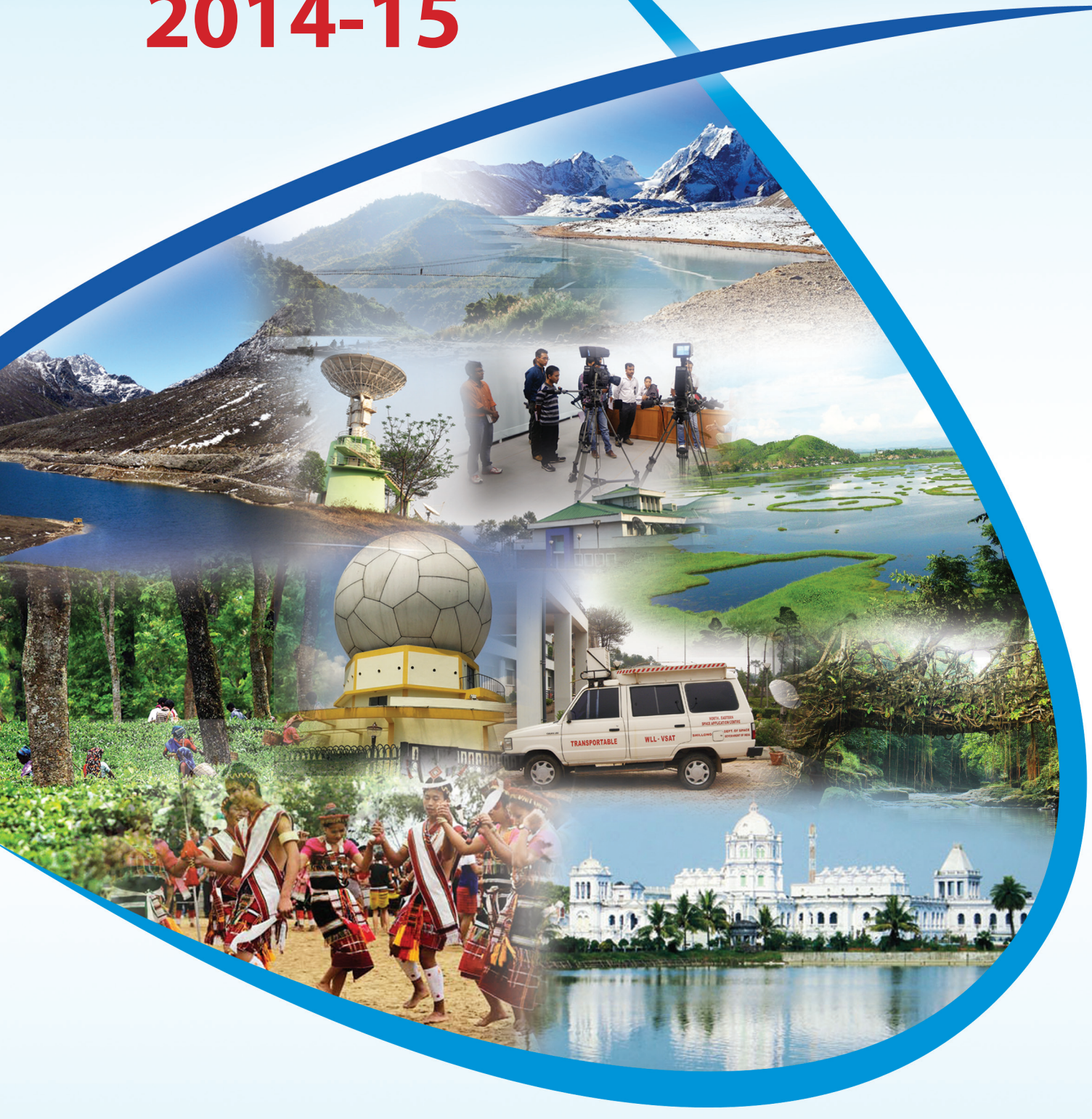
Annual Report
2014-15



North Eastern Space Applications Centre

Government of India, Department of Space, Umiam 793103, Meghalaya
www.nesac.gov.in

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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 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 based natural resource information base to assist 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 establish a space science and climatic change research hub by installation of necessary instrumentation and networking with various academic institutions of NER.

1.2. Management of the Centre

Chairman, NEC presides over the NESAC Society. 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) 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 by NESAC Society and GC. In addition, a High Power Committee (HPC) constituted during 2004 by Chairman, NESAC GC/Secretary, DOS has recommended a Master Plan of Action (MPA) for utilization of space technology in the developmental process of the NER. Sixteen major thrust areas have been identified for implementation by NESAC over a period of five years during the 11th Five Year Plan period (2007-12). During the current year, NESAC has taken up and completed several projects covering the NE states in the areas of natural resources management, infrastructure planning, health, education and space 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), Disaster Management Support (DMS) and Space & Atmospheric Science Programmes.

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 computing and other facilities including servers and workstations for geospatial analysis, digital image processing, very high-end systems for photogrammetry, hydrological modelling etc, GIS and GNSS equipments, Echo sounder, high quality output devices, and so on. 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 has established its own campus wide network for smooth operation and transfer of data across working level scientists for positioning a good environment for data exchange and publishing. The centralized computing facility also has required number of Domain Name Servers (DNS), web servers, database servers and FTP servers with large storage in high availability (HA) and load balancing (LB) mode as part of web hosting infrastructure. Centre has set-up a strong Spatial Data Infrastructures (SDI) covering the NER for necessary geospatial support in the region. The centre has implemented a high bandwidth Local Area Network (LAN) with gigabit ethernet backbone connecting all the laboratories, facilities as well as administrative department spread across the NESAC campus. In addition, Centre has necessary servers on LAN for Intranet usage, software license and antivirus services with all other security features. Necessary storage systems are also on LAN as centralized data repository.

1.4.2. 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 on various subjects. Spacenet system for video conferencing and data transfer activities amongst DOS/ISRO; Expert node for Village Resource Centre (VRC) for disseminating information to villages in the far flung areas; ISRO DMS-VPN node, transportable WLL-VSAT system and satellite phones (Type-D terminals) for communication support under disaster conditions. NESAC also contributes through development of Mobile Apps as part of disaster management support. NESAC has hosted one of the four ground stations to have IRNSS data reception and monitoring facility on 24X7 basis as a part of satellite navigational program of ISRO. Centre also supports Ka-band propagation experiment and IRNSS SPS-GPS receiver experiment.

1.4.3. Space and Atmospheric Science Research

The Centre hosts Multi Wavelength Radiometer (MWR), seven channel Aethalometer, Integrating Nephelometer, Electric Low Pressure Impactor (ELPI), Boundary Layer Lidar (BLL) and Net Radiometer for physical and optical characterization of aerosols. Dr. Pisharotysonde (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 (O^3), and Methane, non Methane hydrocarbon are being used with necessary calibration and centralized data logging system to characterize the regional GHG and their impact on climate. Further, a network of 118 Automatic Weather Stations (AWS) spread over entire NER is established and used by NESAC. 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.

1.4.4. New Instruments and Facilities

NESAC has also 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. The facility is deployed for atmospheric research and other computation intensive

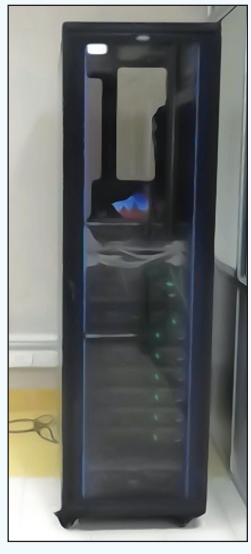


Figure 1.1 Newly installed HPC

applications. Currently Weather Research Forecast (WRF) model is successfully deployed, which also helps in meeting the requirements of Flood Early Warning System (FLEWS).

1.4.5. Library

NESAC library is well-equiped with large collection of books covering wide range of subjects. Necessary softwares are also installed for efficient management of the library. The Centre subscribes a good number of jounals and magazines catering the requirement of research and applications.

1.4.6. Sports and Recreation Facilities

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

2. AGRICULTURE & SOIL

2.1. Rice Crop acreage estimation in NE hilly states for 2014-15 crop season

Availability of reliable and timely crop statistics is of paramount importance to the planners, administrators, policy makers and research workers. There is no objective methodology is available for estimation of areas under different crops in north-eastern hilly states due to the undulating topography and inaccessibility of most of the areas. Also, percentage area under the crops is relatively less, where mostly terraced farming and Jhum cultivation is practiced. Due to persistent cloud cover, during most part of the year, it is difficult to get cloud free satellite images, particularly in monsoon season, making it even more difficult to use space technology in agricultural applications. Yet another dimension to this problem is the absence of cadastral data for NER. The National Statistics Commission has suggested for exploring use of remote sensing, through multi-seasonal data acquisition, for crop statistics of the region, which needs to be explored with the use of RADAR data and other means.

Space Applications Centre (SAC), Ahmedabad coordinated the pilot phase of a project with Indian Agricultural Statistics Research Institute (IASRI) and North Eastern Space Applications Centre (NESAC) to develop the procedures for acreage estimation of rice and other selected major crops in the state of Meghalaya. A judicious mix of remote sensing and field surveys was attempted as a part of this study. Results from the pilot phase of the project were promising and the exercise was further continued to validate the procedure in the state of Tripura in addition to Meghalaya. Acreage estimation of rice crop was found to be reasonably satisfactory and hence recommended for operational use amongst seven hilly states of NER including Sikkim in two phases under FASAL programme, coordinated by Mohalanobis National Crop Forecast Centre (MNCFC), New Delhi. In phase-I, four states viz., Arunachal Pradesh, Meghalaya, Mizoram and Tripura have been taken up in collaboration with the State Remote Sensing Centre-Arunachal Pradesh, Mizoram Remote Sensing Applications Centre and Tripura Space Application Centre. In absence of any State Remote Sensing Centre in the state of Meghalaya, the work pertaining to the state was carried out by NESAC.

The methodology involves an integrated approach of combining RS, GIS, and GPS based ground survey. LISS-III images of Resourcesat-1 and Resourcesat-2 satellites have been used in this study. In order to minimize errors due to undulating topography and misclassification, relationship between area under selected crop in the classified image and actual area has been established. The areas under crop, which are not captured by satellite sensor, due to hill shades and limitations of terrain conditions, have been replaced by data from sample surveys.

2.1.1. Estimation of area under rice crop in Arunachal Pradesh

A total area of 1,35,349 ha has been estimated as area under winter rice in the State of Arunachal Pradesh (Figure 2.1) with overall classification accuracy of 77%. Area acreage under rice crop at district level is given in the Table 2.1.

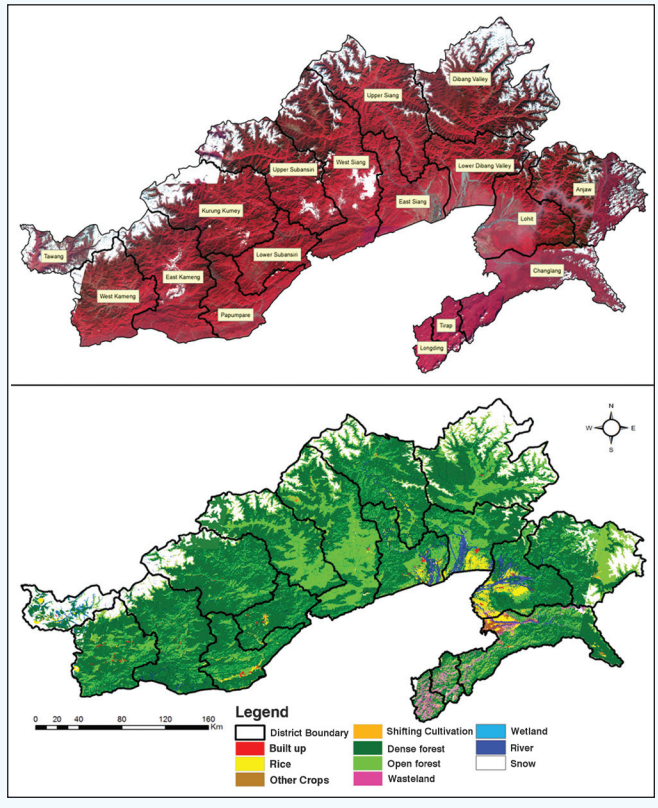


Figure 2.1. FCC and classified image of Arunachal Pradesh showing the rice acreage

Table 2.1 Estimated area under rice crop in the districts of Arunachal Pradesh

District	Rice Area (Ha)	District	Rice Area (Ha)
Anjaw	119	Kurung Kumey	1848
Changlang	18806	Lohit	45220
Lower Dibang Valley	22866	Lower Subansiri	4886
Dibang Valley	98	Upper Subansiri	209
East Kameng	2425	Papumpare	10636
West Kameng	4827	Tawang	327
East Siang	9728	Longding	1138
Upper Siang	7379	Tirap	1105
West Siang	3732		
Total		**135349**	

2.1.2. Estimation of area under rice crop in Meghalaya

Cloud free images available during the peak vegetative growth and during the harvesting stage have been used for the delineation of rice crop in the state (Figure 2.2). Acreage under rice crop in all the districts of Meghalaya is given in the Table 2.2. West Garo Hills districts recorded highest area under kharif rice (11,583 Ha). Overall classification accuracy of 78% could be achieved for the state of Meghalaya.

As most of the rice fields are in the low lying areas, some amount of misclassification of rice crop is observed with respect to marshy and wetlands. Availability of good ground truth and other supporting observation has helped in improving the classification accuracy.

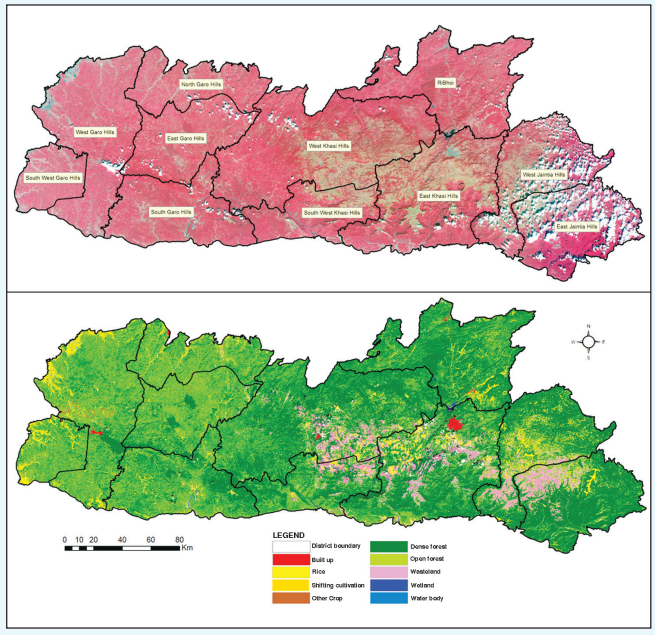


Figure 2.2. FCC and classified image showing the rice acreage

Table 2.2. Estimated area under rice crop in Meghalaya

District	Rice Area (Ha)	District	Rice Area (Ha)
East Khasi Hills	7051	South West Garo Hills	7116
West Khasi Hills	5616	East Garo Hills	3368
South West Khasi Hills	2005	South Garo Hills	3774
RiBhoi	9825	East Jaintia Hills	2939
North Garo Hills	5492	West Jaintia Hills	9877
West Garo Hills	11583		
Total		**68646**	

2.1.3. Estimation of area under rice crop in Mizoram

Images acquired during the peak growth stages and post-harvest period were used for digital classification and delineation of rice crop areas (Figure 2.3). Acreage under rice crop in all the districts of Mizoram is given in the Table 2.3. The overall classification accuracy for the state has been observed to be 91.4% with overall KAPPA (K-Statistics) of 0.73.

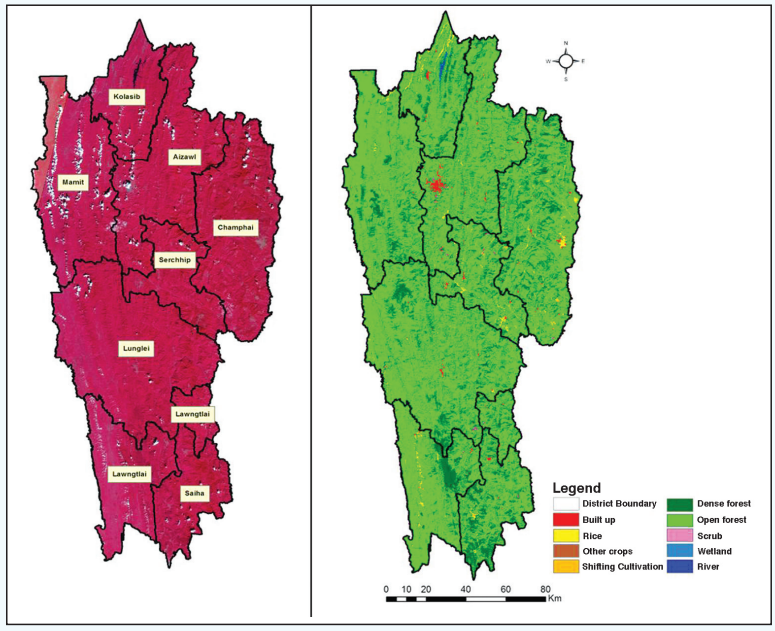


Figure 2.3. FCC and classified image of Mizoram showing the rice acreage

Table 2.3 Estimation of area under rice crop in Mizoram

District	Rice Area (Ha)	District	Rice Area (Ha)
Aizawl	5220	Serchhip	6643
Lunglei	6884	Saiha	1800
Mamit	4783	Kolasib	5781
Lawngtlai	7669	Champhai	12804
Total		**51584**	

2.1.4. Estimation of area under rice crop in Tripura

A false colour composite of LISS-III images along with classified map of rice crop areas and other major land use classes is given in Figure 2.4. Since some of required images were not available during peak vegetation growth for the entire state, images available during the harvesting and post-harvest period have also been used for classifying rice crop areas. Acreage under rice crop in all the four districts of Tripura is given in the Table 2.4. An overall classification accuracy of 86 % was achieved for the state of Tripura.

