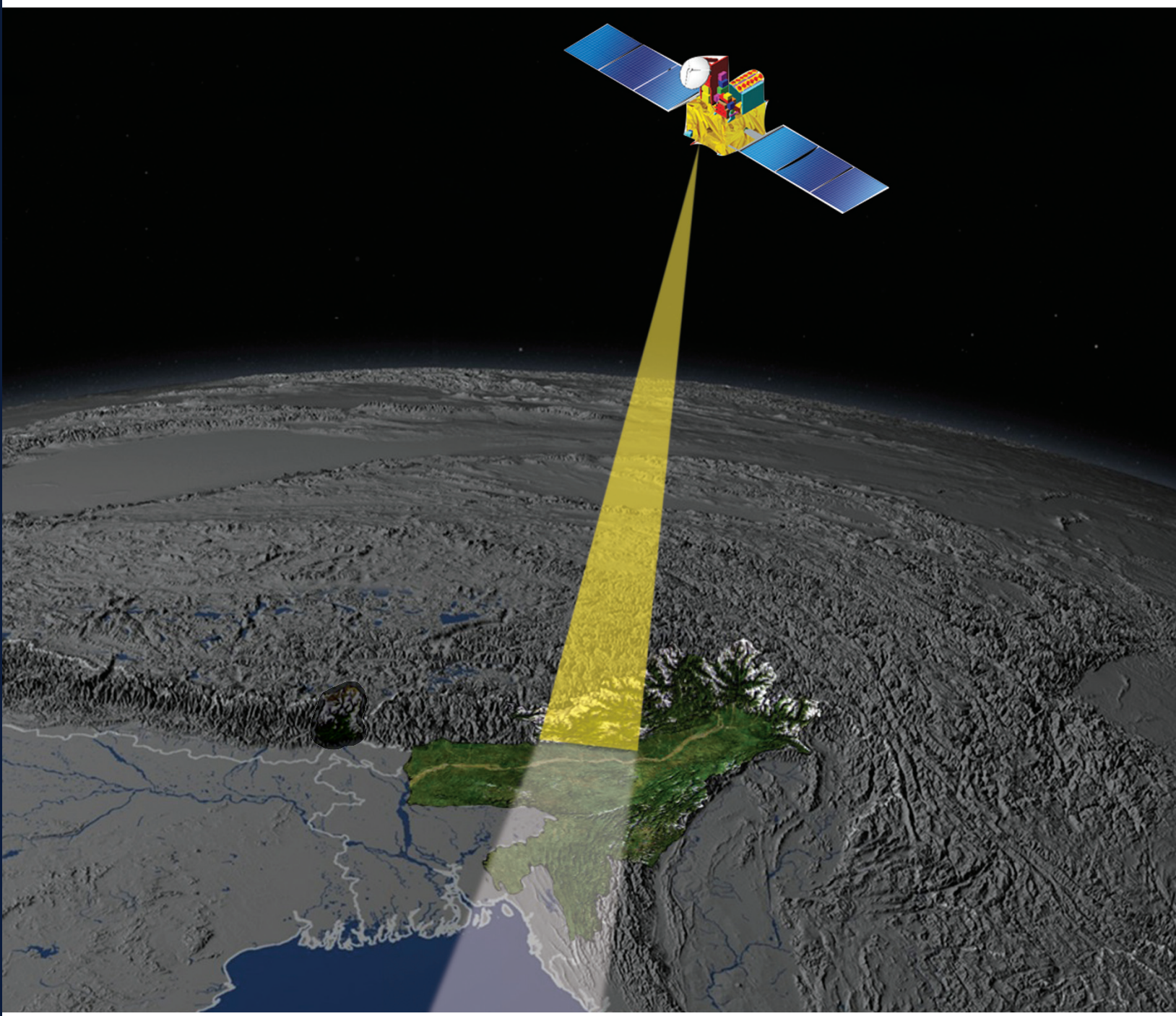
Annual Report
वार्षिक प्रतिवेदन
2015 - 2016



उत्तर पूर्वी अंतरिक्ष उपयोग केंद्र
भारत सरकार, अंतरिक्ष विभाग
उमियम-793103, मेघालय

North Eastern Space Applications Centre
Government of India, Department of Space
Umiam-793103, Meghalaya

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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 recourse management, infrastructure planning, healthcare, education, satellite communication, and disaster management support, and to set up a space and atmospheric science research hub.

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

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Director, S&T, North Eastern Council, Shillong	Member
Director, North Eastern Space Applications Centre	Member Secretary

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1. ABOUT THE CENTRE

1.1. Background

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 15 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:

- 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.
- To provide operational satellite communication applications services in the region in education, health care, disaster management support, and developmental communication.
- To take up research in space and atmospheric science area and establish an instrumentation hub and networking with various academic institutions of NER.
- To enable single window delivery of all possible space based support for disaster management.
- To set up a regional level infrastructure for capacity building in the field of geospatial technology.

1.2. 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 the advice of the Society, manages the activities of the Society/Centre. Secretary, DOS/ Chairman ISRO is the chairman of the GC, and Secretary, NEC is the Alternate Chairman. Chief Secretary, Meghalaya; representatives of the governments of NER States and representatives of central government agencies in the region are the other members of the GC.

1.3. 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. In addition, a High Power Committee constituted during 2004 by Chairman, NESAC GC/Secretary, DOS has recommended a Master Plan of Action for utilization of space technology in the developmental process of the NER. Sixteen major thrust areas were identified for implementation by NESAC over a period of five years during the 11th Five Year Plan period (2007-12) and beyond. 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).

1.4. Facilities

NESAC is located at Umiam (Barapani) about 20 km from Shillong, Meghalaya State. Constructions of the residential complex including guest house cum training hostel are in final stage, which is about 1km from the office complex.

The centre is well equipped with state of the art facilities in the areas of Remote Sensing (RS) and Geographical Information System (GIS), Disaster Management, Satellite communication and Space &Atmospheric Science Research.

1.4.1. 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, 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, Spectro-radiometer to measure spectral reflectance at close narrower interval for creation of spectral library.

1.4.2. Information Technology and Computing facilities

Over the years 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). 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 centralized computing facility maintains 2 Domain Name Servers (DNS), 4 web servers, 2 database servers and 2 FTP servers with a 7 TB SAN in high availability (HA) and load balancing (LB) mode as a part of web hosting infrastructure. Centre has set-up a Spatial Data Infrastructures (SDI) which is comprised of 2 high-end servers with an 8 TB SAN configured in HA/LB mode. In addition, Centre has another 5 mid-level servers connected in LAN for the purpose of Intranet, software license and antivirus server services. Two storage systems; one 12 TB SAN and another 4TB NAS are also connected in LAN as centralized data repository of NESAC. The Centre is also equipped with sufficient number of workstations, printers and scanners. The RS and GIS facility of the Centre includes more than 50 mid-level workstations for digital image processing, 2 very high-end workstations for photogrammetric applications, 4 high-end workstations for hydrological modeling. The Centre is also equipped with A0 Size plotters and scanner along with other printing facilities, 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.

1.4.3. Satellite Communication

NESAC has got advanced satellite communication facilities to support various developmental programs in eight states of NER. The facilities available are: SATCOM studio for content generation in various subject matter; Spacenet system for video conferencing and data transfer activities amongst DOS/ISRO centres; ISRO DMS-VPN node, transportable 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 hosts 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 (formerly IRNSS) SPS-GPS receiver experiment.

1.4.4. 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 (SOx), Oxides of Nitrogen (NOx), 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.

1.4.5. New Instruments and facilities

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. The system installation has been completed and testing of different sub-systems are going on. The system is expected to be operational by June-July, 2016.

Figure 1.1: The DWR building at Cherrapunjee

Installation of systems and networks comprised of 8 high-end blade servers configured in HA/LB mode and 25 TB usable SAN is under progress to operationalize the services of North Eastern Regional node for Disaster Risk Reduction (NER-DRR).

1.4.6. Library

The library facility is well equipped with wide varieties of subjects to cater the requirements of research and applications. Necessary software facilities are also established for efficient management of the library facility. The centre has a very good library facility with wide range of collections of books, journals and periodicals relevant in field of science and technology. NESAC has also joined ISRO Library Consortium - AntarikshGyan (AG) and as part of the AG, all the IEEE journals are received online. In addition, online subscription of Journal TOC (Table of Contents) has been activated for NESAC as part of the AG. NESAC library also will be facilitated with KOHA software under AG.

1.4.7. 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 volleyball court for further diversification of activities. A multi-gym is in the process of final stage of procurement.

2. AGRICULTURE & SOIL

2.1. Applications of Remote Sensing and GIS for Sericulture Development-Phase II

In order to expand Sericulture in the country to the additional potentials areas through identification of these areas with geospatial inputs, a project titled 'Applications of Remote Sensing and GIS for Sericulture Development' funded by Central Silk Board (CSB) was executed by NESAC in collaboration with State Remote Sensing Application Centres. Under this project, mapping of potential areas for development of silkworm food plants for mulberry and non-mulberry sericulture in the non-traditional states on 1: 50000 scale has been done for 108 selected districts covering 24 states. Appraisal surveys were carried out in 8 selected Talukas in four states to evaluate the progress of sericulture development as per the requirement of CSB. Sericulture Information Linkages & Knowledge System (SILKS) web portal developed as part of the project, has been hosted in public domain under the name http://silks.csb.gov.in The portal is now presently available in 12 languages, viz.: English, Hindi, Telugu, Kannada, Assamese, Bengali, Mizo, Manipuri, Khasi, Garo, Ao Naga and Sumi Naga. State Sericulture departments have appreciated project outcome and has started using the findings for sericulture planning and development. SILKS portal contents are helping the user departments for educating the farmers. Requests have been received from state Sericulture departments for covering more areas/districts. The project atlas was released by Hon'ble Union Minister of Textiles, Govt. of India on Nov 17, 2015 during the National Seminar on Innovative Technologies and Best Practices for Sericulture at Central Sericultural Research & Training Institute (CSRTI), Mysore.

Figure 2.1: Release of Sericulture project atlas by Hon'ble Union Minister of textiles.

A meeting on initiation of the 2nd phase of the project on Applications of RS and GIS for Sericulture Development held at NESAC on 21 March, 2016. Representatives from Central Silk Board (CSB), State Remote Sensing Centres and State Directorate of Sericulture from all NE states participated in the meeting.

List of twenty districts which was proposed during the review meeting on North Eastern Region Textile Promotion Scheme (NERTPS) organized by CSB at Guwahati on Nov 24th, 2015, were accepted for taking up in the second phase. These are:

- **Assam:** Kamrup, Goalpara, Dhemaji, Morigaon, Sivsagar, Kokrajhar and Baska

- **Arunachal Pradesh:** East Siang, West Siang and Upper Siang
- **Nagaland:** Kohima, Paren and Dimapur
- **Mizoram:** Kolasib and Serchhip
- **Meghalaya:** Jaintia Hills and West Garo Hills (undivided)
- **Tripura:** Gomati and Sepahijala
- **Sikkim:** West Sikkim

Suitable modification has been made in the Project Manual of the first phase of the project based on the experience of the first phase project implementation and the feedback received from various users. One day training was conducted at NESAC for the scientists from State Remote Sensing Centres on March 22, 2016.

2.2. Application of geo-spatial techniques for large scale mapping, monitoring and management of mulberry Sericulture in West Bengal

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, Mushidabad, Birbhum and Nadia districts are the major contributors of silk in West Bengal. Due to uneven distribution and lack of scientific survey, the actual area under mulberry plantations and their spatial distribution are not available for these districts. Moreover planning and monitoring at block and village level require detail information in geospatial domain.

There is tremendous scope for improving the production and quality of silk through expansion of sericulture to new potential areas, supporting the farmers with up to date scientific information through appropriate dissemination system. Geospatial techniques comprising of remote sensing, GIS and GPS have emerged as important tools for mapping and monitoring of silkworm host plants. Recent advances in hyperspectral remote sensing has added the advantage of assessing crop condition, which may also be used for deriving different biophysical parameters. Keeping in view of the above consideration, a project titled 'Application of geo-spatial techniques for large scale mapping, monitoring and management of mulberry Sericulture in West Bengal' has been taken up in collaboration with Central Sericultural Research & Training Institute, CSB, West Bengal. The objectives are i) To estimate the current spatial extent of mulberry cultivation in selected blocks of 4 major Mulberry growing districts of West Bengal using Remote Sensing, Geographic Information System and Global Positioning Systems ii) Crop condition assessment of existing Mulberry plantation iii) Make an attempt to estimate leaf protein and moisture contents using hyperspectral data with limited laboratory based analysis and iv) to develop block specific MIS (Management Information System) which can be integrated with SILKS portal. A Memorandum of understanding has been signed between NESAC and Central Sericultural Research and Training Institute, Berhampore for implementing the project.

To estimate the current spatial extent of mulberry cultivation in selected blocks of 4 major Mulberry growing districts of West Bengal, satellite data for the all four districts have been ordered and received. Total 31 temporal scenes have been acquired. Pre-processing of the satellite data has been completed. Satellite data classification for estimation of spatial extent of mulberry acreage is in progress. One round of ground truth verification has been completed in the selected districts.

For leaf protein and moisture contents estimation using hyperspectral data and relation with the laboratory based analysis, field spectra of the five Mulberry varieties (C2038, C2028, S1635, S1 and Bombai) have been collected. For the popular S1635 variety field spectra have been collected at different stages of pruning (Dec, Jan, and Feb). Pre-processing of the hyperspectral data and further analysis is in progress. Protein and moisture content analysis is completed by CSRTI. Work is in progress for developing a block specific MIS, which would be integrated with SILKS portal for dynamic rendering and faster dissemination of information.

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

The study has been carried out in collaboration with Assam Agriculture University, Jorhat with the objective of generating spectral signature of selected crops during crop growth stages and to monitor the crop performance under different abiotic stresses due to moisture, nitrogen and elevated CO_2 and temperature condition. Widely grown common cultivars of this region have been selected to study the crop performance under different stress condition. The experimental sites have been arranged under known level of nutrient and water condition as normal and control (stress) condition. Similarly, environment for elevated CO_2 & Temperature can be maintained under CO_2 Temperature Gradient Tunnel (CTGT). In the first phase, potato was grown at different levels of nitrogen fertilization. Spectral measurement has been collected at different phenological stages of potato under stress as well as normal condition using a portable Spectroradiometer (SVC HR-1204). Various morphological & growth characteristics (LAI, yield etc), biochemical analysis such as C/N ratio, Chlorophyll content, Protein content, etc. has been measured under different stress conditions using various field instrument and laboratory analysis. Analysis of different spectral band to find out the correlation with the plant biophysical and biochemical parameter are in progress.

Figure 2.2: Biophysical parameter and spectral measurement of potato plantation using a LAI meter (left) and Photosynthesis measurement

2.4. Soil Resources Mapping

Soil is one of the world's most important natural resources. It is a non renewable finite resource which is required for production of food, feed, fibre, fuel and industrial raw materials as well as generation of energy resources. It is therefore a highly valuable natural resource and maintaining its productivity on sustainable basis is important for meeting the basic needs of the human and animals. Therefore, knowledge of soils with respect to their extent, distribution, characteristics and potential use is important for optimizing land use. Indian Remote Sensing satellites provide state of the art database for natural resources inventories. Many studies have been conducted to explore the potential of LISS-I, LISS-II and LISS-III data for soil resource mapping both at 1:250,000 and 1:50,000 scale. Since soil map at larger scale (>250K) is not available in the NE Region, Soil Resources Mapping at 1:50K and 1:25K was carried out during 2015-16 at NESAC under two projects which are described below:

2.4.1. Soil and land capability mapping for selected agricultural districts of NER

The study has been taken up to prepare soil and land capability maps in 12 intensive agricultural districts (Viz. Bongaigaon, Dhubri, Goalpara, Golaghat, Kokrajhar districts of Assam, Ri-Bhoi, Jaintia and West Khasi Hills districts of Meghalaya and Champhai, Lawngtlai & Lunglei districts of Mizoram) of NER. The work has been completed. From the study, it has been observed that soils in the valley are developed mostly on alluvium parent materials in the floodplains & alluvial plains. On the other hand, soils in hilly areas are mostly developed on granite, gneiss, sandstone, shale, quartzite and limestone. Soils of the study areas are very deep to moderately deep, texture varies from coarse loamy to fine, mineralogy is mixed, moisture regime varies from udic to aquic and temperature regime varies from hyperthermic to thermic.

The soils of Mizoram are classified to 3 order, 5 sub order, 7 great groups, 9 sub groups, 6 family texture and 12 series. Alfisols are the most dominant soil that covers 92 % area followed by Inceptisols (6%) and Entisols (2%). The soils are acidic in pH, organic carbon content is high. The soils are high in available nitrogen, low in phosphorus and potassium content. The soils of the study area have been classified into land capability class II, III, IV, VI and VII. The highest area is under class VI (67%) followed by III (12%), IV (10%), VII (8%) and II (3%). Lands under Class VI and Class VII are grouped under non arable land and these land are not suitable for cultivation. These are suitable for pasture and forest development. On the other hand, land under Class II to IV are classified under arable land which are suitable for cultivation of crops.

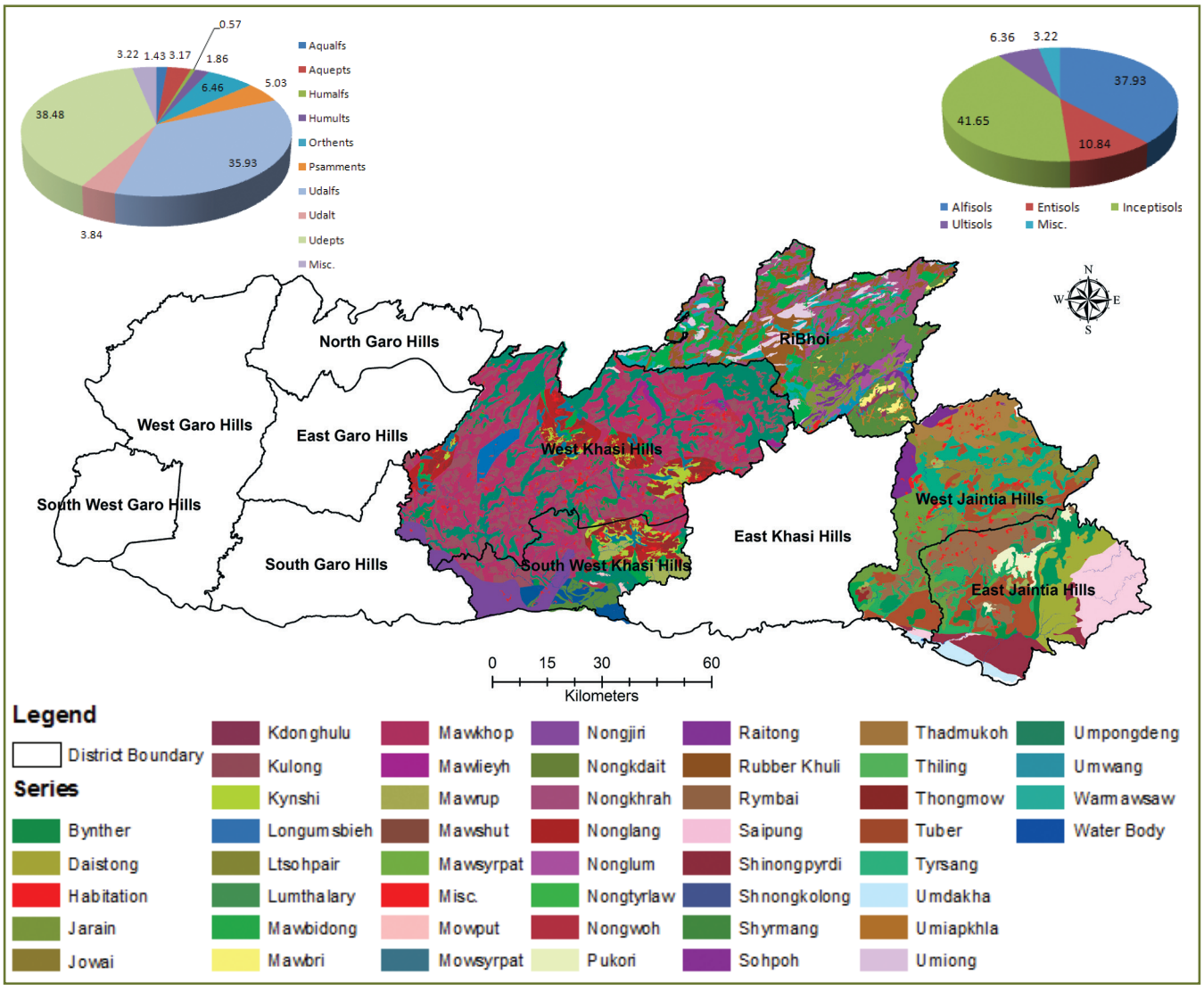

Figure 2.3: Soil map of 3 districts of Meghalaya

Soils of Assam are classified into 4 order, 8 sub order, 15 great group, 34 sub group, 8 texture and 103 soil series. Alfisols are the most dominant soil that covers 65% area followed by Inceptisols (18%), Entisols (10%) and Ultisols (7%). The soils are strongly acidic to neutral in reaction. Organic carbon content varied from low to high. The soils are low to high in available nitrogen, low in phosphorus and potassium content. The soils of the study area have been classified into land capability class II, III and IV. The highest area is under class III (56%) followed by II (23%) and IV (21%).

The soils of Meghalaya are classified into 4 orders, 9 sub orders,12 great groups, 27 sub groups, 7 family texture and 50 series. Inceptisols are the most dominant soil that covers 42% area, followed by Alfisols (38%), Entisols (11%) and Ultisols (6%). The soils are acidic in pH and high in organic carbon content. The soils are high in available nitrogen, available phosphorus and medium in available potassium content. The soils of the study area have been classified into land capability class II, III, IV and VI. The highest are under class IV (52%) followed by III (21%), VI (14%) and II(9%).

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

The Green revolution technology in India led to many fold increase in food grains production, but has created greater demands on water, fertilizer and farm power. The effect of intensive cropping with high doses of fertilisers, pesticides, insecticides and herbicides has resulted in deteriorating soil physical, biological and chemical properties and affecting animal and human health. Increasing consciousness about conservation of environment as well as of health hazards caused by agrochemicals has brought a major shift in consumer preference towards food quality and consumers are increasingly looking forward to organic food that is considered safe and hazard-free which comes from organic farming. To increase the area under organic farming, land users and planners need basic soil information, problems and potential and suitability of soils for various crops for sustained agricultural production. This information can be obtained from soil survey, soil map and land evaluation. 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 was carried out in the state of Assam with following objectives: i) Preparation of soil, physiography and land use land cover map ii) Identification of potential areas for organic farming iii) Characterization of the potential areas for organic farming, and iv) Assessment of soil site suitability for organic crop planning in the potential area.

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

Under this ongoing project lithology, physiography and LULC map of 1:50,000 scale were updated to 1:25,000 scale based on LISS-IV images. Prepared slope map from CartoDEM. Updated road network map. All these maps are integrated and prepared pgysiography base map. Selected sample sites for profile study. Started field survey and covered 25% area of the district. Collected about 150 soil samples from each horizon of 25 soil profiles and started soil sample analysis in the laboratory (Figure 2.4).

