

ANNUAL REPORT 2016-2017

वार्षिक प्रतिवेदन



North Eastern Space Applications Centre

Department of Space, Government of India

Umiam, Shillong, Meghalaya

www.nesac.gov.in

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Annual Report
2016 - 2017

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

Annual Report 2016-17

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PLN 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.



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 North Eastern Space Applications Centre (NESAC) has witnessed exciting growth in multiple areas of its activity. Whereas Remote Sensing and GIS based projects remain at the heart of Centre's activities, newer technologies like Unmanned Aerial Vehicle (UAV) based Remote Sensing has proved its potential for future applications. NESAC has made its presence felt in the North Eastern Region through its wide range of capacity building activities and also bolstered its ties with North Eastern Council under DONER Ministry through multiple collaborations. Use of space technology applications by various state agencies got a major boost through the organization of State Meets conducted for the states of Nagaland, Meghalaya, Assam and Mizoram.

NESAC has been entrusted with the responsibility of implementing the second phase of the Sericulture development project by the Central Silk Board, Ministry of Textiles in 70 additional districts in 25 states, of which 20 districts are from NER. Under this project potential areas are being identified for expansion of sericulture in the selected districts. SILKS portal (www.silks.csb.gov.in) developed as a part of the project has been able to provide required information on Sericulture to all the concerned stakeholders. Similarly site suitability of selected horticultural crops is being taken up under CHAMAN (Coordinated Horticulture Assessment and Management using Geo-informatics) project of Ministry of Agriculture and Farmers' Welfare, Govt. of India.

In the area of Forestry and Ecology, wide range of satellite data products have been used for estimation of various forest resources in the region thereby supporting State Forest Departments in preparation of Forest working plans. During the year, major component of work for the states of Arunachal Pradesh and Assam has been completed. NESAC is also supporting capacity building of Forest Department officials of the states on the use of GPS and field enumeration methods.

In the area of Water Resources, NESAC has started monitoring and evaluation of projects implemented during 2009-10 to 2014-15 under Integrated Watershed Management Program (IWMP) in NER. As drinking water is scarce in many areas of NER an exercise on identification for drinking water sources was carried out for the state of Mizoram with remote sensing inputs.

As part of Urban and Infrastructure Planning, RS and GIS based road network gap assessment and alignment of new roads was carried out in selected districts of Meghalaya and Arunachal Pradesh. NESAC generated present urban land use/land cover map of Nongpoh town in Meghalaya with UAV data and proposed locations for new amenities in the town. GIS based tourism information system has been developed for South West Khasi Hills District in Meghalaya.

The ICT enabled services has increased manifold with the development and expansion of Spatial Decision Support Systems (SDSS) for various user departments. Space Based Information KIOSK, North Eastern District Resources Plan (NEDRP), Sericulture Information Linkages & Knowledge System (SILKS), Tourism Information System and Japanese Encephalitis Early Warning System (JEWS) are few important web based information systems developed by NESAC using open source GIS packages and standards.

NER-DRR (North Eastern Regional node for Disaster Risk Reduction) set up at NESAC to address the relevant disasters in the region has geared up its activities through processing, dissemination and archival of disaster specific information for NER. Operational flood alerts issued under the Flood Early Warning System (FLEWS) has maintained high success rate during 2015 and 2016, which are about 92% and 81% respectively.

Under SATCOM operational programs, Tele-education and Tele-medicine have undergone major revival. For Tele-education, the entire network is being revived along with setting up of new nodes in some states. For Tele-medicine too, revival activities have been planned. New initiatives like ISRO-ONERA joint GSAT-14 Ka-Band propagation experiment and NAVIC based TEC estimation are in progress.

The Space and Atmospheric Science group at the Centre is engaged in research on understanding the spatio-temporal distribution of major climate change drivers like aerosols and different green house gases, through collection and analysis of in-situ data from fixed stations and land campaigns, and satellite data and products. Another major area of activity is research to improve 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 operationalised. The group has also started providing experimental operational short range weather forecast for NER of India. For aerosol measurement, it has set up observatory at Tawang, Arunachal Pradesh in collaboration with SPL and VSSC, Trivandrum.

As a novel initiative under Corporate Social Responsibilities, the Centre has initiated infrastructure development support to a few selected schools of East Khasi Hills District of Meghalaya with financial help from Antrix/DOS. The Centre has been engaged in various capacity building trainings during the year on the various themes like Basics of RS & GIS, UAV Remote Sensing, EPRIS, Use of GIS for Disaster Management to NDRF and many more. NESAC hosts various academic institutions on their study visits besides employing students as interns for completing their external project work.

NESAC residential complex became ready for possession with all necessary facilities during the year. The spacious residential area is providing accommodation and other facilities to the staff of NESAC. Construction of a new outreach facility of the Centre is in full swing, which will augment the academic and capacity building activities of the Centre to an all new height.

(P.L.N. Raju)

NORTH EASTERN SPACE APPLICATIONS CENTRE SOCIETY

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Chief General Manager, Telecom, BSNL

Deputy Director General (NE), GSI

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

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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 16 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/Chairman ISRO 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 Programmes

The scientific programmes 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) programmes, Disaster Management Support (DMS) programme under the North Eastern Regional node for Disaster Risk Reduction (NER-DRR) and Space & Atmospheric Science Programmes under the Atmospheric Science Programme (ASP) and ISRO Geosphere Biosphere Programme (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 has been completed 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 modelling, 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 Analyser to measure leaf area index, Spectroradiometer to measure spectral reflectance at close narrower interval for creation of spectral library.

Information Technology and Computing facilities

Over the years the NESAC has grown significantly in terms of IT infrastructures. Centre has implemented 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). NESAC has campus WiFi connectivity to provide internet browsing facility in a secure way. The Centre has a secure NKN and ISRO Space-net connectivity in all the conference and discussion rooms for video conferencing and other data streaming applications. 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 set-up a High Performance Cluster Computing (HPC) facility with a Master node of 20 cores and 72 cores processing power distributed in 6 Compute nodes attached with 5 TB SAN for atmospheric research and other applications. In addition, a very high-end workstation of 16 cores with 256 GB RAM and 6 TB storage was been installed for atmospheric science applications.

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; Expert node for Village Resource Centre (VRC) for disseminating information to villages in the far flung areas; ISRO DMS-VPN node, transportable WLL-VSAT system 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 station to have NAVIC/ data reception and monitoring facility on 24X7 basis as part of satellite navigational program of ISRO.

Centre also supports Ka-band propagation experiment and NAVIC/new name SPS-GPS receiver experiment.

Space and Atmospheric Science Research

The Centre hosts Multi Wavelength Radiometer (MWR), seven channels Aethalometer, Integrating Nephelometer, Electric Low Pressure Impactor (ELPI), Boundary Layer Lidar (BLL) and Net Radiometer for physical and optical characterization of aerosols. Dr. Pisharoty sonde (GPS based) launching station with hydrogen gas filled balloons, SODAR (SOund Detection And Ranging), a 32 m tower with 3D sonic anemometer and other meteorological instruments at 4 levels (at the heights of 6m, 10.5m, 18m, and 30m) and a Mini Boundary Layer Mast (MBLM) are also put in place to study the vertical structure of atmosphere and atmospheric boundary layer dynamics. Online gas analysers for Green House Gases (GHG) like Oxides of Sulphate (SO_x), Oxides of Nitrogen (NO_x), Carbon monoxide (CO), Ozone (O₃), 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. Further, a network of 118 Automatic Weather Stations (AWS) spread over entire NER is established and used by NESAC.

A Polarimetric (dual polarisation) S band Doppler Weather Radar (DWR) has been set up at Cherrapunjee, Meghalaya. The DWR is indigenously developed by Radar Development Area, ISTRAC, Bangalore and manufactured by BEL, Bangalore. The DWR has been installed with active support from India Meteorological Department and NESAC.

Library

The library facility is well equipped covering wide range of subjects to cater the requirements of research and applications. Necessary software facilities are also established for efficient management of the library facility. The Centre has a very good collection of books, journals and periodicals relevant in field of space science and technology.

Sports and Recreation Facilities

NESAC encourages several indoor and outdoor games and sports for the staff to enable recreational activities. The facilities include tread mill, table tennis, carom, chess, shuttle etc. The centre is also setting up facilities for ball badminton and volleyball court for the staffs.

SPACE APPLICATIONS IN AGRICULTURE AND ALLIED AREAS

Applications of Remote Sensing and GIS in Sericulture Development-Phase II

Sericulture, a significant component under the Ministry of Textiles is one of the important sectors of economy in India and plays an important role in programs of poverty alleviation. But the current production is not adequate to meet the demand for silk in the country. At the same time there is tremendous scope for enhancing the production and quality of silk through expansion of areas under host plants, improved method of information collection, processing and dissemination with the use of geospatial technology.

The first phase of the project on Applications of Remote Sensing and GIS in Sericulture Development funded by Central Silk Board (CSB), Ministry of Textiles, Govt. of India has successfully been executed in 108 districts from 24 states of the country covering all four types of sericulture (Mulberry, Eri, Muga and Tasar). NESAC was entrusted with the responsibility to carry out the project in collaboration with State Remote Sensing Application Centres (SRSACs) and other partner Institutes. Considering the utility of the of the first phase project output, CSB has approved the implementation of 2nd phase of the project in 70 priority districts in the country covering 25 states, out of which 20 districts have been selected from NE states.

Orientation meeting cum appraisal training

Orientation meetings cum appraisal trainings were organized in four places (Shillong: on 18.03.2015 for NE states, New Delhi: on 06.10.2016 for Northern India States, Hyderabad: on 07.11.2016 for South Indian states and Kolkata: on 19.12.2016 for Eastern India States).

Role and responsibilities of NESAC, CSB, State Department of Sericulture (DOS) and State Remote Sensing Centres were discussed during the orientation meeting. It was also discussed regarding required changes in the methodology for suitability analysis and lay out time frame for timely completion of various tasks. State DOS have been assigned with the responsibility of providing district level updated

information for SILKS web portal. It was emphasized during the training to collect feedback from various users on the utility of the webportal and make necessary modification and updation based on the feedback. Feasibility of incorporating information on socio-economic parameters for site suitability analysis through a socio-economic survey was also discussed during the orientation meeting.



Participants of appraisal training at Delhi on Oct 06, 2016

Selection of districts was made based on the suggestions received from respective State Sericulture departments. List of districts selected for the second phase of the project is given below:

The districts selected for 2nd phase of the project

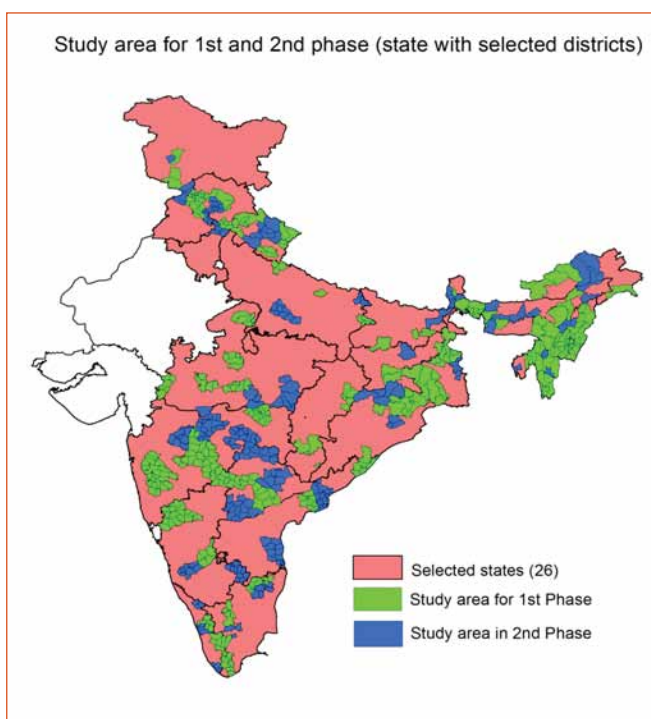
State	Selected districts
Andhra Pradesh	East Godavari, Nellore
Arunachal Pradesh	East Siang, Siang, West Siang
Assam	Baksa, Dhemaji, Goalpara, Kamrup Rural, Kokrajhar, Morigaon, Sivasagar
Bihar	Kishanganj, Supaul, Purnea
Chhattisgarh	Ambikapur, Balarampur
Haryana	Panchkula, Ambala, Yamunanagar
Himachal Pradesh	Mandi, Bilaspur
Jammu & Kashmir	Budgam, Kathua
Jharkhand	West Singhbhum, Giridh
Karnataka	Chikkaballapura, Kolar, Ramanagara
Kerala	Wayanad, Thrissur
Madhya Pradesh	Burhanpur, Chhindawara, Balaghat, Mandla

Maharashtra	Aurangabad, Bhandara, Sangli, Yavatmal
Meghalaya	Jaintia Hills (Undivided), West Garo Hills (Undivided)
Mizoram	Kolasib, Serchhip
Nagaland	Dimapur, Kohima, Parem
Odisha	Dhenkanal, Sundergarh
Punjab	Pathankot, Gurdaspur, Ropar (Rupnagar)
Sikkim	West Sikkim
Tamil Nadu	Tirupur, Dindigul, Krishnagiri
Telanganana	Adilabad, Karimnagar, Mahbubnagar, Warangal
Tripura	Gomati, Sepahijala
Uttarakhand	Bageshwar, Chamoli, Pauri
Uttar Pradesh	Kushinagar, Sonbhadra, Fatehpur, Kanpur Dehat
West Bengal	Darjeeling, Nadia

Mapping of potential areas for expansion of sericulture in 20 selected districts of NER is in final stage of completion. One week programme on quality check and database integration was organized during March 20-24, 2017 at NESAC for the Scientists from State Remote sensing Application Centres. For other states of India, first installment of funds has been transferred and work is progressing as per schedule.

Visit of Member Secretary, Central Silk Board to NESAC

Dr. H. Nagesh Prabhu, IFS, Member Secretary, CSB, Ministry of Textiles, Govt. of India, Bengaluru visited NESAC on 28.01.2017 and discussed about the projects sponsored by Central Silk Board (CSB) to NESAC. The discussion was attended by Shri Sarat Deuri, Joint Secretary (Tech.), Regional Centre (CSB), Guwahati, Shri Moncy Issac, Deputy Secretary (Tech.), CSB, Bengaluru, Shri B. Choudhury, Scientist 'D', CMERTI, Jorhat along with Director, NESAC and Scientists from NESAC.



The Project Manual with technical guidelines has been suitably modified based on the experience from the first phase of project implementation. The Manual has been simplified with step wise procedures to be followed while executing project in their respective states.



Orientation meeting cum hands on training at NESAC

An orientation meeting & hands on training on implementation of the 2nd phase of the project on Applications of RS and GIS for Sericulture Development for 5 states viz., Bihar, Uttar Pradesh, Madhya Pradesh, Haryana and Punjab was organized at NESAC during March 01-02, 2017. Concerned scientists and research fellows from State Remote Sensing Application centres from these five states participated in the training

During the inaugural Session of the programme, Shri PLN Raju, Director, NESAC welcomed all the participants in the meeting. He appreciated the effort of State Remote Sensing Application Centres, State Directorates of Sericulture and the CSB institutes for their sincere support to NESAC in implementing the first phase of the project covering 108 districts in 24 states.

Dr. B.K. Handique, Coordinator of the project gave a detailed presentation on the current status of the project. He informed that all the work pertaining to the first phase of the project has been completed and project outputs are put in the SILKS webportal. The portal is now made available in 12 languages viz., English, Hindi, Telugu, Kannada, Assamese, Bengali, Mizo, Manipuri, Khasi, Garo, Ao Naga and Sumi Naga and information are regularly updated. He sought support from the State Directorates of Sericulture in terms of providing up to date district level information in the SILKS portal.

Hands on training on site suitability analysis based on soil and climate parameters was conducted by concerned scientists of NESAC Smt. Pratibha T. Das and Smt. Jonali Goswami. A field trip was also organized for the participants on March 03, 2017

Assessment of area under Mulberry in major sericulture districts of West Bengal

India is the second largest producer of silk among 20 silk producing countries in the world and has about 15.5 % share in global raw silk production. Sericulture has been traditionally practiced in West Bengal and flourished under the patronage of local rulers under Mughal empire. Cossimbazar, a river port situated off Berhampur, Murshidabad district had been a silk hub even during 17th century. Presently, Malda, Murshidabad, Birbhum and Nadia districts are the major contributors of mulberry cocoons and silk in West Bengal.

Mulberry (*Morus sp.: Moraceae*) thrives extensively in tropical and temperate countries and its leaves are harvested during various phenophases in commensuration with the age of silkworm for its dietary gratification. Farmers of major sericulture districts in West Bengal take up five rearings per year on an average

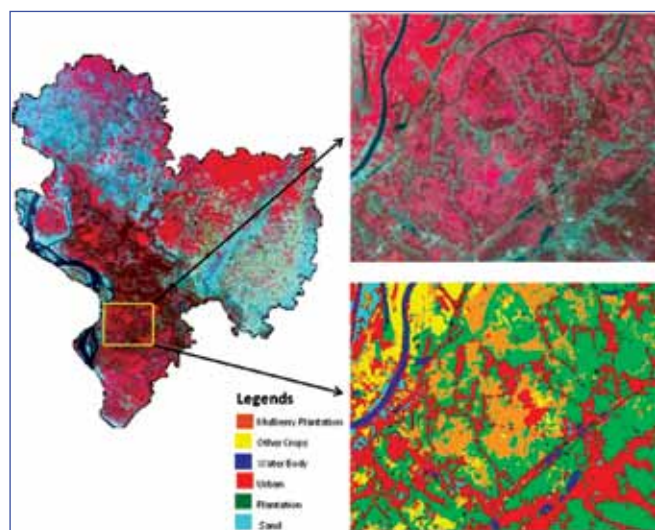
and accordingly mulberry leaves are harvested twice a day to feed the silkworm for a period of 18-27 days depending on season and silkworm breeds, preceded by pruning of the plants for required foliage-flush at desirable height. Mulberry undergoes 5-6 pruning per year at the completion of silkworm larva-stage which feeds voraciously on mulberry. Traditional sericulture farmers uproot and replenish old plantation since the economic life of mulberry extends up to 20 years.

Considering the importance of proper assessment of acreage under mulberry in the major sericulture districts in West Bengal and for crop condition assessment, a project titled Assessment, Development and Management of area under Mulberry in major sericulture districts of West Bengal using geospatial techniques was formulated and are being implemented jointly by NESAC and Central Sericultural Research & Training Institute (CSRTI), Berhampore, West Bengal. The major objectives were defined a) To estimate the current spatial extent of mulberry cultivation in selected blocks of 4 major Mulberry growing districts of West Bengal using RS, GIS and GPS b) Leaf protein and moisture contents estimation using hyperspectral data and relation with the laboratory based analysis c) Make an attempt to estimate leaf protein and moisture contents using hyperspectral data with limited laboratory based analysis. d) To develop block specific MIS which can be integrated with SILKS portal for dynamic visualisation. Satellite data classification utilizing Resourcesat-2 LISS III and LISS IV satellite data has been done for acreage estimation of mulberry in all the selected four districts. Classification results shows variation in the acreage estimates with the recorded estimates by government agencies. Additional points were supplied to CSRTI, Berhampore for ground truth collection so that accuracy of the estimates can be improved and finalise the mulberry acreage estimates.

The potential of using spectral characteristics for evaluating various biochemical parameter of mulberry has been examined from ground based remotely sensed hyperspectral data using spectroradiometer. Canopy reflectance spectra of mulberry has been collected for different varieties at three different leaves: namely glossy, 5th and 8th leaf. Spectral Range, No of Bands and Field of View of the sensors were 0.35-2.5 μm , 1024 bands and 4° respectively. Spectral

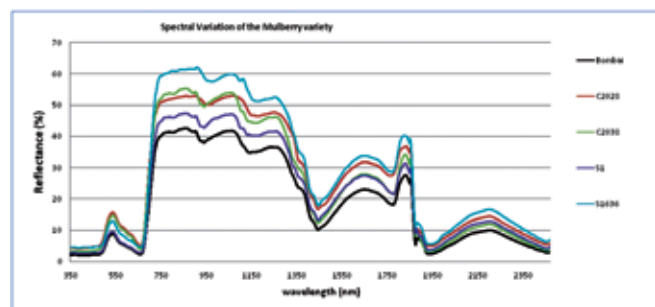
measurements were taken at nadir looking position at a height of 10 cm (approx) over the canopy and timing close to solar noon (between 11:00 to 12:00 hrs) when changes in solar zenith angle is minimum. Acquisitions were obtained through a hand held PDA which gives reflectance values as the ratio of reflected radiance to incident radiance estimated by a calibrated white reference.

Correlation of protein values with spectral reflectance across leaves and varieties has been studied. A number of indices viz., NDRE, CCCI, NDNI, NRI₁₅₁₀, TCARI, Red edge, OSAVI₁₅₁₀ were tried to correlate with mulberry protein content, out of which only OSAVI₁₅₁₀ (Optimal Soil Adjusted Vegetation Index) has been found to have significant correlation with mulberry protein content. For leaf moisture estimation, three indices viz., NDVI, NDWI and MSI have been explored. All the available layers with attribute information have been integrated in the MIS. All the spatial and non-spatial information supplied by CSRTI have been converted to vector layers. Mulberry field plots have been digitized using



Digital classification for delineating mulberry plantations

GF2, Cartosat and google earth satellite images.



Variation in spectral reflance across mulberry varieties

Correlation of protein values with spectral reflectance is performed. The significant absorption bands were taken for comparison with the protein values. The absorption bands taken are in the range of 380nm -530 nm, 530nm -696 nm, 915 nm- 1030 nm, 1085 nm -1113 nm, 1113 nm -1252 nm, 1400 nm -1550 nm, 1635 nm -1810 nm and 1865 nm -1878 nm.

Crop damage assessment using UAV

Farmers from Morigaon and Nagaon districts of Assam got a major shock during the month of April, 2016, when they encountered severe pest infestation in their Boro paddy (summer paddy) areas, which was very unusual for them. Morigaon district with an area of 1,550 km² having a population of about 9.6 lakhs (as of 2011) was the worst affected and four revenue circles out of five revenue circles viz., Mayong, Bhuragaon, Laharighat, Morigaon and Mikirbheta were affected. Investigation made by the District Agricultural Department and Regional Agricultural Research Station, Nagaon confirmed it to be the infestation by



DJI Inspire 1 UAV

Brown Plant Hopper (BPH) *Nilaparvata lugens* (Stal). An Inspire 1 UAV manufactured by DJI (Model T600) was used for the survey.

The survey was conducted in four locations reporting severe infestation by BPH in the district of Morigan viz., Naramari, Mikirbheta, Bhurbandha and Jaluguti. Necessary permissions were obtained from the local administration for the UAV survey. The first UAV flight was conducted in Naramari village under Mayong development block reporting severe infestation of BPH. A total area of 54.94 ha was covered with flying time of 15 minutes. The height of the UAV was maintained at 240m. At this height ground resolution obtained was about 5 cm and the infested areas could clearly be identified. Multiple images were obtained at the

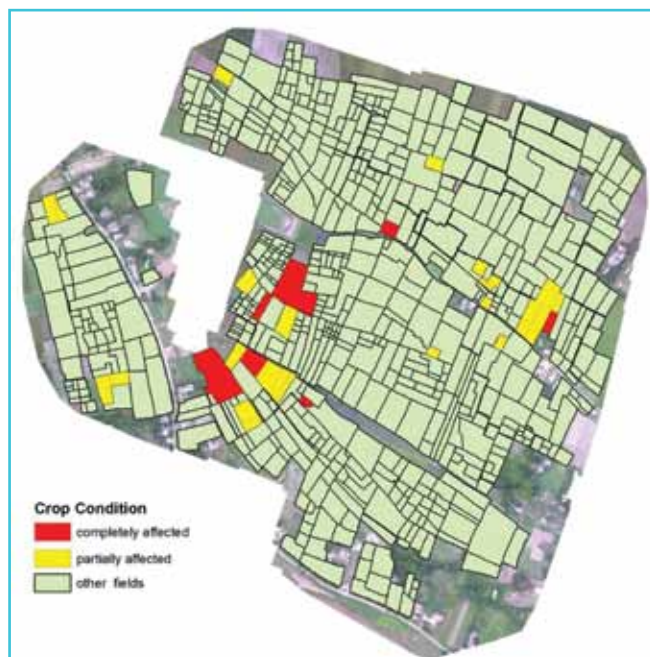
speed of one image per 5 seconds. The second flight was undertaken in Mikirbheta village under Mikirbheta block covering an area of 24 Ha. The UAV flight height was maintained 210 meters. As the infestations were more sporadic with smaller in size, the lower flying height could give better discrimination of infested fields.

The survey in the third location in Bhurbandha under Morigaon block was conducted for both image and video recording. The UAV height was maintained at 225 meters. 300 inclinations was maintained for video recording. Large area visualization was possible due to angular view of the camera. In the fourth site in Jaluguti an area of 32 ha was covered and images were taken from a height of 225 meters. Varying size of infested areas was observed in this site.

