboo growing area. Hyperspectral

satellite data (PRISMA) has been utilised to distinguish bamboo from other vegetation. Various preprocessing and dimensionality reduction techniques have been applied to make the data suitable for classification. Various machine learning algorithms are being tested to identify the bamboo growing area in the study site. The area near Nogpoh (Ri Bhoi district headquarter) has been selected as a study site for carrying out the project.

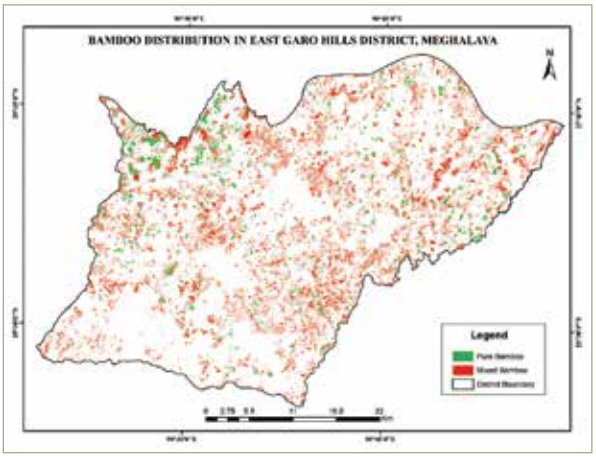


Bamboo occurrence probability in the study site

Mapping of bamboo resources for the state of Meghalaya

The project has been undertaken in collaboration and with funding by the Soil and Water Conservation Department, Govt. of Meghalaya, for mapping the bamboo resources in the state. IRS R2 LISS IV satellite data is being used for mapping the bamboo growing areas while field data information on bamboo are being collected by the Soil and Water Conservation dept. for estimating the bamboo growing stock map.

Mapping of bamboo growing areas has been completed for 9 districts of the state (East Garo Hills, East Khasi Hills, Nort Garo Hills, Ri Bhoi, South Garo Hills, South West Garo Hills, West Garo, West Jaintia Hills and West Khasi Hills). Pure and mixed bamboo growing areas have been identified and mapped. Ground truth verification has been carried out for identifying and validation of the pure bamboo growing areas in the state.



Bamboo growing area in East Garo Hills

Analysis of forest cover change dynamics in North Eastern India

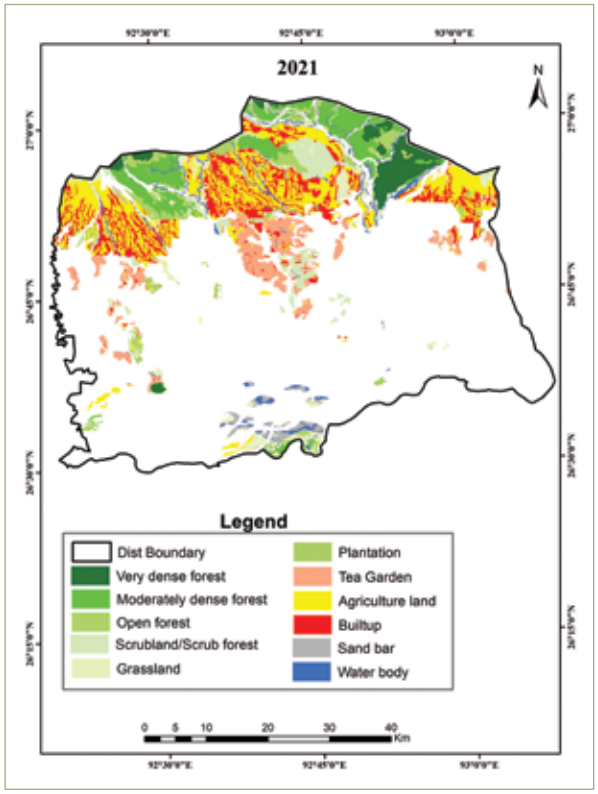
The North Eastern Region of India is rich in natural forest resources. A wide range of forests occur in the region ranging from tropical to subtropical, temperate to alpine regions. However, the forest in the region is depleting at an alarming rate due to anthropogenic activities such as illegal logging, agricultural expansion, shifting cultivation, mining, etc. Expansion of agricultural continues to be the main driver of deforestation, thus resulting in the destruction and loss of the biodiversity in the region. Thus monitoring and analyzing the change in forest cover is required for a sustainable management of the forest resources.

The project has been undertaken to map the forest cover and analyze the changes taking place over a period of time (since 1970s till 2021). Forest cover change has been mapped using 70s and 2020-2021 satellite data for the states of Assam and Tripura. The major changes observed in Assam during the study period were the conversion of forest to agricultural land (2725.66 Km^2) and built up (2605.80 km^2).

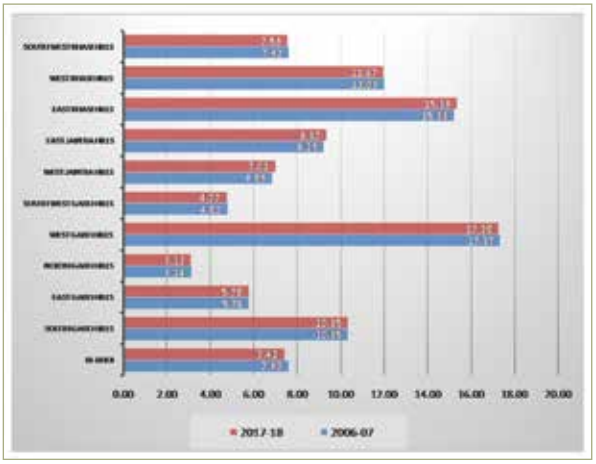
In the state of Tripura, the most prominent changes observed during the study period is the conversion of the scrub forest to rubber plantation contributing 5.23% of the TGA. The district showing highest area (336.97 sq. km) under rubber plantation in the state is Sipahijala.

National Wetland Inventory and Assessment (NWIA) II- Meghalaya

This project aims to map wetlands at 1:50K using Resourcesat LISSIII image and 1:25K using Resourcesat LISS IV image. The overall project is being funded and coordinated by Space Applications Centre (SAC), Ahmedabad. The zonal coordination for Northeast region is being supported by NESAC. The 1:50K mapping has been completed. The LISS IV mapping has been completed and quality check of the data is being carried out at SAC, Ahmedabad. The LISS III based wetland updation for Meghalaya has been carried out by NESAC. It is found that wetlands cover approx. 1.4% of the total geographical area of the state. The district wise comparison of wetland area in Meghalaya (in percentage) does not reveal major changes in wetland area between 2006-07 and 2017-18. Amongst the various wetlands the reservoir and barrages constitute approx. 85% of the total wetland area.



Forest cover in Sonitpur District of Assam



Distribution of wetland area in Meghalaya

Geospatial mapping of forest fire in Meghalaya

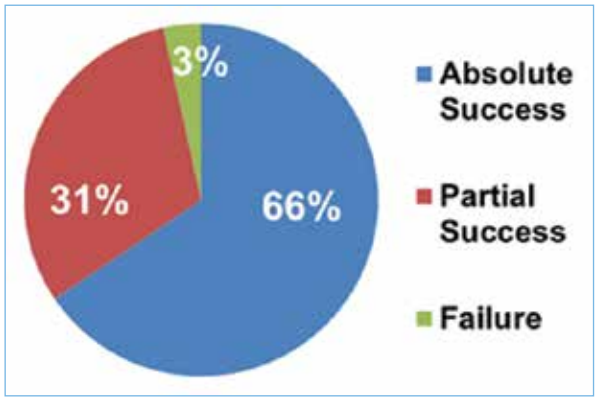
The project is funded by Meghalaya Forest and Environment Department for scientific forest fire management in the state using remote sensing and GIS technology. The project aims to generate forest fire vulnerability zones at 1:25K for entire Meghalaya as one of the deliverables. Under the project two workshops have been conducted for state forest department officials and state disaster management officials. NESAC has developed a Meghalaya forest fire incident reporting App. The App has been launched by Hon'ble Forest and Environment Minister, Govt. of Meghalaya, Shri James P K Sangma on 24th February 2022 at Shillong.

Home page of Forest Fire app

HYDROLOGY & WATER RESOURCES

Flood Early Warning Systems (FLEWS) for Assam

Flood Early Warning System (FLEWS) was initiated in the year 2009 on a pilot basis and became fully operational for Assam in a phased manner from 2012 to 2022. Currently, the project covers all flood prone districts of Assam with actionable flood alerts in the revenue circle level. All these years since the beginning, an average year to year alert success score of 80% and an average alert to alert lead time of 12 to 36 hours have been maintained. On the successful completion of the first (2012-14), second (2015-17) and third operational period (2018-20), with the strong request from the Assam State Disaster Management Authority (ASDMA), NESAC has taken up the fourth operational period from 2021- 23 and it is under progress.



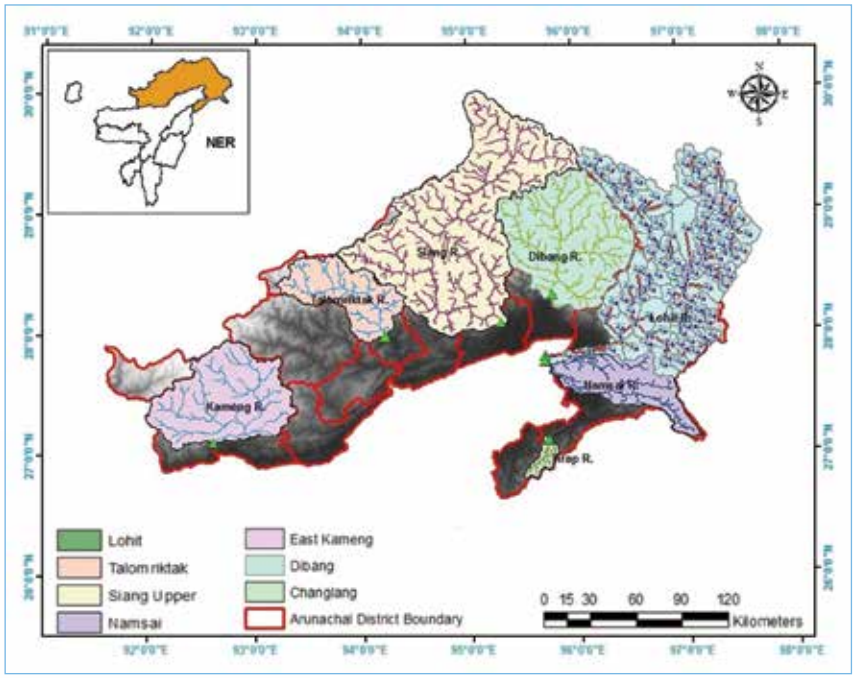
FLEWS success rate during monsoon 2021

Flood Early Warning Systems (FLEWS) for NER

NESAC has taken up the expansion of FLEWS services to the flood prone districts of North Eastern States. As a part of this exercise, the flood prone rivers have been identified and the building of semi-distributed hydrological models is in progress. A series of stakeholder meetings were held with different states of North East for successful implementation of FLEWS in experimental mode initially. During monsoon 2021, few experimental alerts have been issued to the flood prone districts of Arunachal Pradesh, Meghalaya and Tripura.

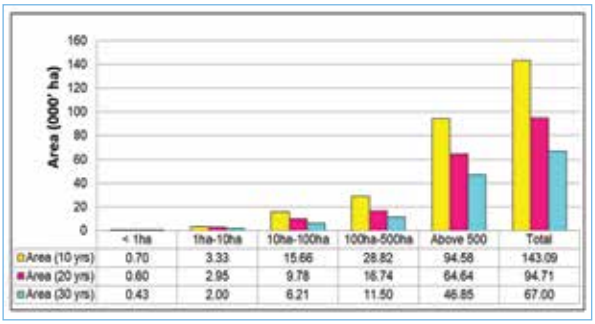
A study of Brahmaputra river islands (chars) using satellite data

This study has been taken up based on the request and funding from Assam Police, Govt. of Assam. In this study, the river configuration of the Brahmaputra main channel has been undertaken to map the changes and present status in order to assess the stability/instability of the chars using temporal satellite remote sensing. This includes assessment of total aggradation and degradation of the chars during the study period of past 30 years (i.e. from 1988 to 2018). In addition to this, the identification of settlements in the stable islands and connectivity to the main land has been carried out. The final project technical report has been



Flood prone rivers and catchments of Arunachal Pradesh

submitted to Assam Police and the project has been completed successfully.



Size wise distribution of stable islands in Brahmaputra during 1988 to 2018

Identification of wetlands/lakes for flood water diversion and to utilize towards irrigation, tourism, etc.

The devastation of flood in Assam is increasing day by day due to climate change and many other anthropogenic factors. Therefore, implementation of an alternate flood mitigation approach becomes essential to minimize the recurring flood damages in the state. During the 9th NESAC society meeting, it was suggested to utilize space technology for flood disaster management. A major action was identified on "Identification of suitable water bodies/wetlands in the state of Assam for flood water diversion". The objectives of the study are a) Identification of wetlands/oxbow lakes in flood plains of Assam using National Wetland Inventory and Assessment (NWIA) layers. b) Selection of suitable wetlands/oxbow lakes to divert water using Flood Hazard Map for exclusion of wetlands in high & very high hazard areas. c) Identification of routes for diverting the flood water to wetlands and assessment of water holding capacity.

For Identification of suitable water bodies/ wetlands for flood water diversion in Assam, the water bodies/wetlands layers prepared under National Wetland Inventory Assessment (NWIA) 2017-18 and Flood Hazard Zonation map prepared by NRSC were utilized. Suitable wetlands were selected by adopting three criteria i.e. i) The wetlands should be located in low to medium flood zones of flood Hazard Maps prepared at NRSC based on long term near real time flood map. ii) The wetlands should be larger than 10 Ha. iii) The wetland should be within 3.5 km buffer zone of the flood causing river. The findings of the study can be summarized as follows:

1) 271 wetlands/lakes having total area of 19,275 Ha were found to be suitable for flood water diversions located in 27 districts of Assam.

2) Based on availability of very high resolution DEM, 206 wetlands/lakes located in 17 districts of Assam are considered for further details analysis.

3) The total area of selected wetlands/lakes (206) is 16,842 Ha and their present volume (capacity) is 575 MCM.

4) It is suggested to excavate the selected wetlands/lakes by 2 metre and construction of 2 meter high embankment surrounding the selected wetlands/lakes.

5) The enhanced volume (capacity) of all these wetlands after rejuvenation is estimated to be 1291 MCM.

6) Hydrological analysis of the flood causing rivers was carried out and it is observed that the flood peak of some rivers may reduce from 20% to 80% after flood water diversion.

Monitoring and Evaluation of IWMP watersheds for NE India

NESAC under the guidance of the National Remote Sensing Centre (NRSC) is coordinating the space based monitoring and evaluation of watersheds under IWMP (Integrated Watershed Monitoring Programme) in NER since 2017. For this purpose, NRSC has developed a geospatial tool called Sristi - a web GIS interface on Bhuvan and Drishti – a mobile based android application. State Remote Sensing Application Centers in NER are executing the project with the support of NESAC and NRSC. For the state of Meghalaya, NESAC is executing the project.

Table: State wise progress of the project

State	No. of Projects	Accepted Geo-tags	Report Prepared
Arunachal Pradesh	88	0	37
Assam	292	13950	197
Manipur	68	3149	35
Meghalaya	62	1715	62
Mizoram	77	6013	67
Nagaland	98	6586	90
Sikkim	11	1058	10
Tripura	56	5097	50

A summary report has been prepared for the completed projects. The report contains primarily the analysis of land use land cover changes after the implementation of IWMP projects. Critical changes are shown with the help of temporal satellite data, i.e., prior and post-implementation of the IWMP projects. Major IWMP activities like construction of check dams, ponds, development of horticulture, agriculture, afforestation etc. are also shown with temporal satellite data.

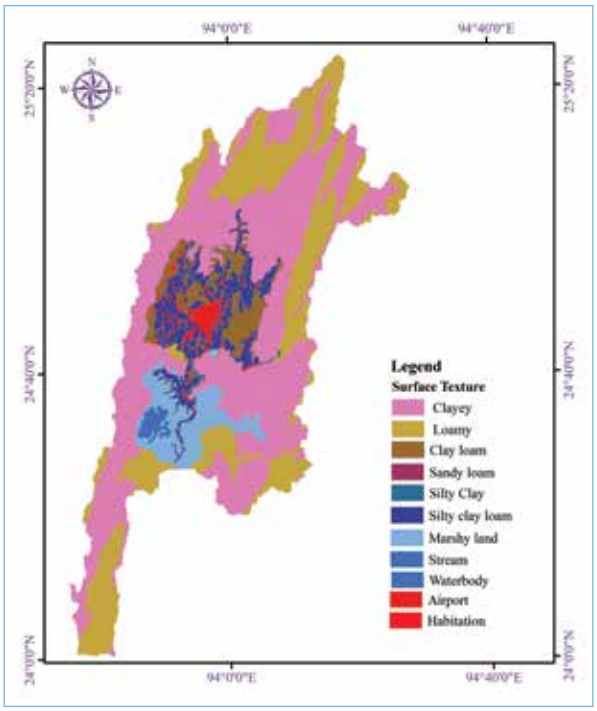
Estimation of Water Bearing Capacity (Storage Volume) of a Rainwater Harvesting Structure (Dam)

Population growth and mismanagement has led to the over exploitation of water resources. The state of Tripura receives about 2300 mm rainfall annually. Because of the undulating topography most of the rainwater drains off to Bangladesh as surface runoff. Appropriate water conservation measures may reduce such wastage. Conservation of the rainwater using structures like check dam is one such practices. The estimation of the storage capacities of the structures help in management of the water stored. Geospatial technology can be effectively utilized for estimation the capacity of the structures. The water spread area of the proposed dam at different elevation was extracted from Cartosat Digital Elevation Model (CartoDEM). Storage capacity of the proposed structures (Check dams) was estimated using definite integral method. The storage capacity of the proposed structures was estimated to be 3.19 Million m^3 (MCM) and 0.35 MCM at Buri Gang and Ghoramara Cherra respectively.

Space based inputs for conservation of Loktak Lake

Loktak is the largest natural freshwater lake in northeast, with surface area varying from 287 sq. km to 500 sq. km during rainy season. The lake is situated in Imphal valley, which is situated centrally in the state of Manipur. This lake serves as a source of water for hydropower generation, irrigation and drinking water supply. The prime issues of Loktak Lake are siltation and water pollution due to the domestic sewage from Imphal city carried by Nambul River. Siltation is caused due to soil erosion from catchment area. This project was taken up to create space based inputs for conservation of the lake.

The catchment area of the lake was delineated using Carto DEM (10 m) as well as micro watershed using ArcHydro tools. The Morgan-Morgan-Finney (MMF) erosion model is used for the estimation of soil loss. The required inputs for MMF model are being prepared. The LULC of the catchment area was updated using latest satellite images. India Meteorological Department (IMD) gridded rainfall data was used for calculation of annual rainfall for the study area which used to derive the kinetic energy of rainfall. The required soil texture map also generated using existing soil map.



Soil texture map of the study area

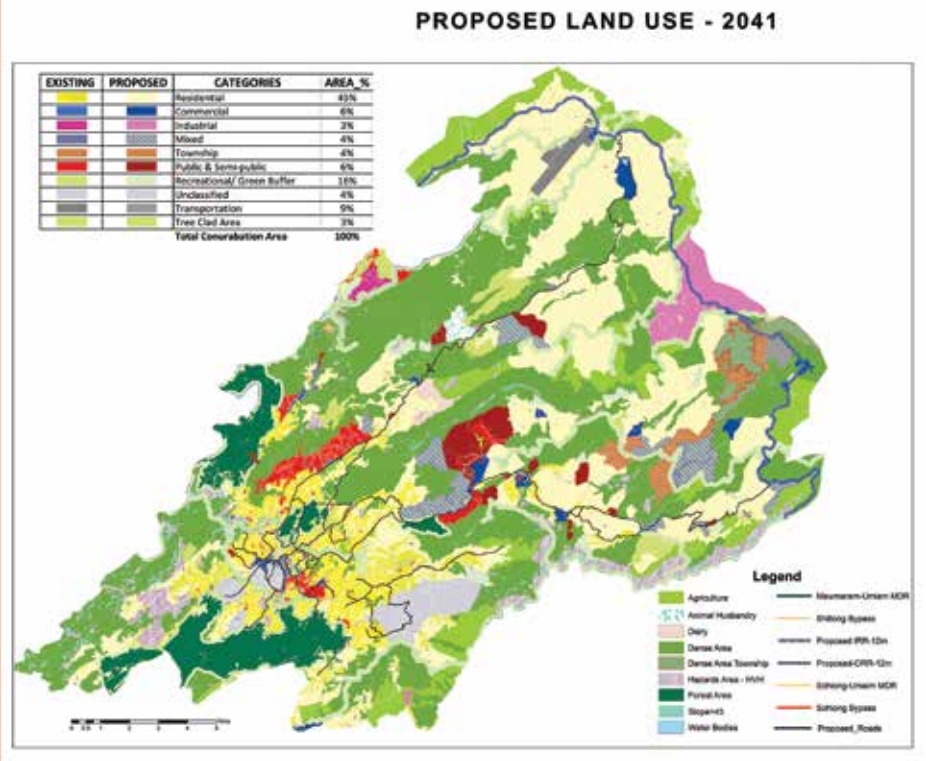
URBAN AND REGIONAL PLANNING

Planning and development refers to the physical and economic growth which meets the needs of the human society effectively. Urban and regional planning requires comprehensive large scale information for various developmental programs. Geospatial technology has catered to this requirement. The availability of very high resolution satellite data coupled with the various applications for field data collection has synthesized the capability to link the spatial and nonspatial data in a very accurate manner. The demand for geospatial data at the urban and regional levels is huge. The centre has been actively involved in urban and regional projects funded by different users. The centre has contributed in the preparation of the Master Plan / Development Plan, Transportation Plan, Urban Site Suitability Analysis, Urban Environmental Planning, etc.

GIS based Master Plan under Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Shillong Planning Area, Meghalaya

The draft report of the master plan for Shillong Planning Area was prepared and submitted to the Directorate of Urban Affairs, Government of Meghalaya. The draft plan was presented to the stakeholders for suggestion and recommendations. In the master plan, the following were the main components: (1) Land use Plan (Residential, Commercial, Recreation, Public and Semi-Public, etc.), (2) Zoning Plan, (3) Transportation Plan, (4) Public Utilities Plan, and (5) Zoning Regulations.

A report including significant data and details on the plan's proposals.



Proposed Land Use for Shillong Master Plan - 2041

Remote Sensing and GIS based inputs for Hazard, Vulnerability and Risk Assessment for Tura, Williamnagar, Nongstion, Nongpoh and Jowai towns in Meghalaya

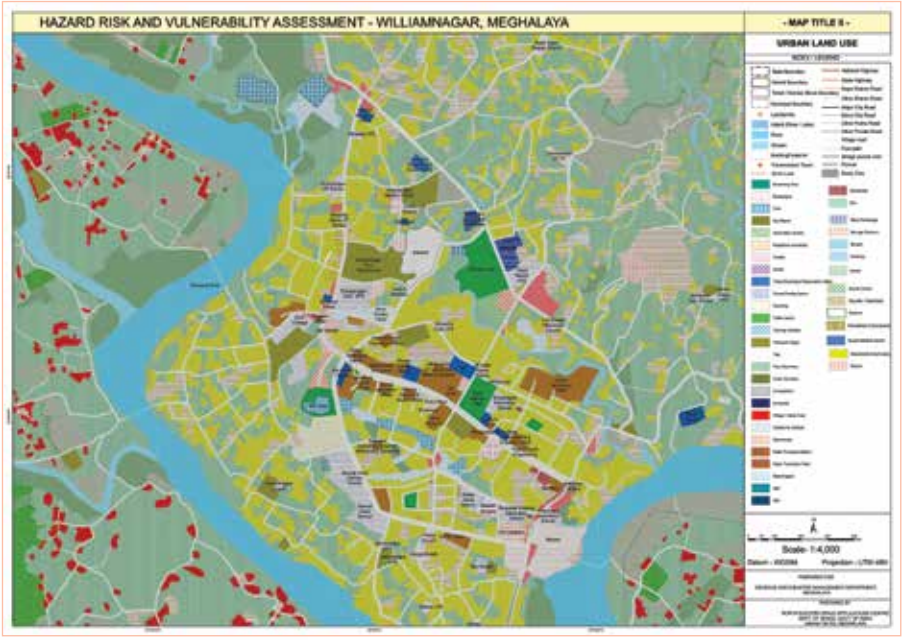
Using high resolution satellite imagery supplemented with ground data, microzonation pertaining to vulnerability and risk to various hazards, namely landslide, flood, and thunderstorm/ lightning, etc., is being carried out for five towns of Meghalaya.

Physical and socio-economic attributes have been assimilated at ward and village level utilizing mobile application developed at NESAC. The attribute data collected was geotagged with spatial references maximizing data integrity. Preparation of Multi Hazard Risk map is at the scale of

1: 4000. This project is being sponsored by Revenue and Disaster managent Department, Govt of Meghalaya. Hazard zonation/ susceptibility mapping, vulnerability analysis for Willaimnagar town have been completed.

Village level mapping for Garo Hills Districts of Meghalaya using high resolution geospatial data

Spatial information at village level will be useful for preparation of village development plans. Detailed mapping using high resolution satellite data coupled with other geospatial techniques is being carried out for the Garo Hills districts of Meghalaya covering a total geographical area of 920 sq km. Thematic layers consisting of land use/land cover, base layer, utilities, landmarks, and others will be generated at 1:4000 scale. An integrated mobile cum dashboard application will be designed and deployed using open source technology and standards following service oriented architecture (SOA). The mobile application supported by GAGAN/ NaVIC will be used for ground truth collection with higher positional accuracy to capture important land feature or any benchmark site along with geo-tagged photos. The derived land feature layers along with other relevant geospatial layers will be populated for effective decision making process.



Urban Land Use of Williamnagar Town

Revision of the Shillong City Disaster Management Plan and Incorporation of Evacuatuion and Rescue Plan

Rescue and evacuation process in case of emergency is required for disaster management of urban centres. In the preparation of a rescue and evacuation plan for Shillong City, inputs which include the urban land use, building footprints, incident micro zones, open spaces and essential services have been used. Optimal routes form the facilities to the incident points and vise versa have been identified. A detailed evacuation plan for lew Duh have been prepared. Unmanned Aerial Vehicle data have been used for base layer generation.

Rural Development Plan for Model Villages (Kaho, Kibithoo and Meshai) of Arunachal Pradesh

The vision of the project is to build Kaho, Kibithoo and Meshai into sustainable and self-sufficient model villages that can be set as an example for the development of other model villages throughout the country.

This work has been initiated as a follow-up action of 9th NESAC Society meeting held on January 23, 2021 at Shillong under the chairmanship of Shri Amit Shah, Hon'ble President of NESAC Society and Union Minister for Home Affairs & Cooperation.

Components that has been incorporated in the model villages are Tele-education and tele-medicine, DEWATS, Medicinal Garden/ herbal garden, Agro forestry- Taxus or Yews Plantation, Cluster nutritional kitchen garden, Pisciculture and Tap the un-tapped potential suchas Wind mills to generate electricity, Capacity Building and Tourism.

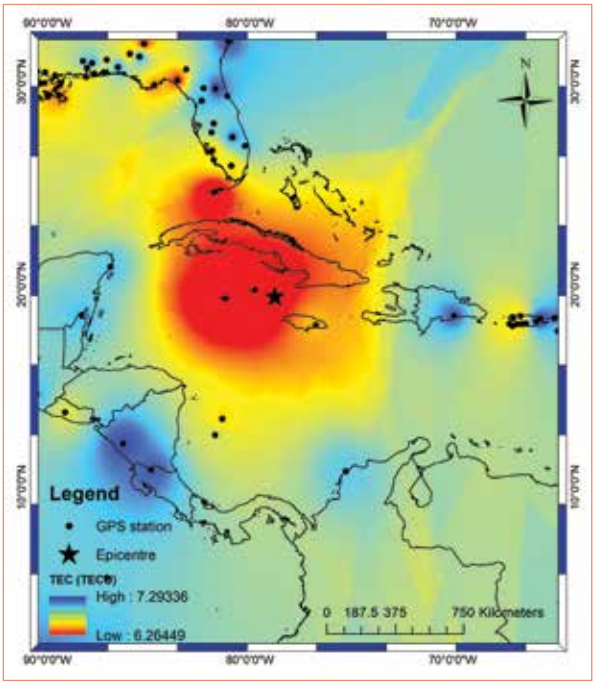
GEOSCIENCES

Geoscience group focuses to cater to the need of the NE Region by utilizing core Geological knowledge in combination with latest Remote sensing technology. It also provides professional training, inputs and support to state departments dealing with Geo-sciences applications, such as mineral exploration, engineering geological survey for tunnels and dams, road alignment, GNSS Surveying and groundwater exploration, etc. Number of research and operational projects in different fields of geological sciences have been successfully executed & completed. It has also completed no. of user specific projects of various state & central government organization. The thrust areas include landslide, environmental hazards, mine mapping, road alignment, active tectonic and crustal deformation, earthquake precursors, SAR interferometry, and thermal image analysis. Some of the works carried out during 2021 -2022 are highlighted in this report.

2-D Ionosphere TEC anomaly before January 28, 2020, Cuba earthquake observed from a network of GPS observations data

Global Positioning System (GPS) observations from 118 Continuously Operating Reference Stations (CORS) were used to study Total Electron Content (TEC) variations in the earth's ionosphere before the occurrence of Mw 7.7 Cuba earthquake on January 28, 2020. The spatial distribution of ionosphere TEC anomaly in 2 dimensions with distance from the observation stations is studied in the present analysis. TEC time series from the nearest observation station suggests anomalies in TEC variations on January 19-20, 2020. At 19.20 UTC on January 19, 2020, a low TEC value was observed at CORS, close to the earthquake epicenter. The epicenter lies approximately 90 km from the centre of the anomaly zone (low TEC). The anomaly zone's size was about 725 km in radius. The study suggests the possibility of observing TEC anomaly zone in the ionosphere a few days before an earthquake occurs.

The study indicated that TEC anomaly zone developed in the ionosphere may have resulted from stress development on the crustal rocks supporting the presence of LAIC mechanism. The analysis also showed that TEC might change due to other unknown sources apart from the seismic origin. Overall the study suggests TEC monitoring with a dense CORS network may help identify the anomaly zone spatially in 2 dimensions before an earthquake occurs. The anomaly zone may coincide with the earthquake epicenter, and hence the techniques may be essential for studying the TEC-earthquake epicenter relationship.



GPS stations and spatial distribution of TEC anomaly on January 19, 2020. The USGS epicenter lies within the anomaly zone on January 19, 2020

DGPS survey of the Mining Lease boundary pillars of the Star Cement Mines, Meghalaya

North Eastern Space Applications Centre (NESAC) with request and financial assistance from Star Cement Ltd. has established Bench Mark (BM) reference point inside the Star Cement premises with initial 72 Hours continuous GPS dual frequency observations. The same BM has

been utilized for surveying of 212 Boundary pillars locations covering seven Mining Lease areas in DGPS mode. All 212 boundary pillars were observed at suitable point on top of the pillar and were marked with red colour post data collection for future reference. The boundary pillars survey was carried out in static mode placing the antenna on a tripod using dual frequency GPS receivers. Vertical height of the antenna was measured from the survey mark to the bottom surface of the antenna housing. Each point was occupied for 2 hours with 30 seconds of sampling intervals.

Time series satellite data covering the study area

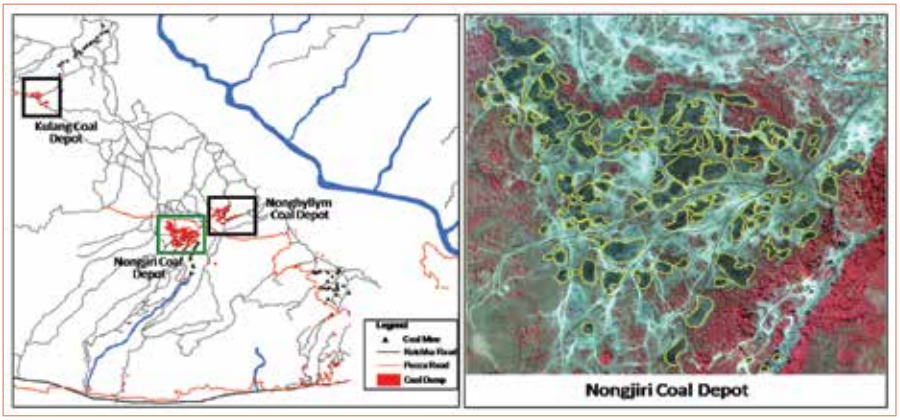
The elevation cut off angle was assigned between 10 -20 degrees depending on site pillar location. Observation data acquired at each boundary pillar was processed with respect to Bench Mark inside the mine premises. The data was processed using double difference (DGPS) techniques to eliminate common errors between Base (bench mark) and Rovers (Boundary pillar locations) observations.

Land cover changes in West Garo Hills and East Khasi Hills

The present pilot study is taken up on request from the Office of the Accountant General (Audit), Meghalaya, Shillong. The study used publicly available satellite data to assess Land cover changes in and around the provided GPS coordinated by AG, Shillong. The data has been analysed and the results were inferred through visual interpretation techniques without field visit/confirmation. First hand visual information on location and temporal changes are provided for West Garo Hills within the supplied coordinates. The area was found to be 79,303 square meters. The changes in land cover within this boundary were analyzed using publicly available satellite data.

Based on the availability, 4 sets of data have been analyzed through visual interpretation techniques. No changes in land cover were observed during October 2016. A small patch of changes were observed in the southern portion of the provided coordinates. A drastic change in the land cover was observed during December 2019 and February 2022 which may be related to mining activity that can be confirmed through field visits. Similar to the case of West Garo Hills, a first-hand visual information on location and temporal changes are provided for East Khasi Hills within the coordinates supplied. Each provided coordinates were joined and a boundary were prepared. The approximate area of the boundary was found to be 28879 square meters. The changes in the land cover were analysed using 4 sets of temporal satellite data. There was no change in land cover observed during April 2014. A linear change in land cover was observed during 2017 which has widened during December 2018 in the southern portion of the boundary. A drastic change in land cover has been observed during December 2021 in the southern portion of the boundary. The extent of land cover changes is observed beyond the boundary line joining coordinates points No. 1 and 4. These changes observed may be the mining activity which may be confirmed through field visits.

Space based inputs for planning and restoration of coal mining affected areas of South West Khasi Hill District, Meghalaya



Coal depot, dump and coal mine areas in part of South West Khasi Hills district

Mining plays an important role in the development of a country, region or state. It is well understood that mining brought wealth and employment opportunities in the area, however, if it is chaotic and unscientific, absence of environmental safety rules and regulations, proper post-mining treatment and management of the mined areas, it may lead to severe environmental problems. With the advent of geospatial technology, identification of areas affected by mining, can be located more accurately. South West Khasi Hill District is one of the coal mining and producing district along with limestone in the state of Meghalaya. The study aims the preparation of various inputs such as road network, dry and perennial streams, springs, coal depots and dumps, land use/ land cover, mini-watershed, suggestion of locations for regular water monitoring, identification of the areas affected by coal mining etc., with limited field survey in the state of Meghalaya. The inputs was prepared using vey high resolution satellite data and this will be utilized by various State and Central government organization in planning and restoration of the affected areas by coal mining.