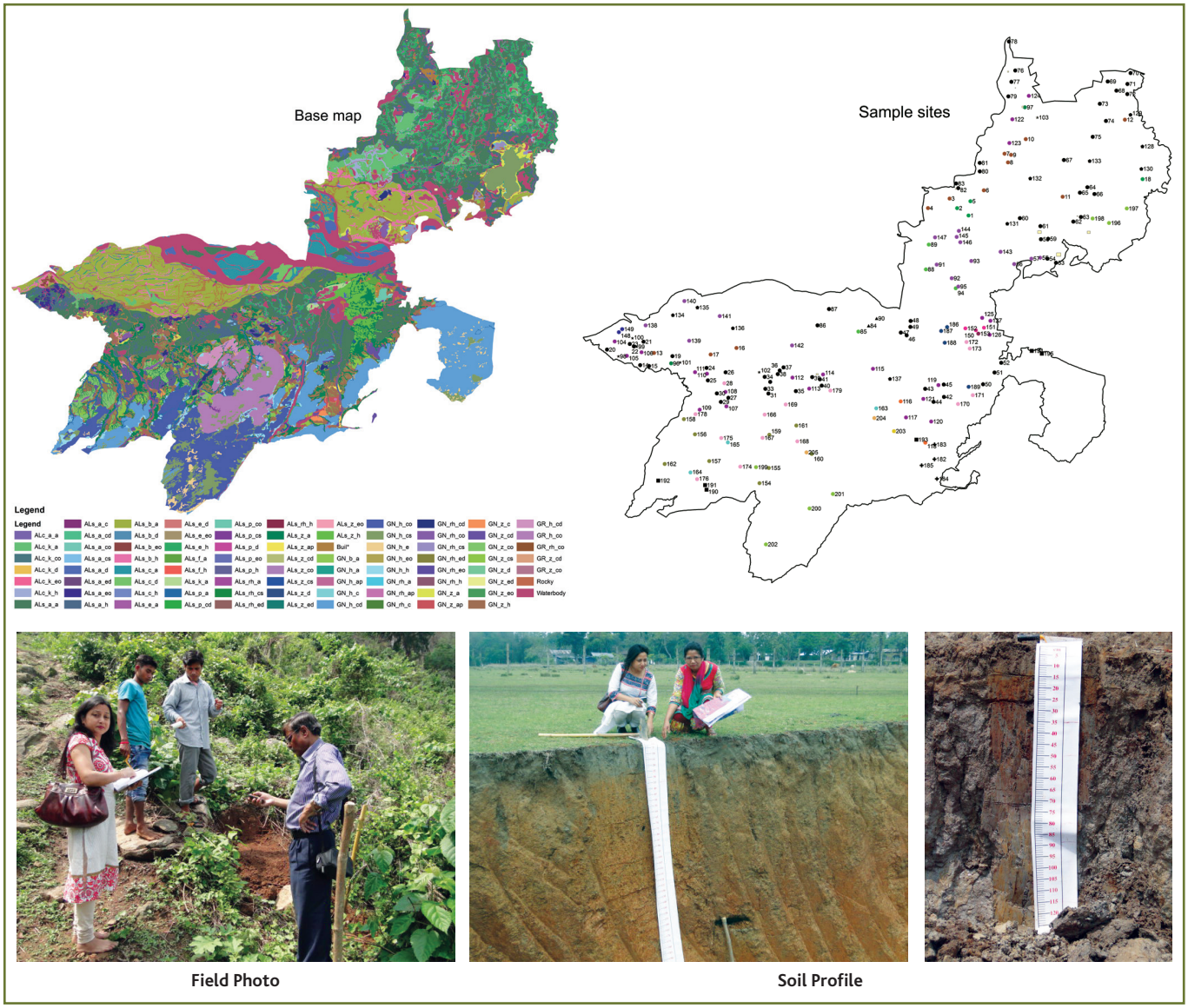

Figure 2.4: Snapshots of soil surveys

3. FORESTRY AND ECOLOGY

Ministry of Environment, Forests and Climate Change (MoEFCC), Govt. of India adopted National Working Plan Code in 2014 for the management of forests under the prescriptions of a working plan/schemes prepared on the basis of principles of sustained management of forests and recognized silvicultural practices. Considering the importance of preparing updated working plan/schemes by all State Forest Departments of NER, specific actions are taken up. As a result, specific work on preparation of remote sensing and GIS (at 1:10K) inputs for forest working plan was taken up in the states of Mizoram, Meghalaya, Arunachal Pradesh, and Assam state in collaboration with the respective State Forest Departments. While the works for the states of Meghalaya and Mizoram has been completed the works for the state of Assam and Arunachal Pradesh are in progress.

3.1. Inputs for Forest Working Plan in Assam

The Project has been taken up in collaboration with Assam Forest & Environment Department, Govt. of Assam for the 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 completed for 228 Reserve Forests of the 21 divisions using CARTOSAT-1 and IRS LISS IV images and classified the forest cover as canopy density <10% (scrub forest), canopy density 10-40% (open forest), canopy density 40-70% (moderately dense), canopy density >70% (very dense). Forest type map for 21 divisions was 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

Table 3.1: Summary of Forest Crown Density and other Landuse Statistics of Lumding RF (ha)

Land Use Type	Crown Density				Others	Total
	D1	D2	D3	D4		
Semi Evergreen Forest	1357.45	6372.73	1030.06	0.00		8760.24
Mixed Moist Decidious	7634.56	8078.59	1138.93	0.00		16852.08
2/2S1 Secondary Moist Bamboo					0.00	0.00
Grassland					0.00	0.00
Plantation					1973.55	1973.55
Built up					121.07	121.07
Agriculture					1010.57	1010.57
Water bodies					161.99	161.99
Riverine Sand					0.00	0.00
Forest Blank					0.00	0.00
Total	**8992.01**	**14451.32**	**2168.99**	**0.00**	**3267.18**	**28879.50**

density has been completed for 21 divisions. The field data collected from each Division was analysed for timber volume calculation into different girth classes like G1, G2 ,G3, G4, G5 & G6 based on GBH (Girth at Breast Height) values 31-60cm at 30 cm interval.

Timber volume estimation has been accomplished for 12 divisions namely, Lower Assam Social Forestry Circle (Dhubri Division & Aie Valley Division), Northern Assam Circle (Nagaon, Nagaon South, Sonitpur East, Sonitpur West &Lakhimpur Divisions), Southern Assam Circle (Cachar, Hailakandi & Karimganj Divisions) and Eastern Assam Circle (Golaghat

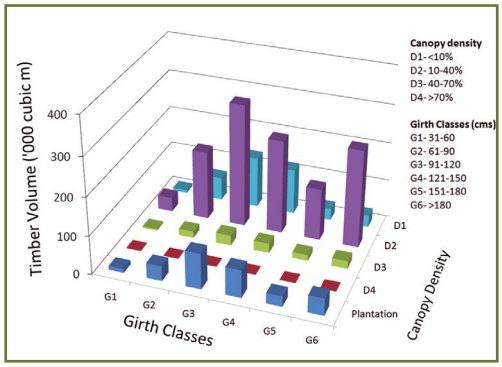

Figure 3.1: Timber volume stock in Lumding RF

& Dibrugarh divisions). Information on forest canopy density and other land use statistics for a Reserve Forest (RF) is shown in table- 3.1, estimated timber volume for an RF is shown graphically in figure 3.1, estimated timber count & stem density for Lumding RF is in table 3.2 & species composition for each RF are also being generated. Forest type map & Forest canopy density map of Kamrup West Division are shown in figure 3.2 & figure 3.3 respectively.

Table 3.2: Estimated Timber Count & Stem Density of Lumding RF (Nos)

Forest Type	Forest Density	Girth Class						Total
		G1	G2	G3	G4	G5	G6	
Semi-Evergreen	D1	14593	20703	26468	14932	5771	1700	**84167**
	D2	116584	190183	145950	69850	21618	16870	**561055**
	D3	18245	25457	19425	8535	4121	2208	**77991**
	D4	0	0	0	0	0	0	**0**
Moist Mixed Deciduous Forest	D1	35629	116500	121023	60794	7636	5937	**347519**
	D2	152177	268095	226014	93560	34008	27051	**800905**
	D3	12814	22067	13239	8685	2420	1282	**60507**
	D4	0	0	0	0	0	0	**0**
Forest Plantation		60900	87119	94731	40037	9304	8741	**300832**
Total		**410942**	**730124**	**646850**	**296393**	**84878**	**63789**	**2232976**

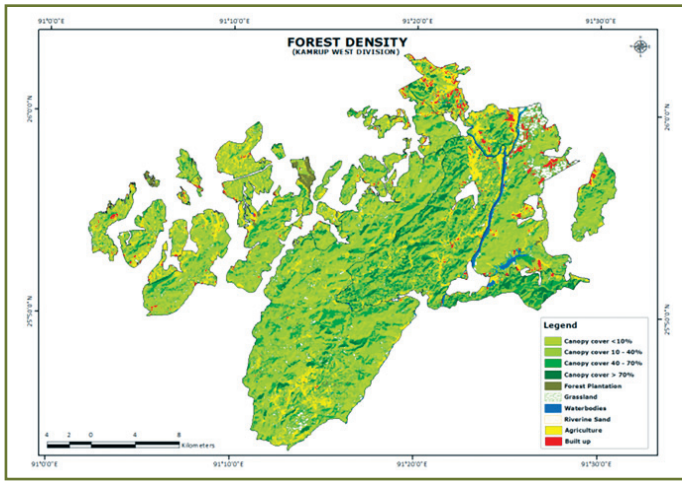

Figure 3.2: Forest type map of Kamrup West Div.

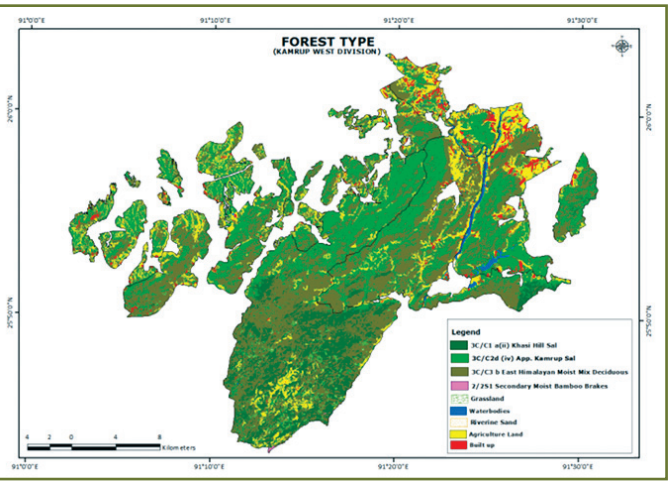

Figure 3.3: Forest density map of Kamrup West Div.

3.2. Inputs for 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 forest crown density mapping at 1:10K using Cartosat-1 data (pertaining to the period 2008-11) along with the associated land use for the entire state has been completed.

Based on field enumeration data from sampling points of Along forest division provided by the forest department during 2014, the detailed estimates of growing stock for each reserve forests (figure 3.4) and compartments (figure 3.5) of the division along with maps showing the location of the compartment, forest types, slope and forest crown density and other land use with base layer overlaid were prepared for all the 2360 compartments of the four ranges under the division. The detailed girth class wise volume and stem number under each strata of the compartment at two different slope categories for each compartment corresponding to the composed maps were also generated.

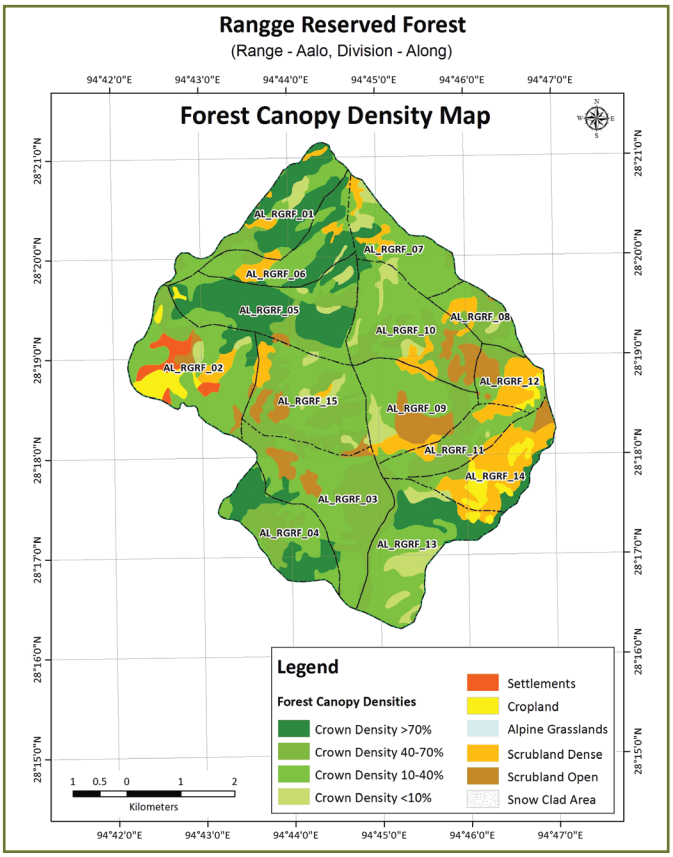

Fig 3.4: Forest density map of Rangge RF

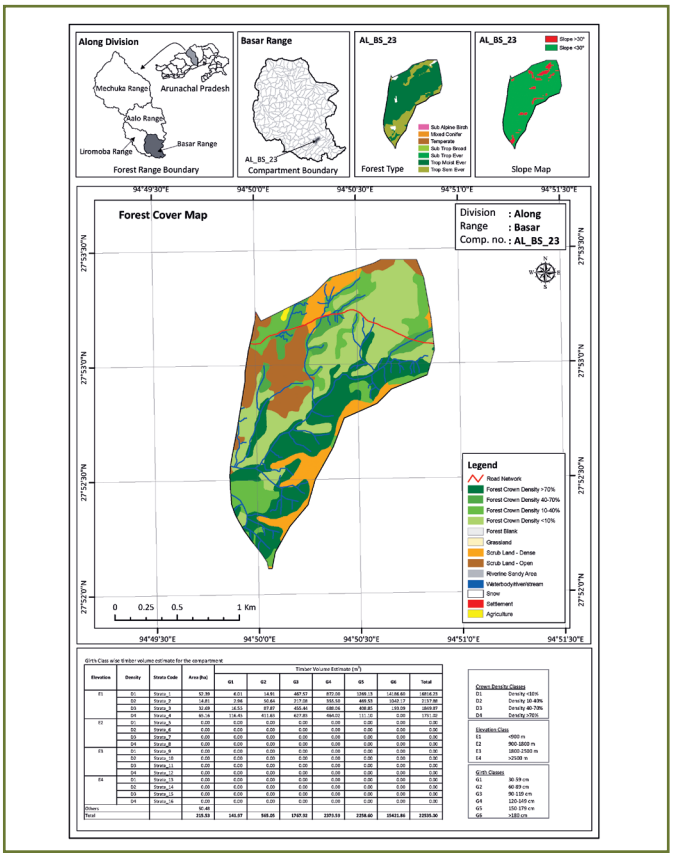

Fig 3.5: Growing stock map of a compartment, Along

About 72% of the total geographical area of Along (6717.75 km^2) were under forest cover. An analysis of the forest crown density map of Along division revealed that about 45% of area under forests were in the moderate dense category and similar was the pattern in all the four ranges of the division (table 3.3). The distribution of forest crown canopy density at different altitudinal zones showed that two third of the forest cover were in the mid altitudes of

Table 3.3: Forest crown canopy density under different ranges

Forest Canopy Density	Basar Range	Liromoba Range	Aalo Range	Mechuka Range	Total
Crown Density < 10%	8485.70	10937.00	23988.64	52565.00	95976.34
Crown Density 10-40%	9315.94	9964.71	26769.83	51647.59	97698.07
Crown Density 40-70%	19485.53	24163.03	57102.53	118906.69	219657.78
Crown Density >70%	5952.20	7214.78	13792.10	47471.88	74430.96
Total	**43239.37**	**52279.51**	**121653.10**	**270591.15**	**487763.15**

800-1800 m and 1800-3000 m above msl while one third were in the low altitudes and upper reaches (figure 3.6). In Basar, Aalo and Liromoba ranges major area of the forest cover were up to 1800 m with very less forest cover in the higher altitudes, while in Mechuka range, large area of forest were in the higher altitudes and less in low altitudes.

Growing stock estimation for Sagalee and Dibang are under progress and based on the preliminary estimates for the two divisions the spatial distribution map of timber growing stock (figure 3.9) and stem density has been prepared. There is no reserve forest under Sagalee forest division and three reserve forests are there under Dibang division.

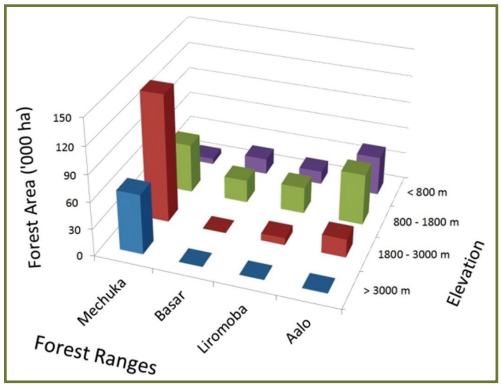

Figure 3.6: Forest cover at different elevations, Along div.

Training of field staffs of the Forest Department on use of GPS were conducted for Central Arunachal circle and Eastern Arunachal Circle on 8-9th February 2016 and 11th February 2016 respectively at Pasighat and Tezu which was participated by about 110 forest field staffs (including Forest Guards, Forester, Draughtsmen, Deputy Rangers, Range Officers, Assistant Conservator of Forests and DFOs, etc.). The field staffs were demonstrated about navigating to sampling points using GPS and steps for field enumeration data collections and entry in field forms.

Figure 3.7: Training on GPS at Pasighat

Figure 3.8: Training on GPS at Tezu

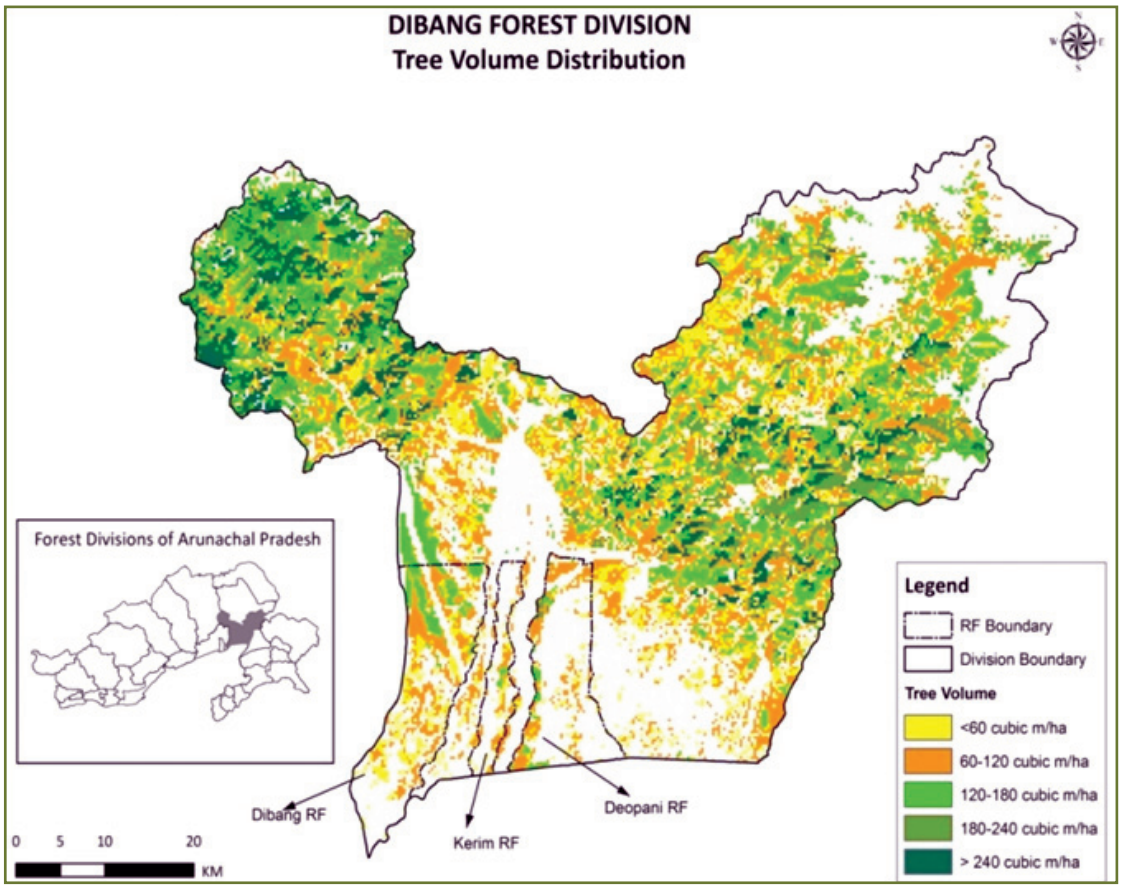

Figure 3.9: Spatial distribution of timber growing stock in Dibang Forest Division

3.3. Inputs for forest working Scheme in Meghalaya

This project has been carried out for Forest & Environment department, Meghalaya. Quantitative details of land resources, forest type, forest density in spatial format, timber volume and stem density estimates at six girth level in different forest type and forest density, dominant trees, etc. in above and below 25 degree slop for all 39 blocks have been submitted to the Forest & Environment department, Meghalaya to prepare working schemes areas

under Autonomous District Council. The base maps on road network, settlement locations, water bodies, watershed boundaries have also been provided for designing efficient management strategies.

The state is dominated by open forest, followed by degraded forest and dense forest (figure 3.10). The growing stock of Meghalaya is estimated as total of 29.93 Million CuM of timber volume of which 5.27 Million CuM available

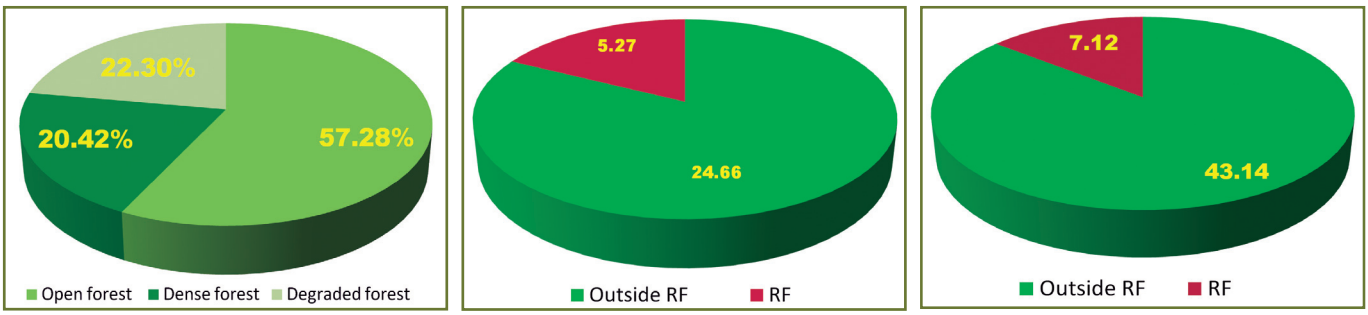

Figure 3.10: Forest density distribution in Meghalaya (left), total timber volume in Million CuM (centre) and number of trees in Meghalaya (in Millions)

within Reserve forest and the remaining under autonomous district council areas (figure 3.10). Total estimated number of trees growing in the state is 50.26 millions of which only 7.12 million is growing within reserve forests (figure 3.10). It is also observed that around 90% of the growing trees of Meghalaya state is below girth class 4 i.e. girth is less than 120 cm (figure 3.11).