The images and the videos were transferred to the computer and processed with Pix4D software. Mosacing of the images done to have seamless boundaries of the scenes. Digitization of the rice fields were done along the field boundaries. Based on the severity of infestation, fields were categorized as completely affected, partially affected and other fields. The infestation which occurs as a result of feeding by both nymphs and adults of the insect at the base of the tillers, plants turn yellow and dry up rapidly. It was observed that at early infestation, round, yellow patches appear, which eventually turn brownish due to the drying up of the plants. The infested fields could clearly be identified in the images based on the tonal variations with the healthy rice fields . Rice plots having more than 50% infestation, categorized as completely



An infested paddy field



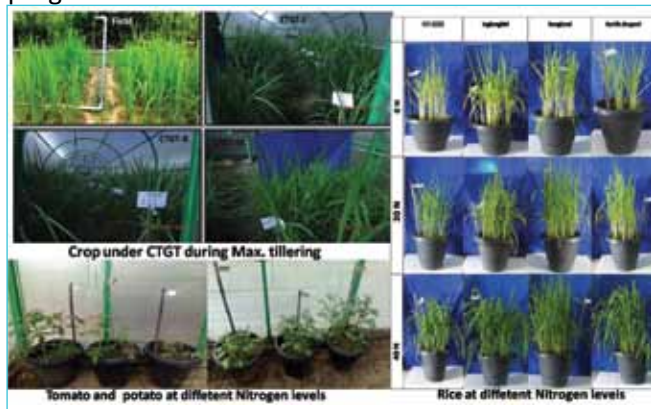
Categorization of BPH infested rice fields (Naramari village)

affected, less than 50% is categorized as partially affected. It has been observed that there will be hardly any yield from the plots categorized as completely affected; whereas with immediate intervention measures partially affected crop areas could be saved.

Crop condition assessment under abiotic stress of few selected crops of NER

Plant functions such as photosynthesis, transpiration, flower development and biomass production are sensitive to elevated CO₂ and temperature and are expected to influence the future ecosystem functions and agricultural yield. High yields can only be obtained if plant stress is kept to a minimum. It is required to detect crop stress as early as possible so that management practices can be instigated to minimize its effect on the harvestable yield of the crop. Under an EOAM funded project, spectral signature of selected crops at different stress conditions during crop growth stages are being generated. Common cultivars that widely grown in this region were selected to study the crop performance under different stress conditions. For two vegetable crops viz., Potato and Tomato data collection carried out for two years under different nitrogen fertilization and under elevated CO₂ and Temperature conditions. Both morphological, biochemical and spectral data collection have been completed. Pooled data and ANOVA analysis for plant biophysical parameter is in progress. For upland rice (Ahu Rice), first year data

collection has been completed. Moisture stress has been induced at maximum tillering as well as at penicle initiation stage. For first year both morphological, biochemical and spectral data collection has been completed, data collection for the second year is in progress.



Monitoring of crop performance under water and nitrogen stress condition is being done with the help of spectroradiometer. Preprocessing such as generation of smooth spectra has been carried out with a Savitzky-Golay filter and calculated the first and second derivatives. Discriminant analysis has been carried out for best band selection and generation of different indices relevant to each stress is in progress.

Land evaluation for organic crop planning in Assam using RS & GIS techniques

The Green revolution in India leads to many fold increase in food grains production. The effect of intensive cropping with high doses of agrochemicals has resulted in deteriorating soil properties and affecting animal and human health. Increasing consciousness about health hazards caused by agrochemicals has brought a major shift in consumer preference towards organic food, which is considered safe and hazard-free. To meet the demand of organic food, there is a need to increase the area under organic farming for which Administrators and planners need basic soil information. This information can be obtained by using satellite images along with soil survey and land evaluation in GIS environment. Keeping in view that land evaluation for organic farming will help the planners and the farmers to expand the area under organic crop with sustainable production, the present study has been carried out in Kamrup (Rural) district of Assam with following objectives: a) Preparation of

soil, physiography and land use land cover map. b) Identification of potential areas for organic farming. c) Assessment of soil site suitability for organic crop planning in the potential area.

Soil map at large scale (1:25K) is being prepared by following the standard soil survey procedures. IRS P6 LISS-IV (MX) images were used for generation of landscape map, physiography and land use/land cover map by using visual image interpretation technique. CartoDEM was used to generate slope and aspect map. All these maps were integrated and prepared physiography base map for the soil survey. Soil site information was recorded from each profile during the field survey. Horizon wise soil samples were collected from each profile for detailed physical and chemical analysis in the laboratory to incorporate the results with field observations and affirm soil taxonomy. The soil boundary will be delineated based on the boundary inferred by base layer in GIS environment.



Study of soil profile and collection of soil samples from sample sites

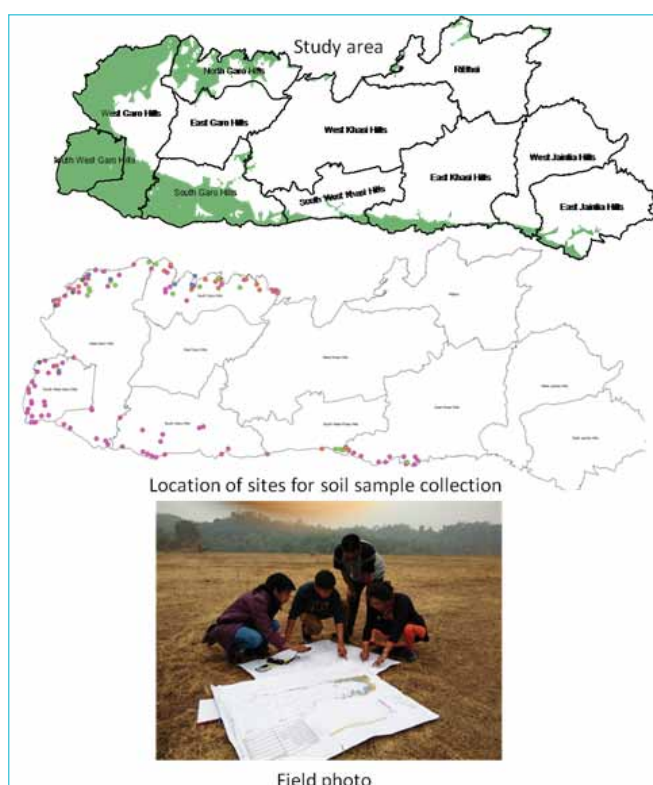
Land evaluation for organic crop planning will be done as per FAO (1983) guidelines. This approach is based on the matching of qualities of different land units in a specific area, with the requirements of actual or potential land use.

As a part of the project lithology, physiography and LULC maps at 1:50000 have been updated using LISS IV images. Prepared slope map from CartoDEM and updated road network map. All these maps were integrated and prepared physiography base map. During field survey studied morphological properties of

soil and collected soil samples from each horizon from 60 soil profiles and started soil sample analysis in the soil testing laboratory.

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 rice covers 25% of TRGA and high altitude rice that covers 5% of TRGA. Area wise, *Sali* rice constitute about 63000 hectares with an average yield of 1.9 MT/Ha, *Ahu* about 33,000 hectares with an average yield of 1.3 MT/Ha and *Boro* about 13,000 hectares with an average yield of 3.7 MT/Ha. Considering the fact that Boro rice has high yield and scope of expansion of Boro rice, 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 with the following objectives a) Preparation of soil map and soil fertility map at 1:50,000 scale. b) Mapping of areas suitable for expansion of areas under Boro rice. c) Acreage estimation of areas under Boro paddy at district/block level. 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 is being done as per FAO



Collection of soil samples from sampling sites

(1983) guidelines. Different thematic maps namely; soil depth, drainage, flooding, texture, gravel/stoniness, pH, organic matter, CEC, base saturation and slope has been prepared based on soil analysis and field data. All these thematic layers will be generated in GIS environment and analysed to find out suitability map for Boro rice.

Under this ongoing project prepared slope and elevation map from CartoDEM. The LULC map was updated by using LISS III images of 2015-2016. Maps showing sample sites along with road, LULC, slope and elevation have been prepared and submitted to DoA. Required training has been provided to the collaborating agency on use of maps and GPS for soil sample collection. Completed collection of soil samples. Soil samples were analyzed and used for preparation of soil fertility map which will be used for mapping of suitable areas for expansion of Boro rice in the state.

CHAMAN project for NER

CHAMAN (Coordinated Horticulture Assessment and Management using Geo-informatics) was initiated in September 2014 by Department of Agriculture, Cooperation & Farmers' Welfare (DAC&FW), Ministry of Agriculture & farmers' Welfare (MA&FW), Govt. of India under the Mission for Integrated Development of Horticulture (MIDH) as a Horticulture Assessment and Development project for better horticulture inventory and management using remote sensing, GIS and collateral field data. The major responsibility of project coordination and implementation has been assigned to Mahalanobis National Crop Forecast Centre (MNCFC), DAC&FW, New Delhi.

A meeting was organized at North Eastern Space Applications Centre (NESAC), Umiam on May 31, 2016 on implementation of CHAMAN project in north eastern states under the chairmanship of Addl. Secretary (Hort), Department of Agriculture and Cooperation & Farmers Welfare (DAC&FW). It was proposed to carry out site suitability study for horticulture development in all the states of NER under CHAMAN project in collaboration with Space Applications Centre (SAC), Ahmedabad, NESAC and State Remote Sensing Application Centre (SRSAC) of all the north eastern states.

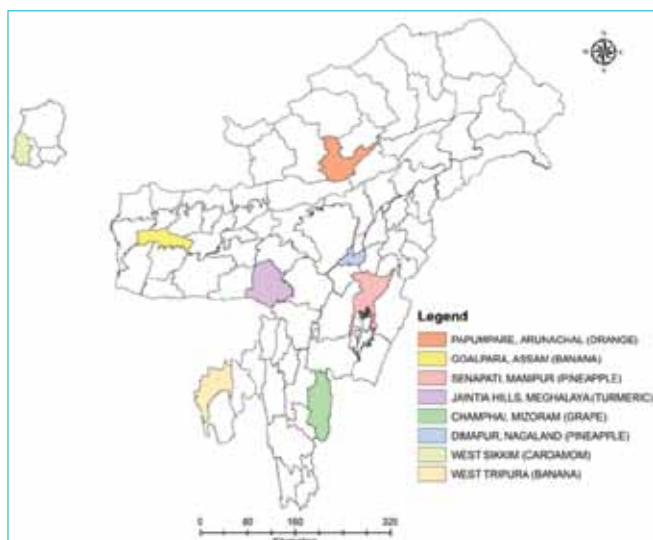


Accordingly, one district and one crop from each state of NE states have been identified. Suitable sites preferably in abandoned jhum areas are being identified following standard methodology provided by SAC/MNCFC/NESAC based on soil, physiographic, climatic and socio-economic parameters. The outputs of the project will be integrated into Bhuvan geo-portal.

NESAC organized four days training programme on Site Suitability Analysis in collaboration with MNCFC & SAC during 18-21 October, 2016 for the Scientists of the Remote Sensing Applications Centres of North-Eastern States. Terms of Reference (ToR) has also been



Participants attending four days training programme at NESAC during 18-21 October, 2016



Study districts with selected crops under CHAMAN project

signed between NESAC and respective SRSACs. The first installment (50% of total project cost) has been released to all the SRSACs after signing of ToR. NESAC purchased LISS-IV MX data of 2015-16 for all the 8 districts of NE states and provided to all the SRSACs for updating LULC-10K (SIS-DP data). Updation of LULC using LISS-IV MX data has been completed for Meghalaya, Mizoram and Nagaland. Extraction of soil attributes from Soil 50K/250K map prepared by NBSS&LUP/ SLUSI/ NESAC has been completed for the state of Meghalaya and Mizoram. Extraction of elevation, slope and aspect from CartoDEM (10m) has been completed for the states of Arunachal Pradesh, Manipur, Meghalaya and Mizoram.

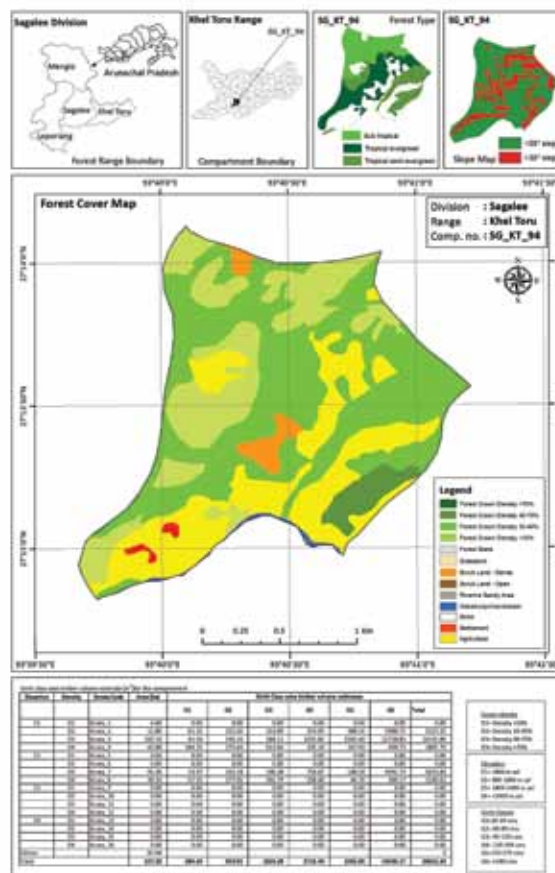
FORESTRY AND ECOLOGY

Forests is one of the major natural resources in north east India with about 65% of the total geographical area under forest cover, with maximum forest areas in Arunachal Pradesh and maximum percent coverage is in Mizoram. These forests are mostly under the private, clan and community ownership and a small portion under the control of the states. Of late the state forest departments are preparing the forest working plans for the divisions where no approved working plan exists and revisions for those which are expiring. NESAC has been supporting different state forest departments in preparing the geospatial inputs and computational estimates of growing stocks. Studies on vegetation and soil carbon, invasive species, bamboo resources, forest biomass estimations are some of the other activities of this group.

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

This project is being carried out for Arunachal Pradesh Forest department, wherein geospatial inputs and computational estimates of growing stock is provided for preparation of forest working plans for different forest divisions.

The detailed growing stock estimation at compartment level for all the ranges under Sagalee forest division is completed. Maximum percent total forest cover was in Leporiang Range while the very dense forest category was highest in Khel Toru Range (12.34%). Major portion of the forest area falls under open forest category (10-40% canopy density) ranging from 41.29 to 52.42% followed by dense forest category (40-70% canopy density) ranging from 21.03 to 28.44% in the different



Detail stock map of a compartment in Sagalee Division

ranges. Percent forest cover was least under Sagalee Range (85.01%) while the overall forest cover stands at 87.68% of the total geographical area. Large portion of the forest cover falls under the 800-1800 m elevation category (52.71%) followed by 1800-2400 m elevation (31.38%) and least (5.67%) in the higher altitudes.

The total timber growing stock per unit area varied from 23.89 m³/ha in compartments falling under the settlement area to as high as 373.67 m³/ha in compartments located in interior areas of the mid

Forest cover under different Ranges in Sagalee Division

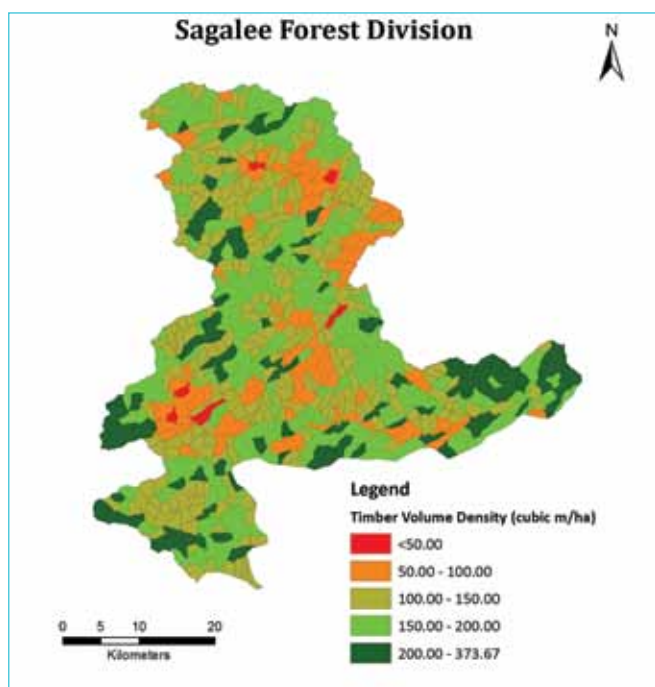
Canopy density	Forest Ranges (area in sq. km)				Grand Total
	Khel Toru	Leporiang	Mengio	Sagalee	
Very dense	32.01	37.99	19.70	15.43	105.13
Dense	73.78	142.82	126.01	95.31	437.91
Open	107.10	289.11	314.07	173.04	883.33
Scrub	20.01	56.04	55.90	27.44	159.39
Total	232.91	525.97	515.67	311.21	1585.76
TGA	259.41	583.93	599.11	366.07	1808.53

Forest canopy densities under different elevation classes in Sagalee Division

Elevation (MSL)	Forest Canopy density (area in sq. km)				
	Very dense	Mod. dense	Open	Scrub	Total
<800	20.35	64.5	44.87	11.22	140.94
800-1800	85.27	418.52	218.29	63.18	785.26
1800-2800	42.15	347.67	152.53	26.16	568.51
>2800	11.63	52.64	22.21	4.57	91.05
Total	159.39	883.33	437.9	105.13	1585.75

altitudes 800-2400 m. The growing stock density maps correspond to the forest canopy density map. It was observed that a very large portion (three fourth) of the growing stock is in the G6 category. A large number

of trees with larger girth at breast height (GBH) were reported from the field data which gives rise to an exponential increase in the estimated timber volume.

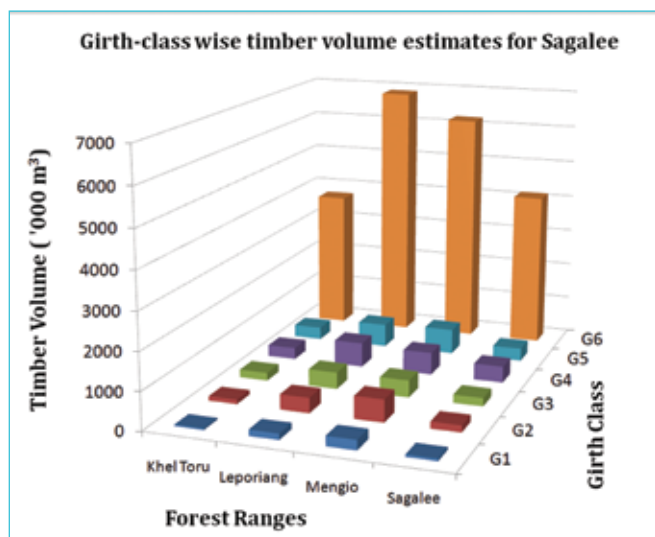


Compartment wise timber stock density in Sagalee division

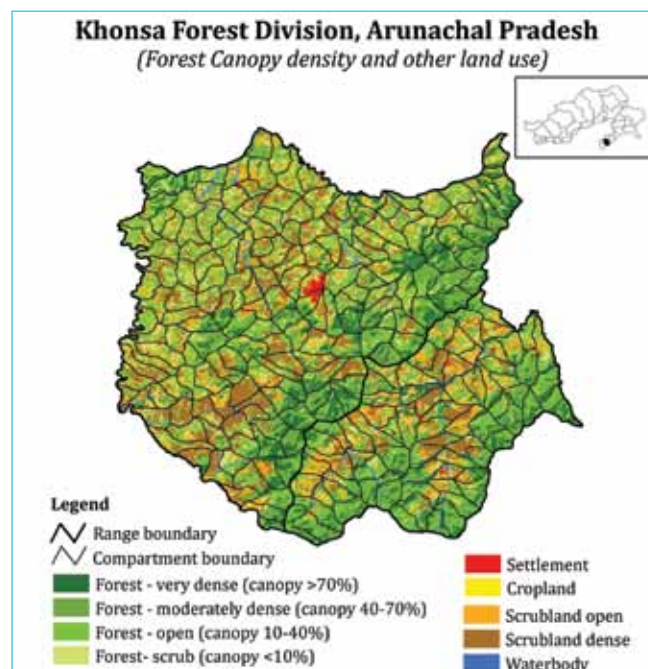
Field data analysis and timber volume estimation for other divisions like Tawang, Khonsa Namsai and Dibang divisions are under process. As requested by the department, maps on district wise distribution of wetlands and their zone of influence have also been prepared for the whole state with area statistics, which were categorised into those inside protected areas and outside protected areas of the state. Trainings were conducted for field staffs of the Forest Department on use of GPS and field enumeration methods for Southern Arunachal Circle at Deomali. The training was attended by DFOs, Rangers and Forest Guards from Nampong, Changlang, Khonsa, Deomali and Longding divisions.

Forest growing stock assessment using geo-spatial techniques in Mizoram

This study to assess the spatial distribution of growing stock in different reserved forest of four forest divisions



Girth class wise total timber volume estimates for Sagalee division

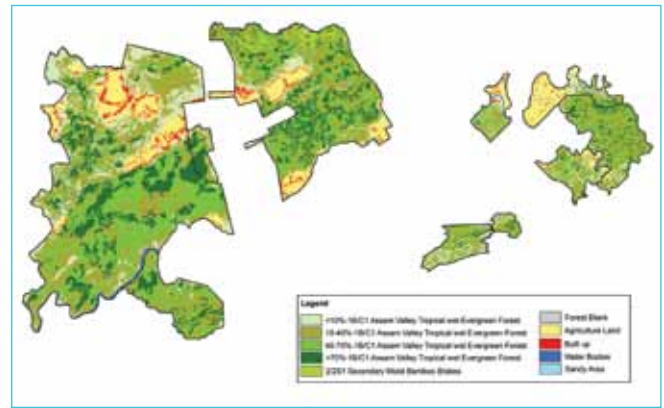


(Champhai, Darlawn, Lai ADC and Mara ADC divisions) of Mizoram has been taken up in collaboration with the Department of Environment and Forest, Mizoram. The forest crown canopy density and forest type map is under preparation at 1:10,000 scale. Field sampling points have been prepared based on 25"x25" grid system as per new working plan code and the land use land cover map. Based on the field data input the growing stock in different reserved forests will be estimated at compartment level and detail analysis of spatial distribution of the growing stock and stock maps at different slope categories will be prepared for the State Forest Department. Tabular information on the girth class wise timber growing stock information will also be generated.

Remote Sensing and GIS inputs for preparation of forest working plan in Assam

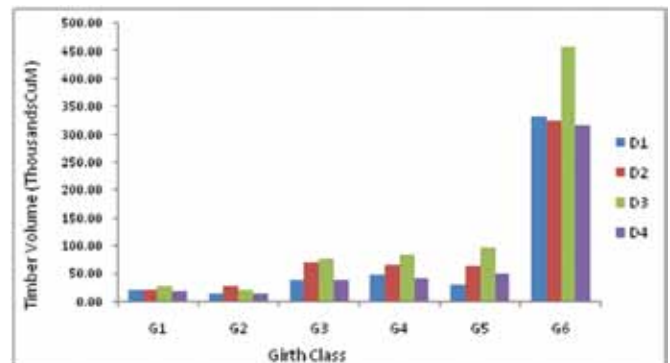
The Project has been taken up in collaboration with Assam Forest & Environment Department, Govt. of Assam for preparation of RS & GIS based Forest Working Plan inputs for 5 Forest Working Circles divided into 21 Territorial Forest Divisions of Assam. Forest crown density mapping has been prepared for 228 Reserve Forests of the 21 divisions using CARTOSAT-1 and IRS LISS IV images. The forest cover classification has been done at four canopy density interval -<10% (scrub forest), 10-40% (open forest), 40-70% (moderately dense), > 70% (very dense). Forest type map for 21 divisions was also prepared using Resourcesat-2 LISS III temporal imageries following forest type classification of Champion & Seth, 1968. Stratification of forest, based on forest type and forest crown density has been completed for 21 divisions. The field data collected from each Division was analysed for timber volume calculation into different girth class like G1, G2, G3, G4, G5 & G6 based on GBH (Girth at Breast Height) values 31-60cm at 30 cm interval. Species composition for each RF is also being generated.

Timber volume has been estimated for the remaining 9 out of 21 divisions namely, Northern Assam Circle (Dhemaji Division) Eastern Assam Circle (Doomdoma, Digboi, Jorhat & Sivasagar divisions) and Central Assam Circle (Goalpara, Kamrup East, Kamrup West & North Kamrup Divisions).

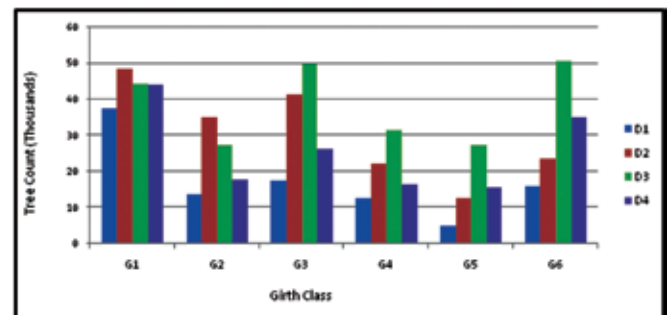


Forest type map of Digboi Division

A detailed analysis of Digboi division revealed that the open forest (10-40% canopy density) covers largest area which is followed by moderately dense forest (40-70% canopy density). The forest type in the division is Assam Valley Tropical Wet Evergreen Forest and *Dipterocarpus retusus* Blume is the dominant species. The Upper Dihing WB reserve forest shows maximum forest cover area in the division. The estimated timber volume in the division is 2.28 million CuM and it was observed that the growing stock is largely contributed by G6 category.