From the study, it is observed that the activities of coal mining are found only in Ranikor Community and Rural Development Block. Three designated coal depots – Nongjiri, Nonghyllum and Kulang are located in this block. More than 426 coal dumps are observed lying in and around the coal depots and also other parts of the block covering a large area. Around 64 number of coal mines are also found in this block. The total area affected due to coal and limestone mining is approximately 394 hectares.

The role of the Dauki fault in the evolution of the Shillong Plateau

The R&D project is taken up in collaboration with Indian Institute of Science, Education and Research (IISER), Bhopal, with financial support from Science and Engineering Research Board (SERB), New Delhi. It is observed that although Dauki fault is well studied but there is no consensus exists on its structural geometry, origin and evolution. It has been recognized as a normal fault, a strike-slip fault and even as a thrust/reverse fault.

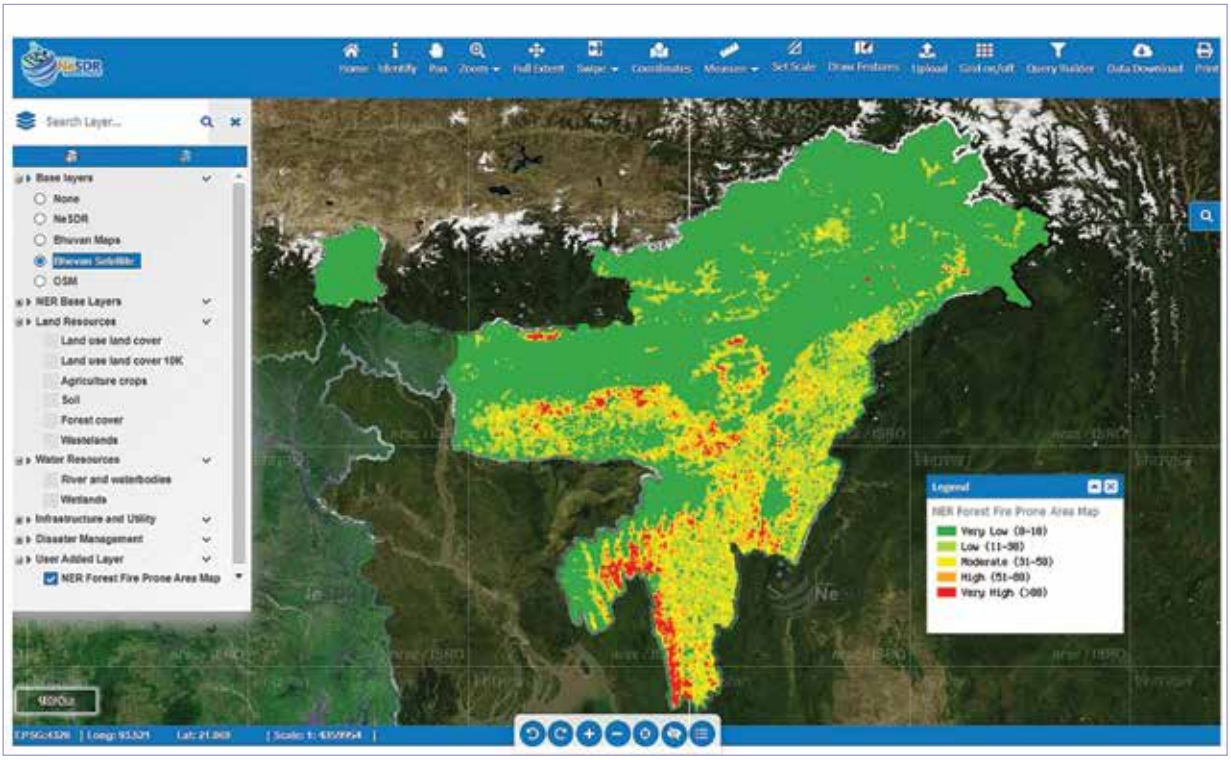
The project has both field and remote sensing (RS) components and NESAC is responsible for RS component. Both optical and SAR images is being used for mapping structural framework and locating geomorphic markers. Exposures of micro/macro folds/faults, unconformity, cross stratification, brecciated fault zones etc. are observed during field visits.

IT & GEOINFORMATICS

IT and GeoInformatics Group is the backbone of the Centre to provide various operational IT and GeoInformatics related services. The group is responsible for establishing high technology infrastructure support to enable NE states to adopt space technology inputs for their development. Following are the major objectives of the group: (1) To provide IT related services by establishing High-end IT infrastructure and also to develop web applications for catering the needs of various users of the centre, (2) To develop and deploy various web applications and spatial decision support systems for Governments Departments in order to enhance their Governance activity, & (3) To conduct advanced Training in the areas of GeoInformatics, Mobile Apps/IoT, Machine Learning/Deep Learning, etc.

North Eastern Spatial Data Repository (NeSDR)

NeSDR is the single window data visualization and sharing gateway pertaining to the North Eastern region of India. Around 1251+ vector datasets under different thematic categories such as land resource, water resource, administrative boundaries, terrain, action plan, infrastructure, weather and climate, utilities, etc. are available in the spatial data repository catalogue. The NeSDR Geoportal is currently being used by a large number of registered users for their needs for geospatial databases for various planning and monitoring activities in the states of NE region. So far, about 35 major departments from different sectors in the region are the primary beneficiaries of the NeSDR database. To sensitize and spread awareness of geospatial data usage in the region, more than 9 training cum workshops have been organized via online/offline modes, and 1500+ personnel have been trained and benefited since the release of the portal in 2020. NeSDR has been becoming popular and effectively used among the numerous user departments of the NE region. The total number of visitors to the portal is more than 3,46,000, with daily average hits of 120+. NeSDR also acts as a perfect hosting platform for various e-governance applications of different users. Around 25 state-of-the-art geospatial Dashboards and Mobile applications are designed and developed in-house based on user requirements.



NeSDR MapViewer showing the forest fire-prone area of NER

NeSDR Analytics for regional level Big Data Analytics

NeSDR Analytics is an indigenously developed powerful geoprocessing platform for performing on-the-fly geospatial big data analytics. The platform has various modules for disseminating the output of research and applications for various thematic areas, such as vegetation monitoring system to monitor vegetation change and disturbances using long-term vegetation index datasets; monitoring air quality using Aerosol optical depth (AOD) products from satellite images; assimilating rainfall from INSAT satellite data; forest fire analytics using night light images; identifying the flood-affected areas using near-real-time flood inundation by performing spatio-temporal analysis on the catalogued images such as temporal statistical analysis and multi-band math operations combined with thresholding operations. An example of on-the-fly geo-operations that can be performed is depicted in the figure.

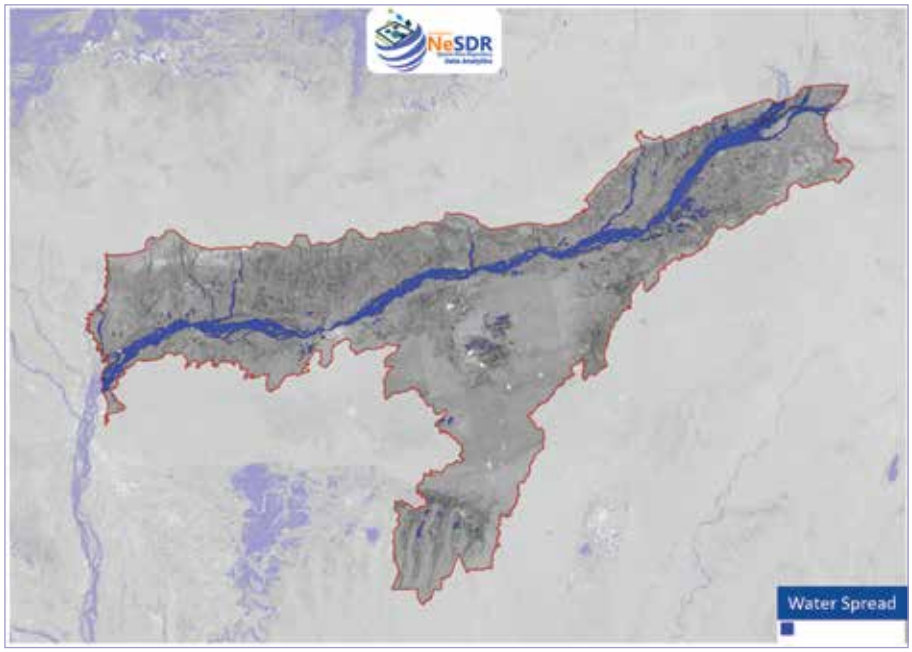
The NeSDR Analytics platform is also catalogued with a collection of widely used geospatial datasets. The bulk of the catalogue comprises Earth-observing remote sensing imagery, including the archive of MODIS and INSAT datasets for the NE region of India and certain cloud-free data scenes of LANDSAT and Sentinel-2. It also includes weather forecasts, land cover data and many other environmental, geophysical and socio-economic datasets. The catalogue is continuously updated with geospatial data from active missions. The repository is made available with 8700+ layers spanning 10 different thematic categories.

Table: Data catalogue available in NeSDR analytics platform

Sl. No.	Data Product	Nos. of products
1	Aerosol Optical Depth	442
2	Evapotranspiration	980
3	INSAT RAIN	2185
4	Land Surface Temperature	1020
5	MODIS FLOOD NRT	2987
6	MODIS NDVI	511
7	NIGHT LIGHT	71
8	SENTINEL	87
9	SOIL Moisture (SMAP)	483
	Total	**8766**

Geo-tagging and geo-monitoring of NEC/MDoNER sponsored project sites

This is one of the unique geo-tagging and monitoring initiatives developed by the Centre with the support of NEC and MDoNER using IT-enabled Geospatial Technology with a lot of innovations towards enhancing the Governance process. The portal is being used to map and monitor 588+ projects spreading across 1664+ locations. This also includes 37 major projects of MDoNER distributed in 90 sites across the NE region. State Remote Sensing Applications Centres (SRSAC) of NER has been engaged in



Waterbody extraction by dynamic thresholding on Sentinel 1 Imagery of May 2022 using NESDR analytics platform

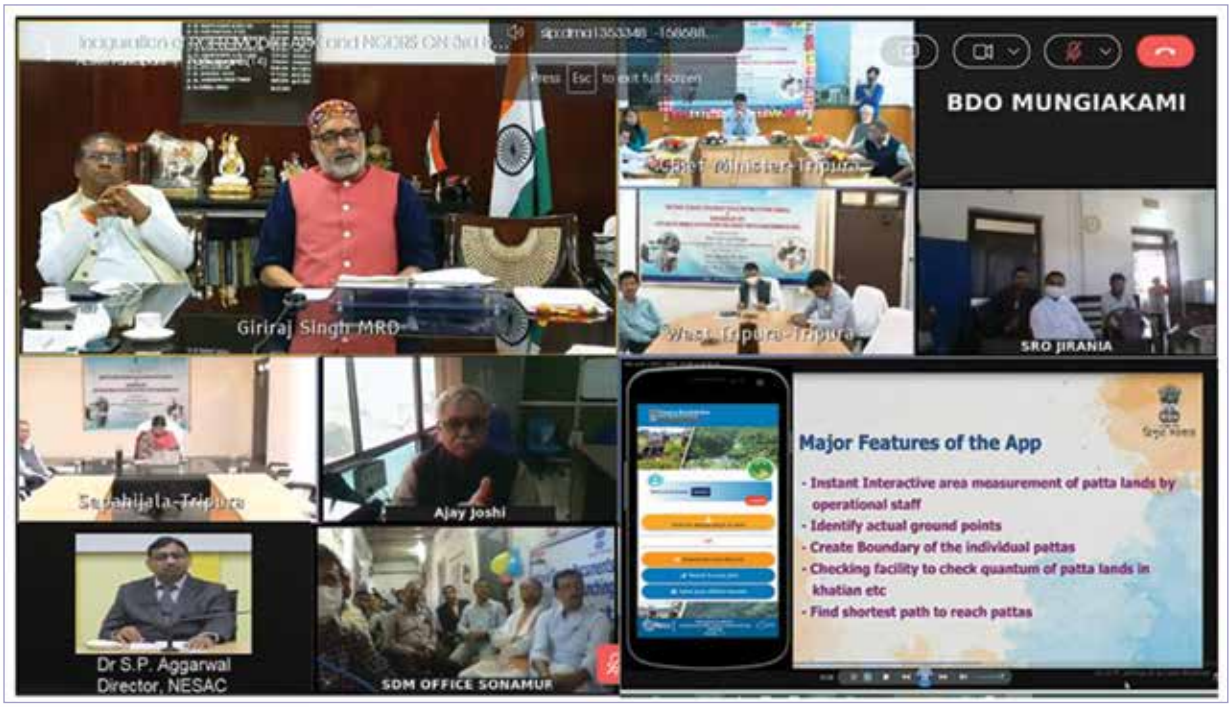
geo-tagging the project sites on the ground. The status of the progress is monitored via three modes – Mobile Apps, satellite imagery and drone images. For medium to large infrastructure-based project sites, satellite and drone images are being used to track their progress. As part of geo-monitoring, 1470 project sites have been integrated with multi-temporal satellite images from different sources to assess the progress. The application was developed in-house using open-source software and standards.

Development of Mobile and Dashboard Application for a geospatial survey of Record of Forest Rights (RoFR) forest pattas in Tripura

NESAC has successfully developed the Tripura Banadhikar App as per the request of Directorate of Land Records and Settlements, Government of Tripura for demarcation of Forest Pattas lands. The Mobile App is integrated with GAGAN/NaVIC technology for enhanced positional accuracy. The app is also expected to help monitor the movements and changes within the forest land allocated to the beneficiaries. The Tripura Banadhikar App can also be used offline (where there is no internet connectivity). It allows users to carry out the land survey with higher positional accuracy, real-time mapping with area measurement and map visualization on top of high-resolution satellite imageries. The App was developed at NESAC using open-source software and standards.

Shri Giriraj Singh, Hon'ble Union Minister of Rural Development & Panchayati Raj, Government of India, New Delhi has launched the app in virtual mode on 3rd December 2021 in the presence of Shri Biplab Kumar Deb, Hon'ble Chief Minister, Government of Tripura and Shri Narendra Chandra Deb Barma, Hon'ble Minister, Revenue & Forest, Government of Tripura, Chief Secretary to the Government of Tripura, Secretary, Revenue Department, Government of Tripura and other dignitaries.

The app is being actively used by 50 field officials for geo-tagging and demarcation of forest patta lands in different districts of Tripura, with a total of 1949 pattas geo-tagged to date.

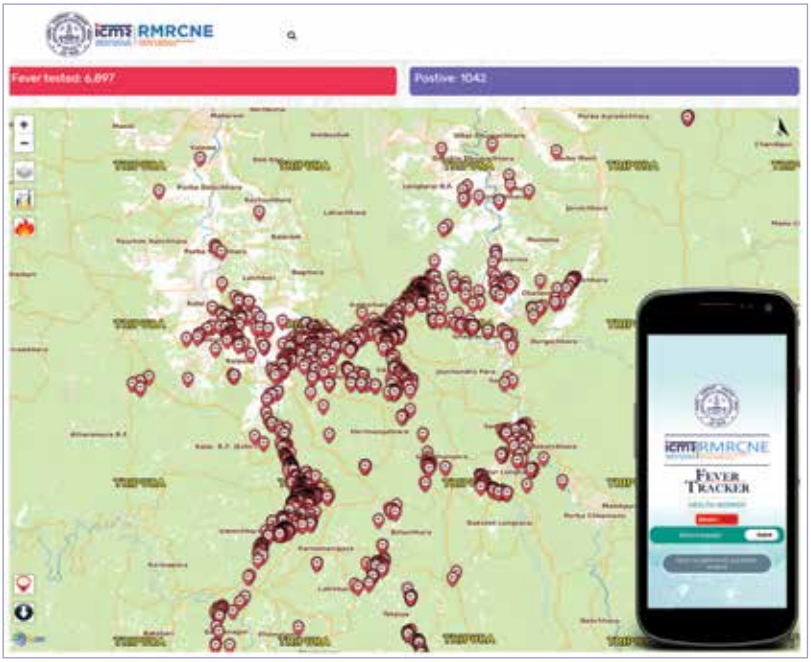


Release of Tripura Ban Adhikar app by Hon'ble Union Minister Shri Giriraj Singh

FeverTracker Mobile App for ICMR

A surveillance system is the foundation for disease prevention and control. Malaria surveillance is crucial for tracking regional

and temporal patterns in disease incidence, assisting in recorded details, timely reporting, and frequency of analysis. NESAC developed an application for ICMR-Regional Medical Research Centre, Dibrugarh for integrated surveillance called FeverTracker, which has been designed to assist the community and health care workers in digital surveillance and thereby contribute toward malaria control and elimination. FeverTracker uses a geographic information system and is linked to a web app with automated data digitization, SMS text messaging, and advisory instructions, allowing immediate notification of individual cases to district and state health authorities in real-time. The use of FeverTracker for malaria surveillance is evident, given the archaic paper-based surveillance tools used currently. The use of the app in 19 tribal villages of the Dhalai district in Tripura, assisted in the surveillance of 1880 suspected malaria patients and confirmed malaria infection in 93.4% (114/122; Plasmodium falciparum), 4.9% (6/122; P vivax), and 1.6% (2/122; P falciparum/P vivax mixed infection) of cases. Digital tools such as FeverTracker will be critical in integrating disease surveillance, and they offer instant data digitization for downstream processing. Using this technology in health care and research will strengthen the ongoing efforts to eliminate malaria. Moreover, FeverTracker provides a modifiable template for deployment in other disease systems. Copyright for the software application has also been obtained under Section 14 of the Copyrights Act, 1957.



Dashboard for visualisation of patient data collected by FeverTracker App

Election eAtlas System for Manipur State Assembly Election 2022

The Election eAtlas System was conceptualized for better planning, monitoring and tracking of electoral processes and assets before and during Poll days. The application was developed based on the requirement defined by the Office of Chief Electoral Officer, Manipur. The system was successfully utilized during Manipur State Assembly Election 2022. The Election eAtlas System comprises four main modules: [a] eAtlas planning Dashboard: Used for overall management and planning of election geospatially. The eAtlas Dashboard has precise geolocations of the entire 2968 Polling Stations of the state-linked with detailed information on voters and polling station facilities along with all essential infrastructure layers such as Police setups, Health Centres, detailed road networks and other vital locations supported by electoral administrative boundary layers for effective pre-planning of election management. [b] The eAtlas Live Dashboard: It allows to capture all data being sent by each 2968 Presiding Officers for their safe arrivals, information on persons in queue, close polls and alerting issues on EVM/VVPATs or any significant incidents. A specialized eAtlas Mobile App was developed these and was given to the Presiding officers. All this information are being alerted in real-time with detailed geotag photos and description at the monitoring dashboard stationed at the office of the Chief Electoral Officer and District Electoral Offices, [c] eAtlas e-Tracker: As per the CEO's requirement, a cost-effective

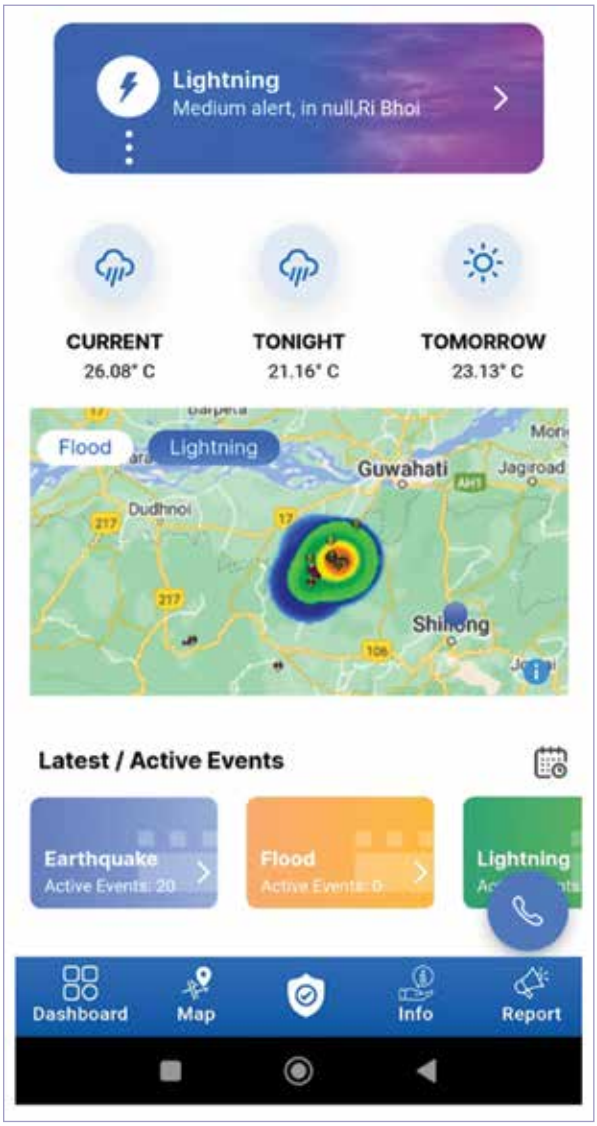
open source GPS tracking solution to track the mobile phone locations of 2043 election officers carrying spare EVM/VVPATs machines were also deployed during election. [d] The VoterFacilitator App: The Citizen-Centric App meant for 80+ and PwD voters extensively to book Wheel Chairs and Postal Ballots. Additionally, this App will allow voters to see average waiting times at every Polling Station, which was updated every 30 minutes.

The eAtlas System was successfully utilized during Phase-I and Phase-II of State Assembly Elections for 60 Assembly Constituencies conducted during 28th February and 5th March of 2022 respectively. Many issues with malfunctioned EVM/VVPATs (142 incidents) were captured and resolved within minutes with the help of eAtlas applications. Major incidents that occurred at a few polling stations were also captured with detailed photographs, and immediate action could be taken by the office of the CEO. For security reasons, application also helped to track all critical election officials, including Presiding Officers and their safe arrivals, etc., who were recorded and alerted on our dashboard. The Application, therefore, helped senior election officials by taking instant action through live alert monitoring.

eAtlas Control and Monitoring Station at Office of Chief Electoral Officer, Manipur

Integrated WebGIS Platform for Dissemination of Real-Time Early Warnings/Alerts and Enabling Analytics in Spatial Domain for Monitoring and Management of Disaster Events

As per the specific requirements of ASDMA, Government of Assam, NESAC has designed and developed an integrated application for dissemination of real-time early warnings & alerts for monitoring and management of disaster events issued by different agencies which are tied-up with ASDMA. It facilitates the dissemination of early warnings issued by the India Meteorological Department (IMD), NESAC, Central Water Commission (CWC) or any other organizations responsible for providing alerts to ASDMA via Mobile Application/SMS. The application is also integrated with time-series data on land use, climate and other relevant information from the publicly available open source web/data services to provide a reference base at a regional scale. The prototype mobile application with Geofencing capability to



Beta version of the Mobile App for dissemination of alerts is ready for release in both android and iOS platforms

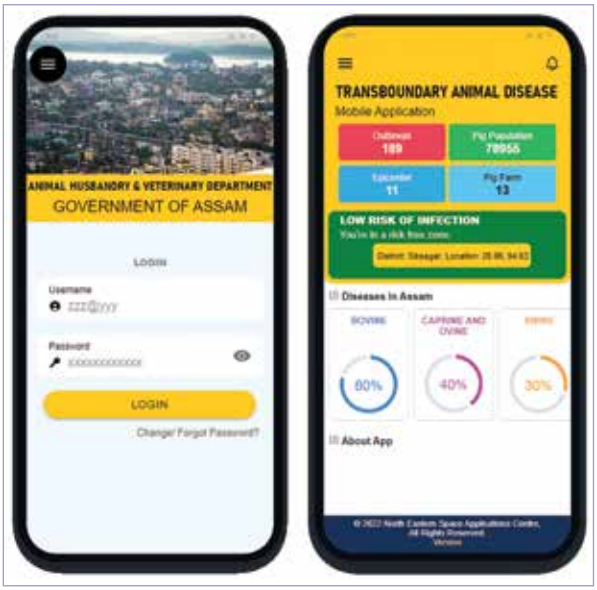
provide real-time information on disseminating alerts/early warnings on floods, lightning, etc., while passing through any disaster risky zones. This can give proximity to the disaster incidents or epicentres from the current location. This enables the application to facilitate the optimal or shortest route by avoiding risky zones during emergencies. The application is coupled with a Dashboard management system which can send alerts to the mobile application, including SMS text messages. AI/DL-based analytical tools for assessment of damage/vulnerability analysis using time-series satellite images (open series) and visualized via on-the-fly analytics to provide real-time reference inputs are also added for enabling quick decision making. The mobile application has been developed both for android and iOS platforms.

Decision Support System (DSS) for Controlling and Monitoring of all Major Transboundary Animal Diseases (TADs) Using Geospatial Analytics and Tools

The project is taken up at the request of the Animal Husbandry Department, Govt of Assam to develop a Decision Support System for controlling and monitoring of African Swine Fever including all other TADs. This work is also a part of PoA of Assam. Initially, NESAC has developed a prototype Dashboard Application with Geospatial Analytics integrated with Mobile Application as per the suggestion of State Innovation & Transformation Aayog (SITA), Government of Assam. On 23rd June 2022, a meeting was held with the Animal Husbandry and Veterinary Department officials, Govt. of Assam, to finalise the requirements framework, scope and workflows. Based on the discussion, around 30 datasets and some core modules were finalized. Some of the datasets include village level economic and livestock Census data ~

- Administrative datasets viz. District, Sub-Division, Block, Circle, Panchayat Ward, Village boundaries
- Datasets pertaining to the Animal Husbandry infrastructure such as livestock holding areas, commercial farm growth areas, breeding farms, hatcheries, feed mills, artificial insemination centres, livestock fodder farms, training institutes, disease diagnostic Labs, Veterinary Hospital / Health Institutions, livestock grazing areas, etc.
- Other relevant remote sensing datasets like climate, land use, rivers, drainage, wetlands, forest areas, road network, etc.

The application will have the following modules: Disease Reporting, Geo-tagging of Risk and Outbreak Zones with Geofencing, Monitoring of Illegal Trade Routes, Search and Navigation, Animal Case History Recording, Trend and Hotspot Analysis, Geospatial Information on Animal Health Centres, Report Generation etc. The requirements gathering, refinement, design and development of the full-fledged dashboard & mobile app are under process.

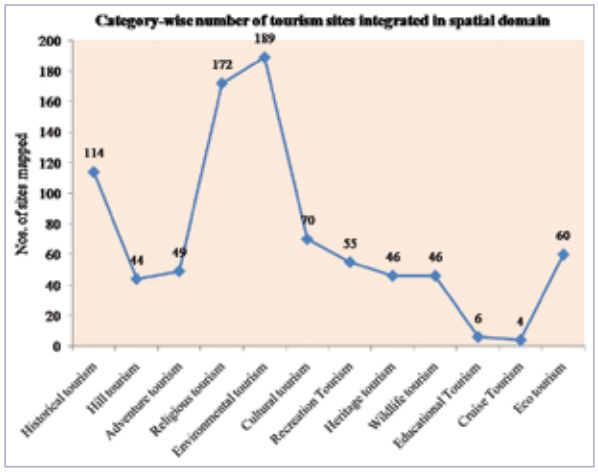


Screenshots from the TAD Mobile App (Under Development)

Development of a GeoTourism Dashboard Application for planning, management and monitoring tourism activity in the NE region

The project aims to promote tourism and other livelihood programmes of NEC/MDONER by developing a GeoTourism Dashboard application using geospatial technology and tools. The GeoTourism Dashboard application will be

networked with the State Tourism State Portals of NE states for effective data flow/transaction within the portals and dashboard applications. Currently, around 863 tourist locations have been geo-located and mapped under 12 different categories for all 8 states of NER. Around 8000+ utility points such as hotels, ATMs and restaurants have also been mapped in the vicinity of tourist locations. The tourism potential index is computed for the state of Meghalaya. Dashboard & mobile app are developed using open source tools and technologies for dynamic visualisation and decision making. Dashboard application also supports the visualisation of 360-degree photos, and integration analytics from social media feeds. 30 tourist circuits have been mapped, encompassing all the NER states.



Category-wise number of tourism sites integrated in spatial domain

Geo-Tagging and Monitoring of Projects/schemes in Meghalaya

Govt of Meghalaya has requested NESAC to develop a project monitoring portal for geo-tagging and monitoring various projects funded by the state Govt. NESAC has developed a prototype dashboard and mobile application for geo-tagging and monitoring of around 73 project locations under 8 sectors of the state Govt. The beta version of the Mobile App is ready for release for operational use.

GIS Based inputs for border fencing in Longding district of Arunachal Pradesh

This is one of the important project requested by Arunachal Pradesh Govt. NESAC has provided geospatial inputs for border fencing of Indo-Myanmar border using multi-criteria analysis in GIS. Three parameters such as (i) Protection from natural elevation and terrain parameters, (ii) border proximity to settlements and (iii) border proximity to connectivity from roads have been used for generation of vulnerability index. Areas of high, medium and low vulnerability were determined based on integrating opportunities from Settlement, Road and Terrain into a single unified vulnerability index by implementing the weighted overlay analysis. Out of the total 33.36 km, 7.5 km of the border was identified under the high vulnerability section, 12.6 kms is identified under medium vulnerability and 13.26 km is identified under low vulnerability.

Utilization of Artificial Intelligence/ Machine Learning/Deep Learning Techniques

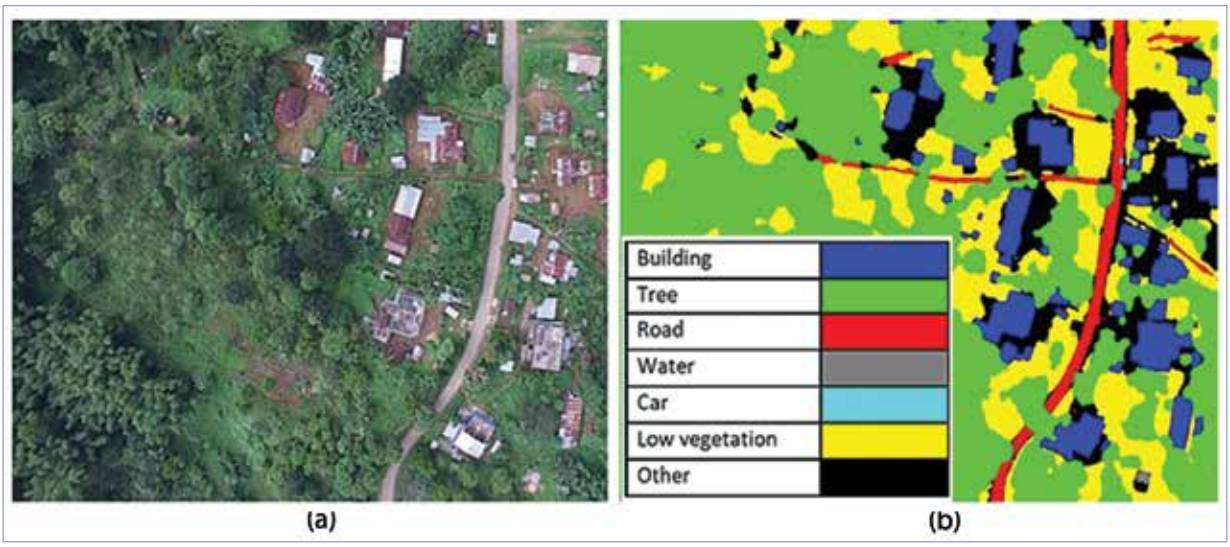
NESAC is utilizing various AI/ML/DL algorithms and tools for near real-time predictive analysis, feature extraction and pattern recognition under Technology Development Projects (TDPs) and R&D activities. The following section illustrates the nine major application-oriented techniques developed by the centre:

i) **Deep Learning model development for semantic segmentation of aerial and satellite imagery:** Semantic segmentation is an important vision task in remote sensing image analysis. It requires the classification of each pixel to predefined labels automatically. Huge efforts are being made toward the learning of neural network architecture developed for this task with the desired level of accuracy. High-resolution benchmark datasets shared by the International Society for Photogrammetry and Remote Sensing (ISPRS), Sentinel-2, Landsat-8, and our UAV images are utilized for this work. A total of two new novel DL models named ACNet and HybridNet are developed for different types of object segmentation tasks. Presently the developed models can segment

water bodies from optical images more efficiently than the traditional indices-based approaches. UAV models can automatically segment multiple class features (road, water, tree, low vegetation, car, other) on any new RGB drone images. Efforts are also being made toward the development of QGIS plugin tools for the operationalization of these models for the larger benefits.

ii) **Development of deep learning-based change detection system for remotely sensed data:** This work has been initiated as a TDP to develop deep learning-based change detection models. The datasets utilized are a combination of Sentinel-2, high-resolution Google imagery, aerial images, etc. International benchmark datasets are utilized for the development and validation of our results. Total 2 new novel models are developed. The proposed DRMNet model has achieved state-of-the-art results on 6 benchmarks datasets. Presently, models utilize visible bands of the data for identification of the changes. The model can identify changes in buildings, trees, roads, etc effectively without any human intervention. Further improvement in the models with the inclusion of additional bands and additional data with better hyperparameter tuning is under progress.

iii) **Development of deep learning-based automatic water mapping model for multispectral and SAR images:** The work has been initiated as part of R&D activity using DL technology. The datasets used in this work are multitemporal Sentinel-2 and Landsat-8 images for the multispectral model and Sentinel-1 images for the SAR model. For the multispectral model, the proposed model DWENet trained with 1.2 TB of data and was able to precisely identify and extract water bodies better than the indices-based (NDWI/ MNDWI/AWEI) approach. The proposed model can work in various areas of interest of the region and is able to distinguish the confusing objects of shadow and cloud from the water. QGIS tools development is underway for the distribution of this model as a plugin. As a pilot study, SAR based deep learning model is also developed for automatic mapping of inundated areas for a small region of Assam.