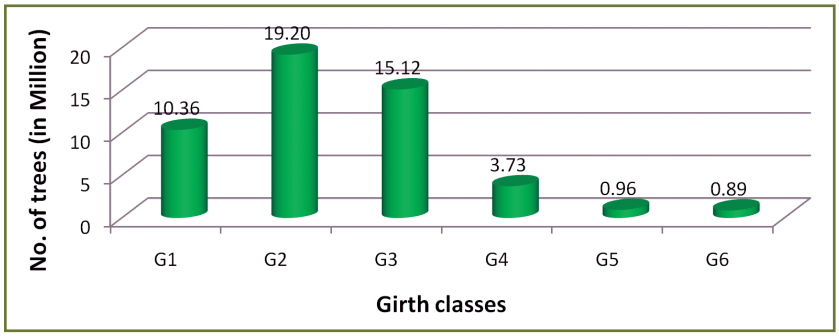

Figure 3.11: Number of trees distributed in different girth classes in the forests of Meghalaya

The database has been used to prepare the working scheme for 39 blocks of Meghalaya. The working scheme is the sustainable forest management plans for next 10 years to be strictly adhered by the concerned authority. Project complete.

3.4. Above ground biomass estimation using SAR data in tropical and subtropical forests of North East India

To estimate the above ground tree biomass using microwave data in the forests of the region, field data were collected from Upper Dehing Reserve Forest, Assam. The study site falls under tropical wet forests and dominated by trees like Canarium bengalensis, Dipterocarpus microcarpus, Mesua ferrea, Castanopsis indica, Shorea assamica, Vatica lanceaefolia, Amoor awallichii, Dysoxylum binectariferum, etc. Plot wise biomass data were generated from the inventory data from each plots (0.1 ha) using available local volume equations and wood density data. The biomass values were then plotted against the backscattered co-efficient of different polarisations of RADARSAT-1 data of to understand the correlation. Further collection of field data from different forest conditions and correlation studies with different microwave data is going on.

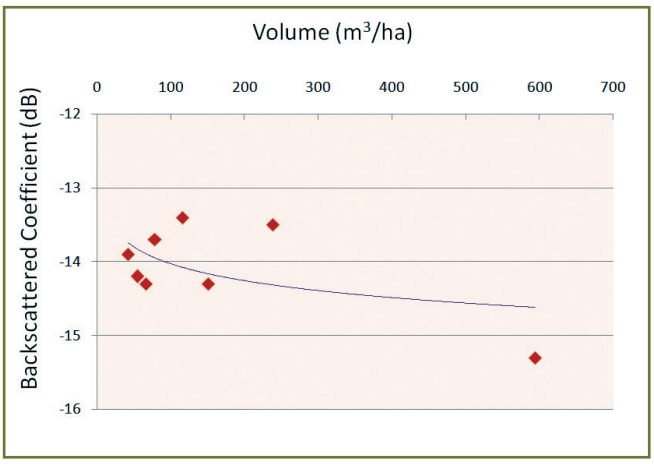

Figure 3.12: Relationship between biomass and backscattered coefficient

4. GEOSCIENCES

4.1. Seasonal groundwater variability in few selected sectors of North Eastern Region of India using GRACE Satellite data

Water storage changes, such as changes in soil moisture, snow and ice cover, surface and groundwater including deep aquifers can be monitored either by in-situ observations or indirectly through changes in gravity. Any change in water storage also manifests in to a change in gravity related to water mass redistribution. This property can be used to infer water storage changes from time-variable gravity observations detected by the Gravity Recovery and Climate Experiment (GRACE) satellite jointly launched by NASA and DLR in March, 2002.

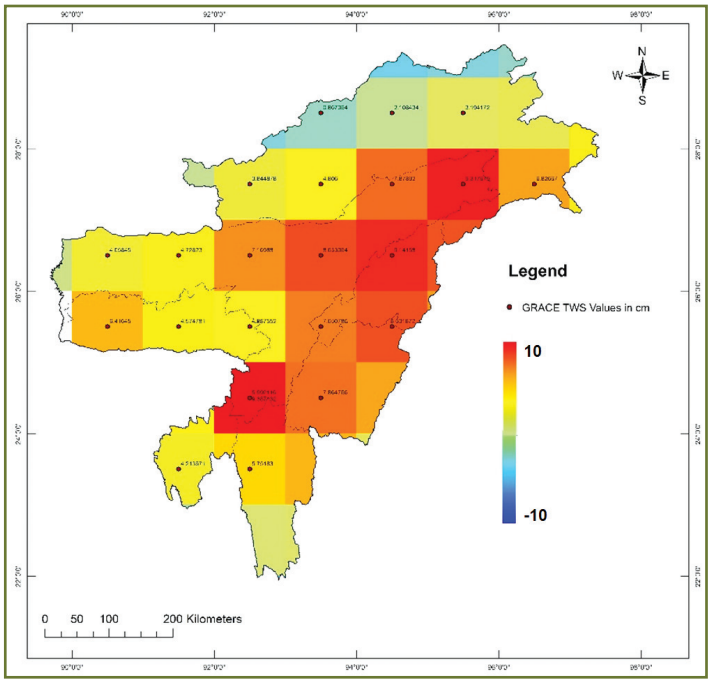

Figure 4.1: Grace TWS variability over NER for July, 2010

A research work has been taken up to characterize and compare spatio-temporal variation of GRACE-derived Total Water Storage Changes (TWSC) with precipitation data from the Tropical Rainfall Measurement Mission (TRMM) over the NER of India with special emphasis on Dibrugarh, Golaghat, Cachar and West Khasi Hills, Meghalaya, representing varying aquifer conditions for the years 2002 to 2013 at monthly time scale.

The Level-3 GRACE products were processed to correct the errors pertaining to certain spherical harmonics and post glacial rebound. Spatial smoothening and destriping filter have been applied with the final output expressed as TWS (in cm of equivalent water thickness). Land Grid Scaling has been applied to the data in order to restore much of the energy removed by the destriping and filtering operations.

Figure 4.1 shows monthly mean of TWS changes as recorded by GRACE for the East Khasi Hills District in Meghalaya. The same has been studied for all station mentioned above. A clear seasonal pattern with the highest positive deviations during June-July and highest negative deviations during November-December were observed for all stations. It takes one or two months until a temporal gravity anomaly observation can detect consequence of precipitation in variation of TWS. A positive correlation between TWS and TRMM precipitation was observed for all stations. During the pre-monsoon and early monsoon season (April-June, AMJ), a linear increase in TWS was observed with precipitation. However, during peak monsoon season and post monsoon season (July-November, JASON), the TWS tends to saturate with precipitation. It is evident that GRACE derived TWS can be very effectively used as a proxy of ground water storage. The study is being continued at NESAC.

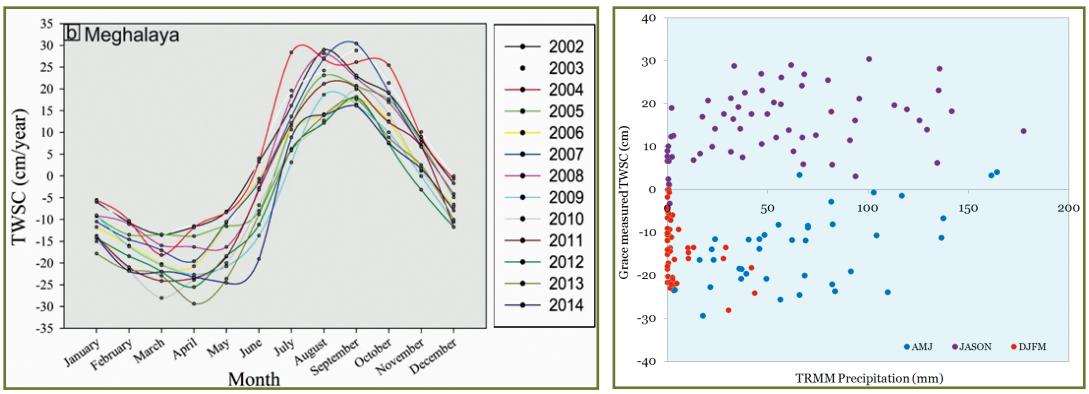

Figure 4.2: Annual variation of TWS for East Khasi Hills district, Meghalaya (left) and variation of TWS with TRMM measured precipitation for the same station

5. URBAN AND INFRASTRUCTURE PLANNING

5.1. Socio-economic vulnerability assessment for disaster management plan of South West Khasi Hills district

Socio-economic vulnerability has been studied for years with sociological, psychological and economical approaches. There need to study the spatial relationship to danger or hazard and this can be an important factor of vulnerability by applying a large number of measurable variables to identify the socially and economically vulnerable groups to natural disaster. Thus, socio-economic vulnerability assessment is a complex process that must consider multiple dimensions of vulnerability, including both physical and social factors. Physical factors that are considered for vulnerability assessment are factors that directly or indirectly affect the assessment of socio-economic vulnerability.

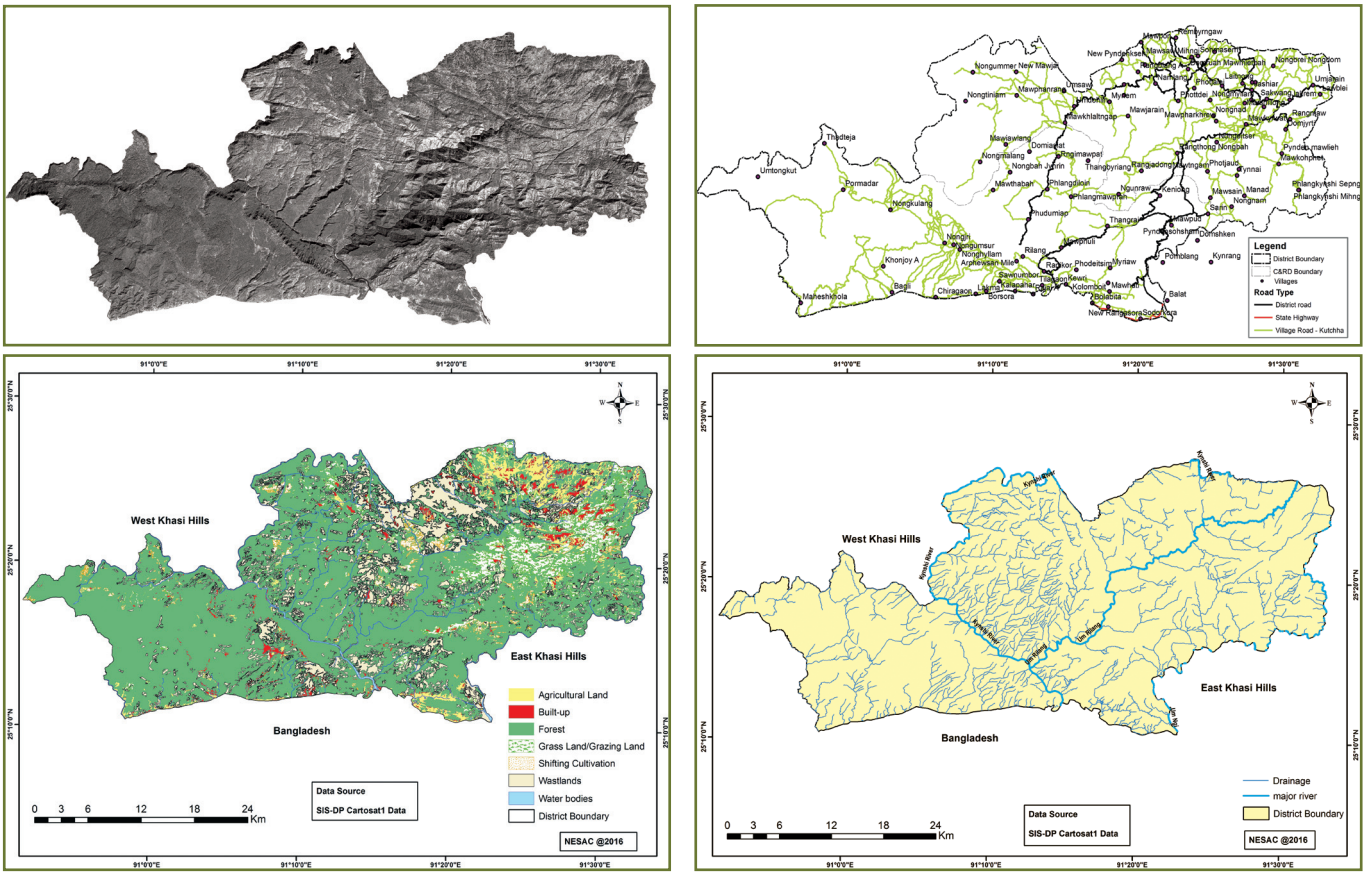

Figure 5.1: South West Khasi Hills District as viewed from Cartosat I (top left), Villages & Road network (top right), Land Use Land Cover map (bottom left) and Drainage network of South West Khasi Hills District of Meghalaya.

In the study, South West Khasi Hills District was taken up for the reason that the district is remotely located in the southern flanks of the Meghalaya Plateau bordering with the Bangladesh plains. The district is characterized by scattered settlements, with thin population density, less accessibility to common facilities and is inhabited 99% by the tribal population (Census, 2011). Based on the discussed background, socio-economic vulnerability assessment of South West Khasi Hills District was taken with the following objectives:

- To find out population vulnerability of the area.
- To find out the accessibility to transportation systems, to shelters and health services.
- To assess economic level of the population by taking into consideration the working population ratio.
- To identify Socio-economic vulnerability at village for the whole district.

The vulnerability assessment was carried out by analyzing the following:

- Firstly population vulnerability (comprising of indicators namely, population compositions, and population structure) was quantified to identify the vulnerable group.
- Secondly, location of the population settlement areas, proximity of the settlement areas to roads, accessibility to health services or centres, accessibility to shelters have been included for assessment for related to remoteness of the settlements and availability of infrastructure and facilities.
- Thirdly, the working population ratio was computed to understand the economic status of the population.

5.2. Urban Information System of Nongpoh Town

Remote sensing data and geographical information system are important tools to support planning and sustainable development of urban areas. These tools have been used to generate outputs in the form of information for Nongpoh Town. The outputs generated are as follows:

- Base line data generated for Nongpoh town includes the road network, location of localities, health centres, educational institutions, service centres, habitations and government offices. This database will assist in strategic planning, resource utilisation management, planning of day-to-day operations and preparation of disaster management - pre-disaster and post-disaster- plans.
- Landuse layer will be an important input for planning future urban development of the town. Based on the existing landuse future growth of the town can be planned.
- Soil, geomorphology and slope information form integral inputs for integrated landuse planning.
- Building characteristics indicate the structure and usage of the building in the town.
- With population increasing, it is imperative that demand for basic infrastructure will increase and this would be a serious challenge in the planning process of the town.
- Outputs namely, location of localities, educational institutions, health facilities, government offices, different facilities (banks) and information of buildings can be used as inputs for disaster management plan of the town.

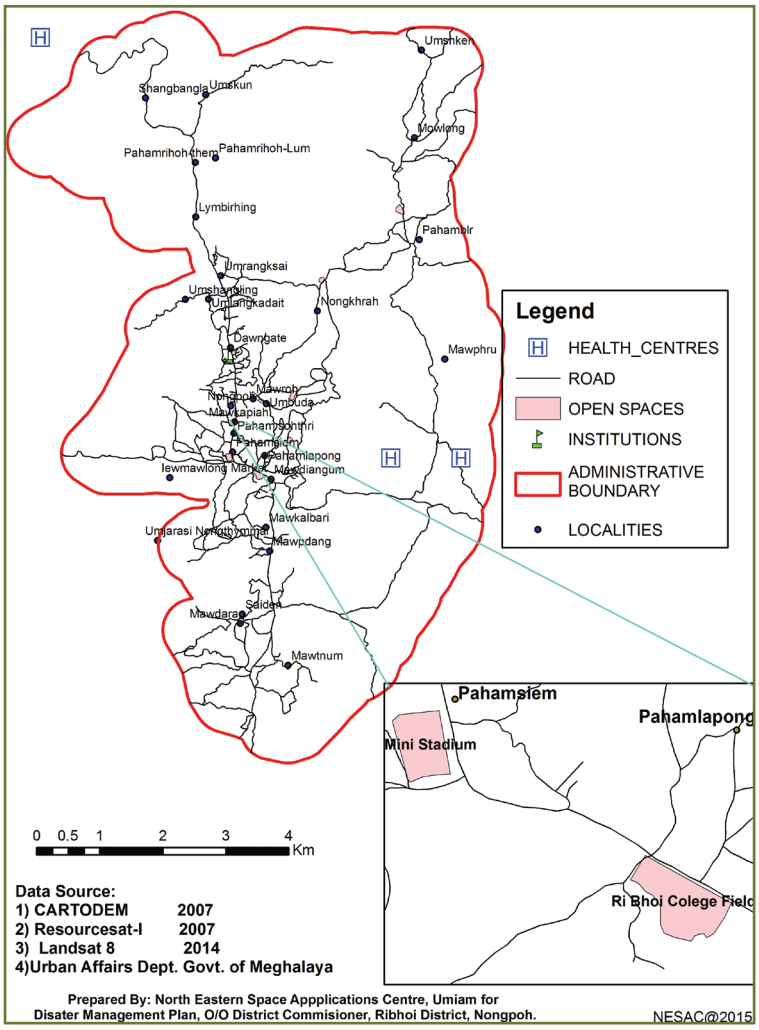

Figure 5.2: Map showing inputs for Disaster Management Plan

The project is completed. The District Disaster Management Authority (DDMA), Ri-Bhoi district, has used the outputs from the project. The District Urban Planner for the preparation of Master plan for Nongpoh Town is using base layers, urban land use, urban sprawl and suitability analysis for future urban growth. It is proposed that in near future there will be the use of UAV high resolution images for updating the database of the town.

6. ICT ENABLED GEOSPATIAL APPLICATIONS AND SERVICES

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. 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) etc. are few significant WebGIS based SDSSs developed by NESAC using open source GIS packages and standards. Spatial data infrastructure (SDI) has been conceptualized and established at NESAC to create repository of satellite data with different spectral/ spatial and temporal resolutions, historical weather data with data cataloguing, searching and retrieving capabilities. Large scale maps, seamless mosaic of orthorectified Carto-1 and LISS4 imagery and the digital elevation model (DEM) generated under Space Based Information Support for Decentralized Planning (SIS-DP) programme are the basis of SDI. In addition, NESAC has initiated the operational work using unmanned aerial vehicle (UAV) for generation of large scale maps, 3D surface models and real-time surveying disaster prone areas. A number of open source packages have been explored for processing of large scale data and customization of interactive tools for the users.

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

Another 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 large scale geospatial maps on present land use land cover, road network, drainage, settlements have been completed for the State of Meghalaya. In addition, 29 legacy layers have been spatially reprojected using SIS-DP referencing system. Ortho products on Carto-I, LISS-IV, fused Carto-I & LISS-IV and 10K DEM and slope have been generated and submitted to NRSC. Total 11 geospatial layers have been uploaded into Bhuvan Meghalaya State portal in addition to the WMS data and services of 385+ geospatial layers for 11 districts of Meghalaya under NEDRP programme.

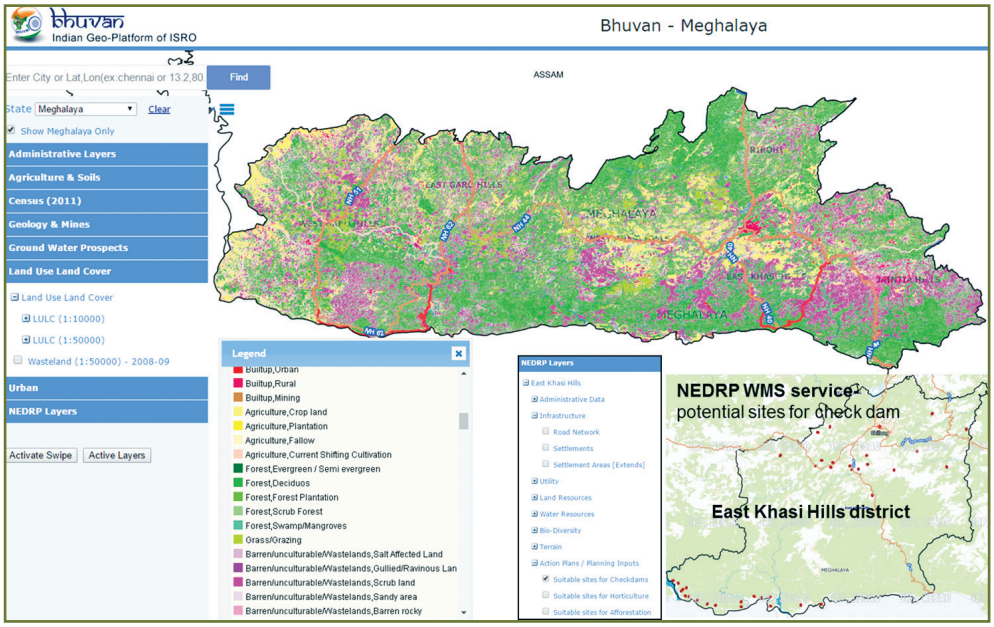

Figure 6.1: 10K land use map of Meghalaya in Bhuvan State portal and potential sites for check dam for East Khasi Hills district is available in Bhuvan through NEDRP WMS data service

SIS-DP database of both 10K and 50K have been disseminated to many Line Departments of Meghalaya through NEDRP and SBIK programme of NESAC. SIS-DP layers have been effectively utilized for preparation of inputs for Forest Working Plan (FWP) of State Forest Department of Meghalaya. In addition, SIS-DP layers also used for preparation of Detailed Project Report (DPR) by the Department of Telecom (DoT), Government of India for setting up of new telecom towers.

A number of User Interactions were conducted for effective utilization of SIS-DP data for developmental planning activities by the State Government. One day Regional Workshop on 'For effective utilization of Space Technology for Decentralized Planning in NE region' was organized at NESAC on 7th December, 2015 under SIS-DP programme. Around 45 participants from SRSACs and other Line Departments of NE region attended the workshop. SIS-DP data services through Bhuvan Panchayat & other Geoportals of NESAC has been presented jointly by NRSC, Hyderabad and NESAC. Hands-on for Asset Mapping using Bhuvan Panchayat Mobile Apps was conducted by NRSC, Hyderabad. 10K SIS-DP land use map of entire Meghalaya and the potential sites for check dam construction for East Khasi Hills district is presented in the figure 6.1. The potential sites for check dam construction for East Khasi Hills district is made available through NEDRP WMS data service from NESAC.

6.2. North Eastern District Resources Plan (NEDRP)

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. Multi-criteria spatial modelling 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. The dissemination mechanism is planned in three modes: via Standalone, Public domain and Bhuvan-based modes. NEDRP has been installed in standalone mode in 18 Deputy Commissioner Offices of NE region (i.e. 1 in Arunachal Pradesh, 1 Manipur, 11 in Meghalaya, 3 Mizoram and 2 in Nagaland) and few Line Departments of the region. NEDRP is now ready for hosting in public domain with www.nedrp.gov.in URL. The official security auditing of the site has been completed. The infrastructure for web hosting for NEDRP has been set-up at NESAC using 100gbps NKN backbone which comprised of 2 Web servers, 2 Applications/Database servers and 2 FTP servers in redundant and high availability cluster mode. It is planned to release the portal during August, 2016. NESAC has been publishing WMS data and services of 1000+ geospatial layers for 36 selected districts of NER through Bhuvan portal under NEDRP programme for developmental planning in the region. In addition, NEDRP district portal is also populated with the maps prepared by respective SRSACs of NE region. Land use map of 1:4K scale for the Thoubal district of Manipur is depicted in the figure 6.2 through NEDRP portal.