Estimated timber volume of Digboi Division



Estimated stem density of Digboi Division

Mapping of major invasive/exotic species using RS & GIS

For strategic management and monitoring of ecosystem in the region, spatial information on the distribution and

density of invasive species will be helpful for prioritizing areas that deserves interventions. A study has been taken up to assess the status of invasive species in the forests of Nagaon District, to understand the extent of spread of these species for effective management. The forest canopy density and other land use were mapped at 1:10,000 scale using latest LISS IV (2015-16) and Cartosat 1(2014-15) data for all the reserve forests and based on the canopy density and land use categories 100 sampling points were distributed in ten of the reserve forests, one wildlife sanctuary and one national park. The field sampling of the work is underway with collaboration with Nowgong College, Nagaon and field data from 23 sample sites have been collected. Ground data on tree density, diversity, abundance of different shrubs/herbs/climbers, light intensity were collected from the sampling points in four reserved forests.

Measurement of Vegetation and Biomass parameters under National Carbon Project (NCP)



Field work in Ri Bhoi district

NESAC is jointly working with NRSC, Hyderabad in the VCP project for Meghalaya. There are 200 sample points (grouped into 50 sample sites) required to be collected under the project. The collection of inventory data in

the sample points is in progress. Procedure of field data collection in prescribed format was explained to forest department field staff in Ri Bhoi district, Meghalaya.

Above ground biomass estimation using SAR data in North East India

To estimate the above ground tree biomass using microwave data in the forests of the region, field data were earlier collected from Upper Dehing Reserve Forest, Assam where species like *Canarium bengalensis*, *Dipterocarpus microcarpus*, *Mesua ferrea* were commonly found. More field data have been collected from other Reserve Forests like Suang RF and Doboka RF where species like *Lagerstroemia speciosa*,



Field data collection

Shorea robusta and plantations of *Tectona grandis* were common. Analysis for studying correlation between biomass values from field plots (0.1 ha) and backscattered co-efficient of different polarizations of SAR data is in progress. Field data collection from other forest conditions are also going on.

LAND RESOURCES PLANNING

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

In continuation to second cycle of mapping, third cycle of National Wasteland Change Analysis was initiated by NRSC, DOS. NESAC is coordinating with the State Remote Sensing Centres of the eight North Eastern States to update the Wasteland map of 2008 -09 using three seasons (Kharif, Rabi and Zaid) satellite data of 2015-16 and also to prepare the Wasteland change map. Work is in progress and finalization of database is being done.

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

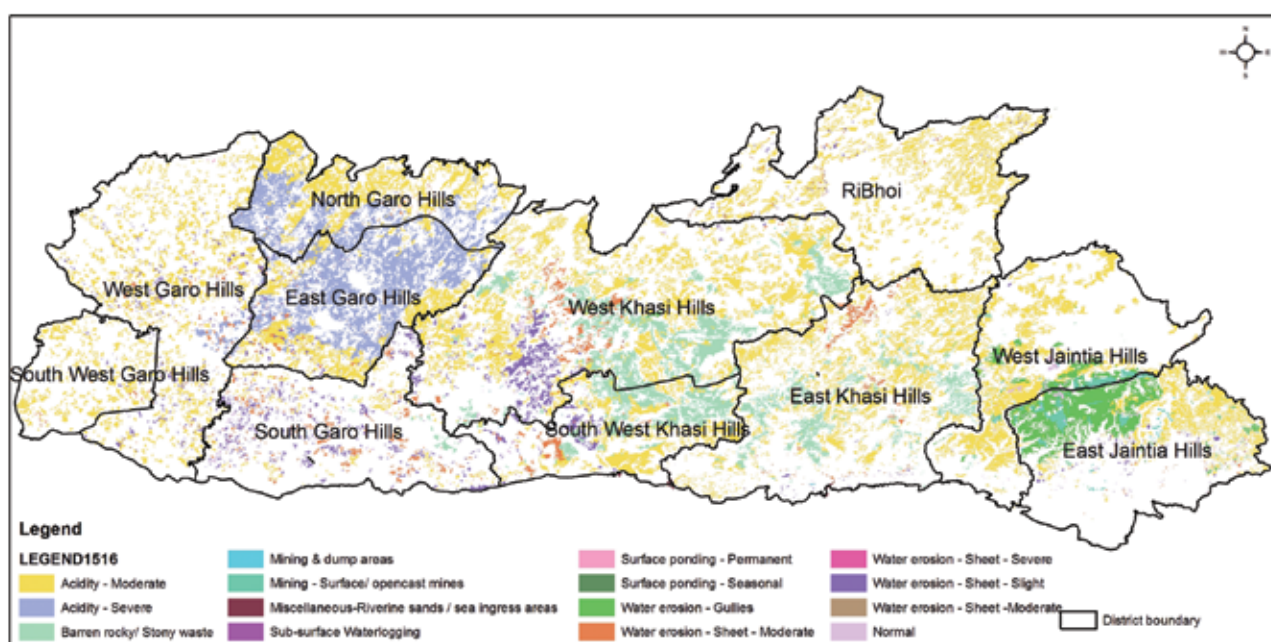
The first cycle of land degradation mapping covering entire country was done during 2005-06 period and presently the 2nd cycle has been initiated using orthorectified Resourcesat-2, LISS III images of year 2015-16. NESAC has been preparing the land degradation map for the state of Meghalaya and is coordinating for remaining state of NE.

Image interpretation along with ground truth data collection and internal quality checking completed and updation of final layer by incorporating suggestions of IQC is in progress. From the study it is observed

that in Meghalaya acidity is the most dominant land degradation class followed by barren rocky/ stony waste, water erosion and mining - surface/ opencast mines. Moderate acidity is the most dominant problem of the state followed by severe acidity. Amongst water erosion, gully erosion is the dominant followed by sheet erosion. Change analysis map showed that there is nominal change in wasteland categories and the interpretation error of less than 1%.

Land use/ Land cover Mapping Using Multi-temporal AWiFS Data in NE states

The mapping of land use/land cover (LULC) on 1:250,000 scale under the Natural Resource Census (NR-Census) is focused on the rapid assessment of National Level LULC on 1:250,000 scale using multi-temporal AWiFS datasets with an emphasis on net sown area for different cropping season. So far eleven cycles have been completed, and NESAC has been entrusted for Zone – 7 (total 16 tiles) from the 12th cycle onwards. The Kharif, Rabi and Zaid season were classified using AWiFS data pertaining to 2015-16 database to generate the integrated map of cropped areas. Other LULC classes were updated based on the ground knowledge. The Accuracy estimation of the zone – 7 was done and the overall classification accuracy found to be 84.25% with Kappa Coefficient of 0.78.



Land degradation map of Meghalaya, 2015-16

WATER RESOURCES

Monitoring and Evaluation of IWMP watersheds

The project envisages monitoring and evaluation of IWMP projects implemented during 2009-10 to 2014-15 using Bhuvan web services and Mobile app for North Eastern part of India. Each project is monitored for a period of 5 years from the date of implementation. NRSC is coordinating the project and they have already developed required geo spatial tools (Srishti – a web GIS interface on Bhuvan and Drishti – a mobile based android application). The tasks involved in the project include processing of high resolution satellite data– LISS-IV and Cartosat; Correction / fine tuning of Watershed boundaries based on SIS-DP database and generation of LULC and NDVI maps, evaluation and assessment based on Drishti photographs, preparation of maps

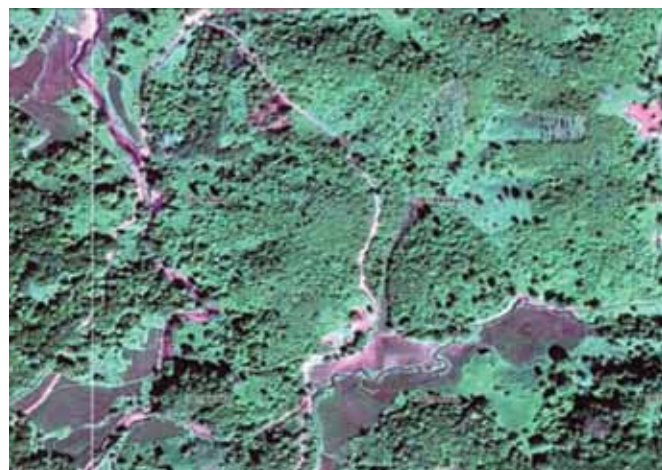
showing change detection in projects supported by limited ground truth of representative sites.

NESAC is carrying out the activities in collaboration with State Remote Sensing Application Centers of NER.

Currently processing of high resolution satellite data and correction/fine tuning of watershed boundaries based on SIS-DP satellite image is in progress for NER states.

Mapping of potential sources of surface drinking water in the state of Mizoram

Mapping of potential sources of surface drinking water in the state of Mizoram has been taken up as a requirement from Mizoram state user meet. The objectives of the project are:

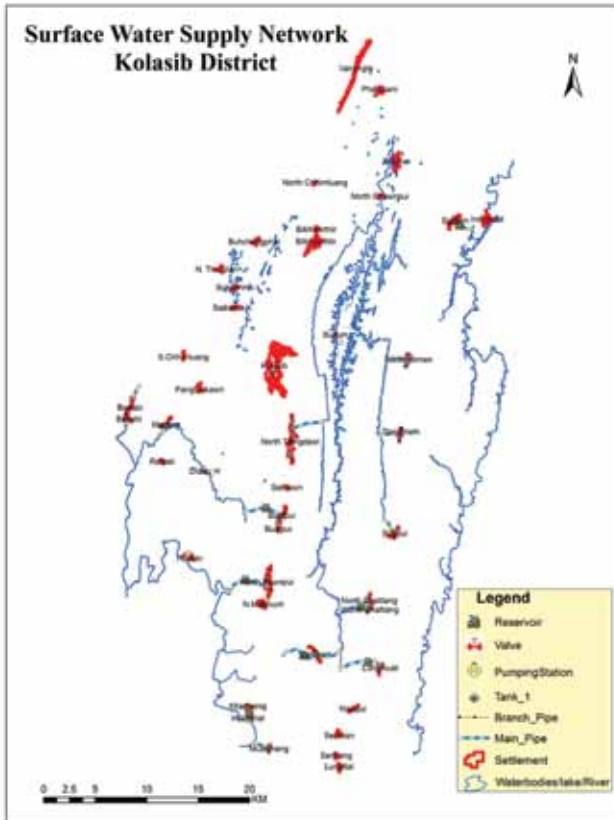


Increase of vegetation in micro watershed 3B1A4d4g of West Garo Hills District of Meghalaya



Creation of pond/tank in 3B1A4d4g micro watershed under IWMP

- Detail mapping of surface water bodies.
- Estimation of seasonal variation of the water bodies.
- To access nearness of the water bodies to the residential area.
- To suggest cost effective layout of pipelines for economic use of water.

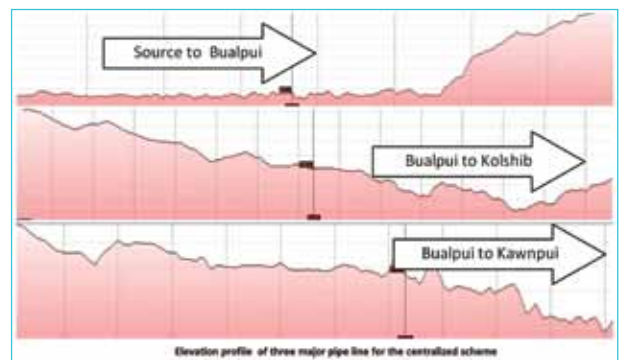


Decentralized minor water supply scheme

Under the project, mapping of potential sources of surface drinking water supply for Mizoram is being done. Here, indices like NDWI is used to map the



surface water which was cross checked visually with high resolution satellite data supported by ground truth verification. Potability of the water source will be decided based on laboratory analysis of samples and the observations will be incorporated in the database in GIS environment. Mapping of surface water sources for Kolasib district has been completed. Study shows that all the water bodies in the district are located in a lower altitude. Based on available geospatial information, two different best feasible schemes for drinking water supply are proposed. One is decentralized minor water supply system and the other is centralized integrated



Elevation profile of three major pipe lines for the centralized scheme

water supply system.

In the decentralized water supply scheme, a layout of water pipe network is shown connecting water bodies located within 3km distance and the lowest altitude difference. For the centralized integrated water supply scheme, a reservoir can be created for common source of drinking water by constructing a check dam on a 2nd order stream located at Northern side of the district at 92.67 N longitude and 23.97 E latitude. Drinking water can be carried to a well populated location i.e. Bualpui at distance of 20 km from where water supply can be done using gravitational force to almost all major places of the district. To get water at Bualpui, another reservoir need to be constructed at a location 6 km away from Bualpui, which is at a height of 31m.

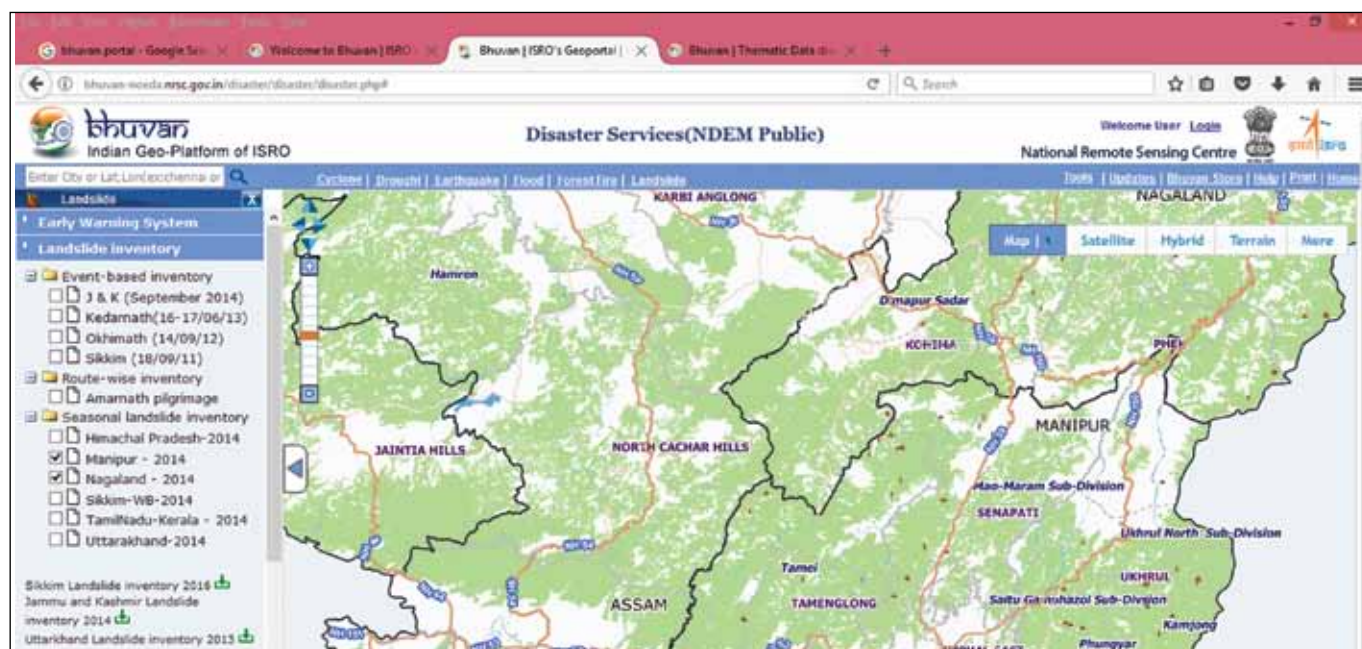
GEOSCIENCES

Seasonal Landslide Inventory Mapping – Manipur and Nagaland

Landslides are important denudational processes in mountainous areas that frequently damages means of communication and transportation besides causing loss to the life and property. Extreme rainfall and high magnitude earthquakes are the predominant triggering factors for occurrence of landslide. Detection of landslide and identification of the affected area is a key requirement for planning post-disaster rescue and relief operations as well as landslide susceptibility and hazard assessment. The aim of the study is to detect

Remote Sensing and GIS based road network gap assessment and alignment for new roads in Ri-Bhoi district

Satellite imagery coupled with limited field survey can effectively be used to assess connectivity status of road network in urban/villages/rural areas. In case of gap areas, before laying new roads, detailed study of the terrain condition and its characteristics such as land use land cover, exposed rock types, landforms, drainage pattern and slope condition etc., can be studied from satellite data of various spatio-temporal resolutions on priority basis. The study is initiated using Cartosat 1 & 2

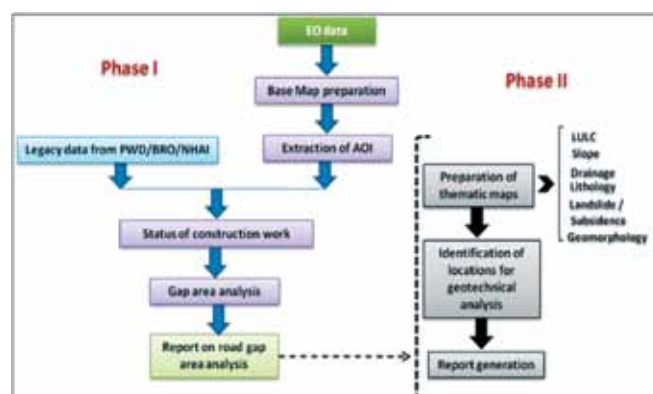


View of the landslide inventory in Bhuvan Portal.

seasonal landslides in a semi-automatic manner so that it can be converted into operational mode in future. The main objective of the project is to prepare 'Landslide Inventory Map' by using LISS-IV data of pre and post monsoon season. Inventory mapping for the state of Manipur and Nagaland has been completed successfully and the output of the study can be accessed through Bhuvan Portal-Indian Geo-Platform of ISRO (<http://www.bhuvan.nrsc.gov.in>).

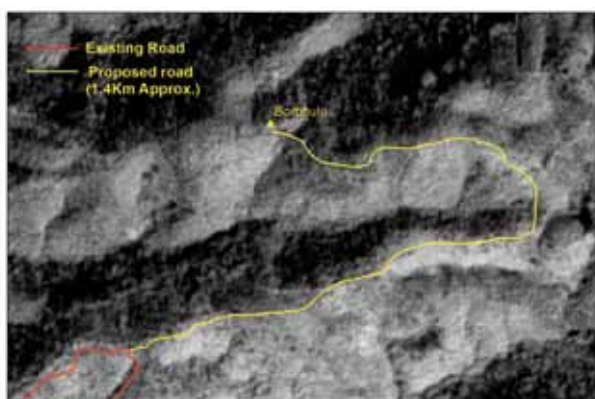
The same exercise has already been initiated for the state of Arunachal Pradesh and the result of the study will also be available in the same portal as mentioned above.

satellite data and other collateral data such as detailed status of existing road networks from concerned State/ Central Authorities as well as census/landrecord maps for village/settlement distribution.



Schematic Workflow

Ri-Bhoi District of Meghalaya was identified to initiate on pilot based study with the following broad objectives 1. To identify gap areas between existing road network and villages/ rural areas, 2. To identify sites for new road alignment in gap areas and 3. To identify locations for conducting geo-technical survey of soil/rock before laying new roads. The work is being carried out in two phases. The first objective is covered in phase I, second and third objective will be covered in phase II. The status of the phase I is in completion stage.

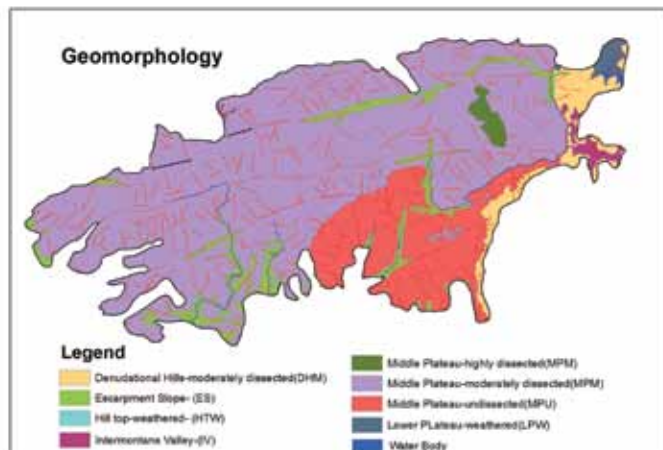
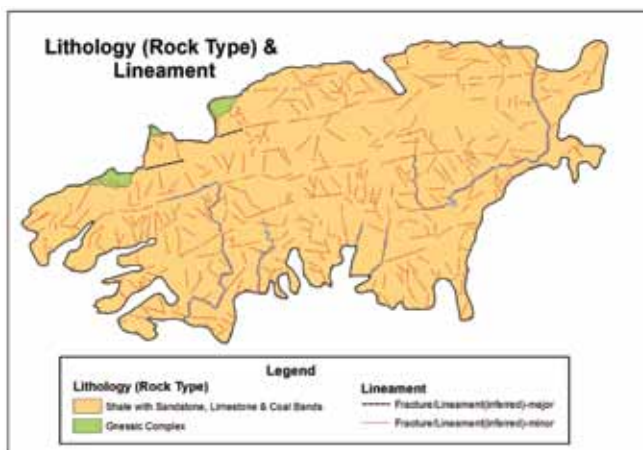
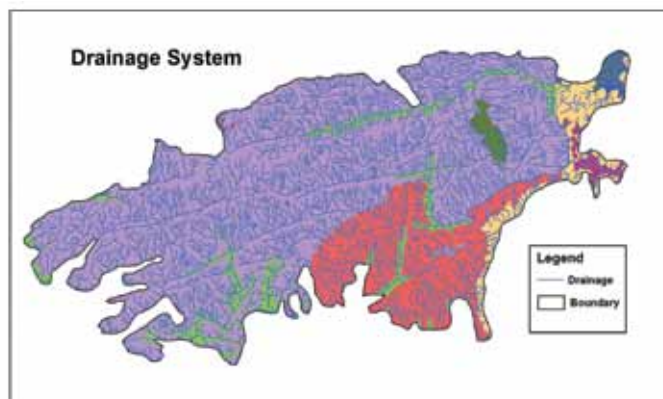
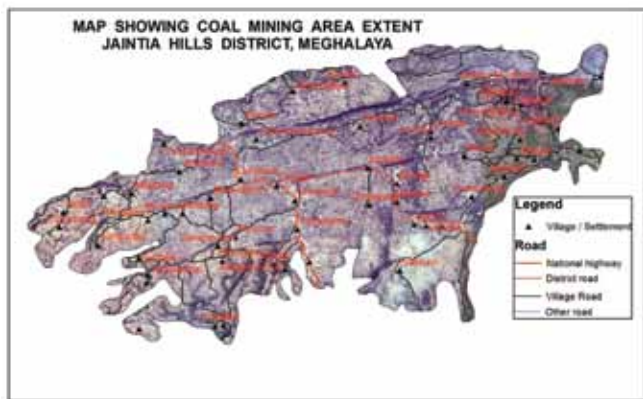


Village with no proper connectivity

The result of the project will provide the status of road type and connectivity map on 1:10,000 scale as well as location for Geo-technical survey of soil and rock samples (exposed /core) that can be used by PWD, NHAI, village authority for further necessary plan of action.

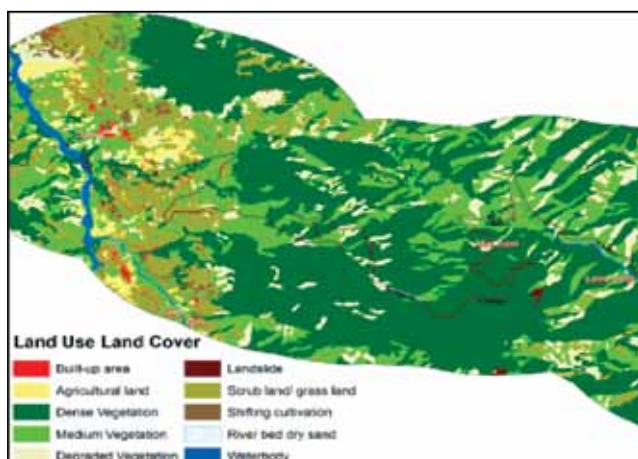
Geospatial Database Preparation and Study of Contamination of Heavy metal in Coal Mining areas of Jaintia Hills District, Meghalaya

The activities of coal mining in Jaintia Hills District even though small scale in nature but sporadic and extensively covered a wide area controlled by individual owners of the land. Primitive sub-surface mining method usually known as ‘rat-hole’ mining is a common practice in the entire mining process. It is well understood that mining brought wealth and employment opportunity in the area, however if it is chaotic and unscientific, absence of post mining treatment and management of the mined areas it may leads to severe environmental problems. Hence, it is relevant to carry out a detail study to address the issues related to concentration of heavy metals and its subsequent impact in coal mining area. The project was initiated under TDP with the following objectives 1. Preparation of Geo-environmental parameters, 2. Extraction of mining holes/areas, 3. Assessment of heavy metal concentration/contamination/pollution in mining areas. An attempt will also be made to understand the contamination/pollution with the probable influence of local geology, geomorphology, geological structures of the study area. High resolution satellite data, existing maps and literature and data collected from ground surveys will also be incorporated.