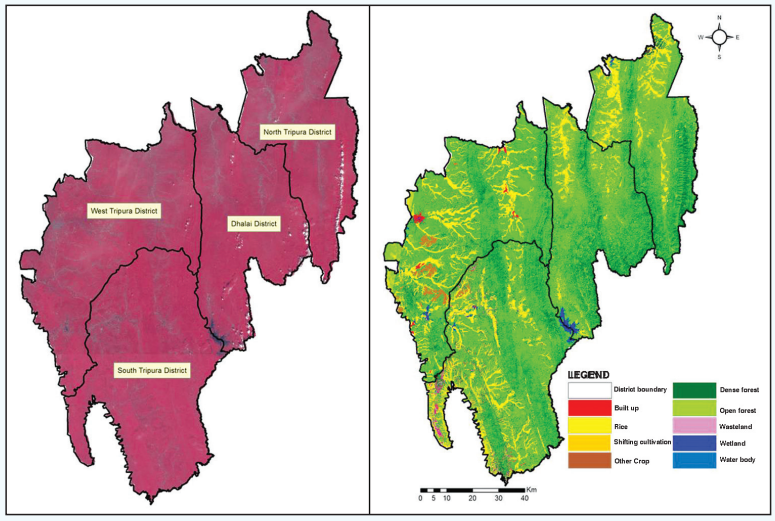


Figure 2.4. FCC and classified image of Tripura

Table 2.4 District wise rice acreage estimates in Tripura

District	Rice Area (Ha)	District	Rice Area (Ha)
North Tripura	29112	West Tripura	53337
South Tripura	53560	Dhalai	23350
Total		**159359**	

Non availability of cloud free images during the peak crop growing season remains the major difficulty in deriving reliable acreage estimates in selected states. Nevertheless, the remote sensing based exercise is expected to help Directorate of Agriculture (DOA) and Directorate of Economics and Statistics (DES) for an improved understanding of the acreage and its distribution in the state, which will be useful in several developmental planning exercises.

2.2. Soil and land capability mapping in NER

Soil is a non-renewable natural resource which is the foundation for various types of land use. Soil also indirectly contributes to regulation of water and recycle of wastes. Because of the increasing population growth and economic development, the dynamics of land usage poses a major challenge. Unscientific land use practices could result in soil health hazards, such as soil degradation thereby declining the quality and productivity. Thus it has become necessary to retard the degradation process or ameliorate the soils to bring back normalcy which requires a systematic soil conservation practices.

Since soil map at larger scale (larger than 1: 2,50,000) is not easily available for the NE Region, an attempt is made to map soil and land capability in 12 districts of NER in the best possible manner for North Eastern Council at 1:50,000 scale. Out of 12 districts, soil mapping has been done for 11 districts viz. Bongaigaon, Goalpara, Dhubri, Kokrajhar (Figure 2.5) and Golaghat districts of Assam, Ri Bhoi, Jaintia Hills (both East & West Jaintia Hills) and West Khasi Hills (including South West & West Khasi Hills) district of Meghalaya and Champhai, Lawngtlai & Lunglei district of Mizoram.

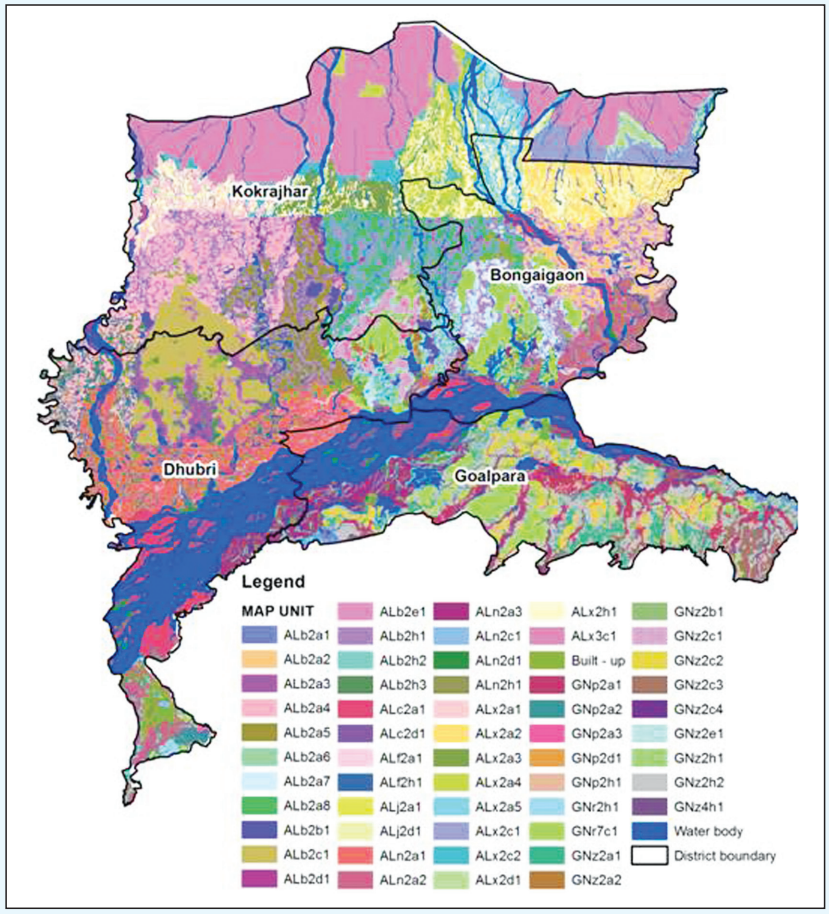


Figure 2.5. Soil map of West Assam on 1:50,000 scale

3. FORESTRY/ECOLOGY

Ministry of Environment, Forests and Climate Change (MoEFCC), Govt. of India adopted National Working Plan Code in 2004 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 RS and GIS (at 1:10K) inputs for forest working plan and scheme is taken up in the state of Mizoram, Meghalaya, Arunachal Pradesh, and Assam state in collaboration with the respective State Forest Departments.

3.1. Inputs for Forest Working Plan/working schemes in Meghalaya

The primary goal of the project is to prepare land resource map for the State of Meghalaya and provide inputs for the preparation of working plan and working schemes for sustainable management of forest. The State Government controls around 10% of the total forest area (4.43% of State total geographic area) which include the reserve forests, national parks, biosphere reserves and wildlife sanctuaries. The remaining forests are under the jurisdiction of the Autonomous District Councils (ADCs) which in principle represent the traditional institutions. A detail Land Resource and Land Use map (Figure 3.1) prepared for Meghalaya State at 1:10,000 scale and the growing stock estimation in terms of timber volume have been done at the compartment (for reserve forest) and block level. This is useful as an input for working plan and working schemes by Meghalaya Forest and Environment Department. Based on the inputs provided by NESAC, the Forest Working Plan written by Meghalaya Forest and Environment Department for 27 reserve forests has been approved by MoEFCC. The required inputs for the preparation of working scheme (outside reserve forest) have also been submitted and awaiting approval.

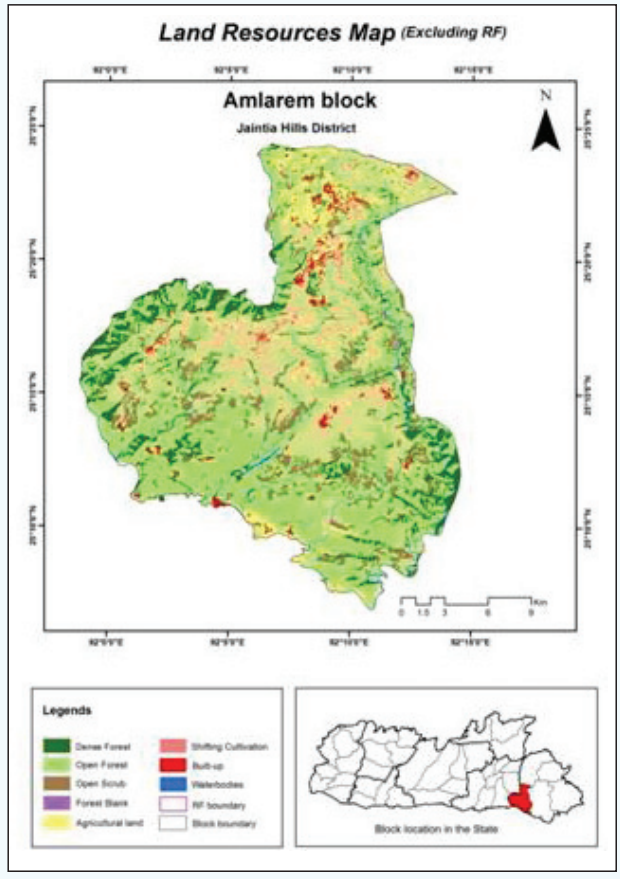
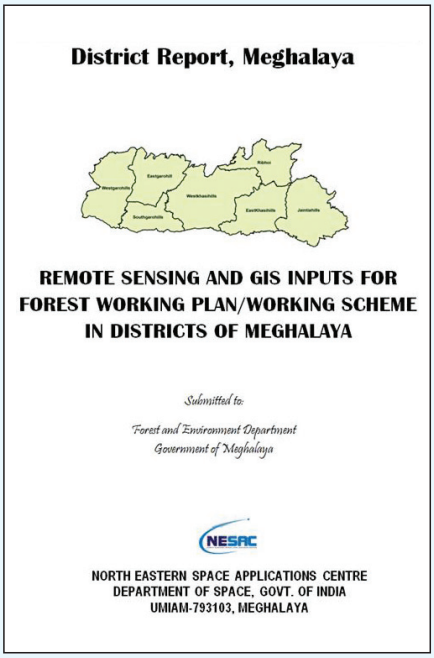


Figure 3.1. Land Resource map of Amlarem Block, Jaintia Hills District, Meghalaya project

West Khasi hills district of Meghalaya have the highest forest cover with respect to total geographical area of the State. Whereas, South Garo hills district has maximum forest cover when compared with total district area. Jaintia hills district of Meghalaya is found to have highest timber volume followed by West Khasi Hills district of Meghalaya. The additional inputs like forest type, forest density, timber volume at different girth classes and forest types and density classes etc. in both >25° slope and <25° slope is also provided. The inputs on the slope class have been provided for 39 blocks and 7 districts. Protected area maps with 2km buffer area are also provided to the department. The project is completed and final reports (inputs for working scheme) are submitted (Figure 3.2a) to Meghalaya Forest and Environment dept. Figure 3.2b shows the sample copy of the Working Plan Report approved under the project.



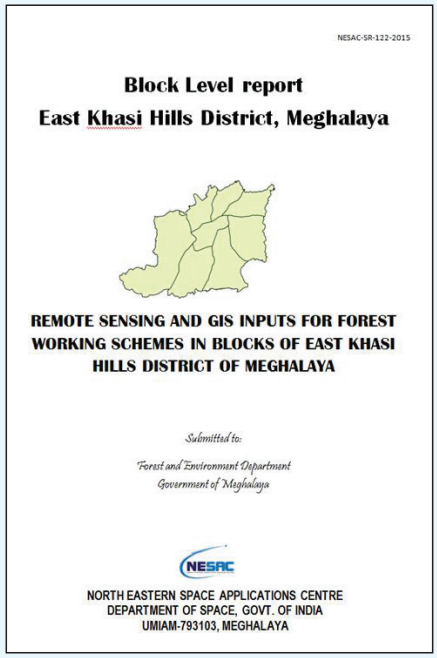


Figure 3.2a. Sample of the reports submitted under the project

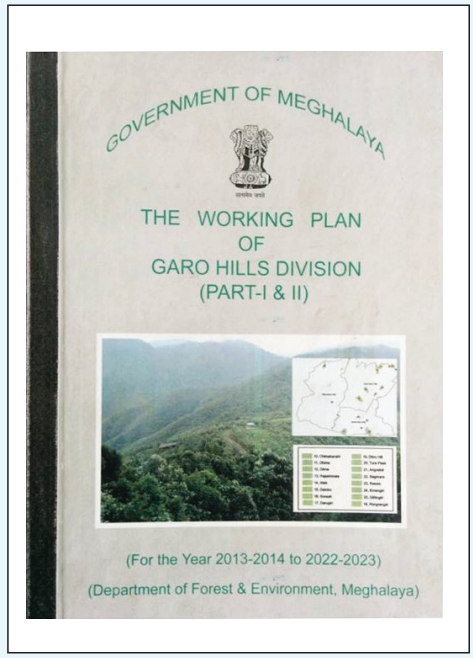


Figure 3.2b. Approved Working Plan for Jaintia Hills Division Meghalaya (2013-14 to 2022-23)

3.2. Inputs for Forest Working Plans in Assam

The exercise has been taken up in collaboration with Assam Forest & Environment Department, Govt. of Assam for the preparation of RS and GIS based forest working plan inputs for 21 forest divisions of Assam Forest. Forest crown density mapping has been carried out using CARTOSAT-1 and IRS LISS IV images and the density mapping is completed for the 21 forest divisions of the state. Resourcesat-2 LISS III imageries are being used for preparing the forest type map for 10 divisions. Stratification of forest based on forest type and forest crown density are completed for 10 divisions, namely, Aie Valley, Dhubri, Digboi, Dibrugarh, Doomdoma, Kamrup East, Kamrup West, Sonitpur West, Golaghat and Lakhimpur (Figure 3.3). Preliminary timber volume estimation for Dibrugarh division has also been accomplished.

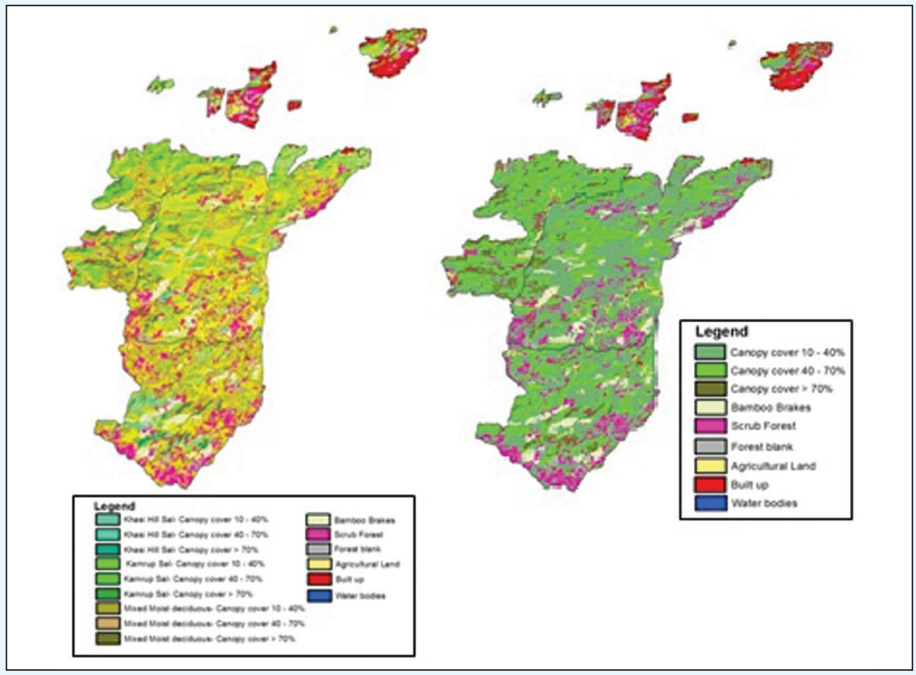


Figure 3.3. Forest crown density and strata map of Kamrup East

3.3. Inputs for Forest Working plan in Mizoram

This work is carried out in collaboration with the Department of Environment and Forest, Mizoram. Field data are collected by the User Department based on the sampling points identified by NESAC and these data are further used for calculating the mean timber volume for each strata of the division. The stratification of the forest is based on forest/vegetation type, elevation and forest crown canopy density. Compartment wise land use area statistics, timber volume and stock estimates, along with the density/stock maps, are provided to the Forest Department for Forest Working Plan preparation. Based on the inputs provided by NESAC, Mizoram Forest Department has prepared the final Forest Working Plan for Aizawl and Thenzawl Division. Figures 3.4 & 3.5 show the forest canopy density and other land cover maps of the RFs of Aizawl and Thenzawl Divisions respectively.

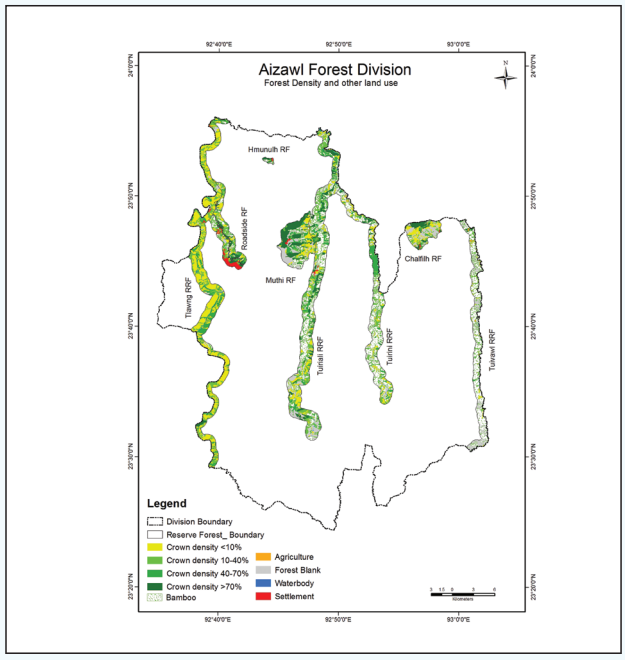


Figure 3.4. Forest density map of Aizawl Division

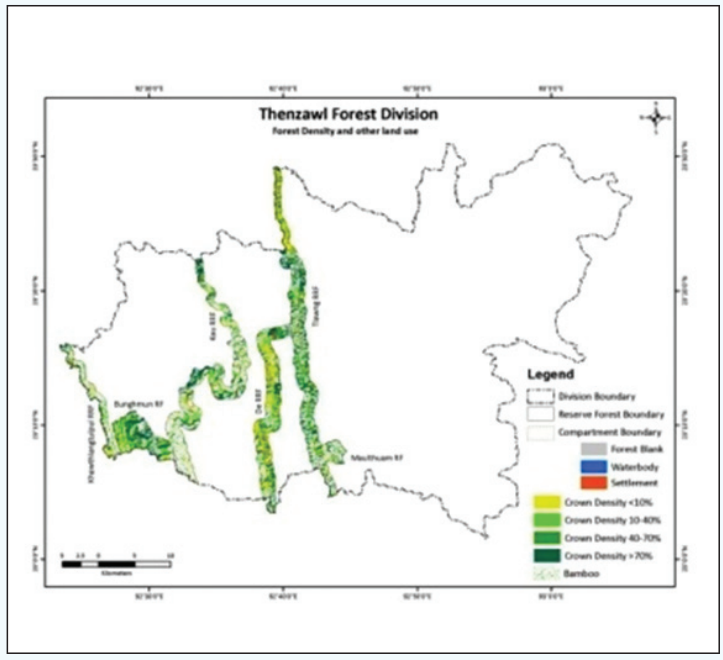


Figure 3.5. Forest density map of Thenzawl Division

3.4. 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 since 2012. In the current year, the forest crown density mapping in1:10K (Figure 3.6) using Cartosat-1 data along with the associated land use for the entire state has been completed. The percentage forest cover under different density categories (5 classes viz., <10%, 10-20%, 20-40%, 40-70% & >70% crown cover) for 19 divisions are shown in Table 3.1. It was found that most of the divisions had proportionately large area under dense category of forest (Figure 3.6).