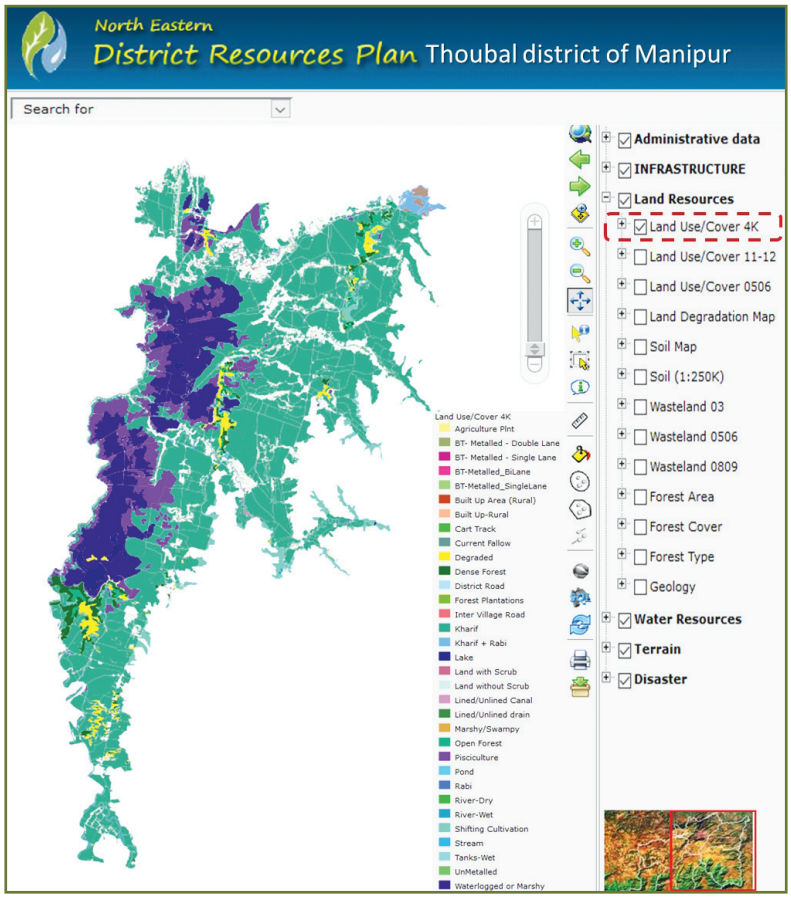

Figure 6.2: Large scale land use map of Thoubal district of Manipur

6.3. Space Based Information KIOSK (SBIK)

SBIK has been becoming one of the important tools for a large number of Line Departments of NE region. SBIK was

sponsored by the Ministry of DoNER, Government of India and is executed by NESAC, in collaboration with SRSACs of NE region to support users and Line Departments of respective State Governments for developmental planning. SBIK showcases the State-wise necessary geospatial data in various scales and spatial resolutions for the state. Each of the SBIK is populated with geospatial layers on natural resources, infrastructure, disaster management etc. with proper linkages to the socio-economic data. In addition, it also contains information related to action plans for forest and environment, agriculture, soil conservation, infrastructure etc. for preparation of detailed project report (DPR) etc. In addition, large scale land use and infrastructure maps, village cadastral maps prepared using high resolution Carto-1 + LISS4 fused imagery at 1:10K scale generated under SIS-DP programme form the basis of SBIK for decentralized planning. SBIK has numerous GIS tools for data visualization, navigation, analysis and printing of the final map. The detail map statistics for spatial layers can also be generated based on user defined area of interest. SBIK is conceptualized to strengthen the planning and monitoring mechanisms of the projects funded by DoNER Ministry & other Central Government funded projects such as Integrated Watershed Management Programme (IWMP), Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA), Pradhan Mantri Gram Sadak Yojna (PMGSY) etc. SBIK has been installed in the offices of Chief Secretaries of NER in a Touch-Screen based system and in the offices of many Line Departments. A number of training and hands-on programme has been conducted by NESAC for effective utilization of space technology using SBIK portal. SBIK portal was installed and deployed in all offices of Chief Secretaries in NE region. During 2015, SBIK was installed in Brahmaputra Board, Government of India, Assam, Departments of Science & Technology, Urban Development, Soil & Water Conservation, Irrigation & Flood control, Fishery, Government of Assam, State Level Nodal Agency (SLNA/IWMP) of Assam, State Institute of Rural Development, Meghalaya (SIRD), Indian Council of Agricultural Research (ICAR) etc. It is planned to install one Touch-Screen based SBIK KIOSK with entire 8 States data of NE region in the reception counter of North Eastern Council (NEC), Secretariat during Jul, 2016. Geoexplorer of SBIK is presented in the figure 6.3.

Figure 6.3: Home page of SBIK Geoexplorer

6.4. Sericulture Information Linkages and Knowledge System (SILKS)

SILKS has been developed using Open source GIS as a single window decision support system to provide spatial and non-spatial information for selected 108 districts in the country and hosted in the public domain at http://silks.csb.gov.in. SILKS portal currently host data services for 900 sets of spatial layers consisting of potential areas for expansion of sericulture development in a single window access system. SILKS is supported by 16 non-spatial modules on sericulture planning, farmers advisory and other services specific to the district. Spatial information on potential areas for expansion of sericulture in 108 priority districts in 24 states has been integrated along with corresponding nonspatial information for all these selected districts. Spatial database on mulberry is made available for 108 districts, Tasar for 53 districts, Eri for 47 districts and Muga for 48 districts for expansion of sericulture activities.

Within a short span of about two years, the geoportal has been able to make significant impact particularly in north eastern region and a number of sericulture expansion activities have been initiated based on the outcome of the study. 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. With the initiation of the 2nd phase of the project on Applications of RS and GIS for Sericulture Development comprising of 25 districts in the NER, the development of SILKS for these districts has been started. Further, the entire framework of SILKS are being upgraded for more user-friendly, additional tools for analysis and initiate interoperable geospatial data services for consuming by third-party systems or applications. Potential sites for expansion of Mulberry in Udalguri district of Assam is depicted in the figure 6.4 through SILKS portal.

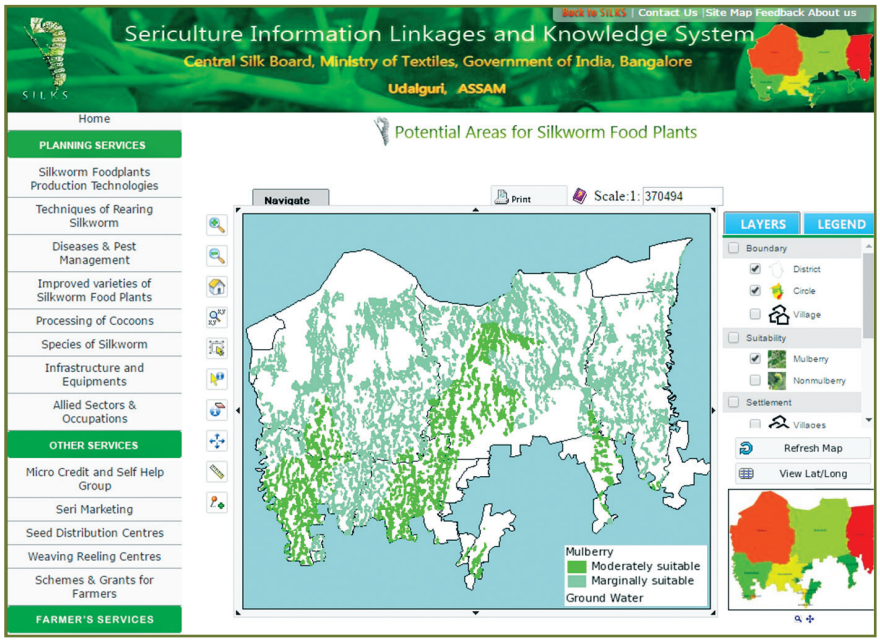

Figure 6.4: Potential sites for expansion of Mulberry in Udalguri district of Assam

6.5. Japanese Encephalitis Warning System (JEWS)

JEWS is a SDSS developed by NESAC to provide near real time surveillance of diseases and control program with value added geospatial maps of disease prone areas for visualization and taking up control measures by the concerned authority. JEWS provides (i) forecast of JE onset, (ii) forecast of JE intensity and (iii) location of JE prone villages. The JEWS software has been installed in the districts of Tinsukia, Sibsagar and Dibrugarh as part of Integrated Disease surveillance programme (IDSP) under Indian council for medical research (ICMR). JEWS databases have been updated with the cases of 2014 and 2015. Further calculations for the year 2016 predictions were done. The month-wise intensity for the year 2015 was also updated for these 3 districts. JE forecast for Tinsukia for the year 2016 and PHC wise forecasted JE cases for Tinsukia for the year 2015 are depicted in the figure 6.5.

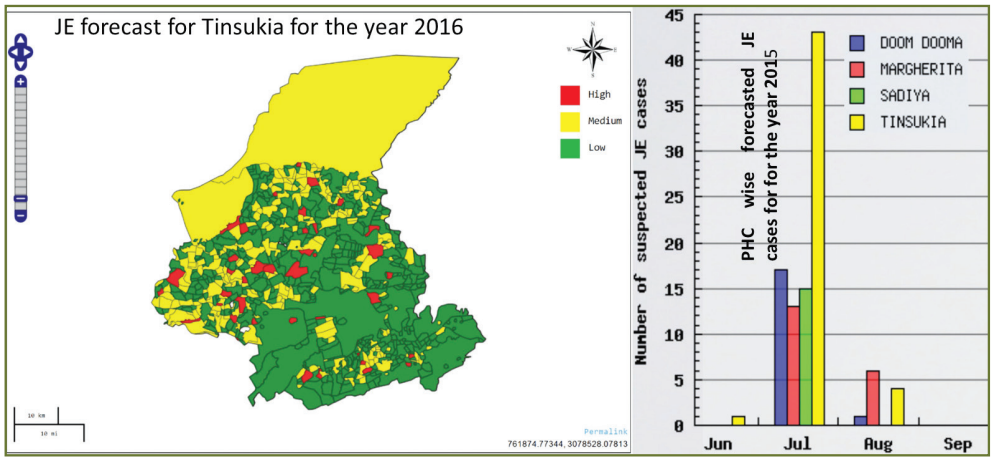

Figure 6.5: JE forecast for 2016 and PHC wise forecasted JE cases for 2015 for Tinsukia

6.6. Applications of Unmanned Arial 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 team of Scientists from NESAC

have participated in a two weeks training programme on UAV design, assembly and processing of UAV imagery in Kohima during 1-12, Feb 2016. During the training period, NESAC has assembled a hexacopter successfully, verified the fly operation and acquired imageries. The hexacopter has 1.5-2.0 kg of payload capability and can be customized to carry sensors such as thermal, multispectral, hyperspectral or LIDAR etc. It can attain maximum altitude upto 2kms with scanning radius of 2kms. It can fly for about 20 mins and sufficiently covers an area of 1-1.5 Sqkms. A number of case studies have been planned for utilization of UAV for large scale mapping, monitoring and mapping of landslide areas, incidents of forest fire, assessment of crop damage areas due to insect infestation. Open source software has been utilized for processing of UAS imageries for generating 3D surface models and generation of large scale ortho-products. Figure 6.6 presents an ortho image of landslide prone area of Kohima along NH39 acquired by UAV.

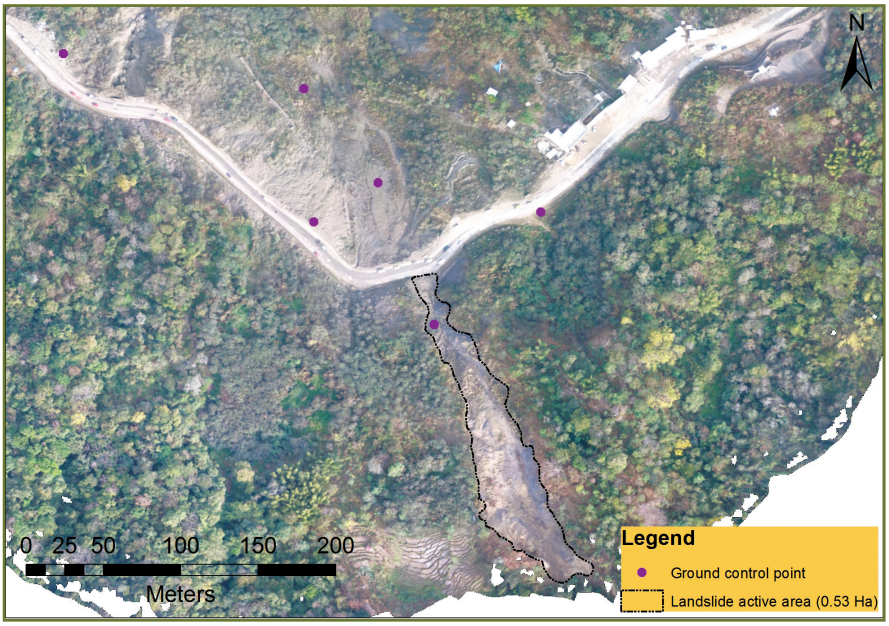

Figure 6.6: Ortho image of active landslide area along NH39 near Kohima, Nagaland

6.7. Spatial Data Infrastructure (SDI)

To leverage the increasing volume of datasets in NESAC, spatial data infrastructure (NESACSDI) has been conceptualized and designed to meet the requirements of data discovery and download of various levels of users at NESAC. NESAC SDI is established to build a unified repository of spatial data which ranges from spectral, spatial and temporal resolutions, historical weather data with data cataloguing, searching and retrieving capabilities. The objective of the NESACSDI is to catalogue all geospatial products (i.e. raster and vector data) as a single unified repository at NESAC. The total catalog of datasets has increased from 2279 to 11891 which comprises of Satellite data, DEMs, vector data, geotag photos etc. pertaining to NE region. These datasets are organized for use on a customized user-friendly geoportal platform which acts as an organization SDI for internal use by the scientists. SIS-DP referencing system is used for orthorectified of all datasets before cataloguing.

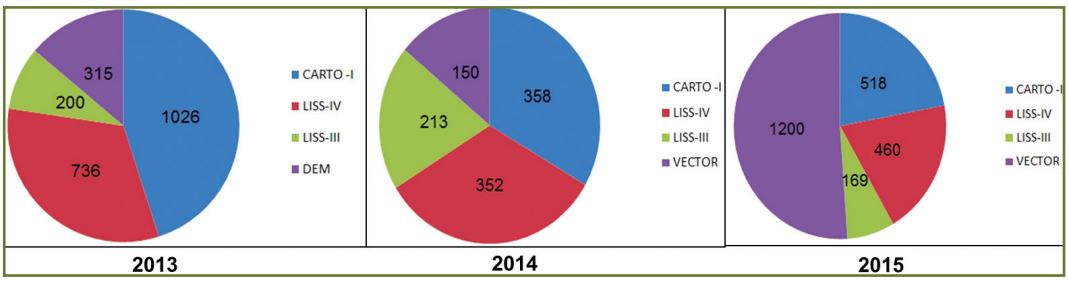

Figure 6.7: Year-wise data cataloguing in SDI since last 3 years

Current version of NESACSDI houses various functionality and has been upgraded from version 2014. The key functionalities apart from the basic functionality of searching and download, user can swipe to see temporal changes between the temporal images within the portal and the datasets are WMTS enabled for better rendering and faster visualization in the NESACSDI portal. Apart from searching and downloading, the web services from NESACSDI can be consumed from any OGC enabled sources.

7. DISASTER MANAGEMENT SUPPORT ACTIVITIES - NER-DRR

7.1. Flood Early Warning System (FLEWS)

Flood being a major hazard in Assam, FLEWS was initiated by NESAC in one district of eastern 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 further for the second operational phase from 2015 to 2017 at a strong request from Government of Assam for continuation with fresh funding support from ASDMA. All the technical components have been subjected to necessary improvements every year. Of late, emphasis has been given to hydro-dynamic modelling of overland flood wave propagation. Few flood events of recent history has also been attempted to be modelled with encouraging results. The alert success for both 2014 and 2015 has been nearly constant at near 90% (combining both absolute and partial success) as shown below. Details on the performance of the FLEWS for 2014 and 2015 are given in figure 7.1.

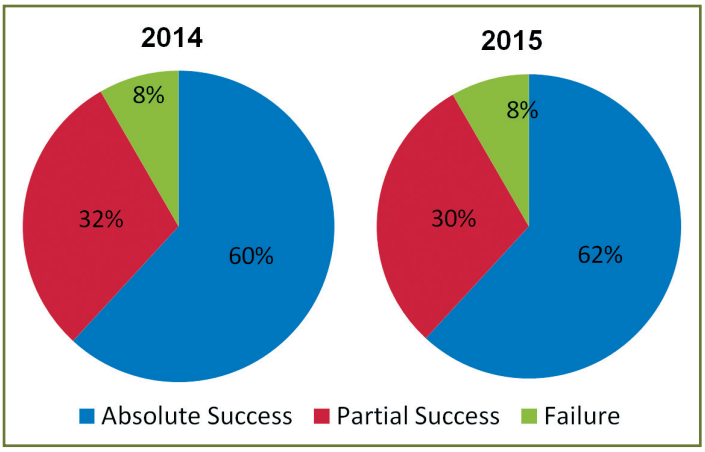

Figure 7.1: FLEWS success rate during 2014 and 2015

During 2015, 39 HEC-HMS models were operational 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 (figure 7.2).

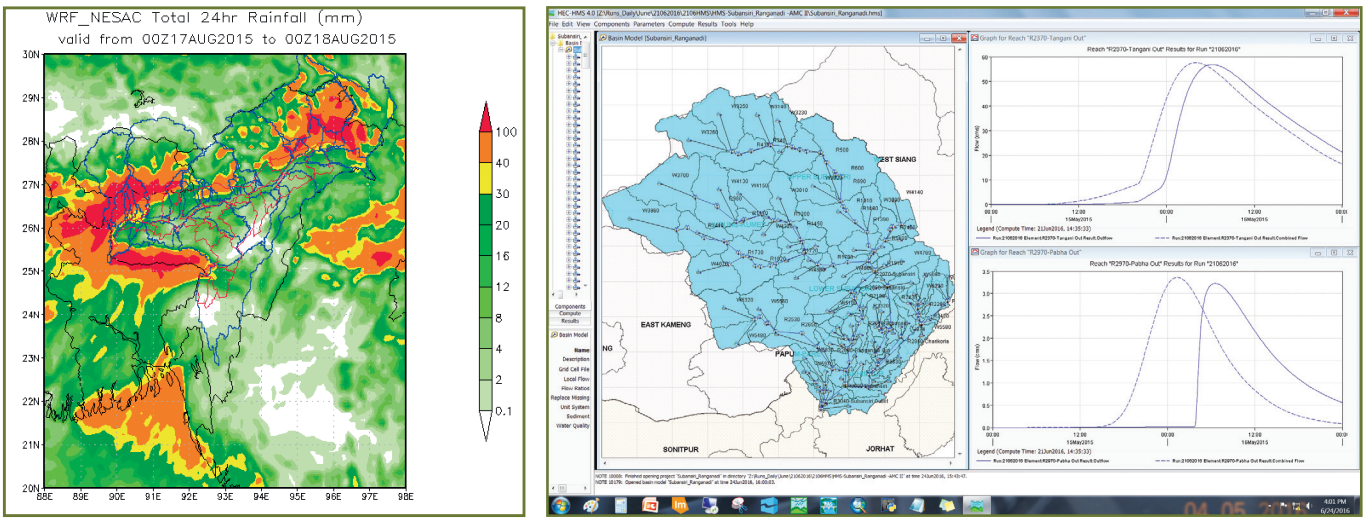

Figure 7.2: The rainfall and discharge prediction

7.2. Forest Fire Monitoring and value addition

Forests fire is one of the most common hazards of the North Eastern Region (NER) of India. Every year about 10,000 forest fire points are recorded over NER of India by MODIS Terra and Aqua with a maximum count in the month of March and April. Under the North Eastern Region – Disaster Risk Reduction (NER-DRR) program at NESAC, every year on a daily basis forest fire alert bulletin has been issued during the months of February to May to the forest

departments. The value added near real time forest fire alert helps to take necessary measures by the concerned forest departments to minimize socio-economic and ecological damages.

In the process of preparation of forest fire alert bulletin, near real time fire points from MODIS Terra and Aqua with 1km & 750m resolution & Bhuvan-NRSC portal, meteorological parameters from IMD-AWSs & ISRO-AWSs (Daily wind speed, wind direction and dew point temperature), topographic factors, proximity to roads, built-ups, water- bodies and the type of land use/ land cover are used for analysis and decision making. The fire alert bulletin were derived using automated geospatial model taking into consideration 8 variables viz., forest type, and fire hot spot (FH), forest cover/density, slope, aspect, elevation, distance to built-up/settlements and distance to roads and the model output gives qualitative risk levels into 5 classes. The forest fire alert bulletin contains fire alert points in the form of a map along with a value added tabular information mentioning exact location, slope, aspect, surrounding landuse/forest type, proximity to road, water body, wind speed, wind direction and dew point temperature. For the forest fire season of 2016, alerts were issued daily from mid-March to end of April 2016 to all forest area districts of NER. This year on pilot basis, validation of forest fire point recorded on 23rd and 26th March 2016 were carried out using on board camera of Unmanned Arial Vehicle (UAV), GPS and GPS enabled field camera in Ri-Bhoi district of Meghalaya as shown in figure 7.3. A typical daily forest fire report is shown in figure 7.4.

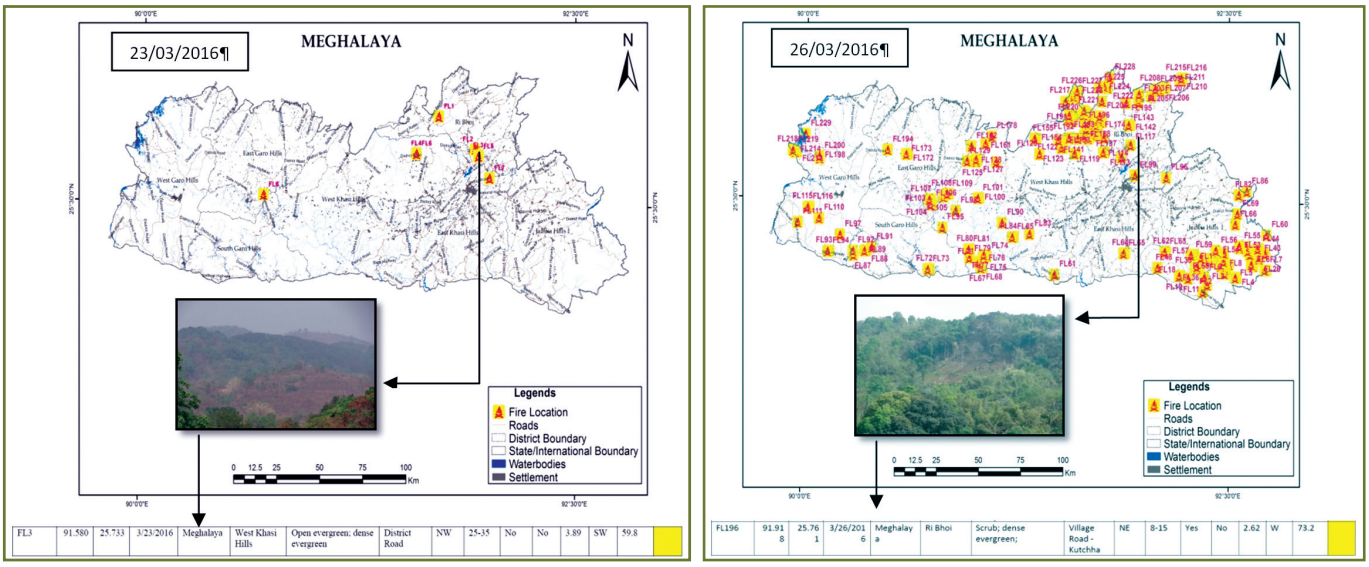

Figure 7.3: Forest fire locations

7.3. Assessment & Monitoring of river embankment breach locations

NESAC is mapping the embankment breaches due to the flood of every year during the month November to February based on availability of cloud free data and monitoring their status prior to onset of successive monsoon for past four years. This is being done in twenty eight districts of Assam using high resolution satellite data (Cartosat-1). A total of thirty four breaches were identified which occurred during the flood season of the year 2015 in different districts of Assam. All the breaches may not be identified due lack of interpretability or lack of satellite data. While monitoring the status it was found that seven breaches were remained unplugged till the month May 2016 out of seventeen breaches considered for monitoring.

