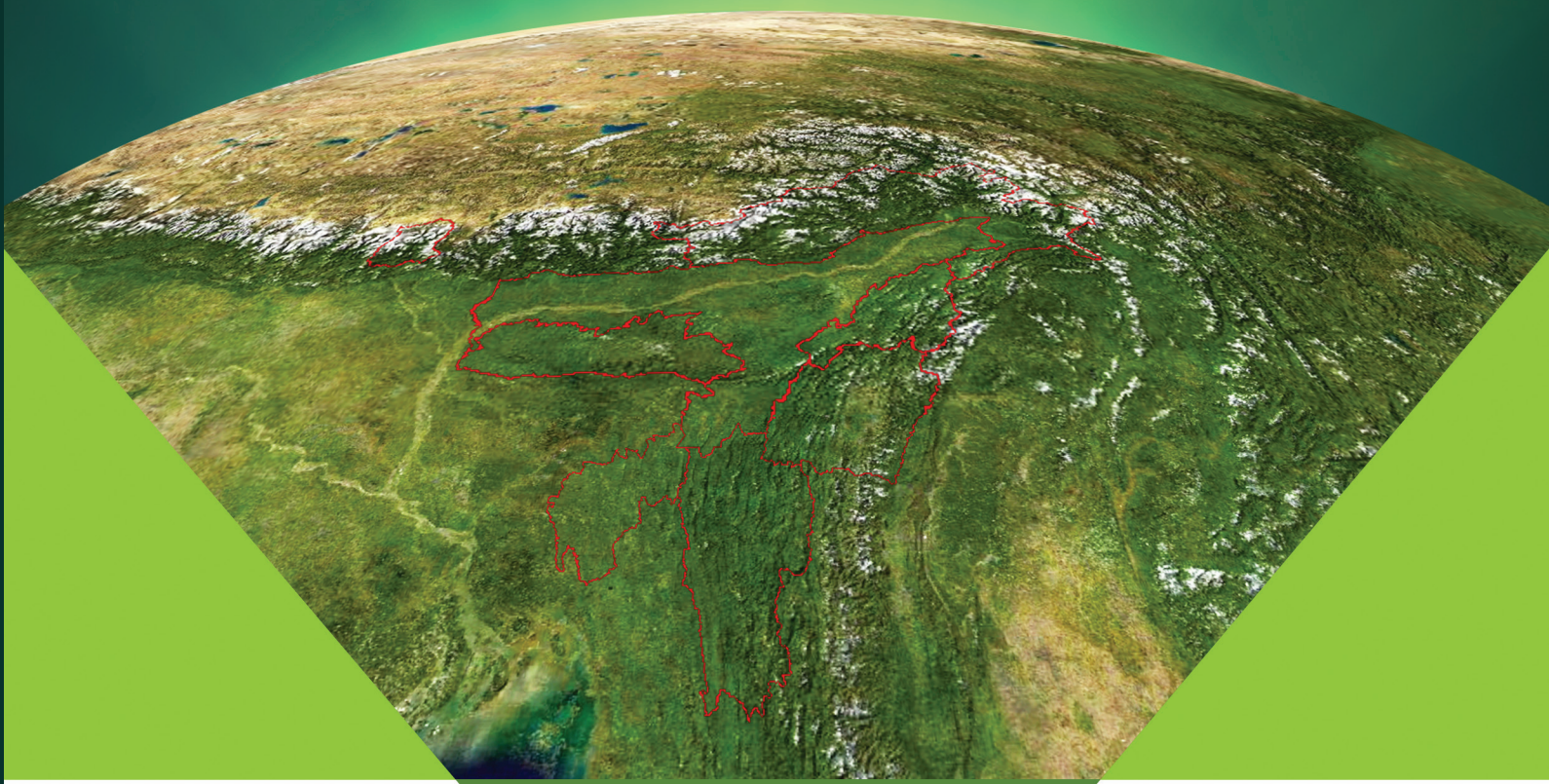
Annual Report
वार्षिक रिपोर्ट
2017-2018



North Eastern Space Applications Centre
Department of Space, Government of India
Umiam, Shillong, Meghalaya
www.nesac.gov.in

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North Eastern Space Applications Centre
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Umiam, Meghalaya

Annual Report 2017-18

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Reviewed by

Shri P.L.N. Raju, 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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has been assessed and found conforming to the following requirement

Standard: ISO 9001:2015

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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

During the year 2017-18, North Eastern Space Applications Centre (NESAC) has achieved a number of significant milestones. The ICT enabled services rendered under NEDRP project has been recognized in the form of National e-Governance award for the year 2017-18 by the Department of Administrative Reforms & Public Grievances (DARPG), Government of India. Indian Register Quality Services (IRQS), Mumbai certified Quality Management System (QMS) of NESAC under ISO 9001:2015 standard for providing value added services for natural resource management and disaster management support using space technology. NESAC has undertaken major expansion of UAV (Unmanned Aerial Vehicle) activities and supplied UAVs to all State Remote Sensing Application Centres with the financial assistance of North Eastern Council (NEC), Ministry of Development of North Eastern Region (DoNER). The State Meet on promoting space technology based tools and applications in governance and development for the state of Manipur was also organized during the year.

In the area of remote sening applications in agriculture and soils, NESAC is implementing the CHAMAN (Coordinated Horticulture Assessment and Management using geo-informatics) project of Ministry of Agriculture and Farmers' Welfare, Govt. of India for NER. Site suitability analysis for selected horticultural crops in selected districts of NER has been carried out under the project. Use of advanced technologies such as hyperspectral remote sensing and UAV remote sensing has also been explored for hill agriculture. Crop condition assessment of selected crops of NER under abiotic stress was carried out using non imaging hyperspectral sensors. Similarly, discrimination of horticultural crops using multispectral sensor onboard UAV has also been attempted as a pilot study in Jaintia Hills of Meghalaya. As per the request of Agriculture Department of Meghalaya, NESAC has identified potential sites for cultivation of Boro rice (summer rice) in the state of Meghalaya. NESAC has also intiated a project on Development of Decision Support System for early warning of selected Muga Silkworm diseases and pests with financial assistance from Central Silks Board, Bengaluru.

NESAC has been supporting the State Forest Departments in preparation of Forest working plans. During the year, inputs for preparation of working plan has been provided to the state of Assam and the work is in progress for the state of Arunachal Pradesh and Mizoram. As per the request of Dept. of Environment & Forest, Govt. of Arunachal Pradesh, wetlands of more than 5 ha along with their zone of influence have been identified. Similarly, burnt area of Keibul Lamjao National Park, Manipur was assessed with the request from Wildlife Institute of India, Dehradun. Use of microwave data has also been initiated for above ground biomass estimation in selected forests of Tripura. Major emphasis was given for assessment of Bamboo in NER and spatial distribution of bamboo has been studied in two districts of Nagaland on a pilot basis.

In the area of Hydrology & Water Resources, Flood Early Warning System (FLEWS) programme initially carried out for the state of Assam, has been extended to other states of NER. As per the request of

Central Water Commission, NESAC has carried out a pilot study on forecasting of inundation in Brahmaputra Basin. The project on River Atlas of Assam was successfully completed during this year as requested by Water Resources Department of Assam. Again, NESAC has been carrying out monitoring and evaluation of projects implemented during 2009-10 to 2014-15 under Integrated Watershed Management Program (IWMP) in NER. Soil & water Conservation Department of Assam requested NESAC to prepare the land resource inventory map and accordingly it was prepared and handed over to the user department. Suitable sites for constriction of check dams in Ukhrul district of Manipur were also identified.

As part of Urban and Infrastructure Planning, NESAC has been carrying out GIS based master/development plan for Shillong Planning area under Atal Mission for Rejuvenation And Urban Transformation (AMRUT) sub-scheme. Capacity building programme under AMRUT sub-scheme has been organized for decision makers, mid level officers as well as junior officers and total 70 officers representing different states of the country were trained.

In the areas of Information Technology, a major programme called North Eastern Spatial Data Repository (NeSDR) is being executed as per the directive of Ministry of DoNER with the objective to establish Geospatial Network among SRSACs of NE region through augmentation of existing IT infrastructures as well as creating the catalogue of existing geospatial data generated at different scales, different time frame available with SRSACs and line departments.

NESAC has expanded the activities of Photogrammetry and UAV Remote Sensing in this year. NESAC has conducted more than 35 UAV surveys for different users and research work in the NER. The service has also been extended beyond NE Region. A pilot study was conducted on estimation of earth work for extension of Shillong Airport using UAV as per the request of Airport Authority of India. Again, Suitable Road Alignment Planning from Dumro to Same Basti of Arunachal Pradesh was carried out for Border Roads Organization.

Under SATCOM operational programs, the Tele-Education project, which already had its presence in all the eight states of North NER except Manipur, has been completely revived in 2017 and new network for the state of Manipur has also been established. A new plan for revival of Tele-Medicine program in North Eastern Region is also under process. NESAC has provided support to Meghalaya Police by providing satellite phones (developed by ISRO) for aiding in their strategic missions.

The space and Atmospheric science group has been engaged in research in the areas of Atmospheric science and Space science, with focus on understanding the spatio-temporal distribution of major climate change drivers like aerosols and different greenhouse gases, through collection and analysis of in-situ data from fixed stations and land campaigns and satellite data and products. Impact of anthropogenic factors such as forest fire on air quality has also been studied. Another major area of activity is research on short and medium range weather forecasting for NER of India to support disaster management. The first S-band polarimetric radar installed at Cherrapunjee has been operationalized. The group has also started providing experimental operational short range weather forecast and development of lightning early warning system for NER of India.

As a part of increasing outreach activities, state of the art infrastructure facility with lecture halls, practical laboratories, 80 bedded hostel with dining facility is in final stage of completion. During this year training programme on various themes like Basics of RS & GIS, UAV Remote Sensing, Geo-Tagging of Rashtriya Krishi Vikash Yojona (RKVY) Assets, Empowering Panchayati Raj Institutions Spatially (EPRIS) and many more have successfully been completed. A large number of students choose NESAC for their external project work. In addition to this large number of students representing various academic institutions visited NESAC as a part of their study tour programme. Six new scientists, one library assistant and one assistant have been recruited during the year.

I convey my sincere appreciation to 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.

(P.L.N. Raju)

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Director, Indian Institute of Technology

Director, SCNP, ISRO, Bangalore

Director, EOS, ISRO, Bangalore

Director S&T, North Eastern Council

Member Secretary

Director, North Eastern Space Applications Centre

Contents

ABOUT THE CENTRE

The North Eastern Space Applications Centre (NESAC), a joint initiative of 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 17 years of dedicated service to the eight states of 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 applications 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, 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 NER states, senior scientists from DOS and NEC and academia of NER. A Governing Council (GC), under advice of the Society, manages the activities of the Society/Centre. Secretary, DOS is the chairman of the GC, and Secretary, NEC is the Alternate Chairman. Chief Secretary, Meghalaya; representatives of the governments of 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 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 Observations Applications Mission (EOAM), 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 Programs under the Atmospheric Science Program (ASP) and ISRO Geosphere Biosphere Program (IGBP).

Facilities

NESAC is located at Umiam (Barapani) about 20 km from Shillong, Meghalaya State. Constructions of the residential complex including guest house cum training hostel are in final stage, which is about 1km 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 modeling, etc, GIS and GNSS equipments, Echo sounder, high quality output devices, etc. The Centre has rich collection of satellite data from Indian and foreign remote sensing satellites, covering entire NER, reference maps and other ancillary data of the region. NESAC is well equipped to process data from wide varieties of platforms to enable digital image processing, geospatial analysis and location based services. Capabilities and expertise do exist from both 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 close narrower interval for creation of spectral library.

Information Technology and Computing facilities

Over the years NESAC has established enhanced IT infrastructures for carrying out research and outreach activity and also to provide operational services. The Centre has a Local Area Network (LAN) with 1Gbps Ethernet backbone connecting all the laboratories, facilities as well as administrative departments. Internet connectivity is provided throughout the NESAC office building with 1Gbps OFC Link (NKN) with a redundant backup link with 10mbps bandwidth. Both NKN and ISRO Space-net connectivity are being used for video conferencing and other data streaming applications. The centre has established web hosting infrastructure with redundant servers and storage in order to provide various kinds of web services including FTP under existing project activities. The Centre is also equipped with sufficient number of workstations, printers, plotters, scanners, GPS systems, GPS-enabled digital cameras, GAGAN GPS and high end DGPS for advanced and precise ground survey applications. In addition, sufficient numbers of image processing and GIS softwares like Erdas, Geomatica, ESRI ArcGIS, eCognition, Supermap, Gama, TNTmips etc. along with other open source software and tools are available in the lab.

NESAC has setup HPC facility during 2014 with 1 master node (20 core), 6 compute nodes (72 core) with 12 TB storage (SAN). The computing facility has been upgraded with another 4 compute nodes (80 cores) with addition of 8TB storage.

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 and satellite phones (Type-D terminals) for communication support under disaster conditions. NESAC also contributes through development of Mobile Apps as part of disaster management support. NESAC has hosted one of the four ground stations to have NAVIC/ data reception and monitoring facility on 24X7 basis as part of satellite navigation program of ISRO. The Centre also supports Ka-band propagation experiment and NAVIC SPS-GPS receiver experiment.

Space and Atmospheric Science Research

The Centre has a dual polarized S band Doppler Weather Radar (DWR) installed at Cherrapunjee, Meghalaya for studies in early warning of hydro-meteorological disasters, convective systems, cloud and precipitation physics, etc. The centre also hosts a Multi Wavelength Radiometer (MWR), Sunphotometer, Aethalometer, 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 4 levels (at the heights of 6m, 10.5m, 18m, and 30m). Online gas analyzers for Green House Gases (GHG) like Oxides of Sulphate (SOx), Oxides of Nitrogen (NOx), Carbon monoxide (CO), Ozone (O_3), and Methane, non-Methane hydrocarbon are being used with necessary calibration and centralized data logging system to characterize the regional GHG and their impact on climate. A network of 118 Automatic Weather Stations (AWS) spread over entire NER was established by NESAC.

Library

The library facility is well equipped with books, journals, magazines and other resources covering wide varieties of subjects to cater the requirements of research and applications. Necessary software facilities are also established for efficient management of the library facility. NESAC library is covered under the *Antariksh Gyaan* consortium of Department of Space. NESAC avails the facility of online subscription of journals, access to a e-library resources under *Antariksh Gyaan*.

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 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 is also setting up full-fledged Gymnasium and Recreational facilities for its upcoming Outreach Facility.

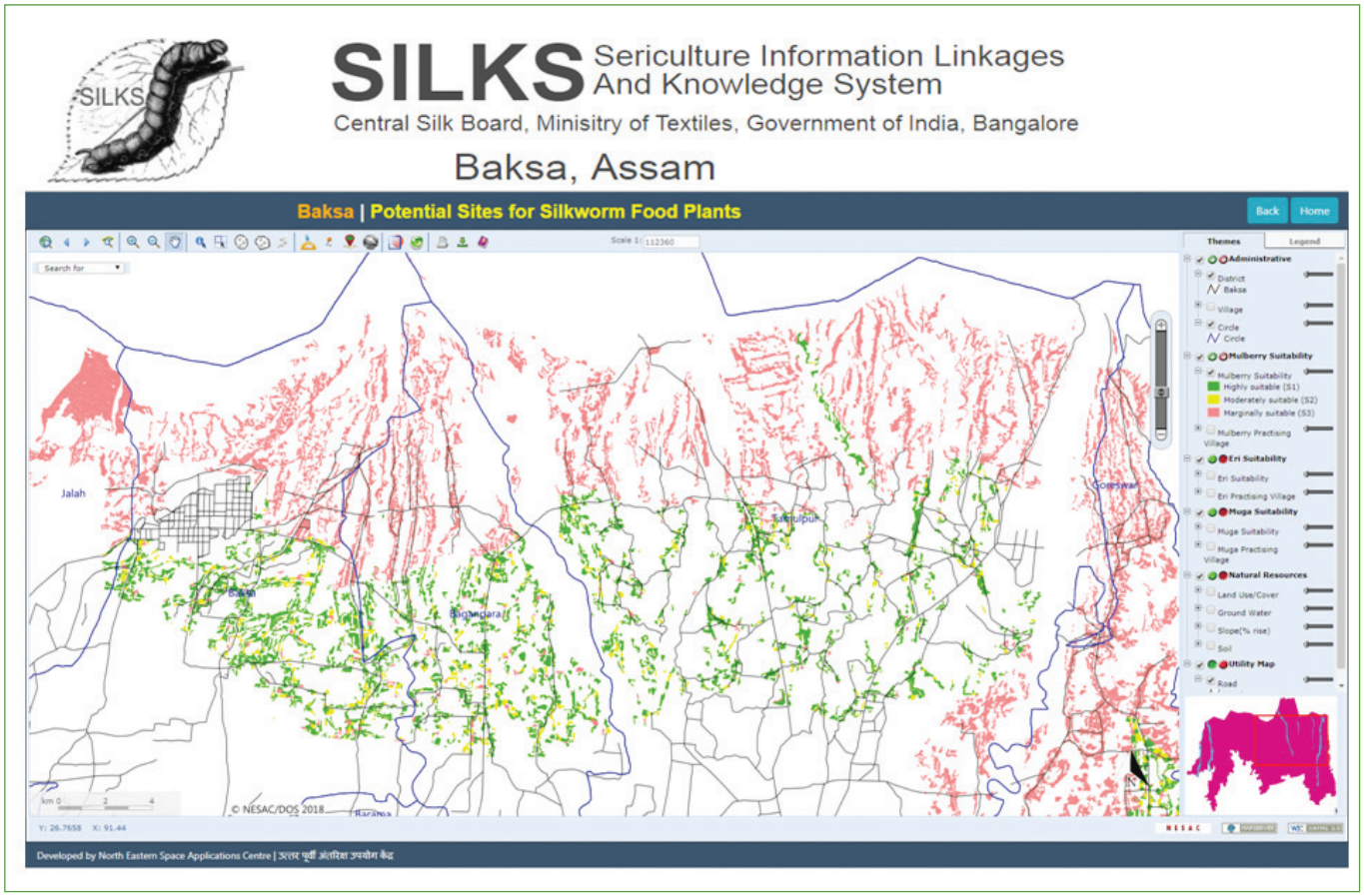
SPACE APPLICATIONS IN AGRICULTURE AND ALLIED AREAS

Applications of Remote Sensing GIS in Sericulture Development-Phase II

NESAC is taking the lead in applications of geospatial tools in Sericulture development in the country by successfully implementing a national level project on Applications of Remote Sensing and GIS in Sericulture Development funded by Central Silk Board (CSB), Ministry of Textiles, Govt. of India. The first phase of the project has successfully been executed in 108 districts from 24 states of the country covering all four types of sericulture (Mulberry, Eri, Muga and Tasar) in collaboration with State Remote Sensing Application Centres (SRSACs) and other partner Institutes.

Now the 2nd phase of the project is being implemented in 70 priority districts in the country covering 25 states, out of which 20 districts have been selected from North Eastern (NE) states. Ground truth collection/ field data collection (including soil sample collection), mapping of potential areas for sericulture development and External Quality Check (EQC) of spatial database has been completed for 33 districts representing 11 states. Mapping is in progress for remaining 37 districts representing 14 states. Integration of spatial database into SILKS portal has been completed for 20 districts from 7 NE states and it is in progress for 13 districts.

The geoportal called Sericulture Information Linkages and Knowledge System (SILKS) developed as a part of the project which is hosted live at http://silks.csb.gov.in has been providing the necessary sericulture related information for selected districts in the Country. The geoportal has been developed using open source tools and follows the open standard for data services. Now, under phase-II of the project, additional district portals for 20 districts have been added to SILKS geoportal. Necessary changes have been made to make the geoportal more robust and make more user-friendly. The entire SILKS site has been made more responsive so as to work on all devices and platforms. The site



Part of Baksa district, Assam showing potential areas for Muga silkworm rearing

re-design has been done to make site grids more proportionate instead of fixed layouts and uses flexible image sizes through CSS (Cascading Style Sheet) media queries.

The new SILKS is upgraded to newer mapping framework based on the latest Mapserver. It has new dynamic tools embedded within the map framework to interact with the map and extract useful information. The legend has been appropriately placed and dynamically displays the legend for the active/selected layers. The print/ download tools allows downloading and printing of the customized maps as per user's choices and selections. The map viewer can be expanded to full screen size for better visualization and interaction of the maps present within the district portal.

Coordinated Horticulture Assessment & Management using GeoiNformatics (CHAMAN)

Over the years, horticulture has emerged as one of the potential agricultural enterprise in accelerating the growth of the economy. Its role in the country's nutritional security, poverty alleviation and employment generation programmes is becoming increasingly important. It offers not only a wide range of options to the farmers for crop diversification, but also provides ample scope for sustaining large number of agro industries which generate huge employment opportunities. Total area occupied by horticultural crops is 24.9 mha and total production is 295.2 million tonnes, which is more than the food grain production of the country. Among various horticultural crops, fruits account for the major share, both in area and production, followed by vegetables and plantation crops (DAC&FW, 2017).

The unique diversity in agro-climatic conditions of North Eastern (NE) region coupled with fertile and well-drained soil makes this region suitable for growing a large number of horticultural crops like a wide range of fruits, vegetables and plantation crops. Some of the selected and promising crops of temperate and tropical fruits are grown commercially by some of the farmers in some potential areas. The dominant horticultural crops of the region include pineapple, citrus, orange, banana and areca nut. The high altitudinal places in the region provide good opportunities to grow offseason vegetables, including potato during the rainy season. The floriculture in these states is also expected to increase and can be explored for export oriented production. Banana, pineapple and orange are the most important crops among the fruits which cover about 60% of the area and account for 66% of the production of fruit crops.

Considering this, Mahalanobis National Crop Forecast Centre (MNCFC), Department of Agriculture, Cooperation & farmers' Welfare (DAC&FW), New Delhi initiated a project entitled Coordinated Horticulture Assessment & Management using GeoiNformatics (CHAMAN). Site Suitability Analysis for area expansion of one Horticultural Crop in one district of each NE State was carried out under CHAMAN programme. This component was coordinated by North Eastern Space Applications Centre (NESAC) and implemented by State Remote Sensing Applications Centre (SRSAC) of NE states.

Multispectral and multi-temporal satellite imagery of Resourcesat-2 LISS-III/IV sensor for the period of 2015-2016 was used for identification of major Land Use Land Cover (LULC) classes following visual image interpretation technique. Again, soil map on 1:50000/2,50,000 scale was used for extracting required soil parameters viz. texture, erosion, depth, soil drainage and pH. On the other hand, Digital Elevation Model (DEM) generated from stereo pair of IRS-P5 CARTOSAT-1 satellite imagery (CARTO-DEM) was used for delineating physiographic parameters viz. elevation, slope and aspect. Automatic Weather Station (AWS) data/ other available meteorological data were used for generating spatial database of climatic parameters viz. average annual rainfall and mean temperature by using Interpolation technique. For potential site selection climatic, physiographic, soil, LULC and ancillary data were integrated in GIS environment. Ranked weighted overlay technique was used for identification of potential sites for turmeric. Ground truth verification for suitable sites was also conducted using Unmanned Aerial Vehicle (UAV) during December 2017.

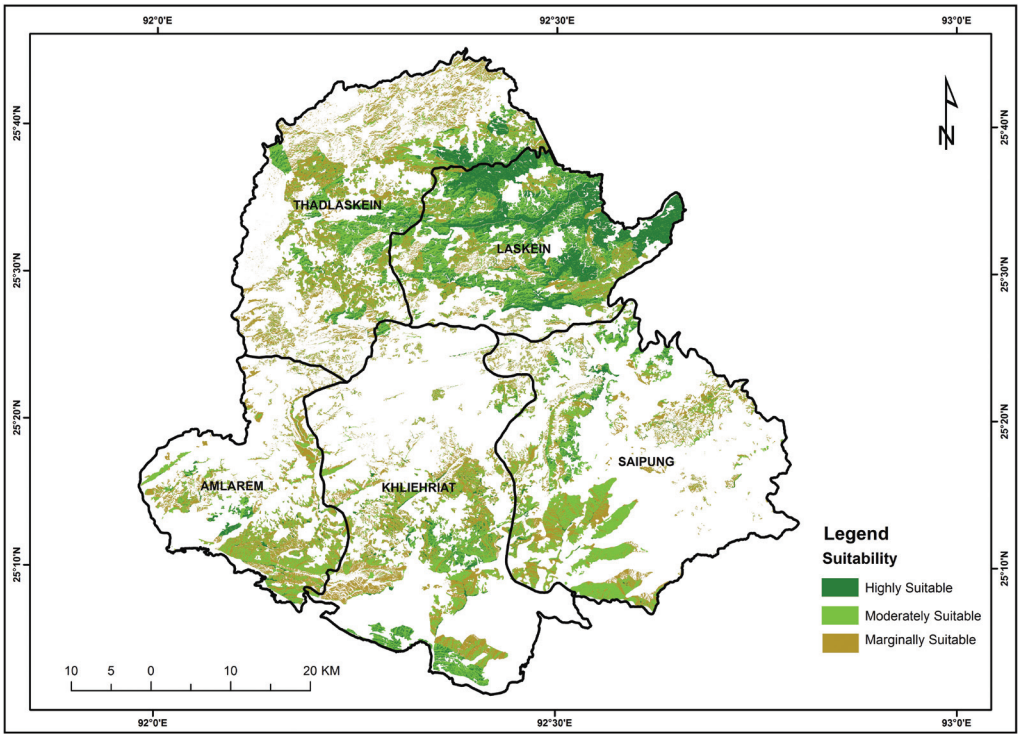
Total suitable areas were found to be highest for turmeric cultivation in Jaintia Hills of Meghalaya followed by Champhai district of Mizoram (for grape) and Senapati district of Manipur (for pineapple). Similarly, highly suitable areas were found to be highest in Jaintia Hills of Meghalaya followed by Senapati

district of Manipur and West district of Sikkim (large cardamom). One day workshop will be conducted at the state capital of each NE states and the outputs will be presented to the concerned state horticulture department. The database will be useful for state horticulture department of respective states of NER for expansion of these crops in the selected districts.

rice covers 25% of TRGA and high altitude rice that covers 5% of TRGA. Area wise, *Sali* rice constitute about 63,000 ha with an average yield of 1.9 MT/ha, *Ahu* about 33,000 ha with an average yield of 1.3 MT/ha and *Boro* about 13,000 ha with an average yield of 3.7 MT/ha. Considering the fact that Boro rice has high yield and there is scope of expansion of Boro rice,

Suitable areas for horticultural crops in NE states

State	Crop	District	Suitable area (ha)			Total (ha)
			High	Moderate	Marginal	
Arunachal Pradesh	Orange	Papumpare	1592	2362	5110	9064
Assam	Banana	Goalpara	4125	11581	8876	24582
Manipur	Pineapple	Senapati	23539	11401	4366	39306
Meghalaya	Turmeric	Jaintia Hills	29582	49592	52782	131956
Mizoram	Grape	Champhai	2257	19286	22237	43780
Nagaland	Pineapple	Dimapur	1129	1841	1303	4273
Sikkim	Cardamom	West Dist	5855	1336	377	8587
Tripura	Banana	West Dist	1037	9635	4989	15661



Potential sites for turmeric cultivation in Jaintia Hills of Meghalaya

Identification of suitable areas for expansion of Boro rice in Meghalaya

In Meghalaya the rice crop is distributed in three rice ecosystems. They are low altitude rice that covers 70% of total rice growing areas (TRGA), mid altitude

Government of Meghalaya has requested NESAC to take up the project on identification of areas suitable for expansion of Boro rice cultivation in the state. The project has been taken up in collaboration with Directorate of Agriculture (DoA), Govt. of Meghalaya, Shillong.

Land evaluation for soil site suitability for Boro rice has been carried out as per Food & Agriculture Organization (FAO) guidelines (FAO 1983). The existing soil map of 1:250,000 scale prepared by National Bureau of Soil Survey and Land Use Planning (NBSS & LUP) was updated to 1:50,000 scale based on base maps prepared from Resourcesat 2 LISS III images of 2016-17. Different thematic maps namely; soil depth, drainage, flooding, texture, and gravel/stoniness were

District wise suitable areas for expansion of Boro rice

District	Suitable Area (ha)				
	High	Moderate	Marginal	Total	% area
West Khasi Hills	-	0.5	70.9	71.4	0.1
South West Khasi Hills	-	11.1	126.6	137.7	0.2
East Garo Hills	-	-	150.5	150.5	0.2
East Khasi Hills	-	1189.9	97.4	1287.3	1.6
North Garo Hills	-	664.2	4514	5178.1	6.4
South Garo Hills	-	3720.6	4390.3	8110.9	10
South West Garo Hills	-	7805.2	9547.2	17352.4	21.5
West Garo Hills	635.2	8516	39277.1	48428.3	60
Total	635.2	21907.4	58174.2	80716.7	100.0

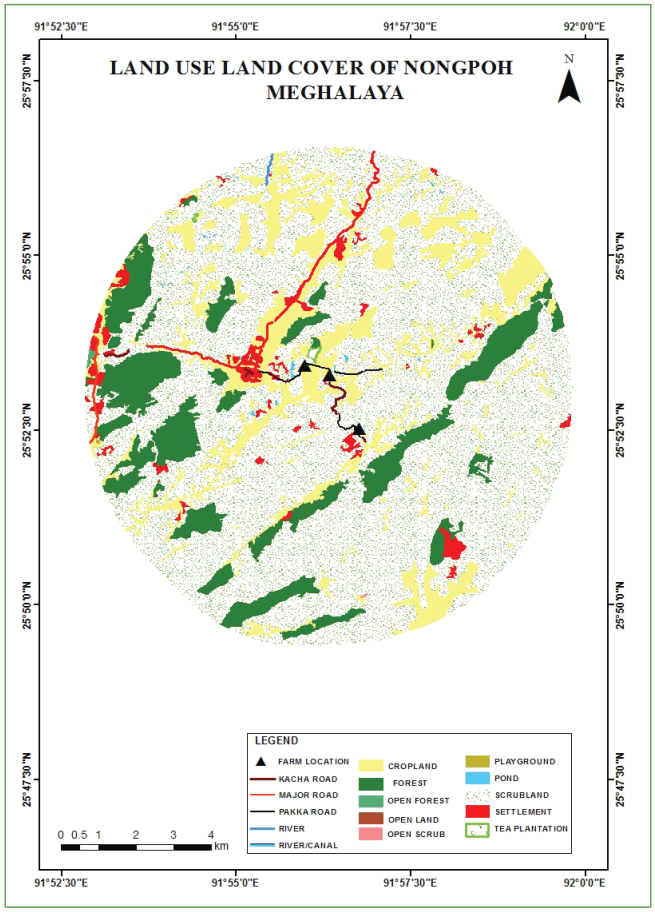
derived from the updated soil map. Land use map of 1:50K scale prepared by NESAC was used to extract the study area which includes all land use classes except forest, built up and barren rocky areas. Carto-DEM generated at NESAC was used to prepare slope and elevation map. Composite surface soil samples were collected from 121 locations representing various physiography, slope and land use. Soil samples were analysed for pH, organic carbon, N, P, K and other micronutrients. Various fertility maps were generated by using interpolation tool of ArcToolbox (ArcGIS software). All these maps were transferred to GIS environment and overlaid and analysed to assess suitability of soil site for Boro rice cultivation by following FAO guidelines.

From the study it is observed that only 80700 ha area (16.5%) is suitable for Boro rice cultivation in the state. Even though 16.5% area is suitable for boro rice, only 0.8 % (635 ha) area is highly suitable which is found in West Garo hills district. It is observed that 58174 ha areas are marginally suitable, whereas 21907 ha is moderately suitable in the state. From the study it is observed that suitable areas are distributed in 20 blocks of 8 districts of the state. More than 50% suitable areas are found in West Garo hills that cover 48430 ha where as only 70 ha area are found in West Khasi hills district.

It is also observed that highest suitable areas are found in Selsella and Dadenggre block of West Garo Hills district followed by Betasing block of South West Garo hills. Lowest area is found in Nongstoin block of West Khasi Hills district.

Development of Decision Support System for early warning of selected Muga Silkworm diseases and pests with Geospatial technique

The “golden silk”, Muga is found exclusively in the rainforest of the Himalayan foothills of NE India, especially in Assam and Meghalaya due to unique climatic conditions. It feeds on som *(Persea bombycina)*



LULC mapping around selected Muga farm of Nongpoh, Meghalaya

and Soalu *(Litsea Polyantha)* as primary food plant and few other plants as secondary and tertiary. It is reared outdoor and it suffers from a large number of problems such as unfavorable weather, infection from other creatures and outbreak of various diseases. The Muga culture is of economic importance and is closely associated with the life, tradition and culture of tribal people. The muga silk productivity is greatly affected by enormous pests and disease problems. Further, the effects are more pronounced in recent days due to human interventions in deteriorating Muga ecosystem resulting from rapid climate changes. The reason behind taking up this project is that, the climate and other natural resources of varied degree have undergone changes in different parts of the state. There is great probability of significant effects of increased climatic variability on the incidence of silkworm diseases if the changes in climate happen to coincide with the critical growth period of silkworm. Now it has become essential to assess the land cover, environmental condition and various climatic parameters which are likely to cause incidence of silkworm diseases. One of the approaches to increase the productivity of muga is to identify the various disease causing parameters and evolve strategies to overcome them in the form of decision support system. The study aims at identifying the various landscape and climatic parameters crucial for disease incidence; development of decision support system for early warning of selected muga silkworm diseases and dissemination of advisory services to farmers through SILKS portal.

Major economically important farms have been identified based on their spatial distribution of adaptibility under various physical and climatic conditions. The selected farms are situated in Nongpoh (Ri-Bhoi), Tura (West Garo Hills) and Jagduar (Jorhat). Detailed large scale mapping of these locations has been done by taking five kilometre buffer from the farm location. Analysis of 10 years historical weather data from MOSDAC is in progress. Moreover, for real time monitoring of weather parameter during four different muga rearing seasons, meteorological instruments are installed in all these selected locations. The comprehensive formats for in-situ measurements of weather variables, physical parameters and socio-economic conditions have been prepared.

Crop condition assessment under abiotic stress of few selected major crops of NER using remote sensing technique

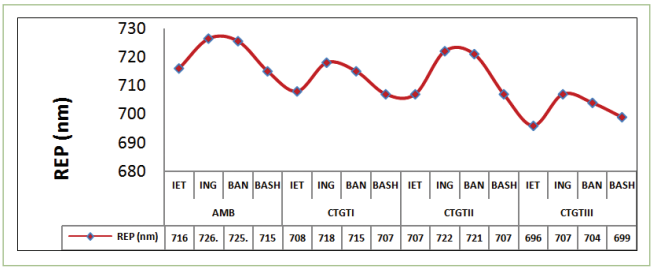
This study has been carried out in collaboration with Assam Agricultural University (AAU), Jorhat to study the responses of crop plants to the elevated CO_2 and temperature and nutrients availability, the physiological

Experiment under CTGT (a) and Pot (b) at AAU, Jorhat

and biochemical characterization of these responses. Hyperspectral remote sensing has been shown to be crucial for quantifying biophysical and biochemical parameters of crops. In the present investigation, the responses of four rice local genotype namely Inglongkiri, Banglami, IET22238 and Bash were to the interaction of elevated CO_2 and temperature stress were studied in Carbondioxide Temperature Gradient Tunnel (CTGT) to simulate elevated CO_2 concentration and temperature. Similarly, pot experiments were carried out at varying level of nitrogen fertilizer to identify the genotype that could thrive under low N level without adversely affecting yield. Spectral profile of the target object under these induced stresses was recorded using spectroradiometer (SVC HR 1024). Physiological and biochemical analysis of these responses was done through quantisation of the effects on the photosynthetic capacity, growth response, changes in some phenological parameters, internal chemical changes. Observations on morphological, physiological, biochemical, membrane related and other defence

mechanism were studied according to standard biochemical procedures and laboratory equipments. In present investigation under CTGT, significant difference was noted in photosynthesis (Pn) among the genotype. In CTGT II (550 ppm CO_2 with ambient temperature + 4°C elevation of temperature) significantly increased the rate of Pn in tolerant rice genotype due to some adaptive mechanisms to thrive under high temperature and CO_2. But significant reduction in Pn rate was recorded in some susceptible genotypes such as Bash and IET-22238 under CTGT-III (750 ppm CO_2 with ambient temperature + 6°C elevation of temperature) might be due to more stomatal resistance with reduction of number of stomatal per unit area with concomitant decreased of size of stomata .

Similarly spectral reflectance at red edge position (REP) of all genotype observed in present investigation is higher at ambient condition followed by CTGT II. The REP of tolerant genotype was the highest wavelength whereas REP of susceptible genotype was the lowest wavelength at CTGT III, which indicates REP at longer



variation of REP under different CTGTs

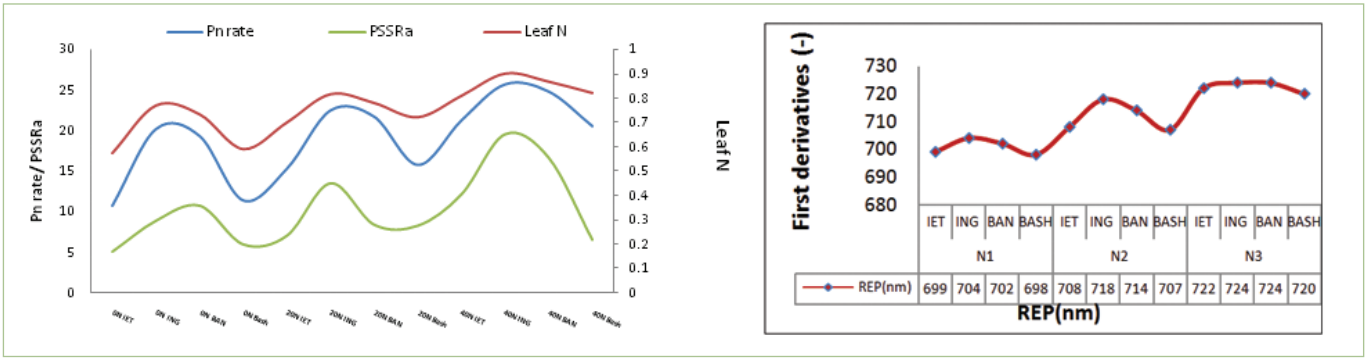
wavelengths with increase in chlorophyll and nitrogen concentration. The resulting index increases the ability to detect stress plant under CO_2 enriched environment.