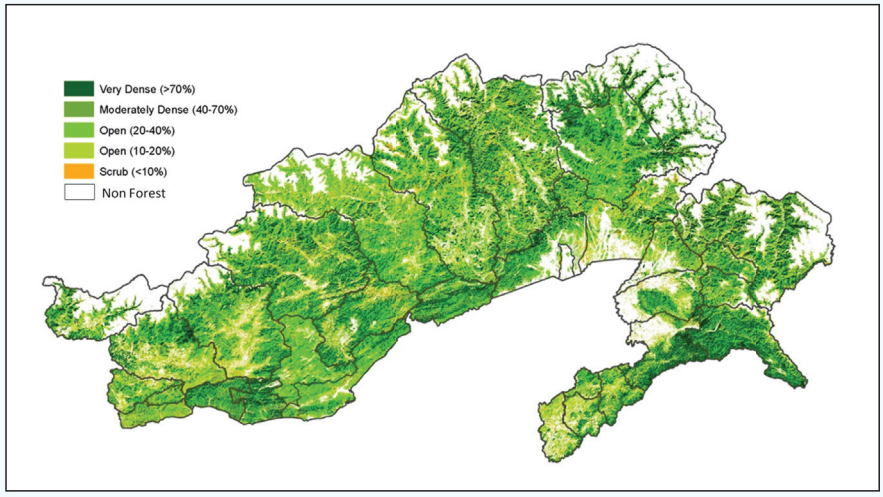


Figure 3.6. Division wise Forest crown density map of Arunachal Pradesh

Field enumeration data from sampling points of "Along forest division", as provided by the Arunachal Forest

Department has been used for estimating the growing stock, for all the 2,360 compartments (Figure 3.7). Based on the area statistics of forest density classes at different elevations within a compartment, the mean timber volume and stem density are extrapolated to estimate the total growing stock for different girth classes.

Table 3.1 Area under different forest crown density classes

Forest Divisions	Area under different density of crown cover (km²) District					Non Forest	Total Geographic Area (km²)
	>70%	40-70%	20-40%	10-20%	<10%		
Anjaw	1220.41	586.48	598.56	487.95	462.2	2637.14	5992.74
Banderdewa	235.35	391.02	483.15	294.3	170.84	244.28	1818.94
Bomdila	390.03	571.03	499.24	407.49	449.42	871.58	3188.79
Changlang	148.59	153.24	130.52	125.71	103.79	117.62	779.47
D'Ering WLS	0	3.21	10.44	4.74	7.36	190.38	216.13
Debang BR	530.95	623.99	301.91	66.23	33.84	3317.86	4874.78
Deomali	54.74	63.59	71.47	60.65	41.54	78.58	370.57
Eagle Nest WLS	26.98	68.17	53.58	46.74	38.73	27.42	234.2
Kamlang WLS	146.83	169.3	140.74	116.38	60.96	218.25	852.46
Khonsa	86.98	93.79	112.07	107.6	99.16	224.63	724.23
Likhabali	435.53	244.36	265.19	163.29	84.29	136.73	1329.39
Lohit	126.21	124.21	164.25	175.48	147.98	528.9	1267.03
Longding	58.92	88.92	102.33	145.07	148.06	365.34	908.64
Namdapha	809.1	682.19	346.01	166.26	103.8	260.46	2367.82
Nampong	532.72	408.54	137.37	163.38	134.73	581.15	1957.89
Pakke TR	184.27	376.4	153.95	20.01	34.85	64.61	834.09
Pashighat	417.46	395.97	392.08	145.46	97.44	820.72	2269.13
Tawang	253.79	187.98	227.16	159.92	146.35	1589.41	2564.61
Yingkiong	1582.07	1080.94	1141.92	1132.98	901.53	2282.91	8122.35

Pre-inventory sampling points based on the 25"x25" (25 seconds) grid methods following the new Working Plan Code 2014 have been generated for 17 more divisions, viz., Anini, Anjaw, Banderdewa, Bomdila, Changlang, Daporijo, Deomali, Hapoli, Kurung Kumey, Likhabali, Lohit, Longding, Namdapha, Nampong, Pashighat, Shergaon, Yingkiong. The sample point distribution in the form of division wise maps has been provided to the forest department for field data collection.

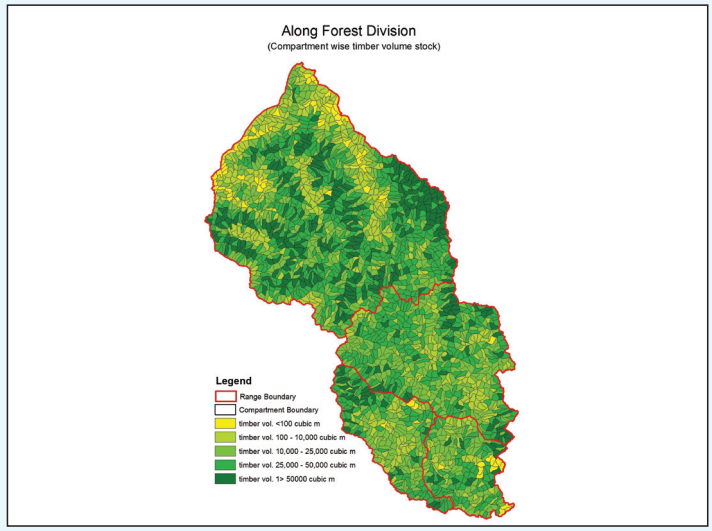


Figure 3.7. Compartment wise Timber growing stock of Along Forest Division

4. WATER RESOURCES

4.1. Forecasting inflow/discharge for Kameng reservoir - Hydro Electric Project

Geospatial techniques are effectively used for estimating reservoir inflow and discharge as part of several hydroelectric projects at NESAC. Kameng Hydro Electric Project of North Eastern Electric Power Corporation Limited (NEEPCO), a public sector undertaking owned by the Government of India under the Ministry of Power, located in West Kameng District of Arunachal Pradesh, is one of the ongoing run-of-river schemes project with a capacity of 600 MW. As per requirement of NEEPCO, a RS and GIS based study to forecast inflow/ discharge for Kameng reservoir using HEC-GeoHMS, HEC-HMS & HEC-Geo RAS based models has been carried out.

The model developed for forecasting inflow/discharge of the reservoir can be divided into two parts i.e. Meteorological and Hydrologic. In Meteorological modelling, Weather Research Forecasting (WRF) is used to forecast mesoscale weather system. Here WRFDA module is used to assimilate the observed data collected from Satellite to update the initial condition of the models.

Inputs from two AWS stations, one at Bomdila and another at Sepa, are compared with WRF rainfall forecast for validation and use (Figure 4.1). The model could explain about 64-74% variation in the volume of rainfall.

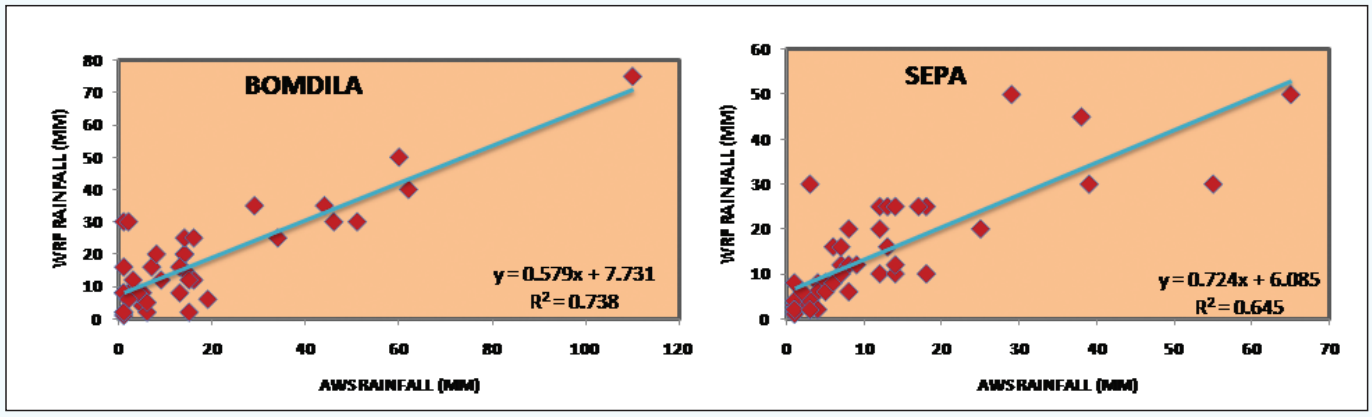


Figure 4.1. Relation of WRF rainfall forecast with AWS data

In this study HEC-GeoHMS was used to generate digital geospatial information to construct hydrologic models (Figure 4.2). The spatial inputs required for the Hydrologic Engineering Center's Hydrologic Modeling System, HEC-HMS were expediently created through GeoHKS interface.

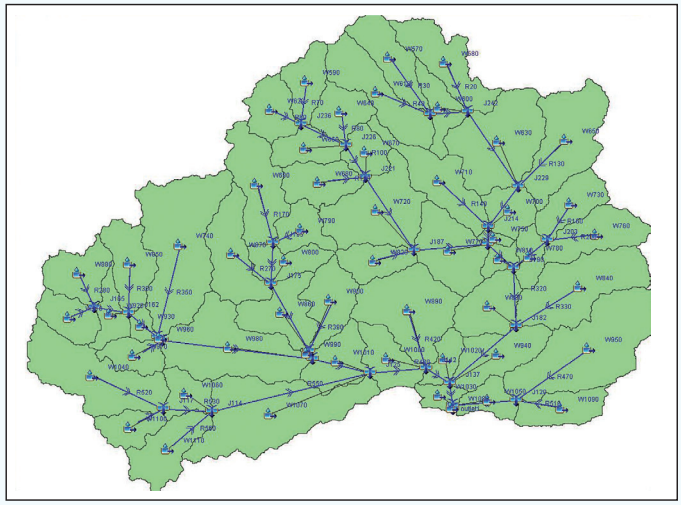


Figure 4.2. Lay out of the HEC-HMS model of the study area

4.2. Assessment and monitoring of River embankment breach locations in Assam

As a flood control measure, Water Resources Department, Govt. of Assam has been constructing embankments on either one side or both sides of many of the major rivers. Bank erosion is a common phenomenon for meandering rivers which leads to embankment breaching. As a part of Flood Early Warning System (FLEWS), NESAC has taken up a task of mapping the existing embankments in major flood prone districts of Assam and also to identify breach points using temporal satellite data. This exercise is done annualy, prior to the onset of monsoon in operational basis.

Due to high magnitude of flood discharge, channel conveyance is often not adequate and unable to contain stream power/flow momentum for a continuous period of time, which often results in embankment breaching frequently in most of the rivers in Assam. In this study, based on the availability of cloud free Cartosat-1 satellite data (2.5m spatial resolution) plugged and unplugged embankment breaches are monitored (Figure 4.3). The exercise cover 14 flood prone districts.

Figure 4.3. Embankment breaches

Further, few breach locations were also verified during the ground visits, such as Sonitpur, Sibsagar and Karimganj districts. Ground truth information collected during 13-16 June 2014, helped in evaluating the accuracy of the study and total 8 breach locations were identified for validation. These breached locations were also cross- validated with the available Cartosat-1 and RISAT-1 data acquired during March to May 2014. It was found that 3 of the breaches were plugged and 5 were unplugged till the month of May 2014. The details of the breach locations are given below. In section 8.1.1, further details of FLEWS project are elaborated.

Table 4.1 Details of the breach locations in Assam

Sl. No	District	Division	River	Name of the scheme
1	Karimganj	Karimganj	Logai	L/B of river Longai at Chandrapur
2	Karimganj	Karimganj	Shingla	At Madanpur
3	Barpeta	Barpeta	Pahumara	L/B Embankment of river Pahumara
4	Tezpur	Sunitpur	Solengi	R/B of Solengi (near Uzabara)
5	Tezpur	Sunitpur	Solengi	L/B of Solengi (Near Sunapur)
6	Tezpur	Sunitpur	Solengi	L/B of Solengi (Near Brahmapur)
7	Tezpur	Sunitpur	Brahmajan	L/B of river Brahmajan (near Nirmala TE)
8	Sibsagar	Sibsagar	Disang	L/B of river Disang

5. GEOSCIENCES

NER is endowed with various rich mineral/ natural resources due to the unique combination of topography and geology. Most of them are of non-renewable categories. However, their identification as well as extraction is not always economically viable due to the rugged and inaccessible terrain condition. Absence of systematic database also pose various limitations in the process of exploration. Further, unscientific mining has also lead to severe environmental problems in the neighbouring areas, which mostly goes unnoticed. Following are highlights of the projects completed addressing some of these issues of NER.

5.1. Mining Area Mapping of Meghalaya - Phase I Jaintia Hills District

The project was initiated to demonstrate the advantages of using very high spatial resolution imaging capabilities of IRS series of satellites and GIS to understand the spatial distribution of rat-hole mines. The study area cover parts of Khliehrat, Sutnga, Sohkynphor, Byndihati, Birwai, Narwan of Jaintia Hills District of Meghalaya. As a result of the study, it was found that images are useful in identification of rat-hole mines both abandoned and existing as well as the ones that are in the process of development for extraction of coal in the area (Figure 5.1). Approximately total 9,131 rat-hole mines are delineated within 175 sq. km of extensively mined study area.

Figure 5.1. High resolution satellite data showing rat-hole mines

Apart from mapping of 'rat-hole' mines, the study also addressed heavy metal pollution / contamination in agricultural soil as well as its effect on quality of surface water. For this, available, published and legacy data from different sources were used. Further, ground samples are also analysed. As per the analysis result of selected heavy metals in agricultural soil, the pollution level of Arsenic (As) as indicated by Geo-accumulation Index (Igeo) ranges from unpolluted to strongly polluted (Figure 5.2), and the contamination factor (CF) i.e. contamination given by a toxic substance is from low to very high contamination (Figure 5.3.). Water Quality Index (WQI) values are classified into five types, "excellent water" to "grossly polluted water". Post-monsoon water quality index shows that 50% of the water samples fall

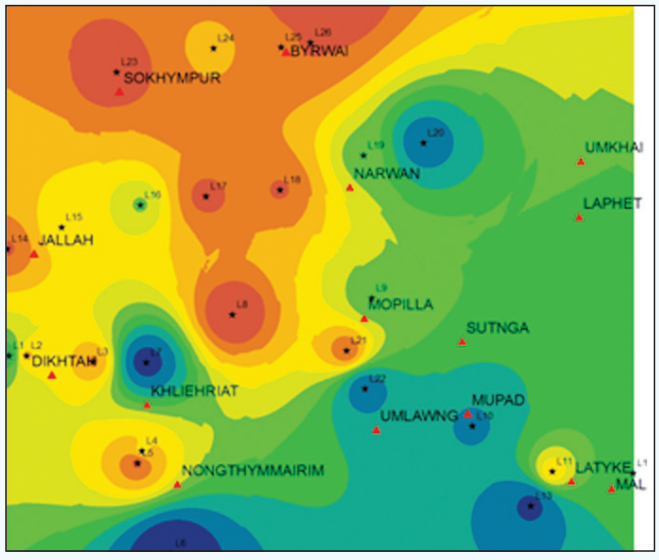


Figure 5.2. Contamination Factor (CF) of Arsenic (As)

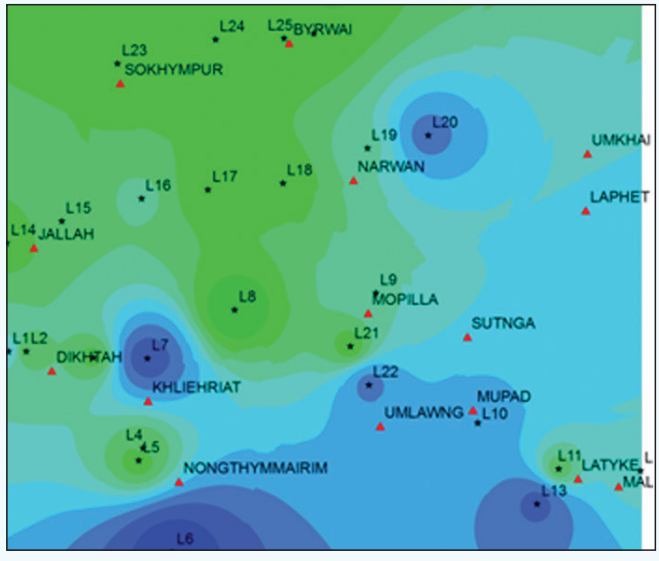


Figure 5.3. Geo-Accumulation Index (Igeo) of Arsenic (As)

under excellent quality while 23% of the samples categorized under "polluted to grossly polluted water". The result of the study may be used as base information for planning and reclamation processes of degraded land due to mining. The final report cited the different classes of Ige and CF as observed for selected heavy metals in agricultural soil, in the study area while for Arsenic details are provided in Tables 5.1 and 5.2.

Table 5.1 Igeo classes of Arsenic

7 Grades/Classes of Igeo			
1	Igeo ≤0	Class 0	Unpolluted
2	0≤ Igeo ≤1	Class 1	Unpolluted to Moderately Polluted
3	1≤ Igeo ≤2	Class 2	Moderately Polluted
4	2≤I geo ≤3	Class 3	Moderately to Strongly polluted
5	3≤I geo ≤4	Class 4	Strongly polluted
6	4≤I geo ≤5	Class 5	Strongly to extremely polluted
7	Igeo>5	Class 6	Extremely polluted

Table 5.2 CF classes of Arsenic

4 Grades/Classes of CF		
1	CF <1	Low contamination
2	1 ≤ CF ≤3	Moderate contamination
3	3 ≤ CF ≤6	Considerable contamination
4	CF ≥ 6	Very high contamination

5.2. Ground Water Prospect Mapping National Mission

Under the Rajiv Gandhi National Drinking Water Mission (RGNDWM) sponsored by the Department of Drinking Water Supply, Ministry of Drinking Water and Sanitation (MDWS), Govt. of India, a major initiative in the NER was taken up by NESAC. Under the guidance of NRSC, ISRO the national lead for the project, the project was implemented in different phases. In this programme, NESAC contributed in Phase III and IV of the mapping and database organisation for the states of Assam and Meghalaya respectively. On completion of the work, NESAC has further contributed in preparation of seamless mosaic database (Figure 5.4) for entire NER along with other State Centres.