(a) The input UAV image is of 4000x3000 pixels with a GSD of 5cm/pixel and (b) Segmentation map produced for UAV image of village area of Nongpoh region Meghalaya

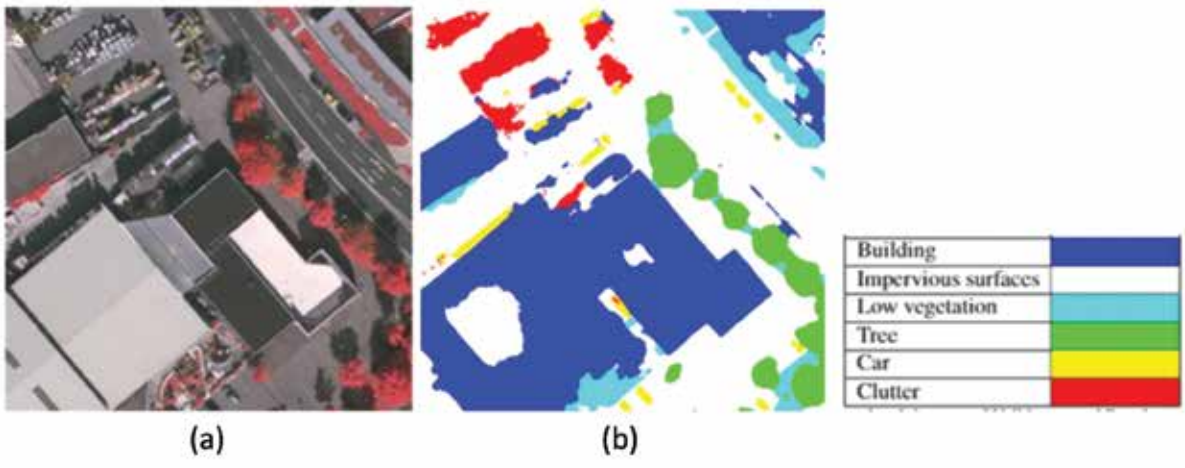
iv) **Deep learning-based automatic building footprint extraction:** As a pilot study, this study is taken up to showcase the efficacy of the developed deep learning model to extract building features for large UAV ortho-mosaics. The ground truth data with 20K annotations for building instances are aggregated for generation of training samples. The model is trained on training

samples of 50K sample patches of size 256 x256 pixels. The major challenge of identification of building footprint in a highly dense urban area is resolved using the development of a convolutional and recurrent neural network-based enhancement module within the proposed network. For independent testing, two unseen study areas (Shillong area and Garo Hills area of drone images) are taken up and the model is fine-tuned to extract the building footprint features. Presently RGB bands are used in the model.

v) **Development of real-time object detection algorithms for UAV videos:** This activity is taken up as a TDP project to develop the real-time surveillance capability within the centre. The already existing deep learning for object detection models is analyzed and finally, a fine-tuned model is developed specifically for handling the real-time UAV videos. The proposed model contains convolutional layers to handle the spatial relation of features and temporal layers (Recurrent Neural Layer, Long Short Term Memory, Gated Rectified Unit). The temporal layer was used to identify and retain the frame-wise object relation which is very important in video-based object detection models. This model is tested on various scenarios for precisely object annotation for humans, cars, bicycles and other objects instantaneously.

Real-time object annotations generated on real-time UAV video feeds of Police Bazar Shillong

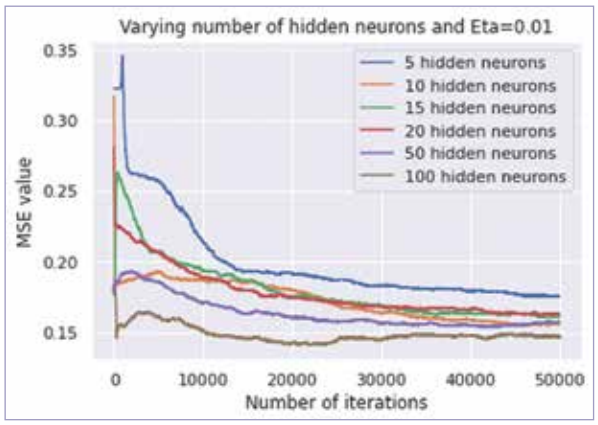
vi) **Development of neural architecture search (NAS) for generation of a deep learning algorithm:** This work is initiated as a TDP, with extensive efforts toward understanding the complex system of NAS. The major challenge in this work is to reduce the search space and come up with human-level architecture. For minimization of search space, the basic components in the search block are predefined, and connections among the components are trained dynamically. Advanced hyperparameter searches are also utilized for better fine-tuning. Two basic vision tasks of classification and semantic segmentation are being selected for NAS development. An initial-based run is completed with a reinforcement learning-



(a) Input ISPRS benchmark aerial dataset and (b)initial results of segmentation map generated by NAS model and colour used

based controller for the model run. Further flow is enhanced with the implementation of evolutionary and proxy-less NAS.

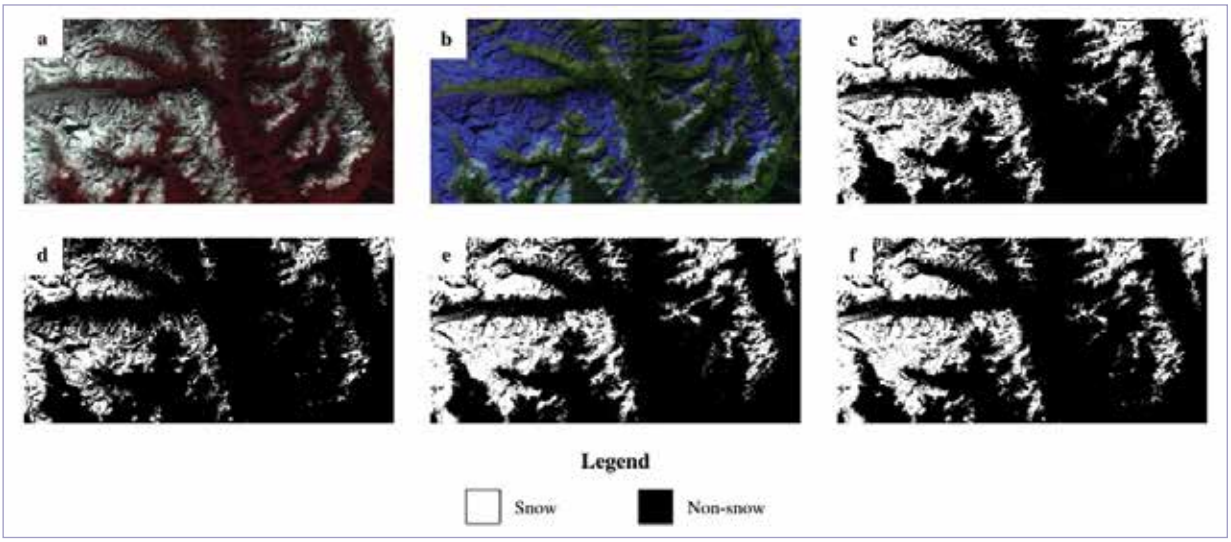
vii) **Predicting Rainfall using Evolutionary Computing and Neural Networks:** The study is taken up as part of TDP to propose suitable neural network architecture for rainfall prediction for a set of lead times. Identifying suitable neural network architectures from an ensemble is faced with severe computational constraints as each model requires several iterations of back propagation-based training before operational use. Hence, it is proposed an alternative to backpropagation to identify suitable neural architectures using evolutionary computing techniques such as genetic algorithms, particle swarm optimization, and evolutionary strategies. The suitable model (assessed separately for reanalysis and satellite observation and for varying lead times) can then be used with a combination of evolutionary computing and backpropagation to yield the predictive models. This is useful to understand the utility of NN-based models for varying lead times and computational efficiency for both approaches.



Representation of training curve (mean squared error) for varying number of neurons in a neural network

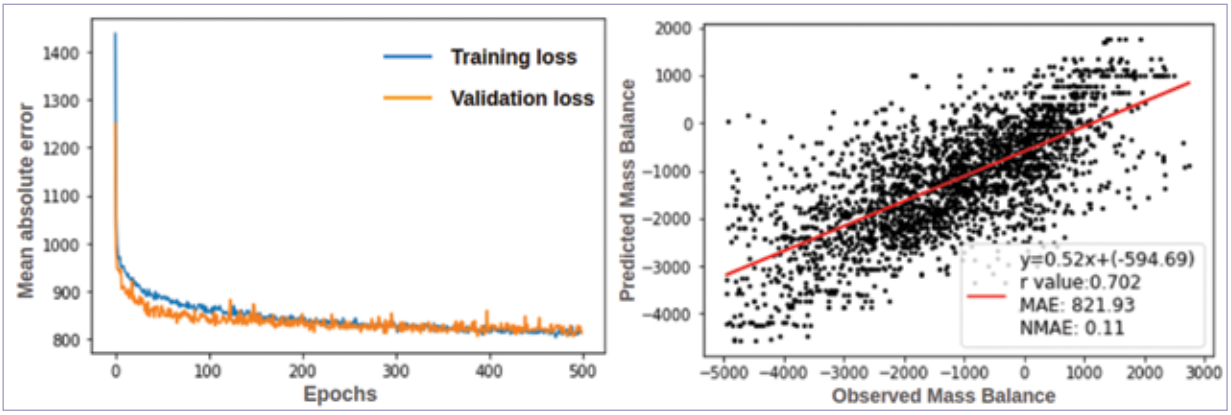
viii) **Development of a machine learning-driven snowmelt estimation model:** The objective of this TDP project is to develop a machine learning-driven snowmelt estimation model. It is tried to assess snow melt at varying lead times using deep learning. The datasets of ERA5-Land and for the meteorological and topographic variables of elevation, albedo, temperature, insolation and accumulated snowfall are used. The target snowmelt values are estimated using a degree day factor method. The meteorological data of time = (t-i) is explored to predict the snowmelt at time=t. Here, i is varied from 1 to 6 to understand the capabilities of deep learning to predict the data for increasing time steps. A snow mask was developed using machine learning to apply over the estimated snowmelt. The results of this are depicted pictographically. Finally, two broad categories of architecture are being developed for snowmelt estimation: artificial neural networks and recurrent neural networks.

ix) **Point Mass Balance Regression using machine learning:** Glacier evolution modelling is important to understand the impact on climate change on the water resources available. The last few years have seen increasing studies on modelling glacier evolution using artificial neural networks (ANN) that can provide a regressed mass balance value using topographic and meteorological input features. A large number of parameters in an ANN demand a large dataset for training the parameter values. This is relatively difficult to achieve for regions with a sparse in-situ data measurement set-up, such as the Himalayas. For example, of the 14326 point mass balance measurements obtained from the fluctuations of glaciers database from the years, 1950-2020 for glaciers between 60S and 60N, a mere 362 points over four glaciers exist for the Himalayan region. These are insufficient to train complex neural network architectures over the region. We attempt to overcome this data hurdle by (a) using transfer learning and (b) using less complex nonlinear algorithms such as random forest, support vector machine, etc. Here, the parameters are first



(a) False colour composite depicting snow-covered regions of Sikkim. (b) False colour to emphasise snowfall. (c) Classification and regression tree snow cover map (d) Support Vector Machine snow cover map (e) Gradient boosted trees snow cover map (f) Random Forest snow cover map

trained over the 9584 points in the Alps, following which the weights were used for retraining for the Himalayan data points. Fourteen meteorological variables from the ERA5-Land monthly averaged reanalysis data were used as input features for the study. Our method is also compared with other machine learning algorithms such as random forest-based regression and support vector-based regression, and we observe that the complexity of the dataset is better represented by the transfer learnt neural network architecture. With an overall normalized root mean squared loss consistently less than 0.09, our results suggest the capability of deep learning to fill the temporal data gaps over the glaciers and potentially reduce the spatial gap on a regional scale.



(left) Training characteristics of neural network for larger datasets and (right) Scatter plot of predicted and observed values for the best performing machine learning model

DISASTER MANAGEMENT SUPPORT ACTIVITIES – NER-DRR

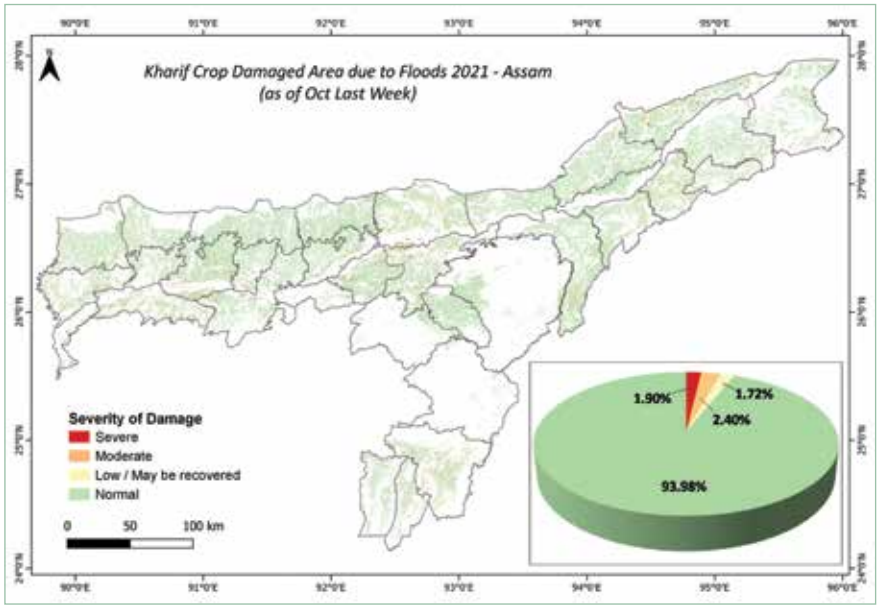
NESAC has been providing all possible space based support for management of disasters in NER of India by building a comprehensive geospatial database, developing decision support tools, actionable products and services for disaster risk reduction under the North Eastern Regional Node for Disaster Risk Reduction (NER-DRR) programme. During the last year, NESAC worked on various disaster related activities which are briefly described below:

Crop Damage Assessment and Monitoring Service (CropDAMS)

Every year, NER region suffers huge crop losses in terms of thousands of hectares due to several factors related to natural calamities. Availability of reliable and timely information on crop damages is of utmost necessity for planning and policy making. The main objective of CropDAMS is to provide near real-time information on the crop damages due to the floods, bank line erosion, drought, disease and pest and other factors.

Floods: Floods have been recognized as one of the significant natural hazards encountered almost every year in several parts of the North-Eastern states: most often around the monsoon season resulting in huge loss of Kharif crops. In 2021, the floods have been reported since the first week of June to till first week of September, affecting lakhs of people at many districts in Assam. The floodwaters from the Brahmaputra river and its tributaries inundated thousands of hectares of agricultural land in the flood-hit districts.

Flood severity towards Kharif crop area damage assessment was done for Assam at District and Revenue Circle level for the year 2021. For this, crop phenological changes and damages has been observed using Sentinel 1A SAR data at 12 days interval from the middle of June to first fortnight of December (Kharif season). In Assam, Kharif rice transplanting starts from mid June to mid July every year. Mapping of Kharif rice transplanting dates was done using the Sentinel 1A for the entire state of Assam and crop area damage assessment was done based on the inundation status as of October last week. A detailed report was submitted to the ASDMA for their planning purposes, also published in the NER-DRR web portal (https://nerdrr.gov.in/). Damaged areas were categorized into: severe, moderate and low. Crop areas not affected by floods are categorized as normal. In 2021 Kharif season, 41,963.40 ha (1.90 % of total Kharif crop area) of crop area were damaged due to floods considering only the Severe category, whereas moderate and low severity areas (90,773 ha) normally recovers later.



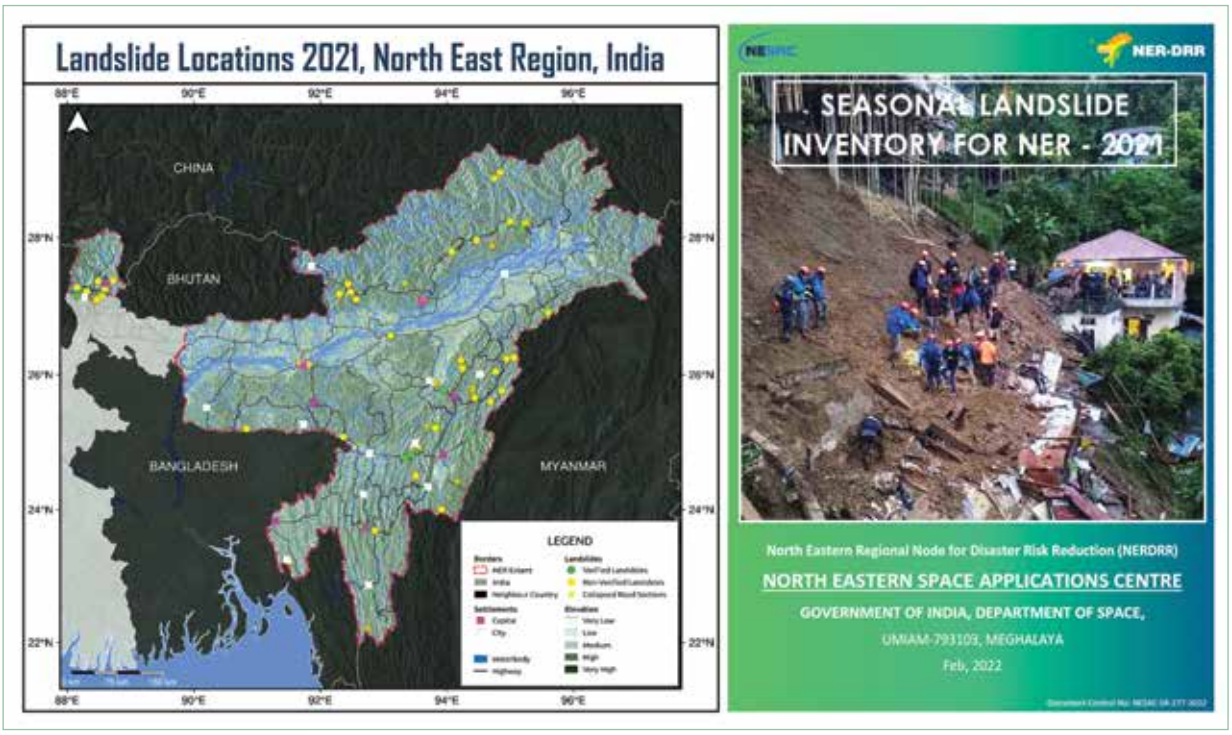
Kharif Crop Area Damage Assessment due to floods 2021 – Assam

Agricultural Drought: In India, the frequency of drought occurrence varies from 2 to 3 years in the western states (Rajasthan, Gujarat) to once in 15 years in north east states (Assam and Meghalaya). North East India receives heavy

rainfall during the monsoon months (June-September), which replenishes the rivers every year. Over the years, there have been deficient of rainfall and a significant increase in frequency of agricultural drought and their spatial extent in NER region. Especially, the number of monsoon rainfall deficit years has increased in the past two decades. In 2021, several states in the North East were suffering from high deficit of rainfall. Manipur had the highest deficit; with 60 per cent less rainfall than normal from June to September whereas Assam had 22 per cent less rainfall during that period (IMD reports). Agricultural drought demotes to a condition when soil moisture is no longer sufficient to meet the needs of growing crops in the field. Careful monitoring of signs of drought and early warning are important in successful management of the catastrophe. Seasonal agricultural drought hazard mapping has been initiated for the NER using time series geospatial data from different sources; Rabi seasonal drought hazard mapping has been done for the NER using 20 years data from 2000 to 2020 and it was classified into very high, high, medium and low hazard. It was found that 6.19 per cent of NER's Rabi crop area falls within the very high drought hazard area.

Seasonal Landslide Inventory 2021

This is an ongoing activity under NERDRR programme of NESAC, Umiam. This is basically a compendium of all reported landslide incidents that have occurred in the NER during 2021. The primary sources contributing to the inventory are Newspapers and online media reports. A total of 75 landslide incidents have been documented for the different states of NER for the year 2021, majority of which have been triggered by rainfall. Further, a total of 21 casualties have been reported out of which 3 are from Arunachal Pradesh, 2 are from Assam, 3 from Manipur, 6 from each Mizoram and Sikkim and 1 is from Tripura. In addition, collapse of road-sections along National/State Highways is also reported from most of the NER states except Tripura. Wherever possible, these locations are verified in terms of precise latitude and longitude, either through field survey, photographs and/or post-dated satellite imagery. Based on the precision of geolocations, the landslide events in the inventory are grouped into three categories - TYPE 1: events for which precise latitude/ longitude information is available; TYPE 2: landslides whose locations are referred to nearby locality/village/settlement names as reported

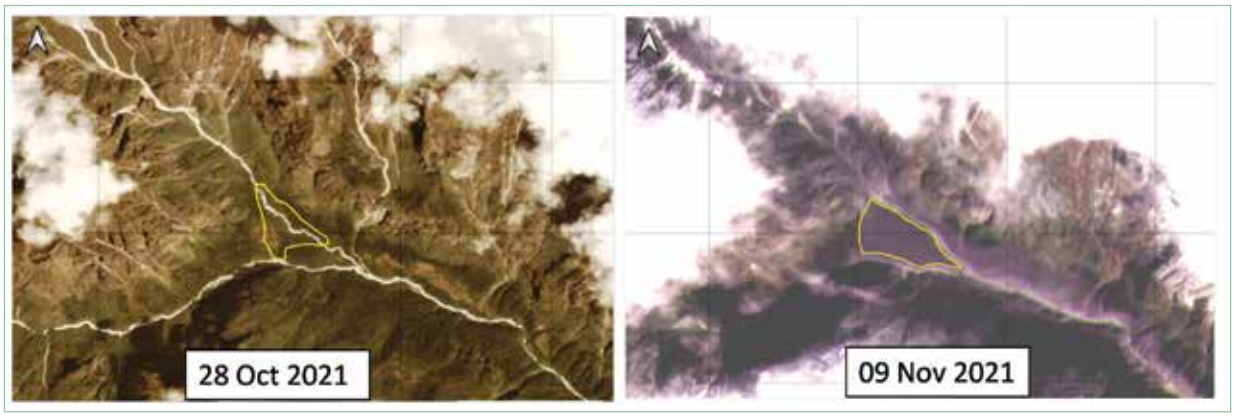


Seasonal Landslide Inventory for NER 2021

in newspaper; TYPE 3: The road-sections along National/State Highways affected by landslides. The inventory database also provides information on the amount of rainfall that has occurred 24 hours prior to each landslide events. Rainfall information is derived from the Global Precipitation Measurement (GPM) IMERG Final Run V6 product. All these information can be accessed at the NERDRR website (https://www.nerdrr.gov.in/).

Event of Debris accumulation in Kameng River

On 29th October 2021, several news agencies reported the incidence of Kameng River water turning black in Arunachal Pradesh and resulting in deaths of hundreds of fishes overnight. The following remote sensing based observations are carried out on request from Govt of Arunachal Pradesh for quick assessment of the situation. Prior to the event on 13th October 2021 only a micro seismic activity of 3.1 magnitude is recorded in the vicinity. Analysis of the pre and post event PlanetScope Dove satellite images of 3m resolution revealed the following with regards to the Warriyang-Bung river, a tributary of the Kameng River: 1) Significant widening of the channel with muddy sediment-laden water flowing in it; 2) Debris accumulation of about 16.90 hectares; 3) Change in the river course, with eastward shift of the river channel of about 100m. Further investigation revealed complete loss in snow-cover in the mountain flank above Glacier ID: G092671E27916N. Probable change in temperature pattern was also investigated using MODIS LST 1km product and temperature variation of 1.922° C above normal was observed mainly for the period between 10-20th October 2021. Furthermore the aforementioned debris accumulation occurred just 1.8 km downstream of the glacier.



Debris Accumulation in Warriyang Bung river

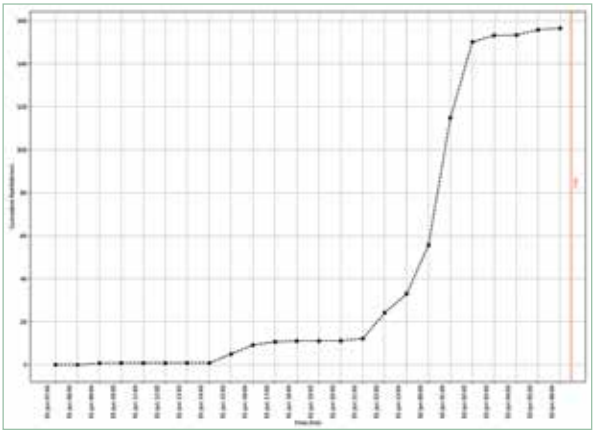
Change in course of Warriyang Bung river

Calculation of rainfall threshold triggering landslides in parts of Barak Valley

On 2nd June 2020, series of landslides have occurred in various parts of Barak Valley, Assam leading to total 21 casualties. Critical Rainfall Intensity - Duration calculations were performed for few landslides that have triggered

in Kanakpur, Chandipur Grant and Mohanpur Grant areas. In absence of well distributed AWS/ ARG, calculation of rainfall parameter was done using the Global Precipitation Measurement (GPM) IMERG Final Run V6 product to assess the applicability in calculation of rainfall-threshold. The study area falls under Low to Very low landslide susceptibility classes. The affected areas are parts of low undulating landforms, characterized by low to moderately dissected denudational hills. 15 Days antecedent and 24 hrs critical Rainfall/Duration plot showing critical duration for Chandipur Grant landslide is shown in the figure.

The predisposing factor of the landslide is found to be antecedent rainfall that has significantly affected the slope 5-6 days prior to the event, where rock type is basically weathered sequence of sandstone and shale belonging to Tertiary formations.



Critical rainfall vs Duration plot for Chandipur Grant landslide

Assessment and monitoring of embankment breach locations under FLEWS in Assam (2021-2022)

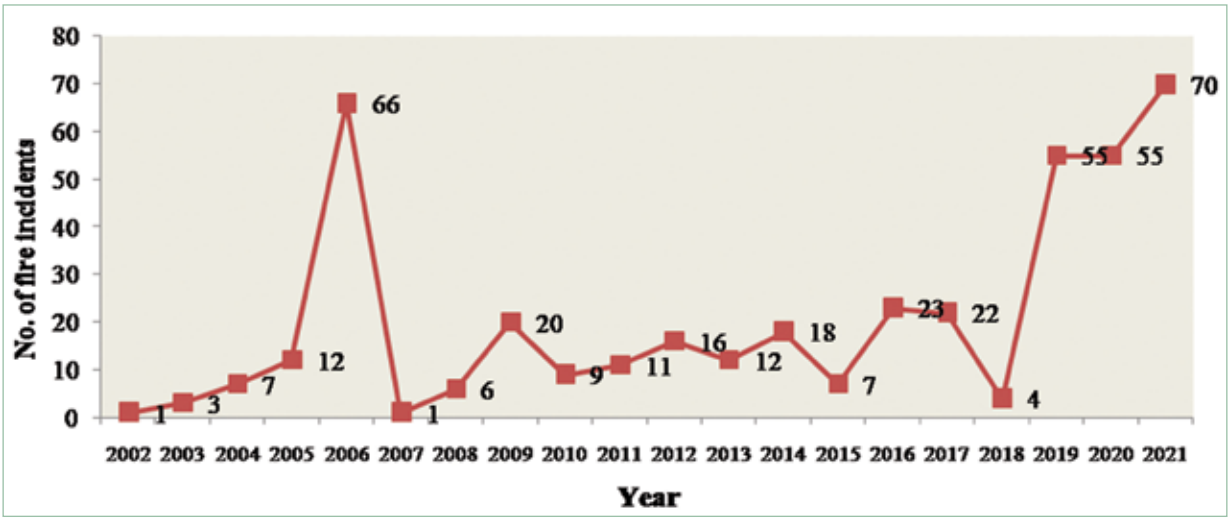
River embankments are also known under various nomenclatures as Levees, Dykes, etc. They are essentially structural flood control measures constructed along the river banks. As a part of the FLEWS programme, NESAC has taken up an exercise of mapping the existing embankments in major flood prone districts of Assam and also to identify breach points using temporal satellite data in various locations of river embankments, after every flood events and relook the breach locations prior to the onset of monsoon on an operational basis. Post-flood Sentinel-1 data were acquired for the year 2021 to identify the embankment breaches due to the floods. Using Sentinel-1 SAR data, 4 breach locations were identified in 4 districts of Assam.

An attempt has also been made to evaluate the embankment breaches using Planet Lab archive data acquired during the month of January to April 2021 and the status of plugged or unplugged breaches have been evaluated. 4 numbers of breach locations that were identified using sentinel-1 data are relooked for monitoring its status and it is found to be pluged.

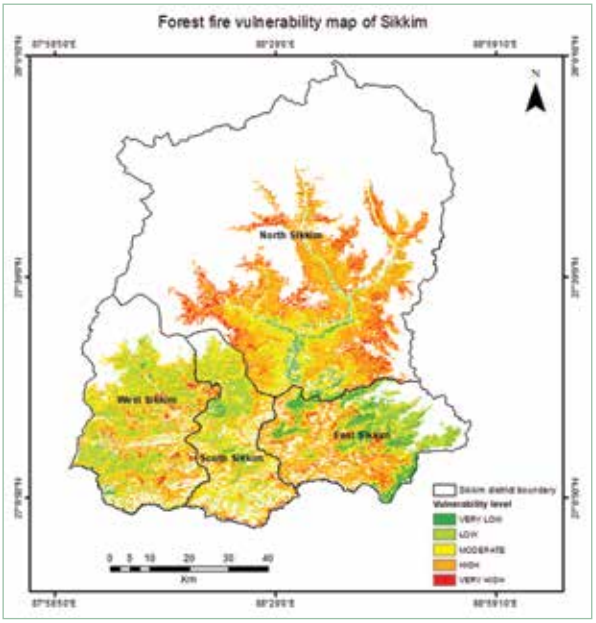
Forest fire case study from Sikkim

Sikkim is located in the northeastern part of the country, in the eastern Himalayas. It is one of the smallest states in India. Total geographical area of Sikkim is 7,096 km^2. The state has tremendous biodiversity and has been identified as one of the Hotspots in the Eastern Himalayas. Forest is the richest natural resources of Sikkim. According to the India State Forest Report 2021, the total forest cover including very dense, moderate dense and open forest category accounts for 47.08% of geographical area. Rhododendrons and Orchids are the major attractions of Sikkim forests. Both plant and animal that characterize the biogeographical regions is unique and unparallel. But forest fires in the region are leading to ecosystem vulnerability threatening forest diversity. The distribution of forest fire incidents from 2002 to 2021 and the annual variation of the fire incidents is shown in the figure.

A forest fire vulnerability map using topography, forests characteristics and proximity analysis has been generated for Sikkim. The vulnerability map has majority area (1561.69 sq. km) under moderate vulnerability class followed by High (895.28 sq. km) and low (841.17 sq. km) category. The vulnerability classes of very high and very low have 50.43 sq. km and 21.07 sq. km area respectively.



Number of forest fire incidents in Sikkim from 2002 to 2021



Forest fire vulnerability map of Sikkim

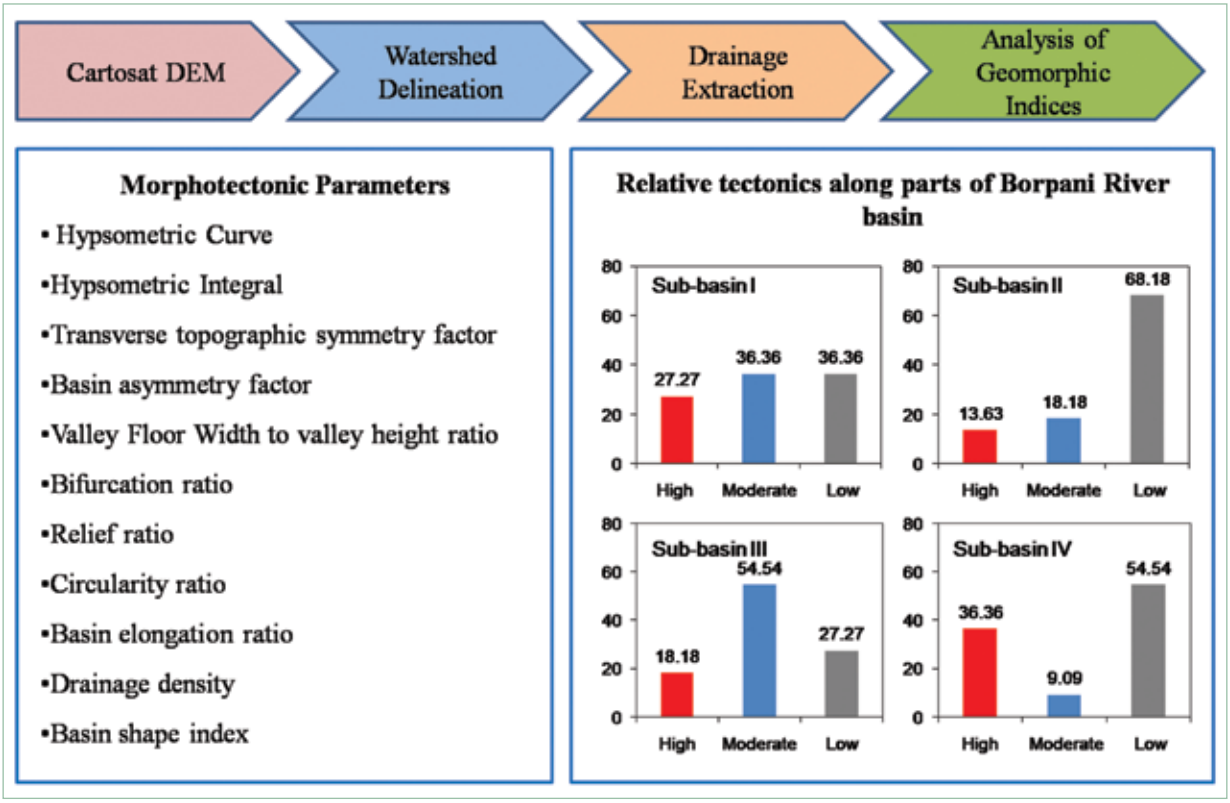
Assessment of the geomorphic indices for relative tectonics study

Digital morphometric, with the aid of satellite images, give a quick assessment of the area for tectonics. Geomorphic indices related to tectonics was studied along the Borpani River using Cartosat 10 m spatial resolution Digital Elevation Model (DEM) data. A total of 11 geomorphic indices such as transverse topographic symmetry factor (Tt), drainage basin asymmetry (AF), valley floor width to valley height ratio (Vf), bifurcation ratio (Rb), hypsometric integral (HI), basin elongation ratio (Re), basin shape index (Bs), circularity ratio (Rc), drainage density (Dd), relief ratio (Rh), hypsometric curves (HC) were studied to access the tectonics along the river in selected locations. Five locations along the river were selected for detailed analysis (sub-basin I, II a, II b, III, and IV). Horton's (1945) scheme was adopted for watershed delineation, while stream ordering was performed using Strahler's (1964) method. The results infer that the sub-basins along the Borpani River are tectonically active. In the case of sub-basin I, 3 geomorphic indices out of 11 falls in the category of highly active, and 2, 1, 2, and 4 indices out of 11 falls in the category of highly active in the case of sub-basins II a, II b, III, and IV. Similarly, 4, 1, 3, 6, 1 and 4, 8, 7, 3, 6 indices fall under moderately active and low active classes in sub-basins I, II a, II b, III, and IV. On average, 23.86%, 29.54%, and 46.58% of the geomorphic indices fall in the active, moderately active, and low active classes.

Crustal Deformation analysis for NER Region (R&D)

For a period of 5 years (2013-2017) GPS data from 4 Continuously Operating Reference Station (CORS) and 10 International GNSS Service (IGS) stations was analyzed for the sub-region of NER, covering the entire eastern zone of the Meghalaya Plateau, and extending beyond Dawki till Tripura in the South.

From north to south, the four CORS were setup at Khanapara (KPRA), Mawtawar (MTWR), Sohra (CRPJ) in Meghalaya and Mohanpur (MPUR) in



Methodology adopted, parameter used and percentage of geomorphic indices falling in highly active, moderately active and low active classes in each basin along Borpani River.

Tripura. Post processing of the GPS data was done using the GAMIT-GLOBK (10.71) suite of software developed by Massachusetts Institute of Technology to obtain precise position and velocity solutions. The position and velocity solutions obtained for region are shown in Figure. Calculation of linear strain and convergence was carried out by calculating yearly change in the baseline lengths between GPS Stations. With the addition of one more GPS Station (HGAT) from a contemporary study, regional strain estimation was also carried out by creating delaunay triangles. Translation (magnitude and components), Rotation (magnitude and direction), Minimum and Maximum Horizontal Extension, Shear Strain, and Area Strain were also calculated for the created triangles.