It was observed that NDVI is useful in distinguishing stress and control leaves under varying level of nitrogen fertilization. There was significant relationship between Nitrogen and canopy reflectance in the visible and near infrared regions. Pigment Specific Simple Ratio for chlorophyll a (PSSRa) was recorded as a good indicator for Pn and leaf Nitrogen. The variability among the genotypes under different nitrogen level can easily monitored using spectral responses at red edge position. REP in tolerant genotypes was found in comparatively longer wavelength at 40Kg of N (N3), which is strongly correlated with foliar chlorophyll content and leaf N content.

The experiments reveal that hyperspectral data could be a valid option for detection of varietal performance, nutrient content and other biochemical parameter of the crop. This entire database on different rice genotype has helped to understand various strategies developed by the plants due to elevated CO_2 and to adjust and acclimate under high temperature stress condition and varying level of nitrogen fertilization. Results of the present study will be useful in identifying genotypes, developing model and modifying cultivation and nutrient application technologies for future environment of higher CO_2, temperature and nitrogen stress.

Characterization of Acid Soils under different land use pattern and its impact on Crop Growth: A Hyperspectral approach

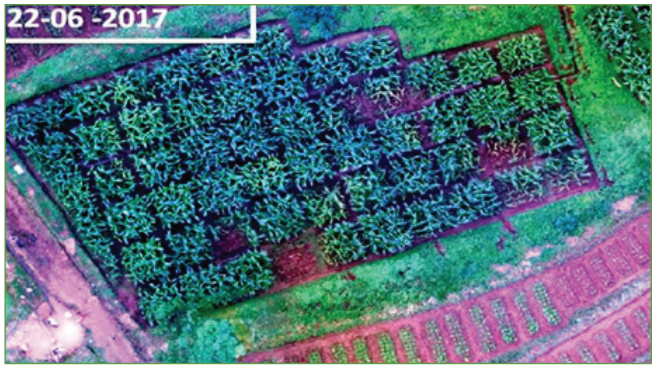
The spectroscopy based estimation of soil properties is the lack of adequate attention to hilly, undulating, high rainfall and land degradation prone sub-tropical soils like in the NE Region of India. Rainfed agriculture under severe abiotic stresses like soil acidity induced fertility, toxicity, moisture etc. also needs special attention in developing spectroscopy based technique for periodic non-destructive monitoring of crop growth condition and adoption of sustainable management



Variability of rate of photosynthesis (Pn), leaf N with PSSRa and REP among genotype under different Nitrogen level.

practices for optimum productivity. Therefore, present study has been carried as a collaborative partner with ICAR Research Complex for North Eastern Hill Region (NEHR), Umiam mainly focused to develop spectroscopic based techniques for discrimination and identification of acidity induced abiotic stresses (toxicity of exchangeable aluminum, iron and deficit in Phosphorus) in maize crops grown in the hilly ecosystems of NER.

Three consecutive field experiments on maize as test crop have been carried out at experiential research farm, Soil Science of ICAR RC for NEHR. Based on critical soil test values three different abiotic stresses- soil acidity, Nutrients- Nitrogen (N) and Phosphorus

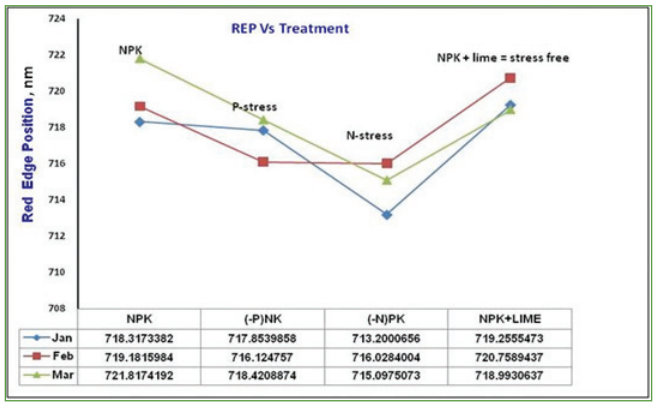


Experimental plot

(P) stresses has been imposed. Standard Irrigation scheduling was followed (as recommended for the region). Soil spectral reflectance has been collected in the maize canopy zone along with the reflectance measurements (ground spectra as well as UAV spectral imaging) of the crop (maize) on-field condition, all in synchronization (field spectra-UAV- lab. Spectra- soil characterization in laboratory). Similarly, collected soil samples from the same location in the same day for soil properties estimation in laboratory. The same soil samples were also sent to IARI, New Delhi for spectral reflectance measurement in laboratory condition as well. Various bio-physical and bio-chemical properties were measured from the standing crop during the last three seasons were periodically measured. Along with crop bio-physical and bio-chemical properties, period reflectance measurements were recorded using ground spectroradiometer as well as UAV.

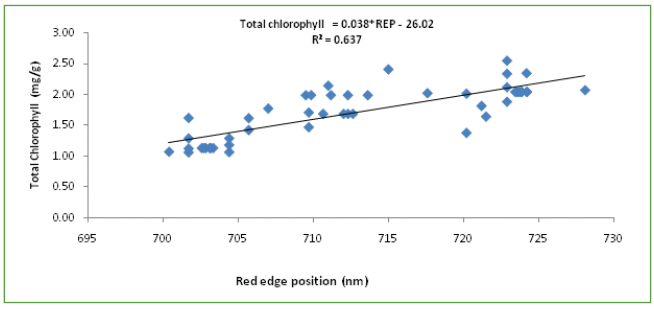
Periodic field spectral data were analyzed following standard procedures (including standard statistical analysis involving sensitive spectral bands, spectral indices, multivariate analysis –PCA etc.) for smoothed, 1st derivatives, normalized and water removal reflectance of the maize crops. 24 indices/sensitive bands were correlated with the bio-chemical and bio-physical properties of the maize plant at different stages of growth across treatment combinations (stress free, N- and P stress conditions). However, some of the selected significant findings from preliminary analysis are highlighted here- particularly P and N stress. Similarly, sensitive indices to bio-chemical properties with high correlations are also presented.

Red, Green, Red edge and Near Infra red band of multispectral sensor mounted on UAV were used to obtain Normalized Difference Vegetation Index (NDVI).

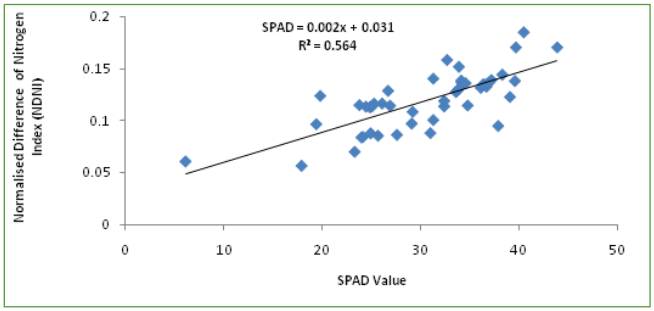


	NPK	(-P)NK	(-N)PK	NPK+LIME
Jan	718.3173382	717.8539858	713.2000656	719.2555473
Feb	719.1815984	716.124757	716.0284004	720.7589437
Mar	721.8174192	718.4208874	715.0975073	718.9930637

Red edge position (REP) across treatment combinations (stress free vs. N& P –stressed)

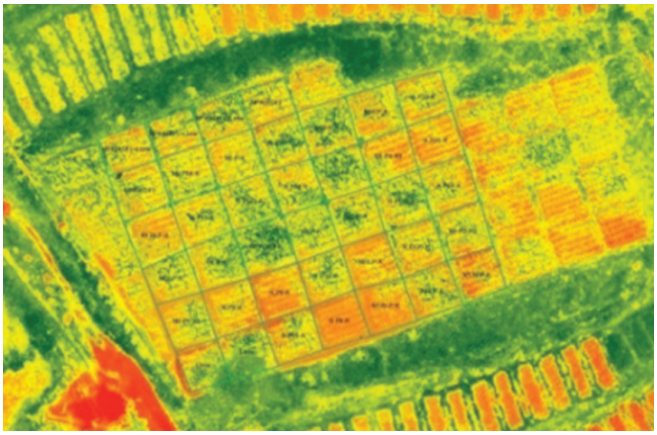


Chlorophyll sensitive index -REP across treatment combinations (stress free vs. N& P –stressed)

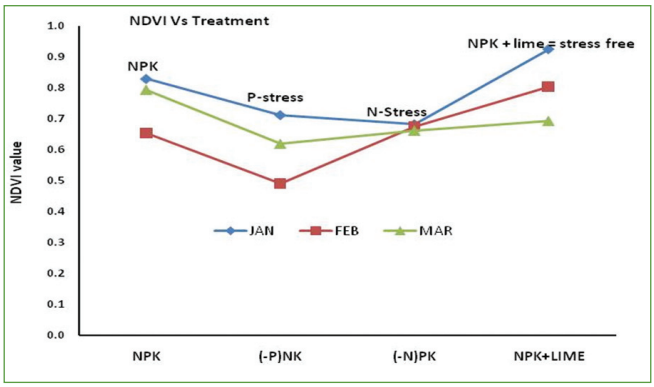


Nitrogen stress sensitive index – NDNI with SPAD values

The plants which were subjected to treatment with nitrogen/phosphorus deficiency have shown poor NDVI as compared to the plant subjected to balanced fertilization of NPK along with lime in the initial stages



Variation in NDVI across treatment combinations (stress free vs. N& P –stressed)



NDVI values across treatment combinations (stress free vs. N& P –stressed)

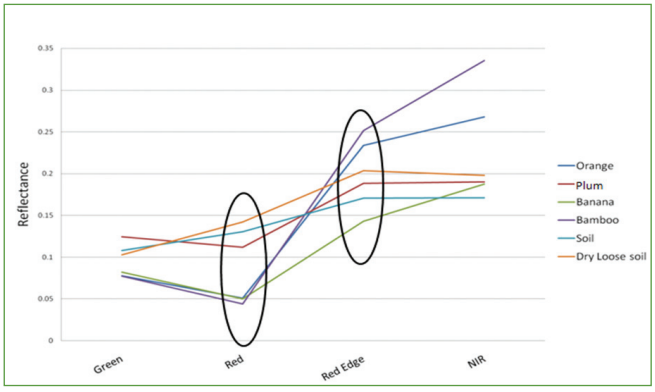
UAV Remote Sensing for Agricultural applications in NER

UAVs are emerging as a remote sensing platform that can fill the gap between high resolution and medium resolution earth observing satellites in agriculture applications. UAVs can carry miniature narrowband multispectral, RGB or hyperspectral cameras to capture patterns in biophysical variables. Revisit times can be optimized to match the phenological cycle of specific species, thus maximizing the availability of information needed for crop management. In addition, due to the flight altitude images are free of cloud contamination. The atmospheric and regular cloud issues can be easily taken care by using UAV data as it flies at a height below the earth surface. In inaccessible terrain such as North East India, where ground survey is not feasible, their utility for ground reference for Satellite data has increased.

NESAC has carried out studies on UAV applications for agriculture using both multispectral, parrot sequoia sensor having four bands and RGB camera. A light weight hexacopter DJI Matrix 600 was employed for these survey. In one study carried out in the West Jaintia Hill district of Meghalaya, discrimination of horticultural crops viz. banana, orange, and plum and the neighbouring bamboo grooves were evaluated using three commonly used indices viz., Normalized Difference Vegetation Index (NDVI), Normalized Difference Red Edge Index (NDRE) and Green Normalized Difference Vegetation Index (GNDVI) NDVI and GNDVI showed nearly similar spectral response, whereas separability among the crops marginally improved with the use of NDRE. The percent variations of spectral response for orange and bamboo were 14 and 19 in terms of NDVI and GNDI respectively, whereas the same value is 49 in case of NDRE. Similarly percent variations of spectral response for banana and bamboo were 7 and 15 in terms of NDVI and GNDI against 27 in case of NDRE.

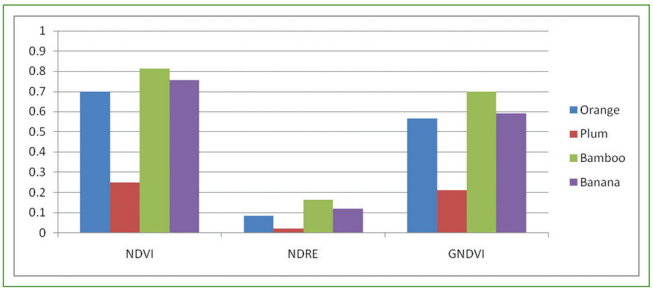
The image acquired from the surveys shows the

FCC image of the study area during June 2017



Spectral response of crops and associated land cover

difference in terms spectral variation of the study area during the both time periods. Spectral response plotted for the crops and the associated features showed better separability in the red edge region. Horticultural crops like Banana and orange having similar reflectance with neighboring Bamboo in the red region could be well separated in the red edge region. Interestingly the separated bands of Banana crop got overlapped with soil and cherry crop in the NIR region.



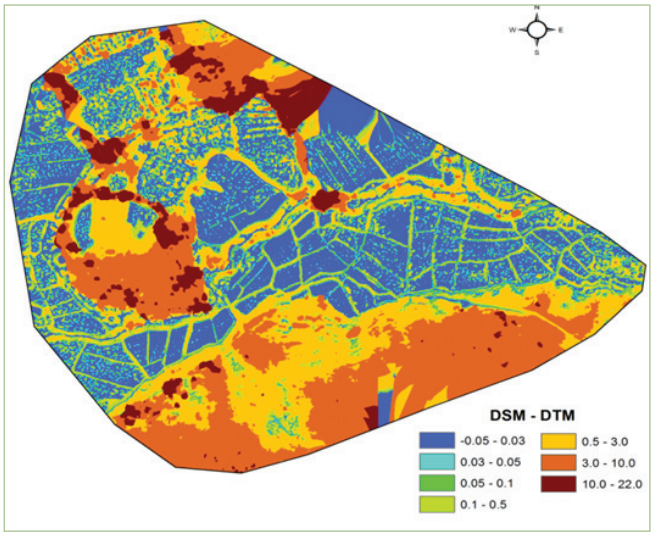
Response to the vegetation indices for selected crops

Correlation among the selected indices reveals that there is closer relation with NDVI and GNDVI (r=0.96) against r=0.85 between NDVI and NDRE. This will suggest in employing of either NDVI or GNDVI as there is no significant additional information due to the use of GNDVI.

Table: Correlation matrix of vegetation indices

	NDVI	NDRE	GNDVI
NDVI	1		
NDRE	0.852703	1	
GNDVI	0.955721	0.839229	1

In another study, in the same block, variation in Digital Surface Model (DSM) from Digital Terrain Model (DTM) was generated to discriminate different crops grown at different elevation. The difference in the surface model has helped in discriminating different crops and other neighboring vegetation. The difference in the surface model has helped in discriminating different crops and other neighboring vegetation with rice, recording difference of -0.05 m to 0.05m for paddy crop, followed by maize (0.05m–0.5m) and pineapple (0.5m–10m). In the higher elevation horticultural crops like pineapple could be differentiated, even though distribution of bamboo grooves lies in similar level in some areas.

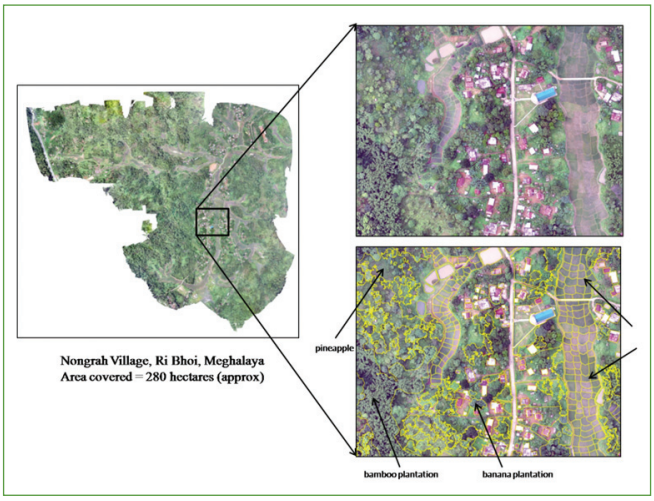


Variation of difference of DTM and DSM of the study area

Distribution of crops vis-a -vis difference of DTM and DSM

DTM (in m)	DSM (in m)	Difference of DTM and DSM (in m)	Crop
1237.8-1245.5	1237-1246	-0.05-0.05	Paddy
1245.5-1250.0	1246-1248	0.05-0.5	Maize
1250.0-1253.2	1248-1253	0.5-10	Pineapple
1253.2-1260.0	1253-1276	10-22	Bamboo

Another study is being carried out in Nongkrah village in Ri Bhoi district, Meghalaya, for development of a Village Information System (VIS) that will have all the information pertaining to the village at individual household level. UAV survey and digitization of the individual households and farms has been completed for approximately 280 hectares of land surveyed. The field survey is going on in association with Directorate of Economics and Statistics, Government of Meghalaya.



Farm level mapping using UAV for Nongkrah village in Nongpoh Block

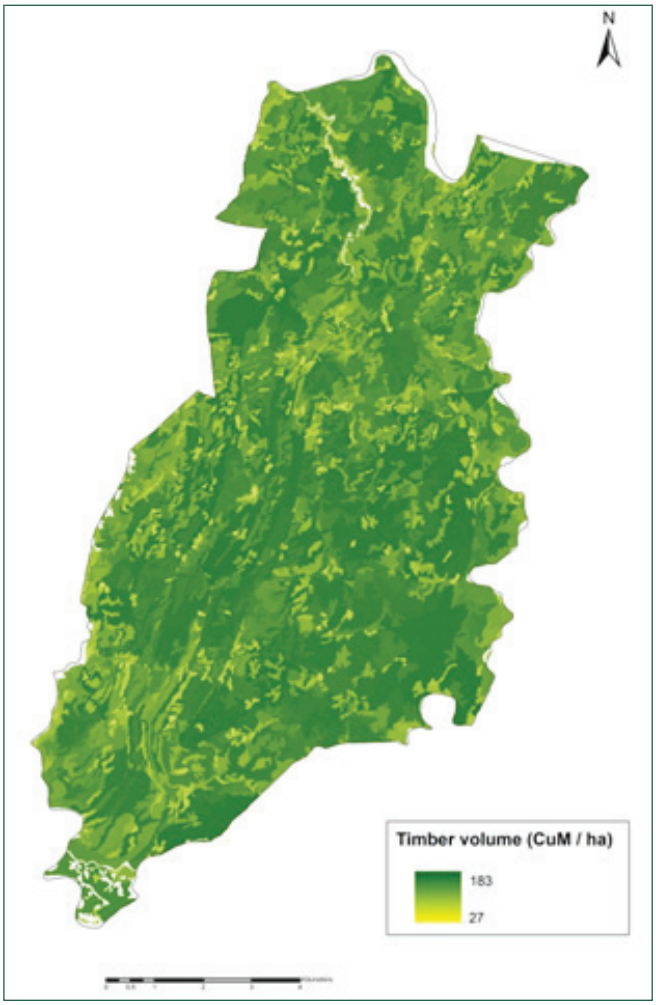
FORESTRY AND ECOLOGY

Forests constitute about 65.45% of the total geographical area of northeastern India. This region represents 24.22% of the country's forest cover (FSI, 2017) although it occupies only 7.98% of the country's land area. Forests of this region are structurally unique and diverse owing to its location in the transition zone between the Indian, Indo-Malayan and Indo-Chinese biogeographic region and the altitudinal variation and rainfall patterns of southwest and northeast monsoon in the region also play a significant role. But these forests are under immense pressure as the ownership is mostly under the community, clan or private and little under the control of the States. The State Forest Departments of the region had been preparing the forest working plans for the divisions where no approved working plan exists and revising for those which are expiring. NESAC has been supporting different state forest departments in preparing the geospatial inputs and computational estimates of growing stocks at forest compartment level. Studies on vegetation and soil carbon, bamboo resources, forest biomass estimations, wetland mapping, shifting cultivation dynamics and burnt area assessment are some of the other activities of this group.

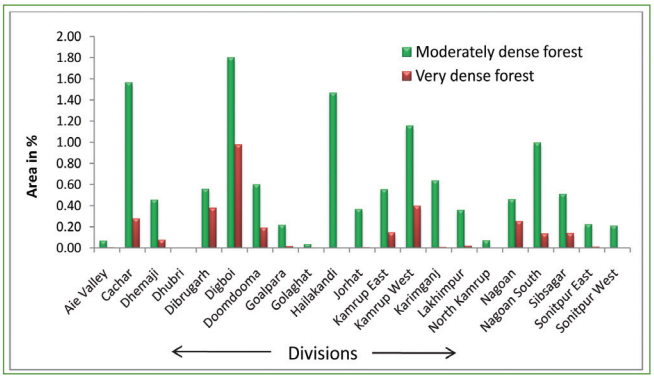
RS and GIS inputs for preparation of forest working plan in Assam

RS & GIS based input preparation for Forest Working plans for 288 Reserve Forests covering 21 Territorial Forest Divisions under 5 Forest Working Circles has been carried out in collaboration with Department of Environment and Forest, Govt. of Assam. The project is completed and timber volume estimates has been submitted to the department. The study revealed that Digboi division has good quality forest cover and it has the highest forest cover area in very dense category amongst all divisions. The divisions with very less forest cover are Golaghat, Aie Valley and Dhubri divisions.

Timber volume estimations were carried out at compartment level for all the reserve forests. The total estimated timber volume in all 21 divisions is 189.67 lakh CuM. Dibrugarh division contributed the highest timber volume (20.32 %) followed by Nagoan South (12.94 %), Digboi division (12 %) and Cachar division (11.49 %). Divisions which have the least timber volume are Aie Valley (0.56 %), Dhubri (0.25 %), Golaghat (0.75 %), Jorhat (0.24 %) and North Kamrup (0.37 %). Amongst the girth classes, G6 contributes the largest timber volume (41.86 %) followed by G3 (13.06 %) whereas, G1 contributes only 4.97 %.

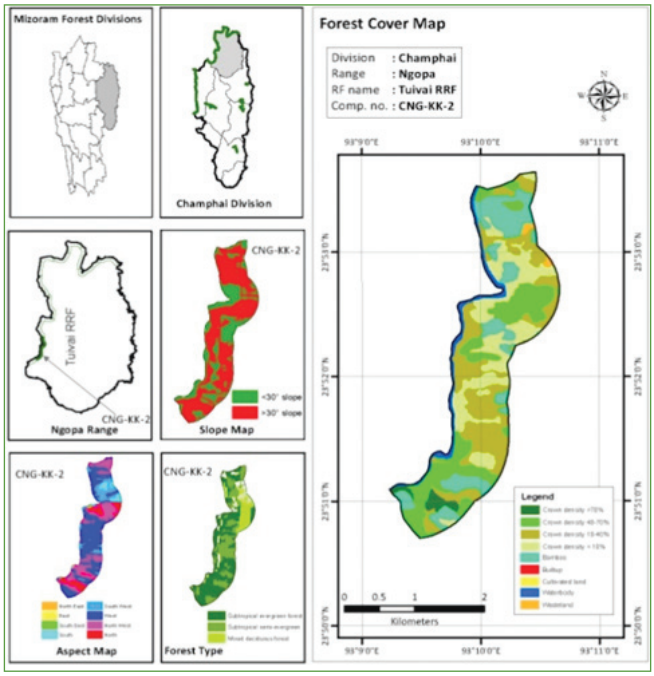


Spatial distribution of estimated timber volume in Joypur RF, Dibrugarh Division, Assam



Forest density distribution in the 21 forest divisions of Assam

Forest growing stock assessment using Geospatial techniques for preparation of forest working plan in Mizoram



Compartment map showing growing stock information

For assessing the spatial distribution of timber growing stock in different reserved forests of the four divisions in Mizoram, two forest divisions of Champhai and Darlawn were taken up in the first phase. Forest Canopy density at 1:10,000 scale was prepared using cartosat-1 and LISS IV data. Stratification of the forest was done on the basis of canopy density and elevation. Based on field enumeration data from sampling points distributed on the basis of 25"x25" grids growing stock information has been generated for each compartment at different girth classes and at different slope categories. Information on timber species composition, phyto-sociology, species richness, etc., has also been generated reserved forest wise. Growing stock maps showing information on spatial location of the compartment and compartment maps showing forest canopy density, forest type, aspect, slope along with timber volume estimate in tabular form has been generated for the 2 divisions.

RS and GIS inputs for preparation of forest working plan in Arunachal Pradesh

This project is being carried out for covering all the divisions of the state, wherein geospatial inputs and computational estimates of growing stock at compartment level are provided to the Forest Department for preparation of forest working plans for different divisions.

The overall forest cover of the division is high since the entire forest division are under reserved forest category and adjacent to the Pakke Tiger Reserve. All

Forest cover under different ranges in Khellong Division

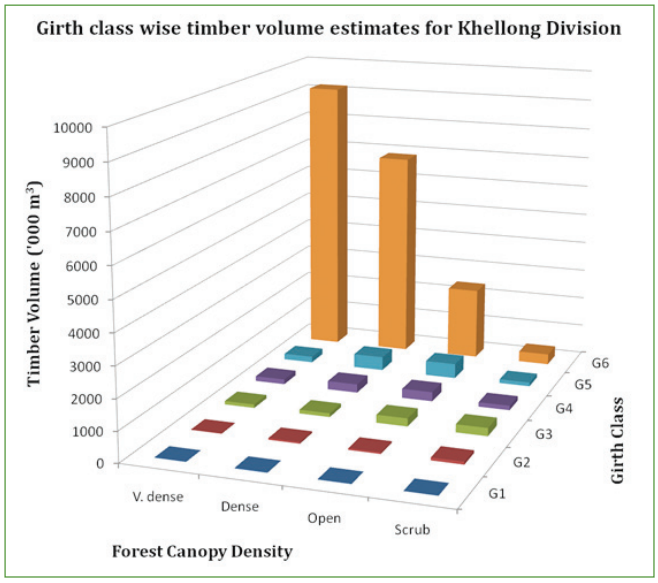
Canopy density	Forest Ranges (area in ha)						Total
	Amartala	Bhalukpong	Foothills	Rowta	Namorah	Seijusa	
Very dense	674	93	1212	2561	18144	8226	30910
Dense	1645	2763	5144	3975	17477	11823	42827
Open	3575	3428	9839	6586	9199	5155	37782
Scrub	3139	3211	5356	5135	7135	2945	26921
Total	9034	9496	21551	18256	51955	28148	138440
TGA	10016	10233	22290	19004	55197	30505	147246

Forest Canopy densities under different elevation categories in Khellong Division

Elevation	Area (ha)	Grand Total				
	D1	D2	D3	D4	Others	
<800 m	11577	23194	22453	18319	6652	82195
800 - 1800 m	1830	2325	1684	817	38	6694
>1800 m	17503	17308	13644	7785	2116	58357
Total	30910	42827	37782	26921	8805	147246

the six ranges under the division have forest cover more than 90%. Namorah and Seijosa ranges in the eastern part have more area under very dense canopy and dense forest canopy (about 65% area) category while Bhalukpong range have the least under (<1%) under very dense canopy category (Fig. FWP-Ar-1 & Table FWP-AR-1). Area under forest cover was maximum in the lower altitude (<800 m elevation) and least under the mid altitude while very dense forest were distributed mostly in the higher altitude (>1800m elevation).

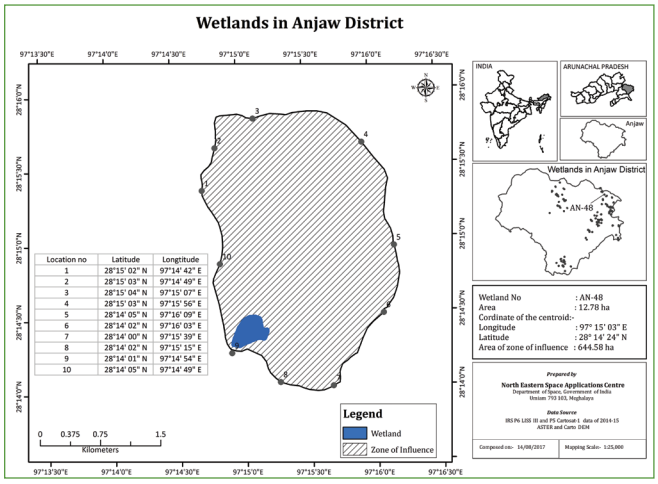
The detailed growing stock estimation at compartment level for all the six ranges comprising of three reserved forests under Khellong forest division has been completed. The stocking rate ranged from 30.65 m^3ha^{-1} in areas close to settlements and higher anthropogenic pressure to as high as 327.44 m^3ha^{-1} in interior undisturbed forests in the eastern ranges.



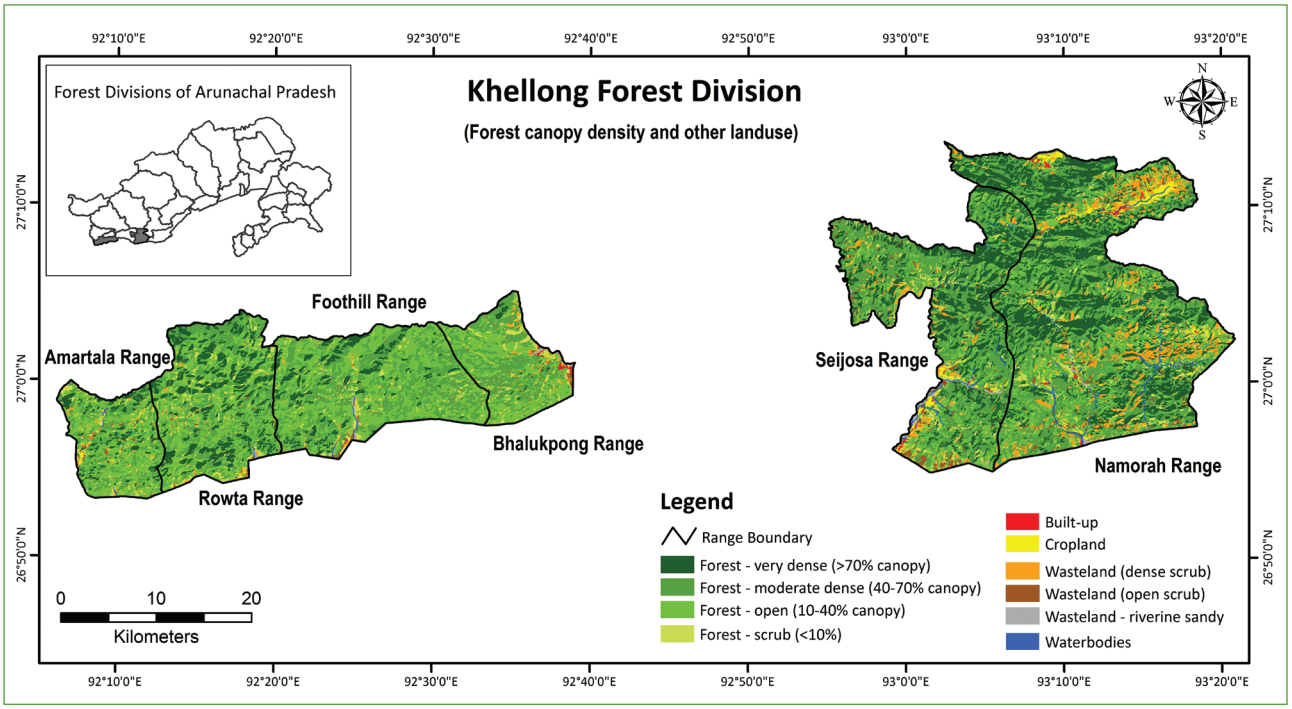
Girth class wise timber volume estimate for Khellong Division

Preparation of wetland atlas of Arunachal Pradesh

The state Environment Department, Arunachal Pradesh require spatial information of each and every wetlands of the state (> 5ha area) for all the districts and their zone of influence, as per Supreme Court Order dated 08.02.2017. In order to generate these information wetlands were identified based on LISS III data (2014-15) and also with reference to the NWIA database.



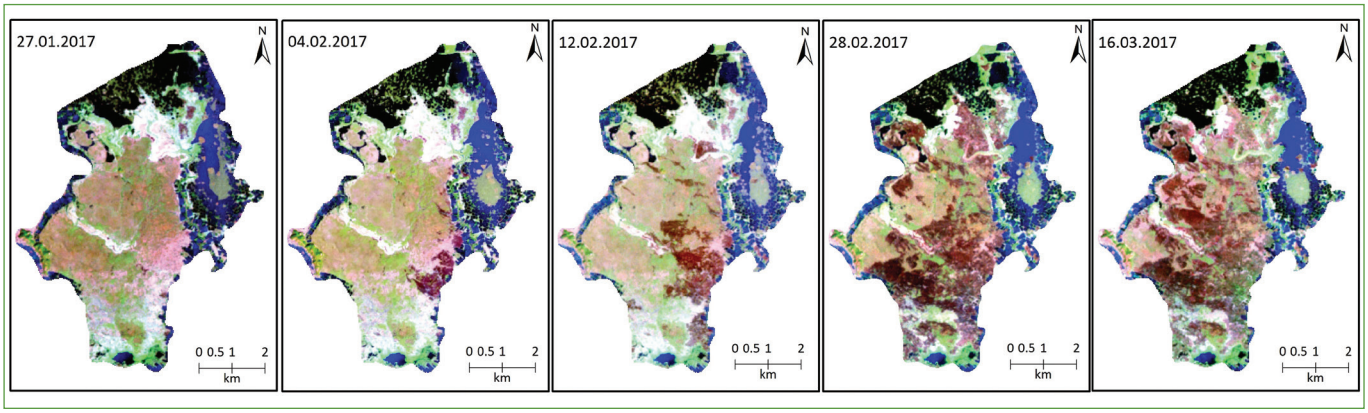
A sample wetland map of Anjaw district with its zone of influence



The wetlands boundaries were again updated using Cartosat-1 data and aspect map from Carto-DEM. Zone of influence (catchment boundary) for each wetland were delineated using digital elevation model, aspect map and drainage layer. An atlas of maps detailing 407 wetlands with maps for each wetland/zone of influence and coordinates of the boundary lines were prepared and provided to the department for formulating conservation planning as per the Supreme Court directives.

over a period of two months during January to March 2017. VIIRS active fire pixels were used for comparing & verifying the burning incidents. Time series analysis of the fire in the park was also conducted for the past 17 years.

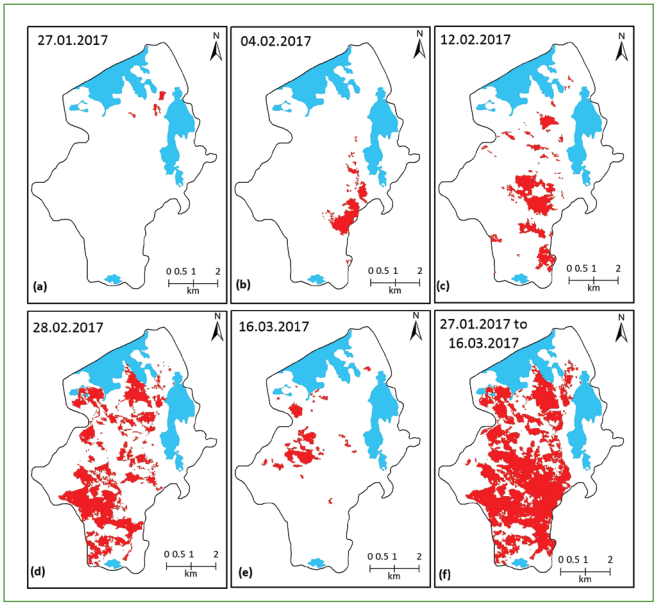
During the investigation it was observed that 52.8% (1388.95 ha) of the grassland area of the park was burnt during the two months period. The VIIRS active fire pixels correspond to the burning instances. Burnt



Landsat-7 & 8 FCC of the study site along with VIIRS active fire pixels

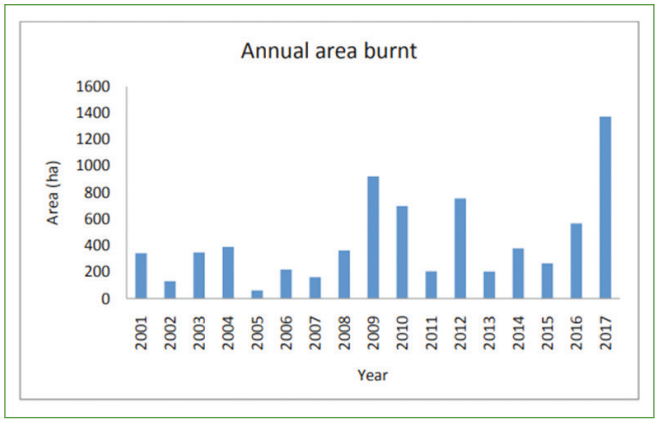
Burnt area assessment in the floating grasslands of Keibul Lamjao National Park, Manipur

As requested by Wildlife Institute of India, Dehradun a rapid assessment of the burnt area in KeibulLamjao National Park (KLNP), Manipur was done for the fire season of 2017 where large scale burning of the *phumdis* (floating grassland) in the park was reported. Extent of fire was analyzed using Landsat-7 and Landsat-8 data



Sequence of the grassland burning (Feb-Mar 2017)

area was maximum during the period from 13th to 28th February where 808.16 ha was affected. Based on the field vegetation analysis remedial measures for management of the grassland in the park was suggested for the forest department in the report.