7.4. Seasonal Landslide Inventory Mapping (SLIM) for the state of Manipur and Nagaland

The exercise has been initiated for Manipur and Nagaland states under the national project lead by NRSC, Hyderabad. In the pilot phase, study aims to detect seasonal changes in landslides areas following a semi-automatic methodology.

Forest fire report for Meghalaya on 23 March, 2016

Fire Location (FL)	Long	Lat	Date	State Name	District	Vegetation type/Land use Land cover category (buffer of 1.5 km centered at FL)	Road connectivity to fire location	Aspect	Slope(deg)	Settlement (if present)	Nearby water body (if any)	WS(km/hr)	WD	Relative Humidity (%)	Vulnerability
FL1	91.920	25.754	3/23/2016	Meghalaya	Ri Bhoi	Scrub; dense evergreen;	Village Road - Kutchha	W	15-25	Yes	No	3.30	SW	45.4	
FL2	91.939	25.727	3/23/2016	Meghalaya	Ri Bhoi	Scrub; open deciduous; dense evergreen	Village Road - Kutchha	NW	25-35	No	No	3.18	SW	42.9	
FL3	91.580	25.733	3/23/2016	Meghalaya	West Khasi Hills	Open evergreen; dense evergreen	District Road	NW	25-35	No	No	3.89	SW	59.8	
FL4	91.938	25.723	3/23/2016	Meghalaya	Ri Bhoi	Scrub; open deciduous; dense evergreen	Village Road - Kutchha	SW	8-15	No	No	3.18	SW	42.9	
FL5	91.579	25.732	3/23/2016	Meghalaya	West Khasi Hills	Open evergreen; dense evergreen	District Road	W	15-25	No	No	3.89	SW	59.8	
FL6	92.003	25.627	3/23/2016	Meghalaya	East Khasi Hills	Scrub; open evergreen; dense evergreen; agricultural land	Village Road - Kutchha	NW	8-15	No	No	4.47	SW	51.2	
FL7	90.698	25.541	3/23/2016	Meghalaya	East Garo Hills	Scrub; open evergreen; ; bamboo	Village Road - Kutchha	NE	8-15	Yes	No	2.99	S	61.4	
FL8	91.707	25.897	3/23/2016	Meghalaya	Ri Bhoi	Scrub; open evergreen; jhum; dense evergreen; ; agricultural land	Village Road - Kutchha	N	15-25	Yes	No	3.83	SW	60.3	

Data source: Bhuvan, MODIS, ISRO & IMD-AWS
NA: Not Available

Severe High Moderate Low

Disclaimer: This report is only for planning tool and not for any legal purpose

Figure 7.4: Forest fire alert dissemination format

For this, 2014 is considered as base year. The main objective of the project is to prepare 'Landslide Inventory Map' by using the pre and post monsoon LISS IV MX images.

Under the work, layer stacking of pre & post monsoon data, ortho-rectification using Cartosat-1 data, Top of Atmospheric Correction (TOA), generation of NDVI, gNDVI & Principal Component Analysis (PCA), generation of slope map from SRTM DEM, creation of tiles corresponding to SOI Topographical Map (1: 50,000 scale) for both the states have been done. Interpretation and change detection of landslide areas have been completed for 20 grids each for Manipur and Nagaland states and submitted to NRSC for quality check. The work for remaining sheets/grids is in progress. Landslides triggered by monsoonal rainfall has been identified and is shown in figure 7.5.

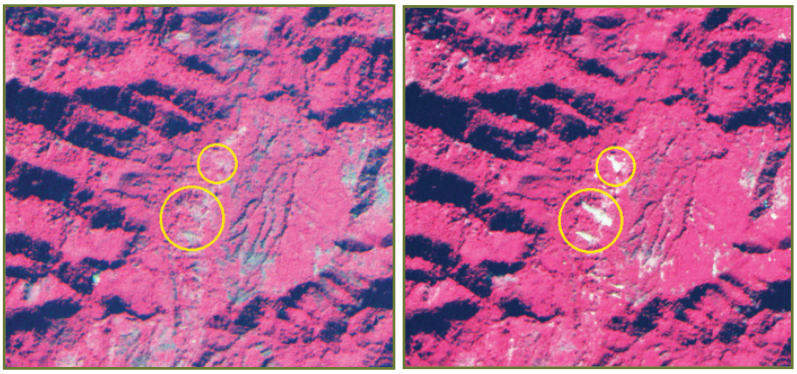

Figure 7.5: Pre - Monsoon Image (left) and Post- Monsoon Image showing landslide

7.5. Communication for DMS

DMS-VPN node is operational at NESAC including access to NDEM data. VC and data transfer activities continued with all node under DMS-VPN network. Transportable VSAT system is also working fine. The SMS based alert system under FLEWS is continued. INSAT Type D terminal for audio calling using satellite for emergency communication is maintained at working level.

8. 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.

8.1. Tele-education project in North Eastern States

During 2015-16, NESAC has accomplished following activities in this regards:

- Handling of comprehensive annual maintenance of existing networks (HUB & SITs) in NER states by awarding contract to suitable agency
- Technical Support & Training for existing network by putting dedicated manpower in each state by establishing a 'Technical Support and Training Centre' at NESAC through a suitable agency
- Provided support for HUB operation by pacing manpower under contract at each HUB
- Continued revival of faulty node by arranging required spares
- Actions initiated for rectifying faulty SITs of Mizoram states
- Conducted a user meet for all the user of NER states

Figure 8.1: Tele-education user meeting at NESAC

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.

8.2. Telemedicine Program in NER

Revival of non-working Telemedicine node is initiated in consultation with DECU/ISRO. NESAC Engineers are visiting many sites for trouble shooting and technical support. Work for commissioning of new Telemedicine nodes is in progress according to the guidelines.

8.3. Communication Support in Disaster Management

DMS-VPN node is operational at NESAC including access to NDEM data. VC and data transfer activities continued with all node under DMS-VPN network. Transportable VSAT system is also working fine. The SMS based alert system under FLEWS project is continued. INSAT Type D terminal for audio calling using satellite for emergency communication is maintained at working level.

Figure 8.2: NER-DRR control room at NESAC

8.4. Ka band propagation experiment at NESAC

Figure 8.3: Dual frequency beacon receiver installed at NESAC

This experiment is a part of MoU signed by Hon'ble PM of India with France Government (ISRO-ONERA-CNES collaboration in space). It is administered by Space Applications Centre (SAC), Ahmedabad and NESAC is one of its participatory agency. It aims to study the effects of various meteorological parameters on Ka band radio propagation. Under this project, a number on equipment like Disdrometer, Microrain Radar (MRR) etc. has been already commissioned and functional. Recently a Dual frequency Beacon Transmitter (20.2 and 30. 5 GHz), Radiometer, Rain gauge with data logging and processing systems are installed at NESAC by ONERA scientist. Data collection and processing using these systems is already started.

8.5. Navigation with Indian Constellation (NAVIC) project at NESAC

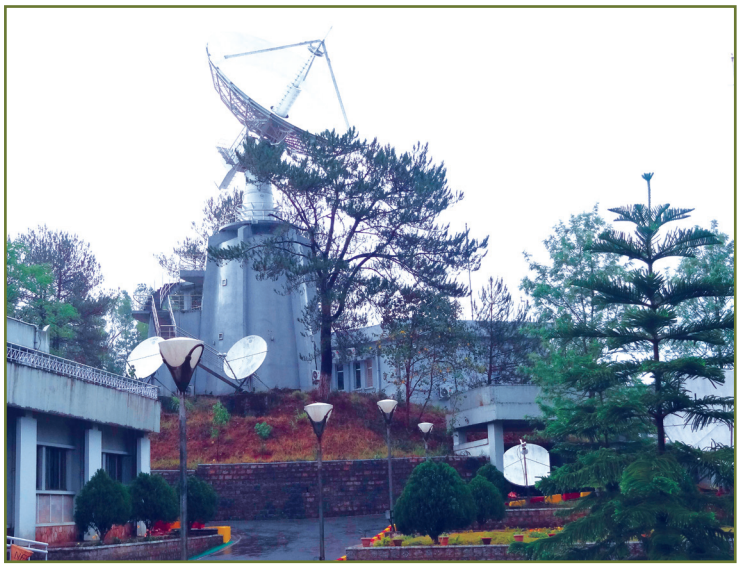

Figure 8.4: NAVIC system ground station at NESAC

The various station 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.

8.6. Commissioning of 30 kVA Solar Power Plant at NESAC

A Solar Power Plant of 30 kVA with battery backup is commissioned at NESAC campus as part of Green energy initiatives of ISRO. The plant is functional.

Figure 8.5: The Solar power plant at NESAC (left) and Shri S Srinivasan, Additional Secretary, DOS inaugurating the plant

9. SPACE AND ATMOSPHERIC SCIENCE RESEARCH

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. The group has also started providing experimental operational short range weather forecast for NER. An instrument hub has been set up at NESAC with instruments for aerosol optical and physical characterisation, atmospheric boundary layer dynamics, greenhouse gas chemistry, etc. for use of the data by academicians and researchers in the region. A network of automatic weather station and a Doppler Weather Radar set up by the centre has reduced the gap in surface meteorological observations in NER.

9.1. IGBP- NOBLE experiment over North Eastern Region of India

To understand the importance on the atmospheric boundary layer dynamics regulated by hilly topography and influence of thermally induced mesoscale winds in modulating the regional meteorology over the hilly terrains (East Khasi Hills) of Northeast India, an experimental campaign was conducted over Umiam (25.67°N, 91.91°E) and Guwahati (26.11°N, 91.81°E) during the month of March 2015. The principal objectives of the campaign was to explore the diurnal evolution of ABL over hilly terrains, the characteristics of the mesoscale circulation (drainage winds and anabatic winds) and role of the ABL & mesoscale circulation in the regional meteorology. In these experimental campaigns a total no of 105 Dr Pisharoty Radiosonde and more than 50 Dr Graw sonde were launched at every 3 hourly interval simultaneously from Umiam and Guwahati during fair-weather conditions.

9.1.1. Effect of boundary layer circulation on regional meteorology over Northeast India

The topography of the Assam-Meghalaya region in northeast India, characterized by the Himalaya at north and East Khasi Hills at south, separated by over 100 km wide Brahmaputra basin, play a pivotal role in regulating the boundary layer development in this region. This is especially the case during January-March period when the region experiences predominantly cloud-free conditions, causing night time radiative cooling and daytime shortwave heating of the surface that drive the mountain circulation. Altitude profiles of virtual potential temperature, water vapour mixing ratio and wind show the development of TIBL (Thermal Internal Boundary Layer) at both stations, which is also marked by a distinct neutral layer between the TIBL height and trade wind inversion. Wind directions at the TIBL and the neutral layer above are markedly different, indicating their origin from the mountain circulation. At Umiam, the TIBL height extends upto ~1.0 to 1.5 km during the afternoon, while the trade wind inversion associated with the large-scale Hadley circulation occurs at ~2.5 km. The nocturnal ABL at Umiam is shallow (<200 m). The TIBL at Guwahati extends upto ~1 km, while the well-mixed neutral layer above the TIBL extends up to the trade wind inversion height at ~3 km. Associated with the trapping of nocturnal air mass to <200 m, the largest specific humidity values

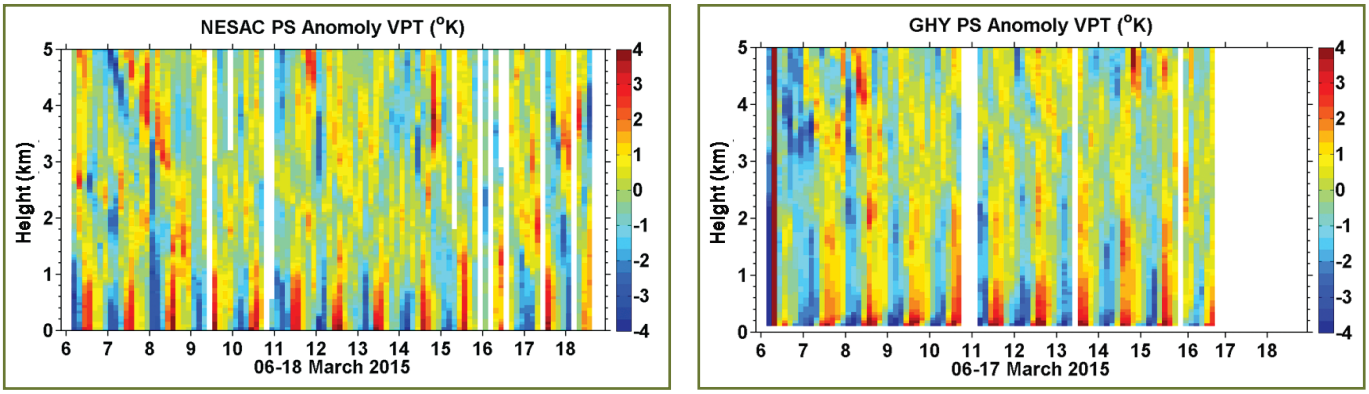

Figure 9.1: Time-height cross sections of virtual potential temperature at Guwahati and Shillong during 06-18 March 2015

at both the stations occur during the post-midnight period, while the corresponding values during noon are only about half of their night time values. Variations in wind directions at Umiam and Guwahati are in-phase, providing experimental evidence for the extension of the mountain circulation originating at the East Khasi Hill to more than 60 km from the mountain peak. However, vertical extension of the neutral layer (flow reversal) above the TIBL height is deeper at Guwahati compared to Umiam. These observations also provide observational evidence for the influence of orographically influenced circulation in shifting the trade wind inversion height.

9.1.2. Characteristics of subtropical jet stream and associated gravity wave generation

Vertical transport of energy and momentum by atmospheric gravity waves from their source regions play a vital role in the dynamical coupling between different atmospheric layers. Deposition of energy and momentum carried by such waves at the altitudes of their dissipation produces acceleration of the mean wind and is often responsible for generating long-period oscillations. Strong vertical wind shear associated with jet streams is recognized as one of the potential sources of atmospheric gravity waves. Northern parts of the Indian subcontinent is manifested by the appearance of sub-tropical westerly jet stream (SWJ) during winter and early part of the pre-monsoon season.

From the experiment as mentioned above, Kalpana-1-VHRR observations of cloud top brightness temperature in the thermal IR and water vapour bands as well as reanalysis data show that these stations come directly under the core of the descending limb of Hadley cell during the experiment period. Core of the SWJ at both these stations are located between 11-13 km, with peak westerly wind speeds of 55-60 ms^{-1}. Vertical wind shear associated with the jet typically varies between 9 to 18 $ms^{-1}km^{-1}$ between the jet core and ~15 km. Occurrence of upward propagating gravity waves above the jet core, with vertical wavelengths of ~1.2 – 2 km, is a regular feature at both these sites. Such features are observed in most of the wind and temperature profiles. These waves, produced by the large wind shear associated with SWJ, generally propagate up to >30 km altitude and have amplitudes of 3-6 ms^{-1} in wind and 2-3 K in temperature. Downward propagation of such waves from below the shear region is less discernible compared to the upward propagation above the shear zone. Propagation characteristics of these waves are inferred using hodograph analysis of wind perturbations, while amplitudes of the wave perturbations are used to estimate the available energy. Downward phase propagation of these waves generally have periodicities of ~20-30 hr, which is close to the inertial period (~28 hr) at these locations. This study shows the importance of inertia gravity waves produced by wind shear associated with westerly jet stream in the vertical transport of energy into the stratosphere.

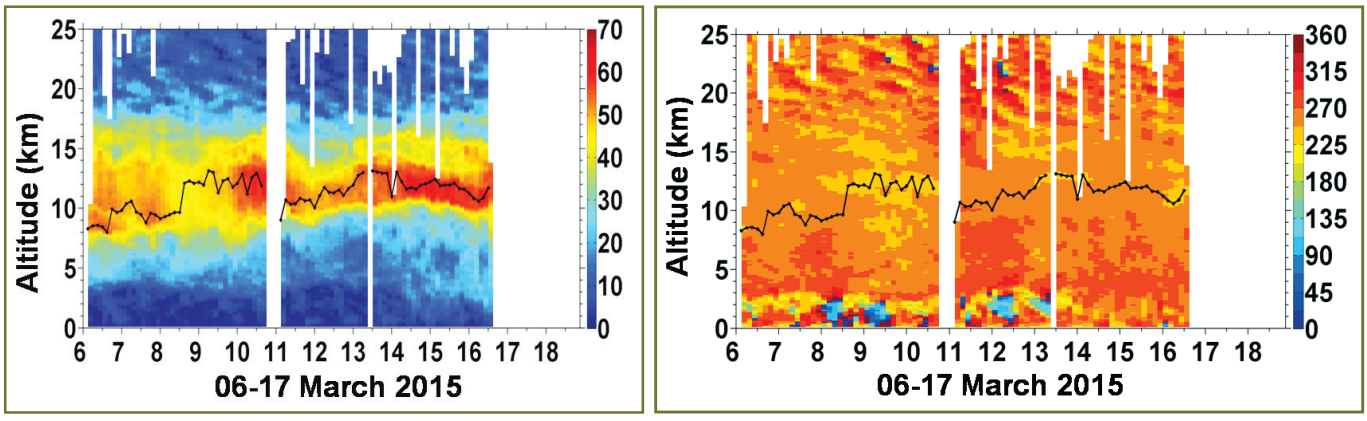

Figure 9.2: Time-altitude cross sections of wind speed and wind direction at Guwahati during 06-17 March 2015, indicating the generation of gravity waves

9.2. Impact of forest fire on surface Black Carbon concentration

Forest fires are one of the principal sources of air pollution. Smoke from forest fire is a mixture of gases and fine particles from burning trees and plants. They can have significant impacts on local air quality, visibility and human health. Emissions from forest fires can travel large distances, affecting air quality and human health far from the originating

fires. These emissions include particulate matter (like Black Carbon), carbon monoxide, atmospheric mercury, ozone-forming chemicals and volatile organic compounds.

The impact of forest fire on air quality over NER of India has been studied. It was observed that the region has experienced more than 1 Lakh active fire events every year with a maximum during the months of March-April. In this study MODIS Collection 6 active fire data with minimum 50% confidence level, MERRA-2 model Black Carbon (BC) Surface mass concentration (kg/m^3) at 0.5 X 0.625 resolution and wind vector from MERRA model at 0.5 X 0.625 resolution were used.

Results show that there is strong positive correlation between fire counts and BC surface concentration over the region. MODIS active fire map shows three distinct hotspots of fire events over the Mizoram - Myanmar bordering area, Nagaland - Myanmar bordering area and Meghalaya plateau region. Similarly high BC surface mass concentration has been observed in the same month over both Nagaland – Myanmar bordering area and Mizoram - Myanmar bordering area. However, the concentration of BC over Meghalaya plateau was found to be less than over other two hotspots. The synoptic wind pattern shows heavy westerly wind over the Meghalaya plateau that could transport the BC generated over Meghalaya plateau towards the Indo-Myanmar hills range making higher BC concentration in those regions. A detail study to identify the source of the observed BC is being taken up at NESAC.

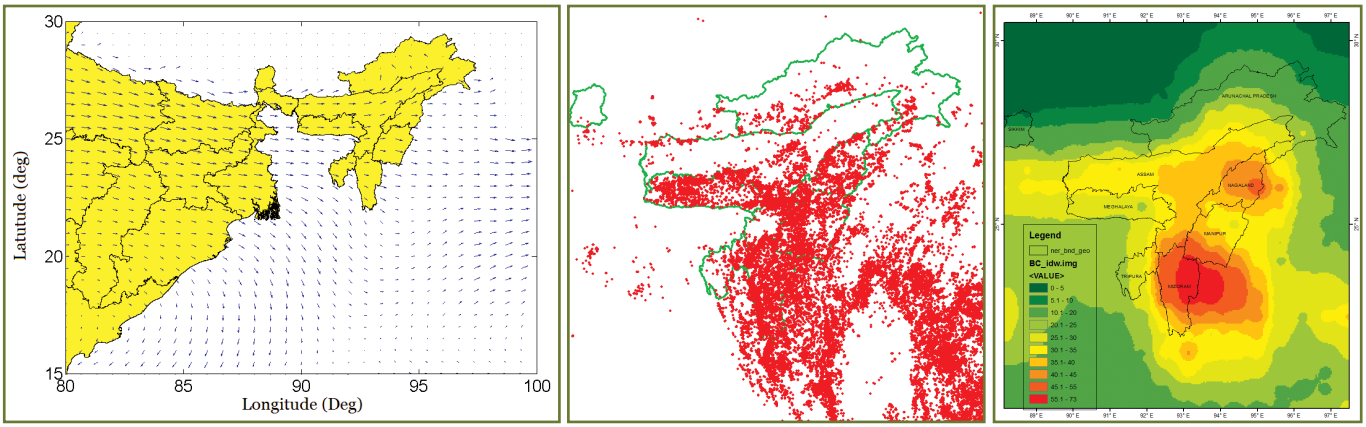

Figure 9.3: Synoptic wind for the month of March 2015 (left), MODIS active fire counts (centre) and Surface Black Carbon concentration (10-10kg/m3)

9.3. Long term climatology of columnar and surface aerosol over Umiam

Aerosol Optical Depth (AOD) and aerosol Black Carbon (BC) are measured over NESAC, Umiam (25.67°N, 91.91°E, 1040m amsl) from 2008 and 2006 with the help of 10 channels Multi Wavelength Radiometer (MWR) and 7 channels Aethalometer respectively under the Aerosol Radiative Forcing over India (ARFI) project. It is observed that AOD always shows maximum in the pre-monsoon months with a minimum in post monsoonal months. 8 years mean value of AOD over the place is 0.51. Similarly BC concentration also shows maximum in the pre-monsoon months with a minimum in post monsoonal months (figure 9.5).