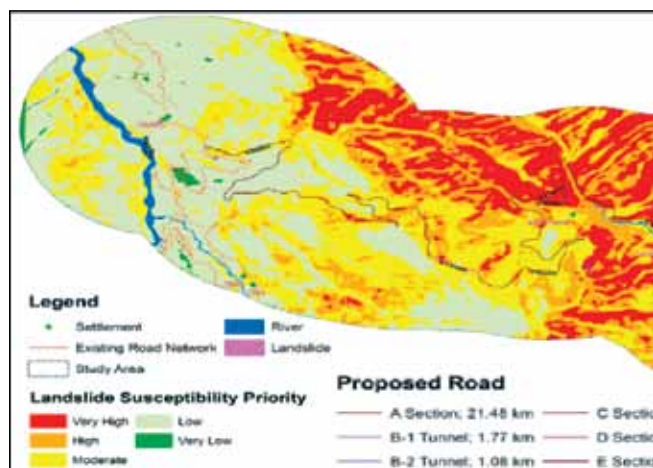
The result of the project will give precise information on different geoenvironmental parameters of the area and degree of contamination of analysed heavy metals of the area. It may be an aid in regeneration of deteriorated environment of the area due to unscientific and uncontrolled mining by various government organization such as Directorate of Mineral Resources, Govt. of Meghalaya, State & Central pollution control Board, Dept. of Agriculture, Govt. of Meghalaya etc.

Remote Sensing and GIS Based Inputs for Alignment Planning of new Road from Dumro – Same Basti, Upper Siang and East Siang Districts, Arunachal Pradesh.



Landuse/Landcover Map

It was realized the need of landslide susceptibility map during the analysis stage of alignment since the majority of NER falls in the high and medium to high category of the Global Landslide Susceptibility Map with few hotspot areas along Arunachal Himalaya. Subsequently, landslide susceptibility map was generated using various geoenvironmental parameters such as lithology, landforms, structures/lineament (density), soil, drainage (density), Landuse/landcover (derived from RS data), slope and aspect (derived for DEM), etc., and each parameters class was assigned weights and integrated them with expert opinion / knowledge based ranks. Finally, the susceptibility pixels are classified into one of the class – very low, low, moderate, high and very high. Using this susceptibility map as an input the most feasible shortest path or in



Landslide Susceptibility Map & Suggested Aligned Road

In general, planning and construction of a new road or highway 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 due its hostile topography which leads to poor accessibility along with thick/dense forest cover. Moreover, the degree of complexities may raise to double fold if the issues related to environment, social and cultural are not properly addressed in public domain. However, in the last two decades with the advent of space technology and GIS, alignment/realignment planning of new and or old roads in any area becomes more easier and viable in resolving these issues drastically. The present study has been carried at the request of Border Road Organization (BRO) under the Project Brahmanak, Arunachal Pradesh. The study aims to find out a best suitable route to connect two villages - Dumro and Same Basti of Upper and East Siang Districts, Arunachal Pradesh using IRS LISS-IV data of 2014, 10m Cato-DEM and other collateral data with limited ground surveys.

other words the path which is having least or no prone to landslide was identified with the capability of GIS by incorporating the criteria required from the user end. The study shows the strength of space technology and GIS and how it helps in various stages the of study where the accessibility is the main cause of concern.



3-Dimensional View of the study area & Aligned Road

URBAN AND REGIONAL PLANNING

High resolution data (Kompsat) processing for Bhuvan's ortho image mosaic generation-NER

Bhuvan is a geo-portal of ISRO to showcase visualization of multi resolution images. It displays satellite images of varying resolution of India's surface, allowing users to visualize cities and important places of interest. To cater the requirement of high resolution (1m) data availability on Bhuvan, NRSC/ISRO has purchased Korean satellite, Kompsat data of K2 & K3 sensors. NESAC was also involved for Kompsat data processing for entire North Eastern Region based on the Standard Operational Procedure formulated by NRSC.

The localized contrast enhanced natural color composite (NCC) Ortho images mosaic has been completed successfully for NER and the Ortho images mosaic has been uploaded to Bhuvan Geo-portal, the Indian Geo-Platform of ISRO (<http://www.bhuvan.nrsc.gov.in>).

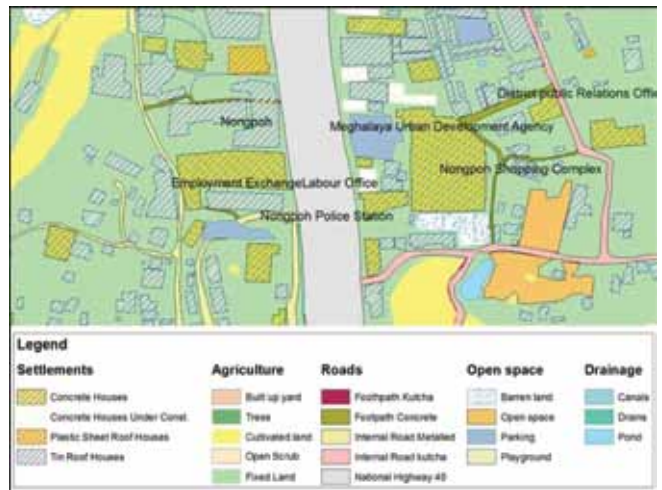
Urban planning using UAV data

Urban planning is concerned with the development and use of land, protection and use of the environment,



UAV Image of Nongpoh Town

public welfare and the design of the urban environment. With this background, it was taken up to identify the existing urban land use/ land cover areas and to its suitability analysis for location of amenities in part of Nongpoh Town. The study area extends from 25°54'15"N - 25°54'35"N and 91°52'29"E - 91°52'48"E and covers an area of 0.33 Sq.km. Details of existing urban



Proposed location of amenities in part of Nongpoh Town

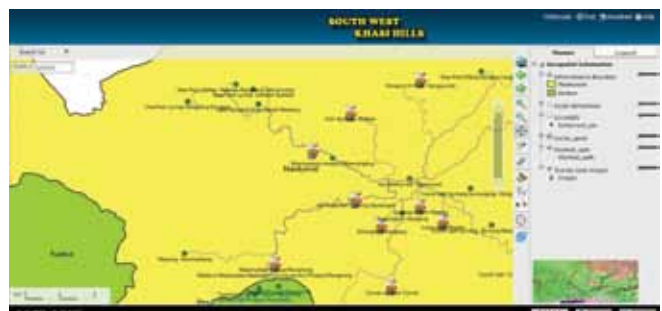
features) was prepared at 1:1000 scale using the image captured from UAV.

Tourism Information System for South West Khasi Hills District, Meghalaya

Rich in its natural beauty, culture and tradition, South West Khasi Hills district of Meghalaya is endowed with great potential for ecotourism. GIS and web based Tourism Information System was prepared for the district based on the satellite based information and also the ground information of the areas. Directions and destination to each tourist spot, shortest path and fly through of the tourist spots and for the entire of the district were carried out.



Base Information of South West Khasi Hills District



Tourism Information System of South West Khasi Hills District Web Page showing the contents

GEOINFORMATICS & IT

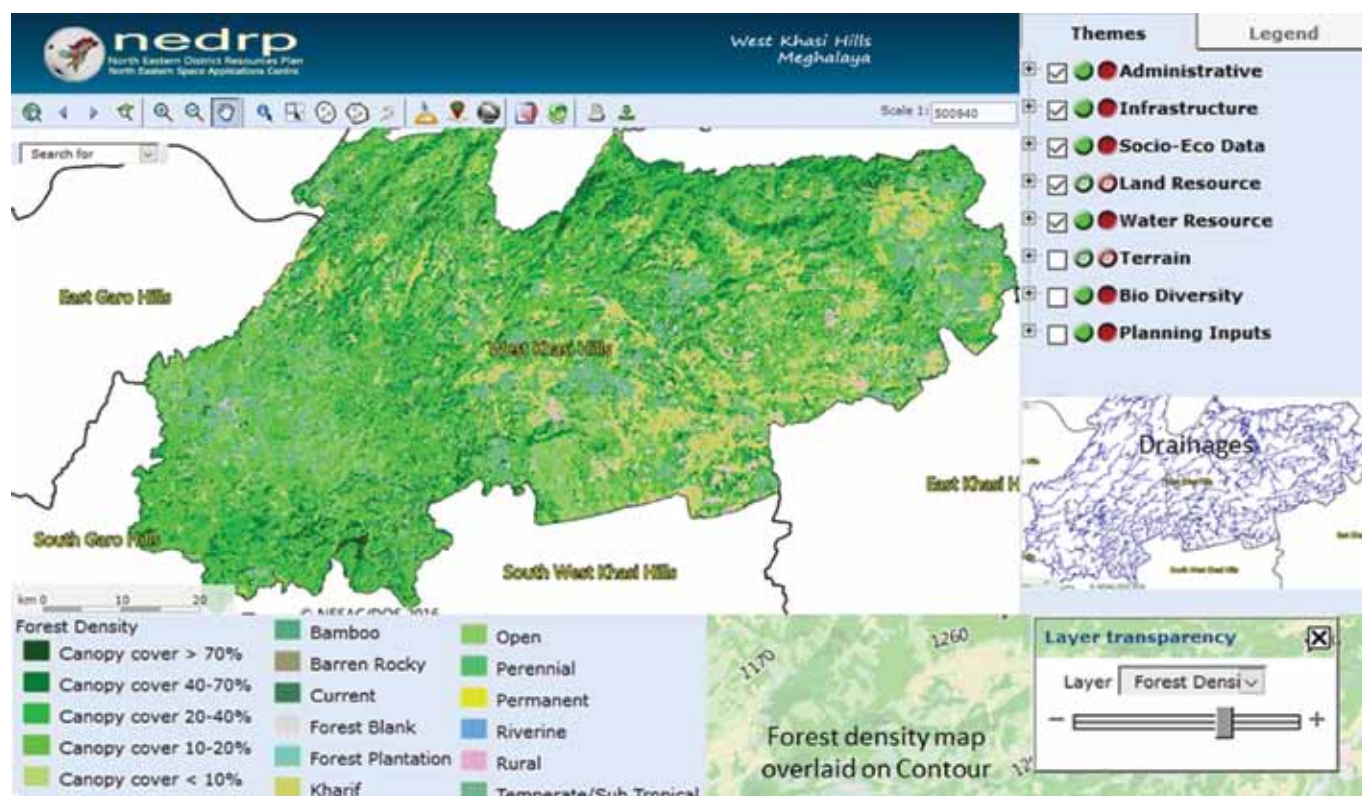
ICT enabled Geospatial Services and Applications

ICT based Geospatial applications are now getting new vistas in space technology for effective developmental programme of our country. NESAC in collaboration with State Remote Sensing Applications Centres (SRSACs) of NE region have been taking lead role for development of various SDSSs for effective management of developmental activities by the government and other non-government agencies. Space Based Information KIOSK (SBIK), North Eastern District Resources Plan (NEDRP at www.nedrp.gov.in), Sericulture Information Linkages & Knowledge System (SILKS at silks.csb.gov.in), Tourism Information System etc. are few significant Webs based Information Systems developed by NESAC using open source GIS packages and standards. Centre has established Spatial Data repository (SDR) with more than 14,000 imageries of various spatial and spectral resolution including more than 3,000 vector datasets. Design and assembling of unmanned aerial vehicles (UAVs) for various thematic applications has given a new dimension to activities of the the Centre. The Centre is now expanding UAV Remote Sensing (UAV-RS) applications in a bigger way to support the requirements of User Departments in collaboration with SRSACs of NE region. Centre has taken up new studies on Crime GIS, monitoring the progress of the

developmental projects etc. at the request of User's Departments. NESAC has initiated the establishment of North Eastern Spatial Data Repository (NeSDR) under the directive of NEC/DONER to enable secure data sharing gateway among the SRSACs of NE region and to strengthen the IT infrastructures of SRSACs for maximum utilization of space technology inputs and applications. A number of open source packages have been explored for processing of large scale data and customization of interactive tools for the users.

North Eastern District Resources Plan

NEDRP is an operational programme of NESAC executed in close collaboration with SRSACs of NE region. The objective of the programme is to strengthen the governance policy through geospatial inputs. Each district NEDRP portal is populated with 30-35 geospatial layers in five main information modules- administrative data, infrastructure details, natural resources information, action plan inputs and disaster management support. The database of each portal is being updated with the latest available data at the Centre. The dissemination mechanism is planned in three modes, viz., Standalone, Public domain and Bhuvan-based modes. NEDRP has been installed in standalone mode in 28 Deputy Commissioner Offices of NE region (i.e. 5 in Arunachal Pradesh, 2 in Assam,



Forest density map of West Khasi Hills of Meghalaya in NEDRP portal

3 in Manipur, 11 in Meghalaya, 3 in Mizoram, 2 in Nagaland and 2 in Sikkim). NEDRP standalone version have been installed in few line departments and provided necessary hands-on training to the nodal officers. NEDRP was successfully released in the public domain on 5th Sept, 2016 with the URL www.nedrp.gov.in. Secure gateway for data sharing among the Line Departments and online geoprocessing tool based on user's defined criteria are successfully added into the recent version of NEDRP at www.data.nedrp.gov.in. Multi-criteria spatial modeling is one of the important components of NEDRP for deriving action plan inputs for land resources (i.e. potential sites for horticulture and afforestation) and water resources (i.e. optimal sites for check dam etc.) activities. A number of decision support tools have been realized on the top of the NEDRP based on user defined criteria. For example, user can generate forest fire vulnerable areas on-the-fly using a set of GIS layers available at NEDRP. WMS data and services of around 1200 geospatial layers for 36 selected districts of NE region has been published through Bhuvan portal for developmental planning. The next version of NEDRP will be comprised of many citizen-centric/Governance oriented application modules.

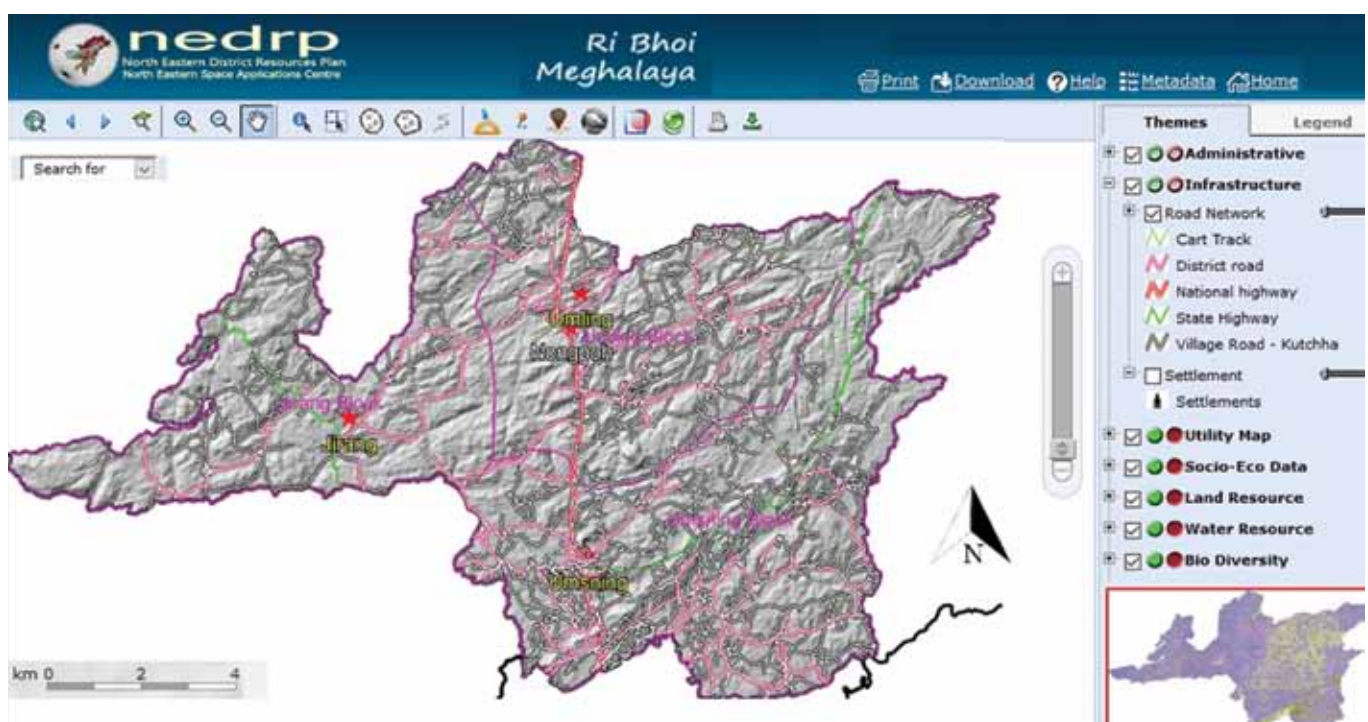
Space Based Information Support for Decentralized Planning (SIS-DP)

SIS-DP is one of the important ICT based geospatial programme executed in collaboration with NRSC, Hyderabad. The main objective of this programme is to prepare district resource geospatial atlas keeping village cadastral data as base, to develop software tools and utilities for providing multipurpose

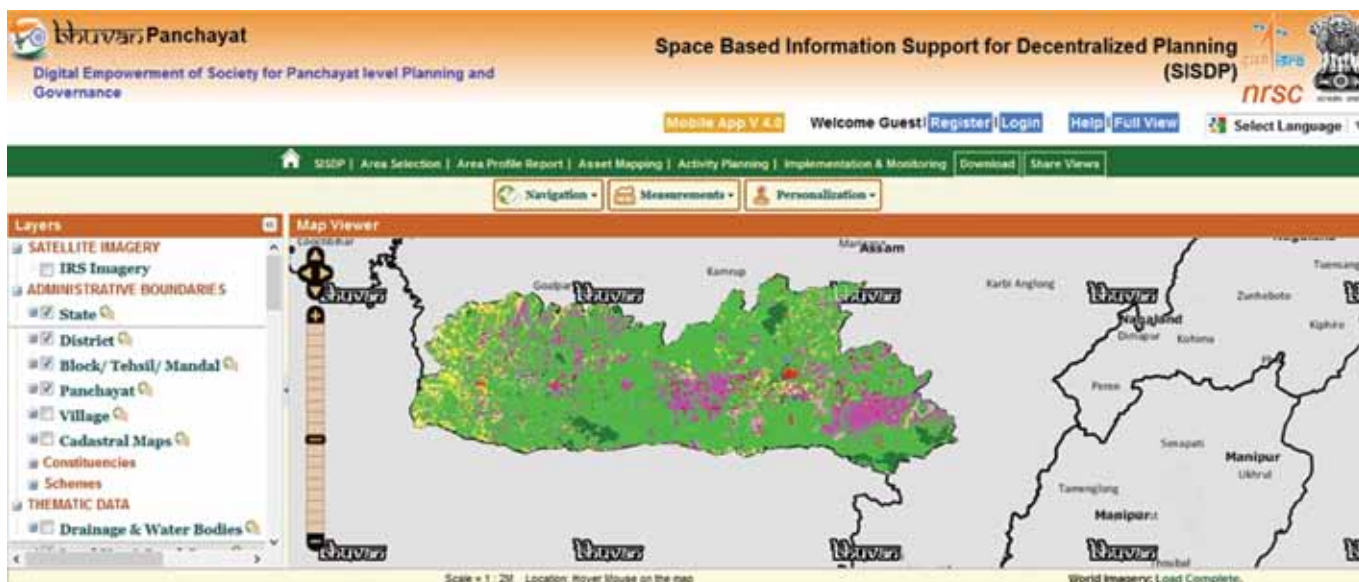
user driven applications for speedy, accurate and transparent decision making for district planning and to organize capacity building in state departments along with training of manpower and capability for spatial data analysis which will maintain, update & manage database for decentralized planning. NESAC is executing SIS-DP programme in the State of Meghalaya and coordinating the programme in entire NE region in collaboration with SRSACs under the guidance of NRSC. Preparation of database at 1:10K scale is completed and made available at Bhuvan. SIS-DP database of both 10K and 50K have been disseminated to many Line Departments of Meghalaya through NEDRP and SBIK programme of NESAC.

Empowering Panchayati Raj Institutions Spatially (EPRIS)

Empowering Panchayati Raj Institutions Spatially (EPRIS) project for NE region is coordinated by NESAC under the supervision of NRSC, Hyderabad with a goal to empower Panchayati Raj Institutions (PRIs)/ Autonomous District Councils (ADCs)/Traditional Institutions (TIs) for resource-based and integrated spatial developmental planning in rural areas using space-based inputs. The project comprises of three objectives; (i) capacity building of Elected PRIs/ADCC/TIs, their support functionaries and facilitators; (ii) asset mapping using Bhuvan Panchayat Mobile App and (iii) activity planning with the involvement of PRIs, Developmental Departments, NIRD, NGOs, academia, etc. NESAC is responsible for implementation of the project in the district of East Khasi Hills of Meghalaya and to support the outreach and asset mapping



Road network of RiBhoi district of Meghalaya generated under SIS-DP



Land use land cover map of Meghalaya generated under SIS-DP

activities in the respective districts of NE region in collaboration with SRSACs. NESAC has successfully organized State level workshop followed by District level workshop and 2 Block level workshops during 2016-17. The State level workshop was presided by the Hon'ble Minister, District Council Affairs, Government of Meghalaya and the workshop was attended by the Commissioner & Secretary of District Council Dept., Deputy Commissioners, representatives from Garo Hills Autonomous District Council (GHADC), Jaintia Hills Autonomous District Council (JHADC) & Khasi Hills Autonomous District Council (KHADC), representatives from Line Departments.

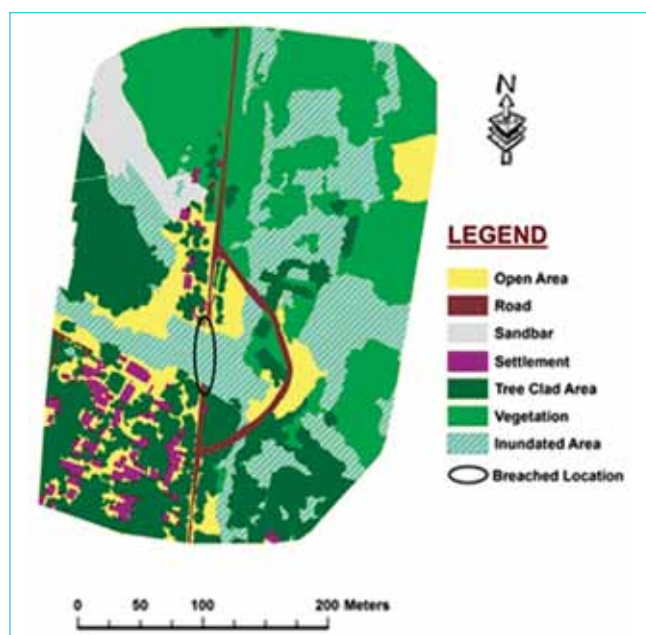
Applications of Unmanned Aerial Survey (UAS) in Remote Sensing

The NESAC in collaboration with Nagaland GIS and RS Centre has initiated a project on UAV based remote

sensing application for real time mapping, monitoring and disaster management in the NER. A number of case studies have been carried out using UAV. Mapping of flood erosion areas, affected breaching location in Majuli Island, mapping of experimental tea garden areas of Assam Agriculture University, tourism sites in West Khasi Hills district, Nehru Park, Umiam of Meghalaya and many other sites at the request of user Departments. Images were acquired with a ground pixel resolution of 5 cms at a breaching location in Majuli Island, Assam. The scene shows that the road which was once there is breached due to flood. With the loss of road, the villagers made a new path to navigate. The damage assessment of these breached locations can be done with these images. The scope of the project was further extended to establish UAV Remote Sensing (UAV-RS) facility in each of the SRSACs of NE region with the financial support from NEC, Shillong.



UAV image captured from 100m height



Classified map showing breaching location

DISASTER MANAGEMENT SUPPORT ACTIVITIES -NER-DRR

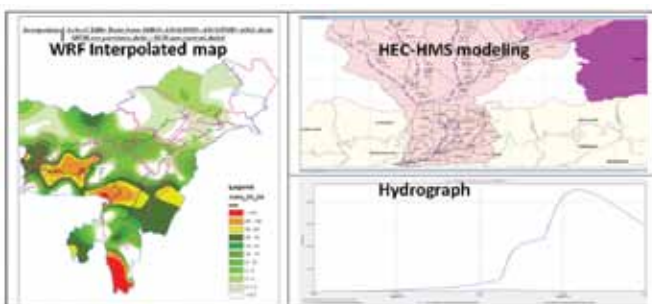
Flood Early Warning System (FLEWS)

Flood being a major hazard in Assam, FLEWS was initiated by NESAC in one district of upper Assam way back in 2009 as a pilot exercise at the request of Assam State Disaster Management Authority (ASDMA), the statutory body for Disaster Management under Government of Assam. With moderate initial success, the activity was gradually extended to increased number of districts every year with progressively increasing success rate. The activity was operationalized from the year 2012 for a three year period till 2014 at the request of ASDMA funded by Govt. of Assam. After the successful completion of the first three year operational phase, the activity has been further extended for the second operational phase from 2015 to 2017 at a formal request from Government of Assam to ISRO/NESAC for continuation with fresh funding support from ASDMA. All the technical components have been subjected to necessary improvements every year. The alert success for both 2015 and 2016 is 92% and 81% (2016 being relatively a low flooding year) respectively.