Annual burnt area in KLNP (2001-2017)

SAR applications in estimation of above ground biomass in selected forests of Tripura

The use of Synthetic Aperture Radar (SAR) for monitoring and analyzing tropical forests is of interest for two primary reasons, the property of microwave region being unaffected by persistent cloud cover and

Field inventory in selected sample points in Tripura

the possibility of deriving information about forest structure (height, stem diameter and frequency, basal area, canopy roughness, and above-ground biomass) makes it an important remote sensing component for forestry applications in northeast India. With an aim to derive the forest parameters, NESAC has initiated pilot project entitled "Development of polarimetric SAR model for estimating above ground biomass of selected forests in Tripura" in collaboration with SAC, Ahmedabad.

The major challenge in northeast region is to understand the significant changes in backscatter behavior of a SAR sensor due to hilly terrain and the limitation of data availability over the region. The goals of this work is determination of canopy height, vegetation type, and vegetation density and robust models and methods for vegetation characterization and biomass estimation. Under this project pre-inventory data has been collected from three districts.

Vegetation Carbon Pool Assessment (VCP) under IGBP program

NESAC is jointly working with NRSC, Hyderabad in the VCP project for Meghalaya. The project aims to assess phytomass and carbon. During the inventory, information are being collected for trees shrubs and herbaceous species. There are 200 sample points (grouped into 50 sample points) required to be collected under the project. The collection of inventory data for the sample points is in progress. A total of 80 sample points (grouped in 20 sample points) have been collected from various parts of Meghalaya.

Field inventory data collection

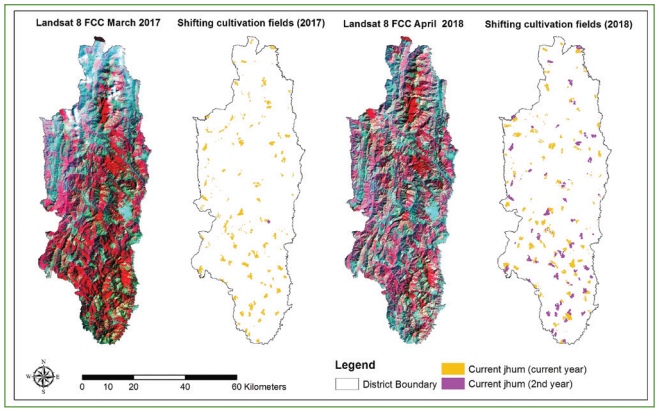
UAV application in tea garden management

The project is being carried out on request from Tea development Centre, Umsning, Meghalaya. Under this work digital database of the tea garden is being prepared for tea garden area of 10 ha. Using the UAV image of the entire garden, detailed information is being provided to the garden management authority on the management blocks, area under tea variety, the infrastructure inside the garden, etc.

Sample of UAV image with tea varieties (Information collected from field)

Monitoring of shifting cultivation fields in north eastern states

Shifting cultivation which is traditionally known as jhum used to be the main form of agriculture in the hills of north eastern India. This practice used to be blamed for wasting valuable forest resources



Shifting cultivation affected area in Champhai district, Mizoram (2017-18)

Area under jhum fields in four states of north east India (km²)

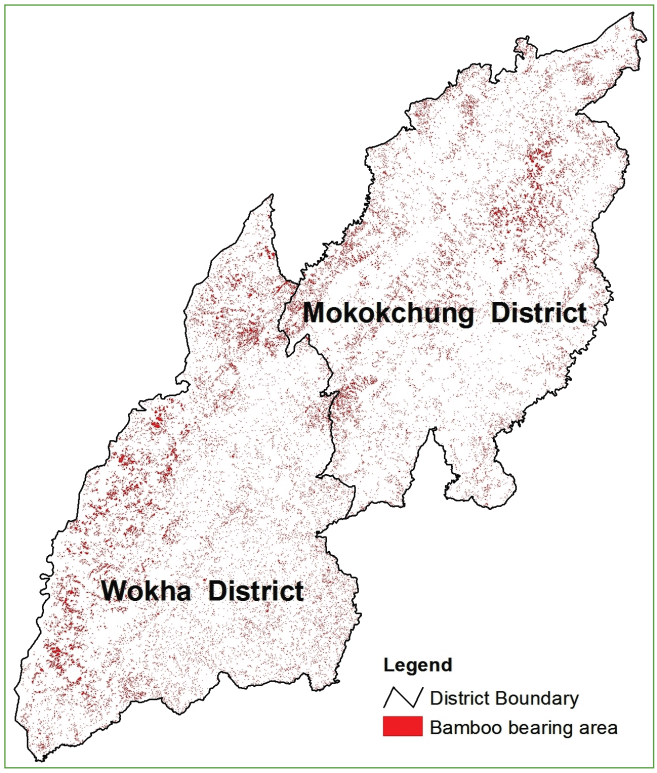
State	2017				2018				
	Current Jhum (current year)	Current Jhum (2nd year)	Total	% of TGA	Current Jhum (current year)	Current Jhum (2nd year)	Current Jhum (3rd year)	Total	% of TGA
Manipur	48.65	9.76	58.41	0.26	26.39	26.329	0.53	53.26	0.24
Mizoram	407.87	0.79	408.66	1.94	404.28	90.71	-	494.99	2.35
Nagaland	375.20	37.83	413.03	2.49	283.26	171.49	1.04	455.79	2.75
Tripura	125.97	-	125.97	1.20	100.19	0.09	-	100.27	0.96

and increasing the danger of runoff and erosion, but of late, considering it as a way of life for a large number of indigenous, tribal and marginalized upland communities, it is now starting to recognize it as one of the multifaceted form of traditional agroforestry practice. In many of the state level meets for promoting space technology based tools and applications in governance and development, many of the state forest departments and agriculture departments as well as ICAR institutions etc., highlighted the requirement of latest area under shifting cultivation. In order to cater these requirements the present work was taken up for monitoring the area under different jhum categories for all the shifting cultivation affected districts of NER.

Latest Landsat 8 data pertaining to March-April 2017 and March-April 2018 data were used for visual on screen digitisation at 1:50,000 scale. Initially the jhum fields of 2017 were mapped and the same layer was again updated using the 2018 data. Different jhum field categories like current jhum field with 2nd year crop, if any, were also identified apart from the current jhum with 1st year crop and the attributes were updated for 2018. Mapping the extent of jhum fields for 4 states of NER has been completed. Jhum field patch sizes were relatively larger (>25 ha) in the districts of Kiphere, Tuensang and Mon districts of Nagaland and Champhai and Serchhip districts of Mizoram. In the two year time period there was a decrease in the area under jhum in Manipur and Tripura whereas an increase in extent was observed in Mizoram and Nagaland.

Spatial distribution of bamboo and estimation of bamboo biomass in Mokokchung and Wokha districts of Nagaland

This project was taken up in collaboration with Nagaland University where bamboo bearing area of Mokokchung and Wokha have been delineated manually at high resolution using Cartosat-1 data and also with reference from freely available high resolution data. Preliminary analysis showed that Mokokchung district had 8575 ha under bamboo while Wokha district had 10499 ha. Identification of bamboo bearing area has also been tried for the study area using LISS III and LISS IV data for comparative analysis with the manual delineation. Field sampling are being done from identified sampling points to assess the growing stock and above ground biomass of bamboo in the study area for generating the growing stock for the two districts.

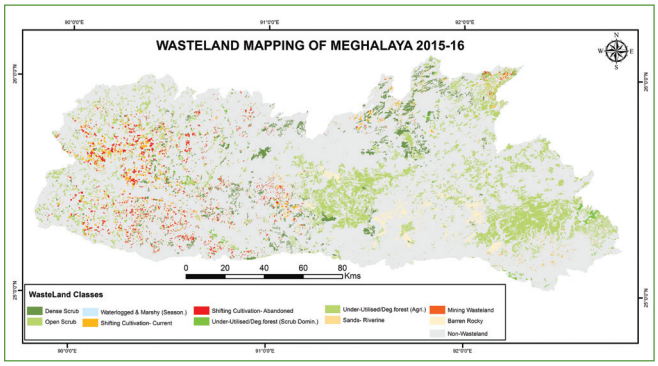


Bamboo bearing area in the study districts

LAND RESOURCES PLANNING

National Wasteland Change Analysis (3rd Cycle) using Multi-temporal Satellite Data

The project is coordinated by NRSC for the entire country and NESAC was responsible for completing the mapping and updating the wasteland map of 2008 -09 and prepare the wasteland change map using three seasons (Kharif, Rabi and Zaid) satellite data of 2015-16 with the State Remote Sensing Centres of the north eastern states. NESAC has also done the mapping exercise for the state of Meghalaya. Entire exercise has been completed and final database submitted to NRSC for integration into the national database.

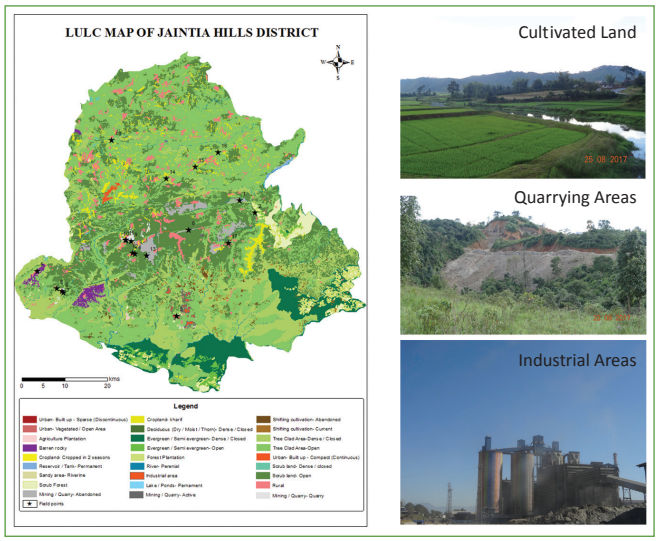


Change from Non- wasteland to Shifting Cultivation (Current)

For the state of Meghalaya, it is observed that during 2015-16, the state has a total wasteland of about 4199.51 sq. km. with Land with Open Scrub is a predominant wasteland (2598.66 sq. km). Total wasteland areas during the earlier cycle (2008-09) was 3865.71 sq. km. There is an increase of 333.8 sq. km in the wasteland area in a span of last six years in the state.

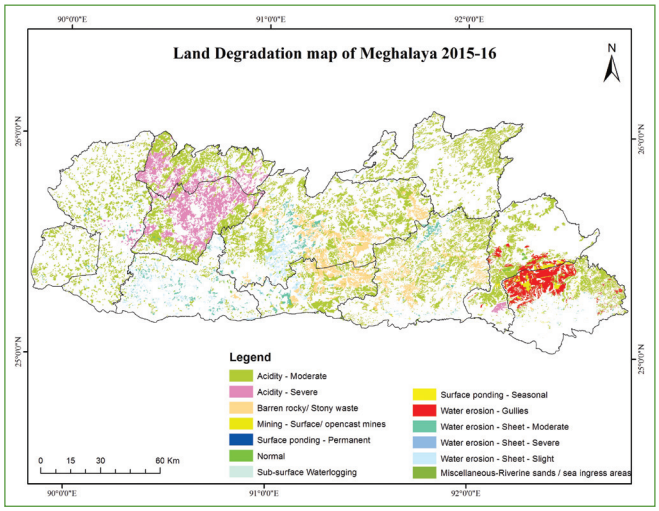
NRC-Land use land cover mapping using Multi-temporal Satellite Data (LULC 50K 3rd Cycle)

The objective of the project is updation of land use land cover map of 2011-12 using three season satellite data of 2015-16 to prepare land use land cover map of 2015-16 and also the LULC change matrix. Updation of land use land cover map of 2011 and 2012 of Meghalaya is carried out at NESAC using three seasons (kharif/rabi/zaid) satellite data of 2015-16 to prepare LULC map of 2015-16 and also the LULC change map. NESAC has coordinated with the States Remote Sensing Centres of NER and conducted EQC at NESAC for all eight states.



Mapping of Land Degradation at 1:50,000 scale - 2nd Cycle (2015-16)

The first cycle of land degradation mapping covering entire country was carried out during 2005-06 period and currently the 2nd cycle has been initiated using orthorectified Resourcesat-2, LISS III images of the year 2015-16. NESAC has been preparing the land degradation map for the state of Meghalaya and is coordinating for remaining state of NER. Preparation of Land degradation map for the state of Meghalaya is completed. The study shows that 6406.21 sq.km (28.96%) land in the state of Meghalaya is in the process of degradation. Acidity is the most dominant land degradation class (20.2%) followed by Water erosion (3.81%), barren rocky/ stony waste (3.63%) and mining-surface/ opencast mines (0.32%). Moderate acidity is the most dominant followed by sheet erosion. Change analysis map showed that there is normal change in wasteland categories and the interpretation error of less than 1%.



HYDROLOGY & WATER RESOURCES

Preparation of Assam River Atlas

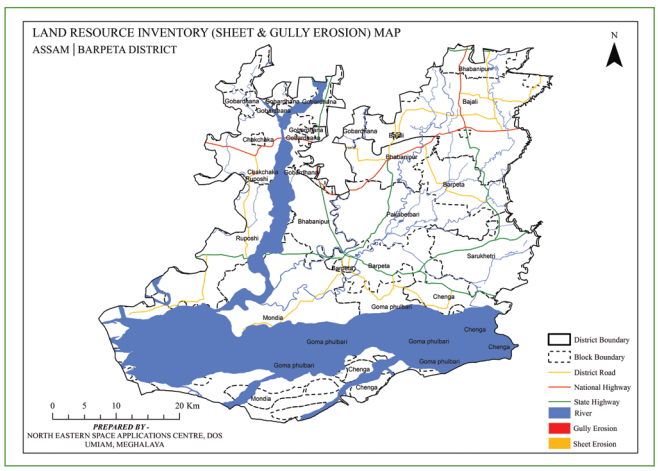
The river atlas preparation for Assam has been initiated during 2017. In this project, all the major and minor rivers entering Assam has been mapped at a scale of 1:4,000. Mapping includes incorporation of left and right bank, sediments, embankments, hydro-meteorological observatories, sluice gates, P&RD bunds, major locations, roads, railway lines etc. The LULC map for all the rivers has been created with defined buffer. In addition to this, district wise river catchment maps are being prepared to show the origin of all the rivers entering the respective districts of Assam.

Interim review by Hon'ble CM, Assam

At present the project is in progress and mapping is in completion stage for 20 districts of Assam. In an interim review of this project during January, 2018, Hon'ble Chief Minister, Assam, expressed satisfaction on progress of the project and hoped that this exercise will be of great help in river planning & development in Assam.

Land Resources Inventory Maps of Assam

Management of Natural Resources, especially land resources, is the key to attain food, water and environmental security. This has special relevance since per capita availability of agricultural land in India is decreasing due to population growth, industrialization and Urban Expansion. Amongst the various options available for improving land productivity, development of wasteland/degraded land is one of the most viable options. Similarly conservation of the productivity of existing land is also another viable options.



The objective of the project is generation of GIS database for Land Resources development and management planning. The database are mapping of land use land cover map (LULC) at 1:50000, sheet and Gully erosion area at 1:25000 scale, detailed drainage at 1:10000 scale, water body map of Assam and identification of agriculture and built up area surrounding to the sheet erosion area and water bodies available in the state . The existing LULC and water body map which were generated under National Natural Resources Census project by Department of Space are used as a input for this project. The LULC and water body map were generated at 1:50000 scale using LISS III multi-temporal data. The LULC map for Assam consist of eight major classes and 43 sub classes. The sheet erosion map was prepared based on the derived information of LULC, Slope and soil texture. The gully erosion map at 1:25000 scale was prepared using Kompsat data utilizing Bbuvan web portal developed by NRSC, Hyderabad along with extensive ground information provided by Soil Conservation Department of Assam. Selected sites were visited for ground verification and collection of spectral signatures for gully erosion. Sheet Erosion is a derived product of LULC, Soil texture and slope of the terrain. The study shows that 2,98,745 ha areas are under sheet erosion and 153 ha area under gully erosion. Study further shows that Golaghat (13.5%),Chirang (11.09%), Kokrajhar (8.14%), Hojai (8.08%), West Karbi Anglong (7.91%) district having higher percent of sheet erosion area and Biswanath (7.29%), Lakhimpur (4.43%), Baksa (3.21%), Chirang (2.62%), Dhemaji (2.49%) districts are having higher percent of Gully erosion areas.

Monitoring and Evaluation of IWMP watersheds

The project envisages monitoring and evaluation of IWMP projects using Bhuvan web services and Mobile app for the sanctioned projects from 2009-10 to 2014-15 (This may differ State to State) for entire India and NESAC is carrying out the project for North Eastern part of India. Each project has to be monitored for a period of 5 years from the date of implementation. The project is being implemented at NRSC and geo spatial tools have been developed (Srishti – a web GIS interface on Bhuvan and Drishti – a mobile based android application). The project duration is up to 2020. The scope of the work of this project include Processing of high resolution satellite data – LISS-IV and Cartosat; Correction / fine tuning of Watershed boundaries based on SIS-DP database; Generation of LULC maps, NDVI, evaluation and assessment based on Drishti photographs , preparation of maps showing change detection in projects supported by limited ground truth of representative sites. The approach includes report generation for each project area year wise in suggested format. NESAC is carrying out following activities in collaboration with State Remote Sensing Application Centers of NER:

- Processing of high resolution satellite data- LISS IV and Cartosat.
- Correction/ fine tuning of watershed boundaries based on SIS-DP Satellite Image.
- Generation of LULC maps, NDVI, evaluation and assessment based on Dristi photographs, change detections maps coupled with ground truth as well as year wise report generation for each project area.
- All the processed data will be made available for online analysis/interpretation.

State	No. of IWMP Project	No. of project boundary shape file fine tuned with SIS DP image	Report Prepared
Arunachal Pradesh	156		
Assam	372	293	
Manipur	102	102	3
Meghalaya	84	46	4
Mizoram	89	89	
Nagaland	111	111	3
Sikkim	15	15	
Tripura	65	65	5

Currently processing of high resolution satellite data and correction/fine tuning of watershed boundaries based on SIS-DP satellite images for the state Assam, Manipur, Meghalaya, Mizoram, Sikkim and Tripura are completed. State wise progress of the project is as below:

Analysis on sudden change of water quality in Siang River using remote sensing and GIS

The Brahmaputra River, a major trans-boundary river in the Eastern Himalayan region, originates in China flows through India and Bangladesh before draining into the Bay of Bengal. The waters of the Brahmaputra are shared by China, India and Bangladesh and any changes in the quality or quantity of the river at any point is likely to affect downstream population drastically as millions of people rely on this river for their survival. Towards the end of November 2017, people residing beside the river at Pasighat (Arunachal Pradesh), where the river just reaches the plains, noticed an abnormal increase in sediments on the river. The Brahmaputra usually carries a lot of sediments during the monsoon season but even after the monsoons had subsided, the sediments on the river had not decreased and there were many reports of fishes and other aquatic life dying and the quality of water not suitable for any use by the local dwellers. The news resulted in several debates and the issue turned into an international concern due to the trans-boundary nature of the river. Many government, research and academic institutions started investigating on the quality of the river as well as the possible genesis of this sudden increase in turbidity levels. Observations made by Central Water Commission, Govt. of India on turbidity levels of water samples taken from the Siang River at Pasighat on 27 November 2017 showed an abnormally high suspended and particulate matter concentration.

This study was taken up to investigate the possible reasons for the sudden increase in turbidity levels of the Siang River with the help of multi-temporal satellite datasets.

Multi-temporal 30m spatial resolution Landsat-8 and 10m spatial resolution Sentinel-2 datasets have been used for this study. The Landsat-8 is an American Earth observation satellite launched on 11 February 2013, which acquire images of the entire earth in every 16 days interval. Sentinel-2 is an Earth observation mission developed by European Space Agency (ESA) as part of Copernicus Program terrestrial observations in support

of services such as forest monitoring, land cover changes detection, and natural disaster management. The Sentinel-2 mission comprises a constellation of two polar-orbiting satellites (Sentinel-2A launched on 23 June 2015 and Sentinel-2B launched on 7 March 2017) placed in the same orbit, phased at 180° to each other. This mission can provide high temporal resolution of 10 days at the equator with one satellite, and 5 days with 2 satellites under cloud-free conditions. Landsat-8 images acquired on 9 November 2017 and 21 December 2017 have been used for the present study. Sentinel-2 images acquired on 5 November 2017, 25 November 2017, 10 December 2017, 4 January 2018 and 20 March 2018 have been analyzed. Sentinel-2 and Landsat-8 have been used for identifying and monitoring the landslide area and landslide-dammed lakes surface area. These satellites provide near real-time earth observation images freely in support of research and development.

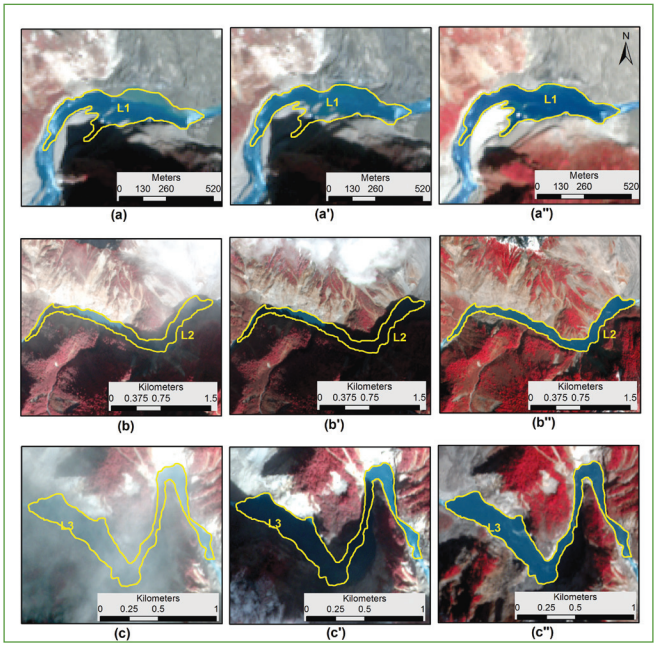
Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) of 30m spatial resolution has been used for estimating the volume of water stored in these landslide-dammed lakes. They can be downloaded freely over the internet (http://dwtkns.com/srtm30m/), and their file format (.hgt) is widely supported. The earthquake epicentres, magnitude and date of occurrence provided by United States Geological Survey (USGS) have been analyzed. Active faults and sutures over the study area provided by HimaTibetMap are also analyzed in this study.

MultiMate satellite data were analyzed to identify the possible source of the sudden change in water quality. Careful observation of temporal satellite images identified a zone of severe landslides on both sides of the river channel around 425 kms upstream of Pasighat lying within Tibet. It is also observed that this area is at a close proximity to the epicentre of the recorded 6.4 magnitude earthquake on 17 November 2017. hese analyses indicates that there was a massive landslide after the 6.4 magnitude earthquake that occurred on 17 November. Satellite images also revealed blockages of the river channel due to the debris of these landslides resulting in natural damming at a few locations. Four such locations of landslide occurrences were identified and shown in the figure and named as L1, L2, L3 and L4 from upstream to downstream

Removal of vegetation and debris deposits at the base of the slope and on the river channel is clear on the Sentinel-2 images acquired on 10 December 2017.

Earthquake triggered landslides are very common in the Himalayas due to its active tectonics but the location of these landslides are crucial as it has occurred on the upstream of the Brahmaputra main channel and partially blocked flow of water. Three of these four locations as given in Figure also show the formation of lakes due to the accumulated debris on the river channel around 429 kms, 435 kms and 459 kms upstream of Pasighat. The total area affected by landslides is around 28 sq kms. Drastic changes in the river course are also observed at all the locations with significant increase in sediments downstream of the landslide affected region.

These landslide-dammed lakes were continuously monitored with the help of satellite images acquired on 21 December 2017, 4 January 2018 and 20 March 2018. The sentinel-2 images of spatial resolution 10m acquired on 10 December 2017, 4 January 2018 and 20 March 2018 are given in Fig 8. Not much change in the surface area of the lakes was observed. All calculations are only indicative as they are based on DEM generated before the occurrence of the landslides and there might be major changes in volume after the occurrence of the landslides due to deposition of debris. landslide-dammed lakes were continuously monitored with the help of satellite images acquired on 21 December 2017, 4 January 2018 and 20 March 2018. The sentinel-2 images of spatial resolution 10m acquired on 10 December 2017, 4 January 2018 and



Temporal Sentinel-2 images showing the landslide dammed lakes (a, b and c images of 10 December 2017; a', b' and c' images of 4 January 2018; a'', b'' and c'' images of 20 March 2018)

20 March 2018 are given in Fig 8. Not much change in the surface area of the lakes was observed. All calculations are only indicative as they are based on DEM generated before the occurrence of the landslides and there might be major changes in volume after the occurrence of the landslides due to deposition of debris.

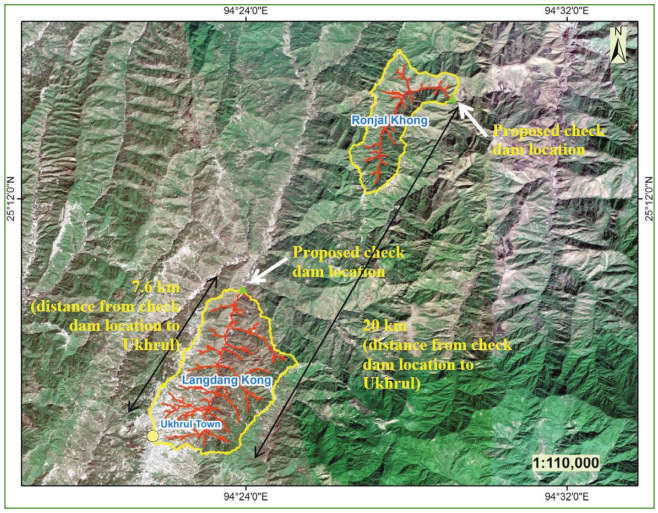
The present analysis has confirmed the occurrence of landslides in upstream areas (Tibet) as the cause of sudden increase in sediment levels in the Siang and Brahmaputra River. The debris from these massive landslides has blocked the river channel at several locations creating lakes and resulted in channel shift. These landslides may have been triggered due to the 6.4 magnitude earthquake recorded in Indo-Tibetan border on 17 November 2017. Three lakes created due to blockage by landslide debris were observed with surface areas of about 12 ha, 55 ha and 49 ha. However no significant change in surface area is observed in multi-temporal images, the breaching of the water impounded in these lakes might induce floods downstream of these locations and cause destruction to life and property. Therefore, a continuous monitoring using near real-time remote sensing data is necessary so that forthcoming devastation due to breaching of these lakes can be minimized.

Proposed check dam location for Langdang Kong and Ronjal Khong in Ukhrul district, Manipur

Secretary, Ministry of DoNER requested to study two river streams i.e. Langdang Kong and RonjalKhong in Ukhrul district, Manipur state for identifying source of water and proposal for check dam to supply drinking water to Ukhrul town. As a part of this exercise a preliminary study has been carried out using satellite imagery, watershed analysis using digital elevation model and ancillary data. Suitable check dam location, total discharge, supply and demand analysis for drinking water requirements have been worked out.

A remote sensing and GIS based methodology was followed in this study as mentioned below:

- Langdang Kong and RonjalKhong streams are identified using toposheets.
- Automatic catchment dileneation is carried out using CartoDEM v3 and drainage lines are derived for both the streams.
- Ground water prospect of Ukhrul town and its surrounding is studied using ground water prospect maps.
- With the help of satellite imagery and DEM the check dam locations are identified by taking into consideration of height of check dams.
- Discharge of both the catchments are computed using rational method.
- Once the check dam locations are identified then inundation area is delineated and the area of inundation and storage volume is calculated.
- The water demand per person for Ukrul town is calculated.
- Map showing Langdang Kong and RonjalKhong catchment along with proposed check dam location



Map showing Langdang Kong and RonjalKhong catchment along with proposed check dam location

From the study following conclusions are drawn:

- Since the RonjalKhong dam is 20 km away from the Ukhrul town, LangdangKhong dam found to be most suitable in terms of distance, discharge and storage capacity.
- The storage volume of the check dam of 50 m height is 1,31,79,620 m^3.
- The discharge from the Langdong Kong catchment is 1,23,622 m^3/day (computed based on rainfall of 1763 mm (100 rainy days) annually).
- Analysis related to ground water shows that, the area is considered as highly weathered zone as a whole. Sometimes the yield is varying due to the presence of fractures/cracks which governs the occurrence/ movements of ground water. It may also be noted that few springs are also located in and around the town which may require immediate attention for conservation measures of these springs to have an alternate source of water supply during the lean season.

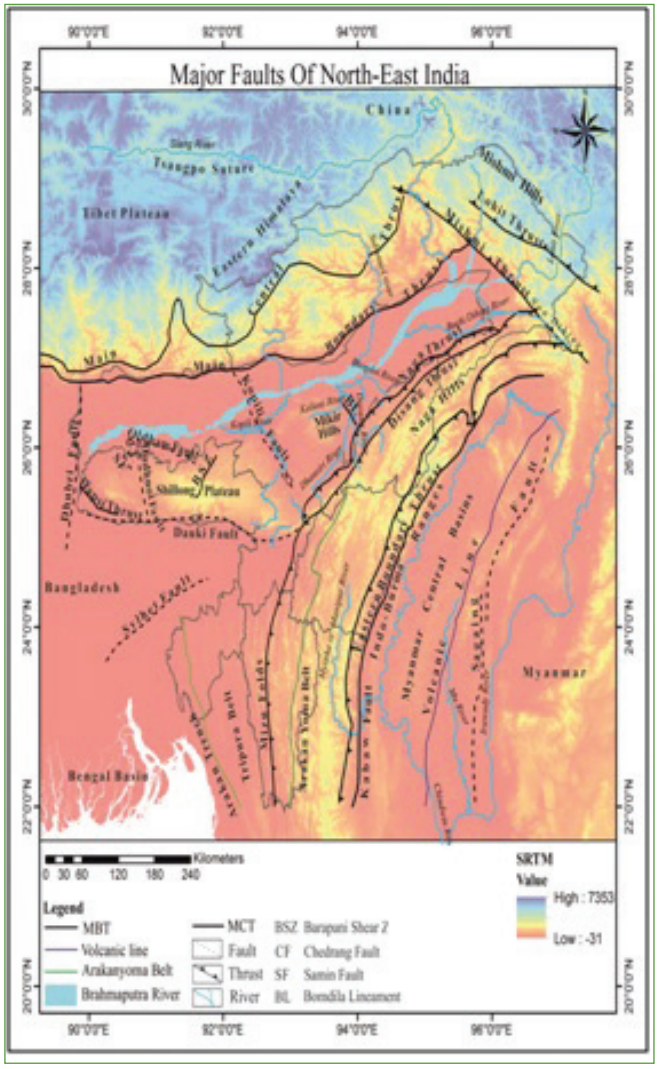
GEOSCIENCES

Active fault mapping using high-resolution data and geophysical survey

An active fault is the seismic source which had activated in the Quaternary period (2.5 Ma) or in the late Pleistocene (0.1–1.2 Ma) and has the potential for reactivation in the future. For effective seismic hazard assessment and its mitigation, demarcation of these areas having similar earthquake threat is essential. This in turn requires detailed and accurate data on active faults, namely, their location, spatial extent, past earthquake activity, recurrence intervals, slip rate, etc. Some faults show frequent displacements and can be the source of high seismic hazard. Therefore, identification and characterization of the active faults/ seismic source zones and assessing their role in seismic processes are considered to be very important for any exercise related to earthquake hazard assessment and risk mitigation. A project was initiated under TDP in collaboration with Department of Applied Geology, Dibrugarh University with the following objectives:

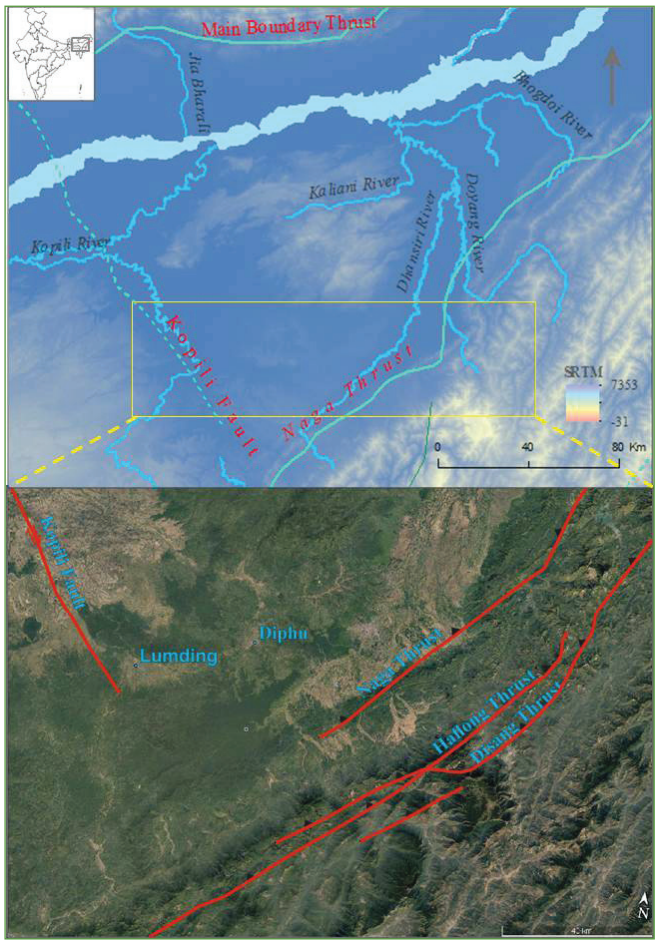
- Delineation and mapping of major active faults using high resolution satellite data.
- Morphometric analysis using high resolution relief and drainage information for understanding the relationship between tectonics and geomorphology.
- Dating of paleoearthquake events using C14 and OSL dating techniques in order to constrain the age of the events.
- Shallow seismic survey for detection of subsurface tectonic features and their geometry (If feasible/ required).

It involves an integrated application of remote sensing techniques, geophysical techniques and optical luminescence dating techniques (OSL)/ Carbon 14 dating in order to accomplish the above objectives. The study would focus primarily on the major faults and vulnerable areas of Northeast India with special emphasis on foothills and densely populated regions. Therefore, an area has been demarcated near Lumding which lies in between latitude 25° 45' 5.85'' N and longitude 93° 10' 22.34'' E of Hojai district and Dayang Mukh which lies in between latitude 25° 48' 39.54'' N and longitude 92° 55' 33.51'' E of Karbianglong district, Assam. This region is bounded by Kopili active fault in the west and Naga Thrust in the east and further surrounded by Mikir hills (Now Dima Hasao), Shillong plateau and Naga Hills on its three sides (east, west and south). The geology of the study area represents younger rocks belonging to the Tertiary Age. To the east and north-east of Lumding, the Barails are seen to be more disturbed and the outcrops are being split up into long narrow strips or small inliers by a system of strike faults. The rocks of this region are overlain by massive current bedded sandstones and argillaceous beds.The study area was further divided into four sub-basins. Survey of India toposheets of 1:50,000 scale were used to manually digitize and extract the drainage networks for comparison. The stream order was extracted following the method of Strahler (1952) and morphometric analysis of active tectonics were derived



Fault map of North-Eastern India showing the major faults and thrusts

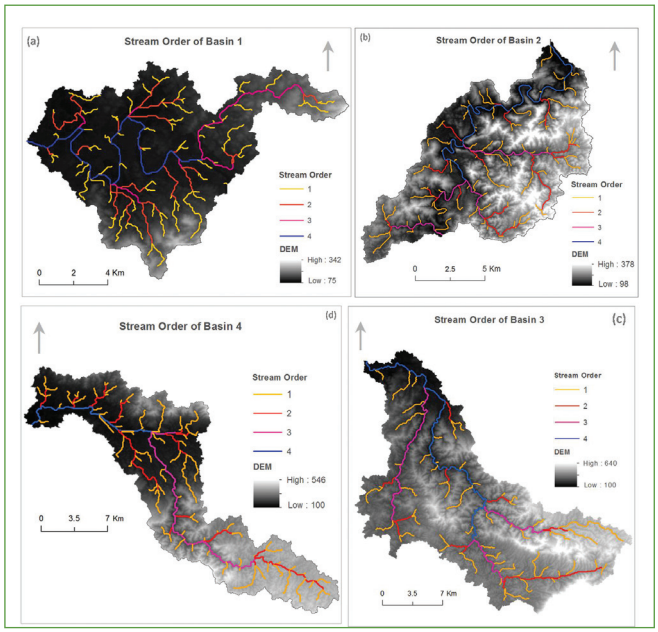
using respective tools, the factors were calculated using established formula. Detailed analysis of four watersheds of Lumding and Dayang Mukh basin has been carried out to assess the deformational changes on drainage development.



Simplified map of the region showing major faults (after Kayal 1998) and rivers with the study area highlighted with a red rectangle. (b) Bhuvan image showing the study area in detail

It has been observed that the drainage pattern in the study area is mainly controlled by the structural features, lithology and terrain characteristics of the region. SRTM-DEM was used to extract the drainage patterns and understand the orientation of streams. Though the dominant drainage pattern of four sub-basins are dendritic, the changes in the meandering course of river have also been examined over the years. The stream networks are mostly oriented in the SE and SW direction.