NERDRR Geoportal

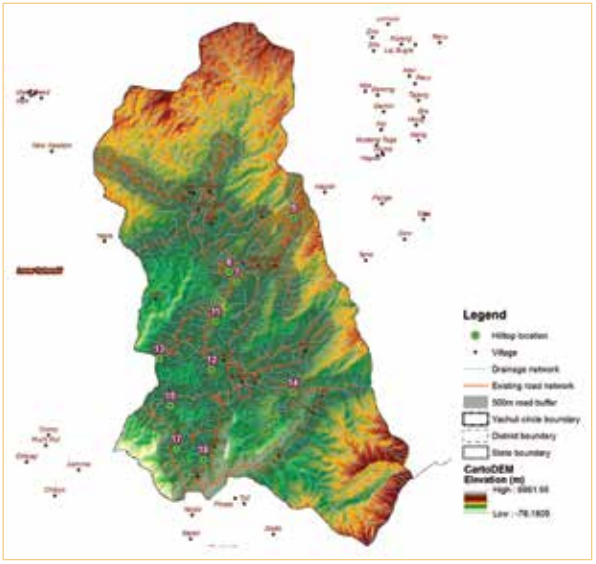
A comprehensive geoportal gateway for delivering data and application services for disaster risk reduction in NER has been made operational at https://www.nerdrr.gov.in. The geoportal is a single window platform that stores and delivers all information and spatial decision support tools with special emphasis to flood, landslides, forest fire, thunderstorm, industrial hazards, earthquake precursors, etc. The portal has a complete geospatial database for different vulnerable areas in the region. The portal has a domain specific customized dashboard for multi alert dissemination and warning system with dynamic maps, disaster monitoring and statistical analysis and interactive visual analysis and information retrieval. Currently, the portal has systematic detailed information on selected disaster domains such as on Crop Damage assessment, Earthquakes Alerts, Epidemological Disasters, Flood Early Warnings, Forest Fire Alerts, Hazard Vulnerability Assessment, Industrial Hazard Landslide, Meteorological Services, Satellite Communication for Disaster management etc.

PHOTOGRAMMETRY & UAV APPLICATIONS

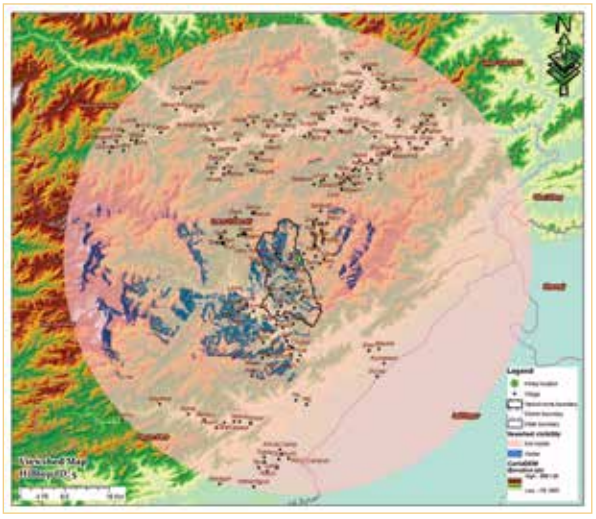
Site suitability analysis using geospatial technique for air traffic control in Yachuli near Ziro

Geographic Information System (GIS) are now recognized broadly as a valuable tool for managing, analyzing and displaying large set of data relevant to many local and regional planning and analyzing activities. The complex nature of Airport Traffic Control site suitability issues can be addressed using GIS tools. Air traffic control (ATC) is a service provided by ground-based air traffic controllers who direct aircraft on the ground and through controlled airspace, and can provide advisory services to aircraft in non-controlled airspace. The primary purpose of ATC worldwide is to prevent collisions, organize and expedite the flow of air traffic, and provide information and other support for pilots. In some countries, ATC plays a security or defensive role, or is operated by the military. Air traffic controllers monitor the location of aircraft in their assigned airspace by radar and communicate with the pilots by radio.

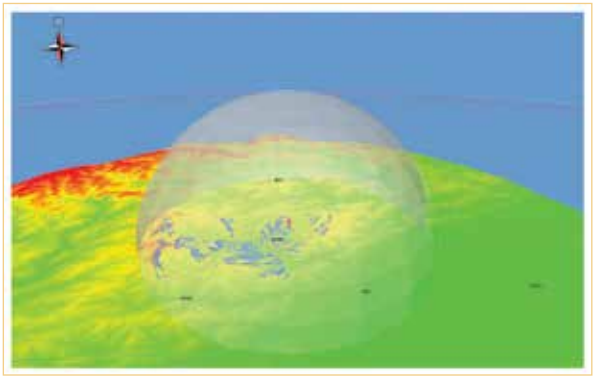
This work has been carried out for the Government of Arunachal Pradesh. The primary objective of the work is to suggest suitable sites for setting up air traffic control (ATC) considering factors that can affect to the ATC location in and around Yachuli near Ziro in Arunachal Pradesh of North East India.



Locations of suitable hilltops for ATC



Viewshed map for hilltop



3-dimensional view of viewshed

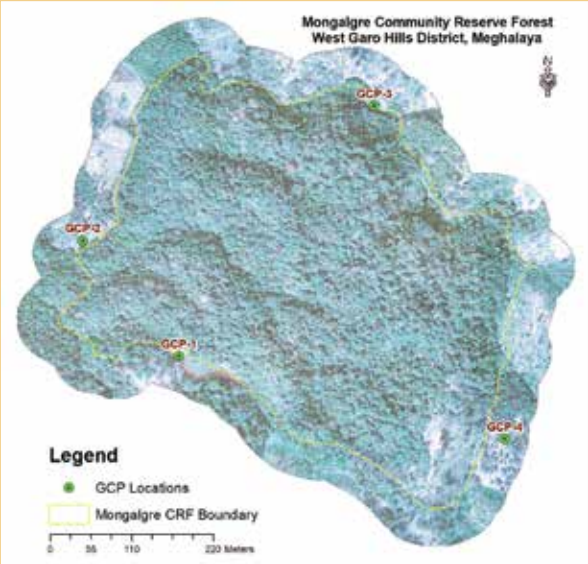
Large Scale Survey and Mapping using UAV

With the development of UAV based surveying approach, time and manpower requirement has reduced drastically for any kind of land survey. The aerial data collected using the UAV platform are processed to generate the ortho-products using the Photogrammetry technique such as 3D point clouds, 3D texture models, Digital Surface Models (DSM), Digital Terrain Models (DTM) and ortho-mosaic images of very high spatial resolution at the range of 2 – 10 cm. Large-scale survey and mapping works were carried out for various user/ line departments from the north eastern region as well as other parts of the country. These UAV-based data and

maps are used by the user/ line departments as inputs for the preparation for their planning and developmental activities. NESAC has been effectively providing operational UAV services in the NER region as well other parts of the country. NESAC has conducted more than 20 UAV surveys in the year 2021-22 for different user departments and research projects going on in the centre. Some of the works carried out using UAVs are given below:

Community Reserve Forest boundary mapping in Garo Hills Districts, Meghalaya

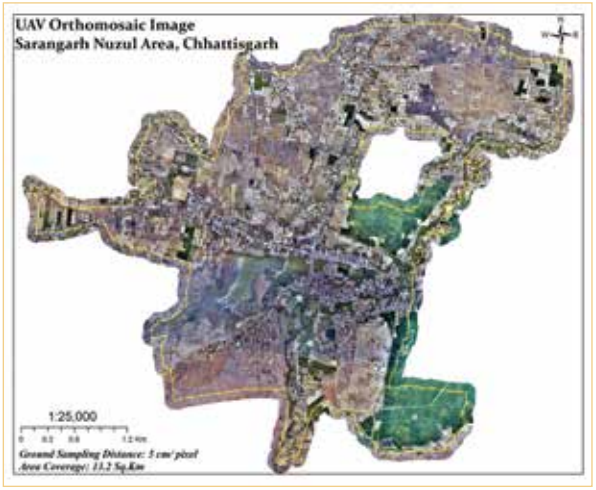
This work has been carried out for Chief Wildlife Warden, Forest Dept., Govt. of Meghalaya. Aerial survey were conducted using UAV platform integrated with RGB camera & Differential Global Positioning System (DGPS) surveys were conducted to Good Clinical Practice (GCP) establishments within the study areas which are incorporated during the UAV data processing to improve the accuracy in sub-centimetres. Using these field surveyed data (DGPS/ UAV) and as per the inputs from the user department, boundaries of 6 nos. of community reserve forests in Garo Hills districts of Meghalaya are delineated and the maps are prepared in the GIS platform. The maps prepared are being used by the department for the preparation of management plans for the identified community reserve forests in the state.



Mongalgre CRF boundary overlaid with UAV based orthomosaic image

UAV based ortho-product generation for Sarangarh, Chhattisgarh

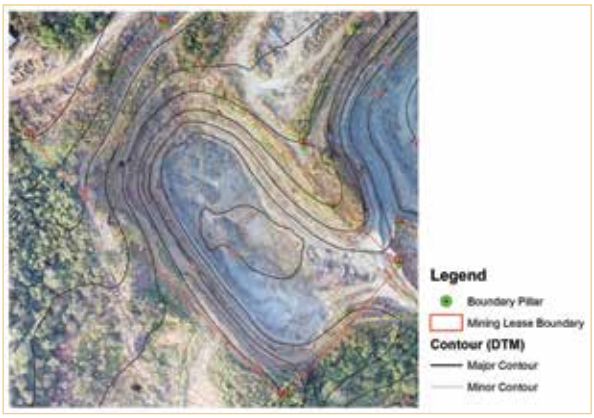
This work has been carried out for Chhattisgarh Council of Science & Technology, Raipur. The scope of the work is to generate ultra high resolution orthomosaic image and digital surface model (DSM) using UAV platform. The maps prepared are used as inputs for preparing the cadastral maps of Sarangarh town in Chhattishgarh.



Orthomosaic image of Sarangarh town

DGPS and UAV surveying of Dalmia Cement Lease areas at Thangskai, East Jaintia Hills, Meghalaya

Surveying with a UAV offers enormous potential to GIS professionals. With UAV coupled with DGPS surveys, it is possible to carry out topographic surveys of the same quality as compared to the highly accurate measurements collected by traditional methods, but in a fraction of the time. This substantially reduces the cost of a site survey and the workload in the field. This work has been carried out for Dalmia Cement Bharat Limited, Meghalaya. The maps prepared using UAV are being used by the user for the mining lease area management. In addition, it is also mandatory for Indian Bureau of Mines to submit the precise maps surveyed by the authorized organizations.

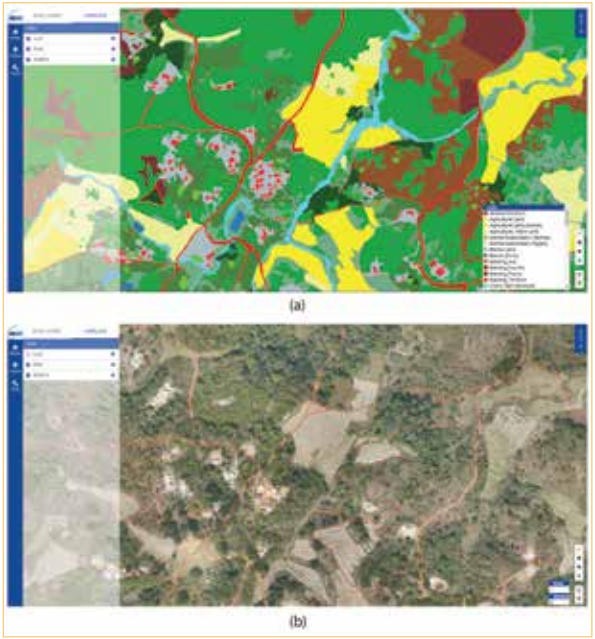


Contour & mine lease boundary overlaid with UAV based orthomosaic image

A pilot project on Village Resource Mapping using UAV in Garo Hills Districts, Meghalaya

The Garo Hills are part of the Garo-Khasi range in Meghalaya, India. They are inhabited mainly by tribal dwellers, the majority of whom are Garo people. Garo Hills comprises of five districts. Tura is the largest town with a population of about 70,000 located at the foothills of often cloud covered Tura peak. There are 3,577 (Census of India 2011) villages in Garo Hills of Meghalaya. All these villages have strong set up of independent democratic governance in the form of Village Councils. At present no definite village boundary is available. This remains a big challenge for taking village as a unit for any development planning. This work has been carried out as a pilot project to understand the feasibilities of using UAV technology to understand the geography of a village settlement and assist the authorities of Garo Hills Autonomous District Council (GHADC), Meghalaya to demarcate the village boundaries. This shall enable GHADC in grassroots level planning more efficiently by providing specific village boundary for any development. The size of survey/ study area is about 15 sq.km. The scope of work involved: DGPS survey and aerial survey of 15 sq.km using UAV; Generation of ultra-high resolution digital surface model and seamless geo-referenced orthomosaic with 10cm/ pixel or better; Generation of thematic maps of roads, water bodies, forested area/ plantations, agriculture land, landmarks, etc. It also involved development of Mobile App for geo-tagging of assets integrated with GAGAN dongle and demarcation of village boundaries. Further, the scope of the work includes the development of web based decision support system for interactive visualization, map analysis and reporting of thematic maps and raster data such as orthomosaic, DSM, etc. This work has been funded by Meghalaya Basin Development Agency (MBDA) & Garo Hills Autonomous District Council (GHADC), Govt. of Meghalaya.

Land use/land cover overlaid with UAV based orthomosaic image



Dashboard system for interactive visualization, map analysis and reporting of thematic maps and raster data (a) & (b)

SATELLITE COMMUNICATION (SATCOM)

NESAC is implementing ISRO's Societal Development programs like Tele-Education, Telemedicine, Emergency Communication System, etc. through the utilization of Satellite Communication Technology in the north eastern states. NESAC had handled Tele-Education and Tele-Medicine programs successfully for the entire north eastern region during 2015-2021 and 2008-2019 respectively. NESAC is also having the facilities of SATCOM studio for content generation, Mobile Satellite Services terminals developed by ISRO, Ka-Band propagation Experiment Facility, etc. Recently, NESAC has been entrusted with responsibilities for local coordination for many ISRO projects like Operational management of GSAT-29 Ground Station, the establishment of Radar under NETRA Project, Commissioning and local coordination for Ground Station under MCF, Hassan at NESAC.

Tele-Education Project in North Eastern States during 2021-22

All the 07 HUBs cum Teaching end and 330 Satellite Interactive Terminal (SIT) are operational in all the North Eastern States. The state wise break up of SITs is as follows: Arunachal Pradesh - 50, Assam-32, Manipur - 25, Meghalaya - 47, Mizoram - 50, Nagaland - 25, Sikkim - 50 and Tripura - 50. It is found that hundreds of programs (Live & Recorded) were conducted by these networks and thousand of target audiences (Students/Teachers/Self Help Group Members/ Panchayati raj members/Rural entrepreneurs etc.) were benefited.

Telemedicine

Under Telemedicine project, many new nodes have been commissioned by ISRO in NE states for military and civil hospital. NESAC is supporting it. The ISRO-NEC joint Telemedicine project in NER was operational in NER till 2019. It was closed in 2019.

ISRO-ONERA-CNES joint Ka-Band Radio Wave Propagation Experiment at NESAC

ISRO-ONERA-CNES joint Ka-Band propagation experiment is operational at NESAC to assess atmospheric effects on the propagation of Ka-Band signal for use in Satellite to earth communication. The Ka-Band Experiment facility at NESAC is a ground station with a set up for measuring the attenuation of the above mentioned signals due to rain. The equipment includes two high gain parabolic receiving antennas to receive the beacon signals, a Tipping Bucket Rain Gauge, a Laser Precipitation Monitor and a Humidity Profiling Radiometer to get atmospheric humidity profile for validating satellite data. With the set up, it has been possible to analyze Rainfall and Signal Attenuation Statistics at Umiam from February 2016 onwards. Various parameters like Rain Drop Size Distribution, Cumulative Probability of Rain Rate, etc. have been deduced from the equipment.

GSAT-29 Ground station cum HUB

NESAC has provided all technical and logistic support for installation, commissioning and testing of GSAT-29 main HUB and diversity sites at Guwahati. The HUB is ready for operation and NESAC is coordinating the management of operation of the HUB on 24 x 7 basis. This HUB will be used to provide VSAT based internet

Shri R.K. Das, Site Custodian, GSAT-29 Hub in front of the Hub Ground Antennas

connectivity in the NE States through some service provider.

NETRA project of ISRO

NESAC is doing necessary coordination and providing support for the setting of the Radar system under the Network for Space Objects Tracking and Analysis (NETRA) project of ISRO. It has been planned to establish the Radar system in any one of the North Eastern states, fulfilling the technical conditions.

MCF Station at NESAC

An MCF station, known as MATRIS (MCF Augmented Telemetry & Ranging Infrastructure

MATRIS Station at NESAC, Umiam

Shillong) has been planned to be installed and commissioned at NESAC for providing telemetry and ranging support to MCF ISRO. NESAC will host this station for MCF by providing land and other amenities. It will be operational on 24×7 basis for telemetry and ranging operation for communication satellites. NESAC is providing all logistic support for this work.

TDP Projects

03 TDP Projects have been initiated by the Division. Following are the briefs about the projects.

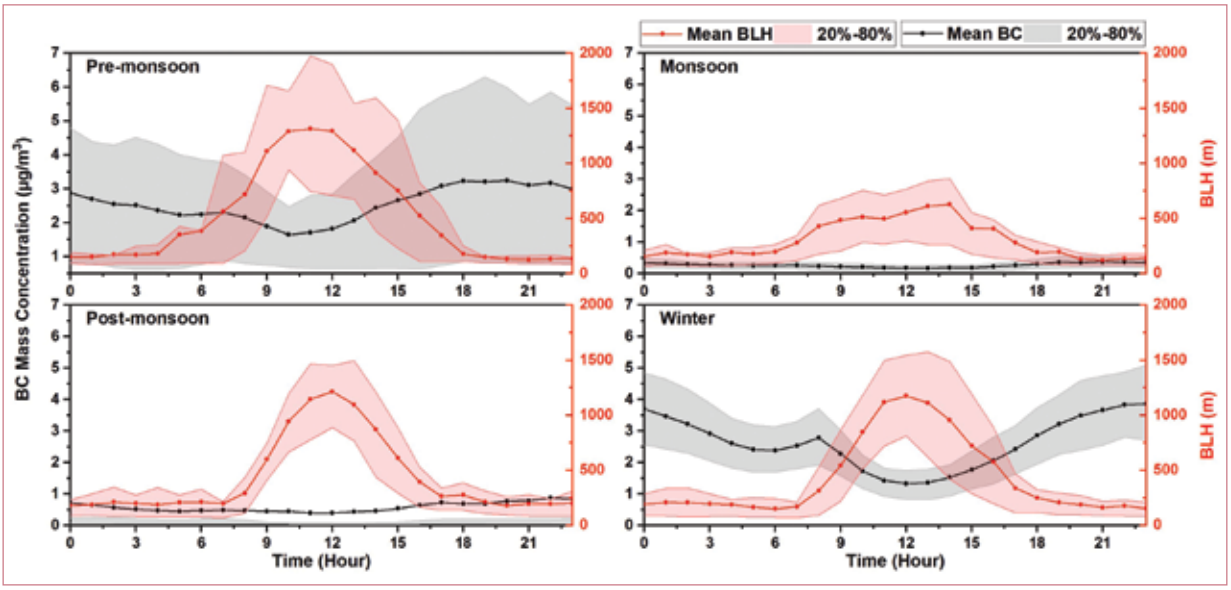
1. TDP-29: Design and development of compact NavIC Receiver for Navigation applications using SkytracQ or other available NavIC Chipset. NavIC or Indian Regional Navigation Satellite System is a satellite based navigation system which provides navigational services using Indian satellites of IRNSS series. To avail these services on the ground, receivers are required which are compatible with NavIC signal structure. Due to scarcity of such receivers, NavIC technology is still largely underutilized. The project aims to develop a usable miniaturized NavIC receiver using existing navigational ASICs.

2. TDP-30: Impact of rain attenuation on Space to Earth satellite communication link using GSAT-14 Ka-Band satellite beacon. ISRO, in collaboration with CNES & ONERA are performing high frequency (Ka-Band, 20/30 GHz) satellite signal propagation experiment over tropical regions to improve existing ITU models. As a part of the experiment, a station has been set up at NESAC to receive Ka-Band satellite beacon signals from geostationary orbit to assess rain attenuation in the high frequency. Additionally, the TDP aims to establish a local rainfall characteristics using high resolution medium term rainfall data as well as compare the characteristics with other station data to understand shortcomings of the existing models.

3. ZigBee (IEE 802.15.4) based Wireless Sensor Network (WSN) for various data collection and field data transmission. Dense sensor data over a small geographic area can be useful for many applications. For gathering and transmitting such field data in autonomous cost-effective way, a Wireless Sensor Network utilizing low power communication protocols is a critical requirement. The present project explores the possibility of using ZigBee as such a candidate low-power communication protocol for WSN. The project aims to develop a prototype sensor based device with communication capability which can sustain on green power and can operate perpetually.

SPACE AND ATMOSPHERIC SCIENCE RESEARCH

The NE region of India is unique in terms of the Atmospheric process over the region and for the associated complexity in understanding the weather and climate over the region. Space and Atmospheric Science group at NESAC has been working to understand and characterize the major drivers for weather and climate variability, through the collection and analysis of in-situ data, satellite based data and products, and numerical modeling. The group also conducts research to improve short and medium range weather forecast, particularly the severe weather forecast over the region. In addition, the group provides support and critical input in the management of major disasters like floods, severe storms, lightning, etc. using data from the S-band polarimetric radar, automatic weather stations, satellites, numerical models, etc. The major activities and achievements of this group are described below:



The diurnal variation of BC and ABLH in different seasons. The solid line is the mean value, and the translucent area is the range between 20 and 80 percentiles.

Impact of Atmospheric boundary layer on ground level absorbing aerosols

Temporal characteristics of absorbing aerosols and Atmospheric Boundary Layer Height (ABLH) and the possibility of a relationship between them have been investigated over Umiam, a hilly station on the Shillong Plateau. Black Carbon (BC) concentration at the surface is influenced by ABL dynamics and other meteorological factors. ABL variation influences BC concentration inversely since ABL is the vessel that contains aerosols. BC in turn, then affects ABL by stabilizing it. So, it is a complicated loop and even becomes more complicated over complex terrain. Over Umiam, the source of aerosols is not always local. But, a considerable proportion comes from long-range transport and mountain-valley wind circulations as reported in several publications. For this study, BC mass concentration is obtained from a seven-channel Aethaloemeter (Make: Magee Scientific, Model: AE33) and ABLH is collected from a ground-based Ceilometer (Make: Vaisala, Model: CL31) from February 2021 to January 2022. Other meteorological parameters such as temperature, relative humidity, wind vector have been taken from a collocated automatic weather station.

The variation of BC has been found to be opposite to that of BLH in all the seasons. The minimum concentration of BC was found during noon time which indicates that BC over Umiam depends on prevailing dispersion conditions. The diurnal pattern is noticeably different than other high-altitude stations across India. The BC concentration and its variation are so low during

monsoon and post-monsoon seasons that their evolution with ABLH variation is not very strong. The observed secondary peak of the wintertime diurnal variation around 8 AM suggests that ABLH is not the sole influencer in driving BC. A wind direction shift is usually observed at that time which is driven by Mountain-Valley wind circulation and brings pollutants from the valley region which increases BC loading in the atmosphere at that time.

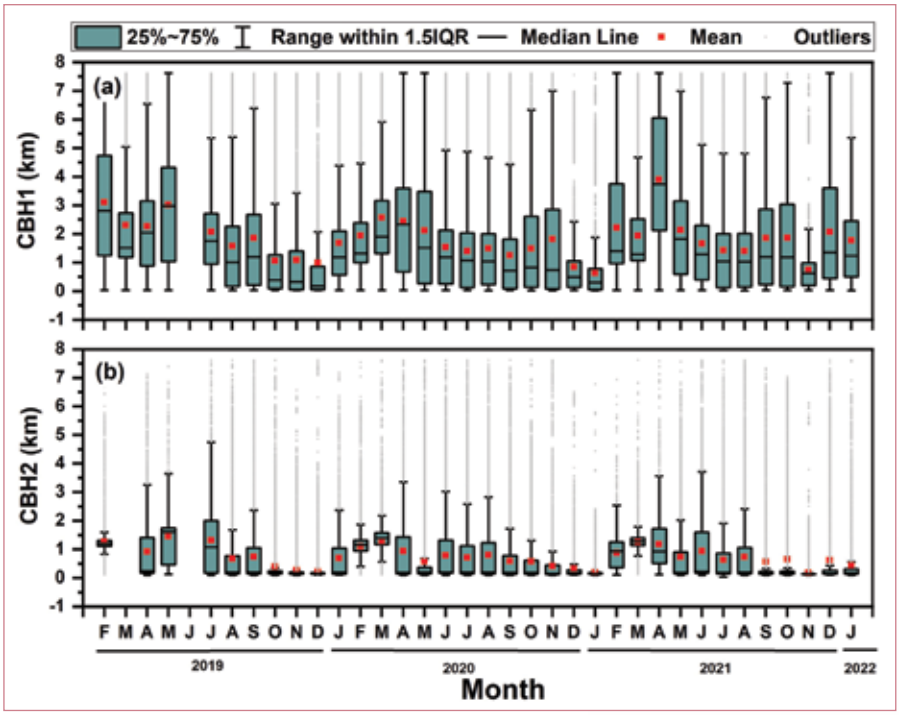
Vertical structure of cloud occurrences over Umiam

The impact of clouds and their vertical structures on the radiative budget, hydrological cycle, and climate is strong but still uncertain. As the cloud are found to occur spanning a large part of the atmosphere, we attempted to understand their occurrence frequencies in the vertical atmosphere by analyzing monthly statistics of the first and second cloud base height (CBH) measurements. The statistics have been computed by using Ceilometer data (collected at 2 sec interval) of both the first (CBH1) and second CBH (CBH2) from February 2019 to January 2022. The frequency of occurrences of the third layer is very low, so we abstained from doing its statistical representation.

Each year, from late monsoon to early winter, the first cloud bases are mostly found in the lower layer of the atmosphere. Although some outliers are there, which indicate the presence of clouds at a greater height too, their numbers are less. After December, the first cloud bases are more likely to occur higher in the atmosphere until April and then start coming down again. Monthly mean CBH follows a similar pattern. The Inter Quartile Range (IQR) is found to vary with seasons too, with lesser value during the winter (within 1 km) and more during pre-monsoon seasons (within 5 km). Most of the second cloud bases are found at a lesser height indicating their presence only when the clouds are shallow. The IQR for CBH2 did not cross 2 km height in any of the months. During the pre-monsoon and winter seasons, the range is even limited to 200 m from the ground. The study is being further extended to understand the CBH dynamics and its climatic impact over the complex mountainous region.

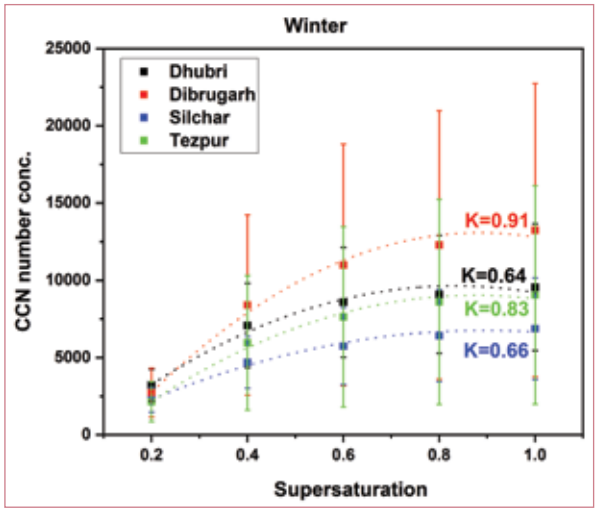
Hygroscopic behavior of aerosols over NE region of India

An improved understanding of aerosols and their hygroscopic behavior can give a better estimation of aerosol's influence on the modification of cloud properties which remains as one of the main uncertainties in climate predictions. This work examines the hygroscopic behavior of the aerosols over four places in NE region of India. Aerosol and Cloud Condensation Nuclei (CCN) data were collected over four stations, namely Dhubri, Tezpur, Dibrugarh, and Silchar under campaign mode. The stations are strategically



Box plots showing vertical distributions of (a) first and (b) second cloud base height detected by Ceilometer in each month. The red square indicates the mean value, the central line is the median, and box edges are drawn at the 25th & 75th percentiles. Whiskers are drawn with 1.5 times of Inter Quartile Range. Values beyond that are outliers and shown by gray dots.

chosen for their unique location and interesting features of aerosol and precipitation climatology as well as the availability of logistical support. The first three stations are representatives of the Brahmaputra River valley's western, central, and eastern parts, whereas the last station is a part of the Barak River valley. At every station, the measurements were carried out for at least four days continuously during December 2021. Measurement of aerosol size distribution has been taken by Optical Particle Counter at every minute. Measurement of CCN concentration at five calibrated super saturations (0.2, 0.4, 0.6, 0.8, and 1.0) was made using a CCN counter. Black Carbon surface mass concentration was acquired every minute by a five-channel Microaethalometer and Aerosol Optical Depth (AOD) was collected using a five-channel Microtops Sunphotometer.

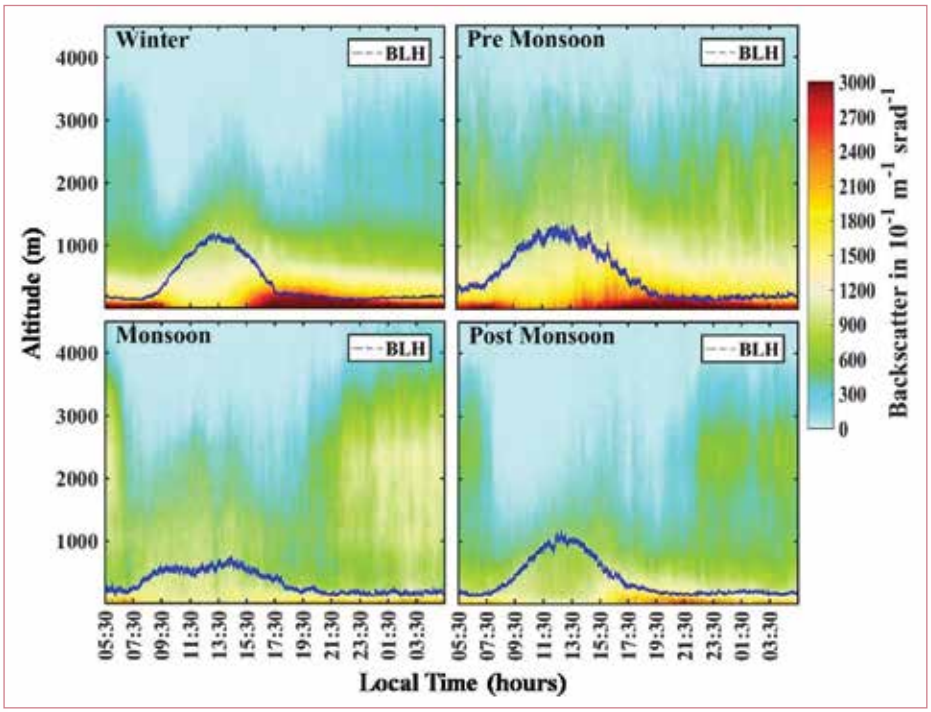


Average CCN number concentration (/cm^3) at five calibrated super-saturations over four selected stations.

The study points to a clear west-to-east gradient in aerosol absorbing and optical properties, as we see more BC and AOD in Dhubri, which reduces as we go towards Tezpur and further reduces reaching Dibrugarh. Aerosol loading over Silchar is almost similar to that of Tezpur during winter. However, Particle concentrations under fine mode obtained from Optical Particle Counter do not follow a similar spatial gradient. It reduces first towards Tezpur and then increases again. Hygroscopic behavior of the aerosols on the other hand shows an east-to-west gradient. Hygroscopic behavior was assessed through Twomey's empirical coefficient (k), obtained from fitting CCN number concentrations at different super saturation with a power law. Very high k- value is present at all sites which indicate an abundance of strong CCN active aerosols. A huge shift in hygroscopicity from Dhubri to Dibrugarh suggests possible heterogeneity in the chemical properties of ambient aerosols.

Characterization of Atmospheric Boundary Layer over high altitude station, Umiam

Atmospheric Boundary Layer (ABL) plays an important role in the vertical distribution and transport of different particulate matter in the atmosphere. Here we studied the characteristics



Diurnal and seasonal variation of ABLH with backscattering coefficient over Umiam as measured using ceilometers.

of the ABL using in situ, remote sensing observations and reanalysis datasets over high altitude station, Umiam. The experimental setup consists of launching Dr Pisharoty Sonde and installing ceilometer in collaboration with Physical Research Laboratory, Ahmedabad. Additionally, three reanalysis products; ECMWF (European Centre for Medium-Range Weather Forecasts) Reanalysis Version 5 (ERA5), Indian Monsoon Data Assimilation and Analysis (IMDAA) and Modern-Era Retrospective analysis for Research and Applications-2 (MERRA2) have been used to investigate long term variation of ABL over Umiam and for comparison with observation data.

Ceilometer data have been used to study ABL evolution over Umiam from December 2019 to November 2021. Strong backscattering have been observed from areas near the surface and the same becomes weaker with increasing height. Maximum ABL height (ABLH) is observed during pre-monsoon, where the backscattering signal indicates well mixing of particles up to an average height of ~1368 m in the afternoon and minimum during monsoon, where maximum ABLH reaches ~766 m during the afternoon. The ABL normally remains shallow during the morning and night time during all the seasons over the study site due to weak turbulence and absence of convection.

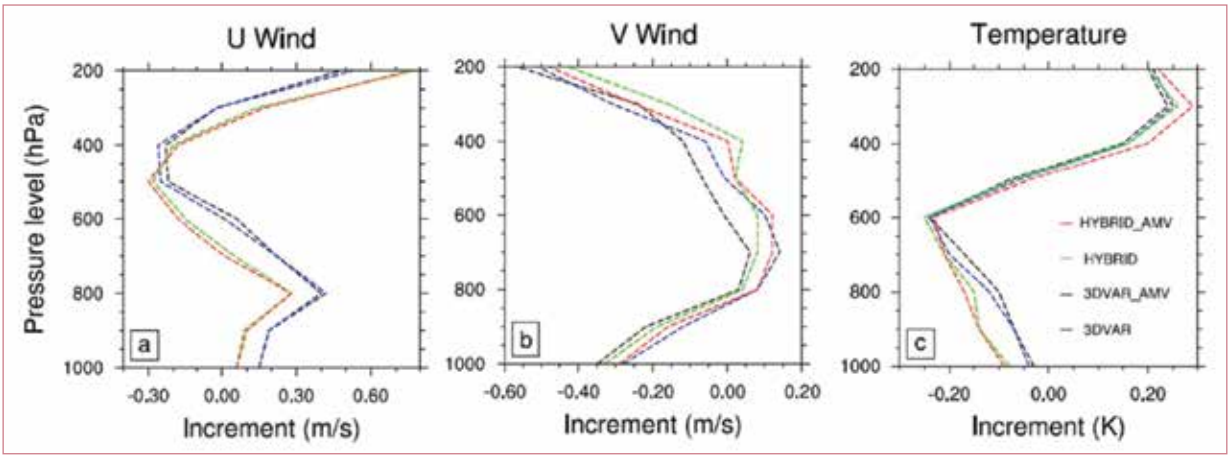
The diurnal evolution of ABLH over Umiam were also computed from set of sonde data using the vertical gradient of virtual potential temperature (θv) as it remains almost constant throughout the ABL. The seasonal variability of ABLH was investigated using 7 years sonde data during 2009 - 2013 and 2019 - 2020, where a record of 104 good meteorological data profiles was used. The ABLH was observed to be maximum during the months of pre monsoon (March, April, May) which varied from 500 m to a maximum of 2250 m above ground. Over Umiam, we recorded minimum ABLH during the months of monsoon season (June, July, August, and September) where it varied from 125 m to 1100 m.