FLEWS success rate during 2015 and 2016

Currently 39 HEC-HMS models were made operational for Assam based on the improvement in the hydrological model, updated LULC layer, soil data, improvised routing parameters, soil moisture conditions incorporated into the WRF model with the use of 9 km gridded hourly data. Presently the focus is on extending FLEWS for



The rainfall and discharge prediction

other North Eastern states and to pilot FLEWS for Meghalaya for 2017 monsoon.

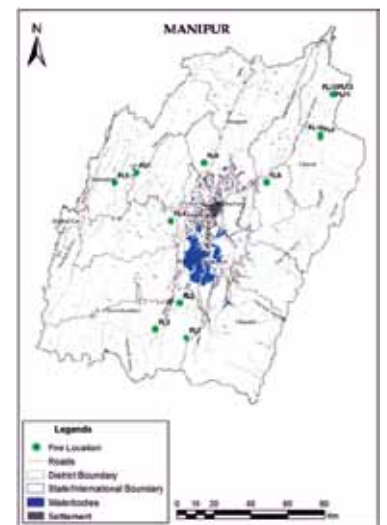
Forest fire monitoring

Under the North Eastern Regional node for Disaster Risk Reduction (NER-DRR), value added forest fire products have been disseminated to all the concerned forest departments and local NGOs. One day workshop on “Forest fire scenario and its mitigation in North Eastern region” was organized at NESAC on 9th November 2016. Various important institutions and organisations participated in the workshop including NRSC, Hyderabad and SAC, Ahmedabad and delegates from Department of Forest and Environment, Meghalaya, Rajiv Gandhi University, Itanagar, Dibrugarh University, Assam, Mizoram University, Mizoram Disaster Management and Rehabilitation Department, Manipur Forest Department, Nagaland Science and Technology Council and NGO’s including Federation of Hima under Umiam sub-watershed, Mawphlang and Asian Confluence, Shillong.



Participants during the Forest Fire workshop

Similar to the previous years, forest fire alerts have been provided to the respective forest departments and related NGOs in all the north eastern states.



Forest fire alert for Manipur on 01 April, 2016 (Afternoon)

SATELLITE COMMUNICATIONS

The centre is implementing ISRO's SATCOM oriented societal applications programs like Tele-education, Telemedicine, Communication support in Disaster Management etc. in the states of the North Eastern Region. The centre has got the state-of-the art satellite communication facilities like Satcom studio for content generation, Spacenet system for inter-communication among ISRO/DOS Centres, transportable WLL-VSAT system, satellite phones (INSAT MSS Type-D terminals) and various equipments under Ka-band propagation experiment & NAVIC project.

Tele-education project in North Eastern States During 2016-17

NESAC has accomplished following activities in this regards:

- Initiated revival of the network in NER states. PO issued and work is continued. This also includes CAMC of the network
- Initiated a new network comprising of 25 SITs for the state of Manipur
- Conducted a meeting at NESAC among MHRD, ISRO/DOS and State Education Dept. of NER for better utilization of Tele-education project in NER states
- Conducted coordinator meet for all the user of NER states

NESAC is also providing full technical and other support for the utilization of the network including visit to various networks, trouble shootings, training, awareness program, content generation etc.

Telemedicine Program in NER

Under ISRO-NEC joint Telemedicine Project, NESAC coordinated with North Eastern Council (NEC) and NEIGRIMHS, Shillong and prepared a revised plan for implementation of Telemedicine network in NER states which is under process. Coordinated all activities for making TM nodes at NEIGRIMHS, Shillong fully operational.

Communication Support in Disaster Management (CSDM)

Under CSDM activities, Emergency Communication Terminals under GSAT-6 received at NESAC which are demonstrated at various states for its utilization. ISRO-VPN is maintained at operational level; continued group SMS based alert services under FLEWS project for the flood affected district of Assam etc. A demonstration of GSAT-6 based Emergency communication terminals by Satcom group of NESAC at Humanitarian Assistance in



Disaster Relief (Nabhas Rahat) Program conducted at Shillong during June 8-10, 2017.

Ka band propagation experiment at NESAC

Under this experiment, installation of various equipments at NESAC by Scientist of ONERA, France were already done as a part of an MoU signed by Hon'ble PM of India with France Government (ISRO-ONERACNES collaboration in space). Data collection/ dissemination/analysis continued as project plan.

Navigation with Indian Constellation (NAVIC) project at NESAC

Various stations commissioned under ISRO's NAVIC project are working fine. NESAC is providing full support for operating the station. The field trial experiment of NAVIC SPS-GPS receiver is continued in collaboration with SAC, Ahmedabad.

SPACE AND ATMOSPHERIC SCIENCE AREA

The space and Atmospheric science group is 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. Another major area of activity is research to improve 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 operationalised. The group has also started providing experimental short range weather forecast for NER of India.

Indigenously developed Polarimetric Doppler Weather Radar at Cherrapunjee dedicated to Nation by Hon'ble Prime Minister of India.

Shri Narendra Modi, Hon'ble Prime Minister of India dedicated the indigenously developed Polarimetric Doppler Weather Radar (DWR) installed at Cherrapunjee, to the nation on May 27, 2016 remotely from Shillong in the August presence of Shri Jitendra Singh, Hon'ble Union Minister of State (Independent Charge) for DONER. The DWR has been designed and developed by ISRO Telemetry Tracking and Command Network (ISTRAC), ISRO and manufactured by Bharat Electronics Limited (BEL), Bengaluru. The DWR was realized with active support from North Eastern Space Applications Centre, Department of Space, Umiam,

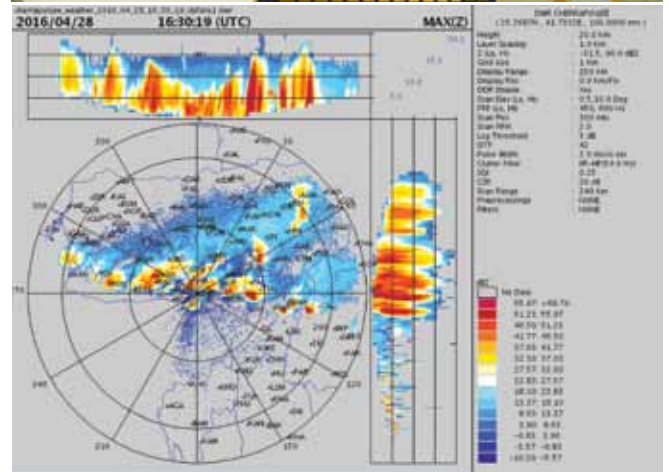


Hon'ble Prime Minister of India dedicating the Polarimetric DWR to the Nation

Shillong and India Meteorological Department's Regional Meteorological Centre (RMC), Guwahati.

The Doppler weather radar (DWR) is an atmospheric observation tool for detecting and tracking severe weather phenomena in real time covering large areas. The DWR is the first of its kind in S-band (operating at 2.7 to 2.9 GHz) and dual polarimetric Radar. NESAC has been operating and maintaining the system since its inauguration. The radar is being operated in a 24 X 7 mode with three shifts operation. Two research scientists and three electricians have been recruited on contract basis to operate and maintain the system.

The DWR has been calibrated with Sun-calibration technique, bore sight testing, and also using metal sphere calibration technique on three occasions.



The DWR building at Cherrapunjee (top) and a typical Range Height Indicator (RHI) product for Maximum reflectivity.

The radar constant, azimuth bias, and elevation bias were calculated and incorporated in the DWR system. All the major supporting systems like the diesel generator, uninterrupted power supply, ACs, etc. are in the process of putting under annual maintenance contract to reduce system downtime. An internet leased line and a data leased line have also been taken for real time data transfer to MOSDAC at SAC, Ahmedabad and to NESAC. The team from NESAC has also provided support in metal sphere calibration of the DWR installed at Gopalpur, Orissa by temporarily setting up a hydrogen gas filled balloon launching facility.

The first meeting of the Test and Evaluation (T & E) committee for DWRs formed by Director, ISTRAC met at Bengaluru and assessed the performance of DWR, Cherrapunjee. The performance was mostly satisfactory with few minor modifications suggested which are being incorporated.

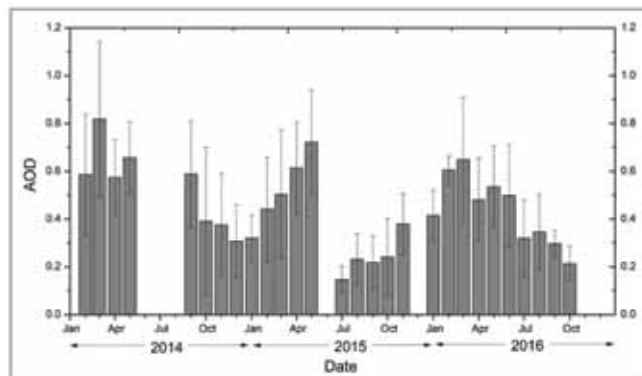
Aerosol Radiative Forcing over NER

North Eastern Space Applications Centre (NESAC) has been contributing to the Aerosol Radiative Forcing over India (ARFI) project since 2008. Several instruments to measure physical and optical properties of aerosol are operated at NESAC. Two land campaigns were also conducted along the east-west and north-south corridor of NER, to study the spatial distribution of aerosol over the region. Efforts are also made to characterise aerosol over the NER of India using satellite based data and products. One more observatory is being established at Tawang (at an altitude of 3000 m above MSL), Arunachal Pradesh with the installation of an Aethalometer since September, 2016 in collaboration with Space Physics Laboratory (SPL), Thiruvananthapuram.

Columnar aerosol properties over Umiam, Meghalaya

The Aerosol Optical Depth (AOD) has been measured over NESAC, Umiam using a Multi Wavelength Radiometer (MWR) and also using five channels Microtops Sunphotometer. The seasonal variation of AOD remained consistent during 2014-2016 period and exhibited similar pattern with those observed during earlier years. However, a slight decreasing trend in AOD was observed during 2016 with respect to AOD values in 2014. Highest AOD value was observed during the

pre-monsoon season (April-May) of each year with the highest value of 0.82 ± 0.32 on April, 2014. The lowest values are observed during the monsoon season (JJAS) and during 2014-2016 period, the lowest AOD value of 0.15 ± 0.06 was observed on July, 2015.



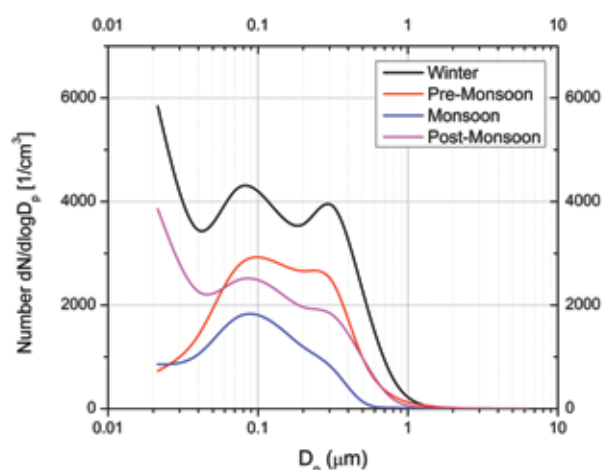
Monthly mean AOD at 500 nm over Umiam, Meghalaya

Number Size Distribution of ambient particles at Umiam, Meghalaya

The measurement of particle number size distribution was carried out at NESAC office campus at Umiam, Shillong during 2014-2016 period. Ambient particles with aerodynamic diameters ranging between 7 nm and 10 μm were investigated by means of a thirteen-stage electrical low pressure impactor (ELPI). The seasonal mean of number concentration is shown in figure below which reveals distinct variation among different seasons both in terms of number concentration and pattern. Almost 99% of the particles observed had aerodynamic diameters $\leq 1 \mu\text{m}$. The primary origin of these particles could be the combustion of fossil fuel and biomass burning. The number-size distribution was bimodal during the post monsoon and winter season. The same during the pre-monsoon season has a tendency of bimodal distribution but the distribution in monsoon season was clearly monomodal. The density function had the local maxima in the aerodynamic diameter intervals of 0.007–0.021 μm range during the post-monsoon and winter season, while the maxima during pre-monsoon season was in the aerodynamic diameter intervals of 0.072–0.120 μm range and during monsoon season in the aerodynamic diameter intervals of 0.040–0.072 μm range. The number density was highest during the winter season for all twelve range bins.

The average particle number in winter was nearly twice as high as in monsoon and post-monsoon season.

The highest number concentrations during winter were in the 0.007–0.021 μm range with two more maxima at diameter range ending at 0.072 μm and 0.316 μm . The anthropogenic particles from fossil fuel combustion are probably the leading contributor in the overall particle loading. The drop size distribution during the post-monsoon season has a similar pattern with that of winter season, but with a lesser magnitude. The particle density is almost equal in the five range bins covering diameter range of 0.072 μm to 0.316 μm during the pre-monsoon season, indicating similar source and process as observed during the winter season. The monsoon season has relatively flat number distribution with maxima at 0.072 μm with almost no particle beyond 0.761 μm diameter. The heavy precipitation over the



Aerosol number size distribution over Umiam, Meghalaya

measurement site during monsoon season does not allow heavier particles to remain in the atmosphere. One distinct feature that was observed was that all season had one maxima at the 0.072 μm diameter, indicating consistent presence of source throughout the year.

Establishment of an aerosol observatory at Tawang

NESAC in collaboration with Space Physics Laboratory (SPL), VSSC, Thiruvananthapuram has set up an aerosol observatory at the district headquarters of Tawang (Latitude: 27° 35' 29" N, Longitude: 91° 52' 23" E and Altitude: 2916 m above MSL, surface pressure 716 hPa) on the northwestern corner of Arunachal Pradesh in Eastern Himalaya, under the Himalayan Cryosphere Programme as part of the Aerosol Radiative Forcing

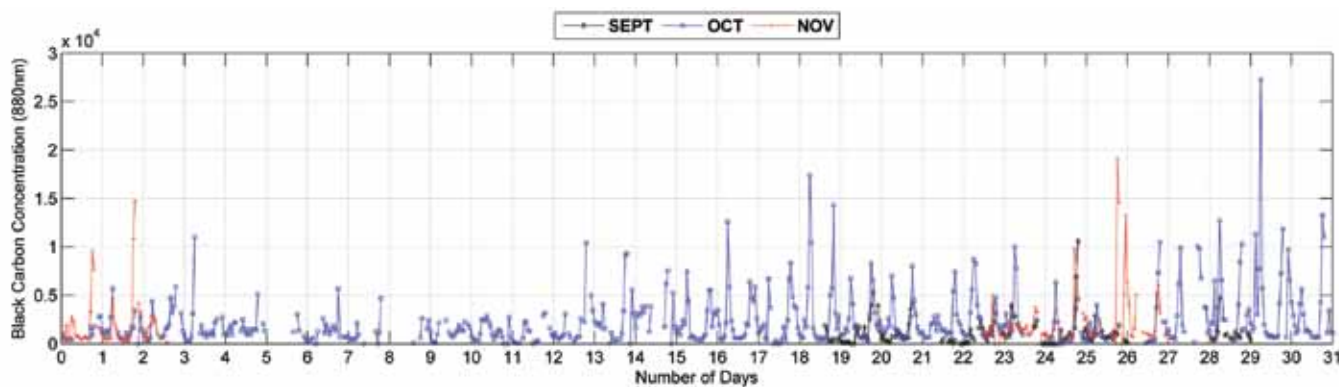
over India (ARFI) project. The observatory has been established within the office premises of the Water Resource Department of Tawang district. A seven channel Aethalometer (AE33) was installed during September, 2016 to start the measurements which are expected to be augmented with more instruments for complete characterization of aerosol over the remote site.



The building with aerosol observatory and the Aethalometer after installation at Tawang, Arunachal Pradesh

The initial data set on black carbon (BC) mass concentration at Tawang is indicative of the very high influence of local vehicular emissions during day and near absolute absence of the anthropogenic sources during night. However, the BC concentration increases very significantly during early morning hours (local time 4 to 6 hours) and late evening hours (local time 17-18 hours). The sudden jump in BC concentration could be because of more dynamic boundary layer fluctuations and also local activities characteristic of the life style of the region.

The hourly mean concentration of BC also indicates dominance of fossil fuel emissions over Tawang. With the onset of winter from end of October, the biomass burning fraction, however, was seen to



Mean hourly concentration of BC over Tawang

increase significantly. The HYSPLIT air mass back-trajectory analysis indicated transport of air from the Brahmaputra valley towards the Tawang, which could also increase the BC concentration.

Characterizing surface layer parameters over a hilly station in Umiam, Meghalaya

A 32-meter meteorological tower was installed within NESAC office campus under the network of boundary layer experiments (NOBLE) project, being coordinated by SPL. The tower is instrumented with a fast response sonic anemometer and slow response meteorological sensors at four levels (8m, 10.5m, 18m, 31m) for measuring wind speed in three dimensions (u_x , u_y , u_z) through programmable flip-flop at a rate of 1 to 60 Hz (as per requirement). Topographically, the site is full of hills and has large water bodies nearby and it is about 1040 meters (890 mb) above mean sea level. 3D wind data are being collected since last three years.

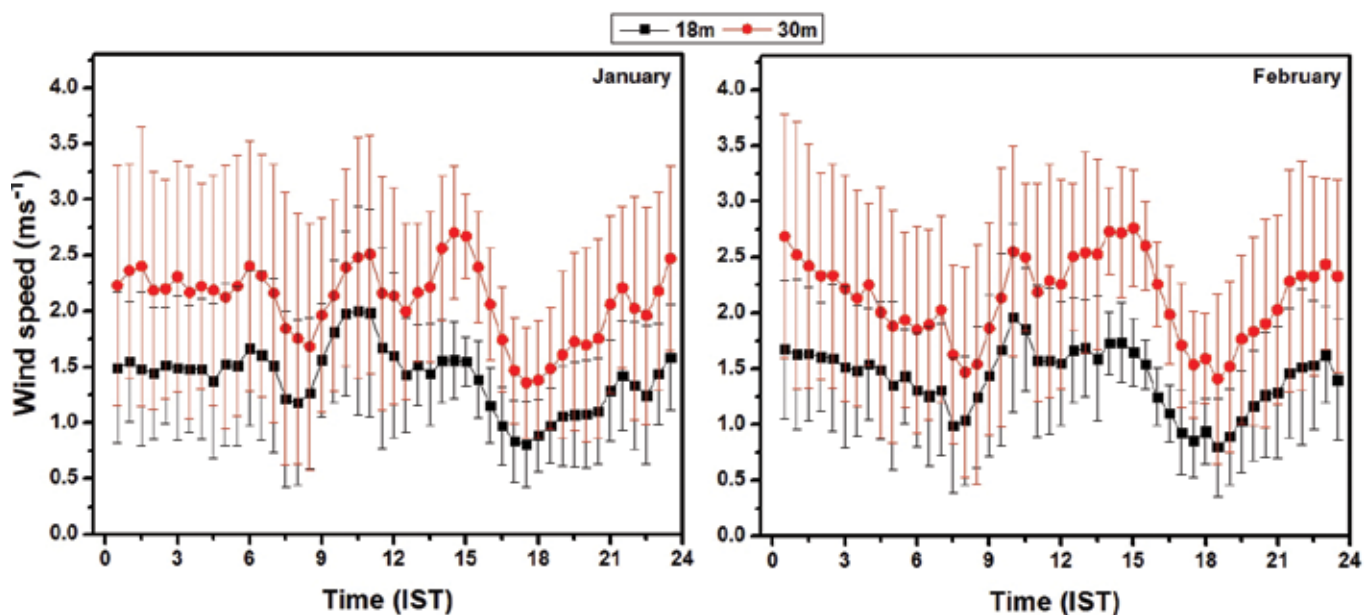
The heterogeneity in the surface cover and the topography of the elevated terrain have a significant impact on the micrometeorological parameters, e.g. Sensible Heat flux (H), Momentum Flux (τ), Latent Heat Flux (L_h), Drag coefficient (C_d) and the circulation of wind over the terrain. The strong synoptic wind flow and its alignment with the topography, along with its interaction with the obstacles and uneven land surface generates more chaos in the systematic evolution of atmospheric boundary layer over a hilly terrain.

Normally, the wind vectors are measured by sonic anemometer in a reference frame which is vertical with respect to gravity, hence it is necessary to transform these measurements into a terrain following reference

frame. Since, sonic anemometer cannot be leveled perfectly, such that its w axis is always perpendicular to the mean flow/mean wind streamlines, the w -component is likely to be contaminated by the other two of the 3D wind components. If an anemometer is placed in a gravity vertical coordinate system over sloping terrain, the fluctuations in the streamwise velocity will create large apparent stresses which are a function of the slope angle relative to the wind direction, making comparison of such measurements with turbulence measurements over flat terrain is difficult. The hilly terrain and valleys are the locations, where coordinate rotation is the most important technique to align an upright component of the instrument perpendicular to the earth surface. For the correction of the data set General Planar Fit (GPF) technique was applied. Here, planar fit coefficients for clear and sunny days were derived at least for 200 numbers of 30-minute average data samples of wind components. After reliable computation of planar fit coefficients, the instrumental offset value was corrected and the surface layer parameters over the elevated terrain, Umiam were calculated.

Wind characteristics

Monthly 30 min bin averaged data was used for understanding the diurnal variation of wind speed and wind direction at the site. Figure below exhibits the diurnal variations in wind speed ranging from 0.3 ms^{-1} to 4.5 ms^{-1} (at 30 m level) and 0.2 ms^{-1} to 2.7 ms^{-1} (at 18 m level) during January and 0.1 ms^{-1} to 3.2 ms^{-1} (at 30 m level) and 0.1 ms^{-1} to 2 ms^{-1} (at 18 m level) during February. The entire winter season sees low to moderate wind over the study area, however, it is very important to study the effect of low/moderate wind



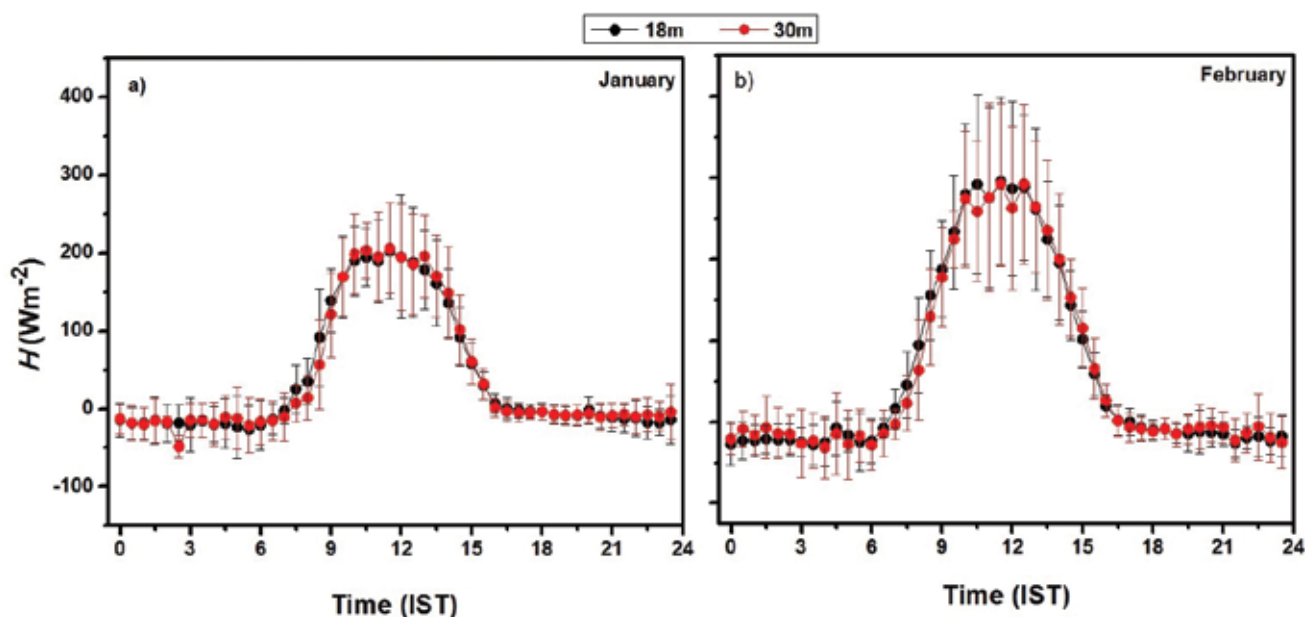
The average wind speed for January (left) and for February.

flows on the surface layer parameters as well as on the evolution of the Atmospheric boundary layer over the region.