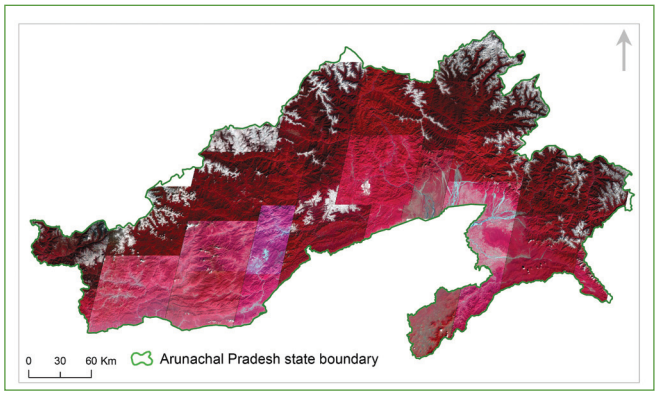
Preliminary investigation in the form of calculation of geomorphic indices such as the asymmetry factor, transverse topographic factor, channel sinuosity, drainage density indicates the region to be seismically active. The study is still in progress and will be followed by detailed field investigations



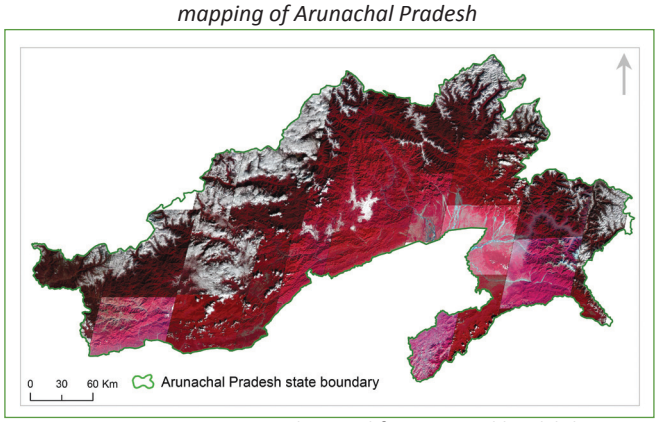
Stream network map of the four sub-basins namely (a) Basin 1 (b) Basin 2 (c) Basin 3 and (d) Basin 4

Seasonal Landslide Inventory Mapping (SLIM) – Arunachal Pradesh

Landslide is one of the major geohazards in the



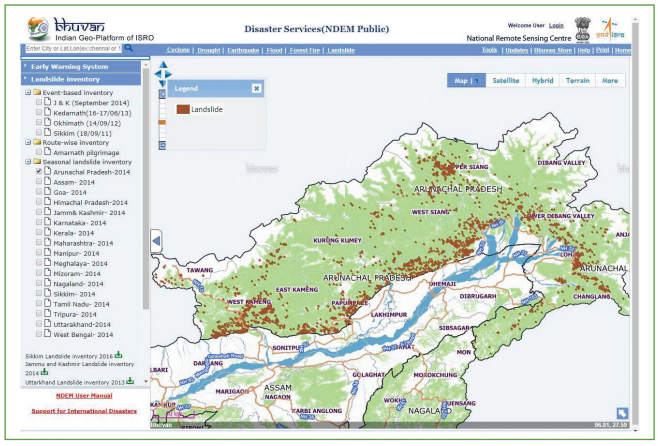
Pre monsoon LISS-IV tiles used for seasonal landslide inventory mapping of Arunachal Pradesh



Post monsoon LISS-IV tiles used for seasonal landslide inventory mapping of Arunachal Pradesh

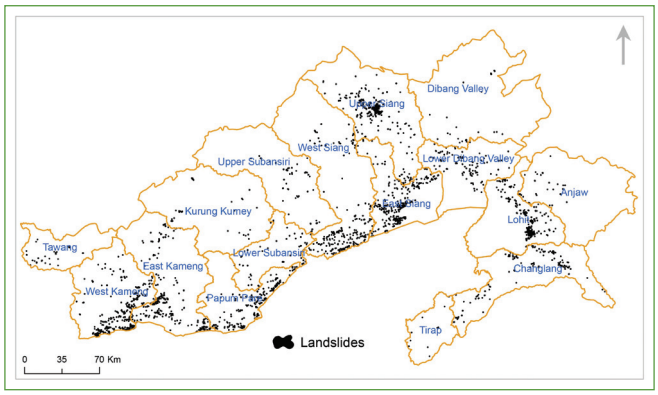
hilly terrains of North East India, that besides causing disruption of connectivity, inflicts significant loss of life and property. The present work aims to understand the number of landslides occurred in a particular season which in turn may be used for future planning of mitigation. Seasonal landslides were delineated for monsoon season of 2014. Total 34 pairs of pre and post monsoon LISS-IV image tiles used for seasonal inventory mapping for the state of Arunachal Pradesh.

A total 3036 landslides were identified. The inventory map has been uploaded to Bhuvan Portal (http://www.bhuvan.nrsc.gov.in) for public viewing.



A snapshot of Bhuvan showing the distribution of landslides in parts of Arunachal Pradesh

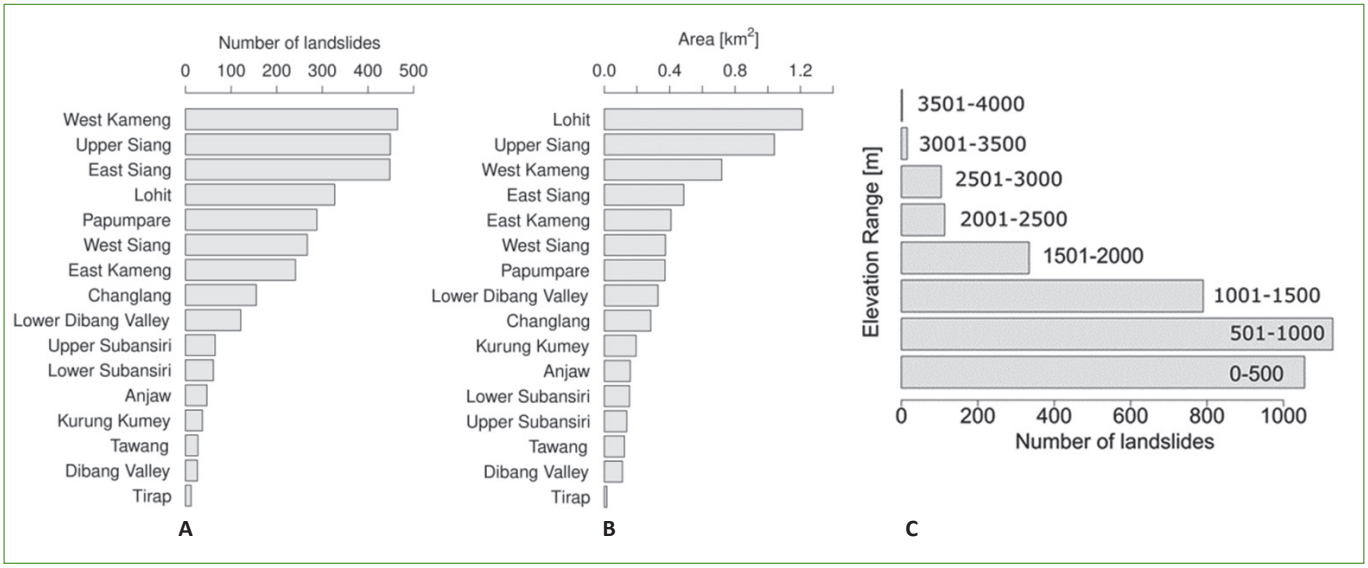
Maximum instances of landslides occurred in West Kameng district with a total of 465 landslides while the least number of landslide occurred in Tirap district with a total of 12 landslides. In terms of landslide area, Lohit district experienced maximum landslide with a total area of 1.2 km^2 while Tirap district experienced the least landslide with a total area of 0.015 km^2.



District wise distribution of seasonal landslides.

In addition to seasonal landslide mapping, preliminary investigation on the control of topographic parameters on seasonal landslides was also carried out. It was observed that majority of landslides occured below the altitude of 2000 m a.s.l. (even though maximum elevation of the state extends up to ~4000 m a.s.l.) while maximum landslides occur between 500 and 1000 m.

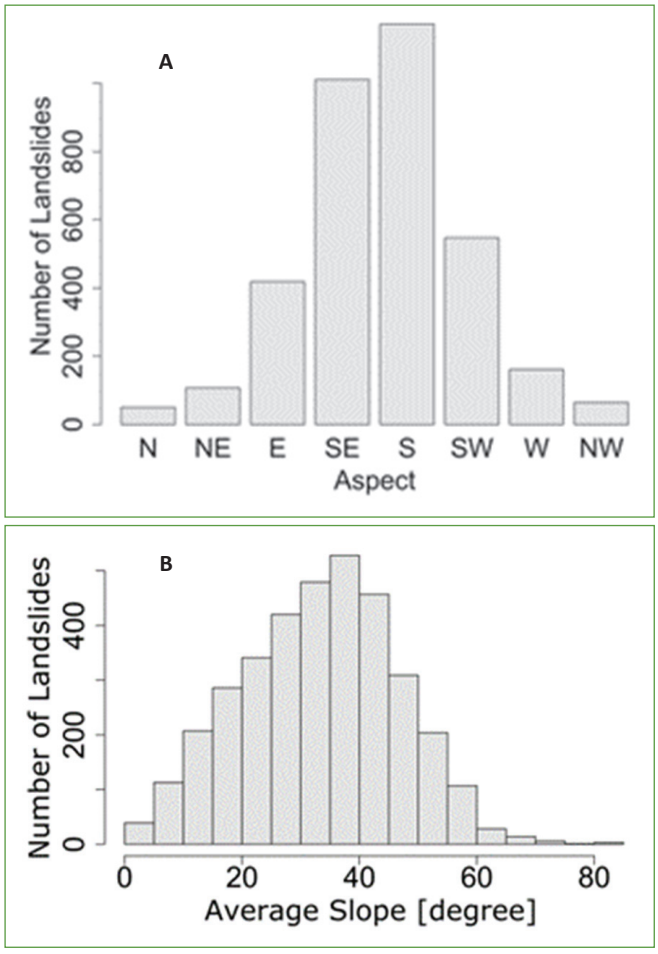
Further, majority landslides having larger dimension are confined to this elevation range. The concentration of landslides in lower elevation belt is attributed to geologically younger and geomorphologically unstable state of the frontal Arunachal Himalayas. With regard to slope aspect, majority of landslides are oriented



A. District wise instances of landslide occurrence B. District-wise distribution of landslides in terms of landslide area. C. Distribution of landslides with respect to elevation

towards southerly aspects, viz., south east, south and south west). The concentration of landslides towards these aspects may be due to facing of the slopes with the direction of advancing southwest monsoon.

Additionally, frequency of landslides peaks around slope value of ~40°. This may be related with the presence of hard rock in >40° slope area which can remain stable if undisturbed by catastrophic events like earthquakes, cloudburst etc. The conclusion drawn from the study could be a critical input for landslide susceptibility mapping which in turn is a prerequisite for developing an alert system and devising a mitigation plan.

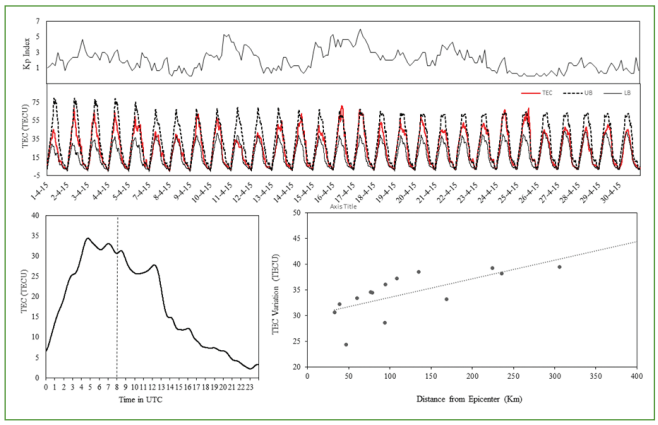


A. Distribution of landslides with respect to slope aspect
B. Distribution of landslide with respect to slope amount

TEC based Earthquake precursory studies

Number of earthquakes has been analyzed in search of precursor signals to impending earthquakes. One of the most significant results obtained during the academic year 2017-2018 are presented here. A large magnitude (Mw 7.8) earthquake had occurred on the 25th April 2015 (06:11 UTC) at 28.1473˚ N and 84.7079˚ E, 34 km East South East of Lamjung, Nepal.

TEC Time series plot, Geomagnetic storm Index, TEC anomaly time, and TEC distribution for 14 GNSS stations. TEC time series for 30 days at Besihari, Lumjung (BESI) 30 km from the epicenter (Plot on the middle). Geomagnetic storm Index (Kp Index) for the period of 30 days vis a vis TEC variation. Kp index on 17th April 2015 (Kp=6) reveal minor storm activity (Plot on the top). The graph on the lowerleft represents the TEC fluctuation on 11th April 2015 at BESI. Dash line represents the TEC Anomaly time: 8:00 UTC. The graph on the lower right shows the TEC values corresponding to 14 GNSS stations at Nepal, detected during the anomaly time (08:00 UTC)



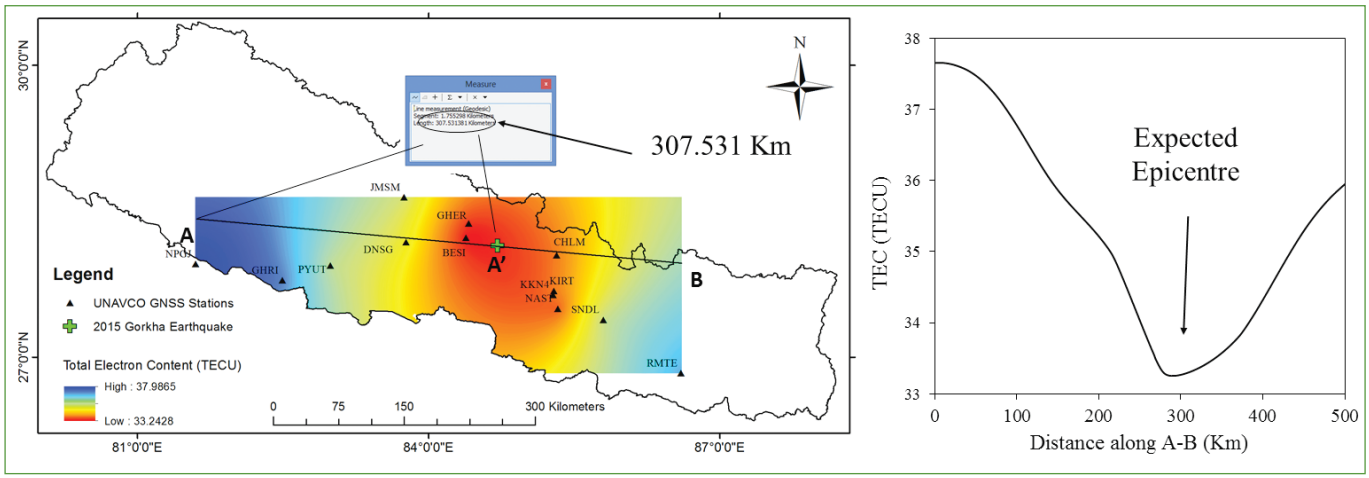
TEC Time series plot, Geomagnetic storm Index, TEC anomaly time, and TEC distribution for 14 GNSS stations. TEC time series for 30 days at Besihari, Lumjung (BESI) 30 km from the epicenter (Plot on the middle). Geomagnetic storm Index (Kp Index) for the period of 30 days vis a vis TEC variation. Kp index on 17th April 2015 (Kp=6) reveal minor storm activity (Plot on the top). The graph on the lowerleft represents the TEC fluctuation on 11th April 2015 at BESI. Dash line represents the TEC Anomaly time: 8:00 UTC. The graph on the lower right shows the TEC values corresponding to 14 GNSS stations at Nepal, detected during the anomaly time (08:00 UTC)

The devastating event was accompanied by two large aftershocks of Mw 6.6 (on 25th April 2015, 06:45 UTC) and Mw 6.7 (on 26th April 2015 at 09:10 UTC). As per USGS Earthquake catalogue 65 aftershocks were recorded within a period of three days from the main event; the strongest aftershock had occurred on 12th May 2015 at 07:05 UTC. The Ionosphere Total Electron Content (TEC) anomaly prior to the main shock on 25th April 2015 observed from the data of 14 Global Navigation Satellite System (GNSS) stations (Plate boundary observatories) at Nepal maintained by UNAVCO, USA was reported. Time series analysis of TEC for the period of 30 days was carried out and anomalies were detected using 15 days running average plus/minus 2 times 15 days running standard deviation. The TEC values crossing these limits were considered as anomalies. The TECs corresponding to

the anomaly time for all 14 stations were detected and were interpolated to plot in 2- dimension to observe the TEC spatial pattern. The linking between ionospheric TEC anomalies and earthquake occurrences has been reported in many studies. These linking are basically governed by the Lithosphere-Atmosphere-Ionosphere coupling mechanism. The ionosphere records the earthquake due to the change in global electric circuit produced by the cluster of ions in the atmosphere emanating due to the development of stress in the crustal region prior to an earthquake.

The TEC time series analysis was carried out using GNSS observation stations located at 30 - 300 km areal distance from the epicentre of the 2015 Mw 7.8 Gorkha earthquake. Analysis with 15 days mean ± 2 standard deviation limit reveals negative (low) TEC anomaly on 11th April 2015, whereas positive (high) anomaly on 24th April 2015 was measured at station BESI (Besihari, Lumjung) located at 30 km from the epicentre. Additionally positive anomalies were also observed on 9th, 14th, 16th, 17th, and 25th April 2015.

the National Oceanic and Atmospheric Administration (NOAA) in assessing the geomagnetic activities. The Kp index of 6 was observed on the 17th April 2015, suggesting geomagnetic storm activity of low intensity. The exact anomaly times were detected for 11th and 24th April and were found to be 8 and 9 UTC, respectively. The TEC values corresponding to the anomaly time for all 14 stations (locations) suggest that the TEC gradient decreases towards the epicentre on 11th April, when negative anomaly was observed, and its increases towards the epicentre on 24th April when positive anomaly was observed. This opens a new avenue for possible detection of the epicentre by establishing large number of GNSS ground network. TEC changes on 11th April 2015 at 8 UTC from 14 GNSS network at Nepal are shown in figures 1 and 2. The TEC profile along AB shows a reduction of TEC at a distance of around 300 km from A which could be the expected epicentre (as shown in second figure). When measured along A and the actual epicentre A', the distance between them is found to be 307.5 km. Therefore there is a definite pattern showing decreased TEC gradient towards the



Relationship between TEC and distance from the epicenter. Left figure represents the spatial distribution of the TEC values for 14 stations at detected anomaly time (08:00 UTC) on 11th April 2015. Figure on the right represents profile along AB. The low TEC zone is the expected epicenter region at around 300 km from A and it coincides well with the actual epicenter (A') of earthquake on 25th April 2015

The space weather conditions were consider to rule out their influence and finally it was confirmed that the detected anomalies were seismogenic in nature. Minor geomagnetic storm for short duration was observed on the 17th April 2015 and hence the increase in TEC could be due to this activity on 17th April. Various indices are used for the assessment of geomagnetic storm activities. We have used Kp index provided by

epicentre, where a negative anomaly is observed. This information can help in detecting the epicentre of impending earthquakes from large number of GNSS observations. Thus, continuous ionospheric TEC monitoring with well distributed GNSS observation stations may open up new avenue towards precursor monitoring and epicentre detection of impending earthquakes.

URBAN AND REGIONAL PLANNING

Assessment and optimal allocation for municipal solid waste collection bins using geospatial technology for Kohima city, Nagaland

The study was taken up on request of Ministry of DoNER to conduct a study on Assessment and optimal allocation for Municipal Solid Waste Collection Bins using Geographic information system and multi criteria analysis for Kohima city, Nagaland. In this study, multi criteria analysis and GIS was adopted to find out the adequate number and position of Municipal waste collection bins within the urban area of Kohima, Nagaland.

Methodology followed in this study includes GIS based analysis to find proper location for bins along the roads by following three phases.

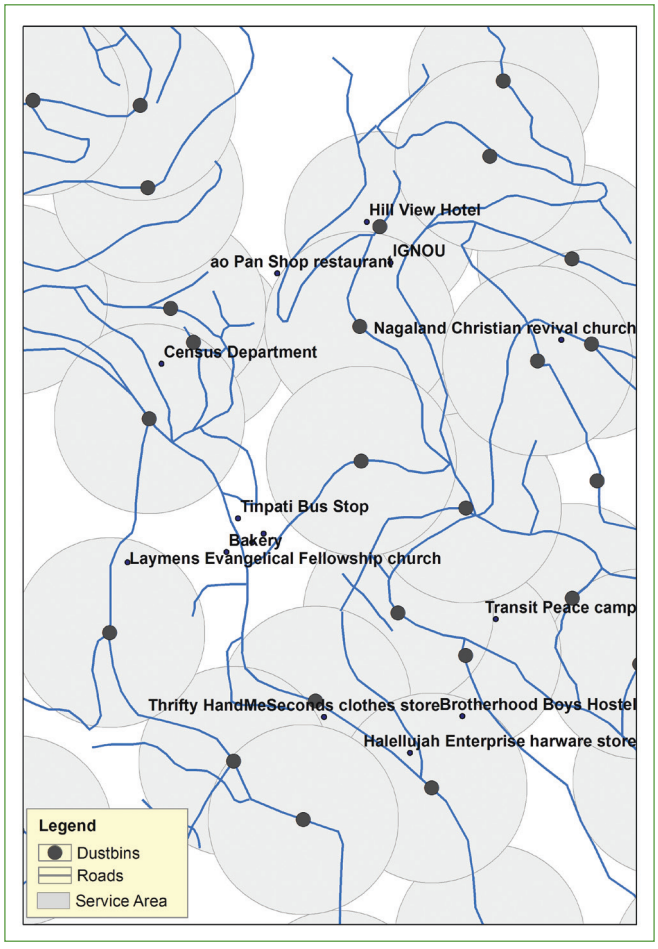
Phase1: Data collection and Development of geo spatial database

Phase2: The optimal allocation of collection bins for the proposed model based on a multi criteria analysis.

Phase3: Analysis of optimal proximity distance by creating buffer zone around the allocated bins to calculate service area for optimal waste collection.

The proposed numbers of collection bins were assessed according to municipal solid waste (MSW) generation in the ward. Then the optimal positions were found with reference to Urban Land Use, proximity to road network and population density. Moreover, based on the public preferable walking distance to drop the MSW to the collection bin, a model was developed. In this model, the three different proximity distances such as 50m, 75m and 100m around existing and proposed bins were generated and found the optimal distance. As a result, the entire area was covered by 75m distance around the collection bin with more than 75% efficiency.

Thus, the proposed model suggested optimum allocation of collection bins and which would recommend best possible collection services.



Estimation of service area around collection bins allocated

Capacity building under AMRUT sub-scheme on formulation of GIS based master plans

NESAC has been conducting training programmes on "Capacity Building under AMRUT Sub-scheme" and aim towards Building capacity among town planning, line departments and other concerned personnel at State and local levels including ULBs and development authorities to create a cadre of professionals proficient in the use of GIS technology for using and updating databases in urban planning and management. The training programmes include hands-on training on

Participants of 1st Batch Tier -1 held at NESAC on 18-20 Jan 2018

the use of GIS softwares including open source GIS/ RS technologies, data-base generation and updation for the formulation and updation of Master Plan etc. Operators, technicians, draftsmen, planning assistants, town planners and administrators will be trained during the program at different stages with regard to their role in implementing the scheme. The duration of the training imparted depends on the role of the personnel. This training is designed to provide sufficient knowledge for urban master planning purposes. Under Capacity Building component, training is to be provided to officials involved in the Sub-scheme and has been divided into three levels:

Tier 1: Decision Makers (3 days training Program)
Tier 2: Middle Level Officers (2 Weeks training Program) and
Tier 3: Junior (Operator) Level Officers (4 weeks training Program).

Till date, training for Tier 1 and Tier 2, has been conducted. The details are as follows:

Tier 1 (Decision Makers Level):

a. 18-20 January 2018 for 1st Batch: 13 participants
b. 19-21 February 2018 for 2nd Batch: 17 participants
c. 29-31 May 2018 for 3rd Batch: 9 Participants

Tier 2 (Middle Officers Level):

a. 16-27 April 2018 for 1st Batch: 20 participants
b. 14-25 May 2018 for 2nd Batch: 11 participants

Training for Tier 3 (Junior Officers Level) is scheduled on 06-31 August 2018 and the total number of expected participants is 26 numbers.

Total 70 participants from Arunachal Pradesh, Andhra Pradesh, Assam, Bihar, Chandigarh, Himachal Pradesh, Kerela, Madhya Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Rajasthan, Uttar Pradesh and Sikkim.

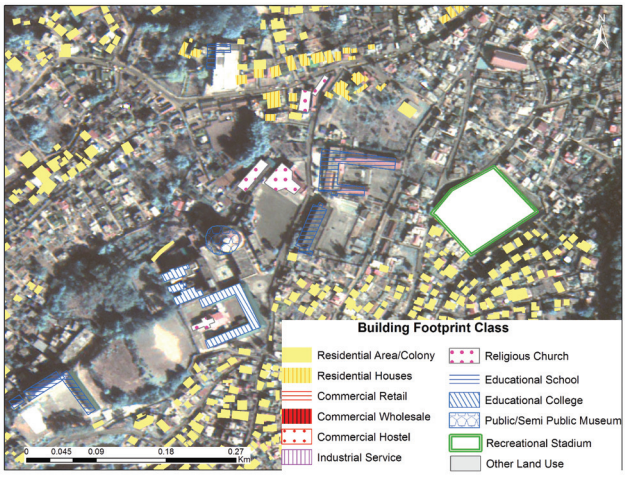
Geodatabase creation of Shillong planning area, Meghalaya under Atal Mission for Rejuvenation and Urban Transformation (AMRUT) sub-scheme

Creation of GIS-based Master/Development Plans for Shillong Planning Area covering an area of 320 km^2 at 1:4000 scale is being carried out at NESAC. The project is funded by Urban Affairs Dept., Govt of Meghalaya. The major objective is to develop common digital geo-referenced base maps and land use maps using Geographical Information System (GIS) as per the National Level Design and Standards. The output will be ideal for formulation of Master Plans/Development Plans as per currently available satellite data. The scope of work includes the following:

- Generation of 1:4,000 scale Urban Geospatial Database using very high resolution orthorectified satellite data of 0.5 m or better.
- Collection of Spatial attribute data and utility layers from the urban local bodies and concerned line departments and putting them in GIS platform.
- Inclusion of administrative boundaries, cadastral boundaries required for master plan formulation and other data from the urban local bodies and concerned line departments into the geodatabase.
- Generation of Contours
- Field verification/Vetting by ULBs.
- The suggestions/modifications of States/ULBs to be incorporated into the final maps during vetting
- Generation of final maps

The project has progressed as follows:

1. Collection of ground control points using Differential Global positioning system, data processing ortho-rectification of Cartosat-2S satellite (PAN and MX) has been completed for the study area
2. Building footprints were generated using the satellite data
3. Urban Landuse mapping is in progress.

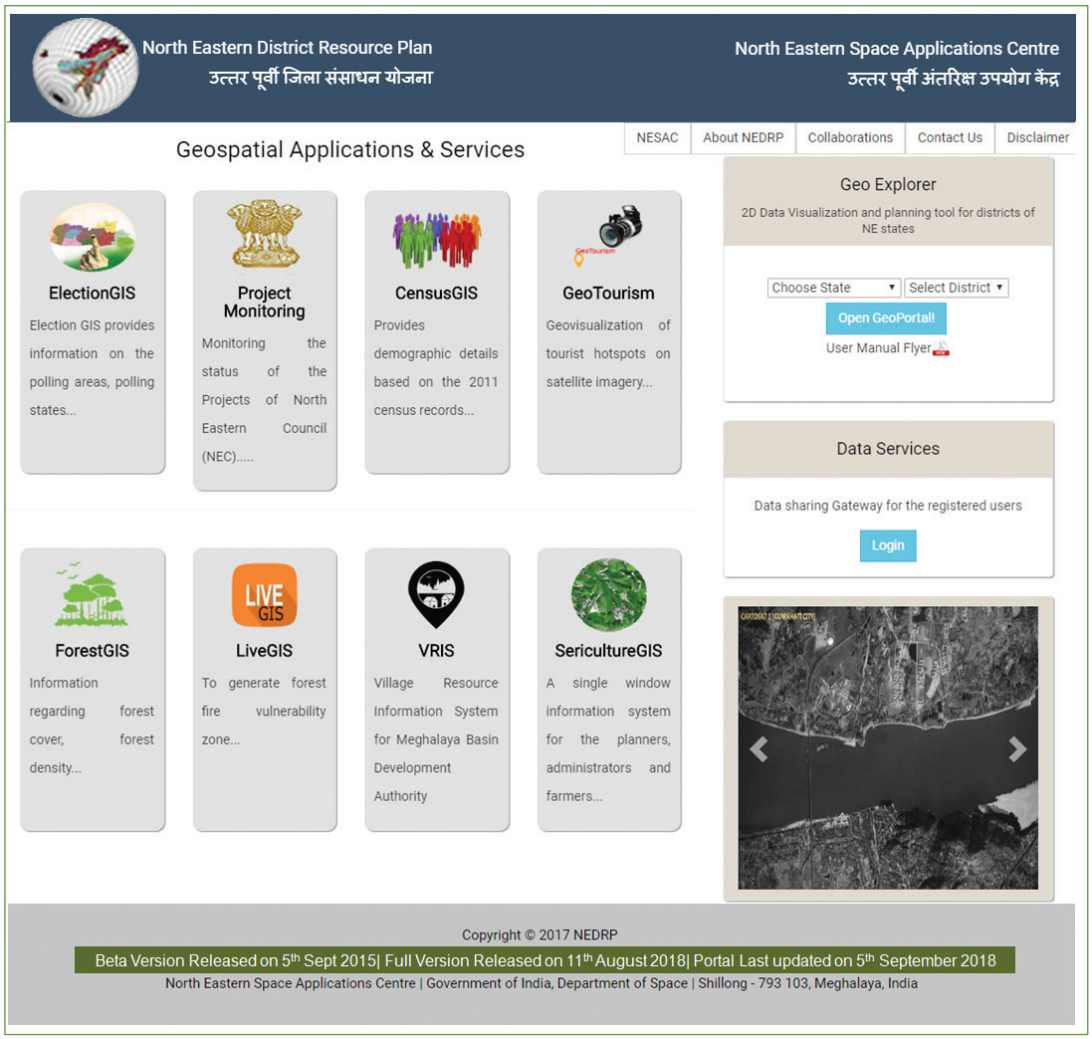


Building Footprint of part of Shillong City overlaid in Merged data of CARTOSAT-2S

IT & GEOINFORMATICS

North Eastern District Resources Plan (NEDRP)

North Eastern District Resources Plan (NEDRP) is one of major activities of NESAC towards strengthening the Governance policy through effective mechanism of geospatial framework. The project has been sponsored by the North Eastern Council (NEC), Government of India, Shillong and executed in collaboration with the State Remote Sensing Applications Centre (SRSACs) of NE region. NEDRP was initiated with 36 selected districts of NE Region and later on extended to remaining districts (65 districts) of the region. Each of the districts comprised of around 30-35 geospatial layers categorized into six major modules- i) Administrative or base data, ii) Infrastructure, iii) Land and Water resources, iv) Planning inputs, v) Terrain module and Disaster management. In addition, NEDRP dashboard is populated with the Governance Applications on Election, Census, Project Monitoring, Geo-Tourism, Village Resources Information etc. The Geoportal is hosted at www.nedrp.gov.in using 1Gbps NKN network. NEDRP Geoportal is developed using the open source software and standards. It provides an interactive and responsive user interface (UI) for visualization of geospatial layers, on the fly-statistics with proximity and multi-dimensional querying capability. Live Dashboard for Governance applications are powered by various web tools and APIs. A number of Spatial Decision Support Systems (SDSSs) like land resources planning based land and climatic condition, suitable sites for check dam construction etc. are part of the NEDRP system. Around 1620 layers maps via public domain and 1200 geospatial layers through Bhuvan node have been already released to the various users for their developmental planning activities. The full web-version of NEDRP was officially launched on 5th September, 2016. In addition, installation of standalone/offline version of the portals were completed in the selected offices of District Administrations and Line Departments because of limited or poor internet connectivity in these areas. NEDRP is now becoming decision making platform for the Governance applications in many Government Departments and agencies for their planning and monitoring activity.



Chronology of NEDRP towards development of Governance activity

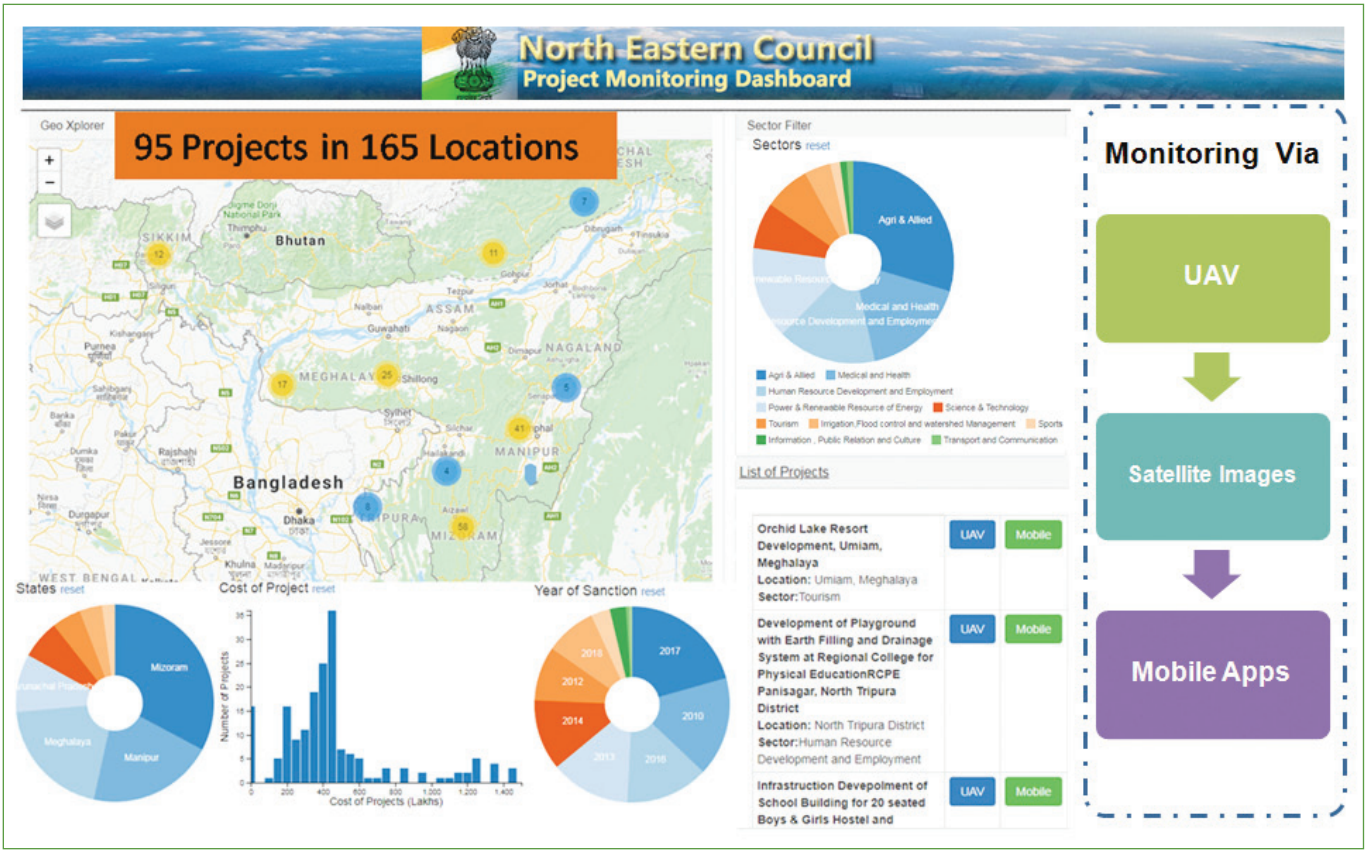
Services rendered under NEDRP project has been recognised in the form of prestigious National e-Governance award for the year 2017-18 by the Department of Administrative Reforms & Public Grievances (DARPG), Government of India.

North East Spatial Data Repository (NeSDR)

NeSDR is one of the major programme of NESAC taken up as per the directive of Ministry of DoNER with the objective to establish Geospatial Network Linkages among State Remote Sensing Application Centres (SRSACs) of NE region through augmentation of existing IT infrastructures as well as creating a standardised geospatial data catalogue by integrating existing spatial data generated at different scales and time from SRSACs and user or line departments. NESAC as Central Node will host regional database including State data whereas respective SRSACs as State Nodes will be responsible for State data generated by SRSACs or other Line Departments. NEC has sponsored the project with a total funding support Rs. 401.37 lakhs. Currently installation of IT Infrastructure of Data Centre at each state is under progress.

Project Monitoring of NEC funded Projects in NE region using Geospatial Technology and Tools

At the request of North Eastern Council, Government of India, NESAC has initiated a project on monitoring of the status of the projects/schemes funded by NEC for various developmental activities of NER. The prototype was developed to showcase the concept. An interactive web based geospatial dashboard and mobile apps has been developed for monitoring of the projects. Progress of the project status are monitored via in three modes - Mobile Apps, satellite imagery and drone images. Satellite and drone images are being used where the project site is relatively large and leading to the construction of roads, stadium etc. Till now, total 95 projects of NEC running in 165 locations of NE region are integrated. Those projects falls under 11 major project sectors of NEC. They are mainly – Agriculture & allied, Human Resource Development and Employment, Science & Technology, Transport and Communication, Information Public Relation and Culture, Medical and Health, Tourism, Irrigation,Flood control and watershed Management, Power & Renewable Resource of Energy and Sports. Bhuvan satellite imagery along with other base maps have been effectively integrated in the Dashboard (Figure) for better visualization of project status.