The seasonal daytime (11:30 - 15:30 IST) mean ABLH obtained from different source has been compared. ABLH obtained from sonde, ceilometer, IMDAA, and ERA5 are observed to be in good agreement with each other during all seasons, while MERRA2 clearly overestimated the ABLH. There was only a difference of 50 m between the ABLH estimated by ceilometer and ERA5 on some occasions, suggesting that the ABLH provided by ERA5 could be widely used for different applications and research, as ABLH measurement using in-situ instruments are very sparse.

Inter-comparison of the impact of INSAT-3D atmospheric motion vectors in 3DVAR and hybrid ensemble-3DVAR data assimilation systems during Indian summer monsoon

A study was taken up to quantify the impact of INSAT-3D atmospheric motion vectors (AMV) observation in the 3DVAR and the hybrid ETKF-3DVAR data assimilation (DA) system in WRF model. The Hybrid DA system incorporates flow-dependent ensemble background error covariance (BEC) that generates optimal analysis through increments that are consistent with the background flow, and respond adaptively to the change in the observing system. Previous studies have shown that in the presence of flow evolving BEC in the Hybrid DA system, the observations are effectively assimilated as compared to traditional 3DVAR DA systems, and hence, it is expected that the impact of INSAT-3D AMV observations may vary in different DA systems. Four experiments were conducted, and the DA system was continuously cycled for 4-week period at every 12-h interval, and 48-h free forecast was commenced from each 0000 and 12 UTC. India Meteorological Department (IMD) gridded rainfall data and GPM rainfall data were used to validate the rainfall forecast. Further, the European Center for Medium Range Weather Forecasting Reanalysis (ERA) interim data was used for verification of atmospheric field variables.

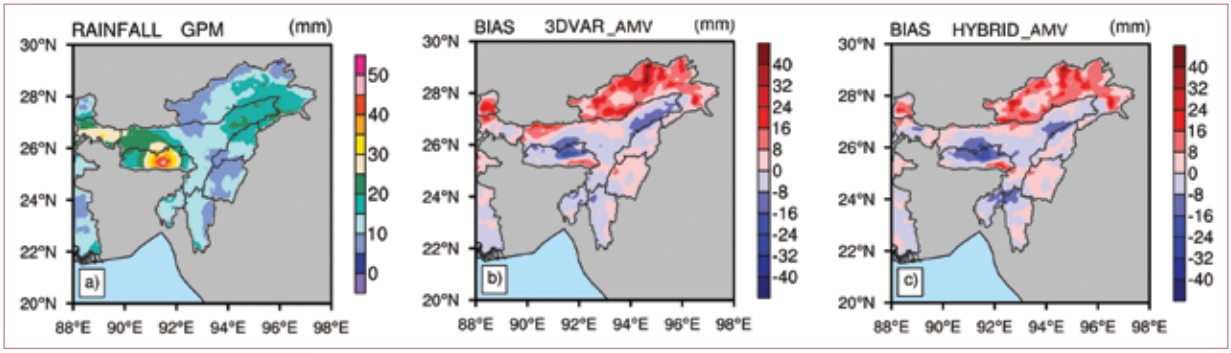
To assess the impact of observations on the model variables, the vertical profile of analysis increment at the radiosonde location were evaluated. The varying effect of two different



Vertical profiles of analysis increment (analysis-background) for three different prognostic variables; analyzed by 3DVAR (black line), 3DVAR_AMV (blue line), HYBRID (green line) and HYBRID_AMV(red line) experiments.

DA techniques is quite visible in the zonal wind analysis increment. Both HYBRID experiments show strong upper-level zonal wind increment compared to 3DVAR experiments. No significant impact of AMV is observed in the HYBRID (HYBRID_AMV) experiments. However, for meridional wind, AMV data's influence is seen in 3DVAR (3DVAR_AMV) from 400 to 800 hPa. The temperature field result shows a negative temperature increment for all the experiments from 1000 to 500 hPa. However, the magnitude of increment is higher in both the HYBRID experiments. In the upper level above 500 hPa, HYBRID_AMV shows a larger positive increment compared to other experiments.

The experiments that assimilate INSAT-3D AMV observations show substantial relative forecast improvements in both 3DVAR and HYBRID DA systems, spatially. The largest positive impact is seen in HYBRID_AMV experiments with 77% improvement for wind. The improvement percentage for RH is not very significant compared to wind. However, marginal improvement due to AMV DA is observed both in 3DVAR and HYBRID. The HYBRID_AMV experiment shows improved skills for precipitation forecast for higher rainfall thresholds as compared to 3DVAR_AMV experiment in the later stage of forecast. The HYBRID_AMV experiments shown lower bias in precipitation as compared to 3DVAR_AMV run. The significant wet bias observed in 3DVAR_AMV for NER of India is considerably reduced in HYBRID_AMV experiment mainly over western Assam and slightly reduced over Arunachal Pradesh and Sikkim.



Bias of monthly averaged (July) 24 h forecasted rainfall (mm/day) with respect to (a) GPM gridded rainfall for (b) 3DVAR_AMV (c) HYBRID_AMV

The overall results from the study indicate that the impact of INSAT-3D AMV observations varies in 3DVAR and HYBRID DA systems. Furthermore, the impact of the new observing system shows

more value to the advanced DA systems such as HYBRID than the traditional 3DVAR approach.

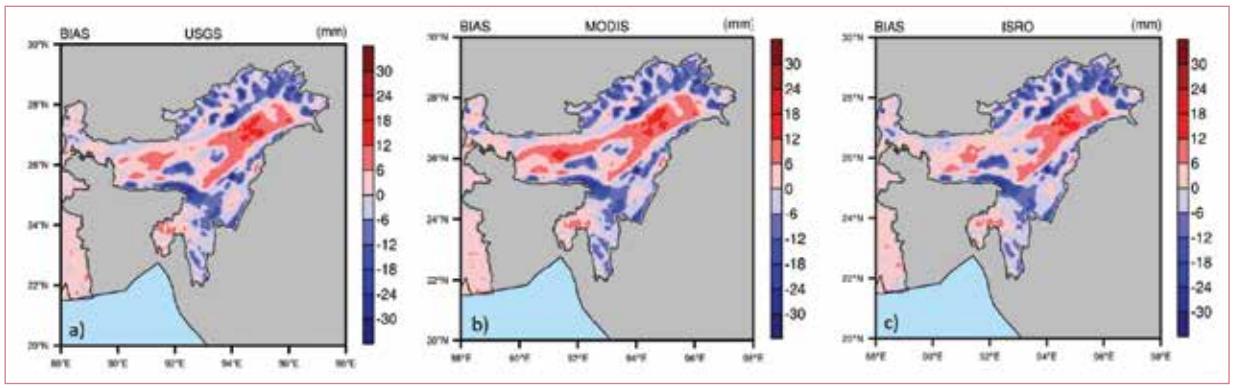
Impact of satellite based geographical data on simulation of rainfall over NER of India using a Limited-Area Model

The performance of any numerical weather prediction model critically depends on model initial condition as well as surface level geographical information such as land use land cover (LULC) and terrain condition of the study area. The topography of North eastern region (NER) of India is very complex which imposes significant challenges in rainfall forecast over this region. In this study, rainfall simulations are conducted using Weather Research and Forecasting (WRF) model for the monsoon season in the year 2018 at 9 km resolution. Three sets of LULC data are taken from USGS, MODIS and ISRO. In the present study, the efficiency of the WRF model is assessed by comparing the model simulated rainfall with GPM rainfall. In addition, model simulated surface level meteorological parameters are compared with ERA5 reanalysis data.

The ISRO experiment (results using ISRO LULC data) shows lower bias in precipitation as compared to the rest of the experiments, mainly over central and the western Assam covering the Brahmaputra valley. Significant wet bias has been observed in MODIS simulations. Further, among the different LULC experiments, ISRO LULC simulations shows improved forecast of surface level meteorological parameters such as wind, temperature, and relative humidity compared to USGS and MODIS simulations. It can be summarized from the results that the utilization of ISRO high resolution LULC data leads to the improved weather forecast over NER.

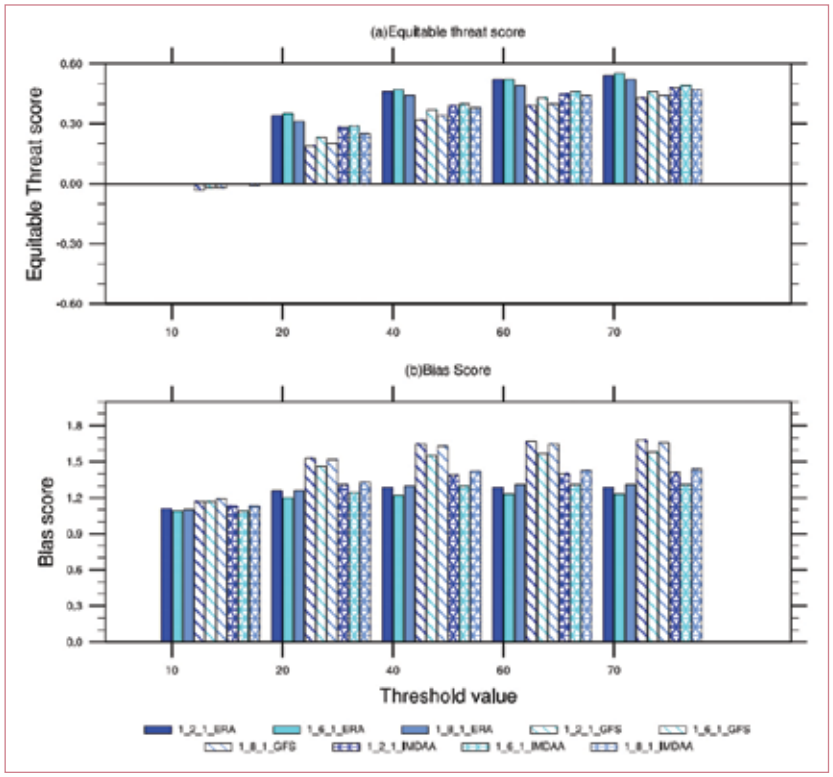
Impact of different initial conditions on rainfall simulation over NER of India using WRF-ARW model

The performance of any numerical weather prediction model is primarily based on the model dynamics represented by the atmospheric governing equations and physical processes represented by the parameterization schemes. An experiment was conducted to evaluate the impact of different initialization data and boundary conditions to improve the rainfall forecasting over NER, India. The initial and boundary conditions taken from GFS, ERA and IMDAA are dynamically downscaled by the WRF model.



Bias of monthly averaged (July) 24 h forecasted rainfall (mm/day) with respect to IMD gridded rainfall for (a) USGS (b) MODIS and (c) ISRO

The WRF model was seen to perform better with ERA data compared to GFS and IMDAA throughout the rainfall threshold values. Additionally, IMDAA data performs better than GFS. The bias score shows overestimation in GFS simulations with all the combination of parameterization schemes for the entire range of rainfall thresholds, whereas, ERA and IMDAA shows better and comparable result. The better performance of IMDAA compared to GFS may be because of the fact that the primary observational data source of IMDAA was the ECMWF archive along with observations from

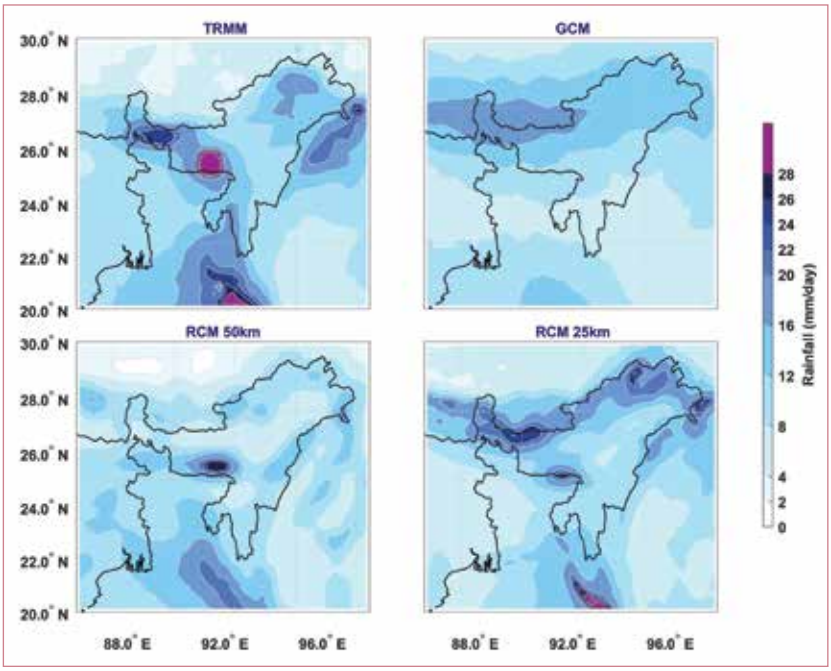


The ETS (a) and bias score (b) for forecasted 24 hour accumulated precipitation for initial condition experiments

the archives of IMD/NCMRWF. The study is further consolidated for more seasons and the results are being analysed. Efforts are also being made for real time access of the IMDAA and ERA initial condition data for operational weather forecast over the NER of India, which could improve forecasting of hydro-meteorological disasters over the region.

Assessment of regional downscaling simulation of climate models over NER

One of the important messages that came out of the Sixth Assessment Report of IPCC (AR6, IPCC) is the importance of regional assessment to understand local scale phenomena. As we are on the verge of a changing climate, more regional simulations are expected to add more representations of the possible future, thereby preparing us to tackle climate change-induced adversities. So, we attempted to find out the performance of existing Global Climate Models (GCM) and Regional Climate Models (RCM) in simulating the climatological rainfall and temperature distribution over North East India. Spatial patterns of near-surface temperature and precipitation are studied from the CMIP5, CORDEX, and CORDEX-CORE multimodal ensemble results for the summer (JJAS) season. Results from the models over historical periods (1976-2005) for precipitation and temperature were verified against TRMM (1998-2014) and APHRODITE (1976-2005) observation climatology respectively. A set of 17 different simulations of 3 different RCMs driven by 12 different GCMs were investigated.



Observation and Multi-model ensemble mean of JJAS climatological rainfall from TRMM, GCM, RCM (50 km), and RCM (25 km) respectively.

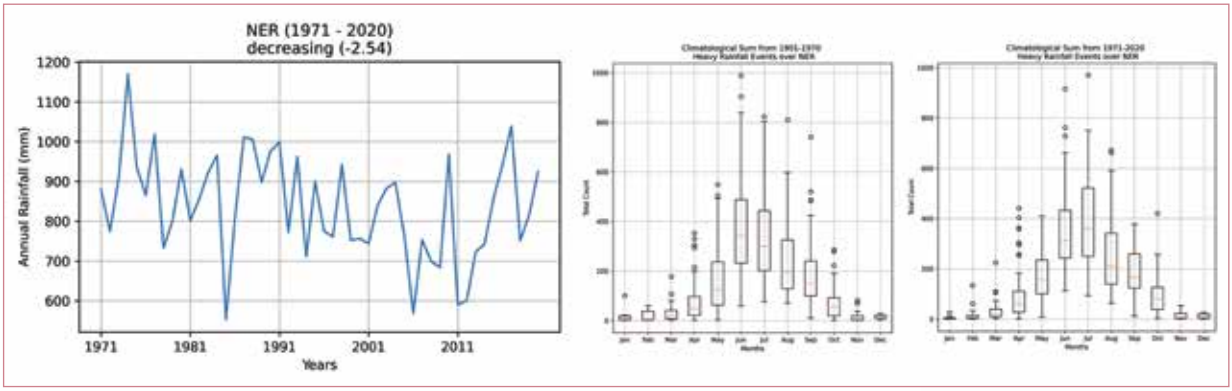
It has been observed that the downscaled multi-RCMs can capture the spatial distribution of rainfall better than their driving GCMs especially over the Shillong plateau and its windward side. On the other hand, most of the RCMs are underestimating temperature over most part of our study domain. According to the results, bias in precipitation is in the range from -11 mm/day to +11 mm/day, while temperature bias is in the range from -11 to 6°C. The bias has been reduced in the high-resolution simulation, although some models are showing positive precipitation and negative temperature bias, leading to the conclusion that the majority of the simulations are still not able to represent orographic precipitation. The topography of this region is very complicated and thus climate models fail to describe it properly. Further, under-represented topography is followed by poor estimation of orographic precipitation, thereby challenging the models to accurately reproduce the observed rainfall. Better representation of spatial distribution with increased resolution suggests that improving the resolution further could incorporate orographic processes and associated feedback and can finally assist in narrowing the bias.

Investigation of Annual Rainfall Climatology of North East India

The NE region (NER) of India has been reported to be highly vulnerable to the impact of climate change. A study was taken up to investigate the climatological characteristics of rainfall over the NER of India using the India Meteorological Department (IMD) gridded daily rainfall product available at a spatial resolution of 0.25°×0.25°. The analysis was performed for the period from 1901 to 2020. The annual rainfall time series averaged over NER from 1971 onwards shows a statistically significant decreasing trend and an annual decrease of 2.54 mm per year. The period prior to 1970 did not show any significant trend. The heavy rainfall days, defined as days with daily accumulated rainfall more than 64.5mm, were separately analyzed. It was observed that prior to 1970, the June was the month with most heavy rainfall days which shifted to July after 1970. Interestingly, the annual trend of number of heavy rainfall days prior to 1970 showed an increasing trend of approximately 10 days per year which shifted to a decreasing trend of 8 days per year after 1970. Similar study using the temperature data is being taken up.

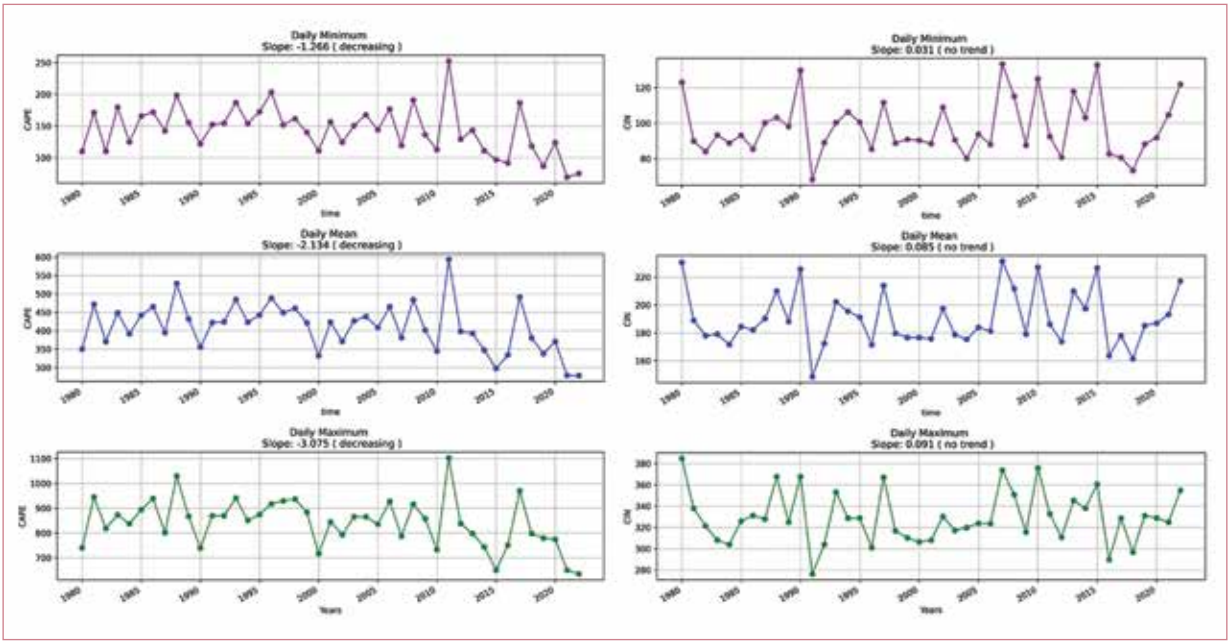
Assessing the climatological characteristics of convective instability over NER

The NER of India is extremely hazardous for the severe storms and lightning, particularly during the pre-monsoon months (March-April-May) every year. The amount of convective instability on any particular day decides the possibility of development of severe weather. An investigation of the trend in convective instability has been performed using two indices that are primarily used to measure the atmospheric instability in terms of buoyancy of an air parcel. These are, Convective Available Potential Energy (CAPE) and Convective Inhibition (CIN). An unstable atmosphere refers to a low CIN and a high CAPE conditions.



Trend of annual accumulated rainfall over NER from 1971-2020 (left), the monthly distribution of heavy rainfall days for the period 1901-1970 (centre) and for the period 1971-2020 (right).

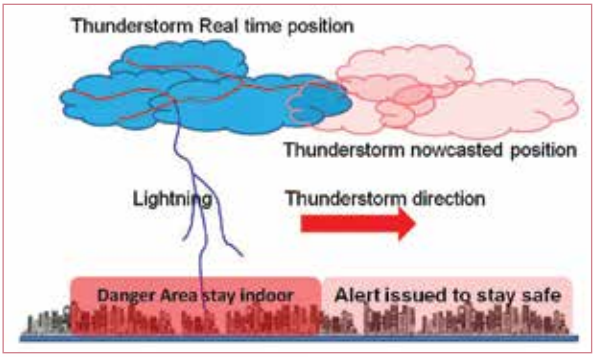
The investigation used the ERA5 atmospheric reanalysis product available hourly at a spatial resolution of 0.25°×0.25° from 1979 to 2022 period. The analysis was performed for the pre-monsoon season from March to May. The analysis showed a decreasing trend of CAPE for maximum, minimum, and mean data. CIN however, showed no significant trend over NER over the years. The decrease in CAPE could cause a decrease in heavy rainfall days over NER during the pre-monsoon season.



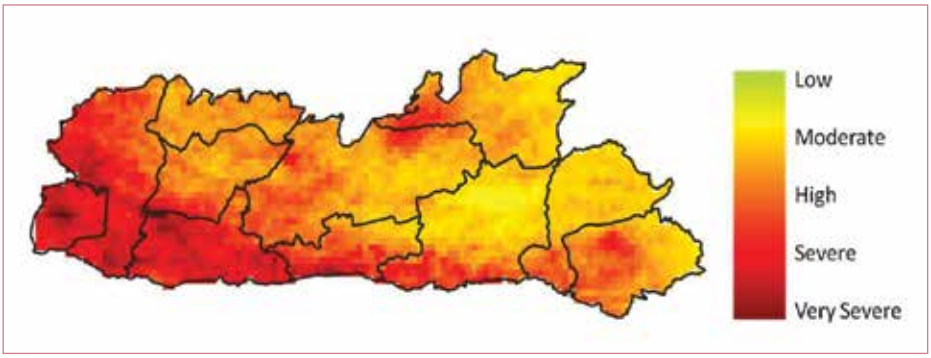
The climatological time series and trend over NER for daily minimum, daily mean, and daily maximum for CAPE (left) and CIN (right)

Development of a thunderstorm tracking system and validation

A thunderstorm tracking algorithm is being developed at NESAC to nowcast the possibility of severe storm and lightning activity over an area of concern by using the total lightning data. The sources of lightning as observed from the ground based lightning detectors have been used to identify the initial phase of development of the severe storm system. The ground based lightning detector data have been used to obtain information about the thunderstorm cells in real time. The boundaries of thunderstorm cells were obtained through the neighborhood technique. After smoothing, these boundaries were used to track the movement of thunderstorms and then extrapolated to nowcast the probable lightning events approaching over an area of concern. The algorithm can deliver admirable results prior to a thunderstorm arriving at the area of concern with lead time varying from 30-45 minutes. The realtime observations of total lightning appear to be significant for thunderstorm tracking and lightning nowcasting, as total lightning tracking could help to fill the observational gaps in radar reflectivity due to the attenuation by hills or other obstacles over the various parts of North Eastern Region (NER). The system is being validated using data from electric field mills, Doppler Weather Radar, and Satellites. The system will eventually be integrated into a web based severe storm and lightning nowcasting system.



Conceptual thunderstorm tracking and nowcasting using total lightning data



Lightning Hazards map of Meghalaya based on cloud to ground lightning events only

Meghalaya lightning hazards zonation mapping

The spatial variability of lightning for the entire Meghalaya have been analysed using ENTLN total lightning (sum of inter-cloud, intra-cloud and cloud to ground lightning) data and data from Lightning Imaging Sensor onboard the Tropical Rainfall Measuring Mission (TRMM) satellite. It has been found that the West Garo Hills and South Garo Hills are the most lightning affected districts in Meghalaya. In addition, we noticed May is the primary hazardous month in western Meghalaya and part of the Ri-Bhoi district. On average more than 50 % of Cloud to round (CG) lightning are experienced by the three districts namely, West Garo Hills (WGH), South Garo Hills (SGH), and West Khasi Hills (WKH) districts of Meghalaya. It was also observed that severely affected districts by lightning are different in different months. The study has been done as part of the Hazard, Risk, and Vulnerability assessment project for Meghalaya funded by the Government of Meghalaya. The brief report on lightning hazard has been submitted and the same is being integrated for preparation of risk and vulnerability assessment. The information could be used by the decision makers to generate awareness and develop safety guidelines.

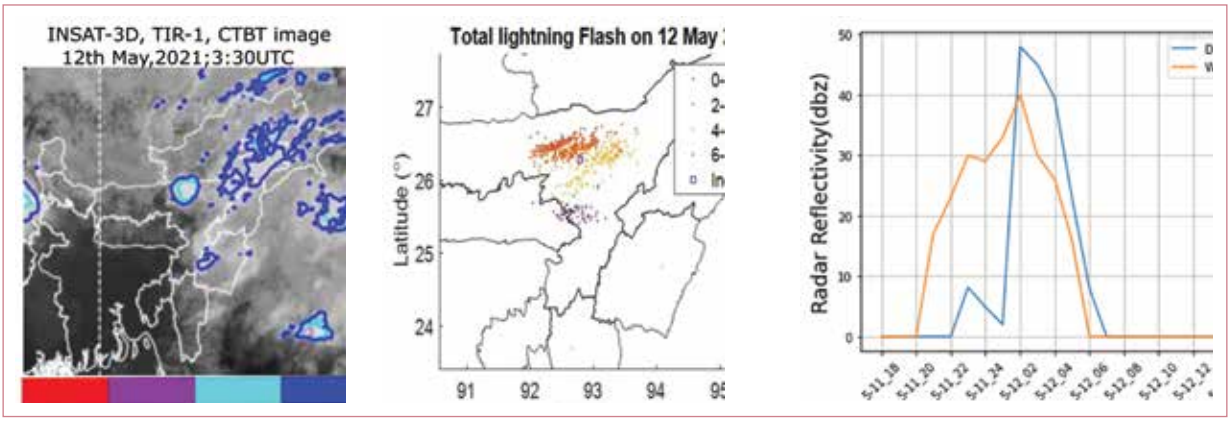
Diagnostic analysis of lightning event using WRF model- a case study

Lightning events around the world claim many lives and cause significant damages to properties and natural resources. In case of wild life the lightning events becomes more dangerous and life threatening as wild animals do not have proper shelter, which makes them more vulnerable to lightning strikes. One such unfortunate lightning event which was reported on 12th May, 2021 in Nagaon district of Assam, India, where lightning strikes claimed lives of 18 wild elephants. NESAC took lead in analysing the events based on all available data and reported all details about the lightning incidents to Government of Assam in a short time.

A study was taken up to assess the potential to forecast such events in future. The characteristic features of lightning (temperature, wind, humidity, radar reflectivity and graupel mixing ratio) events were analysed and compared with WRF model simulations. Simulated results validated with the Doppler Weather Radar (DWR) data revealed that WRF model could predict the actual observed parameters with significant accuracy and is efficient in prediction of meteorological parameters associated with the lightning events.

Classification of hydrometeors using Naïve Bayes classifier form polarimetric DWR measurements

The study of convective systems and precipitation is pivotal to understand and to forecast the weather condition, water cycle, atmospheric pollution as well as the Earth's climate. A mature cloud contains different kinds of hydrometeors. Rain and drizzle are classified as liquid hydrometeors, whereas slush, sleet, snow, graupel, ice crystals, hails, and megacryometeor types of hydrometeors are known frozen precipitation. Ground based weather radars provide valuable data to understand the precipitation. The measurements made by the S-band dual Polarized Doppler Weather Radar (DWR) situated at Sohra (erstwhile Cherrapunjee) have been studied to classify the hydrometeors using the Naïve Bayes classification algorithm. In this approach four radar products are used



INSAT 3D Satellite product on cloud top brightness temperature (left), lightning flash density data of 12th May, 2021 over the incident site (centre) and hourly variation of radar reflectivity from DWR and WRF model (right).

to discriminate between various hydrometers using Naïve Bayes classifier. The data used as Reflectivity (Z), differential reflectivity (ZDR), correlation coefficient (ρ), and differential phase (φdp). The output of the Naïve Bayes classifier is light to moderate rain (LMR), Heavy Rain (HR), Hail (HL) and Hail-Rain Mixture (RHM).

The Naïve Bayes classifier identifies and discriminates four output hydrometeor classes based on four input radar variables. The input to the classifier and the output from the classifier (as shown in the figure) could clearly distinguish the types of hydrometeors shown as different color code in the image. Red color is indicating the presence of hail, orange is indicating the mixture of hail and rain, yellow is indicating the presence of big drop precipitation, dark blue is indicating heavy rain and light blue is indicating light to moderate rain. The study is being continued using more events before the algorithm is used for operational product generation.

NEWS & EVENTS

Training & Workshops

NESAC signed MoU with Assam Agricultural University (AAU), Jorhat

NESAC has signed an MoU with Assam Agricultural University (AAU), Jorhat on April 20, 2021 at AAU Jorhat in the presence of Hon'ble Vice Chancellor, AAU, recognizing the importance of research and development in the areas of Remote Sensing and Geoinformatics, Atmospheric Sciences and other relevant areas, with space technology based inputs. The signatories were by Dr. A. Bhattacharyya, Director of Research (Agri.), AAU and Shri PLN Raju, Director, NESAC. Heads and senior faculties of various Departments attended the ceremony.

In his address, Dr. B.C. Deka, Hon'ble VC, AAU, Jorhat mentioned about the scope and opportunities of the applications of the space technology for the development of flood affected and silt deposited areas of Assam. He opined that the use of Space technology in the studies of soil properties has edged over destructive methods.

The MoU Signing ceremony was followed by a Brainstorming Session, where the NESAC team comprised of Dr. B.K. Handique, Dr Jonali Goswami, Smt Pratibha T. Das and Dr. Francis Dutta made detailed presentations on the scope of space technology for research and applications in various domains of agriculture and allied sectors. A large number of faculties took part in the discussions and suggested different areas for collaborative research.

NESAC conducted Webinar on use of Science and Technology in Early Warning of Disaster in NER

India University and Institution Network on Disaster Risk Reduction – National Institute of Disaster Management (IUINDRR-NIDM) in collaboration with NESAC and the Department of Geology, St. Anthony's College, Shillong, Meghalaya conducted a Webinar on the "Use of Science and Technology in Early Warning of Disaster in North Eastern Region of India" on May 20, 2021 through Zoom and Youtube platforms. A total of 314 participants from various organizations attended the program.

The webinar was coordinated by Dr. Preeti Soni, Senior Programme Consultant, IUINDRR-NIDM and Asst. Prof. Ms. Nisha Chettri, Department of Geology, St. Anthonys College with assistance from NIDM and NESAC. Rev. Father Joby Joseph SDB, St. Anthony's College, Shillong delivered the keynote address and welcomed the participants. Shri PLN Raju, Director, NESAC delivered the special keynote address, where he highlighted the key roles of NESAC in Disaster management. Prof. Santosh Kumar, Head GDRR, NIDM, in his address, emphasized on the use of science and technology in the early warning system, disaster scenarios and other uncertainties, which may play a vital role in the immediate future. The program ended with vote of thanks proposed by Ms. Nisha Chettri, Asst. Professor, St. Anthonys College, Shillong.

Release of Project Report and SILKS Portal for Chirang District of BTR

Mapping of potential areas for expansion of sericulture was taken up under the CSB funded project on Applications of RS and GIS in Sericulture Development for three districts under BTR viz., Udalguri, Kokrajhar and Baksa out of 4 districts. Considering that sericulture development in the Chirang district is equally important, the Directorate of Sericulture, Bodoland Territorial Region, Government of Assam, requested NESAC to take the project on Applications of Geospatial and Web Technology for Sericulture Development in Chirang district of Bodoland Territorial Council, Assam. The project has successfully been completed with the mapping of suitable areas for the expansion of Mulberry, Eri and Muga in the district. The project outputs have been integrated in the SILKS webportal and hosted in the public domain.

Shri Pramod Boro, Hon'ble Chief of BTR released the project report and the SILKs portal for the district on May 29, 2021 via online mode. The program was also attended by Shri Jogesh Deuri, Director, Sericulture, BTR and Shri PLN Raju, Director, NESAC, Dr. B.K. Handique, Project Coordinator and Smt. Pratibha T. Das, Principal Investigator of the project, officials from BTR and the project team of NESAC.

NESAC signed MoU with NERIWALM, Tezpur

NESAC signed an MoU with the North Eastern Regional Institute of Water & Land Management, Tezpur (NERIWALM) on June 29, 2021 at the Director's Conference Hall, NESAC. The signatories of the MoU were Dr. Pradip Bora, Director, NERIWALM and Shri PLN Raju, Director, NESAC. This MoU was signed for carrying out multiple objectives, namely, outreach support to students of NERIWALM under such programs, internship programs, capacity building of faculties of both NERIWALM and NESAC, joint collaboration for projects, opening access to resources of both the institutions to each other etc. Mementos were exchanged between Dr. Pradip Bora, Director, NERIWALM and Shri PLN Raju. Other dignitaries present at the occasion were Dr. K.K. Sarma, Scientist-'SG', NESAC and a few senior Scientists of NESAC.

NESAC signed MoU with NECTAR

NESAC signed an MoU with North East Center for Technology Applications and Reach (NECTAR), Shillong on June 30, 2021 via virtual mode, aiming at joint initiatives and collaborations in the areas of teaching, research, technology support and projects requiring expertise and logistics from both the institutes. The signatories were Dr. Arun Kumar Sarma, Director General, NECTAR and Shri PLN Raju, Director, NESAC.

Director, NESAC appreciated NECTAR for taking a wide range of programs and coming forward to join hands with NESAC in realizing its future endeavours. Dr. K. K. Sarma, Scientist-SG, NESAC made a presentation on the activities of NESAC and highlighted the possible areas of mutual collaboration. Dr. Partha Jyoti Das, Consultant Project Advisor of NECTAR and Dr. Jonali Goswami, Scientist-SF of NESAC also expressed their views on this occasion.