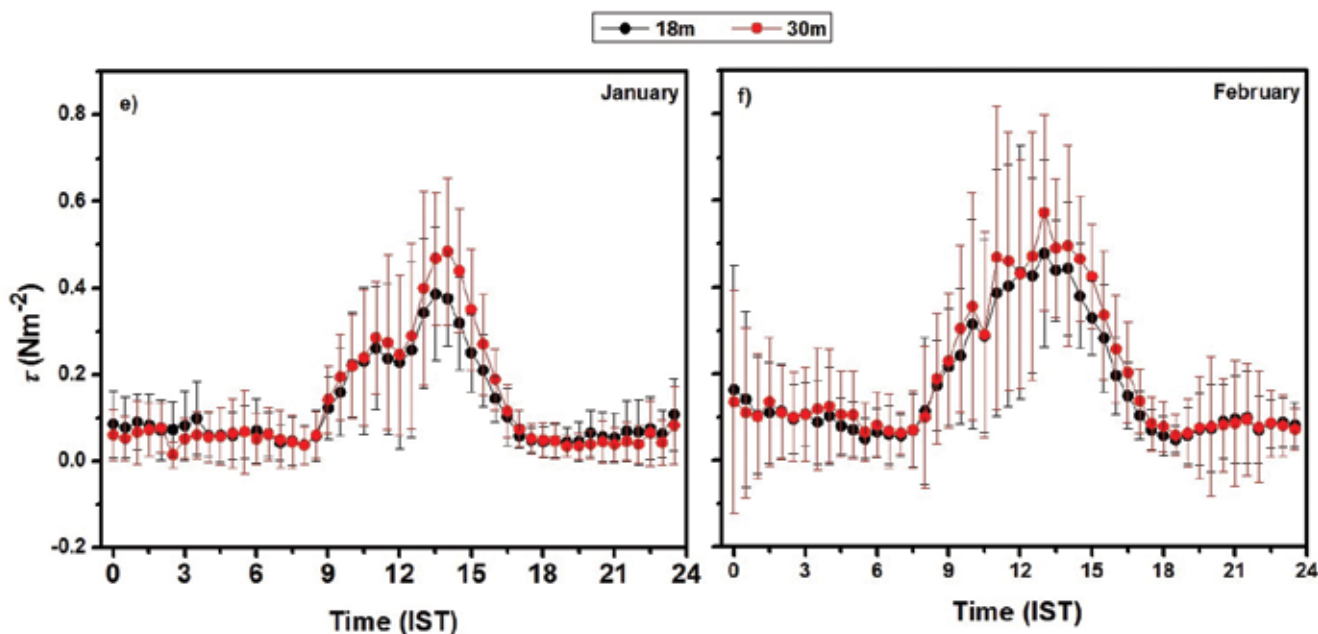
The average diurnal variation of wind direction during the month of January and February was found to flow from the north-easterly zone during morning hours and gradually change to northerly and north-westerly zone by forenoon hours and further changing to westerly and southerly flow in afternoon hours. As the evening sets in, the wind direction gradually moved toward 60° to 90° sectors.

Flux characteristics

The sensible heat flux (H) is a crucial parameter which represents the magnitudes of turbulent exchange of heat energy between the ground surface and the atmosphere. H was computed from sonic anemometer data fixed at the 18 m and the 30 m height. As the incoming solar radiation increases, the H also increases from the negative values ($-38 \pm 33 \text{ Wm}^{-2}$) and ($-28 \pm 31 \text{ Wm}^{-2}$) to the positive values, being $246 \pm 49 \text{ Wm}^{-2}$ and $248 \pm 57 \text{ Wm}^{-2}$ for 18 m and 30 m respectively during the day hours (08:00 to 16:00 IST) of January. Likewise, during February month too, the H enhances from the



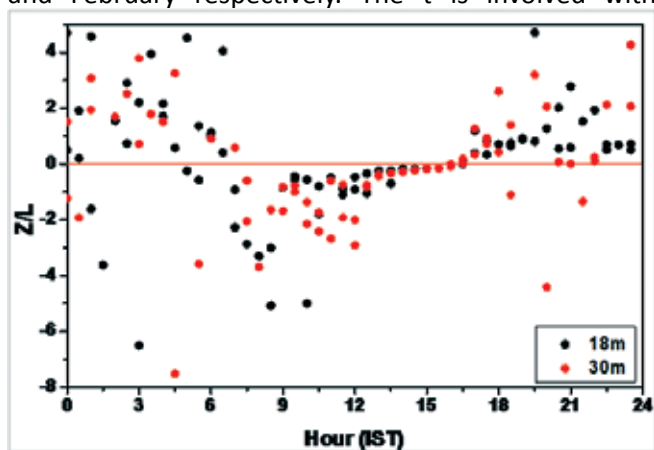
Diurnal variation of H for January (left) and February month



Diurnal variation of τ for January (left) and February month.

lowest magnitudes of $-25 \pm 48 \text{ Wm}^{-2}$ ($-32 \pm 28 \text{ Wm}^{-2}$) in off-sunshine hours to highest magnitudes of $337 \pm 76 \text{ Wm}^{-2}$ ($348 \pm 86 \text{ Wm}^{-2}$) at noontime at the 18 m (30 m) level. The larger value ($348 \pm 86 \text{ Wm}^{-2}$) of H in February than in January ($337 \pm 76 \text{ Wm}^{-2}$) is due higher solar insolation in February as Sun moves from Tropic of Capricorn towards equator. Solanki et al., 2016 reported H of ($353 \pm 147 \text{ Wm}^{-2}$) for the month of May over Nainital, India, which was seen to be comparable with the value of H observed during February over Umiam.

The momentum flux (τ) is depicted in Fig. 9.9. The largest magnitudes of τ are observed during daytime hours (09:00 to 16:00 IST) being $0.36 \pm 0.12 \text{ Nm}^{-2}$ ($0.44 \pm 0.16 \text{ Nm}^{-2}$) and $0.53 \pm 0.20 \text{ Nm}^{-2}$ ($0.58 \pm 0.32 \text{ Nm}^{-2}$) at the 18 m (30 m) level in the month of January and February respectively. The τ is involved with



Diurnal variation of atmospheric stability parameter (ζ) over the site at both levels.

the covariance of fluctuation in wind components; hence it is probably due to the higher wind shear in the month of February, which led to higher τ at both heights. However, in context with similar study over another complex mountainous terrain over Nainital, no significant diurnal variability was depicted by τ , with a spring season mean value of approximately 0.10 Nm^{-2} . Thus on the comparison, the daytime magnitude of τ turns out to be almost three to four times larger over Umiam than the same over Nainital.

Atmospheric Stability characteristics

During the night hours (19:00 to 07:00 IST), when the atmosphere is in the stable state, ζ has positive scalar. The negative values of ζ can be distinguished throughout the forenoon and afternoon hours (07:00 to 16:00 IST) at the both levels. A clear shift from unstable to the neutral state is observed during evening hours (14:00 to 17:00 IST). During the day hours (08:00 to 15:00 IST) surface received maximum solar energy as compared to night and morning hours; which hiked the H and τ values throughout the day hours. In this context, the larger values of H and τ generated instability within the atmospheric boundary layer during day hours.

A sensitivity study of WRF model to LULC changes for simulation of rainfall over NER of India

The Weather Research and Forecasting (WRF) model was configured to provide operational weather forecast for 24 hr over North Eastern Region (NER) of India since

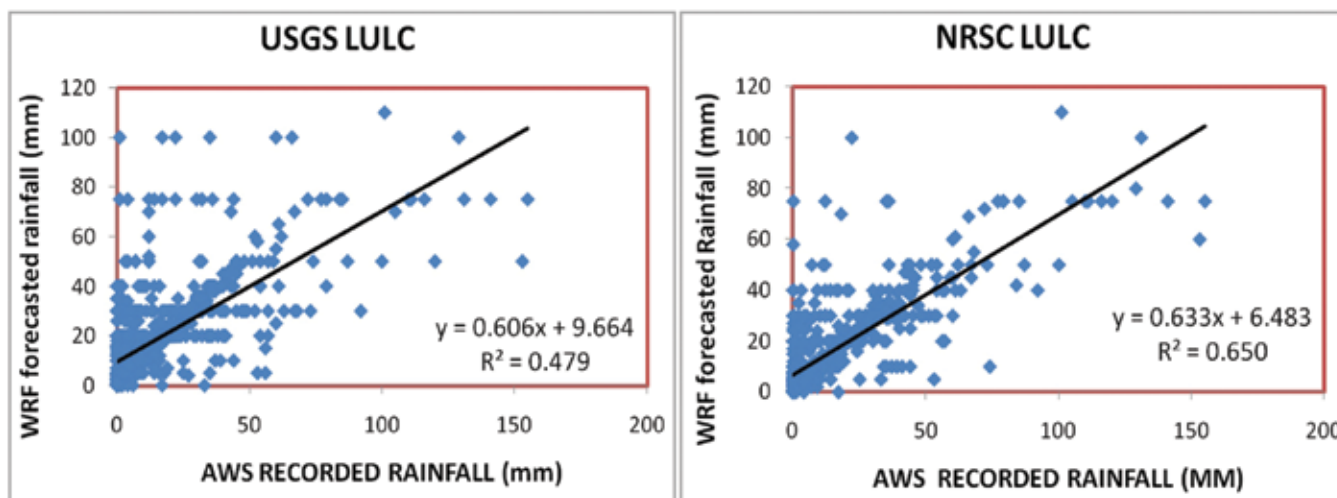
the monsoon season of 2010. Since then significant efforts were made to make best use of the model for Rainfall forecasting, Thunderstorm nowcasting, Cyclone tracking etc.

Accuracy of a numerical model depends on the precision of the input data. Land use characteristic is one of the important information that can modulate the energy exchange processes between land surface and atmosphere by affecting albedo and evapotranspiration. In WRF model the default LULC data is USGS 24 category land-use data, based on AVHRR data spanning April 1992 through March 1993. However, over the period of time the whole globe is undergoing tremendous land use changes due to natural and anthropogenic causes. In this study at NESAC an effort has been made to analyze the sensitivity of WRF model to LULC changes for NER of India.

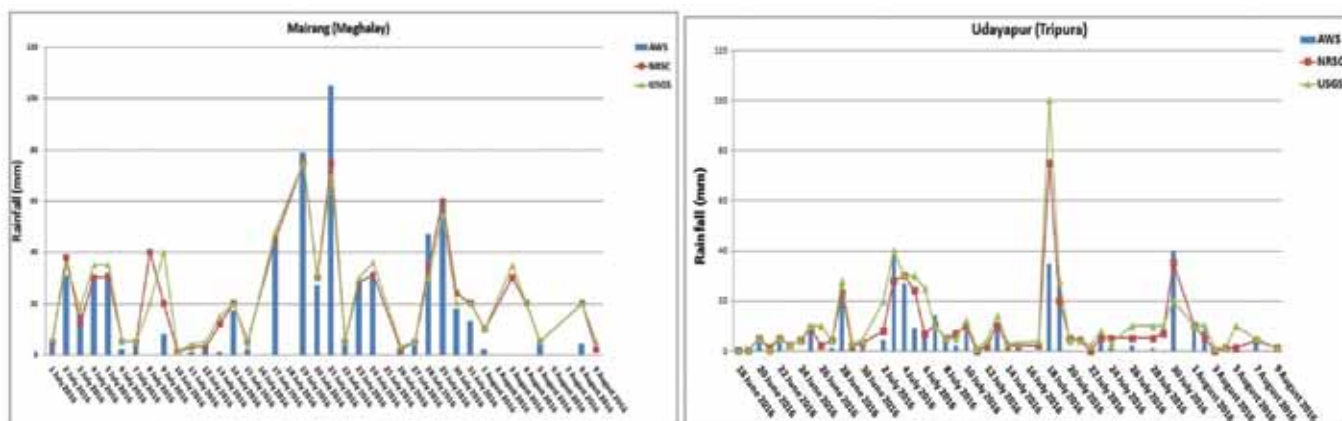
To study the impact, updated LULC data for the period of 2012 to 2013 from NRSC/ISRO has been used along

with the default USGS data at a resolution of 30 sec. For both the cases data assimilation is done by 3DVAR with same data from NCEP ADP global upper air and surface weather observations. Daily rainfall forecast for three consecutive months such as June, July, August were generated and compared with AWS recorded real time rainfall for all the stations covering NER. The result shows that updated NRSC LULC produces good result and improves the rainfall forecast with correlation coefficient of 0.80 as compared to USGS LULC with correlation coefficient of 0.69.

For each of the station both ISRO and USGS characterizes the same LULC category and it is quite visible from the figure that with no changes in LULC, WRF forecasted rainfall follows same pattern. The results obtained herein shows the improvement in numerical weather prediction model's performance and accuracy by fine tuning the land use categories.



Comparison of WRF forecasted rainfall with AWS real time rainfall for LULC data from ISRO and USGS respectively

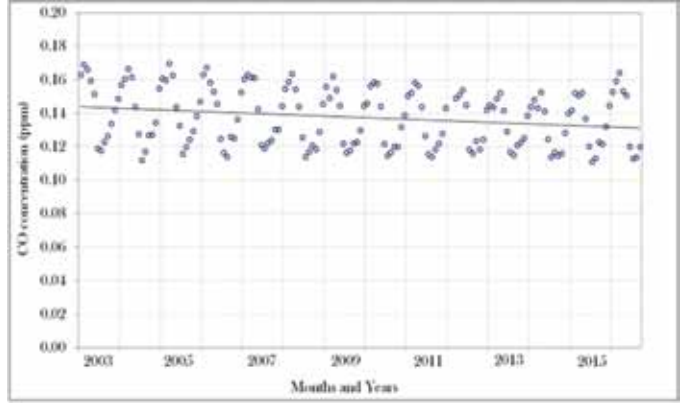
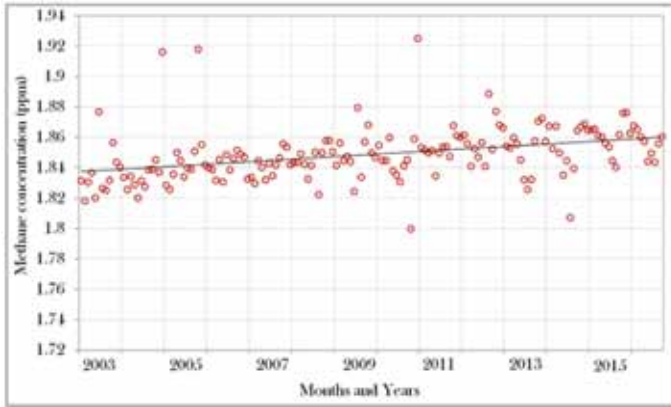


Comparison of WRF forecasted rainfall for Mairang and Udaipur with AWS real time rainfall for LULC data from ISRO and USGS respectively

Long term trend of trace gases over Meghalaya

Annual and seasonal trend of surface level (1000 hpa pressure level) concentration of SO₂, CO, NO₂, O₃, and CH₄ over entire Meghalaya region has been studied with the help of more than 10 years of data retrieved

O₃ and CO concentration data. Seasonal variation of NO₂, O₃ and CO reflects a general trend with highest concentration observed during winter or pre-monsoon time and lower concentration during monsoon and post monsoon time. However there was no general seasonal variation observed for CH₄ and SO₂. The



Trend of Methane (left) and Carbon-monoxide gas over Meghalaya

from satellite sensors like AIRS (Atmospheric Infrared Sounder), OMI (Ozone Monitoring Instrument) and reanalysis data of MERRA (Modern Era Retrospective-analysis for Research and Application). An increasing trend in concentration was observed for NO₂, CH₄ and SO₂, while a decreasing trend was reflected from

concentration of Methane over Meghalaya, which is believed to be the largest contributor to climate change after the Carbon-di-oxide gas was found to be slightly higher than global average. A detail study on the source inventories of these gases is required to be taken up to find the root cause of the observed trend.

OTHER IMPORTANT ACTIVITIES

The 12th meeting of the NESAC Governing Council

The 12th meeting of the NESAC Governing Council was held on 04.07.2016 at NESAC. Shri A S Kiran Kumar, Secretary, DOS & Chairman, NESAC Governing Council chaired the proceedings. The meeting was attended by members and invitees.

Shri PLN Raju, Director, NESAC and the Member Secretary, NESAC-GC, welcomed the Chairman and Members of the 12th meeting of the NESAC GC. He briefed about NESAC activities with emphasis on taking up new activities like UAV Remote Sensing, training and capacity building activities in addition to Remote Sensing & GIS, Space and Atmospheric sciences, satellite communication for societal benefits, Disaster Risk Reduction activities. Shri A S Kiran Kumar, Secretary, Department of Space and the Chairman, NESAC GC, in his opening remarks, appreciated the support of North Eastern Council (NEC) in providing financial support and facilitating linkages with State Governments and various government and private institutions in NER. The chairman mentioned that NESAC plays a catalytic role in utilizing space technology for development of the region. Shri Ram Muivah, Secretary, NEC & Alternate Chairman, NESAC GC in his opening remark emphasized that space technology should reach till village level. He suggested that NESAC should take a lead role for developing monitoring system for NEC funded projects using space technology and mentioned about the utilization of Bhuvan portal for the same.

Director, NESAC has presented the Audit Report for the year 2015-16 and informed the Council that there are only three observations from the Audit which have been followed up and necessary action taken. The GC approved the budget estimates for the Centre along with other necessary approvals on administrative and accounts proposals.

Visit of Department-Related Parliamentary Standing Committee on S&T, Environment & Forests

Department-Related Parliamentary Standing Committee on S&T, Environment & Forests, chaired by

Smt Renuka Chowdhury, made a Study visit to NESAC from 24th to 25th Oct 2016.

The meeting started with an opening remark by Smt. Renuka Chowdhury, Hon'ble Chairperson, Department related parliamentary standing committee on S&T, Environment and Forests. Chairperson made specific mention of the activities that are already taken up by NESAC with regard to Remote Sensing, GIS, Atmospheric Sciences, Satellite Communication Applications while stressing on the need for such technologies to study climate change, infrastructure planning, health and disaster monitoring. Chairperson informed that queries from the Hon'ble members may be replied to in writing within 10 days.

Shri PLN Raju Director, NESAC gave a brief welcome remark and facilitated all the members of the committee. He expressed his gratitude to the committee for choosing NESAC for hosting the visit and wished to get valuable guidance from the committee. Dr. P.G. Diwakar, Scientific Secretary, ISRO made a technical presentation covering various aspects of the space applications activities that are being carried out in the region by NESAC. He highlighted various activities, such as, (a) Remote Sensing Applications in Forestry, Agriculture & soils, sericulture, infrastructure planning, Health & Governance, Disaster management support, use of Geoportals and UAVs etc. (b) Satellite communication applications (Tele education and Tele Medicine) and (c) Atmospheric Science Research.

Based on the technical presentation, the Chairperson and the members to raised few questions, which were responded by the Scientific Secretary and other NESAC Scientists.





World Environment Day celebration

World Environment Day Celebration

World Environment Day was celebrated in the Centre on 6th June 2016. Shri M. Iboyaima Meitei, Adviser (Agri & Allied), North Eastern Council, Shillong, attended the programme as the Chief Guest. A painting competition was organized among school students on the theme 'Go green to save mother Earth' followed by tree plantation program in and around the campus.

2nd International Yoga Day

NESAC celebrated the 2nd International Yoga Day through a week long programme during 13th to 21st



2nd International Yoga Day

June 2016. A week long Art of Living Happiness Program was organized that was participated by 25 staff members. Two invited talks were also delivered by Dr Himanshu Baruah, Medical Officer (Ayu) and Shri J P Dorjee, NEIGRIHMS. Fr (Dr) Joseph Puthenpurakal, SDB, Director, Don Bosco Centre delivered a talk on 'Yoga and its Benefits' during the closing ceremony on 21st June 2016.

Inauguration of NESAC Residential Complex

The NESAC Residential Complex was inaugurated on 4th July 2016 by Shri A S Kiran Kumar, Chairman NESAC GC



/ Secretary, DOS. The new residential complex is having NESAC Guest House, Director's bungalow, 4 E-type, 16



D-type and 4 C-type quarters along with a community Hall and Amenity building.

Swachha Bharat Pakhwada

As part of Swachha Bharat Mission, 3rd to 17th October 2016 was identified for cleanliness drive in the office complex and surrounding areas. The cleanliness fortnight was inaugurated by administering "Swachha Pledge" by Director, NESAC.



Vigilance Awareness Week

NESAC observed Vigilance Awareness Week from 31st October 2016 to 5th November 2016. Following were the programmes conducted:

- Pledge taking ceremony was held on 31.10.2016.
- A speech on the topic 'Prevention of Corruption Act 1988' was delivered by Shri D Roy, Dy Asst Director, Police Science, NEPA, Umiam on 02.11.2016 which was followed by another speech by Smt. Uttara Bora, Branch Manager, SBI, Umiam on the topic 'Preventive Vigilance relating to Banking Operations'.
- An Open Quiz Competition on Vigilance and Information Commission related topic was conducted on 02.11.2016.
- A workshop on the theme 'Public participation in promoting Integrity and eradicating Corruption' was conducted by Shri Avaneesh Shukla, Administrative Officer, NESAC on 04.11.2016.

NESAC Presentations to COPLAT

Department-related Parliamentary Standing Committee on Paper Laid on the Table (COPLAT) visited Shillong and had a meeting with the Officials of NESAC/DOS on 15.01.2017 at Shillong.

Workshop on "Space Technology Inputs for Disaster Risk Reduction"

A two days workshop on "space technology inputs for Disaster Risk Reduction with special emphasis on Early Warning, Preparedness and Mitigation" was organized jointly by North Eastern Council (NEC) and NESAC, Umiam during March 16 -17, 2017 at NESAC. The workshop covered all the natural hazards like flood, river bank erosion, landslides, earthquake, cyclone, thunderstorm, hailstorm, forest fire, disease epidemics etc. under the umbrella of North Eastern Regional Node for Disaster Risk Reduction (NER-DRR).

The workshop was planned in such a manner that it provides an opportunity for interaction among professionals, researchers and the concerned departments engaged in disaster management and mitigation. The participants were facilitated to share the ongoing operational/ research activities so as to help in framing better disaster preparedness and mitigation activities and policy decisions.

The guest of Honour, Shri P.P. Shrivastav, Former Member, NEC stressed on dissemination of information and alerts in disaster situations. Dr. P. G. Rao, Vice-Chancellor, USTM and the Special Guest of the inaugural function appreciated the initiatives of NESAC and NEC



in organizing the workshop which is highly significant for the NE region. An abstract volume of the Workshop proceedings was released by the dignitaries during the inaugural session. During the two days, 40 research papers were presented under six technical sessions covering a range of selected themes. Important resolutions were passed for onward transmission to various users particularly those concerned with disaster management activities.

ISRO/DOS Tele Education Network Coordinators of NER meeting

A meeting was held among ISRO/DOS Tele Education Network Coordinators of NE States, organized by NESAC, Umiam and supported by DECU, Ahmedabad and State Institute of Panchayat and Rural Development (SIPRD), Guwahati on 21st February, 2017 at SIPRD, Kahikuchi, Guwahati to discuss and work out the plan of action for revival and sustenance of the project in NE states and better utilization plan for future.



State level Workshop cum Training programme on EPRIS for the state of Meghalaya

The State level workshop cum training programme on “Empowering Panchayati Raj Institutions Spatially (EPRIS)” for the state of Meghalaya was organized jointly by NESAC, Umiam, National Remote Sensing Centre (NRSC), Hyderabad and District Council Affairs Dept. of Meghalaya at NESAC on 14th December, 2016. Shri Prestone Tynsong, Hon’ble Minister, District Council Affairs etc., Govt. of Meghalaya graced the occasion as the chief guest. Commissioner & Secretary of District Council Dept., Deputy Commissioners, representatives from Garo Hills Autonomous District Council (GHADC), Jaintia Hills Autonomous District Council (JHADC) & Khasi Hills Autonomous District Council (KHADC), representatives from C&RD blocks & other line dept. along with scientists from NESAC attended the programme.



District Level Workshop cum Training programme on EPRIS

The district level workshop cum training programme on “Empowering Panchayati Raj Institutions Spatially (EPRIS)” for East Khasi Hills district of Meghalaya was organized jointly by NESAC and NRSC, Hyderabad and District Council Affairs Dept. of Meghalaya at conference hall of the office of the Deputy Commissioner, Shillong on 24th January, 2017. Shri P.N Syiem, Hon’ble Chief Executive Member (CEM), Khasi Hills Autonomous District Council (KHADC) graced the occasion as the chief guest. Commissioner & Secretary of District Council Affairs Dept. Shri T. Dkhar, IAS and Shri P.S. Dkhar, IAS, Deputy Commissioner (DC) of East Khasi Hills district also attended the programme., Member of District Council (MDC) from KHADC, Block Development Officers (BDOs), representatives from C&RD Dept., Agriculture, Animal Husbandry & Veterinary Dept., Fisheries Dept., Environment & Forest, Soil & Water Conservation Dept., Sericulture Dept., Public Work Dept. (PWD), Public Health Engineering (PHE), Education Dept., & Boarder Area Development Dept. along with scientists from NESAC attended the programme.



NESAC celebrated National Ekta Diwas (National Unity Day)

NESAC celebrated National Ekta Diwas (National Unity Day) on 31st October, 2016 to commemorate the birthday of Sardar Ballav Bhai Patel , whose unparalleled efforts were instrumental in maintaining the political unity of the Free India at the wake of Independence. Director and staff of NESAC took a pledge to maintain unity and integrity at all levels of work. NESAC celebrated Vigilance Awareness Week from 31st October to 05th November, 2016. Director and staff of NESAC took pledge for working within the guidelines of Central Vigilance commission and remain



vigilant in all official work. The pledge taking ceremony was held at NESAC Auditorium.

NESAC celebrated its 16th Foundation Day

NESAC celebrated its 16th Foundation Day on Monday, September 05th, 2016 at Umiam with the Official release of North Eastern District Resources Plan (NEDRP) portal, organizing talks by Eminent academicians from the region and distribution of awards under various categories.