Prototype of Project Monitoring Application

PHOTOGRAMMETRY & UAV REMOTE SENSING

Unmanned aerial vehicle (UAV) popularly known as drone, is an airborne system or an aircraft operated remotely by a human operator or autonomously by an onboard computer. UAV combined with photogrammetry & remote sensing technologies have created new vistas in global scenario to acquire the geospatial data on land resources and environment. UAVs offer promising prospects to create high resolution and highly accurate orthophotos and digital surface models, thus facilitating map creation and updating. The UAV facility at NESAC has been offering a range of value-added services to users, including aerial photography and digital mapping, infrastructure planning, large scale base map, disaster assessment, surveillance, agricultural applications, topographic mapping, etc.

Facilities such as UAV data processing lab, digital photogrammetric systems, GIS systems, survey systems like GPS, etc., supported by dedicated human resources take care of all the analysis and processing requirements.

UAV Systems

NESAC has multi-rotors (Quadcopter & Hexacopter) and fixed wing UAVs and trained human resources to carry out aerial surveys.

DJI Matrice 600 Hexacopter

UAV Sensors

NESAC has a 12 MP RGB camera and another with 2X zooming capability. NESAC also has a Multispectral sensor with four bands as Green, Red, Red Edge and NIR.

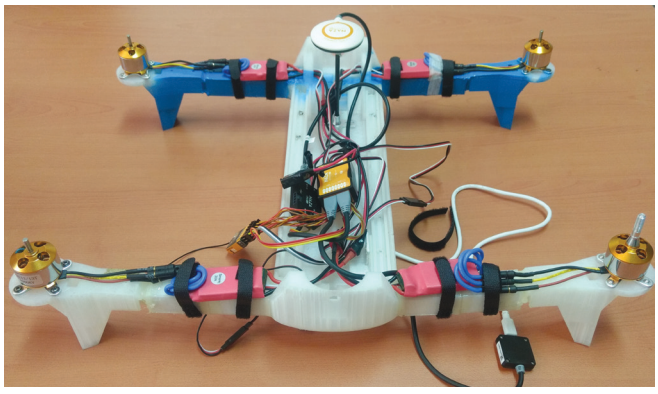
4 band Multispectral Sensor

3D Printing

3D printing facility is new edition to UAV Lab at NESAC. The printer is having a build volume of 215 X 215 X 300 mm with a max. resolution of 20 microns and supports different materials such as PLA, Nylon, ABS, PVA etc. for printing. The 3D printer is being used to develop in-house mini UAVs along with other accessories related to UAVs. A mini quad copter has been designed and printed using 3D printer with Nylon material having a dimension of 100 X 300 X 70 mm and total weight of 1kg.

UAV Remote Sensing facilities for SRSACs of NER

NESAC has also facilitated all the State Remote Sensing Centers (SRSACs) of North Eastern Region (NER) in setting up of UAV Remote Sensing facility which is funded by North Eastern Council (NEC). Each of the SRSACs were provided with a quad copter (M100) and a UAV data processing software (AGISoft). NESAC has also provided training on UAV operation, data



Mini Quad copter printed using 3D printer

acquisition & processing and also providing continuous support to all the SRSACs.

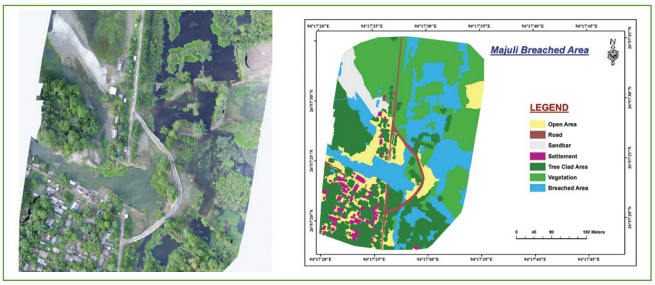
UAV system (M100) given to each SRSAC of NER

UAV Aerial Survey and Digital Mapping

This year NESAC has conducted more than 35 UAV surveys for different users and research work in the NER. The service has also been extended beyond NE Region. UAV survey carried for Hantra Gram Panchayat, Rajasthan for NIRD & PR. Total 90 ha of resident area was covered under the survey and a 10 cm resolution map was given.

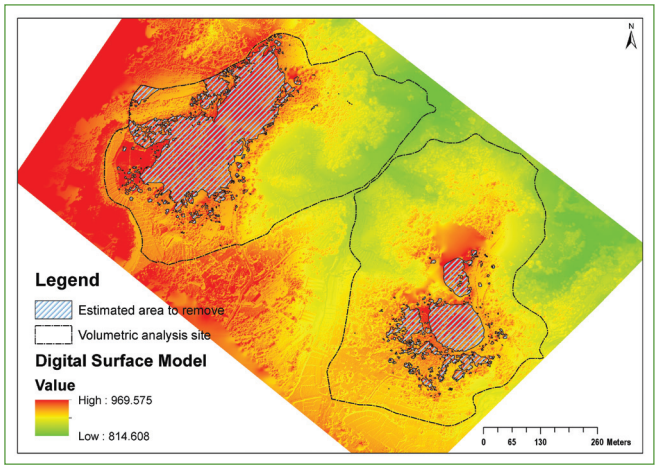
Estimation of Earth Work for Extension of Shillong Airport

Earth work estimation for a large area may be more expensive than expected and time consuming processes in absence of thorough investigation and proper scientific approaches. The process becomes more complex if the area is in rugged hilly terrain. However, in the last two decades with the advent of space technology and GIS, earth work estimation in any area becomes easier. Moreover, due to the advancement of Unmanned Aerial Vehicle (UAV) to capture cloud free Image at low altitude and using photogrammetry technique, high accurate digital surface model (DSM) with less than 20 cm posting can be reconstructed. Also the use of UAV in airborne surveys has many advantages such as risk reduction, better overview, survey of inaccessible locations, improved data density, faster data acquisition, higher data resolution and lower costs. This work has been carried out for Public Work Department (Roads), Ri-Bhoi District, Meghalaya.



High resolution image of embankment breach location in Majuli Island, Assam

A multi-rotor UAV (M600) was used to acquire the data for the identified study sites. The data acquisition has been done with 100m flying height and with total area coverage of 6.6 sq.km for three different sites. During the acquisition, about 4077 images were recorded. The Ground control points (GCPs) were collected by the user department using Differential GPS and Total Station surveys. These data are then transformed into point clouds, orthomosaics images with 4.5 cm/pixel ground sampling distance and digital surface models (DSMs) with 10 cm posting using Pix4D software.



2D map of cut and fill area

The earth work estimations was performed in GIS environment using cut-and-fill operation. The Cut Fill tool summarizes the areas and volumes of change from a cut-and-fill operation. The estimated volume of cut and fill quantities for the proposed sites were done based on the reference levels for the respective sites as provided by the user department.

During the process of earth work, it is expected to influence the local environment due to the cutting of trees which may lead to change in local climate. To minimize the local changes, some of the remedial measures such as aforestation, channel diversion, etc. and proper rehabilitation planning for the displaced settlement are being recommended.

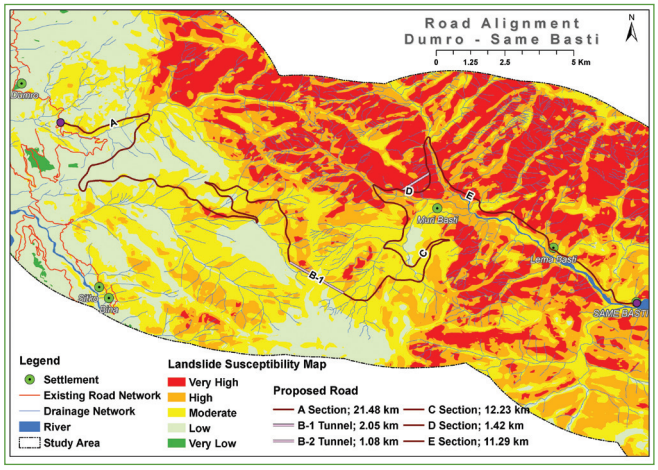
Remote Sensing and GIS Based Inputs and Analysis for Suitable Road Alignment Planning from Dumro to Same Basti, Upper Siang and Lower Dibang Valley Districts, Arunachal Pradesh

This project has been carried out for Border Road Organisation (BRO), 761 BRTF (GREF), Project Brahmank, Arunachal Pradesh to find a best suitable route to connect Dumro village of Upper Siang and Same Basti village of Lower Debang Valley Districts of Arunachal Pradesh using IRS LISS-IV data of 2014, 10m Cato-DEM and other collateral data with limited ground surveys. The methodology to generate and suggest a new road alignment has been categorized broadly into two parts. The first part includes the preparation of landslide susceptibility zonation map and the second part includes alignment of most feasible route (centre line) using the susceptibility map and Digital Elevation Model (DEM for vertical alignment) as input along with the criteria as suggested by the user i.e. for every 20m horizontal length, the permissible vertical raise is 1m (i.e. 1: 20 gradient).

Three exercises were carried out to conclude the final proposed aligned road. In the first exercise it has been observed that the total length of the road is 64.08km. It is also observed that there are about 22 numbers of major hairpin bends/ curves and maximum of the curves are in the same slope/ aspect. The vulnerability and the risk are very high at the lower slope, if anything happens in the high slopes. To reduce the length of the road and overcome the risk, second exercise has been conducted. It has been observed that with the introduction of B-1 tunnel, two alternative routes are generated with reduced lengths and minimizing the number of major hairpin bends/ curves to almost 12. In the third exercise, the section D-4 has been omitted as most of the section traverse within the very high landslide category as indicated in the susceptibility map.

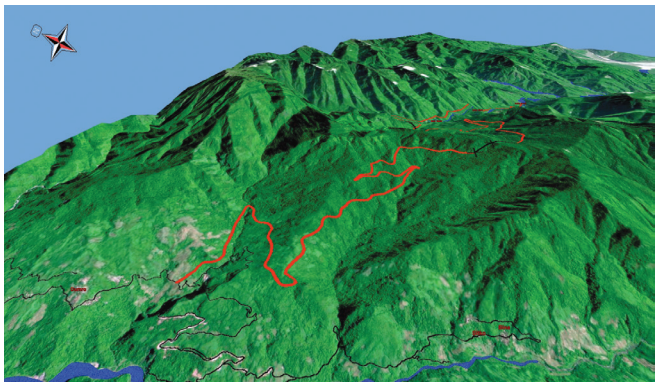
The proposed final aligned road generated is about 48.47 km in length. However, omitting section 'D' and introducing the second tunnel B-2, the total length of the proposed aligned road has reduced to 48.13 km. Section D has been omitted as it falls under very high category in the susceptibility map and also observed that this section is passing just above the crown of an active landslide area that may reactivate at any time.

The tunnels are proposed in such a way that gradient is less than 1.5 degree. The cross section profiles at every 100 m and the longitudinal profiles at every 1 km length are also generated. Hairpin bends, major bridges & curves are also suggested along the proposed aligned road.



Final proposed road alignment

During the entire process of the alignment, an attempt has been made to follow the criteria strictly as per the user requirement and maximum effort has been given to avoid the existing active landslide areas as well as high and very high categories as indicated in the susceptibility map. The following points were also put forward as recommendations in the final technical project report submitted to the user agency:



3D Visualization of proposed aligned road

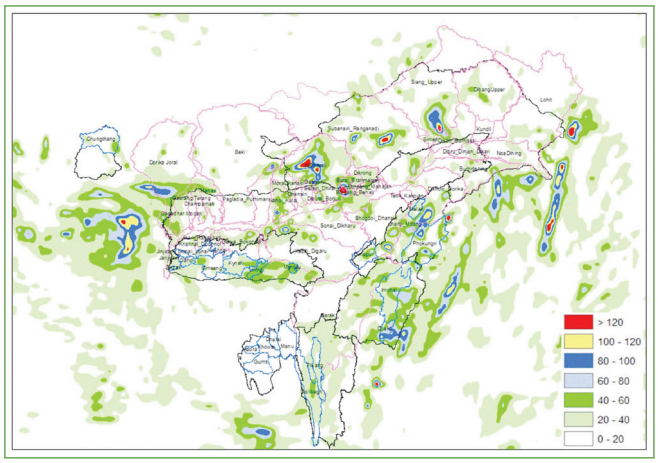
1. Proper channelization of seepage zones
2. Adoption of slope and landslide protection measures wherever possible such as aforestation and other conservation measures (engineering & bio-engineering), terrace cultivation on steep slopes, etc.
3. Protection of river bank erosion or toe cutting.
4. A proper site should be identified or selected as a corridor for the movement of wildlife with caution signboard, speed limit, etc.

DISASTER MANAGEMENT SUPPORT

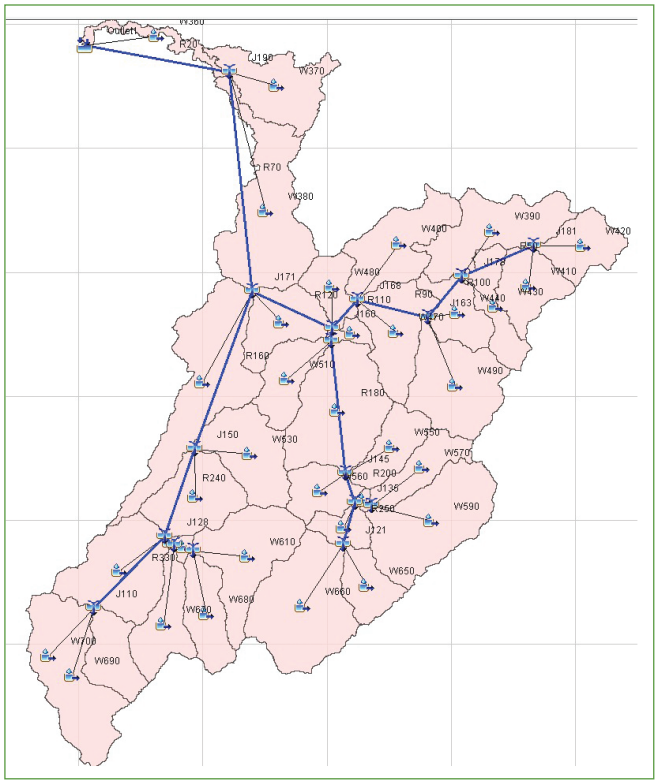
Flood Early Warning Systems (FLEWS)

The state of Assam is fully covered by the Brahmaputra and Barak basins. A severe flood event affected Lakhimpur district of Assam during June, 2008 causing enormous damage. NESAC was formally requested by Govt. of Assam and the North Eastern Council (NEC) to develop an flood warning system using geospatial technology coupled with satellite and ground based hydro-meteorological analysis for issue of actionable alerts and advisories to state and district administration for risk reduction and management of flood in Assam. The project FLEWS was initiated for Lakhimpur district as pilot during 2009-10. At present the project covers all flood prone districts of Assam with actionable flood alerts in revenue circle level. All these years since the beginning, an average year to year alert success score of 75% and an average alert to alert lead time of 12 to 36 hours have been maintained. On completion of the second three year operational period from 2015 to 2017, action has been taken for the third operational period from 2018 to 2020 at the request from Government of Assam.

The technical component of this exercise comprises of two sub component namely the numerical rainfall prediction model called the Weather Research Forecast (WRF) supported by a qualitative synoptic weather monitoring exercise and a GIS based distributed hydrological model known as the Hydrologic Engineering Centre - Hydrologic Modeling System (HEC-HMS). While the first sub component, predicts the rainfall values in different grid resolutions such as 27 km, 9 km, and 5 km at three hourly interval for coming 24 hour period, the second sub-component intake the predicted rainfall values into a spatially distributed mesh of inter-connected hierarchy of watershed run-off models giving predicted values of peak discharge as well as hydro-graphs which in turn is compared with established flooding threshold discharge values of the river or tributaries concerned in order to generate the flood alerts and disseminated accordingly to the revenue circles and district concerned in terms of simple flood advisories with satellite images pertaining to the concerned revenue circle and district lying in the flood plain under the said flood alert. During the monsoon 2017 the overall success of 86% (absolute and partial combined) was achieved.

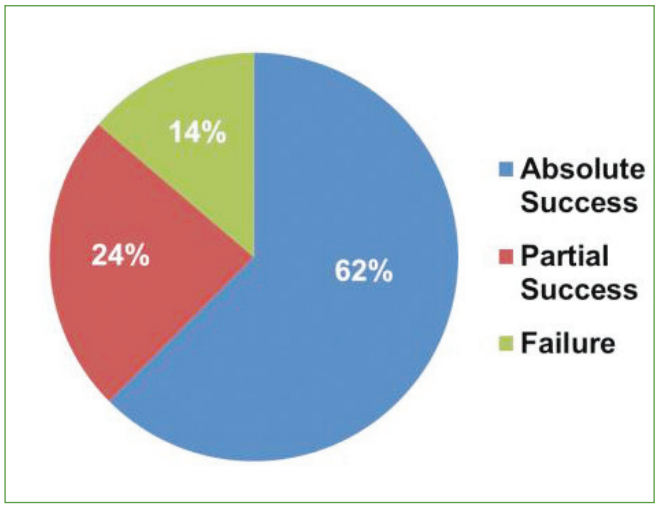


WRF Rainfall prediction



HEC-HMS Hydro modeling

Being the first operational GIS based hydro-met warning system in the country, this scheme of NESAC has been able to get both national and regional level recognition such as Good Governance Initiative and professional best practiceby Union Ministry of Public Grievances and Pensions, Govt. of India as well as winner of E-North East award for E-governance and Citizen services delivery etc. This scheme has generated enough interest in the country that a good numbers Parliament questions (both from LOK SABHA & RAJYA SABHA) have been answered by NESAC / ISRO on this scheme.



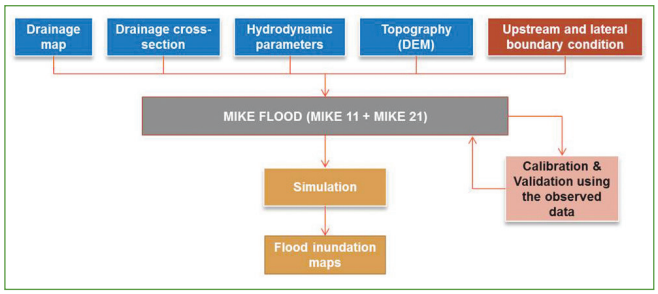
FLEWS success rate in 2017

Future of FLEWS

On the advice from Chairman, ISRO, the present focus is on the extension of FLEWS services to other North Eastern states based on priority. The HEC-HMS models have been built for states of Arunachal, Nagaland, Tripura, Manipur, Mizoram, Meghalaya and Sikkim. Presently the models have been built and made ready for calibration and validation. Simultaneously institutional arrangements are getting established through series of stake holder meetings especially with the state level disaster management authorities and remote sensing centres of Meghalaya, Nagaland, Arunachal Pradesh and Tripura in first phase. Planning is on for similar arrangements with Manipur, Mizoram & Sikkim in future.

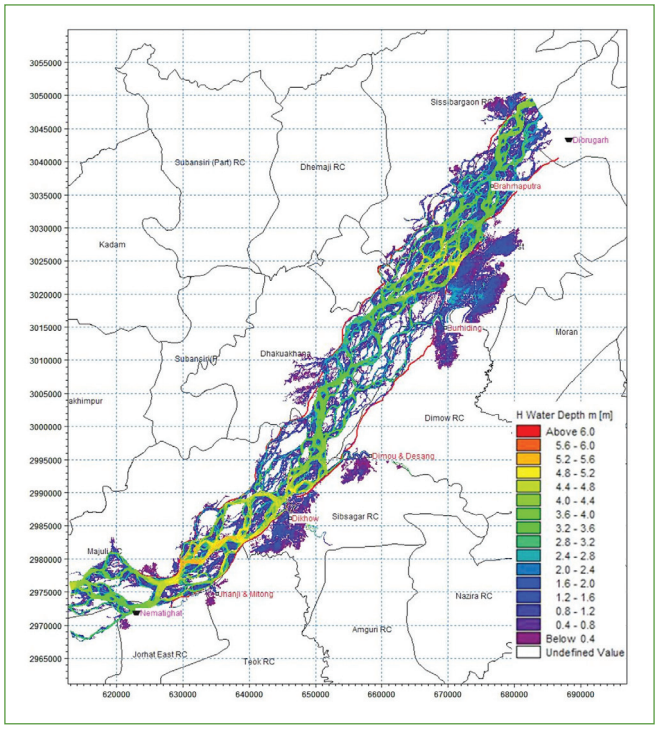
Flood Inundation Forecasting in Brahmaputra

The Union Ministry of Water Resources, Government of India through its major agency the Central Water Commission (CWC), has approached NESAC for collaboration on hydraulic simulation based flood inundation scenario generation in Brahmaputra valley. With the use of high resolution Digital Elevation Model generated from airborne LiDAR data, flood discharge and level based inundation scenario library will be generated. The individual scenarios from these libraries will be used in future as inundation forecast and advisories during flood season. The flood inundation modelling is carried out using a coupled 1D/2D hydrodynamic MIKE FLOOD model using high resolution topographic data generated from airborne LiDAR data. The methodology involved in modelling and generation of inundation map is shown in below figure.



Flood inundation mapping using MIKE FLOOD

The product generated out of this exercise will also help in scientific floodplain zonation and regulation. As a pilot exercise, a hypothetical scenarios has been generated for the upper Assam sector of Dibrugarh to Nematighat (as shown in figure). Further similarly inundation scenarios will be generated for other segments of Brahmaputra.Under this exercise, NESAC team is working closely with different offices of CWC in Assam, Meghalaya and New Delhi.

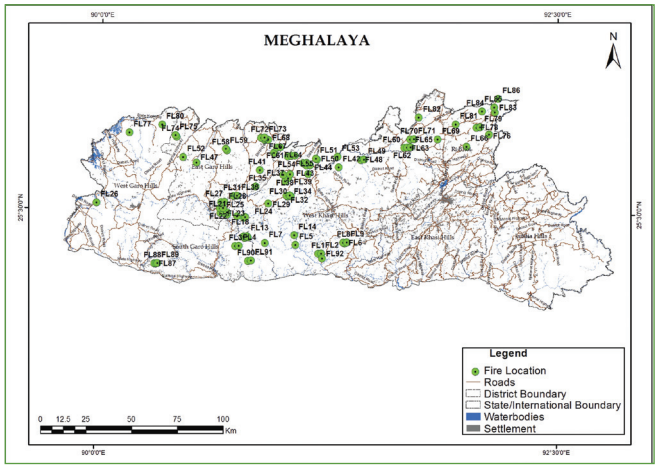


Sample Inundation Scenario

Forest fire monitoring

Under the North Eastern Regional node for Disaster Risk Reduction (NER-DRR), value added forest fire products are being disseminated to all the concerned forest departments and local level NGOs via email. Similar to the previous years, forest fire alerts have been provided during the fire season in the year 2018. In addition to the email alerts, the fire alerts are updated in the website also. The fire alerts contain map showing the distribution of fire location along

with information on the fuel characteristics, proximity to settlement, water bodies, road connectivity and current weather formation. Extensive field verification in the fire affected areas have been carried out.

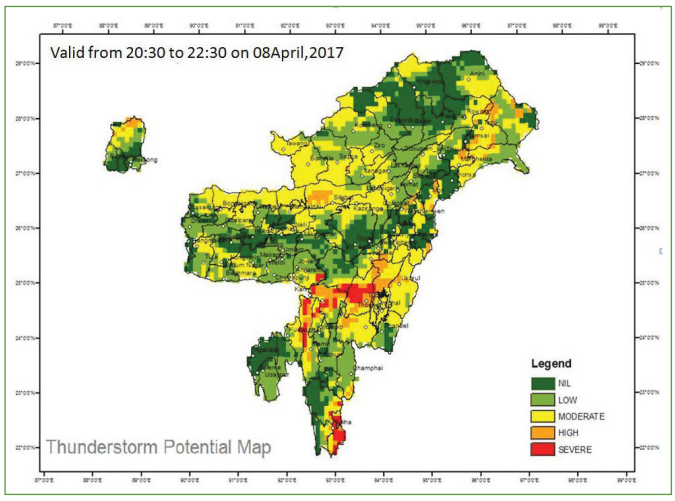


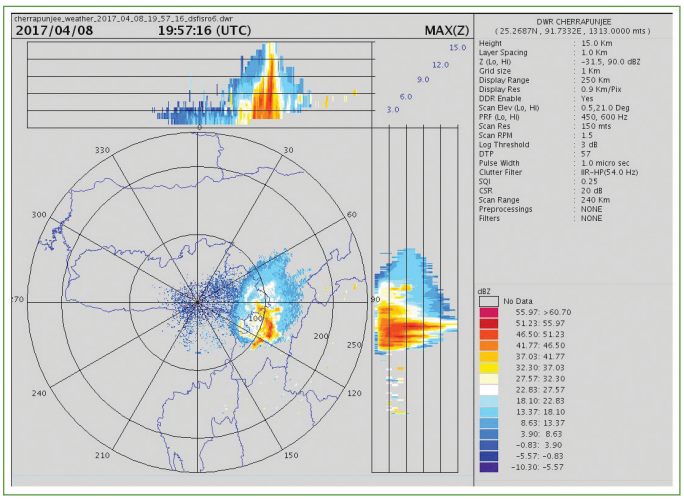
Jhum cultivation a major cause of forest fire in Northeast region (field photo from Garo hills, Meghalaya)

Thunderstorm Nowcasting at NESAC

Severe thunderstorms (TS) associated with lightning is one of the major life threatening disaster over the NER of India. TS nowcasting services are being provided from NESAC since 2014 on pilot basis for the states of Meghalaya, Tripura, Mizoram, and parts of Assam. The same was extended to entire NER of India since 2017 under the NER-DRR initiatives at NESAC. TS nowcasting is provided in two forms, first by preparing a thunderstorm potential map based on numerical weather prediction model outputs, and then by preparation of thunderstorm bulletins based on real time weather watch using data from Doppler weather radar, Satellites, and automatic weather stations. The services are provided from 15th March to 15th June every year, as frequency of TS is highest during this period.

The TS bulletin and potential map was issued thrice daily with TS bulletin having validity of four hour and TS potential map having validity of three hours. The TS potential map uses WRF model based forecast of atmospheric instability indices (like convective available potential energy, convective inhibition energy, K index, Lifted Index, etc) and relative humidity. The TS potential map predicts the potential location where thunderstorm occurrence is likely during a given time. TS warnings in both TS bulletin and potential map is categorized in five category (Nil, Low, Moderate, High, and Severe) based on the likely intensity of the thunderstorm. The TS potential index and the warnings are validated using observed data (Satellite, DWR, IMD reports, etc). The accuracy of thunderstorm potential mapping for the complete pre-monsoon season revealed highest accuracy over the Arunachal Pradesh and lowest over Tripura, Mizoram, and southern Assam. The probability of detection and false alarm ratio for the TS bulleting for the full season was found to be 0.89 and 0.46 respectively.





The thunderstorm potential map prepared on 8 April, 2017 (left) and validation of the same based on DWR data (right)

SATELLITE COMMUNICATION (SATCOM)

NESAC is implementing ISRO's Societal Development programs like Tele-Education, Tele-Medicine and Emergency Communication System through utilization of Satellite Communication Technology. As one of the mandates of NESAC is working towards development of the people in North Eastern Region, NESAC has established extensive network for distance education and remote healthcare in the region as the region lacks quality educational infrastructure and healthcare services. The Tele-Education project, which already had its presence in all the eight states of North Eastern Region except Manipur, has been completely revived in 2017 and new network for the state of Manipur has also been established. A new plan for revival of Tele-Medicine program in North Eastern Region is also under process. NESAC has provided support to the Meghalaya Police Department by providing them satellite phones (developed by ISRO) for aiding in their strategic missions. SATCOM division also has facilities like SATCOM studio for content generation, transportable WLL-VSAT for emergency communication, primary node under ISRO-DMS VPN network, Satellite Interactive Terminals under Tele-education network, Spacenet connectivity for secure communication among other ISRO centres etc.

Tele-Education Project in North Eastern States during 2017-18

NESAC initiated the task of reviving the whole Tele-Education network in North –Eastern region in 2017 and most of the work was completed during the year. The network comprises of 07 Hub cum Teaching Ends in the states of Assam, Meghalaya, Arunachal Pradesh, Tripura, Mizoram, Sikkim and Nagaland and 325 Satellite Interactive Terminals (SITs) in these states. Till now, all the Hub cum teaching ends and around 300 SITs have been recommissioned. Work for commissioning of a new network for Manipur with 25 SITs is also almost completed. After the recommissioning of the networks, several user interaction meetings were organized at the individual states for explaining to the users their responsibility for best utilization of the resources. Teams from NESAC and DECU, Ahmedabad met Chief Secretaries of various states to explain about the support of government machinery to successfully implement the program. A brief description of the network is given in table below.

Sr. No.	Name of State	Hub Location	Number of SITs	Coordinating Agency
01	Assam	State Institute of Panchayat & Rural Development, Kahikuchi, Guwahati	32	State Institute of Panchayat & Rural Development, Kahikuchi, Guwahati
02	Meghalaya	Directorate of Educational Research & Training, Shillong	47	Directorate of Educational Research & Training, Shillong
03	Arunachal Pradesh	Rajiv Gandhi University, Itanagar	50	Rajiv Gandhi University, Itanagar
04	Tripura	SCERT, Agartala	45	SCERT, Agartala
05	Mizoram	SCERT, Aizawl	50	SCERT, Aizawl
06	Sikkim	SCERT, Gangtok	50	SCERT, Gangtok
07	Nagaland	Dept. of IT, Kohima	45	Det. Of IT, Kohima

All the Hubs were made functional by supplying/ replacing Hub equipment. All the equipment for Hub and SIT recommissioning were purchased by NESAC and transported to respective states.

After the Meghalaya Hub and most of the SITs were made functional, a coordinators' meeting was also held for the state of Meghalaya to discuss with the nodal officers of the state (DERT, Shillong) and educational institutions to encourage them to use the Tele-Education facility to the fullest. Meetings with Chief Secretary, Meghalaya and other higher officials were also conducted for successful implementation and utilization of Tele-Education project.

Meghalaya Tele-Education Coordinators' Meet

HUB cum Teaching end of Nagaland Tele-education network has been shifted from Kohima Science College to the old building of Department of IT, Govt. of Nagaland as desired by state govt. Meetings were conducted with Chief Secretary, Nagaland to discuss the plan for revival and utilization of the Nagaland Tele-Education Network .In such meetings, the Department of IT, Govt. of Nagaland was identified as new coordinating agency for Tele-Education program in Nagaland.

For the state of Assam as well, a similar coordinators' meet was organized on October 07th, 2017 to discuss various issues with the implementation and utilization of the network.

The network of Mizoram was fully revived and made functional. It was inaugurated on 24th November, by Minister for Education, Shri H. Rholounu, Govt. of Mizoram.

Inauguration of Mizoram Edusat Network

For the state of Manipur, 25 new SITs were commissioned in District Institute of Education & Training (DIET) under the jurisdiction of State Council of Educational Research & Training. All the nodes are operational now and it will be inaugurated soon.

Installation of SITs and Users' meet in state of Manipur

During the visit of then ISRO Chairman Dr. A.S. Kiran Kumar on 05th October, 2017, a demonstration of the Edusat Network was organized at NESAC. He interacted with Meghalaya Hub and some students from various SITs. During visit of Dr. K. Sivan, Chairman ISRO to NESAC on 07th March, 2018 also a similar demonstration was arranged with Sikkim network.

Chairman, ISRO Dr. A.S. Kiran Kumar in interaction with Meghalaya Tele-Education Hub

Tele-Medicine Project in NER during 2017-18

Under ISRO Tele-Medicine program, a total of 39 Tele-Medicine nodes were set up in the North Eastern Region. Of these, 25 were set up under a joint Tele-Medicine program of NEC and ISRO for development of NER. These nodes were set up in all 8 states of NER. A revival plan for these nodes is being formulated and NESAC is planning to take up the responsibility for connecting a few new nodes in coordination with NEIGRIMHS, Shillong which is an identified Regional Resource Centre for National Medical College Network.

Communication Support for Disaster Management

NESAC under the guidance of Special Project Office, ISRO HQ and SAC, Ahmadabad provided 10 Satellite

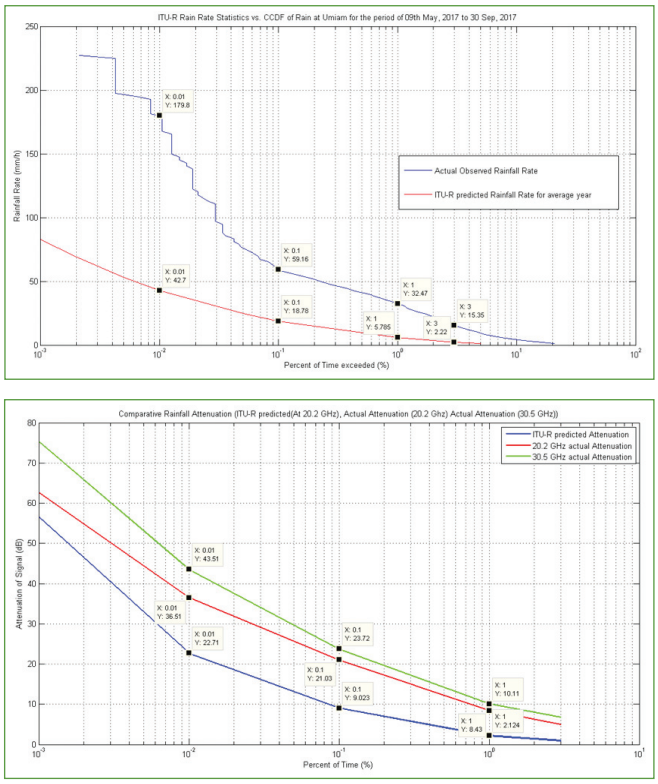
Mobile Radio (SMR) to Meghalaya Police at their request for their emergency communication purpose. NESAC had conducted a one day workshop on 28th July, 2017 for familiarization, demonstration & distribution of Satellite Mobile Radio (SMR) for Meghalaya Police. Around 70 officers from Meghalaya Police including Director General of Police, Inspector General of Police, DIG, SP of various branches and districts, DSPs etc had participated in the workshop.

Workshop on use of SMR and its handing over

NESAC participated in the three-day exercise on Humanitarian Assistance and Disaster Relief (HADR) under the title 'Nabhas Rahat' or 'helping hands from the sky' which was hosted by HQ Eastern Air Command, Shillong during 6-8th June 2017 and demonstrated the use of SMRs and VSAT based communication at the time of emergency.

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

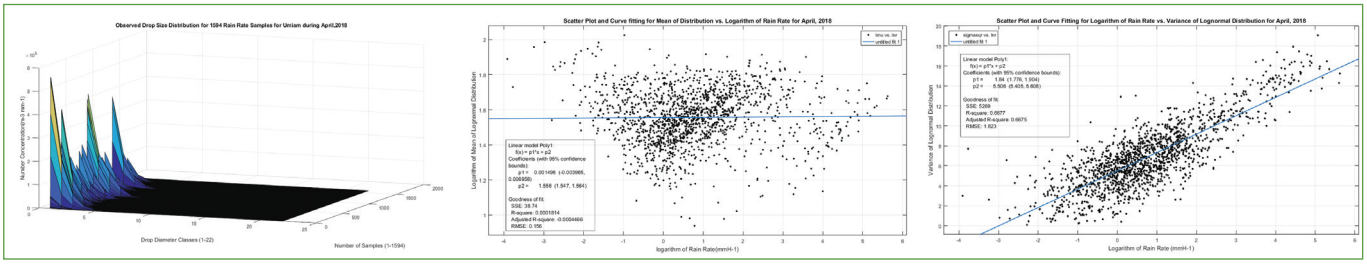
ISRO-ONERA-CNES joint Ka-Band propagation experiment is being carried out at NESAC to study



ITU-R predicted versus actually observed Rainfall Rate CCDF and Rain Attenuation for 20.2 GHz and 30.5 GHz signal at Umiam for 2017

Ka-band signal based satellite communication system performance in high rainfall regions like tropics. Ka-band beacon signals of 20.2 GHz and 30.5 GHz transmitted from GSAT-14 satellite are received at NESAC through two beacon receivers along with a Tipping Bucket Rain Gauge, Laser Precipitation Monitor and Humidity Profiling Radiometer. Results obtained till now suggest underestimation of rain attenuation by ITU-R model.

A Rain Drop Size Distribution (RDSD) study at Umiam suggests log-normal RDSD for 2018. With the Radiometer, it has been possible to carry out various quantitative analyses for meteorological parameters like Liquid Water Path (LWP) and Integrated Water Vapour (IWV) over the Umiam area.



Lognormal Distribution of RDSD and curve fitting for mean and standard deviation parameters of Log normal distribution for various observed rain events during April, 2018 at Umiam

SPACE AND ATMOSPHERIC SCIENCE AREA

The space and Atmospheric science group at NESAC is engaged in research with focus on understanding the spatio-temporal distribution of major climate change drivers like aerosols and greenhouse gases, through collection and analysis of in-situ data, satellite based data and products, and numerical modelling. The group also conducts research to improve short and medium range weather forecast for NE region of India. In addition, the group provides support and critical input in management of major disasters like flood, severe storm, 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:

Operation and utilization of the DWR, Cherrapunjee

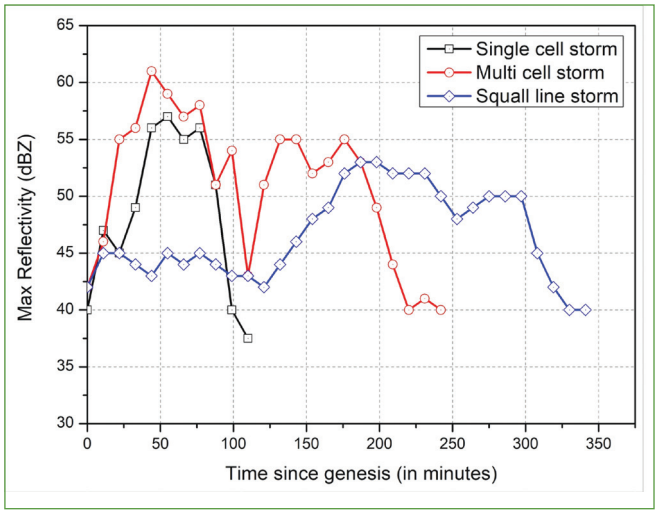
The S-band polarimetric Doppler Weather Radar (DWR) installed at Cherrapunjee is operated on 24 X 7 basis with three shift operation. During 1st April, 2017 to 31st March, 2018 period, the DWR was operational for 343 days. The radar is operated with two scanning modes, viz. long range scanning (at two elevation angles and covering up to 500 km) and short range scanning (at ten elevation angles and covering up to 240 km). The DWR is calibrated at regular intervals through Sun calibration, sphere calibration, bore sight calibration, receiver dynamic range testing, etc.