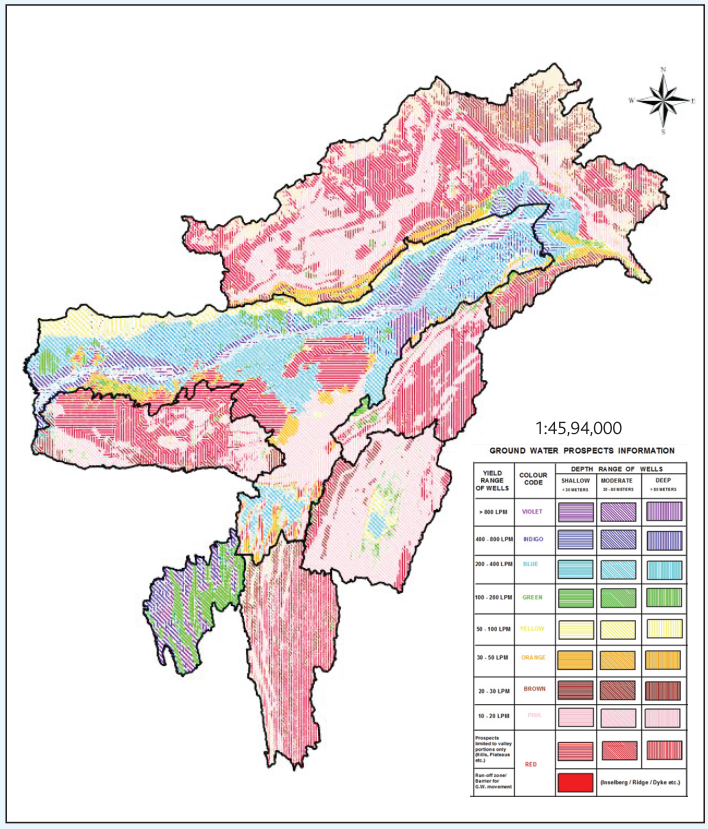


Figure 5.4. Ground water prospect map of NER

6. URBAN AND INFRASTRUCTURE PLANNING

6.1. Urban Information System of Nongpoh Town

Nongpoh town is an administrative and commercial centre in Ri-Bhoi district of Meghalaya. This urban area is experiencing an accelerated pace of urbanization. In recent years, there has been a progressive concentration of population (13,165 persons in 2001 to 17,055 persons in 2011) and development of commercial activities along the NH40. It was felt by the planners that urban planning for this growing town is the need of the hour. Efficient urban information system is a vital requisite for providing inputs in the preparation of the design and regulation of the uses of space that focus on the physical form, economic functions, and social impacts of the urban environment and on the location of different activities within it. Nongpoh town because of its strategic location is also having ample scope for growth. With the main objective to generate urban information system of Nongpoh town, geospatial techniques have been used for extracting information on the physical and cultural aspects of the area.

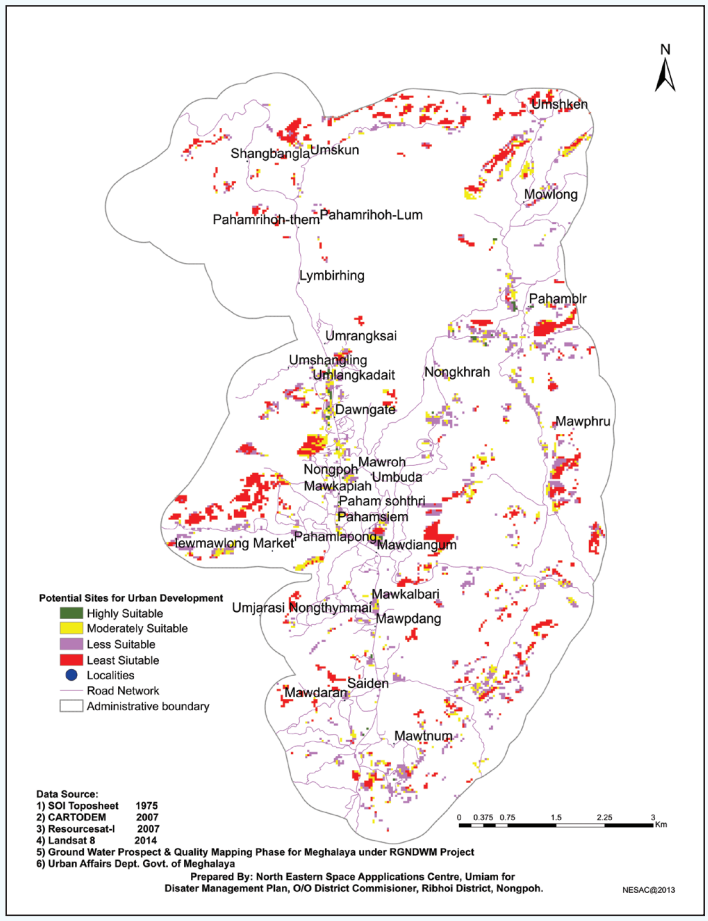


Figure 6.1. Potential sites for Urban Development in Nongpoh Town

Using the temporal data sets from 1979 to 2014, urban sprawl of the town has been mapped (Figure 6.1). The growth has taken place towards the northern part, i.e., from Nongpoh proper to Nongkhra, Lumbyrhing and then towards Shangbangla. Further, a small percentage of growth is observed towards the heart (central business district) of the town. Within a span of seven years (2007-2014), built up areas have sprawled towards the southern part of the town, from Mawkalbari to Mawpdang, Saiden, Mawdaran and Mawtnum. The growth is attributed mainly to the development of commercial activities and also due to increase in services.

This analysis clearly demonstrated growing status of Nongpoh town. Proper planning for the future growth of the town is even more important in the present circumstances. This study was taken up with the objective to prepare sustainable urban suitability analysis. The parameters used in the analysis are land use/cover, groundwater prospects, soil depth, soil texture, slope, surface water bodies, geology, geomorphology and road network. The inventory and analysis of these parameters are done using geospatial techniques. The parameters considered for the analysis are assigned specific weightages and ranking scheme based on the importance for further analysis. These parameters are analysed under a well defined GIS environment. Multi-criteria analysis was carried out based on weighted model to assess the site suitability for urban development (Figure 6.1).

The town has got multiple functions as an administrative unit (a district headquarters), a commercial centre (a midpoint between two State capitals, i.e., Shillong and Guwahati), a main health centre and an educational hub. The town is seen as the growth centre and in recent times it is rapidly growing in its activities. Outputs of the study will serve as important input for urban planning and development of Nongpoh for sustainable future.

7.0 ICT ENABLED GEOSPATIAL APPLICATIONS AND SERVICES

7.1 North Eastern District Resources Plan (NEDRP)

North Eastern District Resources Plan (NEDRP) is an important programme of NESAC executed in close collaboration with State Remote Sensing Applications Centres (SRSAC) of NE region. NEDRP is sponsored by the Ministry of DoNER for 25 selected districts of NE region with an objective to strengthen the governance policy through geospatial inputs. Each district NEDRP portal contains around 30-35 geospatial layers, populated in five main information modules, administrative data, infrastructure details, natural resources information, action plan inputs and disaster management support. Multi-criteria spatial modeling is one of the important components of NEDRP for deriving action plan inputs for land resources (i.e. potential sites for horticulture and aforestation) and water resources (i.e. optimal sites for check dam etc.) activities. In addition, each of the NEDRP portal is also populated with the other relevant geospatial information such as on potential sites for silkworm food plants (i.e. namely eri, muga, mulberry and tasar).

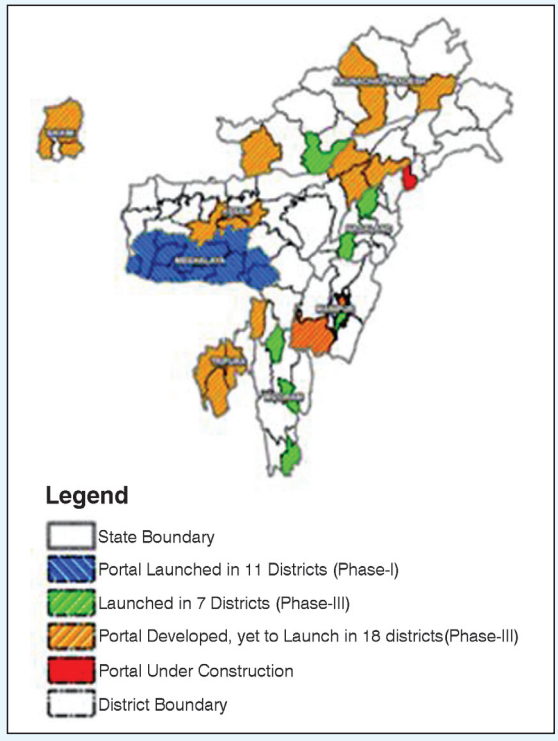


Figure 7.1. NEDRP coverage in NE region

NEDRP is planned to disseminate geospatial information through two modes: i) Stand alone version for all the district head quarters and ii) Public domain via www.nedrp.gov.in. So far NEDRP was successfully launched in 18 districts of NER (11 in Meghalaya, 3 in Mizoram, 2 in Nagaland and 1 each in Anunachal Pradesh and Manipur) (Figure 7.1), while remaining portals are also ready for launching. Recently, NESAC has setup a web infrastructure under NEDRP programme for hosting NEDRP districts database in public domain. A number of geospatial tools for query, search, display, measurement, buffering, network analysis etc. have been developed and enabled on the portal. Bhuvan extended node has also been setup at NESAC to provide special web based map services for 36 NEDRP districts, containing more than 400 geospatial layers of NEDRP (Figure 7.2).

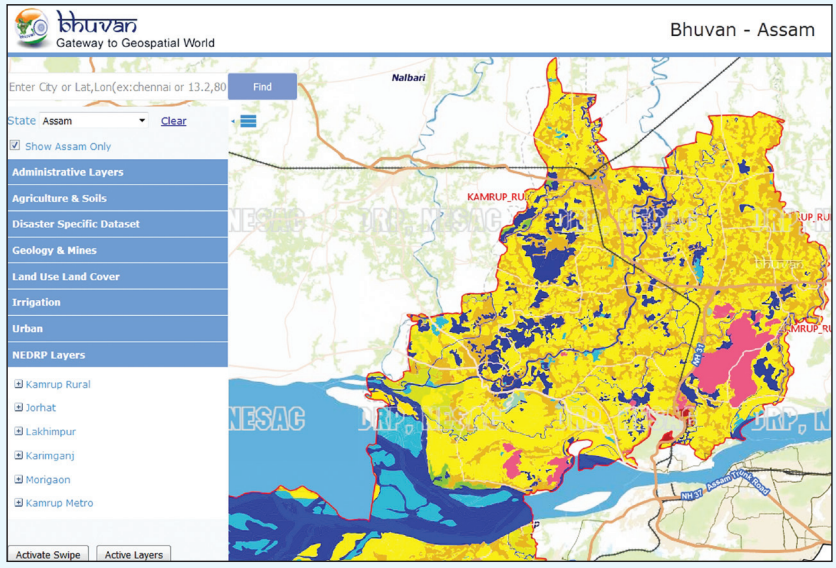


Figure 7.2. NEDRP data service for Land Use of Kamrup Rural district, Assam

7.2 Space-Based Information KISOK (SBIK)

SBIK has been conceptualized to strengthen the planning and monitoring mechanisms of the projects funded by the Ministry of DoNER & other Central Government funded projects in NER. It is one of the most important programmes sponsored by the Ministry of DoNER and executed in collaboration with SRSACs of NE region. SBIK of each State aims to provide State specific geospatial inputs in the form of Decision Support System (DSS), developed using open source GIS packages & standards. Each of the SBIK State portals populated with about 35 geospatial layers and relevant

information on natural resources, infrastructure and disaster management support are deployed for effective planning and management activities. Recent version of each state SBIK portals contains geospatial information on land use/ land cover (LULC), wetlands, wastelands, forest working plan, degraded lands, roads, drainages, and settlements, soils, ground water prospect, wetlands, infrastructures, inputs for disaster management support, etc. along with state/ district wise statistics with graphics for effective use in planning and development process. These are derived using satellite images and inputs from ground samples for different periods and scales. SBIK is a stand alone interactive system with Kiosk features, that are installed on a touch screen based interface for ease of use. Currently, SBIK portal is installed and deployed in all offices of Chief Secretaries in NER. However, Sikkim is to be covered in the next phase (Figures 7.3 and 7.4).

Figure 7.3. Touch screen-based SBIK system

Figure 7.4. Geo-explorer of SBIK portal

SBIK is proving to be a good SDSS for state level planning and decision making process of NE region. A good number of Line Departments of respective state Governments of NE region have requested for similar systems for their planning process. Accordingly, SBIK has now been installed in 3 Line Departments in Arunachal Pradesh, 5 in Nagaland, 2 in Assam. There are many more requests for SBIK in other Line Departments that are being looked into for realisation.

7.3 Sericulture Information Linkages and Knowledge System (SILKS)

SILKS is an Unified Geo-spatial framework for hosting 108 district database containing more than 900 geo-spatial layers for decision making. Geospatial layers on potential sites for silkworm food plants (i.e. eri, muga, mulberry and tasar) forms the core of the information base for each of the 108 districts along with

Figure 7.5. Geo-portal for Sikkim South district

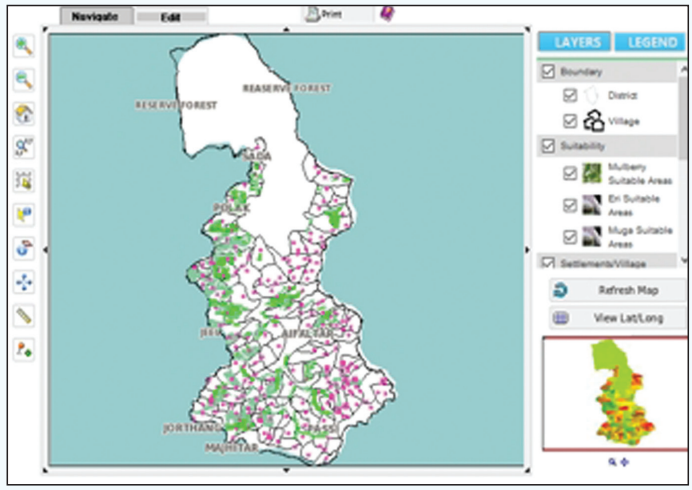


Figure 7.6. SILKS geo-explorer is displaying potential sites for silkworm food plants in the Sikkim South district of Sikkim

soil map, meteorological and other utility information. A set of parameters like temperature and humidity have been modelled into a multi-criteria based spatial analysis tool with the existing land use and soil parameters for the identification of potential sites for silkworms. In addition, each of the district data base is populated with 13 specific modules on sericulture planning, farmers advisory and other services, specific to the districts. Each of the districts also contains a web-GIS viewer having necessary GIS tools for navigation, analysis and extraction of required information.

SILKS is now operational on the URL http://silks.csb.gov.in, hosted from Central Silk Board (CSB), for the planning and advisory services of the farmers, sericulture extension workers, administrators and planners (Figures 7.5 and 7.6).

7.4 North East Forest Management Plan (NEFM)

All the spatial database related to forest resources of NER are integrated and organised into a unified forest database with a single window in a seamless manner for browsing, display, query and analysis for various forestry related planning activities (Figure 7.7). The North East Forest Management Plan (NEFM) contains 1:10K forest density map along with 1:50K forest type map for the selected forest areas of Arunachal Pradesh, Assam, Meghalaya, Mizoram and Sikkim along with all necessary GIS-enabled tools and functions.

Figure 7.7. Forest density of Sikkim from NEFM Database

7.5 Flood Early Warning System (FLEWS)

An SDSS on FLEWS is developed and deployed at NESAC for effective information dissemination. The application tools are developed on open source geospatial platform and consists of required information for decision making. A number of flood early warnings has been generated under the FLEWS project of NESAC Revenue circle to be affected by floods against each of the early warnings is available on geo-explorer along with the locations of villages and AWSs data for online analysis (Figure 7.8). The portal also gives the location of flood affected villages in a geo-explorer along with Revenue circle boundary, existing infrastructure details (i.e. road and train networks etc.), drainages and rivers etc. The geospatial engine also provides an archive of historical flood events that has occurred throughout the operational time period.

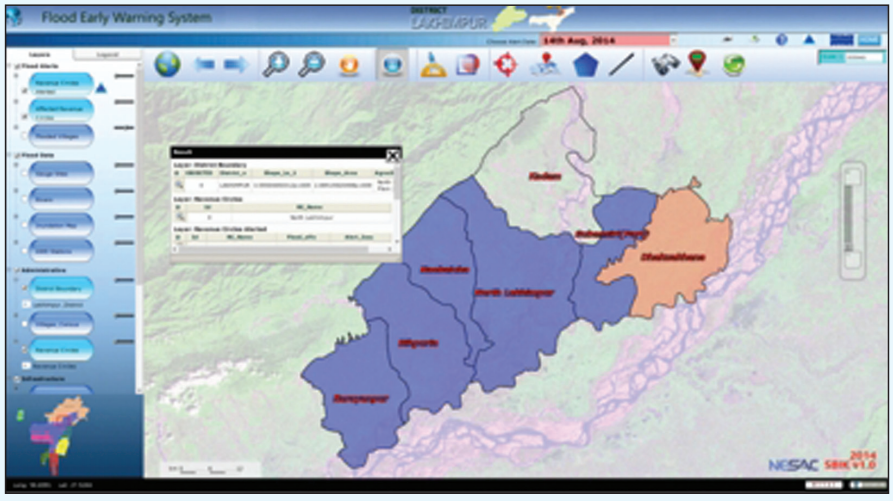


Figure 7.8. Flood alerts at Revenue Circle Level as displayed in FLEWS geo-portal

7.6 Japanese Encephalitis Early Warning System (JEWS)

Japanese encephalitis (JE) is one of the dreaded vector (mosquito) borne viral diseases prevalent in India and is a major public health problem in the state of Assam. It has a complex epidemiology. The JE virus basically resides in some animals and birds (natural cycle or zoonotic cycle). Infection in human beings is occasionally caused as a result of spillover of the virus from the zoonotic cycle.

NESAC has developed an information system (Figure 7.9) where all the necessary information on the JE for three JE endemic districts of Assam have been incorporated. Geospatial map viewer and decision system provides (i) Forecast of JE onset, (ii) Forecast of JE intensity and (iii) JE prone villages (Figure 7.10). The JEWS software has been installed in the districts of Tinsukia, Sivsagar and Dibrugarh as part of Integrated Disease surveillance programme (IDSP) under Indian Council for Medical Research (ICMR). The details of this project is explained in chapter 8.1.3.