The MoU signing ceremony ended with vote of thanks proposed by Dr. Krishna Kumar, Advisor (Technical), NECTAR.

Shri Keshab Mahanta, Hon'ble Minister of Health, S&T and IT, Govt. of Assam visited NESAC

Shri Keshab Mahanta, Hon'ble Minister of Health, Science & Technology and IT, Govt. of Assam visited NESAC on July 22, 2021 with a team of high level officials from his departments. Dr. K.K. Sarma, Director (i/c), NESAC welcomed the Hon'ble Minister and felicitated him on the occasion of his maiden visit to NESAC. Hon'ble Minister reviewed the preparedness with regards to the preparation of the Plan of Action (PoA) on the use of Space Technology by the user departments of Assam as per the suggestion of Hon'ble Union Home Minister & President of NESAC Society. Dr. B.K. Handique, Scientist-SF, NESAC & the State Coordinator on the preparation of the PoA for the state of Assam made a presentation to the Hon'ble Minister on various ongoing activities of NESAC and also the proposed plan for implementation of various projects as per the PoA. Hon'ble Minister appreciated the effort of NESAC in providing space technology support for developing planning in all the eight states of NER and offered his best wishes for future endeavours of NESAC.

Hon'ble Union Home Minister Shri Amit Shah chaired Special Meeting of NESAC Society at NESAC on 24th July 2021

For the first time in NESAC history, a special meeting of NESAC Society was convened by the President of the Society and Hon'ble Union Minister of Home & Cooperation, Shri Amit Shah on July 24, 2021 at NESAC, Umiam. Hon'ble Union Minister of DONER, Shri G. Kishan Reddy, Hon'ble Minister of State (i/c) of MoES, S & T, Space & Atomic Energy, Dr. Jitendra Singh; Hon'ble Minister of State for DONER, Shri B.L. Verma; Hon'ble Chief Ministers of all eight states of NER along with senior officials from Ministry of Home Affairs, MDoNER, Chief Secretaries of NE States, Secretaries of Union Home Ministry, MDoNER, DoS, and NEC, and other members of the NESAC Society participated in the meeting. The meeting was convened to review the progress of the actions identified during the 9th meeting of the NESAC Society.

Dr. K. Sivan, Secretary, Department of Space and Chairman, NESAC Governing Council welcomed Hon'ble Union Home Minister, all other members and invitees. Shri Inder Jit Singh, Secretary, DONER initiated the meeting by highlighting the action points identified during the 9th meeting of NESAC Society held on January 23, 2021. Dr. Raj Kumar, Director, NRSC made a technical presentation highlighting the action taken report of the actions identified during the last Society meeting.

Dr. Jitendra Singh appreciated the valuable contribution made by NESAC since its inception and suggested to expand programs on different areas. He also opined that space technology should support in resolving inter-state boundary issues in NER, to fill the forest gap areas with afforestation measures, etc. He also suggested increasing the number of training and capacity building programs, particularly for the government officials of NE states. Shri B.L. Verma highlighted on greater and efficient use of the large volume of geospatial databases along with web portals & dashboards that NESAC has developed. He also stressed on the need of research on climate change, disaster management support, geo-tagging and monitoring of assets, afforestation in the degraded areas, digital classrooms, and tele-education services in the remote places of NER, etc. Shri. G. Kishan Reddy appreciated the efforts of NESAC in taking up many crucial projects supporting planning and development in NER. He said that Shillong could be the space technology capital of the east with NESAC playing a bigger role in terms of providing strategic inputs for development and governance.

In his Presidential remarks, Shri Amit Shah highlighted the effort of the union government in providing adequate support in improving connectivity and overall development of NE region. He stressed the need for Science & Technology intervention in developing the region.

The meeting provided a unique opportunity for NESAC to place itself at the centre of providing space based support for development, governance, disaster management support and all planning process by various central and state government departments in NER.

NESAC Director visited Assam Survey & Settlement Training Centre (ASSTC), Guwahati

Dr. S.P. Aggarwal, Director, NESAC visited the Assam Survey & Settlement Training Centre (ASSTC) at Dakhingaon, Guwahati on September 23, 2021 along with Shri PLN Raju, Special Secretary, Govt. of Assam. Dr. Aggarwal interacted with Assam Land & Revenue Service officials at an ongoing crash course on 'Mission Basundhara' at the ASSTC. He also attended a separate interactive session with Lot Mandals during a State Level Lot Mandals Capacity Building Program on the Cadastral Survey of NC (Non-Cadastral) villages under Mission Basundhara at the centre. Principal, ASSTC Shri Pankaj Chakravarty, ACS, welcomed Dr. Aggarwal and apprised him of the initiatives taken by NESAC to create quality work in land management systems using modern technology.

NESAC organized Space Exhibition as part of 'Azadi Ka Amrit Mahotsav' at Barnagar College in Barpeta district, Assam

Our country is celebrating 'Azadi Ka Amrit Mahotsav', glorifying 75 years of independence by organizing various programs to showcase the achievements in different sectors since independence. To commemorate this significant occasion, NESAC is also organizing various programs to showcase the tremendous achievement the country has achieved in space

science and technology during the past four decades. Organizing space exhibitions for school and college level students is one of such major programs.

NESAC organized a Space exhibition at Barnagar College in Barpeta district, Assam on September 25, 2021, where the 'Space on Wheel' Exhibition bus was stationed along with other visual displays. A large number of students from the college and from the nearby schools participated in the program. The inaugural program at the college auditorium started with the welcome address by Dr. Asim-ul Islam Twaha, Head, Department of English, Barnagar College. He gave a brief background of the program organized as part of the 'Azadi Ka Amrit Mahotsav'. Dr. B.K. Chakravorty, Principal, Barnagar College chaired the inaugural program and addressed the students, teachers and other participants of the event.

Dr. Sarujinee Gogoi, Asst. Professor, Department of Mathematics, Barnagar College coordinated the exhibition from the host institute. The students and teachers from the college and nearby schools thoroughly enjoyed the exhibition and provided very good feedback to the NESAC team.

WHO Officials visited NESAC to collaborate on National T.B. Elimination Program

A team of Senior Officials from the World Health Organization (WHO), India visited NESAC on September 27, 2021 to discuss the development of a decision support system under the National T.B. Elimination Program. Dr. S.P. Aggarwal, Director, NESAC welcomed the officials of WHO, India and highlighted the role of Space Technology Applications initiated by NESAC for various developmental activities of NE region. He also mentioned that the centre has developed a number of Mobile Apps and Dashboard Applications for various users of the region under various Governance activities. Afterwards, the IT & GeoInformatics Group of NESAC gave a live demonstration on the prototype Dashboard and Mobile Apps on TB developed for the State of Meghalaya. The Officials of WHO, India appreciated the efforts of NESAC and requested Director, NESAC for joint collaboration along with IIM, IIPA, and NIC for the development of Regional Level Application for NER. The Officials of WHO include Dr. Kiran Rade, Team lead NPO, WHO India CTD representative, Dr. Shanta Rao, Regional team lead, WHO, Dr. M. Mawrie, State TB officer, Meghalaya and Dr. Gautom Borgohain, WHO-NTEP consultant, Meghalaya.

NESAC organized Space Exhibition as part of 'Azadi Ka Amrit Mahotsav' at Bhola Nath College in Dhubri, Assam

NESAC organized a Space exhibition at Bhola Nath College in Dhubri, Assam on September 28, 2021, where the 'Space on Wheel' Exhibition bus was stationed along with other visual displays. More than 400 students from the college and from the nearby colleges and schools participated in the programme. The program was inaugurated by Dr Dhruba Chakraborty, Principal B N College in the presence of the Head of the Department of Physics, Dr (Mrs) Nandita Pradhani and heads and senior faculties of several departments. He lauded the ISRO and Department of Space and said that every Indian is proud of the success of ISRO. He specially thanked NESAC for organizing the program at his college.

Shri Rafiul Karim Mollah, Asst. Professor, Department of Physics, B N College coordinated the exhibition from the host institute. The students and teachers from the college, nearby colleges and schools thoroughly enjoyed the exhibition and provided very good feedback to the NESAC team.

Director, NESAC attended validation meeting as a Guest of Honour organized by FAO India at Aizawl

Dr. S.P. Aggarwal, Director, NESAC attended as a Guest of Honour (in virtual mode) in the final validation meeting of Technical Assistance for review of the socio-economic risk of diseases, database development and planning for a Decision Support System (DSS) to manage Transboundary Animal Diseases (TAD) on November 9, 2021. The meeting was attended by the Senior FAO Representatives in India, team of FOCUS including the Senior Veterinary Officers of Mizoram Government. Dr Aggarwal has mentioned the contribution of NESAC towards the development of various important Governance applications for various Govt agencies in the region.

NESAC conducted one week training on UAV technology

NESAC successfully conducted a one week training program on UAV technology and its applications in the field of Forestry during November 08-12, 2021 for the Forest Department officials from the Government of Assam. The course covered all the aspects of understanding the UAVs and its components, flight planning for data acquisitions for various remote sensing applications with a focus on forestry applications, 3D printing & its application in UAV along with different data processing techniques. The data processing includes the generation of orthomosaic, digital surface model (DEM), digital terrain model (DTM), contour maps, volumetric analysis etc., using Pix4D Mapper Pro ArcGIS and QGIS software. The participants were also given hands-on experience of the total end to end workflow starting from UAV operations, mission planning, data processing and data analysis.

Virtual launching of Tripura Banadhikar App developed by NESAC

NESAC has successfully developed the 'Tripura Banadhikar App' as per the request of the Directorate of Land Records and Settlements, Government of Tripura for the demarcation of Forest Pattas lands. Shri Giriraj Singh, Hon'ble Union Minister of Rural Development & Panchayati Raj, Government of India, New Delhi has launched the 'Tripura Banadhikar App' in virtual mode on December 3, 2021 in the presence of Shri Biplab Kumar Deb, Hon'ble Chief Minister, Government of Tripura and Shri Narendra Chandra Deb Barma, Hon'ble

Minister, Revenue & Forest, Government of Tripura, Chief Secretary to the Government of Tripura, Secretary, Revenue Department, Government of Tripura and other dignitaries. The launch programme was attended by Dr S.P. Aggarwal, Director, NESAC along with the IT & GeoInformatics team of NESAC.

NESAC, CPGS-AS and RBFU jointly observed 'Meghalaya Farmers' Day'

One day awareness-cum-workshop on the collaborative research project - 'Integration and Application of UAV for Crop Health Assessment and Monitoring with IIDS in Providing Evidence Based Agro-Advisory Services to Farmers of North-East India' *a.k.a. Drone Ha Ka Buit Rep Thymmai* (DHaBReT) funded by Digital India Corporation, MeitY, GoI was jointly organized by NESAC, CPGS-AS, CAU and Ri Bhoi Farmers' Union (RBFU). More than 83 farmers have participated in the programme.

Dr. S.P. Aggarwal, Director, NESAC presided over the function as Chief Guest. He explained to the farmers how drone technology can be used to survey the agricultural crops, assess their health and thereafter issues evidence based agro-advisory services for increasing the yield of the crops of the individual farmers.

Space Exhibition organized at Army Public School (APS), Umroi

The 'Space on Wheels' Exhibition bus was taken to the Army Public School (APS), Umroi and demonstrated various exhibits on space science and technology to the students and the families residing in Umroi cantonment on December 10, 2021 as a part of the Outreach Initiative of NESAC. The bus was accompanied by two scientists and two research scholars from NESAC. The event was attended by around 80 students from APS and many family members from the army cantonment. The students of APS were very enthusiastic and interacted with the scientists and scholars of NESAC and provided very good feedback on the exhibition.

Inauguration of Course on Earth Observation & Applications at ASSTC, Guwahati

The 2nd two week training programme on Earth Observation & Applications: Fundamentals, Recent Trends in Technological advancement and Services was started at ASSTC, Guwahati from December 13, 2021 in joint collaboration of ASSTC, Government of Assam and NESAC. The initial four days of the training courses would be conducted at ASSTC and the participants would be sent to NESAC for carrying out the remaining courses along with hands-on and mini project implementation. Sri Avinash Joshi, IAS, Principal Secretary to the Govt. of Assam, Revenue and Disaster Management Department stressed

on the need for acquiring technical skills that are contemporary and facilitative as job aids during his inaugural speech. Dr S.P. Aggarwal, Director, NESAC delivered a keynote address to the participants and highlighted the benefits of geospatial technology for the management of natural resources and infrastructure planning including disaster management support. Shri PLN Raju, Director, ASSAC & Special Secretary, Science & Technology also addressed the gathering.

NESAC signed MoU with Dept. of Science & Technology, Govt. of Arunachal Pradesh

A Memorandum of Understanding (MoU) was signed between NESAC and the Government of Arunachal Pradesh on December 20, 2021 at Pasighat for the utilization of space technology for the development of the state. The event was witnessed by Hon'ble Chief Minister Shri Pema Khandu, Deputy Chief Minister, Cabinet Ministers, Chief Secretary, Principal Secretaries, Commissioners, Secretaries and Deputy Commissioners of the state. Dr. S.P Aggarwal, Director, NESAC signed the MoU on behalf of NESAC, while Shri Ajay Chagti, IAS, Secretary, Science & Technology, Govt. of Arunachal Pradesh signed on behalf of Govt. of Arunachal Pradesh.

NESAC participated in Brain Storming Conclave organized by NECTAR

NESAC participated in the 'Brain Storming Conclave on Atmanirbhar North East through S&T Interventions' organized by North East Centre for Technology Application & Reach (NECTAR) at Cotton University, Guwahati, during December 21-22, 2021. A team consisting of four scientists from NESAC exhibited activities and achievements of the Center. The exhibition attracted many students and academicians from different scientific institutes and organizations. The scientists interacted with the students and other visitors and explained to them about the different projects and activities carried out at the Center.

Valedictory program of two week course on Earth Observation & Applications at ASSTC, Guwahati

The 2nd two week training program on Earth Observation & Applications: Fundamentals, Recent Trends in Technological advancement and Services ended on December 24, 2021. The program started with a welcome address by Dr. K.K Sarma, Scientist-SG, NESAC. Then Dr. S.P. Aggarwal, Director, NESAC delivered his address to the participants. Dr Dibyajyoti Chutia, Scientist-SF moderated the mini project demonstrations presented by the participants. The program was attended by all the participants including the senior Faculty members and project mentors of NESAC. Shri Amitabh Rajkhowa, Secretary, Revenue and Disaster Management Department, Government of Assam graced the

occasion as Chief Guest. Shri Pankaj Chakravarty, ACS, Principal, ASSTC addressed the participants as Guest of Honor.

Government of Assam signed MoU with NESAC to promote Space Technology Applications

Department of Science & Technology and Climate Change, Govt. of Assam and NESAC has signed a Memorandum of Understanding (MoU) to promote the space technology applications by various user departments in the state of Assam. The MoU was signed at Guwahati on the January 1, 2022 in the presence of Hon'ble Chief Minister of Assam Dr. Himanta Biswa Sarma and Hon'ble Minister of Science & Technology and Climate Change, Govt. of Assam Shri Keshab Mahanta. Shri Gyanendra Dev Tripathi, Commissioner & Secretary, Department of Science & Technology and Climate Change, Govt. of Assam and Dr. S.P. Aggarwal, Director, NESAC signed the MoU on behalf of Govt. of Assam and NESAC respectively. Smt. Kimnei Changsan, Director, Assam Science Technology and Environment Council (ASTEC), Assam and Shri PLN Raju, Director, Assam State Space Application Centre (ASSAC) signed the MoU as witnesses representing Govt. of Assam, while Dr. K.K. Sarma, Scientist-SG and Dr. Bijoy K. Handique, Scientist-SF signed the MoU as witnesses representing NESAC.

Department of S&T and Climate Change, Govt. of Assam as the nodal department from the Government of Assam will coordinate with all relevant departments, institutions, agencies and organizations in the state of Assam to assess the requirement of space technology support for development planning.

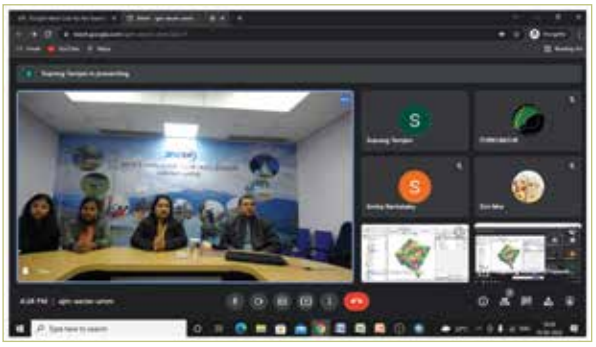
16th Meeting of the NESAC Governing Council (GC)

The 16th meeting of the NESAC Governing Council (GC) was held on January 12, 2022 through video conference mode. Dr. K. Sivan, Secretary, Department of Space (DoS) & Chairman, NESAC-GC, Chaired the meeting. The meeting was attended by Additional Secretary, DoS; Secretaries of Dept. of Science and Technology from the NE states; Scientific Secretary, ISRO; Directors of SAC, PRL, and NRSC, Directors of ICAR-NEH, IIT-Guwahati, NEIGRIHMS, and IIM-Shillong; VC, NEHU; Secretary, S&T, NEC; program directors from the ISRO HQ program offices; and other members of NESAC GC. Director, NESAC made a detailed presentation on the action taken for the actions identified during the 15th meeting of NESAC GC, activities carried out at NESAC since 15th meeting of NESAC GC, plan for next year, audited statement of accounts, and budget for next year.

The Chairman and members of NESAC GC expressed satisfaction on the diverse and voluminous work carried out by NESAC in the last one year and gave a few critical assignments. Chairman, NESAC GC asked to make detailed plan for timely implementation of 110 projects under the Plan of Actions prepared for each state on utilization of space science and technology for development and governance related activities.

Training for officers of SoCRAN, Nagaland conducted under FOCUS

Two days virtual training on 'Use of Agroclimatic Atlas in Land Suitability Studies and Land Use Planning' under FOstering Climate resilient Upland farming Systems in the northeast (FOCUS)- Nagaland Project with financial assistance from Food and Agriculture Organization (FAO)- India was organized for the officers of Society of Climate Resilient Agriculture in Nagaland (SoCRAN) during February 9-10, 2022 (Hybrid mode). The program was organized in collaboration with Nagaland GIS and Remote Sensing Centre (NGISRSC). 23 participants attended the training program. Dr. Jonali Goswami and Dr. Chandan Goswami, from NESAC delivered the online lectures.



Launch of Forest Fire Mobile App

NESAC has developed a forest fire incident reporting App for Forest and Environment Department, Meghalaya. The app was launched by Shri James P K Sangma, Meghalaya Forest and Environment Minister on February 24, 2022 at Shillong. The purpose of the App development is to support the forest field officials engaged in forest fire mitigation activities in the state. The app has the provision of collection of forest fire related information in three local languages widely spoken in Meghalaya i.e. in Garo, Khasi and Jaintia. During the launching of the app, Dr. S P Aggarwal, Director, NESAC informed the role and functions of the fire app developed by NESAC for the benefit of forest fire fighting authorities in the State. The program was attended by Shri B K Lyngwa, PCCF & HoFF, Forest & Environment Department, Meghalaya, Shri Razi, Commissioner & Secretary, Govt. of Meghalaya & Chairman, Meghalaya Biodiversity Board and several other important dignitaries from Govt. of Meghalaya.

One week training program on UAV Remote Sensing and its Applications for ASSTC, Assam

A one week training program on "Unmanned Aerial Vehicle (UAV) Remote Sensing and its Applications" was carried out at NESAC during February 21-25, 2022. A total of 44 trainees from the Recorders Certificate Class Course Training, 2021-22 (Batch-1 Group-B) of Assam Survey and Settlement Centre (ASSTC), Government of Assam attended the training program. The program has been conducted following the MoU executed between NESAC and ASSTC, Government of Assam. The course was focused on understanding the UAV and its components, flight planning for data acquisitions for various remote sensing applications and different data processing techniques for the generation of valuable high resolution data products such as Orthomosaics, Digital Surface/Terrain Models, 3D Textured Models, etc. which can then be used for various planning and R&D purposes. The participants were also given hands-on experience on end-to-end workflow: UAV

operations, mission planning, data acquisition, data processing and data analysis.

NESAC participated in 'Vigyan Sarvatra Pujyate' Program

NESAC actively participated in the "Vigyan Sarvatre Pujyate" program as part of the Science Week Festival under the Azadi Ka Amrit Mahotsav during February 22-28, 2022, organized across the nation and coordinated by Vigyan Prasar. The Space on Wheels vehicle was taken to six schools / venues covering Meghalaya (Shillong and Nongpoh) and Assam (Guwahati, Nagaon, and Jorhat) during the same time. More than 1000 students and teachers visited the Space on Wheels in each of the venues and the students were very happy and enthusiastic to witness the exhibition. The inaugural program of Vigyan Sarvatre Pujyate was organized at Shillong on February 22, 2022 in collaboration with State Council for Education, Research, and Training, where Dr. Shyam S. Kundu, Sr Scientist participated and explained the features available in the Space on Wheels. Dr. K.K. Sarma, Sr Scientist delivered a talk on how the Indian Space Research Organisation helped in nation building and development of the NE region of India. The Space on Wheels vehicle was also visited by the Secretary, Department of Science, Technology, and Environment, Government of Assam and by the Director & Regional Officer, CBSE, Guwahati.

Celebration of National Science Day at NESAC

NESAC celebrated National Science Day on February 28, 2022, organized under the aegis of the Indian Society of Geomatics (ISG)-Shillong Chapter and the Indian Society of Remote Sensing-Shillong Chapter. The program was coordinated by Dr. B.K. Handique, Secretary, ISG-Shillong Chapter and Dr. K.K. Sarma, Secretary, ISRS-Shillong Chapter.

Quiz and painting competitions for high school and higher secondary students were organized as part of the event. Around 80 students accompanied by 15 teachers from Kendriya Vidyalaya, North Eastern Police Academy; MeECL School, Sumer & Barapani; K.V Umroi Cantt., Umroi and Christ School (International), Nongsder attended the talk delivered by Dr. S.P Aggarwal, Director NESAC on the topic 'Indian Space Program and the Societal Benefits'. An exhibition on different aspects of Space technology and its applications was also organized to mark the occasion. The program was concluded with Vote of Thanks proposed by Dr. Chandan Goswami, Treasurer, ISG-Shillong Chapter.

Air Marshal Shri Anjan Kumar Gogoi, Hon'ble Member, NEC visited NESAC

Member, North Eastern Council, Air Marshal Shri Anjan Kumar Gogoi, PVSM, AVSM, VSM (Retd.) has visited NESAC on March 3, 2022. Dr. K.K. Sarma, Scientist/Engineer-SG welcomed the Hon'ble Member, NEC and felicitated him on the occasion of his maiden visit to NESAC. Dr. Sarma made a brief presentation to the Hon'ble Member on the activities and achievements of NESAC during its last 21 years of existence. Hon'ble Member, NEC appreciated the effort of NESAC in providing space-based support with cutting edge technology for

governance and developmental planning in all eight states. He offered his best wishes for future endeavours and expressed interest to work with NESAC on resolving some specific issues of NER.

Training program on "Remote sensing & GIS applications in Forestry & Ecology"

A short training program on "Remote Sensing & GIS applications in Forestry & Ecology" for research scholars from Tezpur University, Assam, was organized during March 22 – 26, 2022 at the NESAC Outreach Facility. A wide range of topics such as satellite image interpretation, GIS analysis, classification and accuracy assessment, GPS and Map projects, Growing stock and biomass estimation, Forest change detection and biodiversity monitoring, wildlife habitat evaluation etc. were covered during the training along with practical sessions. Dr. S.P. Aggarwal, Director, NESAC interacted with the trainees and discussed regarding their ongoing works and research investigations being planned using applications of geospatial techniques. A total of 10 trainees sponsored from Tezpur University attended the training program, which was coordinated by Dr. Rocky Pebam, Scientist-SE, NESAC.

Various Office Events & Celebrations

NESAC bid farewell to Shri PLN Raju as Director, NESAC

Shri PLN Raju, Former Director, NESAC was superannuated from his service on June 30, 2021. He was serving as Director of NESAC at that time. He took over the charge of Director, NESAC from Dr. PG Diwakar on October 7, 2015. During his tenure of almost six years, he was instrumental in

setting up an exclusive outreach facility at NESAC with international standards for conducting training and other outreach activities. Training programs and capacity building was made part of the NESAC core activity by him. The activity of the centre grew both horizontally and vertically during his tenure as Director. He also took personal interest in setting up a vibrant residential facility for NESAC staff at Umiam. The centre attained new heights under the able leadership of Shri PLN Raju, which was lauded by all NESAC family members.

NESAC celebrated 75th Independence Day of the Nation

75th Independence Day was celebrated at NESAC on August 15, 2021. Dr. K.K. Sarma, Sci./Engr 'SG' hoisted the national flag in the presence of other staff and thereafter addressed the NESAC staff. NESAC Main Office Campus & Outreach Facility was illuminated with LED lights to mark Azadi Ka Amrut Mahotsav on August 15, 2021.

NESAC celebrated its 21st Foundation Day

21st Foundation Day of NESAC was celebrated on September 6, 2021 with a combination of technical and cultural fervour. The program began at 10 AM in the NESAC auditorium. Keeping in mind the COVID restrictions, the number of in-person attendees was kept at a minimum, with only the Director-in-Charge, Senior Scientists and members of the administration and organizing committee were present in the auditorium. Other guests were invited to attend the program through virtual mode. The Foundation Day program began with the lighting of the lamp by Dr. K.K. Sarma, Director i/c and senior scientists present in the auditorium, followed by a welcome speech by Dr. B.K. Handique, Sr. Scientist, NESAC.

Shri PLN Raju, former Director, NESAC and Special Secretary, Department of Science & Technology, Govt. of Assam released the upgraded version of the NER-DRR and addressed all the NESAC staff on the occasion. Dr. V.K. Dadhwal, former Director, Indian Institute of Space Science & Technology (IIST), Trivandrum delivered the Foundation Day Talk on "Earth Observation from Space: Opportunities and Challenges", which was thoroughly enjoyed by all.

A brief cultural program was also organized to celebrate the event that included mellifluous singing, exhilarating dancing and heartwarming poem recitation etc.

Dr. S.P. Aggarwal assumed the charge of Director, NESAC

Dr. S.P. Aggarwal assumed the charge of Director, NESAC on September 17, 2021. Dr. Aggarwal is a highly accomplished scientist in the field of Remote Sensing and GIS applications and at the same time, he has immensely contributed to the capacity building and outreach program of ISRO. He did PhD from the Indian Agricultural Research Institute, New Delhi and post-doctoral research from ITC/IHE, The Netherlands in the field of hydrological modelling.

He served as the Group Head of Water Resources Department at the Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun, before joining NESAC.

Mock Drill Exercise on Earthquake Evacuation at NESAC

An earthquake evacuation mock drill exercise

was conducted at NESAC Office on September 24, 2021 in joint collaboration of a team of 1st Battalion, NDRF, Guwahati and CISF Unit, NESAC. Shri H.P.S. Kandari, Commandant, 1st Bn, NDRF, along with other staff of NDRF visited NESAC around 10:30 AM and conducted the mock drill exercise at NESAC for around 2 hours. A brief demonstration of Drone operation and other technological developments at NESAC were also given to the NDRF staff.

NESAC celebrated Vigilance Awareness Week

Vigilance Awareness Week was celebrated nationwide from October 26 - November 1, 2021 coinciding with the birthday of Sardar Ballabhbhai Patel on October 31, 2021 which

is celebrated as National Unity Day. This year, Vigilance Awareness Week was celebrated with the theme "Independent India @75: Self Reliance with Integrity". NESAC celebrated Vigilance Awareness Week and National Unity Day with a week-long program. An essay writing competition for NESAC staff was organized on October 25, 2021 followed by a Patriotic Singing Competition on October 27, 2021 a Slogan Writing competition on October 26, 2021 and a Quiz Competition on October 29, 2021. Director, NESAC administered the Vigilance Awareness Pledge to the staff of NESAC on October 26, 2021 and the National Unity Pledge on October29, 2021. A lecture on the life and activities of Sardar Ballabhbhai Patel was delivered by Shri Sishir Tiwari, Asst. Professor, Dept of Law, NEHU, Shillong via online mode on October 28, 2021. NESAC staff took out a Padayatra to mark the conclusion of the week-long celebration on October 31, 2021. NESAC staff took out a Padayatra to mark the occasion on October 31, 2021.

Celebration of Constitution Day at NESAC

NESAC celebrated Constitution Day of the Nation on November 26, 2021. NESAC Staff watched the live telecast of a program arranged on this occasion from the Central Hall of Parliament, which was led by the Hon'ble President of India. Hon'ble Vice President, Hon'ble Prime Minister, Hon'ble Speaker of Lok Sabha, Ministers, MPs etc. also graced the program. Staff of NESAC led by Director, NESAC joined the Hon'ble President as he read out the Preamble of The Constitution. Two new portals were also inaugurated to mark the occasion.

Awareness Program on Sexual Harassment of Women in Workplace

A one day awareness program on Sexual Harassment of Women in Workplace (Prevention,

Prohibition and Redressal) Act. 2013 was conducted at NESAC on December 9, 2021 to commemorate the 8th anniversary of notification of the Act. Dr. S.P. Aggarwal, Director, NESAC made the inaugural speech stating the importance of the said Act and Dr. Umeshwari Dkhar, from Shillong Law College gave an invited talk on the Prevention of Sexual Harassment (POSH) Act. The program was attended (offline as well as online) by all the employees and staff of NESAC including temporary and outsourced staff and personnel of the CISF Unit. Dr. Pebam Rocky, Scientist/Engineer 'SE' and member, Internal Complaint Committee (ICC), made a brief remark about the activities of the ICC and the findings of the survey report on the awareness level of the Act among the staff of NESAC. Shri Subakordor Syiemlieh, Administrative Officer i/c proposed the vote of thanks and concluded the program.

Celebration of 73rd Republic Day at NESAC

73rd Republic Day of the nation was celebrated at NESAC on on January 26, 2022 with a colourful programme. Dr. S.P. Aggarwal, Director, NESAC hoisted the Tricolor amidst the singing of the National Anthem by the staff of NESAC at 9 AM. The CISF unit of NESAC offered a guard of honour to Director, NESAC and performed the Republic Day parade. Director, NESAC addressed the staff of the centre with an informative speech, where he highlighted the significance of the Republic Day celebration and briefed about the activities and achievements of ISRO and NESAC in recent times. This was followed by the distribution of sweets to all the staff who attended the program.

Swachhata Pakhwada celebration at NESAC

Swachhata Pakhwada was celebrated at NESAC during February 1-15, 2022 in pursuance of CEPO, ISRO HQ Guidelines. A Swachhata Pakhwada Implementation Cell (SPIC) of NESAC was constituted to formulate an action plan for observation of various activities throughout the fortnight. All NESAC Employees, Research Scholars and Outsourced Workers participated enthusiastically in the events to make our workplace and surroundings more clean and plastic free.

International Women's Day Celebration at NESAC

Every year, 8th March is globally observed as International Women's Day for celebrating the social, economic, cultural and political achievements of Women. As part of the celebration, an online programme was organized at NESAC, where an invited talk was delivered by Dr. Sonali Ghosh, IFS, CCF, Assam forest Department, Guwahati on "Role of women in forest conservation". As part of the celebration, selected outsourced women staff of NESAC were awarded for their exemplary services.

Mobile Exhibition as part of Azadi Ka Amrit Mahotsav

A mobile exhibition displaying 75 freedom fighters from across the country along with related video clips was shown to the general public at some of the important locations in Shillong on March 23, 2022 to celebrate and commemorate 75 years of India's independence. This Mahotsav signifies the glorious history of our country, its culture and achievements. The exhibition was aimed at bringing live stories of unsung heroes whose sacrifices have made freedom a reality for us and also revisits the milestones, freedom movements etc.

Dr. S.P. Aggarwal, Director, NESAC flagged off the mobile exhibition from the premise of NESAC main building in the presence of NESAC staff. Dr. Pebam Rocky, Scientist-SE, NESAC coordinated the exhibition in support of the local administration of Shillong.

Official Language Implementation

NESAC celebrated Hindi Fortnight from September 14-29, 2021

Keeping in view the guidelines issued by the Central Government from time to time on Standard Operating Procedures (SOP) in the context of COVID-19, Hindi Pakhwada was celebrated at NESAC from September 14-29, 2021 with limited programs. The fortnight was inaugurated on September 14, 2021 by Dr. K.K. Sarma, Director i/c, NESAC followed by administering of a pledge to all the staff. A message from the Hon'ble Home Minister on the occasion of Hindi Diwas was read out to all.

A number of competitions such as creative writing, Hindi poetry recitation, Hindi story reading, extempore speech, Dictation and calligraphy competition were organized. Throughout the fortnight, key hymns in the Hindi language were displayed.

A Hindi workshop was organized on September 24, 2021 for all permanent employees by Dr. Sharmila Tai, Hindi Pradhyapak from Central Hindi Training Institute, Guwahati on the topic – "Hindi Grammar and Noting – Draft Writing".

The closing ceremony was organized on September 29, 2021 following the COVID guidelines. Dr. S.P. Aggarwal, Director, NESAC chaired the closing ceremony and congratulated everyone on the successful completion of Hindi Pakhwada. He also handed over prize money and certificates to the winners of various competitions. The program ended with vote of thanks proposed by Shri Avaneesh Shukla, Senior Administrative Officer and Member Secretary, Official Language Implementation Committee of the Centre.

Honour for NESAC for implementing the Official Language Policy of the Union during the Year 2017-18

The official language conference for East and Northeast region was organized in Dibrugarh

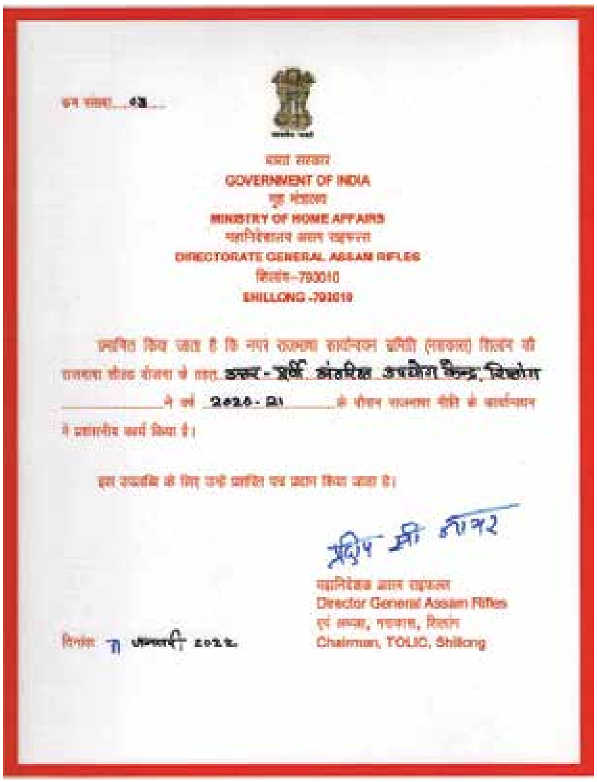
on December 18, 2021 by the Department of Official Language. The conference was attended by about 650 participants including the Heads of Office and Official Language Officers of Central Offices from 13 states. NESAC, Umiam was awarded the first prize for Implementing Official Language Policy of the Union during the year 2017-18 in the category of offices of 11 to 50 personnel located in the North Eastern Region. Dr. K.K Sarma, Senior Scientist of NESAC and Smt. Namita Rani Paul Mitra, Junior Translation Officer received the Official Language Shield and Commendation certificate from Smt. Anshuli Arya, Secretary, Department of Official Language.