Thunderstorm characterization using DWR data

Pre-monsoon storms with squall wind, hails, lightning and moderate to heavy showers are frequent in the NER of India during the months of April and May. The storms affecting this region have both local and non-local origin. A large number of these storms originates over the regions that are west, north-west, and south-west of NER and travels towards the region. Storms with single cell, multi cell, and squall winds that affected the NER of India during 2017 pre-monsoon season were classified. Altogether 49 single cell, 22 multi-cell, and 4 squall line storms were observed within the DWR covered area.

Month	Single Cell	Multi cell	Squall Line
April	33	13	3
May	16	09	1

Table showing the number of thunderstorms observed during the month of April-May 2017



The life cycle of different forms of thunderstorm over the NE region of India

Single cell storms were found to have least lifetime (duration for which the max Z in any cloud system was more than 40 dBZ continuously) with average duration of ~100 minutes. The multi-cell and squall line storms were found to have lifetime of apprx 250 minutes and 350 minutes respectively. The multi-cell storms were seen to have highest intensity among all storms with highest value of Max Z observed at 61.05 dBZ. The life cycle of individual storms are being studied with an objective of utilizing this knowledge for improving the thunderstorm nowcasting services over the region.

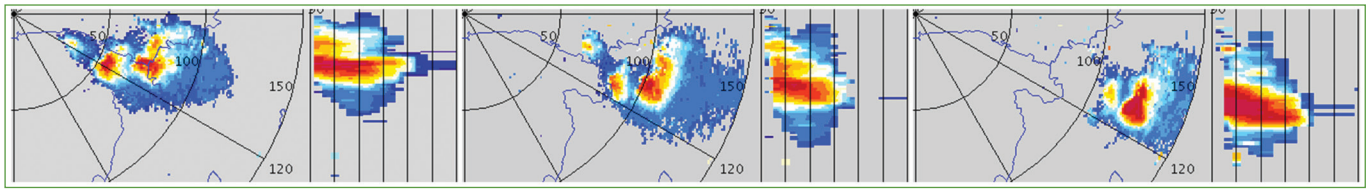
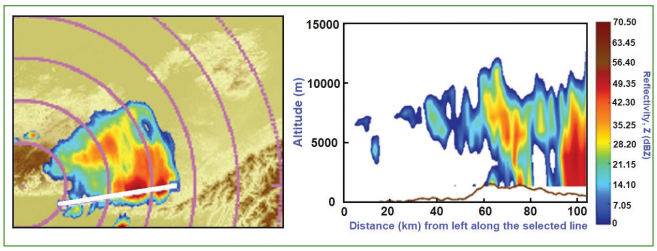


Figure showing how two full grown single cell thunderstorms merging into a single cell storm and intensifying further before dissipating covering a region from South-Eastern Meghalaya to Southern Assam.

Development of new product using the DWR data

Surface Rainfall Intensity (SRI) and Precipitation Accumulation (PAC) estimation are carried out using the reflectivity (Z) data collected by the DWR. SRI is measured as a rainfall rate at a height of 1 km from surface level. PAC is the accumulation of consecutive SRI measured over a specific time interval. The estimation was done based on Marshall-Palmer (MP) Z-R relation. The coefficients in the MP relation, 'A' and 'b' was empirically estimated as A=267 and b=1.3, utilizing data from two weather stations installed at Jowai and Mairang in Meghalaya. The correlation coefficient between the estimated PAC and AWS measured rainfall was found be 0.84. Efforts are being made to improve the accuracy of the PAC estimation by utilizing data from more AWSs in estimating the MP coefficients.

A new approach for generation for another product called Vertical Cut (V-cut) has also been developed. V-cut displays the vertical cross-section of radar data through its entire volume along any arbitrary line drawn on Max Z spatial data. Using V-cut, one can infer the hydrometeor distribution and extent of the convective cloud along any direction of interest to make better assessment of cloud systems.



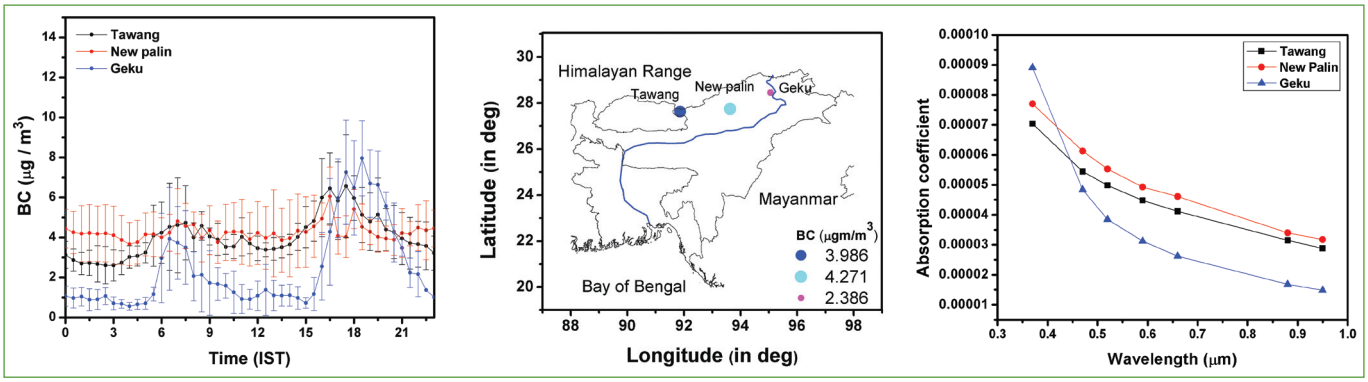
Vertical profile of radar data (Z) along the drawn line represented as V-cut

The Spatial mapping of aerosol parameters along the Sub-Himalayan region of NER

An aerosol land campaign was conducted along the Northern Arunachal Pradesh during February, 2018. The prime objectives of the campaign were to measure the optical and physical properties of aerosol like Aerosol Optical Depth (AOD), Black Carbon (BC) concentration, Aerosol scattering coefficients, PM2.5 loading, etc. in a pristine environment and also to measure some of the chemical compositions of the aerosols. The measurements were carried out at three sites viz. Tawang (altitude ~3000 m above mean sea level, amsl), New Palin (altitude ~1300 m amsl) and Geku (altitude ~ 300 m amsl) continuously for 5 days in each station. Data were collected using aethalometer, nephalomter, sunphotometer and high volume sampler at all stations.

Measurement locations for aerosol campaign (left), and arrangement of instruments in campaign locations (right)

The data collected are being simultaneously analysed at NESAC and Physical Research Laboratory, Ahmedabad (for the chemical compositions). Primary analysis reveals existence of prominent diurnal pattern (morning and evening peak) of BC concentration at all the stations. The BC concentration observed during evening hours (17:00-21:00 IST) at Tawang,



Diurnal variation of BC concentration (left) and daily mean BC concentration (centre) over the campaign sites. The spectral variation of absorption coefficient over the campaign sites is shown in figure in the right.

New Palin and Geku are 5.11±0.87 μgm^{-1}, 4.26±0.47 μgm^{-1} and 6.03±1.4 μgm^{-1} respectively and during the day hours (9:00-15:00 IST) respective BC concentrations are 3.72±0.86 $\mu g\ m^{-1}$, 4.27±0.4 $\mu g\ m^{-1}$ and 1.54±0.9 $\mu g\ m^{-3}$. Daily averages of BC concentration was found to be 3.99±1.01 μgm^{-1} over Tawang, 4.27±0.41 μgm^{-1} over New Palin, and 2.39 ± 2.05 μgm^{-1} over Geku. Spatial variation of BC concentration and absorption coefficient shows higher values towards the western sites (Tawang and New Palin) compared to the eastern location of Geku. High value of absorption coefficient indicates aerosol type over the places is dominated by fossil fuel combustion. HYSPLIT back-trajectories analysis ending over the sampling sites indicate flow of aerosol from the Brahmaputra valley in Assam towards the sampling sites, which can carry BC aerosol from the Brahmaputra valley towards the northern Arunachal Pradesh. The detail analysis of the data collected during the campaign is continued and a full report shall be prepared.

Impact of forest fire on air quality over NE Region of India

Forest fire is one of the major disasters over the NER of India. A large number of forest fires, mostly of anthropogenic origin, occur over the region every year. The impact of forest fire on air quality over NER of India has been studied for the periods from 2006 to 2017 using satellite data. MODIS (Moderate Resolution Imaging Spectroradiometer) collection 6 active fire count data with minimum 30% confidence level, BC mass concentration (MERRA model based), and AIRS tropospheric columnar NO_2 are analysed in this study. Maximum fire count of apprx one lakh events in entire NER is recorded during the Feb-March month every year. The area weighted average BC mass concentration and tropspheric columnar NO_2 has been recorded up to 35×103 $\mu g/m^3$ and 25×1014 no/cm^2 respectively during the same time period. Maximum concentration of BC and NO_2 coincides with the forest fire maxima, signifying the importance of forest fire in controlling air quality over this region. The temporal variation of these parameters during the 2006-2017 periods does not show any significant variability, other than mild decreasing trend in total forest fire counts over the region.

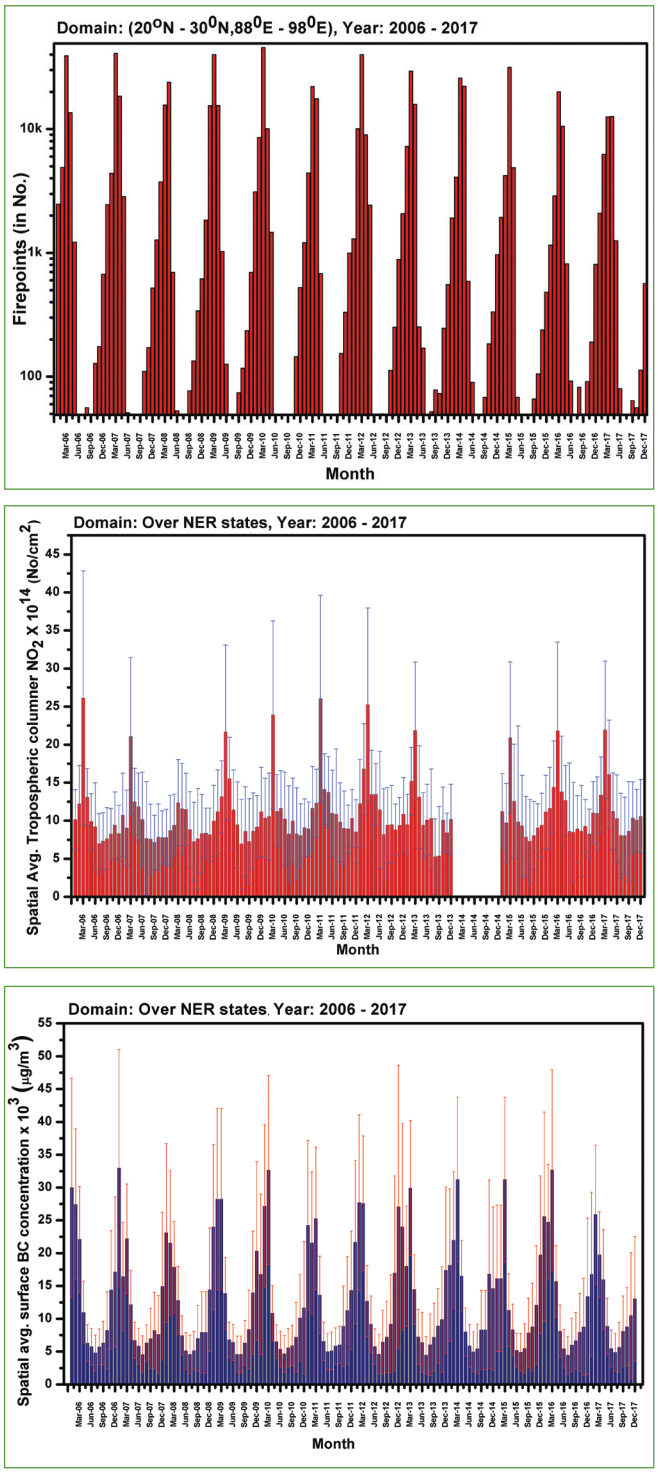


Figure showing the monthly mean fire counts (top), area weighted monthly mean tropspheric columnar NO_2 (middle), and area weighted monthly mean BC concentration (bottom) over the NER of India. The vetical line on each bar represent the standard deviation about the mean for the corresponding months.

Seasonal climatology of Surface Layer Parameters relevant to Atmospheric boundary layer over Umiam

High frequency 3D wind (u_x, u_y, u_z) data are collected at NESAC using fast response sonic anemometers installed at four levels (8 m, 10.5 m, 18 m, 31 m) in a

32 m meteorological tower. Surface layer parameters have been derived from March 2015 to December 2017 using tilt corrected 3D wind speed data. Sensible heat flux (SHF) was found to be maximum during the pre-monsoon season which experiences a sudden drop with the onset of monsoon that continues beyond the monsoon season. The SHF slowly increases during the

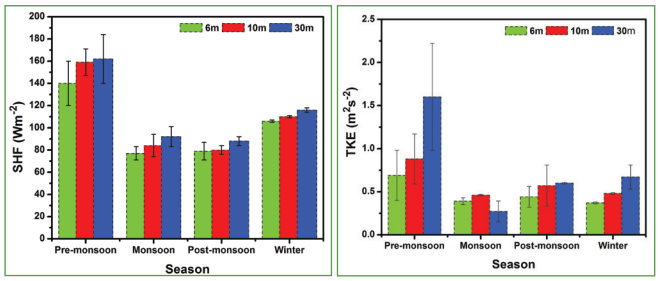


Figure shows the seasonal variation of mean SHF (left) and TKE (right) at three different levels. The vertical lines on each bar represent the standard deviation about the mean.

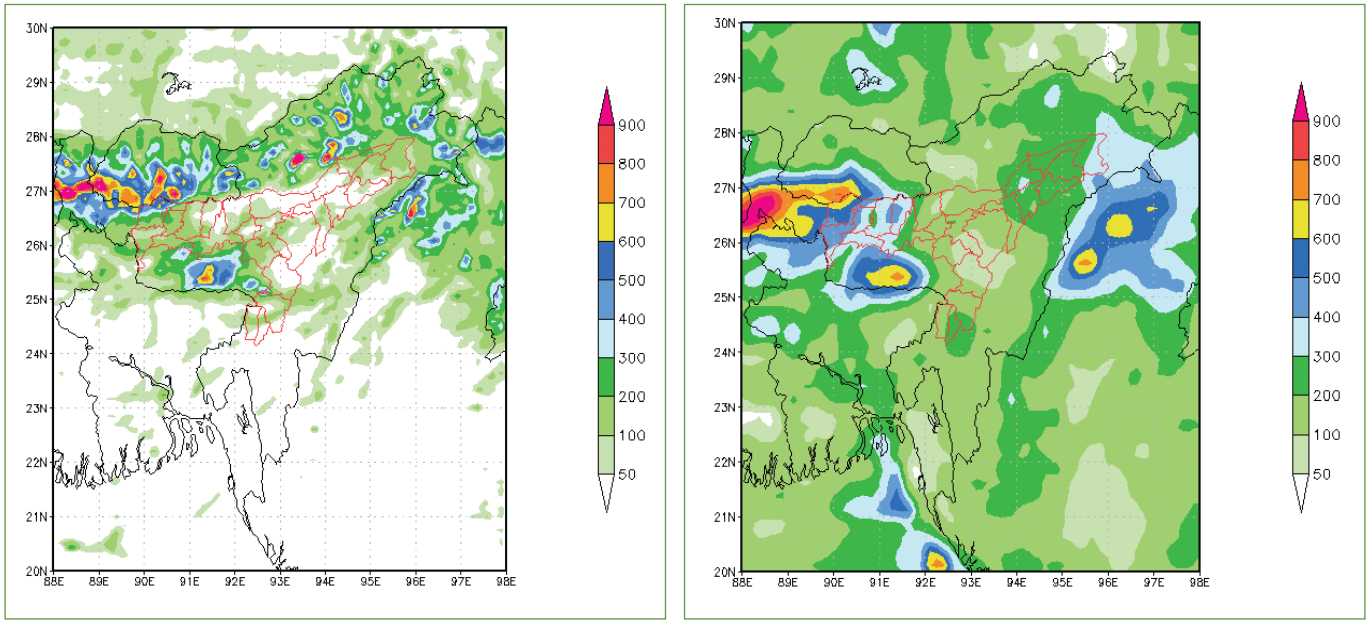
winter season. During the monsoon and post-monsoon seasons, the water content in the soil is higher in comparison to the winter and pre-monsoon seasons, which causes higher evaporation during these seasons and less heat transfer from surface to atmosphere leading to lower SHF. Total kinetic energy (TKE) was found to be maximum in pre-monsoon season compared to other seasons with its value increasing with increase in altitude during all the seasons. In pre-monsoon season, turbulence producing terms like buoyancy (due to strong surface heating) and wind shear are maximum compared to other seasons, which enhance the TKE during this season.

Impact of INSAT 3D radiance data assimilation in WRF model

The potential of Numerical Weather Prediction (NWP) models to produce useful forecast depend on the initial conditions employed for integrating the model. Observational data must be modified in a dynamically consistent fashion in order to obtain a suitable set for model initialization. For better weather forecast we need to assimilate data from dense network of weather observation. Satellite remote sensing data are very useful sources of atmospheric observations for NWP models. Satellite instruments do not directly measure the atmospheric state. Instead, they measure radiation emitted and/or scattered by the atmosphere. In this study, direct assimilation of INSAT-3D radiance data has been made in the Weather Research and Forecasting (WRF) model using WRF-3DVAR to examine its impact on rainfall forecast.

A set of data assimilation experiments have been conducted to simulate several heavy rainfall events. In all the experiments, the model was given a 24 hour spin up time and simulation was continued on daily basis for a month. The results have shown positive impact of INSAT-3D data assimilation with improved analysis. Better forecast of moisture content, temperature and precipitation fields have also been observed from the results.

Heavy rainfall (≥ 7 cm per day) events reported over several places (both in Global Precipitation Mission



GPM estimated accumulated rainfall (right) and WRF model forecasted rainfall (left) in mm with INSAT-3D data assimilation. Most of the heavy rainfall events as shown in GPM image were successfully simulated by the WRF model with INSAT 3D data assimilation.

(GPM) estimates and by the automatic weather stations) in East Khasi Hills district in Meghalaya during the period of 14th to 26th July, 2017. WRF model, with INSAT-3D Imager and Sounder data assimilation, could capture the intensity of rainfall core over Meghalaya, Bhutan, Sikkim, and sub-Himalayan West Bengal region to a large extent with some underestimation in other parts of north eastern region of India.

Validation of WRF model rainfall forecast

A new methodology was adopted to validate the rainfall forecast provided by NESAC using the WRF model. The validation has been done with the evaluation of WRF rainfall simulation with respect to a satellite based rainfall estimate over the NER of India. The model was initialized daily using Global Forecast System (GFS) and a daily forecast of 48 hours was generated. This validation exercise encompasses the validation of daily accumulated WRF rainfall for the June-July-Aug-Sept (JJAS) months. The investigation is done with respect to GPM (GPM-MS) rainfall product available at 0.1° x 0.1° resolution and has a temporal resolution of 30 min.

The validation strategy used in this study entails the estimation of bias (mean Error), root mean square deviation (RMSD), and statistically significant Pearson's correlation coefficient (CC).

The spatial distribution of seasonal mean of WRF model forecasted rainfall, GPM estimated rainfall, standard deviation of GPM mean and WRF model mean for the NER of India have been estimated. The bias in the WRF-RAIN with respect to GPM-MS has also been computed. It shows that the valleys have a lower bias compared to mountainous regions of NE India, like the foothills of Himalayas. It also shows that WRF-RAIN mostly overestimates the rain when compared to its satellite counterpart. The spatial distribution of RMSD of WRF-RAIN with respect to GPM-MS indicates that the WRF has a lower RMSD in most places over the NE region when compared to its satellite counterpart. However, there is a patch of high RMSD and bias over Meghalaya. The spatial distribution of Pearson correlation coefficient over NE region suggests a strong correlation of more than 0.6 over the northern parts of Arunachal Pradesh, parts of Meghalaya and Bangladesh.

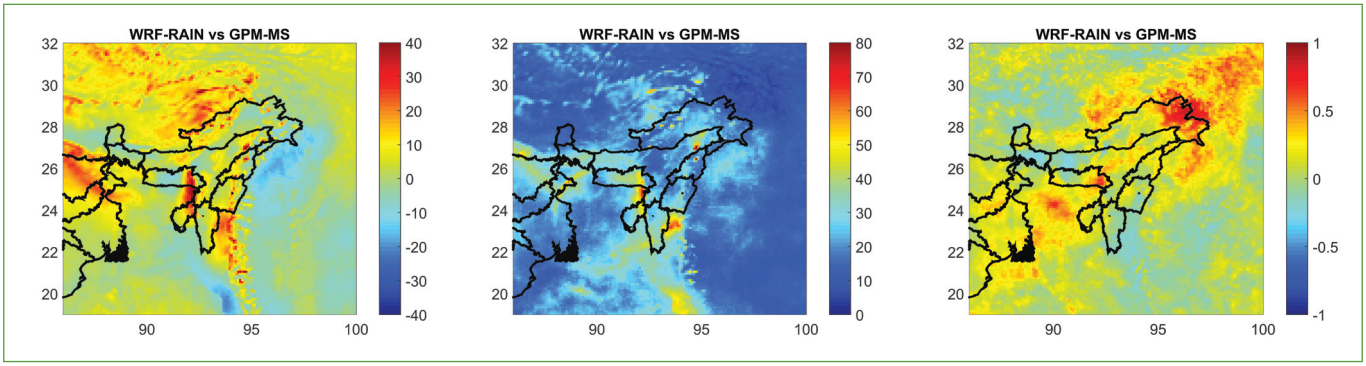
This analysis suggests that the performance of WRF over the NE region is comparatively reliable. However, these results should be used in light to the fact that GPM itself has some inherent ambiguities when it comes to estimating surface rain over a complex terrain.

Development of lightning early warning system for NER

NE region of India is one of the highest lightning prone

Description of the simulation setup

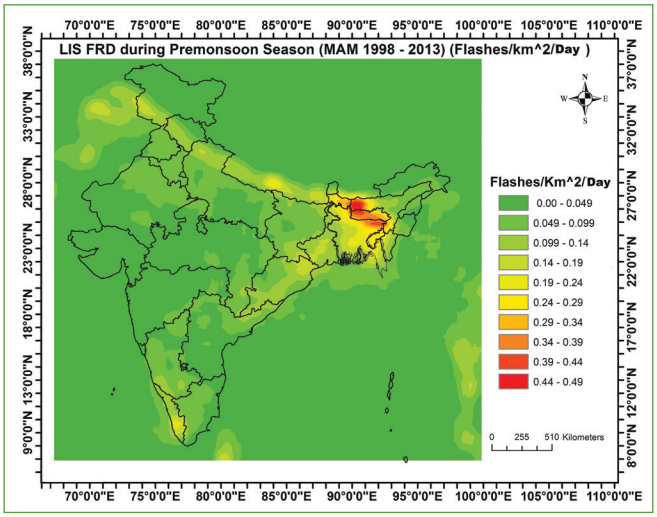
Spatial resolution	2 Domains: 27 km (Indian sub-continent) and 9 km (NER)
Temporal resolution	Hourly
Data for Initialization	Global Forecast System (GFS)
Parameterization Schemes	• Micro-Physics scheme: Thompson
	• Long-wave radiation scheme: RRTM scheme
	• Short-wave radiation scheme: Dudhia scheme
	• Surface layer scheme: Monin-Obukhov (Janjic) scheme
	• Land surface model: Unified Noah land-surface model
	• PBL scheme: Mellor-Yamada-Janjic TKE scheme
	• Cumulus parameterization scheme: Grell 3D ensemble scheme
LULC maps	NRSC updated land-use land cover maps



Bias (left), RMSD (centre), and Pearson correlation coefficient (right) of WRF-RAIN with respect to GPM-MS satellite rainfall.

zones in the world. The lightning climatology map generated using the data from LIS (lightning imaging sensor) on-board the TRMM satellite shows highest lightning strikes over the western part of the NE region of India during the March-April-May months. Each year a large number of lives are lost due to this natural calamity, which is more than any other disasters at a national level. In addition to human death, property loss, domestic animal death and forest fire due to lightning is also significant over India. The most vulnerable period of such phenomenon is pre-monsoon (March, April, May, partially June) season each year.

In this respect, NESAC has taken an initiative to forecast the lightning activity over NER using Numerical Weather Prediction (NWP) models along with the ground based lightning observational networks. The fully compressible, non-hydrostatic WRF model with the advanced research dynamic solver along with a special methodology to generate electric field component

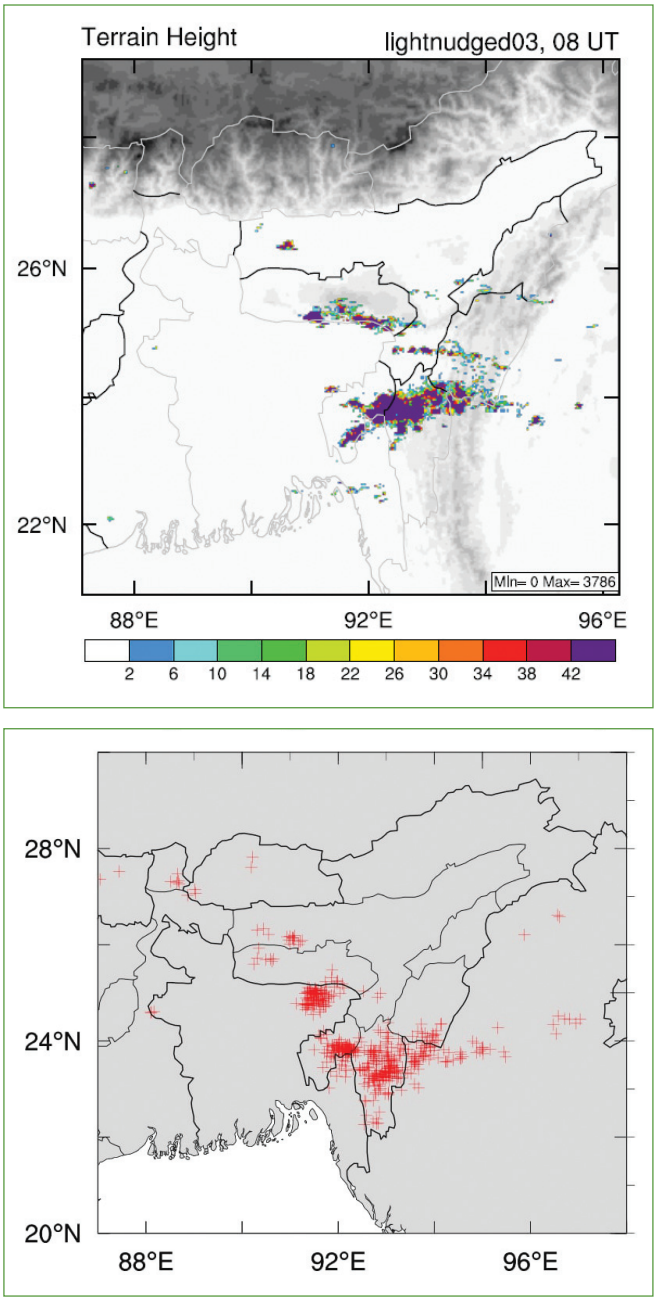


LIS flash rate density (FRD) map prepared for the pre-monsoon season using mean data from 1998-2013 periods

has been utilized in the study. Several severe lightning cases that occurred during April 2017 have been simulated to examine the effectiveness of the model. All the simulations have been done with a uniform time stepping with feedback from the outer domain. The schemes to generate different component of electric field inside the thundercloud charging and discharging regions, was activated only for inner most regions.

Hourly lightning flash counts were simulated and their locations during all the mentioned days were found to have good agreements with the observation based on ENTLN (Earth Network – Total Lightning Network) data. Max radar reflectivity product were also generated using lightning data assimilation in the WRF model which also showed good similarity with the INSAT 3D thunderstorm brightness temperature, confirming the capability of the model to simulate the cloud microphysical properties.

The assimilation of lightning data in WRF model revealed that forecast of lightning is pretty good with lead time of up to four hours. In few cases, deviation of lightning affected area is also noticed which requires further understanding and fine tuning of the model.



WRF model simulated lightning for 8 UTC on April 3, 2017 (in top, based on assimilation of 6 UTC lightning data) and the ENTLN detected lightning location at the same time (bottom) supporting the capability of the model to simulate lightning with two hours lead time.

IMPORTANT EVENTS

Trainings & Workshops

Training programme on Geo-Tagging of Rashtriya Krishi Vikas Yojana (RKVY) Assets using Geospatial Technologies for the North Eastern States (excluding Assam)

One day training programme on "Geo-Tagging of Rashtriya Krishi Vikas Yojana (RKVY) Assets using Geospatial Technologies" was organized on 11th April, 2017 (for the state of Arunachal Pradesh, Sikkim & Tripura) and 13th April, 2017 (for the state of Manipur, Meghalaya, Mizoram & Nagaland) at NESAC, Umiam. State nodal officers of RKVY from Dept. of Agriculture and allied sectors of all the north eastern states (excluding Assam) attended the program. Presentations on Geo-Tagging of RKVY assets using Geospatial Technologies and demonstration cum hands-on training of the Bhuvan RKVY Mobile App were part of the agenda of the programme. Dr. P.V. Krishnarao, Sci./ Engr. 'SG' of National Remote Sensing Centre (NRSC), Hyderabad attended the interaction session and the closing ceremony through video conferencing. All the state nodal officers requested for such kind of training in their respective states. Accordingly, one day training programme for the district level and field level officers of agriculture and allied departments was organized in the state capital of all the north eastern states (excluding Assam) during June 2017 to March 2018 and around 500 officers were trained during the programmes.

Basic course on 'Remote Sensing and Geographical Information System - Technology and Applications' April 17-28, 2017

NESAC conducted basic course on 'Remote Sensing and Geographical Information System - Technology and Applications' of two weeks duration (April 17 - 28, 2017). The objective of the course was to provide sufficient knowledge and training to beginners in the field of geospatial and earth observation applications so that they develop a critical understanding of appropriate tools; exposure to new methods and techniques; gaining competence in developing tools for

Participants of the training on 11th April, 2017 (Left) 13th April, 2017 (Right)

Participants of Basic Course in RS & GIS (2017)

the acquisition, processing, analysis, and presentation of spatial data; using geo-information in identifying and responding to development problems and in drafting development policies. It encompassed topics related to Remote Sensing (RS) and digital image analysis, Global Navigation Satellite Systems (GNSS), Geographical Information system (GIS), open source software and data standards, ground truth and field validation with hands on training on every topic. The first week concentrated on basic topics related to RS, GNSS, GIS and Image Processing and second week on advanced topics. Sessions consists of lectures, demonstrations as well as hands on training with RS and GIS software. The last two days of the course is dedicated towards a mini-project in groups with different application based topics for each group. The course had 23 hours of lectures and 29 hours of practical works for the participants.

One Week training on UAV data processing for the officials from State Remote Sensing Application Centres (May 08-12, 2017)

NESAC has conducted one week training programme on UAV data processing for the officials from State Remote Sensing Centres of NE Region under the project "Use of Unmanned Aerial Vehicle Remote Sensing (UAV-RS) for the states of NE region". Officials from Andhra Pradesh Space Applications Centre have also participated in the training programme. The training course covered UAV data acquisition process and different data processing techniques e.g. generation of point clouds, orthophotos/ images, digital surface model (DEM), digital terrain model (DTM), contour maps, volumetric analysis etc. using various UAV data processing softwares. Under the project mentioned, a DJI quadcopter (Matric 100) and a UAV data processing software license (AgiSoftPhotoscan) has been provided to the State Remote Sensing Application Centres. The training course also included mini-projects which were executed in groups on various topics/ applications. The training course had 6 hours of lectures and 12 hours of practical works. Mr. C.K. Das, Member, NEC was guest of Honor for the Valedictory Session.

Participants of the UAV Remote Sensing Course

NESAC Participated in 'Humanitarian Assistance in Disaster Refief (HADR) joint Mock Drill at Eastern Air Command, Shillong from 6th to 8th June, 2017

NESAC participated in the three-day exercise on Humanitarian Assistance and Disaster Relief (HADR) under the titled 'Nabhas Rahat' or 'helping hands from the sky' which was hosted by HQ Eastern Air Command (EAC), Shillong during 6-8th June 2017. The aim was to synergize the collective efforts from all relevant state and central organizations for successful and seamless execution of HADR operations in disaster-prone region in the north east states. The use of digital database of Shillong and deployment of UAVs for real time monitoring of the mock drill were suggested for the exercise. Shri PLN Raju, Director, NESAC delivered a talk on 'Role of Space Tech tools in Future Advancements in Disaster Management'. On 7th June, a mock drill

NESAC Scientists meeting Air Marshall Anil Khosla at NESAC Stall and demonstrating UAV

simulating a Level-II disaster was carried out at Advance Landing Ground (ALG), EAC, Upper Shillong to showcase the capabilities of different participating groups including NESAC along with IAF. NESAC's Inspire-1 quadcopter UAV was flown to capture entire sequence of mock drill and relay the real time video to 'Control Centre' to further plan sequence of events during the simulated drill. NESAC also put up a stall at ALG to showcase various emergency communication equipments such as VSATs, Satellite Phones etc. and demonstrated its capability to communicate via satellite to other groups at remote location for assistance. During the event, NESAC also showcased digital maps for districts of Meghalaya through NEDRP geo-portal, 3D fly-throughs of Shillong city showing important areas and utility services covering five police jurisdictions of the city, NESAC activities and various projects related to disaster risk reduction.

NESAC participated in 'Recalling the Great Shillong Earthquake of 12th June 1897: Quest for a Reliable & Effective Mitigation and post disaster strategies held on 12th June 2017 at NEC

To commemorate the great 1897 Shillong earthquake, NESAC in collaboration with NEC organized a one day workshop on 12th June 2017. The ultimate objective of the workshop was to explore on reliable short term

Director, NESAC addressing in the workshop

seismic precursors and devise a holistic scheme that integrates all suitable types of precursors in addition to effective early warnings system for earthquakes and landslides. The workshop consisted of two technical sessions, themed "Advancement in Earthquake & Landslide Precursors and Early Warnings in NER" and "Experiences, Preparedness and Response for Post Disaster Management" respectively. Dr. Arun Bapat, Former Head, Earthquake and Engineering Research, Central Water & Power Research Station, Pune discussed different precursory phenomena. Dr. Saurav Baruah, Head, Geoscience, NEIST, Jorhat discussed the use of multi geophysical parameters observation data for earthquake precursor studies.

Two Weeks Training Course on UAV Remote Sensing - Technological Advances & Applications (06-17 Nov, 2017)

The second two weeks training course on UAV Remote Sensing- Technological Advances & Applications was conducted by NESAC during 06-17 Nov, 2017. Officials from public/private sectors, Students, research scholars and teachers from different colleges and universities of the country attended the training. The course covered understanding of the UAVs and its components, flight planning for data acquisitions for various remote sensing applications, different data processing techniques e.g. generation of orthomosaic, digital surface model (DEM), digital terrain model (DTM), contour maps, volumetric analysis etc. for high-resolution UAV data using open source software, Pix4D mapper pro and Agisoftphotoscan pro software. The course had 14 hours of lectures and 27 hours of practical work for the participants. The third and fourth days of the second week were dedicated for mini-projects which were executed in groups with different application based topics for each group.

Participants of 2nd UAV Remote Sensing Training

Workshop on "Effective use of Geospatial Technology in Agriculture and Allied Sectors in North Eastern Region" organized at NESAC

A two days workshop on "Effective use of Geospatial Technology in Agriculture and Allied Sectors in North

Inauguration of Workshop

Eastern Region" was organized at NESAC during November 21-22, 2017. Dr. P.V.N. Rao, Deputy Director (RSAA), National Remote Sensing Centre (NRSC), Hyderabad graced the inaugural session as Chief Guest and Dr. Narendra Prakash, Director, ICAR Research Complex (RC) for North Eastern Hill (NEH) Region, Umiam (Meghalaya) was the Guest of Honour. Around 60 delegates representing NRSC, Hyderabad, Space Applications Centre (SAC), Ahmedabad, Mahanalobis National Crop Forecast Centre (MNCFC), New Delhi, ICAR (RC) for NEH Region, Umiam (Meghalaya), Assam Agricultural University (AAU), Jorhat, College of Veterinary Sciences (CVSc), Guwahati, College of Post Graduate Studies (CPGS), Umiam (Meghalaya), Biswanath College of Agriculture, Biswanath Chariali, National Horticulture Board, Guwahati, Rubber Board, Guwahati, Spices Board, Shillong, Coir Board, Guwahati, Agricultural & Processed Food Products Export Development Authority (APEDA), Guwahati, State Remote Sensing Application Centres (SRSAC) of NEH Region, State Department of Around 60 delegates representing NRSC, Hyderabad, Space Applications Centre (SAC), Ahmedabad, Mahanalobis National Crop Forecast Centre (MNCFC), New Delhi, ICAR (RC) for NEH Region, Umiam (Meghalaya), Assam Agricultural University (AAU), Jorhat, College of Veterinary Sciences (CVSc), Guwahati, College of Post Graduate Studies (CPGS), Umiam (Meghalaya), Biswanath College of Agriculture, Biswanath Chariali, National Horticulture Board, Guwahati, Rubber Board, Guwahati, Spices Board, Shillong, Coir Board, Guwahati, Agricultural & Processed Food Products Export Development Authority (APEDA), Guwahati, State Remote Sensing Application Centres (SRSAC) of NEH Region, State Department of Agriculture & Allied Sectors of NEH Region, Meghalaya Cooperative Apex Bank Limited, Shillong, Kriptoblocks, Begaluru participated and delivered lectures in the workshop.