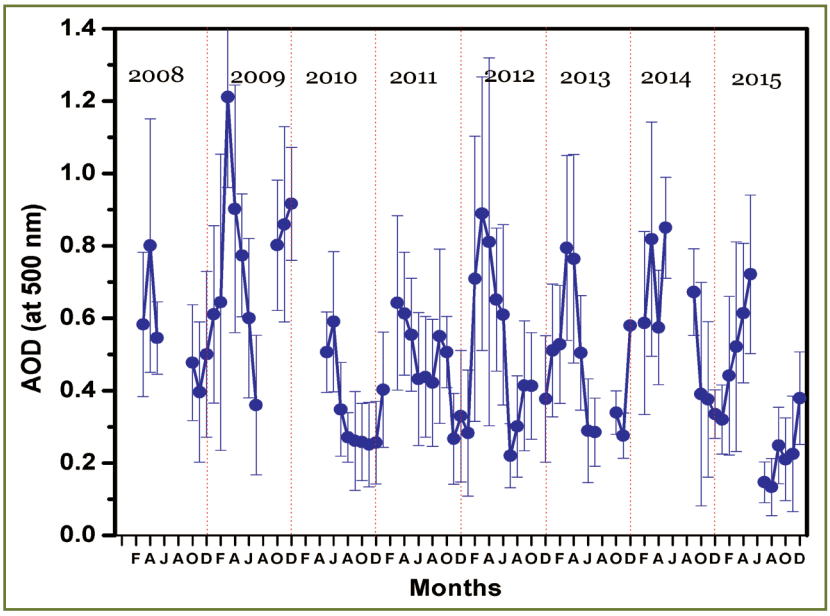

Figure 9.4: AOD from 2008 to 2015 over NESAC

10 years mean value of BC over the place is 5.3 μgmm^{-3}. The AOD shows a mild decreasing trend over the years while BC change has not been showing any significant trend.

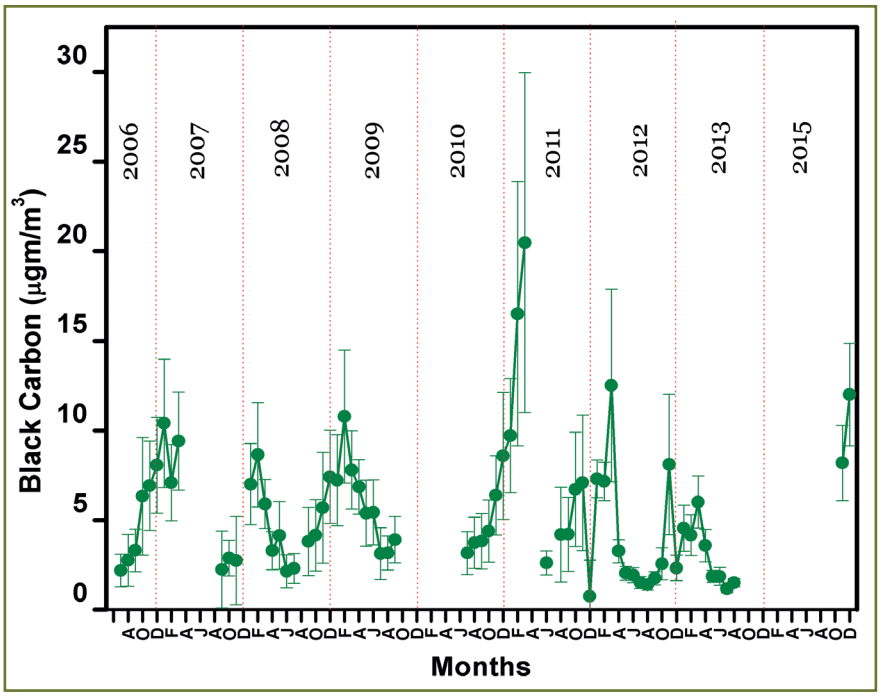

Figure 9.5: Surface BC mass concentration from 2006 to 2015 over NESAC

9.4. Tropospheric Columnar NO_2 (TCN) over NER of India

Monthly average Tropospheric columnar NO_2 (TCN) as obtained from AURA OMI observations at a spatial resolution 0.25° X 0.25° over 10 selected sites (figure 9.6) has been studied for 10 years from Oct 2004 to May 2013. TCN shows maximum value in the months of March and April and minimum values in the months of June-Sep for all sites. Forest fire, pre-harvesting fire activity from agricultural field, and the long range transport from Indo Gangetic Plain during Mar-April, under the influence of strong westerlies, may increase the level of NO_2 over NER of India. High level of TCN has been observed over Aizawl (~7x1015 molecules/ cm^2) and Agartala (~3.5x1015 molecules/ cm^2) in the pre monsoonal months which could be attributed to the common forest fire activity during these months over those areas. Guwahati, Shillong and Diphu recorded more than 2x1015 molecules/ cm^2 of TCN during the pre-monsoonal months and rest of the sites record below 2x1015 molecules/ cm^2. Among all the 9 selected sites in NER of India Dibrugarh and Dhubri recorded minimum level of NO_2. The nearby site Thimphu, Bhutan records ~ 0.6x1015 molecules/ cm^2 indicating cleaner site. Decadal trends of TCN show sharp increase of TCN over Shillong, Guwahati, Agartala, and Aizawl, may be due to rapid urbanization as these are capital cities. These stations shows TCN increase of 0.25x1015 molecules/cm^2 during the last decade. Level of TCN almost remains unchanged over Dibrugarh, Dhubri, Diphu, Itanagar and Kohima during the study period. The decadal average TCN is ~0.60.x1015 molecules/cm^2 over these stations except over Dhubri. Interestingly; TCN over the capital of Bhutan, Thimphu shows decreasing trend during the last decade and decadal average of TCN is below ~0.50.x1015 molecules/cm^2.

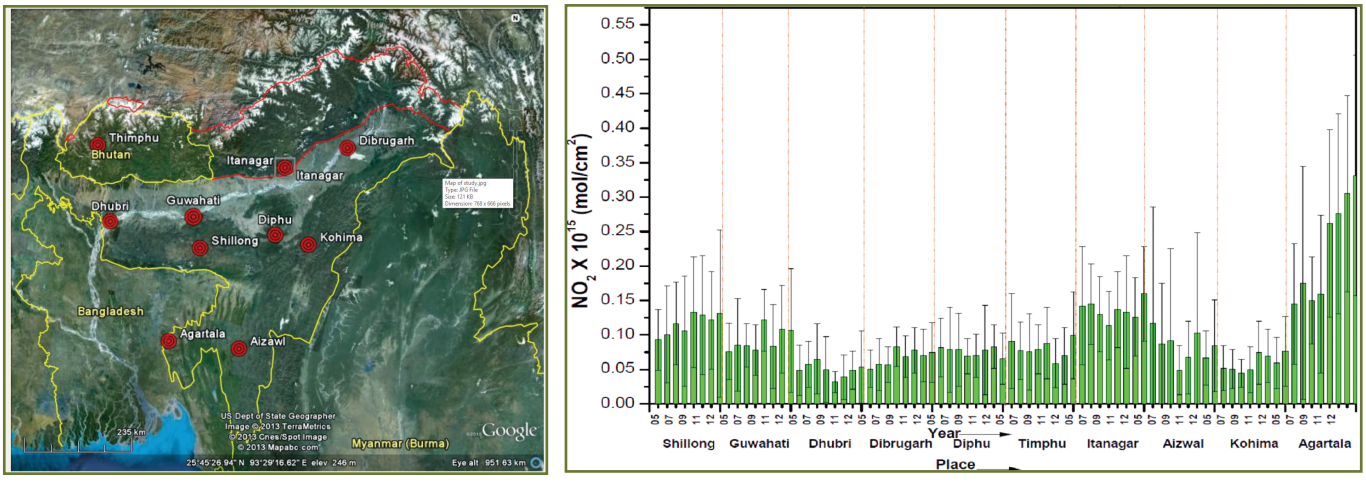

Figure 9.6: Ten selected sites (left) and yearly mean TCN over the sites

9.5. Establishing a facility for weather monitoring and agromet services in the NER

9.5.1. Improving Weather Forecasting over NER

The Weather Research and Forecasting (WRF) model is being run at NESAC with 3DVAR data assimilation technique at 9 km spatial resolution and three hourly time steps for 24 hours weather forecasting over NER of India. The model is run operationally daily during April-October period to support flood forecasting under the FLEWS project and thunderstorm nowcasting, agromet advisory services, etc. Data from different sources like AWS, GFS Prepbufr surface and upper air observations, Radiance from AMSU-A, INSAT 3D, etc are being assimilated in the model. The timely and relatively accurate rainfall forecast using WRF model has enabled NESAC to successfully forecast flood on several occasions under the FLEWS project.

An HPC was installed at NESAC during 2015 and the WRF model was configured in the system. The more advanced data assimilation system like 4DVAR has been implemented in the HPC system. Experiments have been initiated to investigate the effectiveness of 4DVAR data assimilation in high intensity weather forecasting.

Comparing 4DVAR and 3DVAR data assimilation method for simulation of very heavy rainfall:

Data Assimilation is a process to bridge the gap between Numerical Weather Prediction (NWP) model and observations of various weather parameters such as temperature, pressure, humidity, wind etc. It gives the best estimate of the initial atmospheric state for NWP models. There are number of assimilation techniques such as 3DVAR, 4DVAR, EnKF etc. But the recent techniques such as EnKF, 4DVAR are computationally very expensive. With the installation of the new HPC in NESAC, an exercise was carried out to compare the performance of 3DVAR and 4DVAR to simulate heavy rainfall initiated by Mesoscale Convective System (MCS).

Jammu and Kashmir had been devastated by flood due to heavy downpour since 28th March 2015 to 31st March 2015. As the topography of J&K and NER is more or less similar, this case was taken up to investigate the effectiveness of 4DVAR data assimilation in forecasting very heavy rainfall events. As 4DVAR is computationally very expensive; no nested domain was used for the experiment. Various types of meteorological observations from the archived GFS are assimilated during the heavy rainfall event, namely winds, temperature, moisture, and surface pressure from radiosondes, ships, and surface stations; winds from profilers and cloud tracked winds from satellites. The first analysis time for the experiments is at 1200 UTC of 27 March 2015; afterward, continuous DA cycles (analysis and forecast) with 12 hour intervals are performed until the end of the event, valid at every 0000 and 1200 UTC. The assimilation window of 4DVAR covers the period from -3 hours to +3 hours of each analysis time; therefore, all available observations distributed over such a 6 hour window are assimilated at their exact time rather than at an approximate analysis time as in 3DVAR.

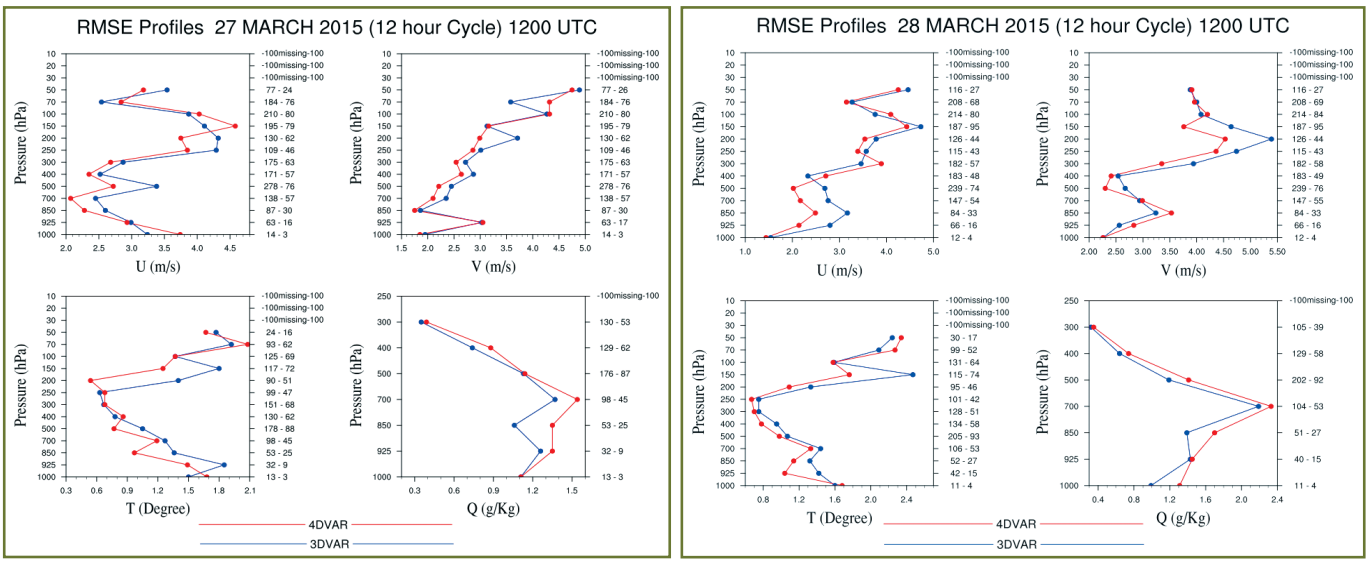

Figure 9.7: RMSE of U, V T, Q compared between model forecasts and radiosonde observations

The root mean square error (RMSE) of horizontal winds (U, V), temperature T, and the mixing ratio of water vapour Q are calculated between model forecasts and radiosonde observations over the model domain. It is observed that the largest RMSE of U, V, and T is around 200 hPa near the tropopause while the largest error of Q is in the mid to lower troposphere. Between the two variational schemes, 4DVAR consistently outperforms 3DVAR for both horizontal winds and temperature but 4DVAR has more amplitude of moisture RMSE to that of 3DVAR at all lead times, suggesting that the simple moist physics used in the adjoin model of 4DVAR is insufficient to adjust the moisture field to other fields.

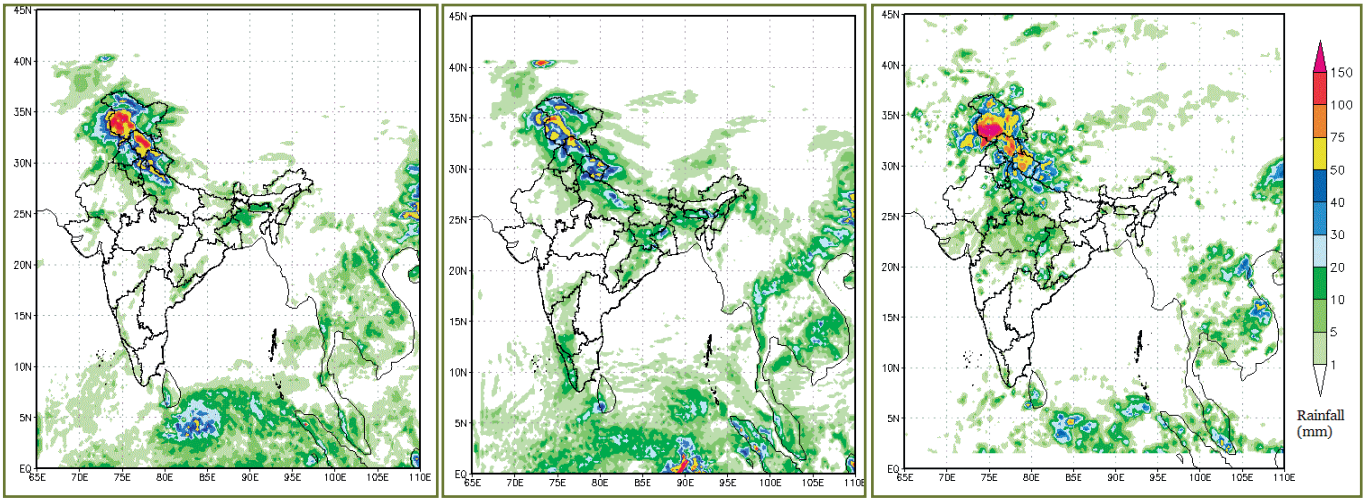

Figure 9.8: WRF rainfall simulation using 3DVAR (left), 4DVAR (centre) and GPM rainfall estimate (right) for 0Z, 29 March to 0Z 30 March, 2015.

The rainfall forecast is compared with Global Precipitation Measurement (GPM) daily rainfall estimates. It was observed that, with 4DVAR, the convection is triggered at the right location and time, and the evolution and spatial distribution of the mesoscale convective systems (MCS) are also correctly simulated. Since moisture is not well represented by 4DVAR, there is under estimation of rainfall amount by 4DVAR as compared to 3DVAR. However spatial distribution is well represented by 4DVAR than 3DVAR.

9.5.2. Synoptic Rainfall Advisory for FLEWS

Synoptic Rainfall Advisory (SRA) is one of the important components of FLEWS. SRA has been issued regularly daily basis to support the FLEWS project during May-October periods. Based on available in-situ weather data, satellite images and products, synoptic scale weather over the FLEWS study area is analyzed and quantitative rainfall estimation are made for the next 12 hours. Near real time meteorological parameters over the North East (NE) sector available from different sources are used.

Table 9.1: Description about the data and their source used for preparation of SRA

SN	Data/Products name		Source	Time resolution
1	Rainfall		AWS (ISRO and IMD)	1 hour
2	Satellite images (IR&WV) from INSAT-3D		ISRO	Half hourly
3	850 mb relative vorticity		IMD, University of Wisconsin-Madison	3 hour
4	Cloud Motion Vector and Atmospheric Motion Vector		IMD & University of Wisconsin-Madison	3 hour
5	Qualitative Precipitation Estimation (QPE)		IMD, INSAT-3D product	3hr/Daily/Monthly
6	DWR products	Precipitation Accumulation	IMD	Daily
		Surface Rainfall Intensity	IMD	Near real time

The rainfall forecast is given region-wise for Eastern Assam, Western Assam, Central Assam, Southern Assam, Arunachal Pradesh, Meghalaya, Manipur, Mizoram, and Nagaland. Whenever heavy rainfall is expected, the forecast is given at district level. The rainfall forecast is categorized as Low (0-10mm), Moderate (11-25mm), Heavy (26-50mm) and Very heavy (>50mm).

9.5.3. Setting up a Doppler Weather Radar (DWR) at Cherrapunjee

The dual polarimetric Doppler Weather Radar (DWR) installed at Cherrapunjee, Meghalaya by ISRO Telemetry, Tracking and Command Network (ISTRAC) in collaboration with NESAC and IMD is ready for operation. The DWR is under test run since February, 2016. The pre site acceptance test has been conducted by ISTRAC with participation from BEL and NESAC. Several minor issues were observed that are being addressed by BEL and is expected to be completed by middle of July, 2016. All infrastructures required for 24 X 7 operation of the DWR have been created and as soon as the final site acceptance test is conducted and the system is taken over from BEL, it will be run continuously in operational mode. Attempts have been made to assimilate the DWR data in WRF model to improve weather forecast over NER. In addition, a project to validate the rainfall product with in-situ rain gauge data and develop new algorithm for rainfall estimation has been taken up.

Major weather products from DWR

Table 9.2: Data and products available from the DWR

Base Products	Velocity & Polarimetric Products	Hydrological Products	Shear & Aviation Products	Warning & Forecasting Products
Reflectivity, Z	Horizontal /vertical wind	Precipitation Accumulation	Wind Shear	Hail Warning
Velocity, V	Hydrometeor classification	Vertically Integrated Liquid	Turbulence	Storm Tracking
Spectral Width, σ	Drop size distribution	Surface Rainfall Intensity	Microburst Detection	Tornado & gust fronts

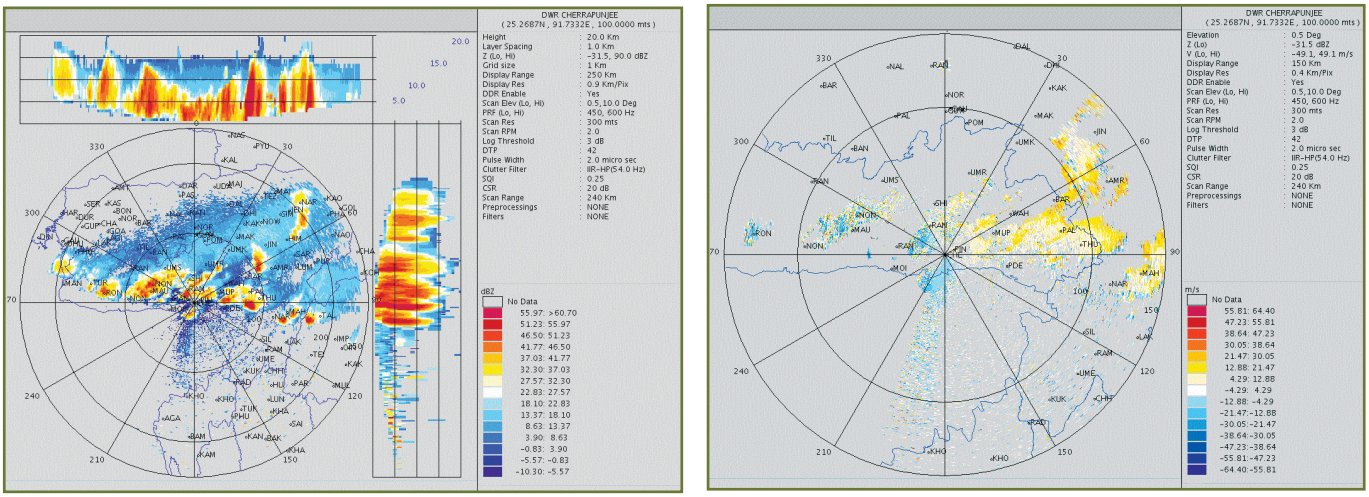

Figure 9.9: A typical RHI product for Maximum Reflectivity (left) and a typical PPI product for velocity

10. OTHER IMPORTANT ACTIVITIES

10.1. Shri P L N Raju takes over as Director, NESAC

Shri P. L. N. Raju took over the charge of Director, NESAC from Dr. P. G. Diwakar on 07th October, 2015. Shri P. L. N. Raju was serving at IIRS, Dehradun as Group Head, PPEG and Group Head, RSGG before joining NESAC. Dr. P. G. Diwakar was on additional charge of Director, NESAC along with his responsibility of Deputy Director, Remote Sensing Applications Area, NRSC, Hyderabad.

Figure 10.1: Shri P L N Raju taking over the charge of Director, NESAC from Dr P G Diwakar

10.2. State Meet for Mizoram on Promoting Space Technology Based Tools and Applications in Governance and Development

A one day state level meet on "Promoting Space Technology Based Tools and Applications in Governance and Development" for the state of Mizoram was held on 8th March 2016 in the Secretariat Conference Hall at Aizawl. Chief Secretary of Mizoram, Pu. Lalmalsawma was the Chief Guest during the inaugural session where Shri P.L.N. Raju, Director, NESAC presented on the Indian Space Programme, which was followed by presentations from various line departments.

Figure 10.2: Hon'ble CM of Mizoram gracing the concluding session of the meet

Pu. Lalthanhawla, Hon'ble Chief Minister of Mizoram graced the concluding session as Chief Guest, where the four session chairmen made presentations to the Chief Minister on the outcome of the deliberations during the four respective thematic sessions. Pu. Lalhmingthanga, Secy., Rural Development; Pu. Lalhmingthanga, Secy., Agriculture; Pu. Zothankhuma, Pr. Secy., Disaster Management & Revenue and Pu. Lalthangpuia Sailo, Secy., Social Welfare, presented the respective session outcomes. Director, NESAC made the concluding remarks to the chief guest and the dignitaries present during the concluding session. The Chief Minister in his concluding address commented that most of the nations who made the most use of the modern technologies are developing and asked the departments in the state to use space technology more and more. The programme was attended by more than 70 officials from different departments. As an outcome of the state meet 6 project proposals has come up addressing the requirements of 11 line departments in Mizoram.