Figure 7.9. Home page of JEWS

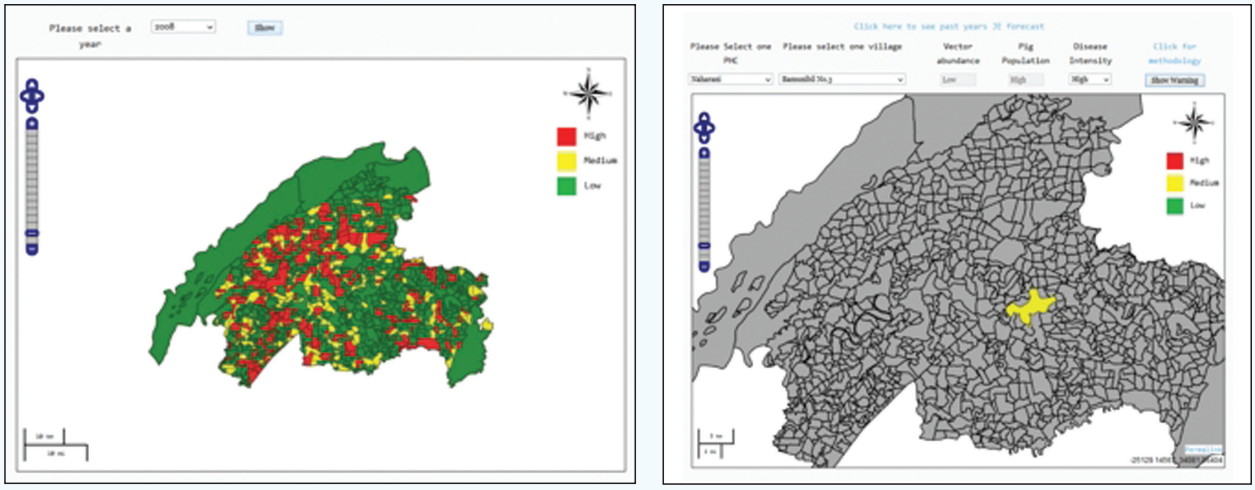


Figure 7.10. JE Forecast / JE Prone Villages

7.7 Spatial Data Infrastructure (SDI)

A 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 cataloging, searching and retrieving capabilities. The three main objectives of SDI are (i) an updated catalogue on all geospatial products (i.e. raster and vector data) as a single unified repository at NESAC; (ii) to enable dissemination of geospatial database as per requirement and (iii) to act as a centralized repository of relevant disasters specific geospatial layers for DRR support programme of NESAC. NESAC SDI has been populated with various raster datasets, vector datasets and DEM pertaining to NE Region. NESAC SDI has been populated with about 3000 raster layers and 400 vector layers with a total volume of more than 4TB of data. These datasets are organised for use on a customized user-friendly webGIS platform for internal use by the scientists (Figure 7.11).

7.8 North East Database Management and Analysis (NEDMA)

North East Database Management and Analysis (NEDMA) is realized with a set of decision support tools as a part of enterprise GIS solution. Various web based SDSSs have been deployed to enable multi-criteria modeling for site suitability, change and trend analysis based on historical events, vulnerability alerts for forest fire etc. On an experimental basis, Geo-processing tools are deployed for online GIS analysis through Web interface (Figure 7.12) for

identification of suitable sites for horticulture, suitable locations of check dam etc. have also been developed using online multi-criteria spatial modelling tools.

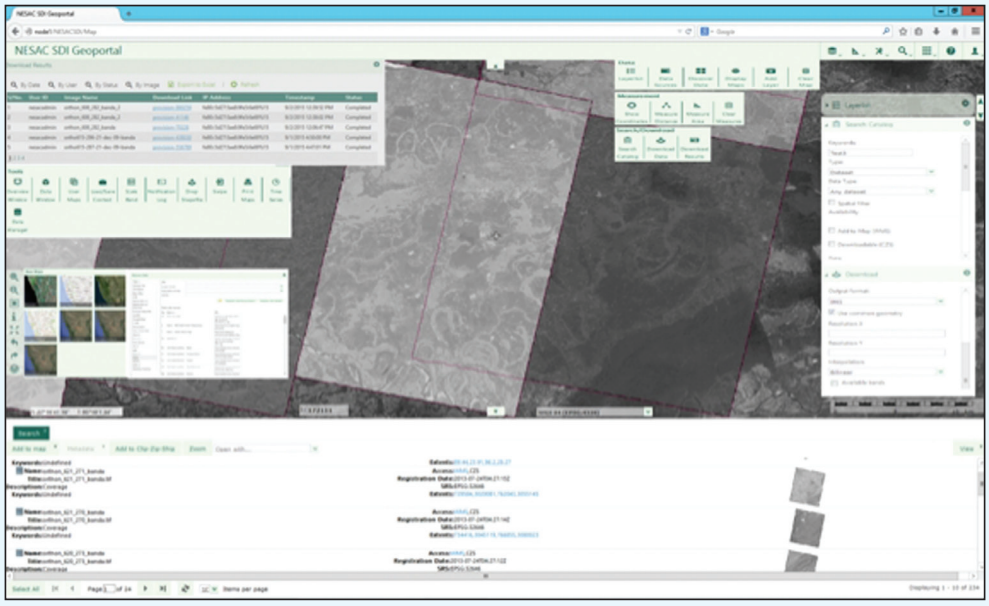


Figure 7.11. Different functionalities of the tools for viewing, querying, managing and downloading the data from SDI

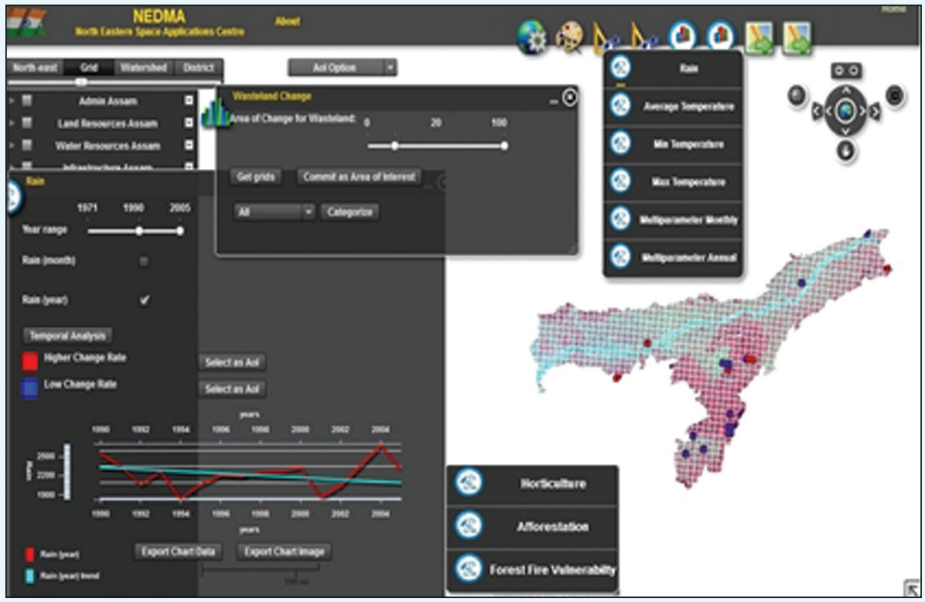


Figure 7.12. Geo-processing of forest fire vulnerability analysis

8. DISASTER MANAGEMENT SUPPORT ACTIVITIES-NER-DRR

8.1. Operational activities

8.1.1. Flood Early Warning System (FLEWS)

The severity of flooding as a chronic problem is well known in the State of Assam. All the flood prone districts of Assam are shared by the two major river valleys of the Brahmaputra and Barak. Every year this chronic combined phenomenon of flood with river bank erosion creates enormous havoc and miseries for the people of Assam living in the otherwise very fertile flood plain areas of these two river valleys. Flood Early Warning System (FLEWS) is developed and deployed as per request from Assam State Disaster Management Athority (ASDMA), Govt. of Assam from the year 2012 with 14 flood prone districts of Assam. The strength of GIS with hydro-meteorological modelling along with synoptic space based weather monitoring was used for achieving better forecasts. With gradual increase in performance and subsequent requests from Govt. of Assam, 15 flood prone districts were brought under FLEWS in the year 2013 and now all 25 numbers of flood prone districts have been brought under its ambit during the flood season of 2014.

In totality, 107 flood alerts were issued during 2014. Out of this, flood inundation and flood like situation were reported in 89 occasions. Details on the performance of the FLEWS for 2013 and 2014 are given in Figure 8.1.

Monitoring the weather condition for Assam involves many important weather parameters that are gathered for neighbouring states like Meghalaya, Arunachal Pradesh, etc. These in turn are geospatially related with the concerned river catchments for providing alerts from time to time, particularly the heavy rainfall warnings, etc. The FLEWS

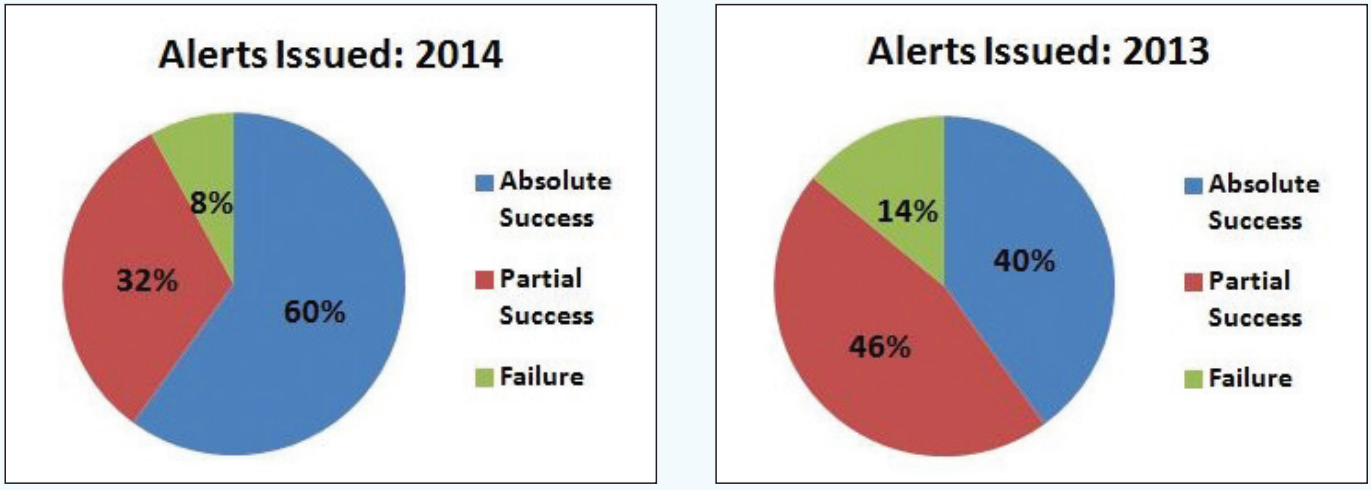


Figure 8.1. FLEWS Success score during 2013 and 2014

program is further extended from 2015 to 2017 based on specific request by the ASDMA. Further improvement in the hydrological model, updated LULC layer, soil data, improvised routing parameters and use of soil moisture conditions are incorporated into the current model. The effort now has resulted in 39 HEC-HMS models set-up for operational use of FLEWS during 2015. In addition, improvement is also done with regard to increasing the spatial resoluton of WRF model forecast to 9 km (Figure 8.2).

8.1.2. Forest Fire Monitoring and value addition

Forest fire is a seasonal phenomenon that occurs during February to May every year in NER. Near real time forest fire alert helps to take necessary measures by the concerned forest departments to minimize socio-economic and ecological damage. In our effort, value added fire alerts are being provided twice daily during fire season along with each fire locations containing information on topographic factors, meteorological parameters, proximity to roads, built-ups, water-bodies and the type of land use/ land cover. Daily wind speed, wind direction and dew point temperature data is downloaded from IMD-AWS (Indian Meteorological Department-Automatic Weather Station) and MOSDAC

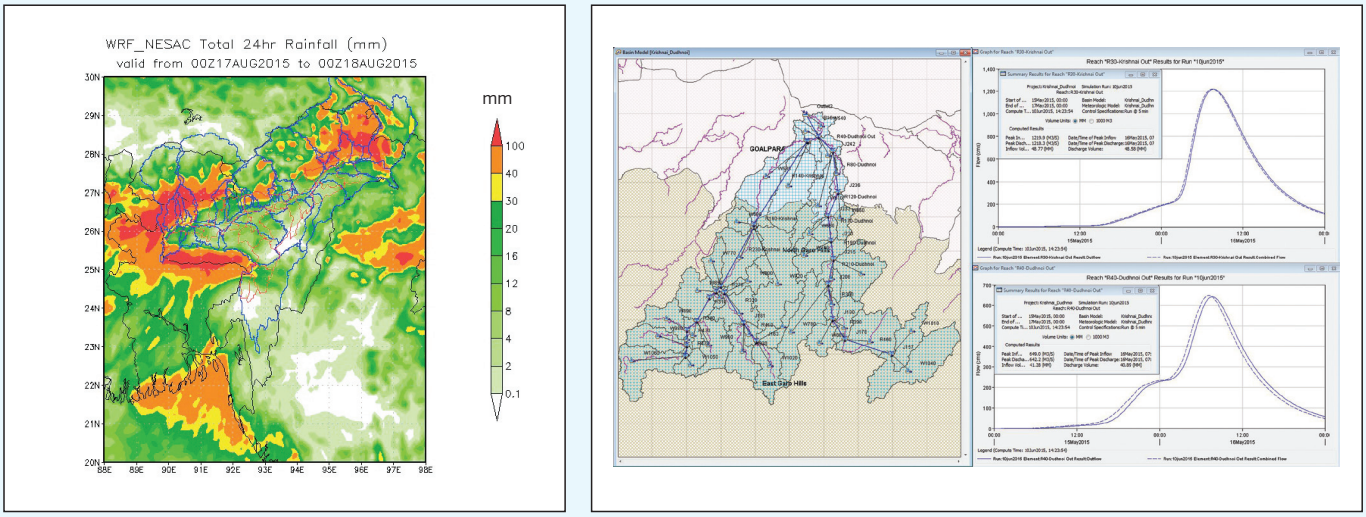


Figure 8.2. The rainfall and discharge prediction Success score during 2013 and 2014

website of ISRO. During 2015, a total of 9892 fire incidents were reported, as compared to 10,084 incidents in the previous year. The state of Mizoram had received maximum number of fire incidents both during 2014 and 2015.

Forest fire hazard zone map of NER (Figure 8.3) was prepared for all NE states. A total of 8 variables are used in the model to generate the fire hazard map viz., forest type, fire hot spot (FH), forest cover/ density, slope, aspect, elevation, distance to built-up/settlements and distance to roads. All parameters are weighted in a scale of 1–5 and the risk levels are qualitatively rated into five classes: very low, low, moderate, high and very high. The fire location hotspot map has been derived using geospatial technological tools. Overall, relative importance of weights was derived by using Analytical Hierarchical Process (AHP).

A comprehensive toolbox has been developed on geospatial platform to facilitate and automate the whole processing chain of generating fire alerts from receiving the fire location and generation of maps within 3 km buffer of fire location. Overall turn-around time for processing helps to generate individual point-wise detailed report within 2 hours after collecting the fire location data from NRSC Bhuvan website. MODIS burnt area product was used for burnt area estimation. Figure 8.4 shows burnt area in Meghalaya during 2015.

In 2015, a total of 248 forest fire hazard alerts were sent to respective Forest Departments of 7 NE states. Fire hazard alerts, in map and table format, are also uploaded in the public domain (www.nesac.gov.in/nerdrr).

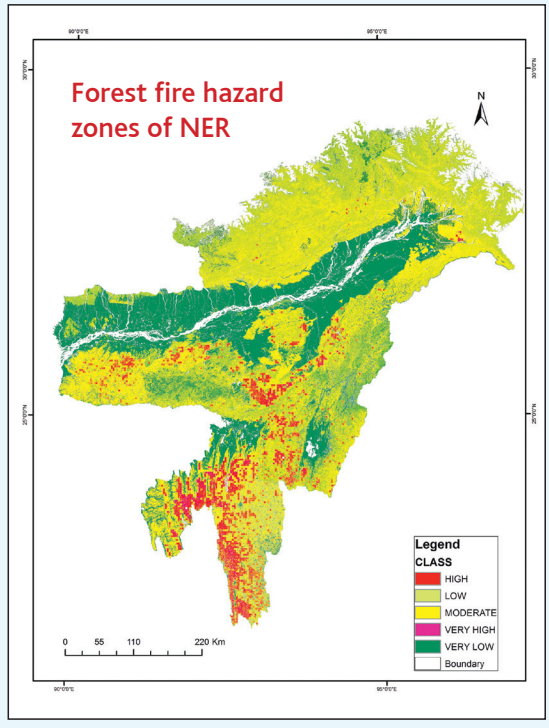


Figure 8.3. Forest fire hazard zones of NER

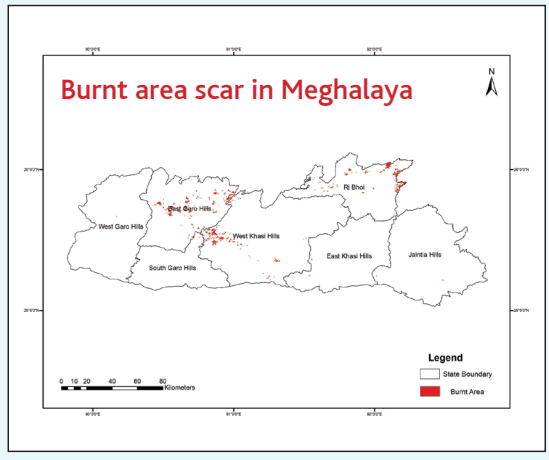


Figure 8.4. Burnt area scar in Meghalaya

8.1.3. Japanese Encephalitis Early Warning System (JEWS)

Decision support system for Early Warning of Japanese encephalitis (JE) in Assam has been developed jointly with Regional Medical Research Centre, NE region (RMRC, NER) Dibrugarh. This was officially released and handed over to State Health Department of Assam during a workshop organized on 11th August, 2014 at NEDFI Convention Centre, Guwahati, Assam (Figure 8.5).

Figure 8.5. Handing over of DSS to State Health Deptt.

The DSS helps in forecasting three aspects of the disease viz., Disease onset, disease intensity and disease prone areas. Forecasting of onset of JE in a particular year is based on the statistical models, considering weather parameters as the independent variable which has bearing on deviation in terms of number of days from the normal. Four seasons of disease occurrence have been identified, based on historical data viz. Very Early (in or before May), Early (June), Normal (July) and Late (in or after August), which have been quantified with categorical variables for forecast of the disease onset.