One Day State Level Workshops on North Eastern District Resources Plan (NEDRP) at Imphal, Manipur and Aizawl, Mizoram

A one day state level workshop on North Eastern District Resources Plan (NEDRP) for the state of Manipur was conducted jointly by North Eastern Space Applications Centre (NESAC) and Manipur Remote Sensing Application Centre (MARSAC) on 29th November, 2017. The objective of the workshop was to deliver the usage of the NEDRP geoportal developed by NESAC to provide geospatial data, services and tools for preparation of DPR, Master Plan documents and other inputs essential for various district level developmental planning activities. Further, demonstration was also given on NEDRP Portal and video demonstration on e-Atlas election management application and NEC Project monitoring application. More than 110 officials from various line departments, district administrations, etc. took part in the workshop.

Similarly, a one day State Level Workshop for NEDRP for Mizoram State was organized on 12th Dec, 2017. The workshop was presided by Dr. C. Vanlalramsanga, Secretary, Planning Dept, Mizoram and attended by officials from Mizoram Remote Sensing Centres and various line departments in the state.

Participants attending NEDRP workshop at Aizawl

Capacity Building Training Programmes Under Amrut Sub-Scheme On Formulation Of GIS Based Master Plans For Decision Makers

NESAC in association with Town & Country Planning Organisation, Ministry of Housing and Urban Affairs, Govt. of India, conducted the training programme on

"Formulation of GIS Based Master Plans for Decision Makers" from 18 to 20 January, 2018 at NESAC. 14 nos. of Decision Makers from different states participated in the training. The inaugural session was chaired by Shri. S. Surendra, Addl. Chief Planner, Town & Country Planning Organization, Ministry of Housing and Urban Affairs, Govt. of India. During the training both theories and demonstrations on the use of geospatial technology for urban applications were delivered. The training concluded with demonstrations on survey techniques and a special lecture on Overview of Geographical Information System and its application in urban areas by Shri P. L. N. Raju, Director, NESAC.

Participants attending Capacity Building Training Program of AMRUT at NESAC

One day state meet on "Promoting Space Technology based Tools and Applications in Governance & Development" for the state of Manipur, 23rd March, 2018, Imphal, Manipur

One day state meet on "Promoting Space Technology based Tools and Applications in Governance & Development" for the state of Manipur was organized by Manipur Remote Sensing Applications Centre (MARSAC) in association with NESAC on 23rd March, 2018 at Classic Grande Hotel, Imphal, Manipur. The event was sponsored by ISRO, Department of Space, Govt. of India. Ms. Nidhi Kesarwani, IAS, Secretary Sc. & Tech. Govt. of Manipur inaugurated the State Meet as a Chief Guest. The inaugural session was followed by technical session represented by 87 officers from 17 departments of Govt. of Manipur and made presentations on the key areas where space technology can be incorporated in their future plan of actions.

P L N Raju, Director, NESAC & Mr. N. Birendra Singh, Hon'ble Chief Minister, Manipur delivering their speeches

The meet was concluded with a special session where Shri N. Biren Singh, the Hon'ble Chief Minister of Manipur was the Chief Guest and Shri Y. Joykumar Singh, IPS, Hon'ble Deputy. Chief Minister of Manipur presided over the event. They released the flyers 'Effective Use of Space Technology' translated into Meetei Script and also distributed the prizes to the winners of painting competition conducted during World Space Week. Subsequently, the salient outcome of the technical session– I and II was presented to Hon'ble Chief Guest and President of the meeting in brief by the respective session's chairpersons. Total 38 projects were identified. Shri P L N Raju Director, NESAC delivered a talk on Strategies and Way Forward highlighting the role of space technology in disaster mitigation, natural resources management, tele-education, tele-medicine and applications of UAV. Deputy Chief Minister Shri Y Joykumar emphasized the need of exchanging thoughts and ideas between Government officials and scientists. During the closing remarks, Hon'ble Chief Minister gave a message to all the participants about the importance and way of utilization of scientific data/information provided by the scientific community for the benefit of the society.

Participants of the State Meet

Other Training/Workshop/Seminar Activities of NESAC

- A one-day workshop on familiarization, demonstration & distribution of Satellite Mobile Radio (SMR) for security applications for Meghalaya Police was conducted on 28.7.2018.
- A one-day workshop on "Popularization of Remote Sensing based Maps and Geospatial Information" was organized in collaboration with ISRS Shillong Chapter and ISRO on the occasion of National Remote Sensing Day on 11.08.2017.
- NeSDR Training was conducted on 16th & 17th October 2017
- Two weeks Capacity Building Training Programme under AMRUT Sub-Scheme on Formulation of GIS based master Plans was conducted from 19th to 21st February 2018
- A training programme on 'Development of Climate Risk Management (CRM) tools in Agriculture and Water Resources Management using extended Range Forecast' was conducted from 13th to 20th March 2018.

Various Office Events & Celebrations

Celebration of Ambedkar Jayanti

Dr. B R Ambedkar Jayanti was celebrated at NESAC on 13.04.2017. Banners were displayed in the Office campus and a lecture on 'Constitutional Provisions for SC/ST/OBC' was delivered by Shri Avaneesh Shukla, Administrative Officer, NESAC.

Celebration of Anti-Terrorism Day

Every year the 21st May is observed as Anti-Terrorism Day. The objective behind observance of this day is to wash away the youth from terrorism and cult of violence by highlighting the sufferings of common people and showing as to how it is prejudicial to national interest. Since, this year the 21st May 2017 falls on Sunday, the Anti-Terrorism Day was observed on 19th May 2017. As part of the observance, Shri PLN Raju, Director, NESAC administered the pledge to all NESAC employees which was followed by a lecture by Shri Randhir Kumar, Assistant Commandant, CISF, NESAC on the topic 'Terrorism and its bad effects'.

World Environment Day celebrated

World Environment Day was celebrated in the Centre on 5th June 2017. Tree plantation programme was organized from 2nd to 5th June 2017. Different types of tree saplings were planted inside NESAC Campus, Residential Complex and in the nearby areas.

Yoga training programme at NESAC on occasion of 3rd International Yoga day

On the occasion of International Yoga day on 21st June 2017, a week long yoga training programmed was organized at NESAC from 13 - 16 June, 2017 and 19 - 21 June, 2017. Yoga training was conducted by yoga trainers and staffs from NESAC and CISF personnel took part in the exercise. Along with this, yoga faculties from "Art of Living" organization were also invited to conduct a yoga course at NESAC. More than 30 participants including Scientists, Research Scientists, SRFs, JRFs and CISF personnel took part in the course. A lecture on "Yoga for health and Happiness" was delivered by Shri Sujeeth Chakraborty, Faculty from Art of Living on June 21, 2017. He has also conducted a short yoga session which can be performed during office hours to reduce stress.

Shri Sujeeth Chakraborty conducting a Yoga Session & delivering lecture on June 21, 2017 at NESAC

National Remote Sensing Day Celebration at NESAC

The National Remote Sensing Day, 2017 was celebrated at NESAC on 11th August, 2017 in collaboration with Indian Society of Remote Sensing (ISRS)– Shillong Chapter. The programme was attended by more than 175 participants from different organizations including the St. Anthony's College, St. Marry's College, Shillong College, Central Agricultural University, Umiam, Meghalaya Pollution Control Board, Meghalaya Basin Development Authority, Soil & Water Conservation Department of Meghalaya, Survey of India, Shillong and NESAC staff. Shri S. Hamilton, Chairman, ISRS

Shillong Chapter and Regional Director of Atomic Mineral Directorate, Shillong and Shri PLN Raju, 1st Vice-President, ISRS and Director, NESAC addressed the gathering. Subsequently, programme of the "National Workshop on popularization of Remote Sensing based Maps and Geospatial Information" from ISRS Dehradun was broadcasted where eminent scientists from ISRO like Chairman, ISRO, Director, SAC, Director, NRSC, Scientific Secretary, ISRO and Director, NESAC and Scientists from SAC, NRSC and IIRS delivered talk on the topic.

Delegates attending the National Remote Sensing Day 2017 at NESAC

71st Independence Day Celebration at NESAC

71st Independence Day of India was celebrated at NESAC on 15th August, 2017. Shri PLN Raju, Director, NESAC hoisted the tricolor National Flag and staff of NESAC chorused National Anthem. This was followed by administering of pledge on 'Sankalpa Parva' or 'The Day of Resolve' by Director, NESAC as all staff of NESAC took the pledge. The CISF unit of NESAC gave a guard of honor to Director, NESAC and performed Independence Day parade. Director, NESAC addressed the staff of NESAC when he stressed on the importance of observing Independence Day at Offices and reflected on the activities and achievements of the centre. This was followed by light refreshment and thereafter by a cultural programme, interactive games, Independence Day quiz and other activities. The program concluded with an official lunch.

71st Independence Day Celebration at NESAC

Opening of SBI ATM for NESAC and nearby areas

A SBI ATM has been opened outside NESAC campus for the staff of NESAC and people of nearby areas by SBI, Barapani. The ATM was inaugurated on 29th August, 2017 by Shri PLN Raju, Director, NESAC. This facility is a great relief to people from NESAC, NERIE, Christ International School, SIRD, Umiam, Nongsder villages and other nearby places as there is no ATM nearby therefore it was a long pending demand of people which had been addressed with the initiative of NESAC.

Opening of SBI ATM at NESAC Campus

17th NESAC Foundation Day Celebration

NESAC celebrated its 17th Foundation day with a day long programme on 5th September, 2017. The inaugural session was started with welcome address from Director, NESAC. Dr. P S Roy, Former Director, NESAC graced the function as the chief guest. Guest of Honor was Prof B N Goswami, former director, IITM and Prof A K Mishra, Director, ASTEC was the Special Invitee. The function was attended by many invitees including Principal, NERIE, Umiam, Principal, Christ School, Branch Manager, SBI, Umiam in addition to the NESAC staff and family members. Considering the diverse field of activities, area of specialization and work culture at

P L N Raju, Director, NESAC giving Opening Remarks

NESAC, four different popular talks were arranged in the technical session. The technical session was started with Foundation Day talk by Dr. P S Roy, Former Director, NESAC on *"Forest and bio-resources of North East: Geospatial perspective for sustainability"* followed by the invited talk by Dr. Subhash Ashutosh, PCCF, Govt. of Meghalaya on *"Adaptation to Climate Change in Meghalaya"*. Dr. Khargeswar Bhuyan, former Principal, Nowgong College gave a popular talk on "Superstitions, ill-reforms and scientific temperament" followed by a talk from Prof. B N Goswami, former Director, IITM on *"How and how much does EL Nino control the Indian Summer monsoon?"* The technical session was followed by cultural program and prize distribution for the week-long sports meet that was arranged by NESAC Recreation Club for its staff.

Cultural Program during the event

13th NESAC Governing Council Meeting

Shri A S Kiran Kumar, Secretary, DOS/ Chairman NESAC Governing Council chaired the 13th NESAC Governing Council Meeting at NESAC on 05.10.2017. Around 19 member and invitees attended the meeting. Presentation on the activities/achievements of NESAC during 2016-17 was made before the Governing Council and various administrative issues were put up for appraisal and approval of the NESAC Governing Council.

Budget estimates for the year 2017-18 was approved by the Governing Council without any modification.

Inauguration of NESAC Guest House & Amenity Building

Inauguration of NESAC Guest House & Amenity Building and Laying of Foundation Stone of CISF Barracks and Quarters was held on 05.10.2017. Shri A S Kiran, Chairman ISRO/Secretary, DOS inaugurated the NESAC Guest House.

Inauguration of NESAC Guest House by Shri A S Kiran Kumar, Secretary, DOS/Chairman ISRO

Celebration of World Space Week (04-10 October, 2017) at NESAC

NESAC, in collaboration with National Remote Sensing Centre(NRSC), Hyderabad conducted a preparatory awareness programme for World Space week at NESAC on 20th September, 2017. A day long program consisting of Quiz and Drawing Competition and popular lecture on Space Technology applications was organized at NESAC for school students of secondary level. In the National Level competitions for drawing and Quiz which took place later, contestants from NER won three prizes.

Glimpses of Various activities during World Space Week Celebration at NESAC

Celebration of Vigilance Awareness Week at NESAC

Vigilance awareness Week was celebrated at NESAC from 30th October to 04th November, 2017. Various programmes like reading of Vigilance Resolution by the staff of NESAC, a special lecture on "Vigilance Awareness at Workplace" by Mr. J.V Raja Reddy , Controller, SDSC-SHAR, ISRO and a quiz competition on the theme of vigilance was organized for the staff of NESAC.

NESAC observed Swachhata Pakhwada

NESAC observed Swachhata Pakhwada from 1st to 15th February, 2018 through multiple activities involving cleaning various parts of NESAC Office Campus, areas adjacent to Office, localities nearby and campaigning among local people for keeping surroundings clean. All staff of NESAC actively participated in the fortnight. A Swachhata Rath was also arranged on one day during the fortnight.

Glimpses of Swachhata Pakhwada during 1st to 15th February, 2018

'Qaumi Ekta Week' observed

'Qaumi Ekta Week' (National Integration Week) was observed in the Centre from 19.11.2017 to 25.11.2016. Following are the events that was conducted at NESAC Auditorium on 23.11.2017.

Observance of 'Qaumi Ekta Week'

a) Short poem recitation by staff of NESAC from different regions of the country to appreciate the Linguistic heritage of all parts of India (Linguistic Harmony).

b) Talk by Dr. J M Nongkynrih, Sci/Engr-SE/ Liaison Officer for SCs/STs, NESAC highlighting programmes under various Government which help SCs/STs and weaker sections with particular emphasis on the distribution of surplus land to landless labourers (Weaker Sections).

c) Talk by Smt. Sheeba S.L, Sr. Accounts Officer, NESAC on the importance of women in Indian Society and their role in development of nation-building (Importance of Women).

d) Talk by Dr. K Chakraborty, Sci/Engr-SE, NESAC on growing needs and action to conserve the environment (Conservation).

- NESAC Celebrated the Constitution Day on 27.11.2017. Shri P L N Raju, Director, NESAC read out the 'Preamble' to the Constitution (as it exists today) followed by the Lecture which was given by Shri Rajesh Kumar Jaiswal, Deputy Assistant Director (Police Science), NEPA, Umsaw

Visit of Distinguished Guests

Visit of Shri A.S.Kiran Kumar, Chairman, ISRO to NESAC

New Guest House of NESAC was inaugurated by Shri A. S. Kiran Kumar, Chairman, ISRO/ Secretary, DOS on 5th October, 2017 in the presence of Dr. P. G. Diwakar, Scientific Secretary, ISRO and other NESAC staff. He also laid the foundation stone for permanent Residential Barrack for NESAC CISF personnel at NESAC. Later he addressed a gathering at the NESAC Community Hall.

Glimpses of events during Chairman, ISRO's Visit to NESAC

Visit of Dr. C.B.S. Dutt, Former Deputy Director, NRSC

Dr. C.B.S. Dutt, Former Deputy Director, National Remote sensing Centre, ISRO, Hyderabad visited NESAC on 19th June,2017. He delivered a scientific talk on "Space Technology Applications in Climate Change" and interacted with the scientists of NESAC.

Visit of Dr. Manzul Kumar Hazarika, Director, Geoinformatics Center, Asian Institute of Technology, Bangkok

Dr. Manzul Kumar Hazarika, Director, Geoinformatics Center, Asian Institute of Technology, Bangkok visited NESAC on 28th December, 2017. He delivered a lecture on "Disaster Risk Reduction an initiatives under Sendai Framework" to staff of NESAC. He visited UAV facility of NESAC and appreciated various activities of NESAC.

Dr. Hazarika Visiting NESAC UAV Facility

Visit of Dr. D Ramaiah, Director, North East Institute of Science & Technology (NEIST), Jorhat

Dr. D Ramaiah, Director, North East Institute of Science & Technology (NEIST), Jorhat visited NESAC and delivered a lecture on "Current activities & future R&D plan/activities of NEIST on 28th December, 2017. All scientists, RSs, JRFs and student trainees attended the lecture. Various Project Plans were prepared by NESAC Staff and were discussed with Dr. D. Ramaiah for collaboration between NESAC and NEIST.

Dr. D. Ramaiah delivering a lecture & interacting with NESAC Staff

Visit of Dr. K. Sivan, Chairman, ISRO to NESAC

Dr. K. Sivan, Chairman, ISRO visited NESAC on 7th March, 2018. He interacted with Scientists of NESAC and inaugurated various facilities at NESAC Residential Campus. A demonstration of the capability of UAV was given. He visited UAV lab, Satcom Studio where a special interaction session was arranged for him with Tele-Education networks of Assam and Sikkim state. He also visited Atmospheric Science Lab and NER-DRR facility where a brief demonstration on all recent UAV

Dr. K. Sivan in a meeting with staff of NESAC at Director's Conference Hall, NESAC

A group photo of Dr. K. Sivan with all staff of NESAC at NESAC Auditorium

based and IT based applications developed by NESAC were given, A small programme was organized at NESAC Auditorium where he addressed all the staffs of NESAC and expressed his views regarding working of NESAC and ISRO's plans for development of NE region. A cultural programme was organized at last to showcase the cultural heritage of NE region.

Other Important Visitors

19.05.2017	Shri Santanu Chowdhury Director, ADRIN, Secunderabad
28.07.2017	Shri S B Singh, IPS DGP, Meghalaya
04.12.2017	Dr K J Ramesh, DG India Meteorological Department, New Delhi
24.01.2018	Shri R R Okhandiar Member Secretary, CSB, Bangalore

Students' Visits

Students from Assam Jatiya Vidyalaya, Guwahati and Little Flowers School, Digboi

Around 300 students along with escorting teachers from Assam Jatiya Vidyalaya, Guwahati and Little Flowers School, Digboi visited NESAC on 17th October, 2017 under one day Education trip. Glimpses of various activities of NESAC were showcased to the students. Lectures on Space Technology Applications were also delivered by Scientists of NESAC. A demonstration on Unmanned Aerial Vehicle usage and applications was also given.

Demonstration of UAV

Students from Royal Global School,Guwahati

Around 100 students from various Science streams of Royal Global School, Guwahati accompanied by escorting teachers visited NESAC on 3rd November, 2017. They were given an idea of the various fields of activities of NESAC including atmospheric science, remote sensing and satellite communication by scientists of NESAC. They were taken for a visit to various facilities of NESAC as well.

Students of Royal Global School interacting with NESAC Scientists

AWARDS & RECOGNITION

NESAC Received Award for securing First Rank for Implementing Official Language Policy in North Eastern Region

North Eastern Space Applications Centre has been adjudged First in implementing the Official Language Policy of the Union during the year 2016-17 in North Eastern region ('C' region) under 'office' category. The award distribution ceremony function was held in Gyan Bhawan Auditorium, Patna on 10th March 2018 and was presided over by Shri Kiren Rijiju, Hon'ble Union Minister of State for Home Affairs of Government of India. Shri P.L.N. Raju, Director, NESAC has received the Shield as an award for the first rank in the North Eastern Region from Hon'ble Minister Shri Kiren Rijiju. Shri Avaneesh Shukla, Sr. Administrative Officer received the commendation certificate for his contribution.

1st Prize for Official Language Implementation

NESAC received the prestigious National e-Governance Awards 2018

NESAC has been awarded with the most prestigious National Awards for e-Governance for the year 2017-18 for the project "GeoPortal on North Eastern District Resources Plan (NEDRP) to support effective Governance applications" for outstanding contribution using Spatial Technology and GIS in e-Governance. National Awards for e-Governance is given by the Department of Administrative Reforms & Public Grievances, Government of India every year to recognize and promote excellence in implementation of e-Governance initiatives.

On behalf of the NEDRP project team, the awards was received by Shri P.L.N. Raju, Director, Dr. Dibyajyoti Chutia, Project Leader and Dr.Jonali Goswami from Dr. Jitendra Singh, Hon'ble Minister of State (Independent Charge) for the Ministry of Development of North Eastern Region, Prime Minister's Office, Personnel, Public Grievances and Pensions, Department of Atomic Energy and Department of Space during National Conference on e-Governance held at Hyderabad on 27th February, 2018. NEDRP was sponsored by North Eastern Council (NEC), Govt of India, Shillong, Meghalaya.

Scientists, NESAC along with Director, NESAC receiving the prestigious National e-Governance Award from Dr. Jitendra Singh, Hon'ble Minister of State, DoNER

ISRO Young Scientist Merit Award, 2016

The young Scientist Merit Awards are conferred on annual basis, to the individual young scientists of ISRO/DOS, who exhibit outstanding initiatives with innovative approach and service delivery. From NESAC, Smt. Rekha Bharali Gogoi, Scientist-SE, was conferred with "Young Scientist Merit Award" for the year 2016.

Smt. Rekha B. Gogoi, Scientist, NESAC Receiving Young Scientist Merit Award from Dr. K. Sivan, then Director, VSSC

Ideas of NESAC Scientists win Smart India Hackathon 2018

The Smart India Hackathon is an initiative of Hon'ble Prime Minister of India Shri Narendra Modi for promoting innovation, out-of-the-box thinking in young minds. 29 Ministries/Departments of Govt. of India including ISRO/DOS posted their problem statements for the students to solve. Under the umbrella of ISRO/DOS 2 problems were posted by NESAC. Proposed problems received 28 submissions, out of which 4 submissions were shortlisted for competing in the

competition. NESAC feels proud to share that both problems received 1st and 2nd prize under the category of Dept of Space in the Smart India Hackathon, 2018. The two problem statements were proposed by Shri Siddhartha Bhuyan, Research Scientist, NESAC and Mentored by Dr. Dibyajyoti Chutia, Sci/Engr-SE, NESAC:

Winner & 1st Runner up of Smart India Hackathon with NESAC Scientists

i. Distributed Panorama Construction of High Resolution UAV Imagery Using Public Compute Nodes

ii. Formation Flying Simulation for UAV Image Acquisition with Real Time Control

Official Language Implementation

Hindi Fortnight Celebration

Hindi Fortnight was celebrated in the centre from 31st August to 14th September 2017. As part of Hindi Fortnight Celebration, a lecture was delivered by Shri Rajendra Ram, Hindi Officer, NEHU, Shillong on 12.09.2017, which was followed by a practice session of Hindi Typing in Unicode. Various other programmes like – Extempore Speech, Hindi Poem recitation, Essay writing, Debate competition were conducted during the Hindi fortnight for all employees. prizes were given to the winners.

Hindi workshop

Annual Hindi Inspection

NESAC's Annual Hindi Inspection (2016-17) was conducted by Shri J V Raja Reddy, Controller, SDSD SHAR on 27.10.2017. He has appreciated the progress of Hindi works in the centre and suggested various measures for implementation of Official Language in the Centre.

Annual Hindi Inspection (2016-17) by Shri J V Raja Reddy, Controller, SDSD SHAR

Vishwa Hindi Diwas Celebration 2018

Vishwa Hindi Diwas was celebrated at NESAC on 10th January 2018. The programme was Inaugurated by lightning the lamps by Shri PLN Raju, Director, NESAC. Director NESAC, presented his views on Vishwa Hindi Diwas and also highlighted the growing influence of Hindi in all over the World. He also encouraged all staffs of NESAC to use Hindi in their daily official works. This was followed by two Power Point Presentation (In Unicode) in Hindi. The programmme concluded with a lecture on Vishwa Hindi Diwas by Shri Avaneesh Shukla, Senior Administrative Officer of NESAC.

Academic Collaboration

MoU between Dibrugarh University and NESAC for academic collaboration

An MoU was signed between NESAC and Dibrugarh

University (DU) on December 21, 2017 for collaboration in the mutual areas of academic and research interests that will benefit both the institutes. Some of the common areas identified were Remote Sensing and GIS, Atmospheric Sciences, Satellite Communications, Civil Engineering, Computer Sciences, Electronics & Communication Engineering, Physics, Life Sciences, Geosciences, UAV remote sensing, etc. Director, NESAC and the Registrar, Dibrugarh University signed the MoU on behalf of NESAC and DU respectively.

Corporate Social Responsibility (CSR) activities in part of East Khasi Hills and Ri-Bhoi district of North-East India

Providing Water purifier to schools in Ri-bhoi district, Meghalaya

There are about 1080 schools in Ribhoi District of Meghalaya. Most of these schools do not have sufficient no of toilets and safe drinking water facilities. The initial survey conducted by NESAC reveals that most of the Sarva Shiksha Abhiyan (SSA) schools have only two toilets for 50-60 students. Additionally none of the school have the water purifier system. It was felt the necessity of expressing corporate responsibility towards the welfare of the rural students. It is proposed to supply water purifier with RO system to 10 most needy schools in Ri-Bhoi district of Meghalaya. These schools have been identified and purchase of water purifiers has been initiated.

Construction of community Toilet

Shillong being the capital of the Meghalaya state has large flow of tourists through out the year. But the city does not have quality toilets in many important locations such as Police Bazaar, Bara bazaar, Umiam etc. Construction of quality toilets will also aid to the hospitality and bring influx of more tourists to the state. It is proposed to construct public toilets in one each in Police Bazaar and Umiam market. Necessary paperwork for obtaining permission has been initiated.

Providing 10 years scientific calendar to schools in Meghalaya

Calendar is the basic necessity for schools and schools do not have. A scientific calendar of 10 perpetual years was prepared and 200 such calendars have been distributed to schools in Meghalaya. The calendar contain the scientific information in addition to information on English calendar.

Welfare of SC & ST

i) The welfare of SC & ST is being taken care in this Centre. This Centre has been observing the guidelines for recruitment, promotion and welfare of Scheduled Caste and Scheduled Tribes. Table-11.4 indicates the status of representations of persons belonging to Scheduled Caste and Scheduled Tribe.

Sl No	Centre / Unit	Total strength of employees 2017-2018	Strength of SC employees 2017-2018	Strength of ST employees 2015-2016
01	NESAC	42	02	04

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) 100% of Group B employees are from ST community or are ST

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

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

LIST OF PUBLICATIONS

Research Papers in Journal

1. Anilkumar, R., Chutia, D., Goswami, J., Sharma, V. and Raju P.L.N. (2018). Evaluation of the performance of the fused product of Hyperion and RapidEye red edge bands in the context of classification accuracy. Journal of Geomatics, 12(1), 35-46.
2. Chakraborty, K., Sudhakar, S., Sarma K.K., Raju. P.L.N and Das, A.K., (2018). Recognizing the rapid expansion of rubber plantation-a threat to native forest in parts of northest India. Current Science 114(1), 207-213.
3. Chutia, D., Bhattacharyya, D.K., Sarma, J. and Raju, P.L.N. (2017). An effective Ensemble Classification Framework using Random Forests and Correlation Based Feature Selection Technique. Transaction in GIS, 20(4), 463-490, http://doi.org/10.1111/tgis.12164.
4. Debnath, A., Das, R.K. and Gogoi, D. (2017). A study of Ka-Band Signal Attenuation at Umiam, Meghalaya with ISRO's GSAT-14 Satellite. ADBU Journal of Engineering Technology, 6(2), 7-10.
5. Francis, T., Kundu, S.S., Rengarajan, R. and Borgohain, A. (2017). SO2 Oxidation Efficiency Patterns during an Episode of Plume Transport over Northeast India: Implications to an OH Minimum. Journal of Environmental Protection. 8, 1119-1143, http://doi.org/: 10.4236/jep.2017.810071.
6. Gogoi, M.M., Babu, S.S., Moorthy, K.K., Bhuyan, P.K., Pathak, B., Subba, T., Chutia, L., Kundu, S.S., Bharali, C., Borgohain, A., Guha, A., De, B.K., Singh, B. and Chin, M. (2017). Radiative effects of absorbing aerosols over northeastern India: Observations and model simulations. Journal of Geophysical Research: Atmospheres.122, http://doi.org/:10.1002/2016JD025592.
7. Goswami, J., Chutia, D., Singhania, S., Chutia, M., Sharma, V., Gupta, C. and Raju P.L.N. (2018). Geospatial assessment on the occurrences of erosion and pattern of channel migration of river Brahmaputra along the Majuli Island of Assam. Journal of Geomatics, 12(1), 77-81.
8. Goswami, J., Sarma, K.K, Handique, B.K., Das, R., Rahman, N. and Raju P.L.N. (2017). Study of cropping system in Morigaon districtof Assam using geospatial technique. International Journal of Advancement in Remote Sensing, GIS and Geography. 5(1), 53-59.
9. Handique, B.K., Khan, A.Q., Goswami, C., Prashnani, M., Gupta, C. and Raju, P.L.N. (2017). Crop discrimination using multispectral sensor onboard unmanned aerial vehicle. Proc. Natl. Acad. Sci., India, Sect. A. Phys. Sci. https://doi.org/10.1007/s40010-017-0443-9.
10. Handique, B.K., Singh, P.S., Prabhakar, C.J., Das, P.T., Goswami, J., Goswami, C., Chutia, D. Sudhakar, S. and Rao, P.P.N. (2017). Sericulture Information Linkages and Knowledge System (SILKS) -a geoportal for sericulture planning and development, Indian Silk, 7(9-11), 8-10.
11. Kundu, S.S., Borgohain, A., Barman, N., Devi, M. and Raju, P.L.N. (2018). Spatial Variability and Radiative Impact of Aerosol along the Brahmaputra River Valley in India: Results from a Campaign. Journal of Environmental Protection, 9, 405-430. http://doi.org/: 10.4236/jep.2018.94026.
12. Lone, J.M., Sivasankar, T., Sarma, K.K., Qadir, A., and Raju, P.L.N. (2017). Influence of slope aspect on above ground biomass estimation using ALOS-2 data. International Journal of Science and Research, 6(6), 1422-1428.
13. Nongkynrih, J.M., Pohshna, C. and Sarma, K.K. (2018). Dynamics of Shifting Cultivation in relation to slope and elevation in parts of Nagaland, India, Current Science, 14(5),1094-1099.
14. Sharma, G., Champatiray, P.K. and Mohanty, S. (2018). Morphotectonic analysis and GNSS observations for assessment of relative tectonic activity in Alaknanda basin of Garhwal Himalaya, India. Geomorphology, 301, 108-120.
15. Sharma, G., Champatiray, P.K., Mohanty, S. and Kannaujiya, S. (2017a). Ionospheric TEC modelling for earthquakes precursors from GNSS data. Quaternary International, 462, 65-74.
16. Sharma, G., Champatiray, P.K., Mohanty, S., Gautam, P.K.R. and Kannaujiya, S. (2017b). Global navigation satellite system detection of preseismic ionospheric total electron content anomalies for strong magnitude (Mw > 6) Himalayan earthquakes. Journal of Applied Remote Sensing, 11(4), 046018.
17. Singh, P.S., Sharma, M., Saikhom, V., Chutia, D., Gupta, C., Chouhan, A., Raju, P.L.N. (2018). Towards generation of effective 3D surface models from UAV imagery using open source tools. Current Science, 114(2), 314-321.
18. Tao, D.L., Singh, N.J. and Goswami, C. (2018). Spatial Variability of Soil Organic Carbon and Available Nutrients under Different Topography and Land Uses in Meghalaya, India. International Journal of Plant & Soil Science. 21(4), 1-16.

Research Papers in Conference/Seminar Proceedings

1. Borah, N., Chutia, D., Baruah, D. and Raju, P.L.N. (2017). Dimension Reduction of Hyperion data

for improving Classification performance - an assessment, Proceedings of IEEE International Conference On Recent Trends In Electronics Information Communication Technology, Bengaluru, India, May 19-20, 2017.

2. Goswami J., Das R., Sarma K.K., Nath N., Ahmed C. and Raju P.L.N (2017). Crop stress assessment using remote sensing technology, Proceeding of 7th International science congress, Chukkha, Bhutan, December 08-09, 2017.
3. Hussain, H.M., Das, G., Barman,U., Goswami, J. and Ahmed, S.A. (2017) Innovative extension approaches for improving the livelihood of sericulture farmers in Assam. Proceedings of National Seminar on Potential, Prospects and Strategies for Doubling Farmers' Income: Multi stakeholder Convergence, Guwahati, November 9-11, 2017.
4. Hussain, H.M., Goswami, J., Handique, B.K., Ahmed, S.A., Gedam, P.C. and Raju, P.L.N (2018). Topographical Characterization of Muga Farms using Remote Sensing and GIS. Proceedings of the Seminar on Advances In Remote Sensing and GIS Applications, North Eastern Space Applications Centre, Umiam, May 10-11, 2018, p. 81.
5. Kharmawphlang, M.F., Nongkynrih, J.M., Saikhom, V., Lyngdoh, R., Chauhan, A., Kharshiing, B., Lyngwa, O.T., Sarma, K.K., Raju, P.L.N. (2018). Tourism information system of South West Khasi HillsDistrict, Meghalaya, India. . IOP Conf. Series: Earth and Environmental Science 169 (2018) 012102, http://doi.org:10.1088/1755-1315/169/1/012102.
6. Kundu, S., Kundu, S.S., Mati, G.R., Pradeel Kumar, C. and Raju, P.L.N. (2018). Observation and Analysis of Pre-Monsoon Storm Using Polarimetric Doppler Weather Radar, India Radar Meteorology Conference (IRAD-2018), Tirupati, January 08-11, 2018.
7. Kundu, S.S., Chhari, A., Vishwakarma, P., Kundu, S., Mati, G.R.. Pradeel Kumar, C. and Raju, P.L.N. (2018). Developing an operational thunderstorm nowcasting system for NE region of India using Polarimetric Doppler Weather Radar data, India Radar Meteorology Conference (IRAD-2018), Tirupati, January 08-11, 2018.
8. Mati, G.R., Kundu, S.S., Kundu, S., Pradeel Kumar, C. and Raju, P.L.N. (2018). An empirical PAC estimation using polarimetric radar data, India Radar Meteorology Conference (IRAD-2018), Tirupati, January 08-11, 2018.
9. Prashnani, M., Qadir, A., Handique, B.K., Gupta, C. and Raju, P.L.N. (2017). Red Edge potential in classification of vegetation using Rapid Eye multispectral imagery and sequoia multispectral sensor onboard UAV, Asian Conference of Remote Sensing (ACRS), October 23-27, 2017.
10. Qadir, A., Prashnani, M., Handique, B. K., Gupta, C. and Raju, P.L.N. (2017). Crop discrimination based on spectral, spatial and height variation using UAV, Asian Conference of Remote Sensing (ACRS), New Delhi, October 23-27, 2017.
11. Raju, P.L.N., Gupta, C. et al. (2017). Applications of UAV Remote Sensing - Case examples of North Eastern Region, Asian Conference of Remote Sensing (ACRS), New Delhi October 23-27, 2017.
12. Riahtam, N.B., Nongkynrih, J.M., Sarma, K.K., Raju, P.L.N., Mishra, A.R., Lal, D., Kharsahnoh, A. M. and Sahkhar, D.J. (2018). Assessment of shifting cultivation dynamics in East Garo Hills District, Meghalaya, India, IOP Conf. Series: Earth and Environmental Science 169 (2018) 012104, http://doi.org:10.1088/1755-1315/169/1/012104.
13. Sathyaseelan, M., Kurbah, S., Arjun, B.M., Barman, D. and Raju, P.L.N. (2018). Hydrological Modelling of Goi River Watershed of Narmada Basin using Soil and Water Assessment Tool (SWAT). International Soil and Water Assessment Tool Conference, IIT Chennai, January 10-12, 2018.
14. Singh, P.S.; Sharma, M.; Saikhom, V.; Chutia, D.; Gupta, C.; Chouhan, A.; Raju, P.L.N; "Towards generation of effective 3D surface models from UAV imagery using open source tools" accepted in Current Science, Vol. 114, 2018.

Technical Reports/Dissertations

1. Chaturvedi, H. (2017). Waste Management in NESAC campus. B.Tech. (4th Semester) summer internship report submitted to School of Planning and Architechture, Vijayawada (Andhra Pradesh).
2. Das, P.T. (2017). Identification of suitable areas for expansion of Boro rice in Meghalaya. NESAC-SR-172-2017.
3. Kalita, P. (2017). Identification of Potential Sites for Mulberry Cultivation in West Garo Hills of Meghalaya using Geospatial Techniques. M.Sc. (Applied Geography) thesis submitted to Central University of Karnataka, Gulbarga, Karnataka, India.
4. Negi, A. (2017). Spatial Decision Support System for Identification of Potential Sites for Turmeric Cultivation in Jaintia Hills of Meghalaya. M.Sc. (Remote Sensing & GIS) thesis submitted to Kumaun University, Almora, Uttarakhand, India.
5. Singh, M.S., Saikhom, V. (2017). Remote Sensing and GIS Based Inputs and Analysis for Suitable Road Alignment Planning from Dumro to Same Basti, Upper Siang and Lower Dibang Valley Districts, Arunachal Pradesh. Scientific Report (NESAC-SR-168-2017).