10.3. Construction of NESAC residential campus

The civil Construction and Maintenance Division (CMD) of NESAC has taken up and completed numbers of construction and maintenance work during the financial year 2015-2016. The major ongoing civil work is construction

of residential complex. It includes 20 Nos. Staff quarters, Director Residence, Guest House and Amenity Building. The physical progress of staff quarters and Directors residence during the financial year 2015-16 has increased from 71% to 94% and the same for Guest House and Amenity Building has increased from 50% to 55% (figure 10.3). A Landmark progress of the Residential Complex is completion of water supply network, and sewerage system. The construction of internal road, storm water drainage system, external electrification of the residential complex are also initiated and well in progress.

Figure 10.3: NESAC residential campus with Guest house (left) and staff quarters

Construction of entrance gate of NESAC office and extension of security room (figure 10.4) were also completed during the year. The construction of boundary wall for the new land was also completed within its stipulated time during 2015-16. Installation of solar panel and construction of a battery room was also completed during this financial year. Other minor works such as painting of existing Director's residence, minor renovation of Boys and Girls hostel was also done.

Figure 10.4: Newly constructed NESAC entrance

10.4. Vigilance Awareness week celebration

Vigilance Awareness Week was celebrated in the Centre from 27.10.2015 to 31.10.2015. Pledge taking ceremony was held on 27.10.2015. Debate and Quiz competition was conducted for all employees on 31.10.2015 which was followed by a speech by Shri G H P Raju, IGP, (L &O Operation), Meghalaya on the topic "Preventive Vigilance as a tool of Good Governance".

Figure 10.5: Shri G H P Raju, IGP, Law and Order Operations, Meghalaya delivering lecture

10.5. Swachha Bharat Abhiyan at NESAC

As part of Swachha Bharat Mission, 29th February 2016 to 14th March 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 who also gave the call to all the staff for making NESAC Plastic Free. All NESAC employees took part in cleaning drive to clean the NESAC office campus and surrounding area outside office campus.

Figure 10.6: NESAC employees cleaning outside office campus

10.6. Induction of 2nd batch of CISF security personnel

The 2nd Phase Induction of CISF at NESAC took place during the month of November 2015. 22 CISF personnel joined during the 2nd phase induction. The present total strength of CISF in the Centre is 41.

10.7. Important Visitors

Date of Visit	Name and designation of the Visitor
22.04.2015	Shri M C Dathan Director, VSSC
14.10.2015	Dr. Tapan Mishra Director, SAC
18.10.2015	Shri K Kasturirangan Chancellor, Jawaharlal Nehru University / Former Chairman ISRO/Secretary, DOS
28.10.2015	Shri D J Saikia Vice Chancellor, Cotton College State University
04.01.2016	Shri Rowel Lyngdoh Deputy C M, Meghalaya
09.01.2016	Shri S Srinivasan Member Finance, DOS
15.01.2016	Shri M Marbaniang Dy. Director, MBOSE, Meghalaya
15.01.2016	Shri E P Kharbhih, IAS Commissioner & Secretary, Education Executive Chairman MBOSE, Meghalaya
21.01.2016	Shri V V Bhat Former Secretary to Govt of India & Member Finance Space & Atomic Energy Commissions

10.8. Training/Workshop/Seminar activities by NESAC

Several new initiatives have been taken in the field of capacity building in different areas of space science and technology applications. Customised training programmes as per requirements of different line departments and also as per project requirements have been conducted at NESAC. Efforts are on to start basic courses on Remote Sensing and Geospatial technologies at regular intervals in near future. Several training programmes were conducted at NESAC during 2015-16 and these are mentioned below:

- Two days customized hands on Bhuvan Training Programme for ENVIS Centres was conducted from 19.11.2015 to 20.11.2015.
- One day Regional Workshop on 'Effective utilization of Space Technology for Decentralized Planning in NE region' was organized at NESAC on 7th December, 2015 under SIS-DP programme. Around 45 participants from SRSACs and other Line Departments of NE region attended the workshop.
- A one day Regional Workshop on 'Space technology for Forest Management with special emphasis on Forest Working Plan' was conducted on 27th February 2015. Various Officials from Forest Departments of NER states, Officials from Regional Office, MoEFCC, Shillong, academicians from colleges and Universities attended the workshop.

- One day state level workshops on Master Plan Formulation using NUIS (National Urban Information System) - Bhuvan for the state of Mizoram, Nagaland and Assam were organized on 8 April, 2015, 10 April, 2015 and 22 April, 2015 respectively in the state capitals and was attended by Secretaries and officials from Town and Country Planning departments and other related departments.
- Two-week training program on UAS assembly, simulation, flight & data acquisition was conducted for a team of Scientists and Research Scientists from NESAC during 1-12 Feb 2016 at Kohima, Nagaland. The training was organized by the Planning Department, Government of Nagaland as part of the implementation of the project entitled "Application of UAVs in real time mapping, monitoring and Disaster Management".
- Two weeks training programme on "Capacity building of Post Graduate Teachers of higher secondary stage in the field of Remote Sensing and Geospatial Information Technology" was organized at NESAC, Umiam in collaboration with National Council of Educational Research and Training (NCERT) during 4-15 January, 2016. 31 Post Graduate Geography teachers from Kendriya Vidalayas and Jawahar Navodaya Vidalayas from different places of NER participated in the training programme.
- One day User Meet on Tele-Education was conducted on January 19, 2016 to discuss various issues related to operation and maintenance of Tele-Education project in NER.
- One day interaction meeting on Applications of RS & GIS for Sericulture development was conducted on 21.03.2016.

Figure 10.7: Participants in different training programme

10.9. Official Language Implementation

Hindi Week was celebrated in the Centre from 14th to 18th September 2015. As part of the Hindi Fortnight Celebration, Hindi Workshop was conducted by Kum Anita Joshi, Sr Hindi Teacher, KV school on the topic "Official Letter Writing" which was followed by Essay Writing, Antakshri, Extempore Speech Competition for all employees.

Annual Hindi Inspection (2014-2015) was conducted by Registrar, ADRIN, Secunderabad on 31.08.2015. He has appreciated the smooth running of Hindi works in the Centre, in spite of non availability of any Hindi staff. He also suggested various measures for implementation of Official Language in the Centre, which includes conducting of Hindi workshops, training and seminars in the Centre.

10.10. Welfare of SC & ST

i) The welfare of SC & ST is being taken care in this Centre. This Centre has been observing the guidelines for recruitment, promotion and welfare of Scheduled Caste and Scheduled Tribes. Table-10.1 indicates the status of representations of persons belonging to Scheduled Caste and Scheduled Tribe.

Table 10.1: Status of SC and ST representation at NESAC

Sl No	Centre / Unit	Total strength of employees 2015-2016	Strength of SC employees	Strength of ST employees
01	NESAC	33	02	04

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

iii) 100% of Group B employees are from ST

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

v) Many of the services manpower such as Data Entry Operators, O&M, Gardening, Cleaning and Canteen have been outsourced and nearly 99% of the workers deployed by the outsourcing firms belong to SC/ST.

10.11. Awards

Shri M. Somorjit Singh, Scientist/Engineer 'SE', NESAC was conferred with ISRO Team Excellence Award, 2015, for his significant contribution as a team member in 'National Geomorphology and Lineament Mapping (NGLM) project' which was coordinated by NRSC, Hyderabad in collaboration with Geological Survey of India (GSI) under Natural Resources Census program.

10.12. Detail of internship/project trainees during 2015-16

SN	Institute/ university	Course	No of Students	Project Title
1	Savitri Bai Phule Pune University	M.A. (Geography)	1	Socio Economic vulnerability assessment of South West Khasi Hills district, Meghalaya.
2	Central University of Karnataka, Gulbarga	M.Sc.	3	Geospatial analysis of forest cover distribution and assessment of woody biomass and carbon stock in Sagalee Forest Division of Arunachal Pradesh.
				Application of remote sensing and GIS in assessment of forest cover distribution & estimation of above ground woody biomass and carbon stock in Dibang forest division.
				Tourism Information System of South West Khasi Hills District.
3	North Orissa University	M.Sc. (Remote Sensing & GIS)	2	A case study on Shifting Cultivation and its Sustainable development in Nagaland.
				Mapping of suitable areas for expansion of Mulberry Sericulture in Jaintia Hills district of Meghalaya using Geospatial technology.
				Study on spatial distribution, timber volume, biomass and carbon stock of Shorea Robusta Gaertn in Kamrup West forest division of Assam using Remote Sensing and GIS technology

4	Sikkim Manipal Institute of Technology, Gangtok	B. Tech. (I.T.)	2	Development of an Open source based data cataloguing application for the management of geospatial data in NER.
		M. Tech. (I.T.)	1	Ensemble of SVM's classification of Remote Sensing Data.
5	NERIST, Itanagar	B.Tech. (E & C)	2	Sensors used in UAV System.
				Comprehensive study of UAV Systems.
6	Florida Institute of Technology, USA	B.S. (Aerospace Engr.)	1	Assembly and functioning of a Multi-copter.
7	Madras University	M.Sc.	6	Application of Hyper spectral remote sensing on agriculture: Derive the impacts of elevated carbon-di-oxide and temperature on rice crop using spectral indices.
				Application of Hyperspectral remote sensing on agriculture: Detection of nitrogen deficiency in potato plant using spectral indices.
				Hydrological Runoff Modelling in watershed scale for some Rivers in Tripura using geo-Spatial dataset.
				Hydrological Runoff Modelling in watershed scale for some Rivers in Mizoram using Geo-Spatial dataset.
				Mapping of Mulberry plantation in Nabagram & Khargram block of West Bengal.

10.13. Important Publications from NESAC during 2015-16

10.13.1. Publications in Journals

i) B. Pathak, T. Subba, P. Dahutia, P.K. Bhuyan, K. Krishna Moorthy, M.M. Gogoi, S. Suresh Babu, A. Borgohain, S.S. Kundu, Aerosol characteristics in north-east India using ARFINET spectral optical depth measurements, Atmospheric Environment (2015), http://dx.doi.org /10.1016/j.atmosenv.2015.07.038.

ii) Chakraborty K, Sarma K K, S. S. Kundu, Ashesh Kr. Das, Shifting cultivation dynamics in Barak basin of north east India - a geospatial approach, International Journal of Advancement in Earth and Environmental Sciences, Vol.3, No. 2, pp 21-29.

iii) Choudhury, B.U., Das, Pratibha T., Ngachan, S.V., Islam, Mokidul., Das, Anup., Verma, B.C., Mohapatra, K.P., Nongkhlaw, L., Islam Syed B., Munda, G.C. Land use Land cover Change detection, soil health Assessment and Socio-economy in Northeast India: A remote Sensing and GIS Approach. Research Bulletin, NAIP publication No.7.ICAR Research Complex for NEH Region, Umiam-793103, Meghalaya, India Pp-1-53.

iv) Chutia, D, Bhattacharyya, DK, Sarma, KK, Kalita, R and Sudhakar, S (2015): Hyperspectral Remote Sensing Classifications: A Perspective Survey, Transactions in GIS, 10.1111/tgis.12164.

v) Handique, B. K., Das, P. T., Goswami, J., Goswami, C., Singh, P.S.,Chutia, D., Rocky, P. and Raju, P.L.N. (2015) Mapping of potential areas for sericulture development and information dissemination through SILKS web-portal, NNRMS Bulletin No 40 (in Press).

vi) Handique, B. K., Singh, P.S., Prabhakar, C.J., Das, P. T., Goswami, J., Goswami, C., Chutia, D. Sudhakar, S. and Rao, P.P.N., (2015). Sericulture Information Linkages and Knowledge System (SILKS)-a geoportal for sericulture planning and development, Indian Silk, Vol 54.

vii) Handique, B.K., Khan, S.A., Dutta, P., Nath M. J. Qadir, A. and Raju, P.L.N., Spatial correlations of malaria incidence hotspots with environmental factors in Assam, north east India, International Journal of Health Geographics (Final Review).

viii) Kharlyngdoh, Adelbert,. Zothansiami, Carolyn,.Bora, Pradip K., Das, Pratibha T., Choudhury, B.U., Singh, A.K. (2015). Characterization and Classification of Soils in Eastern Himalayan Agro-climatic Region: A Case Study in Nongpoh Micro-watershed of Ri-Bhoi District, Meghalaya. Journal of the Indian Society of Soil Science. Vol. 63, No. 1, Pp. 24-29 (DOI: 10.5958/0974-0228.2015.00004.3).

ix) Mrinal Singh, Anil Kumar, Alfred Stein, P. N. L. Raju & Y. V. N. Krishna Murthy, 2015, Importance of DA-MRF Models in Fuzzy Based Classifier, Journal of the Indian Society of Remote Sensing, ISSN 0255-660X, Volume 43, Number 1, 27-35, DOI 10.1007/s12524-014-0382-8".

x) Nongkynrih, J. M., Sudhakar, S. and Bhusan, K., 2015. The Use of Participatory GIS in Population Characteristics with reference to Landslide Problems in Guwahati City, The Deccan Geographer, 53(2), 71-77.

xi) Sahoo, U.K. and Rocky, Pebam, 2015, Species Composition and Plant Diversity as Influenced by Altitude and Size of Homegardens in Mizoram, North-East India, International Journal of Ecology and Environmental Sciences, 41(3-4),195-21.

xii) Singh PS, RB Lyngdoh, D Chutia, Victor Saikhom, Bhargav Kashyap, S Sudhakar (2015): Dynamic Shortest Route Finder using pgRouting for emergency management. Applied Geomatics, 7(4), 2015.

10.13.2. Publications in proceedings

i) Vikas Sharma, Dibyajyoti Chutia, Diganta Baruah, DK Bhattacharya, PLN Raju (2016): An Assessment of Support Vector Machine Kernel Parameters using Remotely Sensed Satellite Data, 2016, 1622-1625, IEEE International Conference On Recent Trends In Electronics Information Communication Technology, May 20-21, 2016, India, at Bangalore.

ii) Chutia, D., Raju, PLN., Sarma K K., Singh, PS., Saikhom, V., Goswami, C., Goswami, J., Rocky, P. and Das, R (2016). Geo-spatial web portals Services for Planning and Developmental activities in NE Region. In Seminar on "Geoinformatics Applications in Rural Development" in National Institute of Rural Development & Panchayati Raj, North Eastern Regional Centre, Guwahti during 7-8 January, 2016, pp 73-74.

iii) Khan, A.Q. Handique, B.K. and Raju, P.L.N. Delineation of deep water rice using C-band RISAT-1 SAR data in Morigaon district of Assam, proceedings of the ISG/ISRS National Symposium held at JK Laxmipat University during Dec 17-19, 2015.

iv) Khan, S.A, Handique, B.K., Dutta, P and Raju, P.L.N. (2015) Development and operationalisation of Japanese Encephalitis Early Warning System in proceedings of the ISG/ISRS National Symposium held at JK Laxmipat University during Dec 17-19, 2015.

v) Nilamoni Barman, Rakesh Roy, J N Roy, Shyam S Kundu, Arup Borgohain, Investigation on the usefulness of curvature effect of Angstrom exponent to classify aerosol types over North East India, NaSAEAST 2015, Guwahati University, Assam.

vi) Rekha Bharali Gogoi, Nilmoni Barman, and Shyam S Kundu, Influence of Data Assimilation Using WRF-3DVAR for Heavy Rain Prediction in the North Eastern Region of India, NaSAEAST2015, Guwahati University, Assam.

vii) Shyam S Kundu, A Borgohain, M Devi, S Babu, P L N Raju, P K Bhuian, Spatial variability and radiative impact of aerosol across Brahmaputra valley in India: Results from a campaign, NSSS2016, Trivandrum.

viii) Arup Borgohain, N. V. P. Kiran Kumar, K. Rajeev, Shyam S. Kundu, Edvin V Davis, Nilomoni Barman, Abhisekh Chhari, P. L. N. Raju, Effect of boundary layer circulation on regional meteorology over Northeast India: First results from a two-station experimental campaign, NSSS2016, Trivandrum.

ix) Arup Borgohain, Shyam S Kundu, Nilomoni Barman, N.V.P. Kiran Kumar, P. L. N. Raju, Temporal Variation of atmospheric boundary layer from radiosonde observations over Shillong (25.67°N, 91.91°E), NSSS2016, Trivandrum.

x) Edwin V. Davis, Arup Borgohain, N. V. P. Kiran Kumar, Shyam S. Kundu, K. Rajeev, Nilomoni Barman, Abhisek Charri, P. L. N. Raju, Characteristics of Subtropical Jet Stream and Associated Gravity Wave Generation, NSSS2016, Trivandrum.

xi) Handique, B. K., Singh, P.S., Das, P.T., Goswami, J., Goswami, C. & Raju, P.L.N. (2016), IT-initiative in transfer of technologies for Muga & Eri silk sector, Proceedings of the National Seminar on Problems & Prospects of Muga and Eri Silk Sectors, Guwahati, Feb 25-26, 2016.

xii) D. Barman, Operational flood early warning system with geo-spatial based hydro-met inputs, International Conference on Water Resource Management (ICWRM) in the eastern Himalayan region, St. Anthony's college, Shillong, Nov, 2015.

xiii) D. Barman, GIS based hydro-met stream flow for early warning of flood in Brahmaputra valley, United Nations/India workshop on the use of earth observation data in disaster management and risk reduction: Sharing the Asian experience, United Nations office for Outer Space affairs (UNOOSA) & ISRO, March, 2016.

xiv) D. Barman, Multi-criteria hazard and vulnerability modeling leading to geospatial risk zonation of riverine flood plain - An approach experimented in Dhemaji district of Assam, ISG/ISPRS WG VIII/1 annual convention workshop, JKL University, Jaipur, Dec, 2015.

10.13.3. Scientific/Technical Reports

i) Remote Sensing based Rice acreage estimation in NE states of India under FASAL. (Project Report No: NESAC-SR-147-2015, Submitted to Director, MNCFC, New Delhi on 13.08.2015).

ii) Applications of Remote Sensing and GIS for Sericulture Development (Project Atlas) No: NESAC-SR-142-2015. (Officially released by Hon'ble Union Minister of Textiles on 17.11.2015)

iii) Das, P.T., Goswami, C. and Sudhakar, S. (2015). Soil Resource Mapping of Dhemaji district of Assam using Geo-spatial Techniques. NESAC-SR-104-2015.

iv) Das, P.T., Goswami, C. and Sudhakar, S. (2015). Soil Resource Mapping of Sonitpur district of Assam using Geo-spatial Techniques. NESAC-SR-105-2015.

v) Das, P.T., Goswami, C. and Sudhakar, S. (2015). Soil Resource Mapping of Lakhmipur district of Assam using Geo-spatial Techniques. NESAC-SR-106-2015.

vi) Das, P.T., Goswami, C., Choudhury, B.U. and Sudhakar, S. (2015). Soil Resource Mapping of Cachar district of Assam using Geo-spatial Techniques. NESAC-SR-107-2015.

vii) Das, P.T., Goswami, C., Karmakar, R.M. and Sudhakar, S. (2015). Soil Resource Mapping of Nagaon district of Assam using Geo-spatial Techniques. NESAC-SR-108-2015.

viii) Das, P.T., Goswami, C., Choudhury, B.U. and Sudhakar, S. (2015). Soil Resource Mapping of Hailakandi district of Assam using Geo-spatial Techniques. NESAC-SR-110-2015.

ix) Das, Pratibha T. and Sudhakar S, Mission on study on shifting cultivation and its sustainable development in selected districts of NER (2015). Project report, NESAC-SR-109-2015.

x) Das, Pratibha T., Goswami C, and Sudhakar S,Soil Health Card for a selected micro watershed of Ri-Bhoi District of Meghalaya (2015). Project report, NESAC-SR-146-2015.

xi) Das, Pratibha T. Goswami, C. and Sudhakar S, (2015). Soil and Land Capability Mapping of Champhai, Lunglei and Lawngtlai districts of Mizoram Using Geo-Spatial Techniques. Project Report, NESAC-SR-143-2015.

11. STATEMENT OF ACCOUNTS FOR THE FY 2015-16

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, 2016 and also the income and Expenditure Account and Receipts & Payments Account of **NORTH EASTERN SPACE APPLICATION CENTRE : UMIAM : MEGHALYA** 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 appear to have been carried out by the management during the year however subsequent to verification 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) FWP-AP - Rs. 3,85,000/-
   ii) Advance Salary - Rs. 25,670/-
   iii) Transfer Grant Advance - Rs. 2,24,083/-

   In respect of (iii) above on the basis of documents produced before us the same appears to have been settled subsequent to year end as on May 13, 2016
3. Attention is invited to Schedule-II relating to Project Accounts – USER Project & ISRO Project under "Current Liabilities and 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.

Further we are to report that:

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, 2016 and

   ii. the income and Expenditure Account of the Centre shows true balance of surplus for the year covered by the account.