Celebration of World Hindi Day & World Hindi Week at NESAC

World Hindi Day & World Hindi week were celebrated on January 10, 2022 and during January 10-17, 2022 respectively at NESAC to promote Official Language Hindi in official work among the staff of NESAC. The inauguration of the week-long celebration was marked by the lighting of the lamp by Dr. S.P. Aggarwal, Director, NESAC.

Various competitions were organized via online mode during January 11-14, 2022, such as- Drawing competition, Hindi poetry recitation competition and creative writing competition. The staff of NESAC participated in these competitions with full enthusiasm. The closing ceremony was organized in online mode with the virtual presence of staff of NESAC on January 17, 2021 in which Dr. S.P. Aggrawal, Director, NESAC thanked everyone for successfully organizing the World Hindi Week.

NESAC awarded with Certificate of Appreciation for doing commendable work in the Implementation of official language Hindi


भारत सरकार
GOVERNMENT OF INDIA
गृह मंत्रालय
MINISTRY OF HOME AFFAIRS
DIRECTORATE GENERAL ASSAM RIFLES
शिलांग-793010
SHILLONG -793010

Director General Assam Rifles
Chairman, TOLIC, Shillong

Under the Town Official Language Implementation Committee, Shillong Shield Scheme 2020-2021, NESAC was awarded a Certificate of Appreciation for doing commendable work in the implementation of the official language Hindi.

Important Visitors

22.07.2021	Shri Keshab Mahanta, Minister, S&T, H&FW, IT, Assam
15.09.2021	Dr. Arun Kumar Verma, Vice Chancellor, ICFAI University, Dimapur
03.03.2022	Air Mshl A K Gogoi (Retd.), Member NEC

Welfare of SC & ST

i) The welfare of SCs & STs is being taken care of in this centre. This centre has been observing the guidelines for recruitment, promotion and welfare of Scheduled Castes and Scheduled Tribes. The following table indicates the status of representations of persons belonging to Scheduled Caste and Scheduled Tribe.

ii) A Liaison Officer for SCs, STs, OBCs and Minority of this centre has been nominated in accordance with Chapter-9 of Brochure on Reservations to SCs, STs, OBCs and Minority in the PSUs/Autonomous Bodies Grant-in-aid organization.

iii) 16.67% (Approx.) of Group B and 25% of Group C employees are from the ST community.

iv) Some of the Research Scholars are from SC/ST Community.

v) Many of the outsourced manpower such as Data Entry Operators, O&M, Gardening, Housekeeping and Canteen have been outsourced and a maximum of the workers deployed by the outsourcing firms belong to SC/ST.

vi) Two posts are reserved for PwD and during 2021-2022 only one candidate has been appointed.

Right to Information:

NESAC is receiving RTI Applications through online and offline modes. The following table shows the number of RTI Applications received and disposed off.

Table: Status of representations of persons belonging to Scheduled Caste and Scheduled Tribe

Sl No	Centre / Unit	Total strength of employees 2021-2022	Strength of SC employees 2021-2022	Strength of ST employees 2021-2022	Strength of PwD employees 2021-2022
01	NESAC	53	02	06	01

Year	Information		Replied		No. of application transferred to other Public Authority	No. of application rejected
	No. of application received	No. of appeal	No. of application disposed off	No. of appeal disposed off		
2021-2022	41	08	37	08	04	Nil

Details of RTI Officials:

Particulars	Name and designation
First Appellate Authority (FAA)	Dr K K Sarma Sci/Engr 'SG', NESAC email: kk.sarma@nesac.gov.in
Central Public Information Officer (CPIO)	Dr. Shyam S Kundu Sci/Engr 'SF', NESAC email: ss.kundu@nesac.gov.in
Assistant Public Information Officer (APIO)	Shri Kumar Anand Administrative Officer, NESAC email: admin@nesac.gov.in

NESAC PUBLICATIONS APRIL 2021 TO MARCH 2022

Journal Publications

1. Ain, A., Gogoi, M., & Chutia, D. (2021). CNN-Enhanced Multi-Indices Patch-Based Classification: A Case Study of Guwahati City. *International Journal for Research in Applied Science & Engineering Technology*, 9(XII), 1824-1840. https://doi.org/10.22214/ijraset.2021.39593
2. Bhowmick, I. P., Chutia, D., Chouhan, A., Nishant, N., Raju, P. L. N., Narain, K., Kaur, H., Pebam, R., Debnath, J., Tripura, R., Gogoi, K., Nag, S. C., Nath, A., Tripathy, D., Debbarma, J., Das, N., Sarkar, U., Debbarma, R., Roy, R., Debnath, B., Dasgupta, D., Debbarma, S., Tripura, K. J., Reang, G., Sharma, A., Rahi, M., & Chhibber-Goel, J. (2021). Validation of a Mobile Health Technology Platform (FeverTracker) for Malaria Surveillance in India: Development and Usability Study. *JMIR Formative Research*, 5(11), e28951. https://doi.org/10.2196/28951
3. Bhowmick, I. P., Nirmolia, T., Pandey, A., Subbarao, S. K., Nath, A., Senapati, S., Tripathy, D., Pebam, R., Nag, S., Roy, R., Dasgupta, D., Dasgupta, J., Gogoi, K., Gogoi, K., Borah, L., Chanda, R., Borgohain, A., Mog, C., Sarkar, U., Gogoi, P., Debnath, B., Debbarma, B., Debbarma, J., Bhattacharyya, D. R., Joshi, P. L., Kaur, H., & Narain, K. (2021). Dry Post Wintertime Mass Surveillance Unearths a Huge Burden of P. *vivax*, and Mixed Infection with P. *vivax* P. *falciparum*, a Threat to Malaria Elimination, in Dhalai, Tripura, India. *Pathogens*, 10(10), 1259. https://doi.org/10.3390/pathogens10101259
4. Kannaujiya, S., Yadav, R. K., Champati ray, P. K., Sarkar, T., Sharma, G., Chauhan, P., Pal, S. K., Roy, P. N. S., Gautam, P. K., Taloor, A. K., & Yadav, A. (2022). Unraveling seismic hazard by estimating prolonged crustal strain buildup in Kumaun-Garhwal, Northwest Himalaya using GPS measurements. *Journal of Asian Earth Sciences, 223*, 104993. https://doi.org/10.1016/j.jseaes.2021.104993
5. Banik, T., Thandlam, V., De, B. K., Kundu, S. S., Gogoi, R. B., Raju, P. L. N. & Guha, A. (2021). Understanding dynamics of tropical cyclones in the Bay of Bengal using lightning data. *Meteorology and Atmospheric Physics, 133*, 1505-1522. https://doi.org/10.1007/s00703-021-00824-y
6. Arun, B. S., Gogoi, M. M., Hegde, P., Borgohain, A., Boreddy, S. K., Kundu, S. S., & Babu, S. S. (2021). Carbonaceous Aerosols over Lachung in the Eastern Himalayas: Primary Sources and Secondary Formation of Organic Aerosols in a Remote High-Altitude Environment. *ACS Earth and Space Chemistry*, 5(9), 2493-2506. https://doi.org/10.1021/acsearthspacechem.1c00190
7. Arun, B. S., Gogoi, M. M., Borgohain, A., Hegde, P., Kundu, S. S., & Babu, S. S. (2021). Role of sulphate and carbonaceous aerosols on the radiative effects of aerosols over a remote high-altitude site Lachung in the Eastern Himalayas. *Atmospheric Research, 263,* 105799. https://doi.org/10.1016/j.atmosres.2021.105799
8. Sharma, G., Walia, D. and Banerjee, P. (2021). Statistical Behavior of Electron Density in the Ionosphere before 2016 Manipur Earthquake from GPS Observation Stations at North East India. *Geotectonics, 55(4)*, 646-653. https://doi.org/10.1134/S0016852121040130
9. Singh, G. R., Dhanya, C. T., & Chakravorty, A. (2021). A Robust Drought Index Accounting Changing Precipitation Characteristics. *Water Resources Research, 57(7)*, e2020WR029496. https://doi.org/10.1029/2020WR029496
10. Romero-Andrade, R., Trejo-Soto, M. E., Vega-Ayala, A., Hernández-Andrade, D., Vázquez-Ontiveros, J. R., & Sharma, G (2021). Positioning evaluation of single and dual-frequency Low-cost GNSS receivers signals using PPP and Static Relative methods in urban areas. *Applied Sciences, 11(22)*, 10642. https://doi.org/10.3390/app112210642
11. Subrahmanyam, K. V., Ramsenthil, C., Girach Imran, A., Chakravorty, A., Sreedhar, R., Ezhilrajan, E., Bala Subrahamanyam, D., Ramachandran, R., Kumar, K.K., Rajasekhar, M., & Jha, C. S. (2021). Prediction of heavy rainfall days over a peninsular Indian station using the machine learning algorithms. *Journal of Earth System Science, 130*, 240. https://doi.org/10.1007/s12040-021-01725-9

12. Nath, A. J., Kumar, R., Devi, N. B., Rocky, P., Giri, K., Sahoo, U. K., Bajpai, R. K., Sahu, N., & Pandey, R. (2021). Agroforestry land suitability analysis in the Eastern Indian Himalayan region. *Environmental Challenges, 4*, 100199. https://doi.org/10.1016/j.envc.2021.100199

13. Goswami, J., Das, R., Sarma, K. K., and Raju, P. L. N. (2021). Red Edge Position (REP), an Indicator for Crop Stress Detection: Implication on Rice (Oryza sativa L). *International Journal of Environment and Climate Change, 11(4),* 88-96. https://doi.org/10.9734/ijecc/2021/v11i430396

14. Pyngrope, O. R., Kumar, M., Pebam, R., Singh, S. K., Kundu, A., & Lal, D. (2021). Investigating forest fragmentation through earth observation datasets and metric analysis in the tropical rainforest area. *SN Applied Sciences, 3,* 705. https://doi.org/10.1007/s42452-021-04683-5

15. Gogoi, R. B., Kundu, S. S., & Raju, P. L. N. (2021). Impact of INSAT-3D radiance data assimilation using WRF 3DVAR on simulation of Indian summer monsoon and high-resolution rainfall forecast over hilly terrain. *Natural Hazards, 109*, 221-236. https://doi.org/10.1007/s11069-021-04833-3

16. Gogoi, R. B., Kutty, G., & Boroghain, A. (2021). Intercomparison of the impact of INSAT-3D atmospheric motion vectors in 3DVAR and hybrid ensemble-3DVAR data assimilation systems during Indian summer monsoon. Theoretical and Applied Climatology, 145, 585-596. https://doi.org/10.1007/s00704-021-03649-2

17. Yuan, S., Qie, X., Jiang, R., Wang, D., Wang, Y., Wang, C., Srivastava, A., & Tian, Y. (2021). In-Cloud Discharge of Positive Cloud-To-Ground Lightning and Its Influence on the Initiation of Tower-Initiated Upward Lightning. *Journal of Geophysical Research: Atmospheres, 126(24)*, e2021JD035600. https://doi.org/10.1029/2021JD035600

18. Handique, B. K., Goswami, C., Jena, P., Dutta, F., Samiam, R., Nongrum, I., Jha, D., Raju, P. L. N., Deka, C. R., Sarma, R., Sarmah, K., Dutta, H. K., Deb, S., Yari, B., Maibam, S., Thanpuli, P., Sailo, R., Muansangi, V., Katiry, D., Medo, T., Sharma, N. P., Lepcha, B., Roy, A., Bhattacharya, B. K., Patel, J. G., Singh, C. P., Manjunath, K. R., Kimothi, M. M., Mamatha, S., Kumar, P., Tahlani, P., & Ray, S. S. (2022). Applications of advanced geospatial technology for expansion of area under horticultural crops in North Eastern region of India. *Journal of the Indian Society of Remote Sensing, 50(2)*, 331-345. https://doi.org/10.1007/s12524-021-01474-8

19. Sahoo, U. D., Patnaik, B., Chintagunta, S., Kundu, S. S., & Aggarwal, S. P. (2022). A Cost-Effective Method for Design Installation and Maintenance of Solar Photovoltaic Power Generation System to Meet the Household Energy Requirement. *International Journal of Electronics and Electrical Engineering, 4(1)*, 1. https://doi.org/10.47893/IJEEE.2022.1182

20. Das, P. T., Lakiang, T. and Saikia, B. (2022). Soil fertility mapping using GIS in Meghalaya plateau. International Journal of Current Microbiology and Applied Sciences, 11(3), 71-79. https://doi.org/10.20546/ijcmas.2022.1103.009

21. Das, P. T., Goswami, C., & Karmakar R. M. (2021). Utilisation of geospatial technology for characterization, classification and mapping of forest soils of Assam. *Journal of Pharmacognosy and Phytochemistry, 10(4)*, 111-118

22. Bhowmick, I. P., Pandey, A., Subbarao, S. K., Pebam, R., Majumder, T., Nath, A., Nandi, D., Basu, A., Sarkar, A., Majumder, S., Debbarma, J., Dasgupta, D., Borgohain, A., Chanda, C., Das, M., Gogoi, K., Gogoi, K., Joshi, P. L., Kaur, H., Borkakoti, B., Bhattacharya, D. R., Khan, A. M., Sen, S., & Narain, K. (2022). Diagnosis of Indigenous Non-Malarial Vector-Borne Infections from Malaria Negative Samples from Community and Rural Hospital Surveillance in Dhalai District, Tripura, North-East India. *Diagnostics, 12(2)*, 362. https://doi.org/10.3390/diagnostics12020362

23. Srivastava, A., Liu, D., Xu, C., Yuan, S., Wang, D., Babalola, O., Sun, Z., Chen, Z., & Zhang, H. (2022). Lightning Nowcasting with an Algorithm of Thunderstorm Tracking Based on Lightning Location Data over the Beijing Area. *Advances in Atmospheric Sciences, 39*, 178-188. https://doi.org/10.1007/s00376-021-0398-2

Conference Proceedings

1. Kundu, S. S., Kundu, A., Borgohain, A., & Raju, P.L.N. (2021, August, 2-6). *Diurnal and seasonal variability of CCN concentration*

and its relation with aerosol optical properties over a mountainous terrain in NE region of India [Paper presentation]. International Conference on Clouds and Precipitation (ICCP), Pune, India. https://iccp2021.ipostersessions.com/Default.aspx?s=iccp_2021_gallery

2. Choudhary, A. K., Barman, S., Moyra, T., Debnath, A., & Bhattacharjee, A. (2021). Gain Enhancement of Dual-Band Microstrip-Fed Antenna with complementary split ring resonators and rectangular slots embedded in Patch for Wireless Applications using Metamaterial Cell-Based Superstrate. *In 2021 2nd International Conference on Range Technology* (ICORT) (pp. 1-6). IEEE. https://doi.org/10.1109/ICORT52730.2021.9581727
3. Singh, P. S., Nongsiej, I. M., & Marboh, V. (2021, April, 2-4). *3D Point Cloud Segmentation using a combination of RANSAC and Clustering methods* [Paper presentation]. 2nd International Conference on Unmanned Aerial Systems in Geomatics - 2021 (UASG-2021), IIT Roorkee, India.
4. Chhari, A. (2021, September, 12-17). *Identification of major air pollutant source location in India using satellite data and statistical based analysis* [Paper presentation]. 16th International Global Atmospheric Chemistry Scientific Conference held online. https://igacproject.org/
5. Gogoi, M., Borgohain, A., Kundu, S. S., Kundu, A., Bhuyan, P. K., Chanda, R., Kumar, P., Maity, A., & Raju, P. L. N. (2021, November, 23-26). *Characteristics of Atmospheric Boundary Layer over Umiam, Meghalaya* [Paper presentation]. International Symposium of Tropical Meteorology (INTROMET-2021), Kochi, India. https://www.intromet2021.org/
6. Kundu, A., Kundu, S. S., Sharma, S. K., Mahanta, R., Banik, T., Gogoi, M., & Borgohain, A. (2021, November, 23-26). *Morphology of the vertical structure of cloud and precipitation over a complex terrain of North East India* [Paper presentation]. International Symposium of Tropical Meteorology (INTROMET-2021), Kochi, India. https://www.intromet2021.org/
7. Chhari, A., Chakravorty, A., Srivastava, A., Kundu, S. S., & Gogoi, R. B. (2021, November, 23-26). *Analysis of a Mesoscale Convective Thunderstorm Event in Assam, India* [Paper presentation]. International Symposium of Tropical Meteorology (INTROMET-2021), Kochi, India. https://www.intromet2021.org/
8. Chhari, A., Chakravorty, A., Kundu, S. S., Gogoi, R. B., Kakati, P., & Sarma, K.K. (2021, December, 21). *Probabilistic Approach to Forecast Severe Convective Thunderstorm Events* [Paper presentation]. American Geophysical Union Fall Meet held online. https://agu.confex.com/agu/fm21/meetingapp.cgi/Paper/923064
9. Chouhan, A., Agrawal, A. & Sur, A. (2021). Unsupervised Change Detection in Very High Resolution Multi-Spectral Images. In *2021 IEEE International India Geoscience and Remote Sensing Symposium (InGARSS)* (pp. 293-296). IEEE. https://doi.org/10.1109/InGARSS51564.2021.9791474
10. Chhari, A., Dhadwal, V. K., Sahu, L. K., Madhvan, B. L., Das, T., Ramasamy, B., Kumar, P., Baburajan, P. K., Chakravorty, A., Raju, P. L. N., & Sinha, P. R. (2021). *Source apportionment of surface-level trace gases and particulate matter at three tropical coastal sites in India* [Paper presentation]. EGU General Assembly 2021 held online. https://doi.org/10.5194/egusphere-egu21-14152
11. Srivastava, A., & Kundu, S. S. (2021, November, 23-26). *Thunderstorm tracking and lightning jump characteristics over northeastern region of India* [Paper presentation]. International Symposium of Tropical Meteorology (INTROMET-2021), Kochi, India. https://www.intromet2021.org/
12. Banik, T., Pattanaik, D. R., Das, A. K., Kundu, S. S., Gogoi, R. B., & Kundu, A. (2022, January 31-February 4). *Explicit lightning forecasting Over North Eastern India: Preliminary results* [Paper presentation]. 21st National Space Science Symposium (NSSS), IISER Kolkata, India.
13. Gogoi, M., Borgohain, A., Kundu, S. S., Sharma, S. K., Bhuyan, P. K., Kundu, A., Barman, N., & Raju, P. L. N. (2022, January 31-February 4). *Characterization of Atmospheric Boundary Layer over High Altitude Station Umiam* [Paper presentation]. 21st National Space Science Symposium (NSSS), IISER Kolkata, India.
14. Gogoi, R. B., Yadav, A., Kundu, S. S., & Aggarwal, S. S. (2022, January 31-February

4). *Impact of Satellite Based Geographical and Meteorological Data on Simulation of Rainfall over North Eastern Region of India Using a Limited-Area Model* [Paper presentation]. 21st National Space Science Symposium (NSSS), IISER Kolkata, India.

15. Kundu, A., Kundu, S. S., Sharma, S. K., Mahanta, R., Banik, T., Gogoi, M., & Borgohain, A. (2022, January 31-February 4). *Understanding the vertical structure of clouds observed over a high altitude station of North East India* [Paper presentation]. 21st National Space Science Symposium (NSSS), IISER Kolkata, India.

Project Report

1. Goswami, C., & Samiam, R. (2021). *Identification of suitable areas for kiwi & walnut cultivation in and around Kaho, Kibithoo and Mosai Village of Arunachal Pradesh* (NESAC-SR-267-2021).
2. Das, P. T., Saikia, B., Lakiang, T., & Aggarwal, S. P. (2021). *Expansion of Khasi mandarin in Pynursla block of Meghalaya using RS and GIS* (NESAC-SR-268-2021).
3. Das, P. T., Saikia, B., Lakiang, T., & Sharma, K. K. (2021). *Expansion of paddy in Umling block of Meghalaya using RS and GIS* (NESAC-SR-265-2021).
4. Das, P. T., Saikia, B., Lakiang, T., Jha, D. K., Longmalai, P., & Raju, P. L. N. (2021). *Mapping of soil fertility in Meghalaya using geospatial technology and soil health card* (NESAC-SR-259-2021).
5. Das, P. T., Goswami, J., Goswami, C., Handique, B. K., Bora, G., Saikia, P., & Raju, P. L. N. (2021). *Applications of Geospatial and Web Technology for Sericulture development in Chirang district of Bodoland Territorial Council, Assam* (NESAC-SR-260-2021).
6. Saikhom, V., & Sharma, G. (2021). *DGPS and UAV Surveying of Dalmia Cement Lease Areas at Thangskai, East Jaintia Hills, Meghalaya* (NESAC-SR-263-2021).
7. Saikhom, V. (2021). *Site suitability analysis using geospatial technique for Air Traffic Control (ATC) in Yachuli near Ziro* (NESAC-SR-258-2021).
8. Sharma, G. (2021). *Surveying of the proposed mining lease boundary pillars over an area of 13.098 ha. of Star Cement Limited, East Jaintia Hills, Meghalaya, using Differential Global Positioning System (DGPS) techniques* (NESAC-SR-253-2021).
9. Sharma, G. (2021). *Differential Global Positioning System (DGPS) surveying of the proposed mining lease boundary pillars over an area of 20.608 ha. of Star Cement Meghalaya Limited, East Jaintia Hills, Meghalaya* (NESAC-SR-254-2021).
10. Sharma, G. (2021). *Proposed mining lease boundary pillars surveying using Differential Global Positioning System (DGPS) techniques over an area of 74.373 ha. of Star Cement Meghalaya Limited, East Jaintia Hills, Meghalaya* (NESAC-SR-255-2021).
11. Pebam, R. (2021). *Area under shifting cultivation in NER and estimation of the jhumia families depending on it* (NESAC-SR-262-2022).
12. Goswami, J., Goswami, C., Nongrum, I., & Rasid, N. (2022). *Agro-climatic Atlas for Fostering Climate Resilient Upland Farming Systems in North East (FOCUS) Project of Mizoram* (NESAC-SR-276-2022).
13. Goswami, C., Goswami, J., Nongrum, I., & Rasid, N. (2022). *Agro-climatic Atlas for Fostering Climate Resilient Upland Farming Systems in North East (FOCUS) Project of Nagaland* (NESAC-SR-275-2022).

Book Chapter

1. Chouhan, A., Chutia, D., & Raju, P. L. N. (2021). Deep Learning Applications on Very High-Resolution Aerial Imagery. In L. Sharma, & P. K. Garg (Eds.), *Artificial Intelligence* (pp. 61-80). Chapman and Hall/CRC. https://doi.org/10.1201/9781003140351
2. Chutia, D., Chouhan, A., Nishant, N., Singh, P. S., Bhattacharyya, D. K., & Raju, P. L. N. (2021). Image Processing Using Artificial Intelligence: Case Study on Classification of High-Dimensional Remotely Sensed Images. In L. Sharma, & P. K. Garg (Eds.), *Artificial Intelligence* (pp. 39-49). Chapman and Hall/CRC. https://doi.org/10.1201/9781003140351
3. Nishant, N., Maharjan, A., Chutia, D., Raju, P. L. N., & Pradhan, A. (2021). Real-Time Road Monitoring Using Deep Learning Algorithm Deployed on IoT Devices. In L. Sharma, & P. K. Garg (Eds.), *Artificial Intelligence* (pp. 137-147). Chapman and Hall/CRC. https://doi.org/10.1201/9781003140351

4. Choudhury, S. A., Tamuly, D., Goswami, C., & Deka, B. (2022). Diffuse Reflectance Infra-Red Spectroscopy: A Novel Analytical Technique for Soil Analysis– A Review. In R. Kalita, & A. Singha (Eds.), *Climate Smart Agricultural Technologies: Challenges and Prospects* (Vol. 1, pp. 140-150). Vital Biotech Publications.

Thesis / Dissertation

1. Gogoi, R. B. (2021). *Impact of Ensemble Derived Flow-dependent Background Error Covariance in a Data Assimilation System for Regional-scale NWP model.* [Ph.D. Thesis, Indian Institute of Space Science and Technology]. https://events.iist.ac.in/phd/thesis/SC15D027FT.pdf

Copyright

1. Chutia, D., Chouhan, A., Nishant, N., Bhowmik, I. P., & Narain, K. (2022). *Fever tracker app for the health workers* [Copyright for computer software]. (RoC No. SW-15293/2022 dated 07.03.2022). ICMR, New Delhi, & NESAC. https://copyright.gov.in/Documents/ERegister/E-Register_March_2022.pdf

INTERNSHIPS AT NESAC

The internship program of NESAC was largely conducted in an online mode due to the uncertainty resulting from the COVID 19 pandemic. The year saw a total of 25 interns engaged in topics ranging from Development of a Landslide Early Warning System using image processing and machine learning, development of a Deep Learning (DL) Inference Server using Python, TensorFlow and Django, to create Deep Learning model and workflow pipeline for disaster risk reduction applications, mobile app development for agricultural assets, development of web-based platform for monitoring water bodies such as wetlands & reservoirs and their capacity using time series optical and microwave satellite images, monitoring of vegetation loss in mined lands and assessment of the geomorphic indices in relation to tectonics along selected sectors of Borpani River Basin, Assam using Cartosat DEM data. The participants were a mix of B.Tech students (Department of Computer Science and Electronics and Communication), M.Sc (Remote Sensing and GIS), and M.Sc Geography from institutions such as BITS Pilani, Panjab University, Assam Don Bosco University, NEHU, NIT Silchar and NIT Meghalaya.

AUDITOR'S REPORT AND STATEMENT OF ACCOUNTS FOR THE FINANCIAL YEAR 2021-2022

SSD & CO.
CHARTERED ACCOUNTANTS

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INDEPENDENT AUDITORS' REPORT

To,
The Members of North Eastern Space Applications Centre
Shillong

Report on the Audit of the Standalone Financial Statements

Opinion

1. We have audited the standalone financial statements of **North Eastern Space Applications Centre which comprise the Balance Sheet as at 31st March 2022**, and the statement of Income and Expenditure then ended, and notes to the financial statements, including a summary of significant accounting policies and other explanatory information.

2. In our opinion and to the best of our information and according to the explanations given to us, the aforesaid standalone financial statements give the information required by the Act in the manner so required and give a true and fair view in conformity with the accounting principles generally accepted in India, of the state of affairs of the organization as at March 31, 2022, and surplus/deficit, for the year ended on that date.

Basis for Opinion

3. We conducted our audit in accordance with the Standards on Auditing (SAs) issued by the Institute of Chartered Accountants of India (ICAI). Our responsibilities under those Standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Institution in accordance with the Code of Ethics issued by the Institute of Chartered Accountants of India (ICAI) together with the ethical requirements that are relevant to our audit of the financial statements and we have fulfilled our other ethical responsibilities in accordance with these requirements and the Code of Ethics. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Management's Responsibility for the Financial Statements

4. Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the organisation in accordance with the accounting principles generally accepted in India. This responsibility includes the design, implementation and maintenance of internal controls relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatements, whether due to fraud or error.

Auditor's Responsibilities for the Audit of the Financial Statements

5. Our objectives are to obtain reasonable assurance as to whether the financial statements as a whole are free from material misstatement, either due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material

misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

Opinion

6. In our opinion and to the best of our information and according to the explanations given to us, **subject to the Observations hereinafter attached**, the aforesaid financial statements gives the information in the manner so required and give a **true and fair view** in conformity with the accounting principles generally accepted in India in case of :
   (a) The Balance Sheet, of the **state of affairs** of the organisation as at **31st March 2022**; and
   (b) In the case of the Statement of Income and Expenditure, of the **Net Deficit** for the year ended on that date.

Emphasis of Matter:

7. Without qualifying our opinion as stated above, we report that the following matters require attention:
   (a) The accounting of accrued interest on MOD and tax deducted need to be reconciled with Interest Certificate issued by the Bank, Form 26AS issued by Department of Income Tax and actual bank receipt entries before closure of accounts. For eg, In case of Canara Bank all the three statements show different balances and hence, a three-way reconciliation should be undertaken.
   (b) Physical verification of Fixed Assets of the organisation was not undertaken by us.
   (c) Separate bank accounts are operational only for ISRO Project, Malaria Project, UAV-IIDS, DST Splice Project and PoA NEC. The following are the balances:

Project Name	Project Balance	Bank Balance	Difference
ISRO PROJECT	17594789.11	97295454	(76700664.89)
Malaria Project -1212	12727987.5	12727987.5	0.00
UAV- IIDS- 1189	2052877.50	2052877.50	0.00
DST SPLICE PROJECT	647623.50	647623.50	0.00
PoA NEC	53536296	53536296	0.00

Difference is on account of expenditures made out of general bank account.

The bank balances of other projects grouped under ISRO and User Project could not be verified as the funds and expenses pertaining to the projects were routed through general account. Thus, matching of project balance vide equivalent bank and cash balances could not be arrived at by the organisation. We recommend that fund transfer entries for such amounts be made.

For M/s SSD & CO.
Chartered Accountants
UDIN: 22303776ATKQBR8521
FRN: 0326761E

SSD & CO. SHILLONG FRN-326761E CHARTERED ACCOUNTANTS

(Sumit Das)
FCA, DISA (ICAI)
Partner
ICAI Mem. No. 303776

Place: Shillong
Date: 29.09.2022

भारत सरकार / GOVERNMENT OF INDIA
अंतरिक्ष विभाग / DEPARTMENT OF SPACE

उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE

उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

BALANCE SHEET AS AT 31-MARCH-2022

(Amount - ₹)

CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Capital Fund	1	66,45,96,113.23	78,95,53,234.12
Earmarked/Endowment Fund	2	2,05,92,181.00	-
Current Liabilities & Provisions	3	41,50,86,347.61	32,52,58,712.30
Pension Fund as per contra*		1,06,65,328.00	1,31,38,537.00
TOTAL		**1,11,09,39,969.84**	**1,12,79,50,483.42**
ASSETS			
Fixed Assets	4	60,70,53,996.96	67,99,86,401.96
Current Assets, Loans & Advances etc.	5	49,32,20,644.88	43,48,25,544.46
Pension Fund as per contra*		1,06,65,328.00	1,31,38,537.00
TOTAL		**1,11,09,39,969.84**	**1,12,79,50,483.42**
Significant Accounting Policies	11		
Contingent Liabilities & Notes on Accounts	12		

This is the Balance Sheet to in our report of even date

for **S S D & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

Date: 20.09.2022

भारत सरकार / GOVERNMENT OF INDIA
अंतरिक्ष विभाग / DEPARTMENT OF SPACE

उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE

उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2022

(Amount - ₹)

INCOME	**SCHEDULE**	**CURRENT YEAR**	**PREVIOUS YEAR**
Grants	6	26,50,00,000.00	20,69,00,000.00
Other Incomes	7	1,48,96,372.91	1,62,09,035.75
Incomes from Services	8	52,81,235.00	62,64,091.00
TOTAL		**28,51,77,607.91**	**22,93,73,126.75**
EXPENDITURE	**SCHEDULE**	**CURRENT YEAR**	**PREVIOUS YEAR**
Establishment Expenses	9	19,97,16,203.00	15,73,38,776.36
Other Administrative Expenses & etc.	10	4,51,06,050.80	4,06,92,140.59
Loss on Sales of Assets Items		13,36,618.00	-
"Depreciation ***(Net total at the year-end – corresponding to schedule 3) (Column 7)"**		6,77,03,350.00	7,62,95,907.00
TOTAL		**31,38,62,221.80**	**27,43,26,823.95**
BALANCE BEING SURPLUS (+)/ DEFICIT (-)		**(2,86,84,613.89)**	**(4,49,53,697.20)**
Less: Prior period expenses - Establishment Expenses		11,80,168.00	-
Less: Prior period expenses - Other Administrative Expenses		3,07,888.00	30,01,526.00
Less: Provision for Pension, Gratuity & Leave Encashment		44,36,911.00	1,13,73,370.00
Less: Prior Period Interest Remitted to DOS		9,48,32,831.00	-
Add: Prior period excess provision (Being excess provision for pension, gratuity & leave encashment made during 2020-2021)		44,85,291.00	-
NET SURPLUS (+)/ DEFICIT (-) CARRIED TO CAPITAL FUND		**(12,49,57,120.89)**	**(5,93,28,593.20)**

This is the Income & Expenditure Account to in our report of even date

for **S S D & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

Date: 20.09.2022

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उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31-MARCH-2022

(Amount - ₹)

	RECEIPTS	CURRENT YEAR	PREVIOUS YEAR		PAYMENTS	CURRENT YEAR	PREVIOUS YEAR
I.	**Opening Balances**			**I.**	**Expenses**		
	a) Cash in Hand	-	-		a) Establishment Expenses	17,53,46,188.00	13,09,55,754.36
	b) Bank Balances:				b) Other Administrative Expenses	4,82,23,581.30	3,62,27,616.95
	i) In Current Accounts, SBI Shillong	74,56,580.45	12,48,07,803.45	**II**	**Investments and Deposits**		
	ii) In Current Accounts, SBI Umiam	3,69,54,316.02	-1,14,15,280.60		a) Deposit with MeSEB/ NRSC/ BSNL	-	-
	iii) In Current Accounts, Canara Bank	3,37,27,507.00	99,48,912.00				
	iv) MOD With Canara Bank	10,99,70,901.00	10,99,64,630.00	**III**	**Fixed Assets & Capital Work-In-Progress**		
	vi) MOD with SBI Shillong	12,91,66,000.00	-				
	v) MOD with SBI Umiam	9,65,02,505.35	15,99,16,593.51		a) Purchase of Fixed Assets	2,45,70,346.00	5,66,77,405.00
	vii) Punjab National Bank "UAV-IIDS"	52,36,891.30	-				
	viii) State Bank of India "DST-Splice Projects"	4,90,367.00	-	**IV**	**Other Payments**		
II	**Grants Received**				a) ISRO Projects	2,73,40,928.00	1,69,35,660.00
	From Government of India:				b) USER Projects	3,26,78,996.50	6,31,84,611.00
	a) Department of Space, Bangalore				c) "UAV" IIDS Projects	60,27,745.80	6,35,017.70
	i) For Salaries	13,50,00,000.00	9,69,00,000.00		d) "DST Splice" Projects	6,18,821.50	7,54,216.00
	ii) For General	13,00,00,000.00	11,00,00,000.00		e) In-House Projects	15,79,214.00	21,26,749.00
	iii) For Creation of Capital Assets	5,50,00,000.00	5,81,00,000.00		f) Advances to Staffs	28,70,210.00	15,57,656.00
	b) Ministry of DONER, NEC Shillong	-	-		g) Advances to Projects	5,49,336.00	6,29,493.00
					h) Training	69,07,171.29	53,19,766.00
III	**Interest Received**				i) Payment of Recoveries	2,14,83,254.00	2,39,21,821.00
	a) On Fixed Deposits & Other Interests	54,71,976.45	95,69,111.00		j) Prior Period Expenses	13,65,695.00	28,26,090.00
					k) Security Deposits	20,05,326.00	23,60,388.00