DETAILS OF INTERNSHIP/PROJECT TRAINEES DURING 2017-18

SN	Institute/ University	Course	No of students	Project Title
1	College of Engineering, Guindy	B.Tech, Geoinformatics	4	Development of WebGIS based Dashboards and Decision support tools for Disaster Risk Reduction Portals
2	Alagappa University, TN	M.Sc. Applied Geology	2	Study of tectonic geomorphology of Lumding division Mapping of Sung Valley carbonatite complex through hyperspectral remote sensing
3	Amity University, Noida	M.Sc. in RS & GIS	1	Crop intensification in Assam using Geospatial technologies
4	Bharathidasan University, Tiruchirapalli	M.Tech, RS & GIS	1	Flood damage assessment of Kharif rice using Geospatial technologies
5	Kumaun University, Uttarakhand	M.Sc. RS & GIS	4	Distribution pattern of different vegetation types in Kmarup district Change detection in forest cover in relation to soil types Modelling urban sprawl of Shillong city Land Use land cover change detection and types of forest in relation to soil type and altitude
6	SHIATS, Allahabad	M Sc Remote Sensing & GIS	4	Geospatial analysis of forest fire using remote sensing and GIS in RiBhoi district of Meghalaya An assessment of temporal forest cover change in Jaintia Hils district of Meghalaya- Osaka Pyngrop, A study on the dynamics of jhum cultivation and vegetation recovery in the jhum falows in East Garo Hills district, Meghalaya - Silrang R Marak Estimation of tree height and species identification using UAV multispectral data
8	CEPT University, Ahmedabad	M.Tech, Geoinformatics	4	Crop monitoring using multi temporal satellite data Urban road network transportation of Shillong city Building vulnerability: A case study of shillong city GIS AND RS based master plan for shillong and web based grievances system

9	Birla Institute Of Technology and Science(BITS), Pilani, Gao, Hyderabad Campus		15	Development Of Plug-In For Auto-Generation Of Map Templates In QGIS, ArcGIS and Independent Platforms Object Based image Classification using Pattern Recognition Techniques Spatial Dashboard Visualisation for Forest Fires Platform Independent Auto-Registration Tool using GDAL To Explore Google Earth Engine for Large Scale Analysis of Remote Sensing Data
10	School of Planning and Architecture (SIPA), Vijayawada	B.Planning	1	Planning for solid waste and waste management at NESAC campus
11	KUFOS, Kochi	M.Sc. in RS & GIS	1	Vegetables and minor crop study using multi temporal SAR data
12	IITM-Trivandrum	M.Tech, Geoinformatics	4	Change Monitoring of Agricultural Lands Using Temporal Hyperspectral Datasets via Feature Extraction and Classification Techniques Spatio-temporal analysis of forest change in North East India Using Time Series Satellite data Google Earth Engine for crop study Development Of Cloud Tracking Tool Using Satellite Imagery For North East Region Of India
13	Central University of South Bihar (CUSB), Patna	M.Sc., Computer Science	1	
14	SRM University, Chennai	B.Tech CS	1	Design and Implementation of Object Detection in Surveillance using Tensor Flow
15	Assam Don Bosco University	M.Tech. (Civil Engineering)	1	UAV applications in road monitoring for maintenance purposes
16	IIST	B.Tech in Aerospace	1	Payload Release Mechanism for a Hex copter
17	Gurukul Vidyapeeth Institute of Engineering &Technology, Patiala, Punjab	B.Tech in Aerospace	1	Design of a Solar Powered Fixed Wing UAV
18	Assam Science and Technology University (ASTU)	M. Tech. Energy Engineering	1	Analysis and Experimentation of two different power mechanism for Hexacopter

AUDITOR'S REPORT AND STATEMENT OF ACCOUNTS FOR THE FINANCIAL YEAR 2017-18

R.Pal & Co.
Chartered Accountants

Membership No – 54234
Firm Registration No: 322343E

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AUDITOR'S REPORT

We have audited the attached Balance Sheet as at 31st March 2018 and also the Income and Expenditure Account and Receipts & Payments Account for the year ended on that date of **NORTH EASTERN SPACE APPLICATIONS CENTRE, UMIAM, MEGHALAYA**. These financial statements are the responsibility of the management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with the auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material mis-statement. An audit also includes examining, on a test basis evidence supporting the amount s and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

We report that:-

1) Physical verification of Fixed Assets have not been carried out by the management during the year. Last physical verification was done during the year 2015-16. No action has been taken till date about write off of damaged and obsolete fixed assets which were found during the physical verification
2) The Centre's provision towards pension, (For employees who joined before 1/1/2004) gratuity & leave encashment as on 31st March 2018 is Rs 12.52 crore which will increase further at the time of retirement of the employees. The Centre is yet to make any earmarked investment in fixed deposits/bonds with banks that can be utilized for payment of pension, gratuity and leave encashment at the time or after retirement of the employees.

Subject to the above observations, we further report that:

(a) We have obtained all the information and explanations which to the best of our knowledge and belief, were necessary for the purpose of our audit.
(b) In our opinion, proper books of accounts as required by law have been maintained by the Centre, so far as appears from our examination of those books.
(c) The Balance Sheet, the Income & Expenditure Account, and the Receipts & Payments Account dealt with by this report are in the agreement with the books of accounts maintained.
(d) In our opinion, and to the best of our information and according to the explanations given to us, the said Balance Sheet, the Income & Expenditure Account, read together with the schedule and notes annexed to and forming part of the accounts, give a true and fair view:
    (a) In case of the Balance Sheet, of the state of affairs of the Centre as at 31st March, 2018 and
    (b) In case of the Income & Expenditure Account, of the deficit of income over expenditure for the period ended on that date.

For R. Pal & Co.
Chartered Accountant

(RANADHIR PAL)
Proprietor
Membership No: 54234
FRN:- 322343E

Place: Shillong
Date: 20th July 2018

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-2018

(Amount - ₹)

CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Capital Fund	1	54,87,71,138.46	41,99,17,665.46
Current Liabilities & Provisions	2	31,31,37,730.00	30,55,64,383.00
Pension Fund as per contra*		91,80,165.00	79,83,832.00
TOTAL		**87,10,89,033.46**	**73,34,65,880.46**
ASSETS			
Fixed Assets	3	47,78,66,106.00	32,28,19,955.00
Current Assets, Loans & Advances etc.	4	38,40,42,762.46	40,26,62,093.46
Pension Fund as per contra*		91,80,165.00	79,83,832.00
TOTAL		**87,10,89,033.46**	**73,34,65,880.46**
Significant Accounting Policies	10		
Contingent Liabilities & Notes on Accounts	11		

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

for **R PAL & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(RANADHIR PAL)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
Director

Date: 20.07.2018

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-2018

(Amount - ₹)

INCOME	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Grants	5	19,50,66,000.00	15,84,00,000.00
Other Incomes	6	30,73,890.18	10,96,323.99
Incomes from Services	7	-	-
TOTAL		**19,81,39,890.18**	**15,94,96,323.99**
EXPENDITURE	**SCHEDULE**	**CURRENT YEAR**	**PREVIOUS YEAR**
Establishment Expenses	8	11,69,08,155.00	9,25,78,363.00
Other Administrative Expenses & etc.	9	3,84,66,107.18	2,84,11,341.00
"Depreciation *(Net total at the year-end – corresponding to schedule 3) (Column 7)"		3,39,96,353.00	2,24,95,173.00
TOTAL		**18,93,70,615.18**	**14,34,84,877.00**
BALANCE BEING SURPLUS (+)/ DEFICIT (-)		**87,69,275.00**	**1,60,11,446.99**
Less: Prior period expenses - Establishment Expenses		7,56,359.00	4,45,964.00
Less: Prior period expenses - Other Administrative Expenses		14,14,064.00	-
Less: Provision for Pension, Gratuity & Leave Encashment		4,27,45,379.00	3,26,49,134.00
NET SURPLUS (+)/ DEFICIT (-) CARRIED TO CAPITAL FUND		**(3,61,46,527.00)**	**(1,70,83,651.01)**

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

for **R PAL & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(RANADHIR PAL)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
Director

Date: 20.07.2018

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

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31-MARCH-2018

Amount In (₹)

	RECEIPTS	CURRENT YEAR	PREVIOUS YEAR		PAYMENTS	CURRENT YEAR	PREVIOUS YEAR
I.	**Opening Balances**			I.	**Expenses**		
	a) Cash in Hand-Imprest	12,000.00	-		a) Establishment Expenses	10,44,17,505.00	8,24,53,730.00
	b) Bank Balances:				b) Other Administrative Expenses	3,91,97,013.00	2,82,89,335.00
	i) In Current Accounts, SBI Shillong	9,69,41,485.41	6,69,36,549.91	II	**Investments and Deposits.**		
	ii) In Current Accounts, SBI Umiam	14,49,83,922.05	12,61,42,063.56		Deposit with MeSEB/ NRSC/ BSNL		
	iii) In Current Accounts, Canara Bank	15,07,19,833.00	6,36,18,391.00			-	12,49,085.00
		-	-	III	**Fixed Assets & Capital Work-In-Progress**		
II	**Grants Received**				Purchase of Fixed Assets	17,74,73,916.00	6,08,60,089.00
	From Government of India:			IV	**Other Payments**		
	a) Department of Space, Bangalore				a) ISRO Projects	13,17,54,197.00	54,36,641.00
	i) For Salaries	6,90,00,000.00	5,07,00,000.00		b) USER Projects	3,29,58,876.00	1,67,09,630.00
	ii) For General	9,00,00,000.00	7,27,00,000.00		c) In-House Projects	12,30,975.00	16,06,078.00
	iii) For Creation of Capital Assets	16,50,00,000.00	4,90,00,000.00		d) Advances to Staffs	38,58,159.00	28,85,004.00
	b) Ministry of DONER, NEC Shillong	3,60,66,000.00	3,50,00,000.00		e) Advances to Projects	6,92,700.00	4,73,250.00
III	**Interest Received**				f) Training	2,20,782.00	-
	On Fixed Deposits & Other Interests	-	-		g) Payment of Recoveries	2,00,85,171.00	1,35,95,552.00
IV	**Other Incomes**				h) Prior Period Expenses	21,64,440.00	4,44,889.00
	a) Others	8,48,841.18	7,76,423.99		i) Security Deposits	82,53,927.00	37,13,072.00
V	**Other Receipts**				j) ISTRAC Expenses	22,40,385.00	12,35,613.00
	a) Miscelleneous Recoveries	27,51,573.00	2,66,406.00	V	**Closing Balances**		
	b) Recovery of Advances and Deposits from:				a) Cash in Hand	-	12,000.00
	i) Staffs (Cont., Imprest, TA/ DA & LTC Advances)	7,98,979.82	8,43,355.00		b) Bank Balances:		
	ii) Others Receipts from ISTRAC/ NRSC/ DWR	1,47,63,658.00	62,63,976.00		i) In Current Accounts, SBI Shillong	11,50,55,456.41	9,52,93,646.41
	c) Receipts on ISRO Projects	5,75,99,559.00	8,96,82,812.00		ii) In Current Accounts, SBI Umiam	13,94,77,429.05	14,41,86,422.05
	d) Receipts on USER Projects	5,98,67,149.00	4,35,69,472.00		iii) In Current Accounts, Canara Bank	11,88,55,868.00	15,07,19,833.00
	e) Security Deposits	85,83,799.00	36,64,420.00				
	TOTAL	**89,79,36,799.46**	**60,91,63,869.46**		**TOTAL**	**89,79,36,799.46**	**60,91,63,869.46**

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

for **R PAL & Co**
Chartered Accountants

Sd/-
(RANADHIR PAL)
Partner

Date: 26.05.2017

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
Director

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-2018

(Amount - ₹)

SCHEDULE 1 - CAPITAL FUND	CURRENT YEAR		PREVIOUS YEAR	
Balance as at the beginning of the year	41,99,17,665.46		38,80,01,316.47	
Add: Balance of Surplus (+)/ Deficit (-) transferred from the "Income & Expenditure Account"	(3,61,46,527.00)		(1,70,83,651.01)	
Add: Grant-In-Aid for Creation for Capital Assets	16,50,00,000.00	54,87,71,138.46	4,90,00,000.00	41,99,17,665.46
BALANCE AS AT THE YEAR END		**54,87,71,138.46**		**41,99,17,665.46**
SCHEDULE 2 – CURRENT LIABILITIES AND PROVISIONS	**CURRENT YEAR**		**PREVIOUS YEAR**	
CURRENT LIABILITIES:				
1. Other Current Liabilities				
a) Establishment Expenses	1,15,82,846.00		87,62,580.00	
b) Other Administrative Expenses	36,41,535.00		17,09,397.00	
c) Others	1,45,24,377.00		44,53,476.00	
d) Audit Fee	46,600.00	2,97,95,358.00	23,000.00	1,49,48,453.00
2. Deposit from Contractors	78,99,810.00	78,99,810.00	72,56,570.00	72,56,570.00
3. Project Accounts: USER Project				
Balance as at the begining of the year	7,88,03,261.00		5,00,85,602.00	
Add: Received during the year	6,07,14,649.00		4,61,64,277.00	
Less: Utilised during the year	3,64,23,206.00		1,74,46,618.00	
Less: Outstanding Liabilities	-	10,30,94,704.00	-	7,88,03,261.00
4. Project Accounts: ISRO Project				
Balance as at the begining of the year	12,20,83,526.00		3,85,13,803.00	
Add: Received during the year	5,75,99,559.00		8,96,82,812.00	
Less: Utilised during the year	13,25,53,179.00		61,13,089.00	
Less: Outstanding Liabilities	-	4,71,29,906.00	-	12,20,83,526.00
PROVISIONS:				
1. Pension, Gratuity & Leave Encashment	12,52,17,952.00	12,52,17,952.00	8,24,72,573.00	8,24,72,573.00
TOTAL		**31,31,37,730.00**		**30,55,64,383.00**

for **R PAL & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(RANADHIR PAL)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
Director

Date: 20.07.2018

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-2018

SCHEDULE 3 – FIXED ASSETS

(Amount- ₹)

DESCRIPTION		GROSS BLOCK					DEPRECIATION				NET BLOCK	
Sl. No	Particular	Cost/ Valuation as at the beginning of the year	Additions 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=(1+2-3)	5	6	7	8	9=(6 +7- 8)	10=(4-9)	11
1	Land & Land Devolop-ment	1,77,53,045.00	-	-	1,77,53,045.00	0%	-	-	-	-	1,77,53,045.00	1,77,53,045.00
2	Boundry of New Land	36,43,529.00	-	-	36,43,529.00	5%	3,52,517.00	1,64,551.00	-	5,17,068.00	31,26,461.00	32,91,012.00
3	Renovation of lease Buildings	52,40,087.00	-	-	52,40,087.00	10%	39,49,161.00	1,29,093.00	-	40,78,254.00	11,61,833.00	12,90,926.00
4	Machinery & Equip-ment	95,40,622.00	-	-	95,40,622.00	15%	76,50,456.00	2,83,525.00	-	79,33,981.00	16,06,641.00	18,90,166.00
5	Furniture & Fixtures	1,52,24,811.76	40,88,109.00	-	1,93,12,920.76	10%	72,51,386.76	10,01,748.00	-	82,53,134.76	1,10,59,786.00	79,73,425.00
6	Office Equipments	39,68,531.00	28,42,706.00	-	68,11,237.00	15%	31,68,218.00	4,24,647.00	-	35,92,865.00	32,18,372.00	8,00,313.00
7	Computer & Pheriph-erals	5,95,66,943.60	48,68,723.00	-	6,44,35,666.60	40%	5,78,38,433.60	18,51,099.00	-	5,96,89,532.60	47,46,134.00	17,28,510.00
8	Library Books	4,07,54,058.93	99,90,633.00	-	5,07,44,691.93	40%	3,69,10,322.93	43,79,762.00	-	4,12,90,084.93	94,54,607.00	38,43,736.00
9	Telephones Installation	19,02,230.00	-	-	19,02,230.00	15%	5,86,016.00	1,97,432.00	-	7,83,448.00	11,18,782.00	13,16,214.00
10	Other Equipments	5,29,34,980.00	1,14,84,454.00	-	6,44,19,434.00	15%	1,84,22,912.00	60,67,263.00	-	2,44,90,175.00	3,99,29,259.00	3,45,12,068.00
11	NE-SAC Complex	17,30,84,370.00	2,25,486.00	-	17,33,09,856.00	10%	6,48,99,636.00	1,08,35,081.00	-	7,57,34,717.00	9,75,75,139.00	10,81,84,734.00
12	Vehicles	15,11,088.00	7,44,741.00	-	22,55,829.00	15%	10,26,669.00	1,28,519.00	-	11,55,188.00	11,00,641.00	4,84,419.00
13	Air Conditioner (Heating & Cooling)	7,84,968.00	19,43,867.00	-	27,28,835.00	15%	2,56,962.00	2,24,991.00	-	4,81,953.00	22,46,882.00	5,28,006.00
14	Apple I-Pad	71,250.00	-	-	71,250.00	15%	36,847.00	5,160.00	-	42,007.00	29,243.00	34,403.00
15	Aquarium	35,630.00	-	-	35,630.00	15%	18,425.00	2,581.00	-	21,006.00	14,624.00	17,205.00
16	CISF Barrack	24,85,690.00	2,22,914.00	-	27,08,604.00	5%	3,94,040.00	1,15,728.00	-	5,09,768.00	21,98,836.00	20,91,650.00
17	Mobile Set	48,100.00	-	-	48,100.00	15%	18,891.00	3,759.00	-	22,650.00	25,450.00	29,209.00

18	Motorised Treadmill	1,26,000.00	-	-	1,26,000.00	15%	65,160.00	9,126.00	-	74,286.00	51,714.00	60,840.00
19	SMF Batteries	6,35,400.00	-	-	6,35,400.00	15%	3,50,370.00	42,755.00	-	3,93,125.00	2,42,275.00	2,85,030.00
20	Vending Machine	20,500.00	-	-	20,500.00	15%	11,404.00	1,364.00	-	12,768.00	7,732.00	9,096.00
21	Water Dispenser	21,200.00	-	-	21,200.00	15%	11,794.00	1,411.00	-	13,205.00	7,995.00	9,406.00
22	Residential complex	13,59,63,968.00	2,20,14,137.00	-	15,79,78,105.00	5%	-	78,37,728.00	-	78,37,728.00	15,01,40,377.00	13,59,63,968.00
Capital Work In Progress:												
23	Outreach Facilites	-	11,51,95,856.00	-	11,51,95,856.00	0%	-	-	-	-	11,51,95,856.00	-
24	CISF Quarter/Barrack	-	1,54,20,878.00	-	1,54,20,878.00	0%	-	-	-	-	1,54,20,878.00	-
Intangible Assets:												
25	Software	31,47,676.00	-	-	31,47,676.00	40%	24,25,102.00	2,89,030.00	-	27,14,132.00	4,33,544.00	7,22,574.00
TOTAL FOR CURRENT YEAR		**52,84,64,678.29**	**18,90,42,504.00**	**-**	**71,75,07,182.29**		**20,56,44,723.29**	**3,39,96,353.00**	**-**	**23,96,41,076.29**	**47,78,66,106.00**	**32,28,19,955.00**
TOTAL FOR PREVIOUS YEAR		**46,20,22,306.29**	**6,64,42,372.00**	**-**	**52,84,64,678.29**	**-**	**18,31,49,550.29**	**2,24,95,173.00**	**-**	**20,56,44,723.29**	**32,28,19,955.00**	**27,88,72,756.00**

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

for **R PAL & Co**
Chartered Accountants

Sd/-
(RANADHIR PAL)
Partner

Date: 20.07.2018

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
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-2018

(Amount- ₹)

SCHEDULE 4 – CURRENT ASSETS, LOANS & ADVANCES etc.	CURRENT YEAR		PREVIOUS YEAR	
A. CURRENT ASSETS:				
1) Cash balances in hand	-	-	12,000.00	-
2) Bank balances with scheduled banks				
a) On Current Accounts	37,33,88,753.46	37,33,88,753.46	39,26,45,240.46	39,26,57,240.46
B. LOANS, ADVANCES AND OTHER ASSETS:				
1) Advances to:				
a) Staffs:				
TA/ DA	2,40,690.00		1,76,999.00	
Contingencies	33,040.00		15,800.00	
Others	4,43,228.00	7,16,958.00	1,79,994.00	3,72,793.00
b) Projects (User & ISRO)		3,16,600.00	4,76,690.00	
c) Others		9,54,902.00	8,64,758.00	13,41,448.00
2) Claims Receivable/ Recoverable	40,04,453.00	40,04,453.00	22,14,254.00	22,14,254.00
3) Deposits for:				
a) Telephone with BSNL	1,15,658.00		1,15,658.00	
b) Deposit with MeECL	11,70,080.00		23,69,165.00	
c) Satellite Data's with NRSC	33,75,358.00	46,61,096.00	35,91,535.00	60,76,358.00
TOTAL		**38,40,42,762.46**		**40,26,62,093.46**

for **R PAL & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(RANADHIR PAL)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
Director

Date: 20.07.2018

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-2018

(Amount - ₹)

SCHEDULE 5 - GRANTS	Current Year	Previous Year
Central Government:		
a) Department of Space, Bangalore	15,90,00,000.00	12,34,00,000.00
b) North Eastern Council, Shillong	3,60,66,000.00	3,50,00,000.00
TOTAL	**19,50,66,000.00**	**15,84,00,000.00**
SCHEDULE 6 - OTHER INCOMES	**Current Year**	**Previous Year**
Miscellaneous	27,09,546.18	9,93,382.99
Maintenance Charges	99,740.00	42,401.00
Guest House Rent	2,64,604.00	60,540.00
TOTAL	**30,73,890.18**	**10,96,323.99**
SCHEDULE 7 - INCOME FROM SERVICES	**Current Year**	**Previous Year**
Service of Scientists	-	-
Institutional Overhead	-	-
Infrastructure Usage	-	-
TOTAL		

for **R PAL & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(RANADHIR PAL)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

Sd/-
(P. L. N. RAJU)
Director

Date: 20.07.2018

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-2018

(Amount - ₹)

SCHEDULE 8 - ESTABLISHMENT EXPENSES		Current Year		Previous Year	
a)	Salary & Allowances	6,25,33,544.00		4,75,66,339.00	
b)	Honorarium	2,43,710.00		2,01,000.00	
c)	Employer Contributions	21,22,734.00		21,32,588.00	
d)	Wages	24,75,264.00		23,05,556.00	
e)	LTC	12,69,415.00		11,66,015.00	
f)	Leave Encashment Expenses	1,92,093.00		1,69,006.00	
g)	Children Education Allowance	6,77,596.00		3,28,168.00	
h)	Outsourced DEO	26,92,926.00		22,12,572.00	
i)	Outsourced Electrician	14,32,006.00		10,58,056.00	
j)	Outsourced Worker for Various Services	73,05,086.00		30,84,036.00	
k)	NER-DRR- Salary	60,57,027.00		31,77,087.00	
l)	CISF Salary	2,93,35,898.00		2,91,77,940.00	
m)	Pension	5,70,856.00	11,69,08,155.00	-	9,25,78,363.00
	TOTAL		**11,69,08,155.00**		**9,25,78,363.00**

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SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2018

(Amount - ₹)

SCHEDULE 9 - OTHER ADMINISTRATIVE EXPENSES & etc.		Current Year		Previous Year	
1	Postage, Courier & Telephone Charges	10,44,984.00		7,29,693.00	
2	Bank Charges	8,710.00		7,810.00	
3	Electricity & Power Charges	38,82,768.00		29,42,977.00	
4	Hospitality	-		31,331.00	
5	Printing & Stationery	13,17,454.18		9,26,756.00	
6	Advertisement & Publicity	17,99,549.00		13,13,227.00	
7	Hiring of Vehicles	30,11,626.00		36,91,317.00	
8	Travelling & Conveyance	47,27,414.00		27,06,103.00	
9	Professional Charges	10,56,743.00		17,02,739.00	
10	Project Expenses [In-house]	16,77,218.00		19,86,678.00	
11	Rent	6,36,435.00		10,80,250.00	
12	Repair & Maintenance/Minor Work	91,87,240.00		23,14,652.00	
13	Books & Periodicals	46,487.00		31,972.00	
14	Trainings/ Seminars & Workshops	7,08,340.00		2,67,044.00	
15	Medical Expenses	7,98,032.00		7,83,565.00	
16	Parliamentary Standing Committee (PSC)	6,500.00		11,09,224.00	
17	Other Charges	14,50,886.00		4,83,557.00	
18	POL	4,41,514.00		4,81,707.00	
19	Sanitary Items	2,29,991.00		1,02,252.00	
20	Hindi Week Celeberations	62,701.00		-	
21	Annual Maintenance Contracts	21,56,248.00		27,82,381.00	
22	Fooding & Lodging	2,19,702.00		2,33,158.00	
23	Miscellaneous Expenses	7,68,644.00		2,93,640.00	
24	Repair & Maintenance of Vehicles	1,85,074.00		1,35,010.00	
25	Operational Charges & Maintenance of Canteen	12,03,165.00		4,68,468.00	
26	ICRB Examination	6,34,593.00		3,81,623.00	
27	NER-DRR Expenses	6,51,401.00		4,66,812.00	
28	CISF Expenses	5,39,788.00		9,13,895.00	
29	Supply of Water for Hostels	12,900.00	3,84,66,107.18	43,500.00	2,84,11,341.00
	TOTAL		**3,84,66,107.18**		**2,84,11,341.00**

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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31-MARCH 2018

SCHEDULE 10 – 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: -** Income from Consultancy Projects is accounted on cash basis.

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 30.09.17 – 100% as per the applicable rate.
   - Assets acquired after 30.09.17 – 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 t 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:-** Revenue and Capital Expenditure which is of revenue nature is charged to the Income & Expenditure Account while the capital expenditure added to fixed in the year in which these are incurred. For USER and ISRO Funded Projects, fund received and utilized during the year are accounted in the Project Account and the unutilized balances is reflected as under Current Liabilities.

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

8 **Grant-In-Aid:-** Grant-In-Aid are accounted on realization basis and Grant-In-Aid in nature of contribution towards capital cost are added to Capital Fund

for **R PAL & Co**
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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31-MARCH-2018

SCHEDULE 11 – NOTES ON THE ACCOUNTS & CONTINGENT LIABILITIES

NOTES ON THE ACCOUNTS

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

b) Pension, gratuity and leave encashment liability has been provided till 31.03.2018.

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

d) Schedules 1 to 11 are annexed to and form an integral part of the Balance Sheet as at 31-March-2018 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 **R PAL & Co**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
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Director

Date: 20.07.2018

Acronyms

3DVAR	:	Three-Dimensional Variational
AAU	:	Assam Agricultural University
ADC	:	Autonomous District Council
ADP	:	Automated Data Processing
AIRS	:	Atmospheric Infrared Sounder
ALG	:	Advanced Landing Ground
AMRUT	:	Atal Mission for Urban Rejuvenation & Transformation
MSL	:	Mean Sea Level
ANOVA	:	Analysis of Variance
AOD	:	Aerosol Optical Depth
ARFI	:	Aerosol Radiative Forcing over India
ASDMA	:	Assam State Disaster Management Authority
ASI	:	Astronautical Society of India
ASP	:	Atmospheric Science Program
ATM	:	Automated Teller Machine
AVHRR	:	Advanced Very High Resolution Radiometer
AWiFS	:	Advanced Wide Field Sensor
AWS	:	Automatic Weather Stations
BC	:	Black Carbon
BEL	:	Bharat Electronics Limited
BLL	:	Boundary Layer Lidar
BRO	:	Border Road Organization
BSNL	:	Bharat Sanchar Nigam Limited
CAMC	:	Comprehensive Annual Maintenance Contract
CARTOSAT	:	Cartographic Satellite
CCCI	:	Canopy Chlorophyll Content Index
CEC	:	Cation Exchange Capacity
CHAMAN	:	Coordinated program on Horticulture Assessment and Management
CISF	:	Central Industrial Security Force
CMD	:	Construction and Maintenance Division
COTS	:	Commercial Of-The-Shelf
COPLOT	:	Committee on Paper Laid on the Table
CSB	:	Central Silk Board
CSDM	:	Communication support in Disaster
CSR	:	Corporate Social Responsibility
CSRTI	:	Central Sericultural Research & Training Institute
CSS	:	Cascaded Style Sheet
CTGT	:	Carbondioxide Temperature Gradient Tunnel
CWC	:	Central Water Commission
DAC&FW	:	Department of Agriculture, Cooperation & Farmers' Welfare
DAR&PG	:	Department for Administrative Reforms & Public Grievance
DDMA	:	District Disaster Management Authority
DEM	:	Digital Elevation Model
DERT	:	Directorate of Educational Research & Training
DGPS	:	Differential Global Positioning System
DIET	:	Directorate of Education & Training
DIG	:	Deputy Inspector General
DMS	:	Disaster Management Support
DNS	:	Domain Name Servers
DONER	:	Development of North Eastern Region
DoA	:	Directorate of Agriculture
DOS	:	Department of Space
DoT	:	Department of Telecom
DPR	:	Detailed Project Report
DSM	:	Digital Surface Model
DTM	:	Digital Terrain Model
DWR	:	Doppler Weather Radar
EAC	:	Eastern Air Command
e-cognition	:	Electronic Cognition
ELPI	:	Electric Low Pressure Impactor
EOAM	:	Earth Observations Applications Mission
EOS	:	Earth Observation Satellite
EPRIS	:	Empowering Panchayati Raj Institutions Spatially
EQC	:	External Quality Check
ESRI	:	Environmental Systems Research Institute
FAO	:	Food and Agriculture Organization
FCC	:	False Colour Composite
FLEWS	:	Flood Early Warning System
FSI	:	Forest Survey of India
FTP	:	File Transfer Protocal
FWP	:	Forest Working Plan
GAGAN	:	GPS Aided Geo Augmented Navigation
GBH	:	Girth at Breast Height
Gbps	:	Giga bits per second
GC	:	Governing Council
GCP	:	Ground Control Point
GFS	:	Global Forecast System
GHADC	:	Garo Hills Autonomous District Council
GHG	:	Green House Gases
GHZ	:	Giga Hertz
GIS	:	Geographical Information System
GNDVI	:	Green Normalized Difference Vegetation Index
GNSS	:	Global Navigation Satellite System
GPF	:	General Planar Fit

GPM	:	Global Precipitation Measurement
GPS	:	Global Positioning System
GRACE	:	Gravity Recovery And Climate Experiment
GSAT	:	Geo-StationarySatellites
GSI	:	Geological Survey of India
HEC-HMS	:	Hydrology Engineering College Hydrologic Modeling System
HPC	:	High Performance Computing
HYSPLIT	:	Hybrid single particle Lagrangian Integrated Trajectory
IARI	:	Indian Agricultural Research Institute
ICAR	:	Indian Council of Agricultural Research
ICMR	:	Indian council for medical research
ICT	:	Information & Communication Technologies
IDSP	:	Integrated Disease surveillance program
IEEE	:	Institute of Electrical and Electronics Engineers
IITM	:	Indian Institute of Technology Madras
IGBP	:	ISRO Geosphere Biosphere Program
INSAT	:	Indian National Satellite
IQC	:	Intermediate Quality Check
IRS	:	Indian Remote Sensing (Satellite)
ISAC	:	ISRO Satellite Centre
ISPRS	:	International Society of Photogrammetry and Remote Sensing
ISTRAC	:	ISRO Telemetry Tracking and Command Centre
IWMP	:	Integrated Watershed Management Program
JEWS	:	Japanese Encephalitis Early Warning System
JHADC	:	Jaintia Hills Autonomous District Council
KHADC	:	Khasi Hills Autonomous District Council
KLNP	:	KeibulLamjao National Park
LAN	:	Local Area Network
LB	:	Load Balancing
LISS	:	Linear Imaging Self Scanning
LiDAR	:	Light Detection & Ranging
LULC	:	Land Use Land Cover
MA&FW	:	Ministry of Agriculture & farmers' Welfare
MARSAC	:	Manipur Remote Sensing Application Centre
MBLM	:	Mini Boundary Layer Mast
Mbps	:	Mega Bits Per Second
MCS	:	Mesoscale Convective System
MERRA	:	Modern-Era Retrospective analysis for Research and Application
MGNREGA	:	Mahatma Gandhi National Rural Employment Guarantee Act
MHRD	:	Ministry of Human Resource Development
MIS	:	Management Information System
MIDH	:	Mission for Integrated Development of Horticulture
MNCFC	:	Mahalanobis National Crop Forecast Centre
MODIS	:	Moderate-resolution Imaging Spectroradiometer
MoEFCC	:	Ministry of Environment, Forests and Climate Change
MOSDAC	:	Meteorological and Oceanographic Satellite Data Archival Centre
MoU	:	Memorandum of Understanding
MRR	:	Micro Rain Radar
MSI	:	Media Sustainability Index
MSS	:	Mobile Satellite Service
MSW	:	Municipal Solid Waste
MWR	:	Multi Wavelength Radiometer
NAS	:	Network Attached Storage
NASA	:	National Aeronautics and Space Administration
NAVIC	:	Navigation with Indian Constellation
NCEP	:	National Centers for Environmental Prediction
NCP	:	National Carbon Project
NDEM	:	National Database for Emergency Management
NDRE	:	Normalized Difference Red Edge
NDRF	:	National Disaster Response Force
NDNI	:	Normalized Difference Nitrogen Index
NDVI	:	Normalized Difference Vegetation Index
NDWI	:	Normalized difference water index
NEC	:	North Eastern Council
NEDRP	:	North Eastern District Resources Plan
NEIST	:	North East Institute of Science & Technology
NEHR	:	North Eastern Hill Region
NEIGRIMHS	:	North East Indira Gandhi Regional Institute of Medical & Health Sciences
NEPA	:	North East Police Academy
NER-DRR	:	North Eastern Regional node for Disaster Risk Reduction
NERTPS	:	North Eastern Region Textile Promotion Scheme
NESDR	:	North East Spatial Data Repository
NHAI	:	National Highways Authority of India
NIRD&PR	:	National Institute of Rural Development & Panchayati Raj
NKN	:	National Knowledge Network

NNRMS	:	National Natural Resources Management System
NOBLE	:	Network Of Boundary Layer Experiments
NWIA	:	National Wetland Inventory and Assessment
NWP	:	Numerical Weather Prediction
NUIS	:	National Urban Information System
OFC	:	Optical Fiber Communication
OLI	:	Official Language Implementation
OMI	:	Ozone Monitoring Instrument
ONERA	:	Office National d'Etudes et de Recherches Aérospatiales
PAC	:	Precipitation Accumulation
PCA	:	Principal Component Analysis
PDA	:	Personal Digital Assistant
PM	:	Particulate Matter
PRI	:	Panchayati Raj Institutions
PSSRa	:	Pigment Specific Simple Ratio for chlorophyll a
PWD	:	Public Welfare Department
PMGSY	:	Pradhan Mantri Gram SadakYojna
RAM	:	Random Access Memory
REG GCM	:	Regional Global Climate Model
REP	:	Red Edge Position
RGB	:	Red Green Blue
RHI	:	Range Height Indicator
RKVY	:	Rashtriya Krishi Vikas Yojana
RMC	:	Regional Meteorological Center
RMSD	:	Root Mean Square Deviation
RMSE	:	Root Mean Square Error
RRTM	:	Rapid Radiative Transfer Model
RS	:	Remote Sensing
RSAA	:	Remote Sensing Application Area
SAC	:	Space Applications Centre
SAN	:	Storage Area Network
SAR	:	Synthetic Aperture Radar
S&T	:	Science and Technology
SATCOM	:	Satellite Communications
SBIK	:	Space Based Information KIOSK
SCERT	:	State Council of Educational Research & Training
SCNP	:	Satellite Communications & Navigation Program
SDI	:	Spatial Data Infrastructures
SDR	:	Spatial Data Repository
SDSC SHAR	:	Satish Dhawan Space Centre Sriharikota Range
SDSS	:	Spatial Decision Support System
SILKS	:	Sericulture Information Linkages & Knowledge System
SIRD	:	State Institute of Rural Development
SIS-DP	:	Space Based Information Support for Decentralized Planning
SIT	:	Satellite Interactive Terminal
SLIM	:	Seasonal Landslide Inventory Mapping
SLNA	:	State Level Nodal Agency
SMR	:	Satellite Mobile Radio
SMS	:	Short Message Service
SNR	:	Signal to Noise Ratio
SODAR	:	Sound Detection And Ranging
SOI	:	Survey Of India
SPL	:	Space Physics Laboratory
SPS	:	Standard Positioning Services
SRA	:	Synoptic Rainfall Advisory
SRI	:	Surface Rainfall Intensity
SRSAC	:	State Remote Sensing Applications Centre
SRTM	:	Shuttle Radar Topography Mission
SSA	:	Sarva Siksha Abhiyan
SWJ	:	Subtropical Westerly Jetstream
TB	:	Tera Byte
TCARI	:	Transformed Chlorophyll Absorption Reflectance Index
TCN	:	Tropospheric Columnar NO_2
TDP	:	Technology Demonstration Project
TEC	:	Total Electron Content
TIBL	:	Thermal Internal Boundary Layers
TKE	:	Tau Kappa Epsilon
ToR	:	Terms of Reference
TRGA	:	Total Rice Growing Area
UAV	:	Unmanned Aerial Vehicle
ULB	:	Urban Level Block
UNAVCO	:	University NAVSTAR Consortium
USA	:	United States of America
USGS	:	United States Geological Survey
UTC	:	Universal Coordinated Time
VCP	:	Vegetation Carbon Pool
VIS	:	Village Information System
VPN	:	Virtual Private Network
VSSC	:	Vikram Sarabhai Space Center
VSAT	:	Very Small Aperture Terminal
WEKA	:	Waikato Environment for Knowledge Analysis
WiFi	:	Wireless Fidelity
WLL	:	Wireless in Local Loop
WRF	:	Weather Research And Forecasting

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