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

D DAS & ASSOCIATES Chartered Accountants SHILLONG

Debapratim Das
(Partner)

Place : Shillong
Date : 03/06/2016

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

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-2016

(Amount - ₹)

CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Capital Fund	1	38,80,01,316.47	35,96,57,860.51
Current Liabilities & Provisions	2	15,59,13,636.00	15,67,82,792.00
Pension Fund as per contra*		59,38,657.00	50,64,880.00
TOTAL		**54,98,53,609.47**	**52,15,05,532.51**
ASSETS			
Fixed Assets	3	27,88,72,756.00	27,13,31,689.00
Current Assets, Loans & Advances etc.	4	26,50,42,196.47	24,51,08,963.51
Pension Fund as per contra*		59,38,657.00	50,64,880.00
TOTAL		**54,98,53,609.47**	**52,15,05,532.51**
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/-
(VIKAS KISHANWAL)
Accounts Officer

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

Date : 03.06.2016

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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-2016

(Amount - ₹)

INCOME	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Grants	5	12,21,00,000.00	12,20,00,000.00
Other Incomes	6	5,84,508.96	6,01,507.30
Incomes from Services	7	13,85,000.00	44,000.00
TOTAL		**12,40,69,508.96**	**12,26,45,507.30**
EXPENDITURE	**SCHEDULE**	**CURRENT YEAR**	**PREVIOUS YEAR**
Establishment Expenses	8	6,62,92,215.00	6,29,20,774.00
Other Administrative Expenses & etc.	9	2,20,07,603.00	1,97,29,928.00
"Depreciation ***(Net total at the year-end – corresponding to schedule 3) (Column 7)**		1,90,60,048.00	1,68,59,127.00
TOTAL		**10,73,59,866.00**	**9,95,09,829.00**
BALANCE BEING SURPLUS (+)/ DEFICIT (-)		**1,67,09,642.96**	**2,31,35,678.30**
Less: Prior period expenses - Establishment Expenses		2,06,620.00	-
Less: Prior period expenses - Other Administrative Expenses		3,73,003.00	-
Less: Provision for Pension, Gratuity & Leave Encashment		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		**2,83,43,455.96**	**2,31,35,678.30**

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/-
(VIKAS KISHANWAL)
Accounts Officer

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

Date : 03.06.2016

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31-MARCH-2016

(Amount - ₹)

	RECEIPTS	CURRENT YEAR	PREVIOUS YEAR		PAYMENTS	CURRENT YEAR	PREVIOUS YEAR
I	**Opening Balances**			I	**Expenses**		
	a) Cash-in-hand	-	32.00		a) Establishment Expenses	6,47,54,890.00	5,47,66,041.00
	b) Bank Balances:				b) Other Administrative Expenses	2,05,76,129.00	1,77,76,904.00
	i) In Current Accounts, SBI Shillong	4,60,13,821.91	2,95,53,384.91	II	**Investments & Deposits**		
	ii) In Current Accounts, SBI Umiam	14,49,58,380.60	8,28,50,805.30		Deposit with MeSEB/ NRSC	21,70,080.00	-
	iii) In Current Accounts, Canara Bank	4,49,20,011.00	3,57,75,956.00				
				III	**Fixed Assets & Capital Work-In-Progress**		
II	**Grants Received**				Purchase of Fixed Assets	2,39,45,908.00	3,41,73,432.00
	From Government of India:			IV	**Other Payments**		
	a) Department of Space, Bangalore				a) ISRO Projects	1,98,21,882.00	1,25,39,018.00
	i) For Salaries	4,08,00,000.00	3,90,00,000.00		b) USER Projects	1,02,79,487.00	2,84,47,101.00
	ii) For General	5,13,00,000.00	6,30,00,000.00		c) In-House Projects	18,53,552.00	1,771.00
	iii)For Creation of Capital Assets	-	8,70,00,000.00		d) Advances to Staffs	27,60,673.00	22,17,097.00
	b) Ministry of DONER, NEC Shillong	3,00,00,000.00	2,00,00,000.00		e) Advances to Projects	10,90,900.00	10,82,835.00
					f) Advance to NRSC	17,282.00	-
III	**Other Incomes**				g) Payment of Recoveries	79,30,064.00	47,13,662.00
	a) Others	4,33,237.96	3,99,442.30		h) Prior Period Expenses	1,86,705.00	99,040.00
	b) ISTRAC	-	28,86,427.00		i) Security Deposits	49,13,099.00	39,97,169.00
IV	**Other Receipts**				j) ISTRAC Expenses	8,95,049.00	25,98,121.00
	a) Miscelleneous Recoveries	15,09,562.00	-	V	**Closing Balances**		
	b) Recovery of Advances and Deposits from:				a) Cash in Hand	12,000.00	-
	i) Staffs (Cont., Imprest, TA/ DA & LTC Advances)	6,81,545.00	4,69,886.00		b) Bank Balances:		
	ii) Others Receipts from ISTRAC/ NRSC/ DWR	77,81,640.00	16,87,177.00		i) In Current Accounts, SBI Shillong	6,69,36,549.91	4,60,13,821.91
	c) Receipts on ISRO Projects	2,22,99,948.00	1,03,46,038.00		ii) In Current Accounts, SBI Umiam	12,61,42,063.56	14,49,58,380.60
	d) Receipts on USER Projects	2,61,49,058.00	2,09,57,760.00		iii)In Current Accounts, Canara Bank	6,36,18,391.00	4,49,20,011.00
	e) Security Deposits	10,57,500.00	43,77,496.00				
	TOTAL	**41,79,04,704.47**	**39,83,04,404.51**		**TOTAL**	**41,79,04,704.47**	**39,83,04,404.51**

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

For **D DAS & ASSOCIATES**
Chartered Accountants

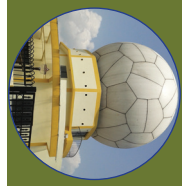
Sd/-
(DEBAPRATIM DAS)
Partner

Date : 03.06.2016

for and on behalf of **NORTH EASTERN SPACE APPLICATIONS CENTRE**

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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



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

उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31-MARCH-2016

(Amount - ₹)

SCHEDULE 1 - CAPITAL FUND	CURRENT YEAR		PREVIOUS YEAR	
Balance as at the beginning of the year	35,96,57,860.51		24,95,22,182.21	
Add: Balance of Surplus (+)/ Deficit (-) transferred from the **"Income & Expenditure Account"**	2,83,43,455.96		2,31,35,678.30	
Add: Grant-In-Aid for Creation for Capital Assets	-	38,80,01,316.47	8,70,00,000.00	35,96,57,860.51
BALANCE AS AT THE YEAR END		**38,80,01,316.47**		**35,96,57,860.51**
SCHEDULE 2 - CURRENT LIABILITIES AND PROVISIONS	**CURRENT YEAR**		**PREVIOUS YEAR**	
CURRENT LIABILITIES:				
1 Other Current Liabilities				
a) Establishment Expenses	61,58,867.00		58,95,025.00	
b) Other Administrative Expenses	19,67,050.00		13,87,645.00	
c) Others	31,90,380.00		15,87,294.00	
d) Audit Fee	22,900.00	1,13,39,197.00	56,508.00	89,26,472.00
2 Deposit from Contractors	61,51,595.00	61,51,595.00	-	90,90,153.00
3 Project Accounts: USER Project				
Balance as at the begining of the year	3,76,89,461.00		4,74,31,401.00	
Add: Received during the year	2,52,62,187.00		2,16,65,324.00	
Less: Utilised during the year	1,28,66,046.00		3,14,07,264.00	
Less: Outstanding Liabilities	-	5,00,85,602.00	-	3,76,89,461.00
4 Project Accounts: ISRO Project				
Balance as at the begining of the year	3,90,39,831.00		4,19,58,680.00	
Add: Received during the year	2,22,47,300.00		1,03,52,638.00	
Less: Utilised during the year	2,27,73,328.00		1,32,71,487.00	
Less: Outstanding Liabilities	-	3,85,13,803.00	-	3,90,39,831.00
PROVISIONS:				
1 Pension, Gratuity & Leave Encashment	4,98,23,439.00	4,98,23,439.00	-	6,20,36,875.00
TOTAL		**15,59,13,636.00**		**15,67,82,792.00**

For **D DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

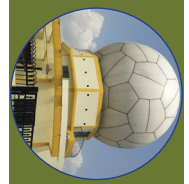
Sd/-
(P. L. N. RAJU)
Director

Date : 03.06.2016

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31-MARCH-2016

(Amount - ₹)

SCHEDULE 3–FIXED ASSETS													
	DESCRIPTION	GROSS BLOCK					DEPRECIATION				NET BLOCK	
Sl. No	Particular	Cost/ Valuation as at the beginning of the year	Additions during the year	Sale/ Disposal	Cost/ Valuation as at the end of the year	Rate (%)	As at the beginning of the year	During the year	On deduction during the year	Total up to the year-end	As at the Current year-end	As at the previous year-end
		1	2	3	4=(1+2-3)	5	6	7	8	9=(6 +7 - 8)	10=(4 -9)	11
1	Land & Land 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	33,20,131.00	2,85,793.00	-	36,05,924.00	5%	-	1,80,296.00	-	1,80,296.00	34,25,628.00	33,20,131.00
3	Renovation of lease Buildings	52,40,087.00	-	-	52,40,087.00	10%	36,46,351.00	1,59,374.00	-	38,05,725.00	14,34,362.00	15,93,736.00
4	Machinery & Equipment	95,40,622.00	-	-	95,40,622.00	15%	69,24,475.00	3,92,422.00	-	73,16,897.00	22,23,725.00	26,16,147.00
5	Furniture & Fixtures	1,43,87,725.76	5,31,252.00	-	1,49,18,977.76	10%	54,63,449.76	9,18,991.00	-	63,82,440.76	85,36,537.00	89,24,276.00
6	Office Equipments	37,47,693.00	1,44,663.00	-	38,92,356.00	15%	25,51,197.00	4,15,025.00	-	29,66,222.00	9,26,134.00	11,96,496.00
7	Computer & Pheripherals	5,51,28,028.60	16,99,635.00	-	5,68,27,663.60	60%	5,41,47,394.60	10,98,272.00	-	5,52,45,666.60	15,81,997.00	9,80,634.00
8	Library Books	2,81,57,600.93	73,30,636.00	-	3,54,88,236.93	60%	2,46,29,444.93	65,15,275.00	-	3,11,44,719.93	43,43,517.00	35,28,156.00
9	Telephones Installation	2,65,649.00	16,36,581.00	-	19,02,230.00	15%	2,24,883.00	1,28,859.00	-	3,53,742.00	15,48,488.00	40,766.00
10	Other Equipments	2,42,95,641.00	2,39,240.00	-	2,45,34,881.00	15%	1,16,19,203.00	16,99,081.00	-	1,33,18,284.00	1,12,16,597.00	1,26,76,438.00
11	NE-SAC Complex	16,69,47,656.00	21,82,434.00	-	6,91,30,090.00	5%	5,34,50,577.00	7,79,683.00	-	5,92,30,260.00	0,98,99,830.00	11,34,97,079.00
12	Vehicles	15,11,088.00	-	-	15,11,088.00	15%	8,40,611.00	1,00,572.00	-	9,41,183.00	5,69,905.00	6,70,477.00
13	Air Conditioner (Heating & Cooling)	4,88,218.00	2,96,750.00	-	7,84,968.00	15%	80,349.00	83,436.00	-	1,63,785.00	6,21,183.00	4,07,869.00



14	Apple I-Pad	71,250.00	-	-	71,250.00	15%	23,633.00	7,143.00	-	30,776.00	40,474.00	47,617.00
15	Aquarium	35,630.00	-	-	35,630.00	15%	11,817.00	3,572.00	-	15,389.00	20,241.00	23,813.00
16	CISF Barrack	24,85,690.00	-	-	24,85,690.00	5%	1,68,072.00	1,15,881.00	-	2,83,953.00	22,01,737.00	23,17,618.00
17	Mobile Set	48,100.00	-	-	48,100.00	15%	9,266.00	5,203.00	-	14,469.00	33,631.00	38,834.00
18	Motorised Treadmill	1,26,000.00	-	-	1,26,000.00	15%	41,792.00	12,631.00	-	54,423.00	71,577.00	84,208.00
19	SMF Batteries	6,25,600.00	9,800.00	-	6,35,400.00	15%	2,40,895.00	59,176.00	-	3,00,071.00	3,35,329.00	3,84,705.00
20	Vending Machine	20,500.00	-	-	20,500.00	15%	7,911.00	1,888.00	-	9,799.00	10,701.00	12,589.00
21	Water Dispenser	21,200.00	-	-	21,200.00	15%	8,181.00	1,953.00	-	10,134.00	11,066.00	13,019.00
Capital Work In Progress:												
22	Residential complex	10,11,06,845.00	1,00,39,331.00	-	11,11,46,176.00	0%	-	-	-	-	11,11,46,176.00	10,11,06,845.00
Intangible Assets:												
23	Software	97,191.00	22,05,000.00	-	23,02,191.00	60%	-	13,81,315.00	-	13,81,315.00	9,20,876.00	97,191.00
	TOTAL FOR CURRENT 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**
	TOTAL FOR PREVIOUS YEAR	**39,97,67,506.29**	**3,56,53,685.00**	**-**	**43,54,21,191.29**	**-**	**14,72,30,375.29**	**1,68,59,127.00**	**-**	**16,40,89,502.29**	**27,13,31,689.00**	**25,25,37,131.00**

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 : 03.06.2016

for and on behalf of **NORTH EASTERN SPACE APPLICATIONS CENTRE**

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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

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

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उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31-MARCH-2016

(Amount - ₹)

SCHEDULE 4 – CURRENT ASSETS, LOANS & ADVANCES etc.	CURRENT YEAR		PREVIOUS YEAR	
A. CURRENT ASSETS:				
1) Cash balances in hand	12,000.00	-	-	-
2) Bank balances with scheduled banks				
a) On Current Accounts	25,66,97,004.47	25,67,09,004.47	23,58,92,213.51	23,58,92,213.51
B. LOANS, ADVANCES AND OTHER ASSETS:				
1) Advances to:				
a) Staffs:				
TA/ DA	86,043.00		40,900.00	
Contingencies	24,000.00		68,200.00	
Others	94,600.00	2,04,643.00	12,66,661.00	13,75,761.00
b) Projects: (External)	5,06,462.00		31,25,149.00	
c) Projects: (Internal)	-		4,41,585.00	
d) Others	9,37,560.00	14,44,022.00	-	35,66,734.00
2) Claims Receivable/ Recoverable	14,35,286.00	14,35,286.00	9,77,444.00	9,77,444.00
3) Deposits for:				
a) Telephone with BSNL	65,658.00		65,658.00	
b) Deposit with MeECL	11,70,080.00			
c) Satellite Data's with NRSC	40,13,503.00	52,49,241.00	32,31,153.00	32,96,811.00
TOTAL		**26,50,42,196.47**		**24,51,08,963.51**

For **D DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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

Date : 03.06.2016

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उमियम / UMIAM - 793103, मेघालय / MEGHALAYA

SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2016

(Amount - ₹)

SCHEDULE 5 - GRANTS	Current Year	Previous Year
Central Government:		
a) Department of Space, Bangalore	9,21,00,000.00	10,20,00,000.00
b) North Eastern Council, Shillong	3,00,00,000.00	2,00,00,000.00
TOTAL	**12,21,00,000.00**	**12,20,00,000.00**
SCHEDULE 6 - OTHER INCOMES	**Current Year**	**Previous Year**
Miscellaneous	4,97,019.96	5,28,773.30
Maintenance Charges	24,624.00	44,484.00
Guest House Rent	62,865.00	28,250.00
TOTAL	**5,84,508.96**	**6,01,507.30**
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	44,000.00
TOTAL	**13,85,000.00**	**44,000.00**

For **D DAS & ASSOCIATES**
Chartered Accountants

Sd/-
(DEBAPRATIM DAS)
Partner

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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Director

Date : 03.06.2016

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SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31-MARCH-2016

(Amount - ₹)

SCHEDULE 8 - ESTABLISHMENT EXPENSES	Current Year		Previous Year	
a) Salary & Allowances	3,15,45,026.00		3,16,41,439.00	
b) Honorarium	1,03,500.00		1,16,500.00	
c) Employer Contributions	14,03,611.00		12,77,946.00	
d) Wages	22,94,360.00		24,84,081.00	
e) LTC	6,44,912.00		13,27,532.00	
f) Leave Encashment Expenses	24,054.00		1,79,266.00	
g) Children Education Allowance	3,30,739.00		2,08,666.00	
h) Outsourced DEO	21,11,033.00		16,82,902.00	
i) Outsourced Electrician	22,90,982.00		17,71,659.00	
j) Outsourced Worker for Various Services	32,59,982.00		24,89,566.00	
k) Pension, Gratuity & Leave Encashments	-		21,05,857.00	
l) NER-DRR (Salary)	41,74,396.00		42,96,579.00	
m) CISF Salary	1,67,02,418.00		1,18,35,081.00	
n) Retirement PF	14,07,202.00		-	
o) Prior Period Expenses	-	6,62,92,215.00	15,03,700.00	6,29,20,774.00
TOTAL		**6,62,92,215.00**		**6,29,20,774.00**

SCHEDULE 9 - OTHER ADMINISTRATIVE EXPENSES & etc.	Current Year		Previous Year	
1 Postage, Courier & Telephone Charges	9,28,721.00		9,37,948.00	
2 Bank Charges	6,028.00		11,396.00	
3 Electricity & Power Charges	28,27,769.00		21,69,069.00	
4 Hospitality	-		52,350.00	
5 Printing & Stationery	9,31,697.00		8,77,789.00	
6 Advertisement & Publicity	4,83,120.00		4,93,619.00	
7 Hiring of Vehicles	30,97,573.00		28,30,718.00	
8 Travelling & Conveyance	19,52,900.00		15,02,191.00	
9 Professional Charges	4,10,793.00		2,91,943.00	
10 Project Expenses [In-house]	13,62,859.00		21,565.00	
11 Rent	9,24,807.00		8,42,234.00	
12 Repair & Maintenance	9,05,914.00		13,20,872.00	
13 Books & Periodicals	29,559.00		33,383.00	
14 Trainings/ Seminars & Workshops	97,505.00		2,66,853.00	

(Amount - ₹)

SCHEDULE 9 - OTHER ADMINISTRATIVE EXPENSES & etc.	Current Year		Previous Year	
15 Medical Expenses	8,06,312.00		4,41,534.00	
16 Prior Period Expenses	-		1,31,168.00	
17 Other Charges	4,69,547.00		1,78,921.00	
18 POL	3,29,844.00		5,90,630.00	
19 Consignment Clearing Charges	-		1,81,778.00	
20 Hindi Week Celebrations	19,130.00		-	
21 Annual Maintenance Contracts	33,43,492.00		15,88,732.00	
22 Fooding & Lodging	1,36,334.00		78,906.00	
23 Satellite Data's	-		87,260.00	
24 Miscellaneous Expenses	-		1,47,508.00	
25 Repair & Maintenance of Vehicles	1,94,467.00		2,10,706.00	
26 Operational Charges & Maintenance of Canteen	3,20,016.00		3,53,806.00	
27 ICRB Examination	3,76,696.00		2,80,320.00	
28 NER-DRR Expenses	4,41,995.00		7,62,841.00	
29 CISF Expenses	15,81,725.00		30,38,644.00	
30 Computer Consumables	-		1,344.00	
31 Supply of Water for Hostels	28,800.00	2,20,07,603.00	3,900.00	1,97,29,928.00
TOTAL		**2,20,07,603.00**		**1,97,29,928.00**

For **D DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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

Date : 03.06.2016

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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31-MARCH-2016

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

Fixed Assets has been stated at cost and accounted for at historical cost.

4. DEPRECIATION

4.1 Depreciation on assets acquired during the year is provided for as under:

- Assets acquired up to 30.09.15 – 100% as per the applicable rate.
- Assets acquired after 30.09.15 – 50% as per the applicable rate.

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

5. RETIREMENT BENEFITS

Pension, gratuity and leave encashment liability has been provided for employees recruited in the Centre. The retirement benefits in respect of deputationists are accounted for on Cash basis.

6. FOREIGN CURRENCY TRANSACTION

Foreign exchange transaction arising during the year is recorded at the exchange rates prevailing at the transaction date.

7. RESEARCH & DEVELOPMENT

Revenue and Capital Expenditure on various internal projects are charged to the Income & Expenditure Account. For external project, fund received and utilized are accounted in the Project Account and the unutilised balance is reflected as under Current Liabilities.

For **D DAS & ASSOCIATES**
Chartered Accountants

Sd/-
(DEBAPRATIM DAS)
Partner

for and on behalf of
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Sd/-
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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31-MARCH-2016

SCHEDULE 11 – NOTES ON THE ACCOUNTS & CONTINGENT LIABILITIES

NOTES ON THE ACCOUNTS

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

b) Pension, gratuity and leave encashment liability has been provided till 31.03.2016.

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

d) Schedules 1 to 11 are annexed to and form an integral part of the Balance Sheet as at 31-March-2016 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

Sd/-
(DEBAPRATIM DAS)
Partner

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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

Date : 03.06.2016

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BALANCE SHEET (PF) AS AT 31-MARCH-2016

(Amount - ₹)

CAPITAL FUND AND LIABILITIES	CURRENT YEAR	PREVIOUS YEAR
Opening Balance:	50,64,880	43,96,334
Add: Balance of surplus transferred from "Income & Expenditure Accounts (PF)"	8,73,777	6,68,546
TOTAL	**59,38,657**	**50,64,880**
ASSESTS	**CURRENT YEAR**	**PREVIOUS YEAR**
Bank Balance with Schedule Bank as at 31.03.2016	59,38,657	50,64,880
TOTAL	**59,38,657**	**50,64,880**

For **D DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
(DEBAPRATIM DAS)
Partner

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

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

Date : 03.06.2016

Acronyms

AOD	:	Aerosol Optical Depth
ASDMA	:	Assam State Disaster Management Authority
ASP	:	Atmospheric Science Program
AWS	:	Automatic Weather Stations
BC	:	Black Carbon
BLL	:	Boundary Layer Lidar
CISF	:	Central Industrial Security Force
CMD	:	Construction and Maintenance Division
COTS	:	Commercial Of-The-Shelf
CSB	:	Central Silk Board
CSRTI	:	Central Sericultural Research & Training Institute
DDMA	:	District Disaster Management Authority
DEM	:	Digital Elevation Model
DMS	:	Disaster Management Support
DNS	:	Domain Name Servers
DOS	:	Department of Space
DoT	:	Department of Telecom
DPR	:	Detailed project report
DWR	:	Doppler Weather Radar
ELPI	:	Electric Low Pressure Impactor
EOAM	:	Earth Observations Applications Mission
FLEWS	:	Flood Early Warning System
FWP	:	Forest Working Plan
GBH	:	Girth at Breast Height
GC	:	Governing Council
GFS	:	Global Forecast System
GHG	:	Green House Gases
GIS	:	Geographical Information System
GPM	:	Global Precipitation Measurement
GRACE	:	Gravity Recovery And Climate Experiment
GSI	:	Geological Survey of India
HPC	:	High Performance Computing
ICAR	:	Indian Council of Agricultural Research
ICMR	:	Indian council for medical research
IDSP	:	Integrated Disease surveillance programme
IGBP	:	ISRO Geosphere Biosphere Program
INSAT	:	Indian National Satellite
IWMP	:	Integrated Watershed Management Programme

JEWS	:	Japanese Encephalitis Warning System
LAN	:	Local Area Network
LISS	:	Linear Imaging Self Scanning Sensor
MBLM	:	Mini Boundary Layer Mast
MCS	:	Mesoscale Convective System
MERRA	:	Modern-Era Retrospective analysis for Research and Application
MGNREGA	:	Mahatma Gandhi National Rural Employment Guarantee Act
MIS	:	Management Information System
MODIS	:	Moderate-resolution Imaging Spectroradiometer
MoEFCC	:	Ministry of Environment, Forests and Climate Change
MPA	:	Master Plan of Action
MRR	:	Micro Rain Radar
MWR	:	Multi Wavelength Radiometer
NAS	:	Network Attached Storage
NASA	:	National Aeronautics and Space Administration
NAVIC	:	Navigation with Indian Constellation
NDEM	:	National Database for Emergency Management
NDVI	:	Normalised Difference Vegetation Index
NEC	:	North Eastern Council
NEDRP	:	North Eastern District Resources Plan
NER	:	North Eastern Region
NER-DRR	:	North Eastern Regional node for Disaster Risk Reduction
NERTPS	:	North Eastern Region Textile Promotion Scheme
NESAC	:	North Eastern Space Applications Centre
NKN	:	National Knowledge Network
NOBLE	:	Network Of Boundary Layer Experiments
NRSC	:	National Remote Sensing Centre
NWP	:	Numerical Weather Prediction
OMI	:	Ozone Monitoring Instrument
PCA	:	Principal Component Analysis
PMGSY	:	Pradhan Mantri Gram Sadak Yojna
RF	:	Reserve Forest
RMSE	:	Root Mean Square Error
RS	:	Remote Sensing
SAC	:	Space Applications Centre
SAN	:	Storage Area Network
SATCOM	:	Satellite Communications
SBIK	:	Space Based Information KIOSK
SDI	:	Spatial Data Infrastructures
SILKS	:	Sericulture Information Linkages & Knowledge System
SIRD	:	State Institute of Rural Development, Meghalaya

SIS-DP	:	Space Based Information Support for Decentralized Planning
SLIM	:	Seasonal Landslide Inventory Mapping
SLNA	:	State Level Nodal Agency
SODAR	:	Sound Detection And Ranging
SOI	:	Survey Of India
SRA	:	Synoptic Rainfall Advisory
SRSAC	:	State Remote Sensing Applications Centres
SRTM	:	Shuttle Radar Topography Mission
SWJ	:	Subtropical Westerly Jetstream
TCN	:	Tropospheric columnar NO_2
TIBL	:	Thermal Internal Boundary Layers
TOA	:	Top Of Atmosphere
TRMM	:	Tropical Rainfall Measurement Mission
TWSC	:	Total Water Storage Changes
UAS	:	Unmanned Arial Survey
UAV	:	Unmanned Aerial Vehicle
VHRR	:	Very High Resolution Radiometer
VPN	:	Virtual Private Network
VRC	:	Village Resource Centre

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North Eastern Space Applications Centre

Department of Space, Government of India

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