Forecasting of JE disease intensity is based on analysis of long term trend of disease incidence along with seasonal adjustment of disease occurrence. Forecasting of spatial distribution of disease occurrence is based on three factors viz., mosquito vector abundance (measured in terms of species diversity and man hour density), pig population and the historical disease intensity at village level. Categorization of villages is done into different levels of JE risk viz. high, medium and low JE risk villages, based on the above analysis.

8.2. R&D activities

8.2.1. Landslide inventory in NER

Landslides as well as slope failure and subsidence are also major damaging natural hazards in mountainous terrain of NER causing loss of lives, properties, and blocking transportation links. A comprehensive and systematic landslide inventory data depicting the dynamic behaviour of landslides is a prerequisite for any landslide related study. Further, multi temporal landslide inventory demonstrates the triggering factors and multiple events over a period. In preparatory phase under NER-DRR (North Eastern Regional Node for Disaster Risk Reduction) programme, temporal landslide inventory mapping is initiated using Cartosat-1 data at 1:10,000 scale. Other temporal data, LISS III & LISS IV MX, Landsat 7 MX are also used in the process. Topographic maps are referred while interpreting older landslides, specially triggered by major earthquake events, in the region. Further, published and archived documents are integrated with the database while interpreting temporal images (Figure 8.6). The database once finalised after field verification can be used as base information for developmental planning and risk reduction.

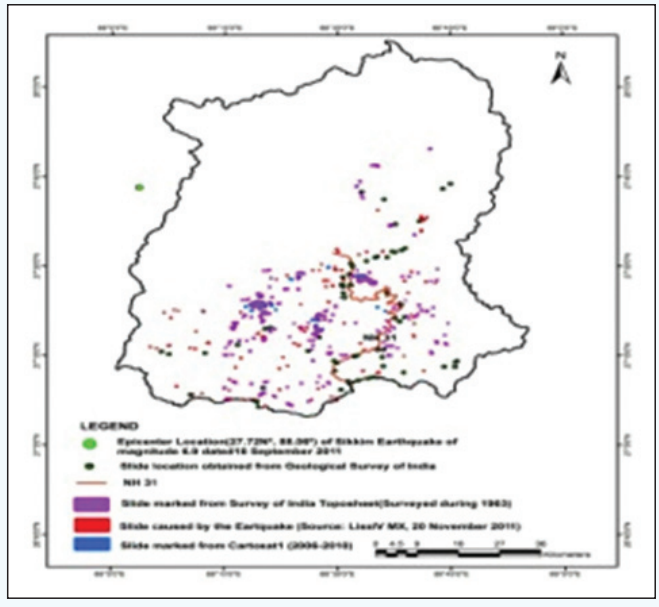


Figure 8.6. Landslide Inventory of Sikkim state as integrated from various sources

8.2.2. Two-dimensional hydraulic simulation model for flood plain inundation flow

Identification of area likely to be inundated by an upcoming flood is an important Decision Support System (DSS) tool in any flood forecasting system. The present Flood Early Warning System (FLEWS) under NER-DRR is giving probable area of inundation in district and revenue circle level. Presently efforts are on to improve this DSS tool up-to village level.

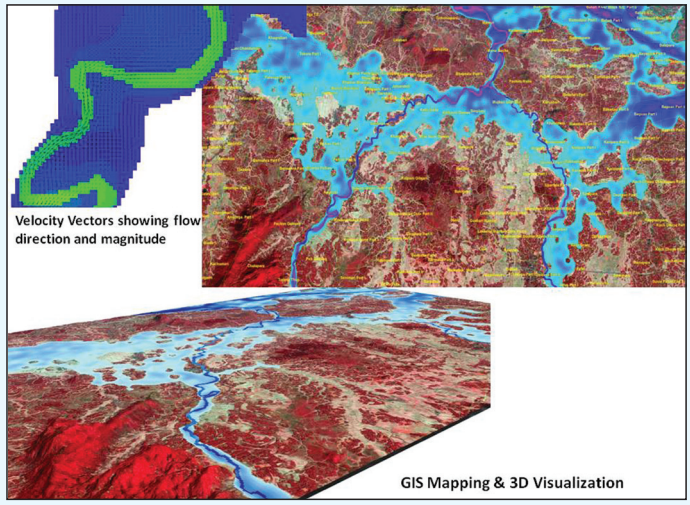
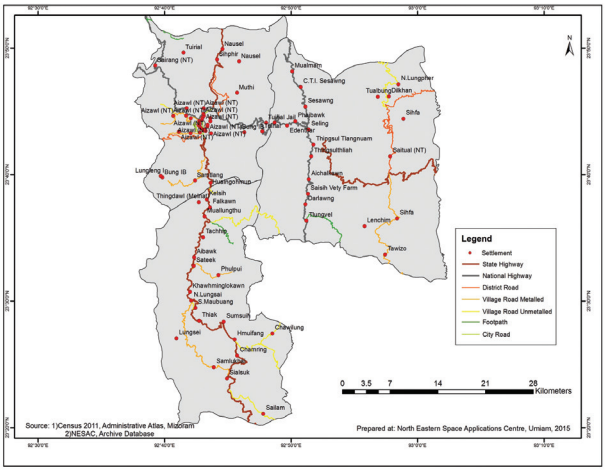


Figure 8.7. Flood plain inundation simulation

In order to achieve the above objective, presently two dimensional hydraulic simulations (Figure 8.7) are done with moderately accurate (for flat alluvial terrain of Brahmaputra valley) digital elevation models of SRTM, ASTER, CARTODEM, etc. on experimental basis. Such simulations has been carried out in the flood plains of Krishnai-Dudhnoi river system in Goalpara district of lower Assam. This particular simulation was run using flood model and in a robust mode for flood inundation studies using MIKE modelling tools. The bathymetry was prepared using SRTM of 30m resolution. Significant filtration (low pass filter) was done in the bathymetry to reduce the noise in raw data. The river cross-section was also extracted for the model. The upstream boundary used in the model was discharge hydrograph from HEC-HMS model (with input from WRF rainfall prediction model) and a constant water level was used as the downstream boundary condition. The model was run in a dry bathymetry state and the river cells were blocked to prevent double calculations of the equations in the main channel grids.

8.2.3. Baseline Disaster Database for NER

Building of comprehensive geo-spatial database for the region and developing actionable products for DRR activities are the important goals of NER-DRR. Towards this, geospatial layers, viz., road network, settlement layer (village locations, boundary and settlement area) etc. are being integrated with census data. Baseline data of Rural Blocks of Aibawk, Thingsulthliah and Tlangnuam in Mizoram is shown in Figure 8.8.



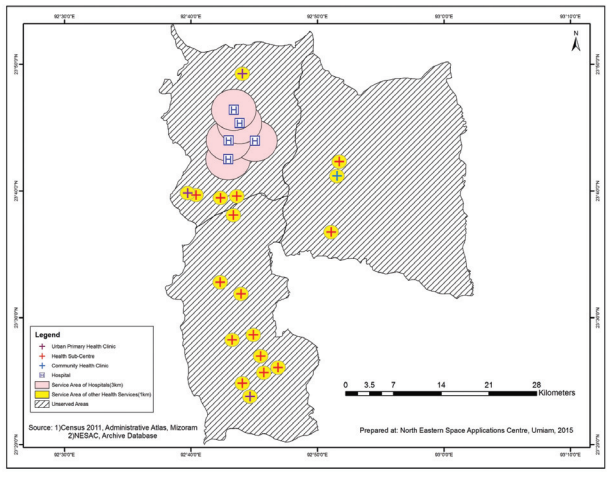


Figure 8.8. Transportation networks & villages of Aibawk, Thingsulthliah and Tlangnuam in Mizoram respectively

8.3. ICT and DSS under NER-DRR

Existing activities of NER-DRR has been initiated with 10 high-end workstations connected to the NESAC centralized computing facility. In addition, NESAC SDI along with GIS and image processing software have been accessible through

LAN for preparation of geospatial layers relevant for DRR activities. In addition, NESAC SDI along with GIS and image processing software have been accessible through LAN for preparation of geospatial layers relevant for DRR activities. Also, the HPC and other high performance computing facility procured under different projects have been utilized for NER-DRR activities.

Since NER-DRR is a critical operational facility pertaining to disaster management with multiple stakeholders, it is imperative that the computer architecture is designed with high availability and redundancy features, preferably with no single point failure. NER-DRR aims at maintaining a central repository of voluminous data sets for NER, whose availability is critical. Hence the computer architecture must provide robust data protection features. Considering the existing data sizes and the expected additional requirements due to inclusion of high resolution data sets from multiple sources, NESAC has recently initiated the procurement of 8 servers along with an initial data storage size of 20TB (usable) capacity for smoothly carrying out all envisaged NER-DRR operations. Since many of the hosted data sets in NER-DRR are sensitive in nature and come from various nodal agencies, security is of paramount importance and should be taken care of in the architecture. Two WAN links are considered essential to ensure redundancy/ reliability. The DMS VPN connectivity represents one of the WAN links via VSAT. NESAC has an existing 100Mbps broadband Internet connectivity from BSNL through leased line as part of NKN. The NER-DRR system architecture is shown in Figure 8.9.

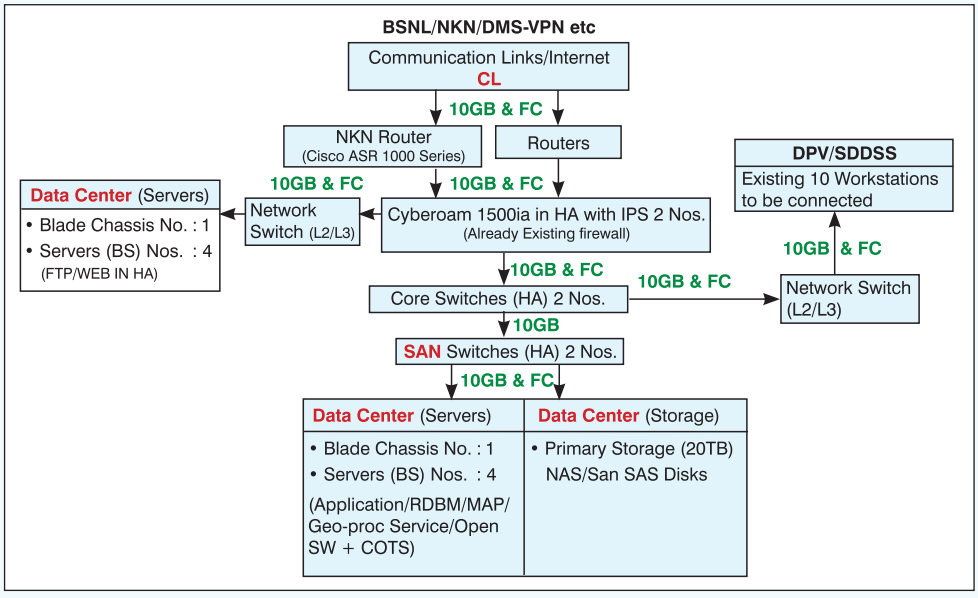


Figure 8.9. Overall NER-DRR system architecture

8.4. Satellite communication services under NER-DRR

NER-DRR is equipped with a VPN node utilizing 3.8m VSAT system as part of ISRO DMS VPN network. Video conferencing and data transfer activities can be done with all nodes under the network. These activities are carried out on regular basis with the nodes in the capital of NE States and central locations. NDEM portal also can be accessed and necessary data can be downloaded as per requirements from the portal. A transportable VSAT system is also available for providing communication support at the actual site during any disaster. INSAT Type D terminal for audio calling using satellite for emergency communication is also available at NER-DRR (Figure 8.10).

NESAC has also developed a mobile application for dissemination of data (position, photo, video, text) from disaster site (Figure 8.11). The SMS based alert system under FLEWS project is being continued using this application.

Figure 8.10. Disaster related communications infrastructure of NER-DRR

Field Data Transmission using Mobile Technology (FIDATRA)

Salient Feature

- Apps developed in Android platform
- Any phone with Android O/S, GPS and Camera can be used
- Communication through GPRS
- Following data may be send
  - Positional data (Lat, Long and Alt.)
  - Photo
  - Video
  - Text
- Graphical representation of data using map/table in the server end
- Also can be used for sending ground truth data from field for any project

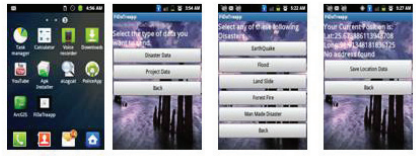


Figure 8.11. Mobile app developed at NER-DRR

9. SATELLITE COMMUNICATIONS

The centre has implemented SATCOM oriented societal applications programs likeTele-education, Telemedicine, and Communication support in Disaster Management etc. in the North Eastern Region. NESAC has also set up satellite communication facilities like Satcom studio for content generation, Spacenet system for intercommunication among ISRO/DOS Centres, transportable WLL-VSAT system, satellite phones (INSAT MSS Type-D terminals) and various equipment under Ka-band propagation experiment & IRNSS project.

9.1 Tele-education project in North Eastern States

During 2014-15, NESAC has accomplished following activities in this regards:

- Comprehensive annual maintenance of existing networks (HUB & SITs) in NE states
- Technical Support & Training for existing network through dedicated manpower in each State
- Establishing 'Technical Support and Training Centre' at NESAC
- Support facility for HUB operation at all sites
- Revival of faulty node through necessary spares and corrective measures
- Re-commissioned Mizoram HUB. Migration of SITs -accomplished. Rectification of faulty SITs - in process
- Web based monitoring of the utilization of the networks
- Conducted content generation training at NESAC for NE states through DECU support

Figure 9.1. Content generation training

Beside these, NESAC is providing full technical support for the utilization of the network including visit to various sites, trouble shootings, training, awareness program, content generation etc.

9.2 Telemedicine Program in NER

NESAC is working towards revival of the nodes. Renewal of deployment of technicians has been done in the working telemedicine centres in NER under ISRO-NEC programme. NESAC also participated and contributed in the meeting of Joint Working Group (JWG) for discussion on "Formulation of North-East Telemedicine Grid'' at NEIGRIHMS, Shillong.

9.3 Village Resource Centre (VRC) Network in NER

Program Office of VRC from ISRO HQ has taken up the task of reviewing/revival of VRC network on national level. Towards that a national level rapid sample survey was conducted to understand impact of VRC applications in various fields. NESAC has conducted the survey for NER States. As part of the survey, data has been collected from the state of Assam, Sikkim and Nagaland in proper formats and submitted to ISRO for the needful.

9.4 Communication Support in Disaster Management

DMS-Virtual Private Network (DMS-VPN) is operational at NESAC including access to National Database for Emergency Management (NDEM) data. Video Conference and data transfer activities continues with all node under DMS-VPN network. Transportable VSAT system is re-configured under DMS-VPN network and is always

kept ready for disaster services. The SMS based alert system under FLEWS project provides necessary alert information as described in section 8.4. INSAT Type D terminal for audio-calls for emergency communication is maintained and ready for use. Mobile Apps are developed for providing important information (position, photo, video, text) from disaster hot spot at the time of disaster, on experimental basis.

Figure 9.2. ISRONET System of NESAC

9.5 Indian Regional Navigation Satellite System (IRNSS) project at NESAC

The various stations commissioned under ISRO's IRNSS project at NESAC are maintained and kept in good working condition (Figure 9.3).

The Centre has also taken part in the field trial experiment of IRNSS SPS-GPS receiver (Figure 9.4).

Figure 9.3. IRNSS Antenna

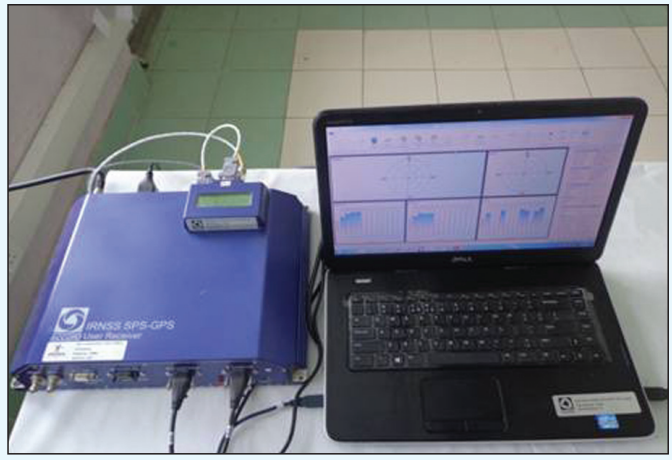


Figure 9.4. IRNSS SPS-GPS Receivers

10. ATMOSPHERIC SCIENCE RESEARCH

10.1. Network of Boundary Layer Experiments (NOBLE)

The activities under the NOBLE project, being coordinated by Space Physics Laboratory, Trivandrum, are continued at NESAC since 2014. A 32 m micro-meteorological tower has been installed at NESAC with fast response sonic anemometer and slow response meteorological sensors installed at four levels (8m, 10.5m, 18m, and 31m). The Campbell scientific make CSAT3 fast response sonic anemometer is an ultrasonic anemometer for measuring wind speed in three dimensions (east-west, north-south, and vertical) through programmable flip-flop at a rate of 1 to 60 Hz (as per requirement). It uses three pairs of non-orthogonally oriented transducers to sense the horizontal wind. Each pair of transducers transmits and receives the ultrasonic signal. The time of flight is directly related to the wind speed along the sonic transducer axis. The data from a Doppler SODAR and Dr. Pisharoty Sonde are also used together to study the diurnal, seasonal, and annual variation of atmospheric boundary layer (ABL) over Umiam. Land based campaigns are also planned to study the regional ABL characteristics and its impact on local and regional weather and climate.

The speed of sound is directly related to the air density, e.g. temperature and humidity. The CSAT3 can be used to measure average horizontal wind speed and direction or turbulent fluctuations of horizontal and vertical wind. From the turbulent wind fluctuations, momentum flux is calculated (Figure 10.1). From the fast response sonic anemometer data, diurnal variations of monthly mean of Momentum Flux (MF), Sensible Heat Flux (SHF) (Figure 10.2), Turbulent Kinetic Energy (TKE), Stability parameter (z/L), Temperature and wind speed at 4 levels over NESAC, Umiam has been derived.