IV	**Other Incomes**				l) ISTRAC Expenses	22,79,712.00	17,57,611.00
	a) Others Income	1,07,63,337.20	78,36,851.30		m)DWR Cheerapunji	6,14,134.00	26,02,829.00
					n) Interest Remittance	9,48,32,831.00	-
V	**Other Receipts**			**V**	**Closing Balances**		
	a) Miscelleneous Recoveries	28,85,566.50	11,70,673.36		a) Cash in Hand		
	b) Recovery of Advances and Deposits from:				b) Bank Balances:		
	i) Staffs (Cont., Imprest, TA/ DA & LTC Advane)	2,46,441.00	1,65,908.11		i) In Current Accounts, SBI Shillong	95,14,363.00	74,56,580.45
	ii) Others Receipts from ISTRAC/ NRSC/ DWR	54,26,095.00	1,20,18,582.00		ii) In Current Accounts, SBI Umiam	34,19,235.55	3,69,54,316.02
	c) Receipts on ISRO Projects	1,63,98,412.00	2,69,51,788.00		iii) In Current Accounts, Canara Bank	7,886.00	3,37,27,507.00
	d) Receipts on USER Projects	6,58,45,632.00	4,30,11,729.00		iv) MOD with Canara Bank	9,72,87,568.00	10,99,70,901.00
	e) Receipts on "DST Splice " Projects	6,38,966.00	12,77,708.00		v) MOD with SBI Umiam	17,79,85,635.38	9,65,02,505.35
	f) Receipts on "UAV" IIDS Projects	36,22,257.00	52,36,909.00		vi) MOD with SBI Shillong	12,82,53,364.45	12,91,66,000.00
	g) Receipts on "Malaria Projects"	1,27,28,135.00	-		vii) Punjab National Bank "UAV-IIDS"	20,52,877.50	52,36,891.30
	h) Receipts on "PoA Dos Bangalore	1,67,00,000.00	-		viii) State Bank of India "DST-Splice Projects"	6,47,623.50	4,90,367.00
	i) Receipts on "PoA NEC Shillong"	5,35,36,296.00	-		ix) ICICI Bank Project A/c	1,27,27,987.50	-
	j) Security Deposits	9,58,145.00	25,15,834.00		x) SBI Umiam PoA NEC Project A/c	5,35,36,296.00	-
	TOTAL	**93,47,26,327.27**	**76,79,77,752.13**		**TOTAL**	**93,47,26,327.27**	**76,79,77,752.13**

This is the Receipts & Payments Account referred to in our report of even date

for **S S D & Co**
Chartered Accountants

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Date: 20.09.2022

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

भारत सरकार / GOVERNMENT OF INDIA
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उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31-MARCH-2022

(Amount - ₹)

SCHEDULE 1 - CAPITAL FUND	**CURRENT YEAR**		**PREVIOUS YEAR**	
Balance as at the beginning of the year	78,95,53,234.12		79,07,81,827.32	
Add: Balance of Surplus (+)/ Deficit (-) transferred from the "Income & Expenditure Account"	(12,49,57,120.89)		(5,93,28,593.20)	
Add: Grant-in-aid for creation of Capital Assets		66,45,96,113.23	5,81,00,000.00	78,95,53,234.12
BALANCE AS AT THE YEAR END		**66,45,96,113.23**		**78,95,53,234.12**
SCHEDULE 2 - Earmarked Fund	**CURRENT YEAR**		**PREVIOUS YEAR**	
Opening Balance	-		-	
Add: Grant-In-Aid During the Year	5,50,00,000.00		-	
Less: Asset not Capitalised in NESAC	32,12,703.00		-	
Less-Expenditure toward objective of Fund	3,11,95,116.00	**2,05,92,181.00**	-	-
BALANCE AS AT THE YEAR END		**2,05,92,181.00**		
SCHEDULE 3 – CURRENT LIABILITIES AND PROVISIONS	**CURRENT YEAR**		**PREVIOUS YEAR**	
CURRENT LIABILITIES:				
1 Other Current Liabilities				
a) Establishment Expenses	1,68,23,451.00		1,71,27,811.00	
b) Other Administrative Expenses	41,63,401.00		59,62,406.00	
c) Others	1,55,54,074.00		1,81,38,811.00	
d) Audit Fee	87,900.00	3,66,28,826.00	87,900.00	4,13,16,928.00

2 Deposit from Contractors	54,98,913.00	54,98,913.00	62,16,376.00	62,16,376.00
3 Project Accounts: USER Project				
Balance as at the begining of the year	4,80,99,934.30		7,18,14,086.00	
Add: Received during the year	13,86,71,710.00		4,98,56,875.00	
Less: Utilised during the year	4,78,39,026.80			
Less: Deposit for Satellite Data with NRSC	11,95,173.00	13,77,37,444.50	7,35,71,026.70	4,80,99,934.30
4 Project Accounts: ISRO Project				
Balance as at the begining of the year	2,86,37,426.00		1,99,91,953.00	
Add: Received during the year	3,30,85,119.00		2,75,81,023.00	
Less: Utilised during the year	2,74,41,048.89	3,42,81,496.11	1,89,35,550.00	2,86,37,426.00
5 PROVISIONS:				
Pension, Gratuity & Leave Encashment	20,09,39,668.00	20,09,39,668.00	20,09,88,048.00	20,09,88,048.00
TOTAL		**41,50,86,347.61**		**32,52,58,712.30**

for **S S D & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

Date: 20.09.2022

भारत सरकार / GOVERNMENT OF INDIA अंतरिक्ष विभाग / DEPARTMENT OF SPACE

उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE

उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31-MARCH-2022

(Amount - ₹)

SCHEDULE 4 – FIXED ASSETS

	DESCRIPTION	GROSS BLOCK						DEPRECIATION				NET BLOCK	
Sl. No	Particular	Cost/ Valuation as at the beginning of the year	Additions during the year	GIA on creation of Capital Assets received during the year	Sale/ Disposal	Cost/ Valuation as at the end of the year	Rate (%)	As at the beginning of the year	During the year	On deduction during the year	Total up to the year-end	"As at the Current year-end"	As at the previous year-end
		1	2	3	4	5=(1+2-3-4)	6	7	8	9	10=(7 +8 - 9)	11=(5 -10)	12
1	Land & Land Development	5,02,62,139.00	-		-	5,02,62,139.00	0%	-	-	-	-	5,02,62,139.00	5,02,62,139.00
2	Boundry of New Land	51,23,504.00	21,38,153.00	21,38,153.00	-	51,23,504.00	10%	14,38,338.00	3,68,517.00	-	18,06,855.00	33,16,649.00	36,85,166.00
3	Renovation of Lease Buildings	52,40,087.00	-		-	52,40,087.00	10%	43,93,111.00	84,698.00	-	44,77,809.00	7,62,278.00	8,46,976.00
4	Machinery & Equipment	95,40,622.00	-		2,09,820.00	93,30,802.00	15%	85,53,944.00	1,48,002.00	1,56,934.00	85,45,012.00	7,85,790.00	9,86,678.00
5	Furniture & Fixtures	3,04,65,629.76	1,93,154.00	1,93,154.00	1,14,947.00	3,03,50,682.76	10%	1,36,98,334.76	16,76,729.00	92,346.00	1,52,82,717.76	1,50,67,965.00	1,67,67,295.00
6	Office Equipments	98,29,257.00	4,53,291.00	4,53,291.00	5,72,922.00	92,56,335.00	15%	55,97,934.00	6,86,348.00	5,17,905.00	57,66,377.00	34,89,958.00	42,31,323.00
7	Computer & Peripherals	7,04,91,626.60	3,03,203.00	3,03,203.00	71,27,077.00	6,33,64,549.60	40%	6,69,25,574.60	14,26,421.00	71,27,017.00	6,12,24,978.60	21,39,571.00	35,66,052.00
8	Library Books	6,14,27,814.93	36,30,102.00	36,30,102.00	-	6,14,27,814.93	40%	5,53,85,288.93	24,17,010.00	-	5,78,02,298.93	36,25,516.00	60,42,526.00
9	Telephones Installation	19,02,230.00	-		-	19,02,230.00	15%	12,15,158.00	1,03,061.00	-	13,18,219.00	5,84,011.00	6,87,072.00
10	Other Equipments	11,24,07,210.96	83,01,459.00	83,01,459.00	27,06,698.00	10,97,00,512.96	15%	5,25,44,353.00	89,28,400.00	10,83,335.00	6,03,89,418.00	4,93,11,094.96	5,98,62,857.96
11	NE-SAC Complex	18,20,54,103.00	-		4,85,750.00	18,15,68,353.00	10%	10,35,15,827.00	78,53,828.00	2,42,628.00	11,11,27,027.00	7,04,41,326.00	7,85,38,276.00
12	Vehicles	45,54,532.00	67,160.00	67,160.00	-	45,54,532.00	15%	24,10,563.00	3,21,595.00	-	27,32,158.00	18,22,374.00	21,43,969.00
13	Air Conditioner (Heating & Cooling)	35,04,812.00	-		-	35,04,812.00	15%	14,65,366.00	3,05,917.00	-	17,71,283.00	17,33,529.00	20,39,446.00
14	Apple I-Pad	71,250.00	-		-	71,250.00	15%	53,291.00	2,694.00	-	55,985.00	15,265.00	17,959.00
15	Aquarium	35,630.00	-		-	35,630.00	15%	26,650.00	1,347.00	-	27,997.00	7,633.00	8,980.00
16	CISF Barrack	27,08,604.00	-		-	27,08,604.00	10%	11,05,653.00	1,60,295.00	-	12,65,948.00	14,42,656.00	16,02,951.00
17	Mobile Set	48,100.00	-		48,100.00	-	15%	30,871.00	1,962.00	32,833.00	-	-	17,229.00
18	Motorised Treadmill	1,26,000.00	-		-	1,26,000.00	15%	94,241.00	4,764.00	-	99,005.00	26,995.00	31,759.00
19	SMF Batteries	15,12,600.00	-		-	15,12,600.00	15%	7,30,036.00	1,17,385.00	-	8,47,421.00	6,65,179.00	7,82,564.00
20	Vending Machine	20,500.00	-		20,500.00	-	15%	15,752.00	712.00	16,464.00	-	-	4,748.00

21	Water Dispenser	1,02,200.00	-		-	1,02,200.00	15%	38,767.00	9,515.00	-	48,282.00	53,918.00	63,433.00
22	Wifi Connectivity	14,45,666.00	-		-	14,45,666.00	15%	5,57,769.00	1,33,185.00	-	6,90,954.00	7,54,712.00	8,87,897.00
23	Residential Complex	15,97,49,009.00	-		-	15,97,49,009.00	10%	4,89,99,636.00	1,10,74,937.00	-	6,00,74,573.00	9,96,74,436.00	11,07,49,373.00
24	Outreach Facilities	23,02,62,540.00	-		44,07,000.00	22,58,55,540.00	10%	5,90,75,524.00	1,71,18,702.00	11,94,297.00	7,49,99,929.00	15,08,55,611.00	17,11,87,016.00
25	CISF Quarter/Barrack	9,69,79,654.00	-		-	9,69,79,654.00	10%	1,81,72,541.00	78,80,711.00	-	2,60,53,252.00	7,09,26,402.00	7,88,07,113.00
26	Residential Complex Phase II	6,73,76,132.00	3,78,000.00	3,78,000.00	-	6,73,76,132.00	10%	60,32,625.00	61,34,351.00	-	1,21,66,976.00	5,52,09,156.00	6,13,43,507.00
27	Creche Building	6,67,629.00	-		-	6,67,629.00	10%	66,763.00	60,087.00	-	1,26,850.00	5,40,779.00	6,00,866.00
28	Computer/Software	61,38,691.00	5,74,145.00	5,74,145.00	-	61,38,691.00	40%	44,33,249.00	6,82,177.00	-	51,15,426.00	10,23,265.00	17,05,442.00
	Capital Work In Progress:												
29	Annex Building Offlce	2,25,15,789.00	1,51,56,449.00	1,51,56,449.00		2,25,15,789.00		-	-		-	2,25,15,789.00	2,25,15,789.00
	TOTAL FOR CURRENT YEAR	**1,13,65,63,562.25**	**3,11,95,116.00**	**3,11,95,116.00**	**1,56,92,814.00**	**1,12,08,70,748.25**		**45,65,77,160.29**	**6,77,03,350.00**	**1,04,63,759.00**	**51,38,16,751.29**	**60,70,53,996.96**	**67,99,86,401.96**
	TOTAL FOR PREVIOUS YEAR	**1,07,37,28,130.25**	**6,28,35,432.00**	**-**	**-**	**1,13,65,63,562.25**	**-**	**38,02,81,253.29**	**7,62,95,907.00**	**-**	**45,65,77,160.29**	**67,99,86,401.96**	**69,34,46,876.96**

for **S S D & Co**
Chartered Accountants

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Date: 20.09.2022

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

भारत सरकार / GOVERNMENT OF INDIA
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उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE

उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31-MARCH-2022

(Amount - ₹)

SCHEDULE 5 – CURRENT ASSETS, LOANS & ADVANCES etc.	CURRENT YEAR		PREVIOUS YEAR	
A. CURRENT ASSETS:				
1) Cash balances in hand		-		-
2) Bank balances with scheduled banks				
a) On Current Accounts	1,29,41,484.55		7,81,38,403.47	
b) MOD with Canara Bank	9,72,87,568.00		10,99,70,901.00	
c) MOD with SBI Umiam Bank	17,79,85,635.38		9,65,02,505.35	
d) MOD With SBI Shillong	12,82,53,364.45		12,91,66,000.00	
e) On Project Accounts	6,89,64,784.50	48,54,32,836.88	57,27,258.30	41,95,05,068.12
B. LOANS, ADVANCES AND OTHER ASSETS:				
1) Advances to:				
a) Staffs:				
TA/ DA	2,40,450.00		2,08,510.00	
Contingencies	81,400.00		65,100.00	
Others	2,18,704.00	5,40,554.00	2,31,738.00	5,05,348.00
b) Projects: (User & ISRO)	2,33,500.00	2,33,500.00	-	4,99,115.89
c) Others	3,54,097.00	3,54,097.00	-	47,70,329.00
d) Imprest amount to staff		20,000.00		15,000.00
2) Claims Receivable/ Recoverable	1,22,800.00	1,22,800.00	1,22,800.00	1,22,800.00
3) TDS receivable	21,80,011.00	21,80,011.00	12,32,060.00	12,32,060.00
4) Interest receivable	29,57,571.00	29,57,571.00	55,47,563.45	55,47,563.45
5) Deposits for:				
a) Telephone with BSNL	1,15,658.00		1,15,658.00	-
b) Deposit with MeECL	-		-	-
c) Satellite Data's with NRSC	12,63,617.00	13,79,275.00	25,12,602.00	26,28,260.00
6) Closing Stock of Cartridges	-	-	-	-
TOTAL		**49,32,20,644.88**		**43,48,25,544.46**

for **S S D & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

Date: 20.09.2022

भारत सरकार / GOVERNMENT OF INDIA
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उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE

उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2022

(Amount - ₹)

SCHEDULE 6 - GRANTS	CURRENT YEAR	PREVIOUS YEAR
Central Government:		
a) Department of Space, Bangalore	26,50,00,000.00	20,69,00,000.00
b) North Eastern Council, Shillong	-	-
TOTAL	**26,50,00,000.00**	**20,69,00,000.00**
SCHEDULE 7 - OTHER INCOMES	**Current Year**	**Previous Year**
Miscellaneous	30,71,400.10	43,25,867.20
Maintenance Charges	2,47,085.00	4,45,784.73
Guest House Rent	4,06,844.55	83,214.08
Income from Sales of Assets Items	76,924.00	-
Interest from Bank	1,10,94,119.26	1,13,54,169.74
TOTAL	**1,48,96,372.91**	**1,62,09,035.75**
SCHEDULE 8 - INCOME FROM SERVICES	**CURRENT YEAR**	**PREVIOUS YEAR**
Service of Scientists	-	23,29,107.00
Infrastructure Usage	-	6,79,070.00
Institutional Overhead	52,81,235.00	32,55,914.00
TOTAL	**52,81,235.00**	**62,64,091.00**

for **S S D & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

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SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2022

(Amount - ₹)

SCHEDULE 9 - ESTABLISHMENT EXPENSES		Current Year		Previous Year	
a)	Salary & Allowances	10,63,97,385.00		7,82,38,571.36	
b)	Honorarium	56,040.00		1,58,800.00	
c)	Employer Contributions towards NPS	68,44,486.00		46,65,018.00	
d)	Wages	44,22,423.00		40,08,051.00	
e)	LTC	9,22,020.00		12,14,583.00	
f)	Leave Encashment Expenses	17,17,606.00		1,69,326.00	
g)	Children Education Allowance	7,29,000.00		3,78,000.00	
h)	Outsourced DEO	29,14,524.00		34,91,402.00	
i)	Outsourced Electrician	19,83,734.00		18,68,196.00	
j)	Outsourced Worker for Various Services	1,47,38,525.00		1,48,01,038.00	
k)	NER-DRR (Salary)	77,41,913.00		24,22,529.00	
l)	CISF Salary	4,63,90,733.00		4,15,71,595.00	
m)	Retirement Pension	13,17,506.00		11,93,916.00	
n)	DWR-Outsourced worker	22,25,885.00		16,29,836.00	
o)	DWR-(Salary)	13,14,423.00	19,97,16,203.00	15,27,915.00	15,73,38,776.36
	TOTAL		**19,97,16,203.00**		**15,73,38,776.36**

for **S S D & Co**
Chartered Accountants

for and on behalf of
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Date: 20.09.2022

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SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2021

(Amount - ₹)

SCHEDULE 10 - OTHER ADMINISTRATIVE EXPENSES & etc.		Current Year		Previous Year	
1	Postage, Courier & Telephone Charges	6,72,474.00		11,54,135.00	
2	Bank Charges	16,203.30		15,393.59	
3	Electricity & Power Charges	95,22,141.50		79,31,360.00	
4	Maintenance of Garden	25,230.00		61,074.00	
5	Printing & Stationery	19,53,829.00		18,73,954.00	
6	Advertisement & Publicity	11,17,184.00		19,20,425.00	
7	Hiring of Vehicles	25,94,442.00		25,71,289.00	
8	Travelling & Conveyance	18,06,273.00		11,11,630.00	
9	Professional Charges	6,44,817.00		21,77,698.00	
10	Project Expenses [In-house]	16,29,005.00		23,08,078.00	
11	Repair & Maintenance	53,86,599.00		46,93,761.00	
12	Books & Periodicals	56,598.00		49,075.00	
13	Trainings/ Seminars & Workshops	1,99,370.00		2,70,545.00	
14	Medical Expenses	20,07,849.00		17,57,911.00	
15	DWR Cherrapunji Expenses	26,71,743.00		33,94,354.00	
16	Other Charges	14,61,106.00		2,97,004.00	
17	POL	19,46,947.00		16,25,043.00	
18	Sanitary Items	4,39,719.00		4,96,289.00	
19	Hindi Week Celebrations	59,764.00		23,750.00	
20	Annual Maintenance Contracts	45,53,715.00		28,72,284.00	
21	Miscellaneous Expenses	30,58,593.00		16,19,569.00	
22	Repair & Maintenance of Vehicles	-		1,41,473.00	
23	Operational Charges & Maintenance of Canteen	6,92,809.00		4,77,877.00	
24	Rent Rate & Taxes & ICRB Examination	4,67,584.00		3,87,000.00	
25	NER-DRR Expenses	3,32,330.00		3,94,736.00	
26	CISF Expenses	17,26,906.00		10,46,483.00	
27	Supply of Water for Hostels	62,820.00	4,51,06,050.80	19,950.00	4,06,92,140.59
	TOTAL		**4,51,06,050.80**		**4,06,92,140.59**

for **S S D & Co**
Chartered Accountants

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Date: 20.09.2022

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

भारत सरकार / GOVERNMENT OF INDIA
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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31-MARCH-2022

SCHEDULE 11 – SIGNIFICANT ACCOUNTING POLICIES

1. **Accounting Convention:**-The Financial statements have been prepared on the basis of historical cost convention and on accrual basis.

2. **Revenue Recognition:** - Grant received during the year has been classified as Grant in Aid General, Grant in Aid Salaries and Grant in Aid for Creation of Capital Assets and accounted on realization basis.

   As per accounting standard 12 issued by ICAI grant related to specific fixed asset are shown as deductions from the gross value of the assets concerned in arriving at its book value. Grant related to revenue are presented as credit in the Income and expenditure account.

3. **Fixed Assets And Depreciation**
   3.1 Fixed Assets has been stated at cost and accounted for at historical cost.
   3.2 Depreciation on assets acquired during the year is provided for as under:
   - Assets acquired up to 30.09.21 – 100% as per the applicable rate.
   - Assets acquired after 30.09.21 – 50% as per the applicable rate.

   3.3 Depreciation has been provided on written down value method as per the rates prescribed in the Income Tax Act 1961.

4. **Retirement Benefits:-** Pension, Gratuity and Leave Encashment liability is provided on the basis of Actuarial Valuation as at the end of each financial year the retirement benefits in respect of deputationists are accounted for on Cash basis.

5 **Foreign Currency Transaction:-** Foreign exchange transaction arising during the year is recorded at the exchange rates prevailing at the transaction date.

6 **Research & Development:-** For USER & ISRO Funded Projects, fund received and utilized during the year are accounted in the Project Accounts and the un-utilized balances is reflected as under Current Liabilities.

7 **Inventories:-** Store and spares are valued at cost.

for **S S D & Co**		for and on behalf of
Chartered Accountants		**NORTH EASTERN SPACE APPLICATIONS CENTRE**
Sd/-	Sd/-	Sd/-
(SUMIT DAS)	**(SUBAKORDOR SYIEMLIEH)**	**(DR SHIV PRASAD AGGARWAL)**
PARTNERSHIP	ACCOUNTS OFFICER	DIRECTOR
UDIN: 22303776ATKQBR8521		

Date: 20.09.2022

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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31-MARCH-2022

SCHEDULE 12 – NOTES ON THE ACCOUNTS & CONTINGENT LIABILITIES

NOTES ON THE ACCOUNTS

a) The previous year's figure was re-arranged/ regrouped whereever necessary to make them comparable.

b) Pension, gratuity and leave encashment liability has been provided till 31.03.2022.

c) Prior period items have been disclosed separately so that the effect thereof on the net expenditure during the year is known.

d) The Centre has received an Exhibition Bus in kind from Department of Space, Govt. of India and the same has not been accounted at nominal value during the year as the vehicle has not yet been registered in the name of the Centre.

e) GPF Account is forming part of the Balance Sheet.

f) Schedules 1 to 12 are annexed to and form an integral part of the Balance Sheet as at 31-March-2022 and Income & Expenditure Account for the year ended as on that date.

These are the notes to Accounts referred to in our report of even date.

As per our report of even date.

for **S S D & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SUMIT DAS)
PARTNERSHIP
UDIN: 22303776ATKQBR8521

Sd/-
(SUBAKORDOR SYIEMLIEH)
ACCOUNTS OFFICER

Sd/-
(DR SHIV PRASAD AGGARWAL)
DIRECTOR

Date: 20.09.2022

ACRONYMS

3DVAR	:	Three-Dimensional Variational
AAE	:	Absorption Ångström Exponent
AAS	:	Agromet Advisory Services
ABL	:	Atmospheric Boundary Layer
AI	:	Artificial Intelligence
AI	:	Amenities Index
ALOS	:	Advanced Land Observation Satellite
AMRUT	:	Atal Mission for Rejuvenation and Urban Transformation
AMV	:	Atmospheric Motion Vectors
AOD	:	Aerosol Optical Depth
API	:	Application Programming Interface
ARG	:	Automatic Rain Gauge
ASC	:	Administrative Staff College of India
ASDMA	:	Assam State Disaster Management Authority
ASLV	:	Augmented Satellite Launch Vehicle
ASP	:	Atmospheric Science Program
ATMA	:	Agricultural Technology Management Agency
AWEI	:	Automated Water Extraction Index
AWS	:	Automatic Weather Stations
BC	:	Black Carbon
BEC	:	Background Error Covariance
BIMSTEC	:	Bay of Bengal Initiative for Multi Sectoral Technical and Economic Cooperation
BRIDGE	:	Building River Dialogue and Governance
BRO	:	Border Roads Organization
BTC	:	Bodoland Territorial Council
BTR	:	Bodoland Territorial Region
CAI	:	Cumulative Amenities Index
CALIOP	:	Cloud-Aerosol Lidar with Orthogonal Polarization
CALIPSO	:	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation
CAPE	:	Convective Available Potential Energy
CARTOSAT	:	Cartographic Satellite
CAU	:	Central Agricultural University
CBH	:	Cloud Base Height
CCE	:	Crop Cutting Experiment
CCN	:	Cloud Condensation Nuclei
CEGIS	:	Centre for Environmental and Geographic Information Services
CEPO	:	Civil Engineering Programme Office
CHAMAN	:	Coordinated Horticulture Assessment and Management using geoiNformatics
CISF	:	Central Industrial Security Force
CMD	:	Construction and Maintenance Division
CMER&TI	:	Central Muga Eri Research and Training Institute
CMOS	:	Complementary Metal Oxide Semiconductor
CNES	:	National Centre for Space Studies
CORS	:	Continuous Operating Reference Stations
COTS	:	Commercial Off-The-Shelf
CROPC	:	Climate Resilient Observing Systems Promotion Council
CropDAMS	:	Crop Damage Assessment and Monitoring Service
CRU-NCEP	:	Climatic Research Unit - National Centers for Environmental Prediction
CSB	:	Central Silk Board
CSIR	:	Council of Scientific and Industrial Research
NEIST	:	North East Institute of Science & Technology
CSR	:	Corporate Social Responsibility
DDMA	:	District Disaster Management Authority
DEM	:	Digital Elevation Model
DES	:	Directorate of Economics & Statistics, Govt. of Meghalaya
DEWATS	:	Decentralised Waste Water Treatment System
DGPS	:	Differential Global Positioning System
DInSAR	:	Differential InSAR
DL	:	Deep Learning
DMS	:	Disaster Management Support
DoNER	:	Development of North Eastern Region

DOS : Department of Space
DoS : Department of Sericulture
DSM : Digital Surface Model
DTM : Digital Terrain Model
DVI : Desertification Vulnerability Index
DWR : Doppler Weather Radar
EDI : Economic Development Index
ELPI : Electric Low Pressure Impactor
ENTLN : Earth Networks Total Lightning Network
ENVI : Environment for Visualizing Images
EO-A : Earth Observation Applications
EOS : Earth Observatory of Singapore
EOS : End of Season
ESA : European Space Agency
FAO : Food and Agriculture Organization
FLEWS : Flood Early Warning Systems
FOD : Flash Origin Density
FORTRAN : Formula Translator
FOV : Field of View
FSI : Forest Survey of India
FTP : File Transfer Protocol
GAGAN : GPS Aided Geo Augmented Navigation
GBM : Ganga-Brahmaputra-Meghna
Gbps : Gigabits per second
GC : Governing Council
GCP : Ground Control Point
GEE : Google Earth Engine
GIS : Geographical Information System
GIT&DL : Geoweb Services, IT and Distance Learning
GNSS : Global Navigation Satellite System
GPM : Global PrecipitationMeasurement
GPM-MS : GPM-multi satellite
GPS : Global Positioning System
GPU : Graphics Processing Unit
GSAT : Geostationary Satellite
GSD : Ground Sampling Distance
GSI : Geological Survey of India
GSLV : Geosynchronous Satellite Launch Vehicle
GTOPG : Geospatial Technology and Outreach Programme Group
GUI : Graphical User Interface
HCA : Hydrometric Classification
HCM : Highway Capacity Manual
HFOV : Horizontal Field of View
HPC : High Performance Computing
HTS : High Throughput Satellites
HVS : High Volume Sampler
ICAR : Indian Council of Agricultural Research
ICAR RC NEH : ICAR Research Complex for North Eastern Hill Region
ICAR-ATARI : ICAR-Agricultural Technology Application Research Institute
ICFAI : Institute of Chartered Financial Analysts of India
ICMR : Indian Council of Medical Research
ICMR-RMRC : ICMR-Regional Medical Research Centre
IDY : International Day of Yoga
IEEE : Institute of Electrical and Electronics Engineers
IEG : Institute of Economic Growth
IET : Institution of Engineering and Technology
IGS : International GNSS Service
IIRS : Indian Institute of Remote Sensing
IISc : Indian Institute of Science
IIST : Indian Institute of Space Science and Technology
IMD : India Meteorological Department
IMS : Indian Meteorological Society
InSAR : Interferometric Synthetic Aperture Radar
INSAT : Indian National Satellite
IoT : Internet of Things
IPCC : Intergovernmental Panel on Climate Change
IRS : Indian Remote Sensing (Satellite)
ISBT : Inter-State Bus Terminal
ISG-SC : Indian Society of Geomatics-Shillong Chapter
ISRO : Indian Space Research Organisation
ISRS-SC : Indian Society of Remote Sensing-Shillong Chapter
IST : India Standard Time
ISTRAC : ISRO Telemetry, Tracking and Command Network
IT : Information Technology
ITI : Industrial Training Institute
IWMP : Integrated Watershed Monitoring Programme

JSA : Jal Shakti Abhiyan
KUFOS : Kerala University of Fisheries and Ocean Studies
LAIC : Lithosphere–Atmosphere Ionosphere Coupling
LAN : Local Area Network
LCL : Lifting Condensation Level
LISS : Linear Imaging Self-Scanning System
LLJ : Lower Level Jet
LPI : Lightning Potential Index
LPM : Laser Precipitation Monitor
LSM : Land Surface Model
LUI : Land Utilization Index
LULC : Land Use and Land Cover
MAMETI : Meghalaya Agricultural Management & Extension Training Institute
MBDA : Meghalaya Basin Development Authority
MCF : Master Control Facility
MCM : Million Cubic Metre
MeECL : Meghalaya Energy Corporation Limited
ML : Machine Learning
MNCFC : Mahalanobis National Crop Forecast Centre
MNDWI : Modified Normalized Difference Water Index
MODIS : Moderate Resolution Imaging Spectroradiometer
MoEF&CC : Ministry of Environment, Forests and Climate Change
MOS : Middle of Season
MOSDAC : Meteorology and Oceanographic Scientific Data Archival System
MOSPI : Ministry of Statistics and Programme Implementation
MoU : Memorandum of Understanding
MSPCB : Meghalaya State Pollution Control Board
MSSO : Maintenance and Support Services Organization
MSWS : Mean Sustained Wind Speed
MWR : Multi Wavelength Radiometer
NAVIC : NAVigation with Indian Constellation
NCSC : National Children's Science Congress
NDEM : National Database for Emergency Management
NDMA : National Disaster Management Authority
NDRF : National Disaster Response Force
NDSI : Normalized Difference Snow Index
NDVI : Normalized Difference Vegetation Index
NDWI : Normalized Difference Water Index
NE : North Eastern
NEC : North-Eastern Council
NEEPCO : North Eastern Electric Power Corporation Limited
NEHU : North Eastern Hill University
NEIAH : North Eastern Institute of Ayurveda and Homeopathy
NER : North Eastern Region
NER-DRR : North Eastern Regional node for Disaster Risk Reduction
NERIST : North Eastern Regional Institute of Science and Technology
NERTPS : North Eastern Region Textile Promotion Scheme
NESAC : North Eastern Space Applications Centre
NeSDR : North Eastern Spatial Data Repository
NETRA : Network for Space Objects Tracking and Analysis
NGO : Non-Governmental Organisation
NGT : National Green Tribunal
NIC : National Informatics Centre
NKN : National Knowledge Network
NMHS : National Mission on Himalayan Studies
NRSC : National Remote Sensing Centre
NWP : Numerical Weather Prediction
OFC : Optical Fiber Communication
OGC : Open Geospatial Consortium
ONERA : Office National d'Etudes et de Recherches Aérospatiales
ONGC : Oil and Natural Gas Corporation
P&RD : Panchayat & Rural Development
PALSAR : Phased Array type L-band Synthetic Aperture Radar
PCU : Passenger Car Unit
PHC : Primary Health Centre

PHE	:	Public Health Engineering Department
PMO	:	Prime Minister's Office
PolInSAR	:	Polarimetric InSAR
PRL	:	Physical Research Laboratory
PSLV	:	Polar Satellite Launch Vehicle
QCM	:	Quartz Crystal Microbalance
R&D	:	Research and Development
REG GCM	:	Regional Global Climate Model
RGB	:	Red, Green and Blue
RHEP	:	Ranganadi Hydro Electric Power Project
RIST	:	Regional Institute of Science & Technology
RLV-TD	:	Reusable Launch Vehicle – Technology Demonstrator
RMC	:	Regional Meteorological Centre
RMRC	:	Regional Medical Research Center
RMSE	:	Root Mean Square Error
RS	:	Remote Sensing
RTI	:	Right to Information
RTTOV	:	Radiative Transfer for the TIROS Operational Vertical Sounder
S&T	:	Science & Technology
SAC	:	Space Applications Centre
SAN	:	Storage Area Network
SAR	:	Synthetic Aperture Radar
SATCOM	:	Satellite Communication
SBI	:	State Bank of India
SCERT	:	State Council of Educational Research and Training
SCSTE	:	State Council of Science, Technology & Environment
SDMA	:	State Disaster Management Authority
SfM	:	Structure from Motion
SHC	:	Soil Health Card
SHS	:	Swachhata Hi Seva
SI	:	Soil Index
SILKS	:	Sericulture Information Linkages And Knowledge System
SIS-DP	:	Space based Information Support for Decentralised Planning at Panchayat level
SIT	:	Satellite Interactive Terminal
SLV	:	Satellite Launch Vehicle
SMIT	:	Sikkim Manipal Institute of Technology
SMR	:	Satellite Mobile Radio
SMS	:	Short Message Service
SNAP	:	Sentinel Application Platform
SNPP	:	Suomi National Polar-orbiting Partnership
SOI	:	Survey of India
SOS	:	Start of Season
SPA	:	School of Planning and Architecture
SPIE	:	Society of Photographic Instrumentation Engineers
SPS	:	Standard Positioning Service
SRSAC	:	State Remote Sensing Application Centre
SSE	:	Safe Shutdown Earthquake
SSS	:	Support for Statistical Strengthening
SUFALAM	:	Space technology Utilization for Food Security, AgricuLtural Assessment and Monitoring
TDP	:	Technology Development Programme
TEC	:	Total Electron Content
TIFR	:	Tata Institute of Fundamental Research
TKE	:	Turbulent Kinetic Energy
TOVS	:	TIROS Operational Vertical Sounder
TRMM	:	Tropical Rainfall Measuring Mission
UAV	:	Unmanned Aerial Vehicle
UAV-RS	:	UAV Remote Sensing
URDPFI	:	Urban and Regional Development Plans Formulation and Implementation
URL	:	Uniform Resource Locator
UTC	:	Universal Coordinated Time
VPN	:	Virtual Private Network
VSAT	:	Very Small Aperture Terminal
VSSC	:	Vikram Sarabhai Space Centre
VTS	:	Vehicle Tracking System
WRF	:	Weather Research and Forecasting
WRF-ELEC	:	WRF-Electric Model
WWLLN	:	World Wide Lightning Location Network
YuViKA	:	YUva VIgyani KAryakram
ZVWS	:	Zonal Vertical Wind Shear

Published by

North Eastern Space Applications Centre

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Designed & Printed by: Imagic Creatives Pvt Ltd, Bangalore - 560071