Dr. J.S. Parihar, the founder Director of NESAC and former - Satish Dhawan Professor, ISRO & Dy. Director, SAC, Ahmedabad graced the occasion as the chief guest. He delivered talk on "Space Technology for Development of NE". Eminent academicians from the region Dr. Amarjyoti Choudhury, former Vice Chancellor, Guwahati University & Pro-VC, Tezpur University, delivered a talk on "Technology demands for development of NE" and Dr. Dulal C Goswami, former Professor, Guwahati University, delivered a talk on "Wealth and woes of the Bhramaputra River: Geospatial Technology & Management" on the occasion. Many officials and public representatives from the area were also present. Shri C.H. Kharshiing, Advisor (Planning), North Eastern Council (NEC) released the NEDRP portal in the public domain. Shri Kharshiing appreciated the efforts made by NESAC for development of north eastern region.

NEDRP is one of the successful programme of NESAC with an objective to make use of geospatial inputs for preparation of Detailed Project Report (DPR), Master plan document and planning of various developmental activities in the NE region. It is sponsored by the North Eastern Council and executed by NESAC in collaboration

with State Remote Sensing Centre of NE region in order to strengthen the governance policy through geospatial inputs. It is noted that NEDRP will facilitate Geo-spatial data sharing within the Government Departments through the secure authentication gateway and on-the-fly Geo-processing of action plan inputs based on the user's criteria. This version of NEDRP covers 36 districts of NE Region, remaining districts of NE Region will be covered soon.



NESAC-Academia and Students Interaction meet

To create awareness and generate interest among academicians and researches in the field of space technology applications, space and atmospheric science and satellite communication, a one day Academia and Students Interaction meet was conducted at NESAC, Umiam on 24th June, 2016. This was a novel initiative as it brought the best Academicians of the region at the same platform with the students and aspiring researchers of the region from various academic institutions. It also served as a platform for discussing present and future/proposed activities of the NESAC and possible areas of collaboration between NESAC and various Academic Institutions.

The meet was inaugurated by lighting the lamp by Chief Guest, Dr. Dilip Kumar Saikia, Director, NIT, Meghalaya and other dignitaries. Sri PLN Raju, Director, NESAC presented on the current status of 'Indian Space Program' and 'Role of NESAC in Space Technology Applications for North Eastern Region; Possible linkages with academia for research, training and capacity building'. Dr. Ganesh Raj, Director, RESPOND, ISRO gave a presentation on 'RESPOND-Sponsored Research Program of ISRO'. Dr. Minakshi Devi, Professor, Department of Physics, Gauhati University, delivered

a talk on 'Research in Atmospheric Science: Present status and Future Vision: A brief report based on GU research activities'.

Total 155 participants from 21 institutes of NE India attended the meet and participated actively in the discussion. A poster session was also conducted in a separate parallel session where around 10 participants presented their posters. In the poster session there were total 10 participants, out of which 3 best posters were also selected and awarded. Total 20 presentations were made by various faculty members and researchers, out of which 10 were from remote sensing and GIS theme, 7 are from Atmospheric Sciences and 3 are from Satcom applications. This was followed by a panel discussion where interaction between the participants and the panelists had taken place with respect to the possibility of collaboration on the proposed projects and technological issues etc.



Training on Bhuvan Postal Mapper for Postal Officials of NER

One day training programme on Bhuvan Postal Mapper was organized by NESAC and NRSC on 8th April, 2016. The training was attended by 8 officials from North East

Postal circles. Hands-on training using Bhuvan Postal Mapper was given via Bhuvan portal.



State Meet on Space Technology uses for Meghalaya

State Meet on "Promoting Space Technology based tools and applications in Governance and Development in the state of Meghalaya" was organized at Meghalaya Secretariat, Shillong. The inaugural session was chaired by Shri. Y. Tsering, IAS, Addl. Chief Secretary to Govt. of Meghalaya. Dr. B. D. R. Tiwari, IAS, Secretary Planning to the Govt. of Meghalaya welcomed all the dignitaries



and the participants to the State Meet. Three parallel technical sessions were conducted. Each Department presented the projects identified, the benefits anticipated to the department and plan of action. The Meghalaya State Meet concluded with a special session where Shri K. S. Kropha, I.A.S, Chief Secretary to the Government of Meghalaya was the Chief Guest. Outcome of the technical sessions was presented by the Secretary Planning to the Chief Secretary of

Meghalaya. Altogether 52 projects were identified. The meeting was attended by 116 officers representing 42 departments of the Government of Meghalaya.

Visit of Secretary, DoNER to NESAC

Shri Naveen Verma, Secretary, DoNER visited NESAC on 7th May 2016. He was briefed about the NESAC activities by Director, NESAC with focus on the progress of the projects that was taken up as part of National meet on “Promoting use of Space Technology for Governance and Development”. He took keen interest on several activities of NESAC and requested NESAC to focus on the projects with objective of livelihood generation, infrastructure development, watershed management etc.

Basic Course on Remote Sensing and GIS for NDRF officials, 16-27th May 2016

Two weeks training on basics of Remote Sensing and GIS was organized at NESAC for the NDRF Officers during 16-27 May, 2016. Special emphasis was given in the course on the disaster risk reduction activities for operational flood early warning system, landslide and



earthquake, etc. Various satellite communication based emergency communication facilities; GIS data portals like BHUVAN, NEDRP have been also demonstrated.

Basic Course on Remote Sensing and GIS at NESAC

For the first time, NESAC initiated to conduct two regular courses in every year since 2016. The first Basic Course on Remote Sensing & GIS-Technology and Applications was organized during April 18-29,

2016. Total 45 participants from different parts of India attended the course.



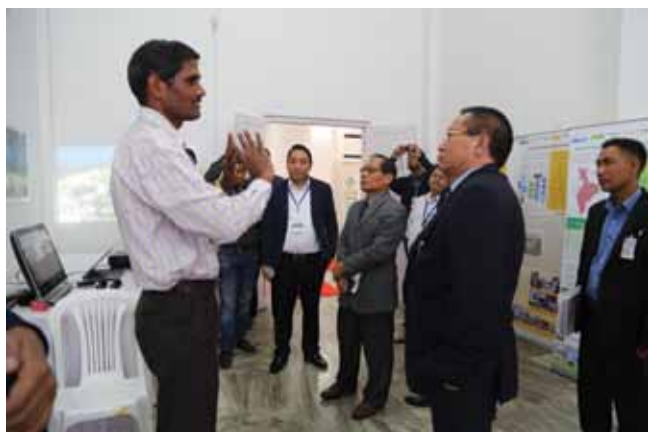
Meeting with the Govt. of Assam for Asset Mapping

NESAC and NRSC participated in a meeting organized by Planning and Development Department, Government of Assam on 9th May, 2016 for implementation of asset mapping work for the State of Assam. A model framework using Bhuvan Panchayat and GAGAN GPS developed for the State of Andhra Pradesh was demonstrated in the meeting.



Nagaland State Meet on Promoting use of Space Technology

Nagaland State Meet on Promoting Use of Space Technology and Applications in Governance & Development was organized jointly by Nagaland GIS & Remote Sensing Centre, Planning & Coordination Department, Government of Nagaland, ISRO and NESAC, Department of Space, Government of India on 6th April 2016. A Total number of 204 participants attended the State Meet. In the inaugural session the Chief Guest Shri. Neiba Khronu, Hon'ble Parliamentary Secretary, Planning & Coordination Department, Evaluation & Taxes grace the session. A geospatial



exhibition gallery was organized and was inaugurated by Hon'ble Parliamentary Secretary, Planning & Coordination Department, Evaluation & Taxes. All together 37 line Departments made power point presentations on the key areas identified by their respective Department. The special session was graced by Shri. T.R. Zeliang, Hon'ble Chief Minister, Nagaland as the Chief Guest and Chief Secretary, Nagaland chaired the session. The session started with a video documentary on the activities of the Nagaland GIS & RS centre, followed by the presentation on the salient outcome of the Thematic Session by the Additional Chief Secretary & Development Commissioner, Nagaland. Strategies & Way Forward was presented by Shri. P L N Raju, Director, NESAC and A Reflection on the importance of Space Applications in the region was highlighted by Hon'ble Parliamentary Secretary, Planning & Coordination, Evaluation & Taxes. A total of 107 Key areas were Identified for use of Space Technology in Governance and Development for the State of Nagaland.

Laying of foundation stone of the NESAC Outreach Facility

Shri A S Kiran Kumar has laid the foundation stone of the NESAC Outreach Facility Building at the newly acquired one acre land at Umiam, on 2nd March 2017.



Important Visitors

Following were the important personalities who visited NESAC during the year 2016-17.

07.05.2016	Shri Naveen Verma Secretary, Ministry of Development of North Eastern Region, Govt. of India
31.05.2016	Shri Raghvendra Singh Addl. Secretary, DAC & FW
21.06.2016	Fr (Dr) Joseph Puthenpurakal SDB Director, Don Bosco Centre for Indigenous Cultures, Shillong
04.07.2016	Shri Ram Muivah, IAS Secretary, NEC
16.09.2016	Shri M V Dhekane Director, IISU
03.10.2016	Shri R R Navalgund Professor Vikram Sarabhai Distinguished Professor
28.10.2016	Smt Renuka Chowdhury Chairperson, Parliamentary Standing Committee on S&T, Environment & Forests
11.11.2016	Shri J N Goswami Former Director, PRL
13.12.2016	Shri Prestone Tynsong Minister, Govt of Meghalaya

28.01.2017	Dr H Nagesh Prabhu, IFS Member Secretary, Central Silk Board, Meghalaya
30.01.2017	Shri Puneet Agarwal Joint Secretary, Ministry of Textiles, Govt of India

Training/Workshop/Seminar organised at NESAC

- Two weeks Basic Course on “RS& GIS – Technology & Applications” was conducted from 18th to 29th April 2016
- Basic course on RS & GIS–Technology & Applications) was conducted for NDRF from 16th May to 27th May 2016
- NUIS Workshop was conducted on 20th June 2016
- NESAC Academia & Students Interaction Meet was held on 24th June 2016.
- A one day State Level Workshop on Master Plan Formulation Using NUIS-Bhuvan for the state of Manipur was conducted on 20th June 2016
- EPRIS Training was conducted on 5th October 2016
- Short Term Course on the Application of UAV Remote Sensing was conducted from 31.10.2016 to 11.11.2016
- Workshop on “Forest fire scenario and its mitigation in North Eastern Region was conducted on 9th November 2016
- A one day State Level Workshop cum Training programme on EPRIS for the state of Meghalaya was conducted on 14th December 2016
- IWMP Workshop was conducted from 10th to 11th January 2017
- Hands on training on Application of RS & GIS in Sericulture Development (Phase II) was conducted from 28th February to 2nd March 2017
- Workshop on Space Technology Inputs for Disaster Risk Reduction in North Eastern Region with special emphasis on Preparedness and Mitigation was conducted from 16th to 17th March 2017.
- A total number of 650 students from 15 Educational Institutions visited the Centre during 2016-17.

Official Language Implementation

Hindi Fortnight was celebrated in the Centre from 1st to 15th September 2016. As part of the Hindi

Fortnight Celebration, a lecture was delivered by Shri J S Parihar, on 05th September 2016, which was followed by a practice session of Hindi typing in Unicode. Various other programmes like workshop on noting and drafting, Extempore Speech, Essay writing , Newspaper reading, Singing, Recitation, Antakshri and Debate competitions were conducted during the Hindi Fortnight for all employees. Prizes were given to the winners.

Annual Hindi Inspection (2015-2016) was conducted by Shri B R Rajput, Joint Director, OLIC, DOS on 29.12.2016. He has appreciated the progress of Hindi works in the Centre, in spite of non availability of any Hindi staff and suggested various measures for implementation of Official Language in the Centre. Shri B L Rajput, also conducted a workshop on the topic ‘Information regarding Official Language Policy and Practice of Office related works’ on 29.12.2016.

World Hindi Day was celebrated in the Centre on 10th January 2017. Programmes like Hindi Handwriting, Debate and Letter Writing competitions for all staff members were organized on this day.

A workshop on the topic ‘Hindi –Language, Alphabets and words was conducted by Shri A K Pandey, Retd Hindi Teacher, MeECL School, Umiam on 31.03.2017, wherein most of the staff members actively participated.

Welfare of SC & ST

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. Following table indicates the status of representations of persons belonging to Scheduled Caste and Scheduled Tribe.

Sl No	Centre / Unit	Total strength of employees 2015-2016	Strength of SC employees 2015-2016	Strength of ST employees 2015-2016
01	NESAC	37	02	04

- 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.

- ii) 100% of Group B employees are from ST community or are ST
- iii) Some of the Research Scholars are from SC/ST Community
- iv) Many of the services 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.

Awards & Recognitions

National Geomatics Award- Applications- 2016 to Shri PLN Raju



In recognition of his outstanding contribution in the field of applications of Geomatics in various aspects of education, outreach and capacity building, The Indian Society of Geomatics conferred “National Geomatics Award-Applications” for the year 2016 on Shri PLN Raju,

Director, NESAC. The award was presented during the National Symposium on Recent Advances in Remote Sensing and GIS with Special Emphasis on Mountain Ecosystems & Annual Conventions of Indian Society of Remote Sensing & Indian Society of Geomatics during December 7-9, 2016 at Dehradun.

ISRO-ASI Young Scientist Award to Dr. Bijoy K. Handique

Dr. Bijoy K. Handique, Scientist-SF, NESAC was selected for ISRO-ASI Young Scientist Award 2014 for his significant contribution on space applications in the field of Agriculture, Sericulture and Spatial



Epidemiology. The Award was declared through a Press release of Astronautical Society of India (ASI) on June 30, 2016. The Award was conferred during the ASI Award Function organized at ISRO Satellite Centre (ISAC), Bangalore.

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3. Handique, B. K., Goswami, J., Qadir, Abdul, Gupta, C., and Raju, P.L.N. (2016) Rapid assessment of Boro paddy infestation by Brown Plant Hopper in Morigaon district of Assam using Unmanned Aerial Vehicle (UAV), *Current Science* Vol 111, No 10 pp.1604-1606.
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5. Handique, B.K., Khan, S.A., Dutta, P., Nath, M. J., Qadir, A. and Raju, P.L.N. (2016) Spatial correlations of malaria incidence hotspots with environmental factors in Assam, north east India, *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, Volume III-8, pp: 51-56.
6. Chakraborty, K., Sarma, K.K., Kundu, S.S., Das, A. K., 2016. Shifting cultivation dynamics in Barak basin of North East India- a geospatial approach, *International Journal Of Advancement In Earth And Environmental Sciences* (2015) Vol.3, No.2, 21-29.
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9. Sharma, V., Chutia, D., Baruah, D., Raju, P.L.N., Bhattacharya, D.K. 2016. An Assessment of Support Vector Machine Kernel Parameters using Remotely Sensed Satellite Data, *IEEE International Conference On Recent Trends In Electronics Information Communication Technology*, May 20-21, 2016, India, 1622-1625.
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11. Raju, P. L. N., Sarma, K. K., Barman, D., Handique, B. K., Chutia, D., Kundu, S. S., Das, R. K., Chakraborty, K., Das, R., Goswami, J., Das, P., Devi, H. S., Nongkynrih, J. M., Bhusan, K., Singh, M. S., Singh, P. S., Saikhom, V., Goswami, C., Pebam, R., Borgohain, A., Gogoi, R. B., Singh, N. R., Bharali, A., Sarma, D., Lyngdoh, R. B., Mandal, P. P., Chabukdhara, M., 2016. Operational remote sensing services in north eastern region of India for natural resources management, early warning for disaster risk reduction and dissemination of information and services, *The International Archives of the ISPRS, XLI-B4, 2016 XXIII ISPRS Congress*, 12–19 July 2016, Prague.
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15. Hazarika, N., Barman, D., Das, A.K., Sarma, A.K., Borah, S.B., 2016, Assessing and mapping flood hazard, vulnerability and risk in upper Brahmaputra river valley using stakeholder's knowledge and multi-criteria evaluation (MCE), *Journal of Flood Risk Management, Wiley online library, May, 2016.*
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1. Jenita et al. 2016. Tourism Information System of South West Khasi Hills District Meghalaya, NESAC-SR-165-2016.
2. Sarma K K, Chakraborty K, Sohlang N N and Yumnam J Y 2015 District Report, Meghalaya: Remote Sensing and GIS inputs for forest working schemes in Meghalaya. Scientific Report, NESAC (NESAC-SR-111-117-2015).
3. Sarma K K, Chakraborty K, Sohlang N N and Yumnam J Y 2015 Remote Sensing and GIS inputs for forest working schemes in blocks of South Garo Hills Hills district of Meghalaya. Scientific Report, NESAC (NESAC-SR-118-2015).
4. Sarma K K, Chakraborty K, Sohlang N N and Yumnam J Y 2015 Remote Sensing and GIS inputs for forest working schemes in blocks of East Garo Hills District, Meghalaya. Scientific Report, NESAC (NESAC-SR-119-2015).
5. Sarma K K, Chakraborty K, Sohlang N N and Yumnam J Y 2015 Remote Sensing and GIS inputs for forest working schemes in blocks of West Garo Hills District, Meghalaya. Scientific Report, NESAC (NESAC-SR-120-2015).
6. Sarma K K, Chakraborty K, Sohlang N N and Yumnam J Y 2015 Remote Sensing and GIS inputs for forest working schemes in blocks of West Khasi Hills District, Meghalaya. Scientific Report, NESAC (NESAC-SR-121-2015).

DETAILS OF INTERNSHIP/PROJECTRAINEES DURING 2016-17

SN	Institute/ University	Course	No of students	Project Title	
1	Bharathidasan University, Trichy	M.Tech, Geoinformatics	3	Mapping of forest biomass for Nongkhyllem reserve forest and wildlife sanctuary of Meghalaya.	
				Catchment level rainfall runoff modelling in tributaries of Brahmaputra valley.	
				Modelling and Mapping of Aboveground Forest Biomass Using Alos-2 Palsar-2 Data in Nongkhyllem Reserve Forest and wildlife sanctuary, Meghalaya.	
2	Central University of Karnataka, Gulbarga	M.Sc. Applied Geography & Geoinformatics	1	Identification of potential sites for mulberry cultivation in West Garo hills of Meghalaya using geospatial techniques.	
3	National Institute of Technology (NIT), Sikkim	B.Tech, Elect & Comm.	2	A multi-parameter based earthquake prediction study.	
				Study of total electron content in Ionosphere.	
4	Sikkim Manipal Institute of Technology(SMIT), Sikkim	M Tech, IT		A study on feature extraction and selection in improving classification performance for remotely sensed data.	
5	Kumaun University, Uttarakhand	M.Sc. RS & GIS	2	Application of Geospatial Technology in erosion studies of Majuli island, Assam.	
				Spatial decision support system for identification of potential sites for turmeric cultivation in Jaintia hills of Meghalaya.	
6	Bhartiya Vidhyapeeth University, Pune	M.Sc. Geoinformatics	1	Vegetation condition assessment of North Eastern Region using Geo-Spatial Technologies	
7	Gurukul Vidyapeeth Institute of Engineering & Technology (GVIET), Patiala	B.Tech, Aerospace Engr.	1	Assembly of Fixed wing Unmanned Aerial Vehicle (UAV)	
8	Assam Don Bosco University, Guwahati	M Tech, Civil Engr.	1	UAV Applications in Road Monitoring for maintenance purpose	
9	Birla Institute Of Technology and Science(BITS), Pilani, Gao, Hyderabad Campus	B.Tech in Computer Science/Electrical & Electronics	3	Development Of Plug-In For Generation Of Map Template. Plug-In Should Support Both QGIS & Arcgis Or Platform Independent	
				1	To Explore Google Earth Engine For Large Scale Analysis Of Remote Sensing Data
				3	GIS Solutions – Incident Reporting And Data Analytics
				3	Object based image classification with pattern recognition techniques
				3	Dashboard visualization based on slider/query tool- to be tested & deployed on www.nerdr.gov.in & www.nedrp.gov.in
				3	Auto-Registration Tool Using GDAL – Should Be Platform Independent
10	School of Planning and Architecture (SIPA), Vijayawada	B.Planning	1	Planning for solid waste & waste water management for NESAC Campus	

AUDITORS REPORT & STATEMENT OF ACCOUNTS



D. Das & Associates
Chartered Accountants

E-mail : ddasgs@rediffmail.com
d_dasassociates@yahoo.co.in
FRN No. : 323899E

AUDITORS– REPORT

We have audited the attached Balance Sheet as at March 31st, 2017 and also the Income and Expenditure Account and Receipts & Payments Account of NORTH EASTERN SPACE APPLICATIONS CENTRE : UMIAM : MEGHALAYA for the year ended on that date annexed thereto. These financial statements are the responsibility of the Centre's Management. Our responsibility is to express an opinion on these financial statements based on our audit.

We have 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 misstatement. An audit includes examining, on a test basis, evidence supporting the accounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion, subject to the observation that

1. Physical verification of Fixed Assets have not been carried out by the management during the year. Moreover subsequent to verification of assets identified as scrap remains to be written off as at the end of the year.
2. There has been undue delay in settlement of following advances given to:
 - i) LUP of Tirap District-AP – Rs. 3,85,000/-
3. Attention is invited to Schedule-II relating to Project Accounts – USER Project & ISRO Project under "Current Liabilities & Provisions". Reporting under this head is restricted to deduction of relatable expenses from Grants received. Relatable expenses also include assets procured under the schemes & projects. However, no register is being maintained in respect of assets procured. The management is requested to initiate the same at the earliest.
 - a) We have obtained all the information and explanation, which to the best of our knowledge and belief were necessary for the purpose of our audit and have found them to be satisfactory.
 - b) In our opinion, proper books of accounts as required by law have been kept by the Centre so far as appears from our examination of the books.
 - c) In our opinion and to the best of our knowledge and information and according to the explanations given to us, the said accounts read with the notes attached hereto give a true and fair view:
 - i) The Balance sheet is full and fair Balance Sheet of the centre containing the necessary particulars and is properly drawn up so as to exhibit a true and fair view of the affairs of the Centre as on March 31st, 2017, and
 - ii) The income and Expenditure account of the centre shows true balance of deficit for the year covered by the account.