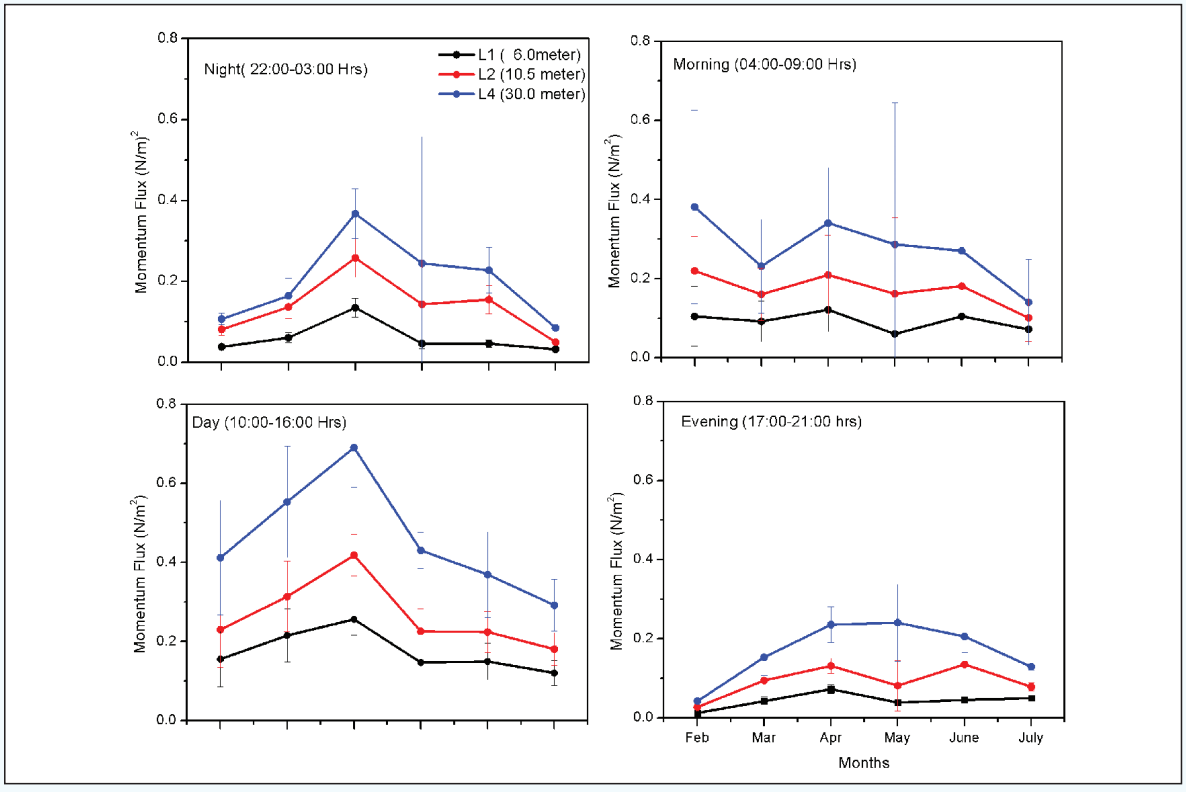


Figure 10.1. Momentum flux for different time periods during Feb-July

Semi-annual variation of diurnal MF, SHF and TKE at 3 levels over NESAC, Umiam has also been derived for Feb-July periods. Preliminary results show strong and in-phase diurnal variations of SHF, MF and TKE as shown in

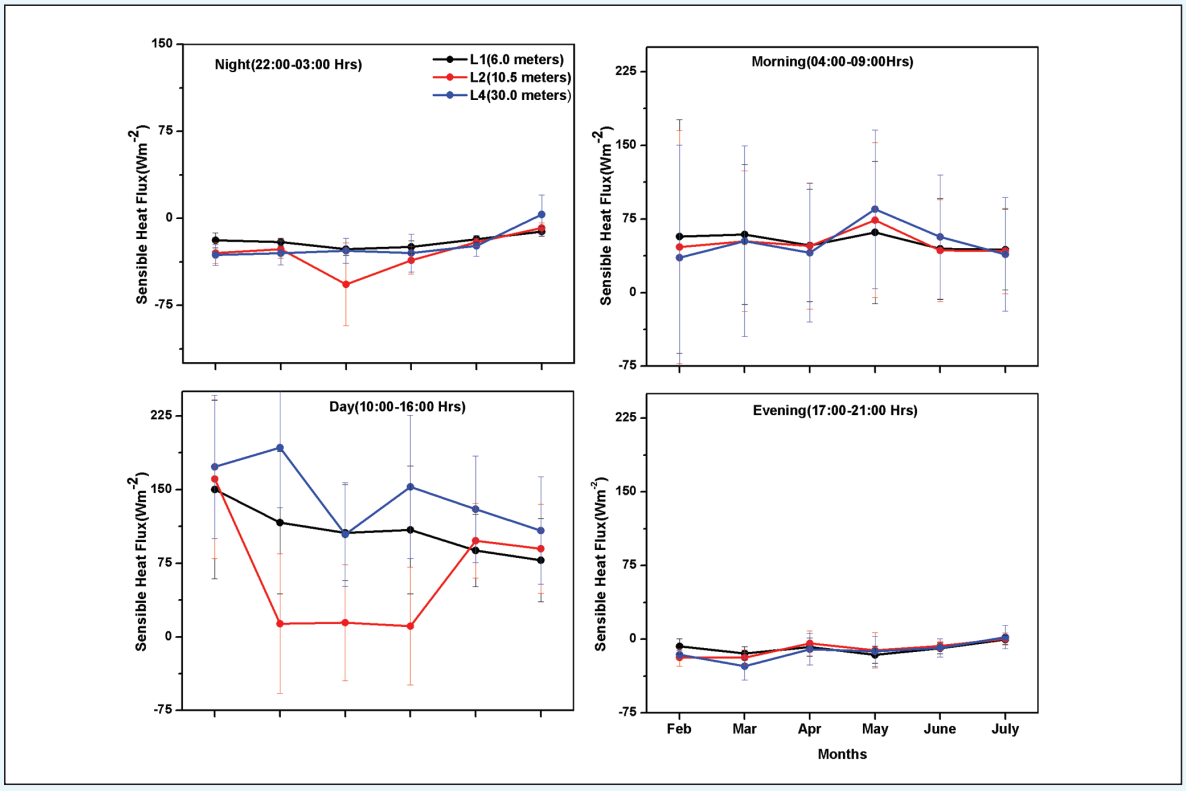


Figure 10.2. Sensible heat flux for different time periods during Feb-July month

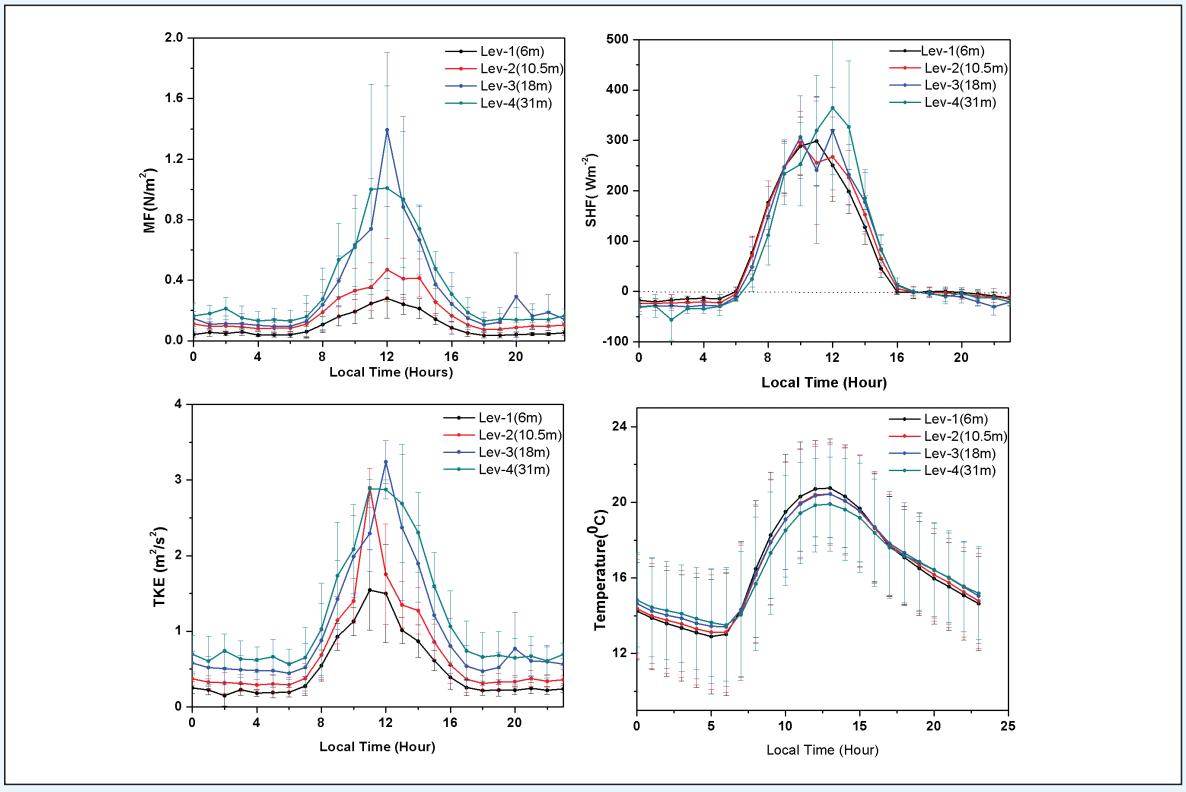


Figure 10.3. Diurnal variation of MF (top left), SHF (top right), TKE (bottom left), and Temperature over Umiam

Figure 10.3. MF, which is referred as the rate of change of horizontal momentum which is moving across a unit area that acts in a direction perpendicular to the direction of air flow, shows maximum during pre-monsoon season (April and May as shown is Figure 10.1) and reaches up to 0.7 N/m^2 during day hours (10:00-16:00Hrs). MF is minimum

during July month due to precipitation over the region. On the other hand, SHF is minimum during April month and higher during February and July months. SHF is highly stable and has downward flux during NABL (Nocturnal ABL), while the same is upward and turbulent during CABL (convective ABL). Seasonal mean SHF is about 59 to 65 Wm^{-2} upward, quantifying the role of SHF in surface energy budget over this region. Semi-annual mean diurnal variation of TKE (Figure 10.2) shows strong in-phase variation, except for level 4 during noon time. TKE is positive and has a diurnal variation which is in synchronization with the evolution of local ABL. As sun rises TKE increases up to 3.24 ± 0.38 m^2/s^2 by noon time and then gradually fall to a nocturnal mean state of approx. below 1 m^2/s^2. Stability parameter shows a reversal after the sunrise to attain peak instability around noon and reverses to stable condition after sunset.

10.2. Numerical weather prediction using WRF model

Numerical Weather Prediction models are widely used all over the globe to predict weather. The capability of numerical forecasting model to produce useful forecast depends not only on the resolution of the model and the accuracy with which dynamical and physical processes are represented, but also critically dependent on the initial conditions employed for integrating the model. Traditionally, data assimilation was typically divided into two processes: objective analysis of the observations and data initialization. More recently both the processes have been combined in an approach called four dimensional data assimilation (4DVAR) which makes optimal use of all available observational and forecast information.

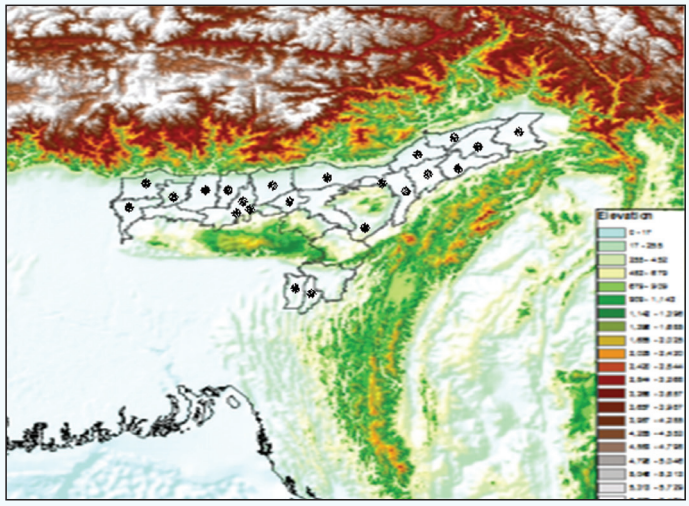


Figure 10.4. Spatial distribution of AWS locations used for forecast validation

The WRF (weather research and forecasting) model is being run at NESAC with three dimensional data assimilation (3DVAR) technique at 9km spatial resolution for north eastern region of India. Data from varied sources like GFS Prepbufr surface and upper air observations, Radiances from AMSU-A, MHS, HIRES, AWS data and INSAT 3D wind vector are being assimilated. The model forecasts are compared with AWS observed rainfall (Figure 10.4 and 10.5).

It is well observed that WRF can simulate the rainfall events to a large extent for most of the stations. However predictions for some of the stations such as Dibrugarh, Lakhimpur that are from the eastern side of the study area are not as accurate as western stations such as Gossaigaon, Dhubri etc. These missed rainfall events mostly came in the early hour of the day. A scatter plot is shown in Figure 10.6 to compare the WRF forecasted

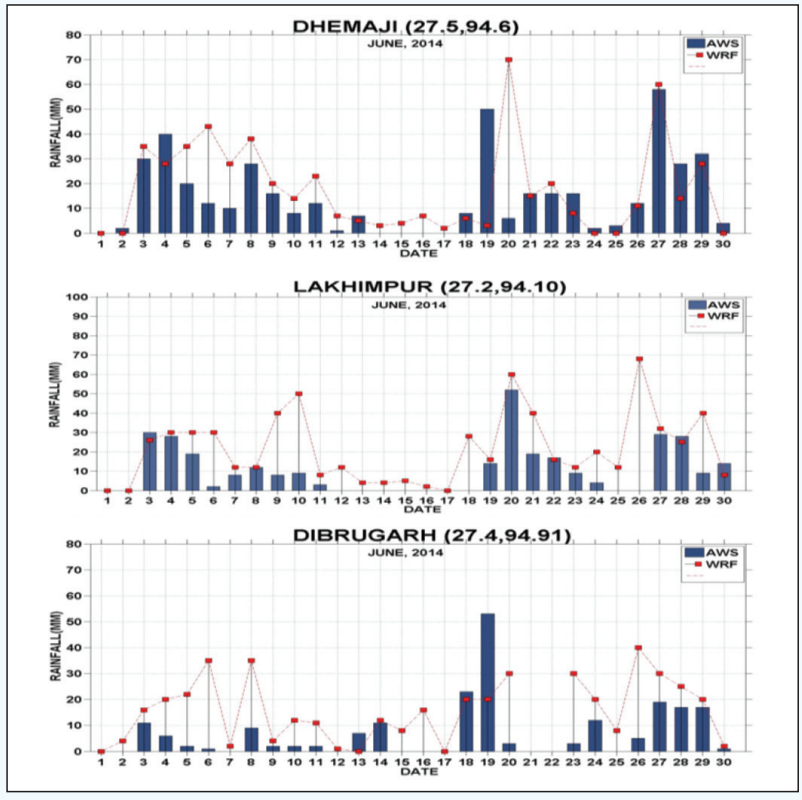


Figure 10.5. Histogram showing the comparison of WRF forecasted rainfall with AWS observed rain

rainfall with the observed rainfall for eastern, central, western, and southern Assam region during June 2014. The correlation for the eastern Assam region is poor as compared to the other regions. This may be due to the inability of the model to resolve the convective processes at this resolution or may be due to the initialization error.

A high performance computing (HPC) system has been commissioned at NESAC and WRF-ARW model has been installed and configured on this parallel computing system with all necessary libraries. The recently developed and much better data assimilation techniques, such as, 4DVAR and Hybrid ensemble techniques will also be implemented on HPC.

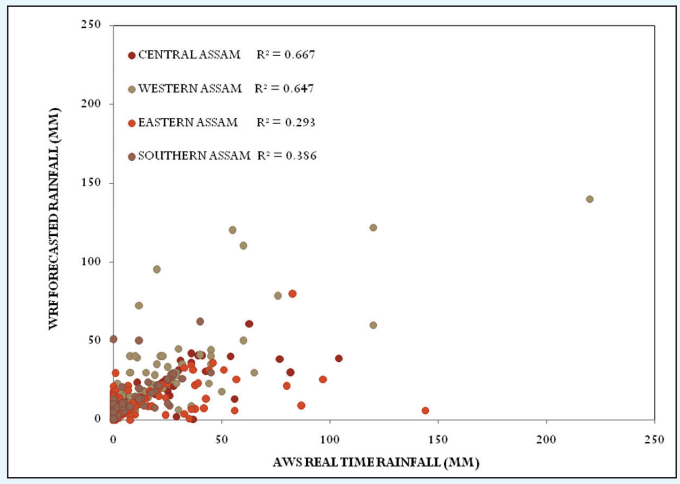


Figure 10.6. Scatter plot of rainfall for four different zones within Assam

10.3. Doppler Weather Radar (DWR) for nowcasting services

Indian Space Research Organisation has set up a Doppler Weather Radar (DWR) at Cherrapunjee, Meghalaya. The project is being executed by ISRO Telemetry, Tracking and Command Network (ISTRAC) in collaboration with NESAC. The DWR installed is a S-band RADAR, with a capacity to provide data within a circle of radius 300-500 km with the DWR at centre.

The system installation is completed and all the radar subsystems and integrated systems are tested. First weather data for single polarization was obtained in September 2014. The dual polarisation software developed for the system is in the final stage of testing at BEL, Bangalore. The DWR shall provide valuable data on spatial distribution of rainfall and wind over Meghalaya and western and southern Assam. This will help in improving flood early warning over the region and research towards thunderstorm nowcasting.