Place : Shillong
Date : 26/05/2017



for **D. Das & Associates**
Chartered Accountants

Debapratim Das
(Partner)

HEAD OFFICE : 1st Floor, Hotel Utsav Building, Above Chapala Book Stall, Jail Road, Shillong - 793 001, Ph. : 0364-2500444, 2504670

BRANCH OFFICE : 3rd Floor, Girish Bhawan, Opp. IDBI Building, ABC, G.S. Road, Guwahati - 781005, Cell : 98647-54817

Name of the Partners : Debapratim Das (Membership No. 059206), Kishore Baishya (Membership No. : 305230)

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-2017

(Amount - ₹)

CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Capital Fund	1	41,99,17,665.46	38,80,01,316.47
Current Liabilities & Provisions	2	30,55,64,383.00	15,59,13,636.00
Pension Fund as per contra*		79,83,832.00	59,38,657.00
TOTAL		73,34,65,880.46	54,98,53,609.47
ASSETS			
Fixed Assets	3	32,28,19,955.00	27,88,72,756.00
Current Assets, Loans & Advances etc.	4	40,26,62,093.46	26,50,42,196.47
Pension Fund as per contra*		79,83,832.00	59,38,657.00
TOTAL		73,34,65,880.46	54,98,53,609.47
Significant Accounting Policies	10		
Contingent Liabilities & Notes on Accounts	11		

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

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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-2017

(Amount - ₹)

INCOME	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Grants	5	15,84,00,000.00	12,21,00,000.00
Other Incomes	6	10,96,323.99	5,84,508.96
Incomes from Services	7	-	13,85,000.00
TOTAL		15,94,96,323.99	12,40,69,508.96
EXPENDITURE	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Establishment Expenses	8	9,25,78,363.00	6,62,92,215.00
Other Administrative Expenses & etc.	9	2,84,11,341.00	2,20,07,603.00
“Depreciation *(Net total at the year-end – corresponding to schedule 3) (Column 7)”		2,24,95,173.00	1,90,60,048.00
TOTAL		14,34,84,877.00	10,73,59,866.00
BALANCE BEING SURPLUS (+)/ DEFICIT (-)		1,60,11,446.99	1,67,09,642.96
Less: Prior period expenses - Establishment Expenses		4,45,964.00	2,06,620.00
Less: Prior period expenses - Other Administrative Expenses		-	3,73,003.00
Less: Provision for Pension, Gratuity & Leave Encashment		3,26,49,134.00	4,46,529.00
Add: Prior period excess provision (Being excess provision for pension, gratuity & leave encashment made during 2014-15)		-	1,26,59,965.00
NET SURPLUS (+)/ DEFICIT (-) CARRIED TO CAPITAL FUND		(1,70,83,651.01)	2,83,43,455.96

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

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

भारत सरकार / GOVERNMENT OF INDIA
उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE
अंतरिक्ष विभाग / DEPARTMENT OF SPACE
उमियम / UMIAM - 793103, मेघालय / MEGHALAYA
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31-MARCH-2017

Amount in (₹)

RECEIPTS		CURRENT YEAR	PREVIOUS YEAR	PAYMENTS		CURRENT YEAR	PREVIOUS YEAR
I.	Opening Balances			Expenses			
	a) Cash in Hand	-	-	a) Establishment Expenses	8,24,53,730.00	6,47,54,890.00	
	b) Bank Balances:			b) Other Administrative Expenses	2,82,89,335.00	2,05,76,129.00	
	i) In Current Accounts, SBI Shillong	6,69,36,549.91	4,60,13,821.91	Investments and Deposits.			
	ii) In Current Accounts, SBI Umiyam	12,61,42,063.56	14,49,58,380.60	Deposit with MeSEB/ NRSC/ BSNL	12,49,085.00	21,70,080.00	
	iii) In Current Accounts, Canara Bank	6,36,18,391.00	4,49,20,011.00	Fixed Assets & Capital Work-In-Progress			
		-	-	Purchase of Fixed Assets	6,08,60,089.00	2,39,45,908.00	
II	Grants Received			Other Payments			
	From Government of India:			a) ISRO Projects	54,36,641.00	1,98,21,882.00	
	a) Department of Space, Bangalore			b) USER Projects	1,67,09,630.00	1,02,79,487.00	
	i) For Salaries	5,07,00,000.00	4,08,00,000.00	c) In-House Projects	16,06,078.00	18,53,552.00	
	ii) For General	7,27,00,000.00	5,13,00,000.00	d) Advances to Staffs	28,85,004.00	27,72,673.00	
	iii) For Creation of Capital Assets	4,90,00,000.00	-	e) Advances to Projects	4,73,250.00	10,90,900.00	
	b) Ministry of DONER, NEC Shillong	3,50,00,000.00	3,00,00,000.00	f) Advance to NRSC	-	17,282.00	
III	Interest Received			g) Payment of Recoveries	1,35,95,552.00	79,30,064.00	
	On Fixed Deposits & Other Interests	-	-	h) Prior Period Expenses	4,44,889.00	1,86,705.00	
IV	Other Incomes			i) Security Deposits	37,13,072.00	49,13,099.00	
	a) Others	7,76,423.99	4,33,237.96	j) ISTRAC Expenses	12,35,613.00	8,95,049.00	
V	Other Receipts			Closing Balances			
	a) Miscellaneous Recoveries	2,66,406.00	15,09,562.00	a) Cash in Hand	12,000.00	-	
	b) Recovery of Advances and Deposits from:			b) Bank Balances:			
	i) Staffs (Cont., Imprest, TA/ DA & LTC Advances)	8,43,355.00	6,81,545.00	i) In Current Accounts, SBI Shillong	9,52,93,646.41	6,69,36,549.91	
	ii) Others Receipts from ISTRAC/ NRSC/ DWR	62,63,976.00	77,81,640.00	ii) In Current Accounts, SBI Umiyam	14,41,86,422.05	12,61,42,063.56	
	c) Receipts on ISRO Projects	8,96,82,812.00	2,22,99,948.00	iii) In Current Accounts, Canara Bank	15,07,19,833.00	6,36,18,391.00	
	d) Receipts on USER Projects	4,35,69,472.00	2,61,49,058.00				
	e) Security Deposits	36,64,420.00	10,57,500.00				
	TOTAL	60,91,63,869.46	41,79,04,704.47	TOTAL	60,91,63,869.46	41,79,04,704.47	

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

for **D. DAS & ASSOCIATES**
Chartered Accountants

Sd/-
(DEBAPRATIM DAS)
Partner

Date: 26.05.2017

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

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

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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-2017

(Amount - ₹)

SCHEDULE 1 - CAPITAL FUND		CURRENT YEAR		PREVIOUS YEAR	
Balance as at the beginning of the year		38,80,01,316.47		35,96,57,860.51	
Add: Balance of Surplus (+)/ Deficit (-) transferred from the "Income & Expenditure Account"		(1,70,83,651.01)		2,83,43,455.96	
Add: Grant-In-Aid for Creation for Capital Assets		4,90,00,000.00	41,99,17,665.46	-	38,80,01,316.47
BALANCE AS AT THE YEAR END			41,99,17,665.46		38,80,01,316.47
SCHEDULE 2 – CURRENT LIABILITIES AND PROVISIONS		CURRENT YEAR		PREVIOUS YEAR	
CURRENT LIABILITIES:					
1	Other Current Liabilities				
	a) Establishment Expenses	87,62,580.00		61,58,867.00	
	b) Other Administrative Expenses	17,09,397.00		19,67,050.00	
	c) Others	44,53,476.00		31,90,380.00	
	d) Audit Fee	23,000.00	1,49,48,453.00	22,900.00	1,13,39,197.00
2	Deposit from Contractors	72,56,570.00	72,56,570.00	-	61,51,595.00
3	Project Accounts: USER Project				
	Balance as at the beginning of the year	5,00,85,602.00		3,76,89,461.00	
	Add: Received during the year	4,61,64,277.00		2,52,62,187.00	
	Less: Utilised during the year	1,74,46,618.00		1,28,66,046.00	
	Less: Outstanding Liabilities	-	7,88,03,261.00	-	5,00,85,602.00
4	Project Accounts: ISRO Project				
	Balance as at the beginning of the year	3,85,13,803.00		3,90,39,831.00	
	Add: Received during the year	8,96,82,812.00		2,22,47,300.00	
	Less: Utilised during the year	61,13,089.00		2,27,73,328.00	
	Less: Outstanding Liabilities	-	12,20,83,526.00	-	3,85,13,803.00
PROVISIONS:					
1	Pension, Gratuity & Leave Encashment	8,24,72,573.00	8,24,72,573.00	4,98,23,439.00	4,98,23,439.00
TOTAL			30,55,64,383.00		15,59,13,636.00

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

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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-2017

SCHEDULE 3 – FIXED ASSETS

(Amount- ₹)

Sl. No	Particular	GROSS BLOCK				DEPRECIATION				NET BLOCK		
		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 Development	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	36,05,924.00	37,605.00	-	36,43,529.00	5%	1,80,296.00	1,72,221.00	-	3,52,517.00	32,91,012.00	34,25,628.00
3	Renovation of lease Buildings	52,40,087.00	-	-	52,40,087.00	10%	38,05,725.00	1,43,436.00	-	39,49,161.00	12,90,926.00	14,34,362.00
4	Machinery & Equipment	95,40,622.00	-	-	95,40,622.00	15%	73,16,897.00	3,33,559.00	-	76,50,456.00	18,90,166.00	22,23,725.00
5	Furniture & Fixtures	1,49,18,977.76	3,05,834.00	-	1,52,24,811.76	10%	63,82,440.76	8,68,946.00	-	72,51,386.76	79,73,425.00	85,36,537.00
6	Office Equipments	38,92,356.00	76,175.00	-	39,68,531.00	15%	29,66,222.00	2,01,996.00	-	31,68,218.00	8,00,313.00	9,26,134.00
7	Computer & Pheripherals	5,68,27,663.60	27,39,280.00	-	5,95,66,943.60	60%	5,52,45,666.60	25,92,767.00	-	5,78,38,433.60	17,28,510.00	15,81,997.00
8	Library Books	3,54,88,236.93	52,65,822.00	-	4,07,54,058.93	60%	3,11,44,719.93	57,65,603.00	-	3,69,10,322.93	38,43,736.00	43,43,517.00
9	Telephones Installation	19,02,230.00	-	-	19,02,230.00	15%	3,53,742.00	2,32,274.00	-	5,86,016.00	13,16,214.00	15,48,488.00
10	Other Equipments	2,45,34,881.00	2,84,00,999.00	-	5,29,34,980.00	15%	1,33,18,284.00	51,04,628.00	-	1,84,22,912.00	3,45,12,068.00	1,12,16,597.00
11	NE-SAC Complex	16,91,30,090.00	39,54,280.00	-	17,30,84,370.00	5%	5,92,30,260.00	56,69,376.00	-	6,48,99,636.00	10,81,84,734.00	10,98,99,830.00
12	Vehicles	15,11,088.00	-	-	15,11,088.00	15%	9,41,183.00	85,486.00	-	10,26,669.00	4,84,419.00	5,69,905.00
13	Air Conditioner (Heating & Cooling)	7,84,968.00	-	-	7,84,968.00	15%	1,63,785.00	93,177.00	-	2,56,962.00	5,28,006.00	6,21,183.00
14	Apple I-Pad	71,250.00	-	-	71,250.00	15%	30,776.00	6,071.00	-	36,847.00	34,403.00	40,474.00
15	Aquarium	35,630.00	-	-	35,630.00	15%	15,389.00	3,036.00	-	18,425.00	17,205.00	20,241.00
16	CISF Barrack	24,85,690.00	-	-	24,85,690.00	5%	2,83,953.00	1,10,087.00	-	3,94,040.00	20,91,650.00	22,01,737.00
17	Mobile Set	48,100.00	-	-	48,100.00	15%	14,469.00	4,422.00	-	18,891.00	29,209.00	33,631.00

18	Motorised Treadmill	1,26,000.00	-	-	1,26,000.00	15%	54,423.00	10,737.00	-	65,160.00	60,840.00	71,577.00
19	SMF Batteries	6,35,400.00	-	-	6,35,400.00	15%	3,00,071.00	50,299.00	-	3,50,370.00	2,85,030.00	3,35,329.00
20	Vending Machine	20,500.00	-	-	20,500.00	15%	9,799.00	1,605.00	-	11,404.00	9,096.00	10,701.00
21	Water Dispenser	21,200.00	-	-	21,200.00	15%	10,134.00	1,660.00	-	11,794.00	9,406.00	11,066.00
Capital Work in Progress:												
22	Residential complex	11,11,46,176.00	2,48,17,792.00	-	13,59,63,968.00	0%	-	-	-	-	13,59,63,968.00	11,11,46,176.00
Intangible Assets:												
23	Software	23,02,191.00	8,45,485.00	-	31,47,676.00	60%	13,81,315.00	10,43,787.00	-	24,25,102.00	7,22,574.00	9,20,876.00
TOTAL FOR CURRENT 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
TOTAL FOR PREVIOUS YEAR		43,54,21,191.29	2,66,01,115.00	-	46,20,22,306.29	-	16,40,89,502.29	1,90,60,048.00	-	18,31,49,550.29	27,88,72,756.00	27,13,31,689.00

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

for **D. DAS & ASSOCIATES**
Chartered Accountants

Sd/-
(DEBAPRATIM DAS)
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-2017

(Amount- ₹)

SCHEDULE 4 – CURRENT ASSETS, LOANS & ADVANCES etc.	CURRENT YEAR		PREVIOUS YEAR	
A. CURRENT ASSETS:				
1) Cash balances in hand	12,000.00	-	12,000.00	-
2) Bank balances with scheduled banks				
a) On Current Accounts	39,26,45,240.46	39,26,57,240.46	25,66,97,004.47	25,67,09,004.47
B. LOANS, ADVANCES AND OTHER ASSETS:				
1) Advances to:				
a) Staffs:				
TA/ DA	1,76,999.00		86,043.00	
Contingencies	15,800.00		24,000.00	
Others	1,79,994.00	3,72,793.00	94,600.00	2,04,643.00
b) Projects: (External)	4,76,690.00		5,06,462.00	
c) Projects: (Internal)	-		-	
d) Others	8,64,758.00	13,41,448.00	9,37,560.00	14,44,022.00
2) Claims Receivable/ Recoverable	22,14,254.00	22,14,254.00	14,35,286.00	14,35,286.00
3) Deposits for:				
a) Telephone with BSNL	1,15,658.00		65,658.00	
b) Deposit with MeECL	23,69,165.00		11,70,080.00	
c) Satellite Data's with NRSC	35,91,535.00	60,76,358.00	40,13,503.00	52,49,241.00
TOTAL		40,26,62,093.46		26,50,42,196.47

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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 INCOME AND EXPENDITURE ACCOUNT
FOR THE YEAR ENDED 31-MARCH-2017**

(Amount - ₹)

SCHEDULE 5 - GRANTS	Current Year	Previous Year
Central Government:		
a) Department of Space, Bangalore	12,34,00,000.00	9,21,00,000.00
b) North Eastern Council, Shillong	3,50,00,000.00	3,00,00,000.00
TOTAL	15,84,00,000.00	12,21,00,000.00
SCHEDULE 6 - OTHER INCOMES	Current Year	Previous Year
Miscellaneous	9,93,382.99	4,97,019.96
Maintenance Charges	42,401.00	24,624.00
Guest House Rent	60,540.00	62,865.00
TOTAL	10,96,323.99	5,84,508.96
SCHEDULE 7 - INCOME FROM SERVICES	Current Year	Previous Year
Service of Scientists	-	9,90,000.00
Institutional Overhead	-	3,01,000.00
Infrastructure Usage	-	94,000.00
TOTAL	-	13,85,000.00

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

**SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT
FOR THE YEAR ENDED 31-MARCH-2017**

(Amount- ₹)

SCHEDULE 8 - ESTABLISHMENT EXPENSES		Current Year		Previous Year	
a)	Salary & Allowances	4,75,66,339.00		3,15,45,026.00	
b)	Honorarium	2,01,000.00		1,03,500.00	
c)	Employer Contributions	21,32,588.00		14,03,611.00	
d)	Wages	23,05,556.00		22,94,360.00	
e)	LTC	11,66,015.00		6,44,912.00	
f)	Leave Encashment Expenses	1,69,006.00		24,054.00	
g)	Children Education Allowance	3,28,168.00		3,30,739.00	
h)	Outsourced DEO	22,12,572.00		21,11,033.00	
i)	Outsourced Electrician	10,58,056.00		22,90,982.00	
j)	Outsourced Worker for Various Services	30,84,036.00		32,59,982.00	
k)	NER-DRR (Salary)	31,77,087.00		41,74,396.00	
l)	CISF Salary	2,91,77,940.00		1,67,02,418.00	
m)	Retirement PF	-	9,25,78,363.00	14,07,202.00	6,62,92,215.00
TOTAL			9,25,78,363.00		6,62,92,215.00

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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

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**SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT
FOR THE YEAR ENDED 31-MARCH-2017**

(Amount- ₹)

SCHEDULE 9 - OTHER ADMINISTRATIVE EXPENSES & etc.		Current Year		Previous Year	
1	Postage, Courier & Telephone Charges	7,29,693.00		9,28,721.00	
2	Bank Charges	7,810.00		6,028.00	
3	Electricity & Power Charges	29,42,977.00		28,27,769.00	
4	Hospitality	31,331.00		-	
5	Printing & Stationery	9,26,756.00		9,31,697.00	
6	Advertisement & Publicity	13,13,227.00		4,83,120.00	
7	Hiring of Vehicles	36,91,317.00		30,97,573.00	
8	Travelling & Conveyance	27,06,103.00		19,52,900.00	
9	Professional Charges	17,02,739.00		4,10,793.00	
10	Project Expenses [In-house]	19,86,678.00		13,62,859.00	
11	Rent	10,80,250.00		9,24,807.00	
12	Repair & Maintenance	23,14,652.00		9,05,914.00	
13	Books & Periodicals	31,972.00		29,559.00	
14	Trainings/ Seminars & Workshops	2,67,044.00		97,505.00	
15	Medical Expenses	7,83,565.00		8,06,312.00	
16	Parliamentary Standing Committee (PSC)	11,09,224.00		-	
17	Other Charges	4,83,557.00		4,69,547.00	
18	POL	4,81,707.00		3,29,844.00	
19	Sanitary Items	1,02,252.00		-	
20	Hindi Week Celebrations	-		19,130.00	
21	Annual Maintenance Contracts	27,82,381.00		33,43,492.00	
22	Fooding & Lodging	2,33,158.00		1,36,334.00	
23	Miscellaneous Expenses	2,93,640.00		-	
24	Repair & Maintenance of Vehicles	1,35,010.00		1,94,467.00	
25	Operational Charges & Maintenance of Canteen	4,68,468.00		3,20,016.00	
26	ICRB Examination	3,81,623.00		3,76,696.00	
27	NER-DRR Expenses	4,66,812.00		4,41,995.00	
28	CISF Expenses	9,13,895.00		15,81,725.00	
29	Supply of Water for Hostels	43,500.00	2,84,11,341.00	28,800.00	2,20,07,603.00
TOTAL			2,84,11,341.00		2,20,07,603.00

for **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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उत्तर-पूर्वी अंतरिक्ष उपयोग केंद्र / NORTH EASTERN SPACE APPLICATIONS CENTRE
उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

**SCHEDULES FORMING PART OF THE ACCOUNTS
FOR THE YEAR ENDED 31-MARCH-2017**

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 30.09.16 – 100% as per the applicable rate.
 - Assets acquired after 30.09.16 – 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 **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

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

**SCHEDULES FORMING PART OF THE ACCOUNTS
FOR THE YEAR ENDED 31-MARCH-2017**

SCHEDULE 11 – NOTES ON THE ACCOUNTS & CONTINGENT LIABILITIES

NOTES ON THE ACCOUNTS

- The previous year's figure was re-arranged/ regrouped where ever necessary to make them comparable.
- Pension, gratuity and leave encashment liability has been provided till 31.03.2017.
- Prior period items have been disclosed separately so that the effect thereof on the net expenditure during the year is known.
- Schedules 1 to 11 are annexed to and form an integral part of the Balance Sheet as at 31-March-2017 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 **D. DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(SHEEBA S L)
Sr Accounts Officer

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

Date: 26.05.2017

Acronyms

3DVAR	: Three-Dimensional Variational	DOS	: Department of Space
ADC	: Autonomous District Council	DoT	: Department of Telecom
ADP	: Automated Data Processing	DPR	: Detailed project report
AIRS	: Atmospheric Infrared Sounder	DWR	: Doppler Weather Radar
ANOVA	: analysis of Variance	ELPI	: Electric Low Pressure Impactor
AOD	: Aerosol Optical Depth	EOAM	: Earth Observations Applications Mission
ARFI	: Aerosol Radiative Forcing over India	EOS	: Earth Observation Satellite
ASDMA	: Assam State Disaster Management Authority	EPRIS	: Empowering Panchayati Raj Institutions Spatially
ASI	: Astronautical Society of India	FAO	: Food and Agriculture Organization
ASP	: Atmospheric Science Program	FLEWS	: Flood Early Warning System
AVHRR	: Advanced Very High Resolution Radiometer	FWP	: Forest Working Plan
AWiFS	: Advanced Wide Field Sensor	GAGAN	: GPS Aided Geo Augmented Navigation
AWS	: Automatic Weather Stations	GBH	: Girth at Breast Height
BC	: Black Carbon	Gbps	: Giga bits per second
BEL	: Bharat Electronics Limited	GC	: Governing Council
BLL	: Boundary Layer Lidar	GFS	: Global Forecast System
BRO	: Border Road Organization	GHADC	: Garo Hills Autonomous District Council
BSNL	: Bharat Sanchar Nigam Limited	GHG	: Green House Gases
CAMC	: Comprehensive Annual Maintenance Contract	GIS	: Geographical Information System
CCCI	: Canopy Chlorophyll Content Index	GPF	: General Planar Fit
CEC	: Cation Exchange Capacity	GPM	: Global Precipitation Measurement
CHAMAN	: Coordinated programme on Horticulture Assessment and Management	GPS	: Global Positioning System
CISF	: Central Industrial Security Force	GRACE	: Gravity Recovery And Climate Experiment
CMD	: Construction and Maintenance Division	GSAT	: Geo-Synchronous Satellites
COTS	: Commercial Of-The-Shelf	GSI	: Geological Survey of India
COPILOT	: Committee on Paper Laid on the Table	HA	: High Availability
CSB	: Central Silk Board	HEC-HMS	: Hydrology Engineering College Hydrologic Modeling System
CSDM	: Communication support in Disaster	HPC	: High Performance Computing
CSRTI	: Central Sericultural Research & Training Institute	HYSPLIT	: Hybrid single particle Lagrangian Integrated Trajectory
CuM	: Cubic Meter	ICAR	: Indian Council of Agricultural Research
DAC&FW	: Department of Agriculture, Cooperation & Farmers' Welfare	ICMR	: Indian council for medical research
DDMA	: District Disaster Management Authority	ICT	: Information & Communication Technologies
DEM	: Digital Elevation Model	IDSP	: Integrated Disease surveillance programme
DFO	: Divisional Forest Officer	IEEE	: Institute of Electrical and Electronics Engineers
DGPS	: Differential Global Positioning System	IGBP	: ISRO Geosphere Biosphere Program
DMS	: Disaster Management Support	INSAT	: Indian National Satellite
DNS	: Domain Name Servers	IQC	: Intermediate Quality Check
DONER	: Development of North Eastern Region		

IRS	: Indian Remote Sensing (Satellite)	NCC	: Natural Color Composite
ISAC	: ISRO Satellite Centre	NCEP	: National Centers for Environmental Prediction
ISPRS	: International Society of Photogrammetry and Remote Sensing	NCP	: National Carbon Project
ISTRAC	: ISRO Telemetry Tracking and Command Centre	NDEM	: National Database for Emergency Management
IWMP	: Integrated Watershed Management Programme	NDRE	: Normalized Difference Red Edge
JEWS	: Japanese Encephalitis Warning System	NDRF	: National Disaster Response Force
JHADC	: Jaintia Hills Autonomous District Council	NDNI	: Normalized Difference Nitrogen Index
KHADC	: Khasi Hills Autonomous District Council	NDVI	: Normalised Difference Vegetation Index
LAN	: Local Area Network	NDWI	: Normalized difference water index
LB	: Load Balancing	NEC	: North Eastern Council
LISS	: Linear Imaging Self Scanning	NEDRP	: North Eastern District Resources Plan
LiDAR	: Light Detection & Ranging	NEIGRIMHS	: North East Indira Gandhi Regional Institute of Medical & Health Sciences
LULC	: Land Use Land Cover	NER	: North Eastern Region
MA&FW	: Ministry of Agriculture & farmers' Welfare	NER-DRR	: North Eastern Regional node for Disaster Risk Reduction
MBLM	: Mini Boundary Layer Mast	NERTPS	: North Eastern Region Textile Promotion Scheme
MCS	: Mesoscale Convective System	NESAC	: North Eastern Space Applications Centre
MERRA	: Modern-Era Retrospective analysis for Research and Application	NGO	: Non Government Organization
MGNREGA	: Mahatma Gandhi National Rural Employment Guarantee Act	NHAI	: National Highways Authority of India
MHRD	: Ministry of Human Resource Development	NIRD	: National Institute of Rural Development
MIS	: Management Information System	NKN	: National Knowledge Network
MIDH	: Mission for Integrated Development of Horticulture	NNRMS	: National Natural Resources Management System
MNCFC	: Mahalanobis National Crop Forecast Centre	NOBLE	: Network Of Boundary Layer Experiments
MODIS	: Moderate-resolution Imaging Spectroradiometer	NRSC	: National Remote Sensing Centre
MoEFCC	: Ministry of Environment, Forests and Climate Change	NWP	: Numerical Weather Prediction
MoU	: Memorandum of Understanding	NUIS	: National Urban Information System
MPA	: Master Plan of Action	OFC	: Optical Fiber Communications
MRR	: Micro Rain Radar	OLI	: Official Language Implementation
MSI	: Media Sustainability Index	OMI	: Ozone Monitoring Instrument
MSS	: Mobile Satellite Service	ONERA	: Office National d'Etudes et de Recherches Aérospatiales
MT	: Metric Tonne	PCA	: Principal Component Analysis
MWR	: Multi Wavelength Radiometer	PDA	: Personal Digital Assistant
NAS	: Network Attached Storage	PRI	: Panchayati Raj Institutions
NASA	: National Aeronautics and Space Administration	PWD	: Public Welfare Department
NAVIC	: Navigation with Indian Constellation	PMGSY	: Pradhan Mantri Gram Sadak Yojna
		RAM	: Random Access Memory
		RF	: Reserve Forest
		RHI	: Range Height Indicator
		RMC	: Regional Meteorological Center

RMSE	: Root Mean Square Error	SPL	: Space Physics Laboratory
RS	: Remote Sensing	SPS	: Standard Positioning Services
SAC	: Space Applications Centre	SRA	: Synoptic Rainfall Advisory
SAN	: Storage Area Network	SRSAC	: State Remote Sensing Applications Centres
SAR	: Synthetic Aperture Radar	SRTM	: Shuttle Radar Topography Mission
S&T	: Science and Technology	SWJ	: Subtropical Westerly Jetstream
SATCOM	: Satellite Communications	TB	: Tera Byte
SBIK	: Space Based Information KIOSK	TCARI	: Transformed Chlorophyll Absorption Reflectance Index
SCNP	: Satellite Communications & Navigation Program	TCN	: Tropospheric columnar NO2
SDI	: Spatial Data Infrastructures	TDP	: Technology Demonstration Project
SDR	: Spatial Data Repository	TEC	: Total Electron Content
SDSS	: Spatial Decision Support System	TIBL	: Thermal Internal Boundary Layers
SILKS	: Sericulture Information Linkages & Knowledge System	ToR	: Terms of Reference
SIRD	: State Institute of Rural Development, Meghalaya16	TRGA	: Total Rice Growing Area
SIS-DP	: Space Based Information Support for Decentralized Planning	UAV	: Unmanned Aerial Vehicle
SIT	: Satellite Interactive Terminal	USGS	: United States Geological Survey
SLIM	: Seasonal Landslide Inventory Mapping	VPN	: Virtual Private Network
SLNA	: State Level Nodal Agency	VSSC	: Vikram Sarabhai Space Center
SMS	: Short Message Service	VSAT	: Very Small Aperture Terminal
SODAR	: Sound Detection And Ranging	WB	: West Block
SOI	: Survey Of India	WiFi	: Wireless Fidelity
		WLL	: Wireless in Local Loop
		WRF	: Weather Research And Forecasting



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