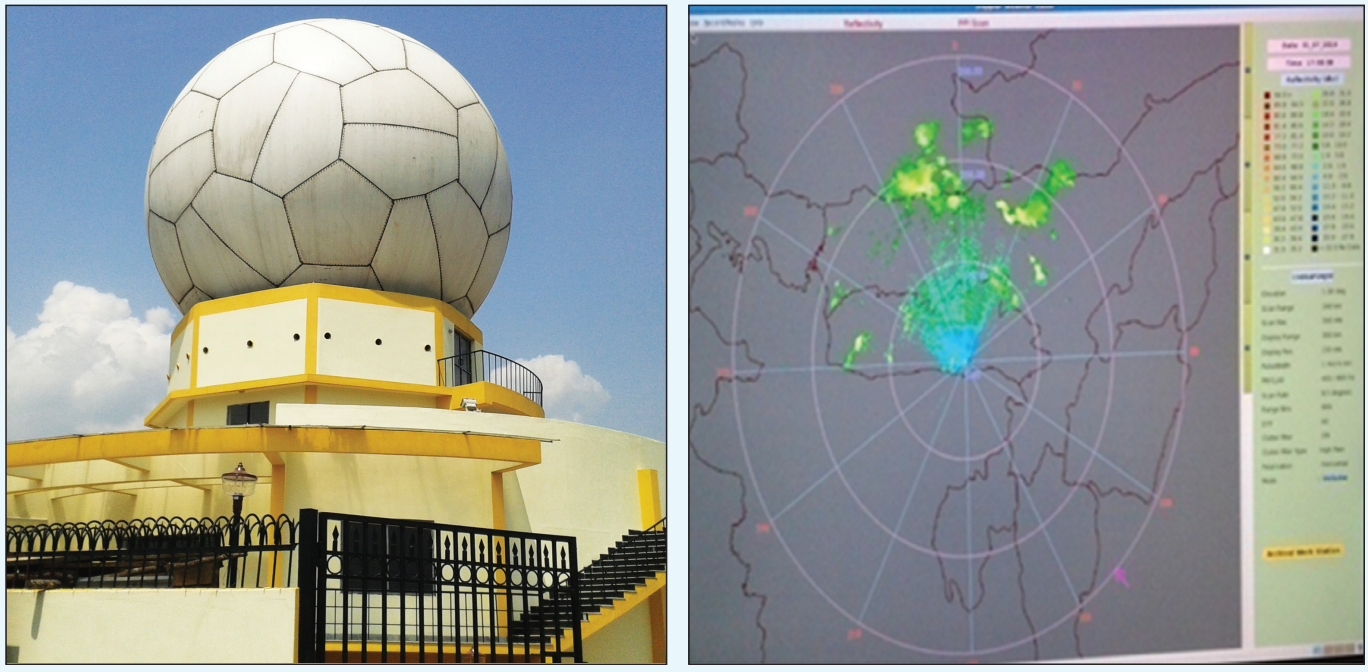


Figure 10.7. The DWR at Cherrapunjee (left) and Single polarization scan for PPI (plan position indicator) reflectivity obtained during test run

11. OTHER IMPORTANT ACTIVITIES

The 'Vigilance Awareness Week' has been celebrated in the Centre whereby a speech on the theme "Combating Corruption – Technology as an enabler" was delivered by Dr. A Sukumar, Principal, NERIE, Umiam, Meghalaya on 31.10.2014 which was followed by Quiz Competition. Observance of 'Sadbhavana Diwas' and 'Communal Harmony Fortnight' also have been celebrated in this Centre.

11.1. Important Visitors

25.11.2014	Shri Rajiv K Bhatia DG, Indian Council of World Affairs
01.12.2014	Shri S Srinivasan Member Finance, DOS
18.02.2015	Dr. Harsh Vardhan Hon'ble Union Minister of S & T & Earth Sciences

11.2. Workshop/Exhibition Activities of NESAC

NESAC has actively conducted as well as participated in the following workshops during the past one year period,

i) One day Training Programme for EDUSAT network coordinators of North Eastern States on 27.05.2014.

ii) Regional Conference on "Geoinformatics for Early Warning of Disasters with Special Emphasis on NE Region" in collaboration with Indian Society of Geomatics (ISG) and North Eastern Hill University (NEHU) held during 18th and 19th September, 2014.

iii) NESAC scientists have participated in ISPRS TC VIII International Symposium held at Hyderabad from 9th to 12th December 2014.

iv) Regional Workshops on Bhuvan – NUIS for formulation of Master Plan for NER States held on 02.02.2015 in Shillong, Meghalaya and on 24.02.2015 in Itanagar, Arunachal Pradesh.

v) NESAC scientists have participated in 3rd Assam Water Conference held during 6th -8th February, 2015 at Assam Water Research and Management Institute in Guwahati.

vi) Regional workshop on 'Space technology for forest management with special emphasis on forest working plan' was organised at NESAC on 27.02.2015.

11.3. Official Language Implementation

As part of Hindi Fortnight Celebration, Prof. D K Choubey, HOD, Hindi Department, NEHU had delivered a lecture in Hindi on the topic "Relevance of Hindi language in India" on 15.09.2014. Shri Badari Yadav, RO (Impl), Regional Impl. Office, Dept. of OL, Guwahati visited NESAC for Official Language Inspection and was also the observer of the proceeding of the NESAC Official Language Implementation Committee Meeting held on 16.09.2014.

Sufficient numbers of Hindi Books, Magazines and Newspapers have been made available at NESAC Library.

11.4. Welfare of SC & ST

i) The welfare of SC & ST is being taken care in this Centre. This Centre has been observing the guidelines for recruitment, promotion and welfare of Scheduled Caste and Scheduled Tribes. Table-11.1 indicates the status of representations of persons belonging to Scheduled Caste and Scheduled Tribe

Table-11.1

Sl. No	Centre/Unit	Total strength of employees 2014-2015	Strength of SC employees 2014-2015	Strength of ST employees 2014-2015
1	NESAC	32	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 organisation.

iii) 100% of Group B employees are from ST

iv) 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

11.5. Detail of internship/project trainees during 2014-15

Sl. No	Institute/University	Course	No of students
1	Indian Institute of Technology (IIT), Patna	B.Tech. (Electrical Engineering)	1
2	National Institute of Technology, Silchar	B.Tech. (Computer Sci. & Eng.)	4
3	National Institute of Technology (NIT), Nagaland	B.Tech. (Computer Sci. & Eng.)	1
		B.Tech. (Electronics & Telecommunications)	1
4	National Institute of Technology (NIT), Meghalaya	B.Tech. (Electronics & Telecommunications)	2
5	Royal School of Engineering & Technology, Guwahati	B.Tech. (Electronics & Telecommunications)	2
6	North Eastern Hill University (NEHU), Shillong	B.Tech. (Electronics & Telecommunications)	3
7	ICFAI University, Tripura	B.Tech. (Computer Sci. & Eng.)	5
8	Tezpur University, Tezpur	B.Tech. (Civil Engineering)	2
9	Karunya University, Coimbatore	B.Tech. (Computer Sci. & Eng.)	1

10	SRM University, Chennai	B.Tech. (Electronics &Engg.)	1
		M.Tech. (Civil Engineering)	1
11	Sikkim Manipal Institute of Technology, Gangtok	M.Tech. (I.T.)	2
12	Assam Engineering College (AEC), Guwahati	M.Tech. (Civil Engineering)	1
13	Madras University, Chennai	M.Sc. (Applied Geography)	6
14	Bhartiya Vidyapeeth, Pune	M.Sc. (Geoinformatics)	1
15	Symbiosis Institute of Geoinformatics, Pune	M.Sc. (Geoinformatics)	3
16	Amity University, Noida	M.Sc. (Geoinformatics)	2
17	St. Anthony's College, Shillong	MCA	2
18	Indian Institute of Technology (IIT), Guwahati	Ph.D. (Center for Energy, Dept. of Chemical Enegry)	1
19	Doon University, Dehradun	M.Sc. (Environmental Management)	1

11.6. Important Research Paper Published from NESAC during 2014-15

- Baidya, P., Chutia, D, Sudhakar, S., Goswami, C., Goswami, J., Saikhom, V., Singh, P.S., and Sarma, K. K., 2014, Effectiveness of Fuzzy Overlay Function for Multi-Criteria Spatial Modeling—A Case Study on Preparation of Land Resources Map for Mawsynram Block of East Khasi Hills District of Meghalaya, India, Journal of Geographic Information System, 6(6), 605-612.

- Binita, P., Arup, B., Pradip, K. B., Shyam, S. K., Sudhakar, S., Mukunda, M. G., and Toshihiko, T., 2014, Spatial heterogeneity in near surface aerosol characteristics across the Brahmaputra valley, Journal of Earth System Science, 123, No. 4, pp. 651–663

- Chakraborty, K., Mondal, P. P., Chabukdhara, M., and Sudhakar, S., 2014, Forest fire scenario and challenges of mitigation during fire season in North East India, The international archives of the photogrammetry, remote sensing and spatial information sciences, Vol XL-8.

- Chutia, D., Bhattacharyya, D. K., Sarma, K. K., Kalita, R., and Sudhakar, S., 2015, Hyperspectral Remote Sensing Classifications: a perspective survey. Transactions in GIS, DOI:10.1111/tgis.

- Kuntala, B., Kundu, S. S., Goswami, K., and Sudhakar, S., 2014, Susceptibility mapping and estimation of rainfall threshold using space based input for assessment of landslide hazard in Guwahati city in North East India. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XL-8.

- Singh, P. S., Lyngdoh, R., Chutia, D., Saikhom, V., Kashyap, Sudhakar S., 2015, Dynamic shortest route finder using pgRouting for emergency management., Applied Geomatics, Springers DOI 10.1007/s12518-015-0161-4.

- Kundu, S. S. and Minakshi, Devi, 2015, Role of Aerosol in Contrasting Change in Pre-Monsoon Rainfall Over Eastern And Western Region of Brahmaputra Valley in Assam, Indian Journal of Physics, 4, issue 4, 22-25, DOI : 10.15373/22501991.

- Sudhakar, S., Das, R. and Chutia, D., 2014, "Micro Level Planning- RS and GIS Approach" Indian cartographer Volume 33.

- Pakrashi, D. and Sarma, K. K., 2014, Impact of rainfall intensity on infestation level of tea mosquito bug in tea gardens of North East India – A preliminary study. Journal of Environment and Management. 1(1): 42-48.

- Sarma, K. K., Debasmita, P., and Sudhakar. S., 2014, Impact of land use and land cover on infestation level of Tea Mosquito Bug (Helopeltistheivora Waterhouse) in tea garden– A RS & GIS approach. International Journal of Advancement in Earth and Environmental Sciences. 2(2):1-11.

12. STATEMENT OF ACCOUNTS FOR THE FY 2014-15

D. Das & Associates
Chartered Accounts

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, 2015 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. Fixed Assets register remains to be updated at the year end.
2. Physical verification of Fixed Assets does not appear to have been carried out by the management during the year.
3. There has been undue delay in settlement of following advances given to:
   EOAM – Rs. 8,50,000.00
   FWP-AP – Rs. 3,85,000/-
   Advance Salary – Rs. 25,670.00
   Transfer Grant Advance – Rs. 2,24,083/-
4. No internal Audit has been undertaken during the year under audit.
5. 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, 2015 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 : 09.09.2015

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

BALANCE SHEET AS AT 31st MARCH 2015

(Amount - ₹)

CAPITAL FUND AND LIABILITIES	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Capital Fund	1	359657860.51	249522182.21
Current Liabilities & Provisions	2	156782792.00	162126048.00
Pension Fund as per contra*		5064880.00	4396334.00
TOTAL		**521505532.51**	**416044564.21**
ASSETS			
Fixed Assets	3	271331689.00	252537131.00
Current Assets, Loans, Advances etc	4	245108963.51	159111099.21
Pension Fund as per contra*		5064880.00	4396334.00
TOTAL		**521505532.51**	**416044564.21**
Significant Accounting Policies	**11**		
Contingent Liabilities & Notes on Accounts	**12**		

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/-
(DR. P.G. DIWAKAR)
Director

Date : 09.09.2015

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2015

(Amount - ₹)

INCOME	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
Grants	5	122000000.00	73300000.00
Interest Earned	6	0.00	854027.00
Other Incomes	7	601507.30	363526.00
Incomes from Services	8	44000.00	15695270.00
TOTAL		**122645507.30**	**90212823.00**
EXPENDITURE			
Establishment Expenses	9	62920774.00	59833299.00
Other Administrative Expenses etc.	10	19729928.00	23340622.50
Depreciation **(Net Total at the year-end-corresponding to schedule 3)** (Column 7)		16859127.00	17314933.59
TOTAL		**99509829.00**	**100488855.09**
BALANCE BEING SURPLUS (+) / DEFICIT (-) CARRIED TO CAPITAL FUND		**23135678.30**	**-10276032.09**
Significant Accounting Policies	**11**		
Contingent Liabilities & Notes on Accounts	**12**		

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/-
(DR. P.G. DIWAKAR)
Director

Date : 09.09.2015

RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31 ST MARCH 2015

(Amount - ₹)

	RECEIPTS	Current Year	Previous Year		PAYMENTS	Current Year	Previous Year
I.	**Opening Balances**			I.	**Expenses**		
	a) Cash in hand	32.00	0.00		a) Establishment Expenses	54766041.00	32925504.00
	b) Bank Balances:				b) Other Administrative Expenses	17776904.00	19588272.00
	i) In Current Accounts, SBI, Shillong	29553384.91	9860444.91	II	**Investments and Deposits**		
	ii) In Current Accounts, SBI, Umiam	82850805.30	23813140.30		Deposit for:		
	iii) In Current Accounts, Canara Bank	35775956.00	5321273.00		a) Deposit for Telephone	0.00	0.00
	iv) In Fixed Deposit Accounts	0.00	30582266.00	III	**Fixed Assets & Capital Work-in-Progress**		
II	**Grants Received**				Purchase of Fixed Assets	34173432.00	47872849.00
	From Government of India:			IV	**Other Payments**		
	a) Department of Space, Bangalore				a) ISRO Projects	12539018.00	13959128.00
	For Salaries	39000000.00	29100000.00		b) USER Projects	28447101.00	20399100.00
	For General	63000000.00	44200000.00		c) In house Projects	1771.00	98139.00
	For Creation of Capital Assets	87000000.00	79000000.00		d) Advances to Staff	2217097.00	2844586.00
	b) Department of DONER, NEC Shillong	20000000.00	0.00		e) Advance projects	1082835.00	1613946.00
III	**Interest Received**				f) Advance to others	0.00	70697.00
	On Fixed Deposits & other Interest	0.00	2127471.00		g) Payment of Recoveries	4713662.00	9737318.00
					h) Prior Period Expenses	99040.00	100581.00
IV	**Other Incomes**				i) Security Deposits	3997169.00	1461166.00
	a) Others	399442.30	273792.00		j) ISTRAC expenses	2598121.00	1138091.00
	b) ISTRAC	2886427.00	306107.00				
				V	**Closing Balances**		
V	**Other Receipts**				a) Cash in hand	0.00	32.00
	a) Recovery of Advances and Deposits from:				b) Bank Balances:		
	i) Staff (Cont., Imprest, TA/DA & LTC Advances)	469886.00	524608.00		i) In Current Accounts, SBI, Shillong	46013821.91	29553384.91
	ii) Others	1687177.00	240000.00		ii) In Current Accounts, SBI, Umiam	144958380.60	82850805.30
	b) Receipts on ISRO Projects	10346038.00	29853780.00		iii) In Current Accounts, Canara Bank, Shillong	44920011.00	35775956.00
	c) Receipts on USER Projects	20957760.00	43209671.00		iv) In Fixed Deposit Accounts:	0.00	0.00
	d) Security Deposit	4377496.00	1577002.00				
	TOTAL	**398304404.51**	**299989555.21**		**TOTAL**	**398304404.51**	**299989555.21**

This is the Receipts & Payments Account referred to in 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/-
(DR. P.G. DIWAKAR)
Director

Date : 09.09.2015

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2015

(Amount - ₹)

SCHEDULE 1 - CAPITAL FUND:	CURRENT YEAR		PREVIOUS YEAR	
Balance as at the beginning of the year	249522182.21		180798214.30	
Less: Balance of Deficit transferred from the **'Income & Expenditure A/C'**	23135678.30		10276032.09	
Add: Grand-In-Aid for Creation of Capital Assets	87000000.00	359657860.51	79000000.00	249522182.21
BALANCE AS AT THE YEAR END TOTAL		**359657860.51**		**249522182.21**

SCHEDULE 2-CURRENT LIABILITIES AND PROVISIONS	CURRENT YEAR		PREVIOUS YEAR	
CURRENT LIABILITIES:				
1 Other Current Liabilities				
a) Establishment Expenses	5895025.00		5028238.00	
b) Other Administrative Expenses	1387645.00		990922.00	
c) Others	1587294.00		477795.00	
d) Audit Fees	56508.00	8926472.00	33708.00	6530663.00
2 Deposit from Contractors		9090153.00		6274286.00
3 Project Accounts : USER Project				
Balance as at begining of the year	47431401.00		43904640.00	
Add: Received during the year	21665324.00		50165664.00	
Less: Utilised during the year	31407264.00		46876253.00	
Less: Outstanding Liabilities	0.00	37689461.00	0.00	47194051.00
4 Project Accounts : ISRO Project				
Balance as at begening of the year	41958680.00		32888465.00	
Add: Prior Period adjustment	0.00		320.00	
Add: Received during the year	10352638.00		29118080.00	
Less: Utilised during the year	13271487.00		19810835.00	
Less: Outstanding Liabilities	0.00	39039831.00	0.00	42196030.00
5 Provision for pension, gratuity & leave encashment		62036875.00		59931018.00
TOTAL		**156782792.00**		**162126048.00**

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/-
(DR. P.G. DIWAKAR)
Director

Date : 09.09.2015

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2015

(Amount - ₹)

SCHEDULE 3 - FIXED ASSETS

DESCRIPTION		GROSS BLOCK				DEPRECIATION					NET BLOCK	
		Cost/valuation as at beginning of the year	Additions during the year	Sale/ Disposal	Cost/ valuation at the year-end	Rate (%)	As at the beginning of the year	During the year	Accumalated depreciation for the purpose of write off/ disposal	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 Devolopment	17753045.00	3320131.00	0.00	21073176.00	0%	0.00	0.00	0.00	0.00	21073176.00	17753045.00
2	Renovation of lease Buildings	5240087.00	0.00	0.00	5240087.00	10%	3469269.00	177082.00	0.00	3646351.00	1593736.00	1770818.00
3	Machinery & Equipment	9540622.00	0.00	0.00	9540622.00	15%	6462802.00	461673.00	0.00	6924475.00	2616147.00	3077820.00
4	Furniture & Fixtures	11816027.76	2571698.00	0.00	14387725.76	10%	4614735.76	848714.00	0.00	5463449.76	8924276.00	7201292.00
5	Office Equipments	3593191.00	154502.00	0.00	3747693.00	15%	2102654.00	448543.00	0.00	2551197.00	1196496.00	1490537.00
6	Computer & Peripherals	55121729.60	103490.00	0.00	55225219.60	60%	52608273.60	1539121.00	0.00	54147394.60	1077825.00	2513456.00
7	Library Books	23362051.93	4795549.00	0.00	28157600.93	60%	19338034.93	5291410.00	0.00	24629444.93	3528156.00	4024017.00
8	Telephones Installation	265649.00	0.00	0.00	265649.00	15%	217689.00	7194.00	0.00	224883.00	40766.00	47960.00
9	Other Equipments	21844760.00	2450881.00	0.00	24295641.00	15%	9843809.00	1775394.00	0.00	11619203.00	12676438.00	12000951.00
10	NE-SAC Complex	166352735.00	594921.00	0.00	166947656.00	5%	47492702.00	5957875.00	0.00	53450577.00	113497079.00	118860033.00
11	Vehicles	1511088.00	0.00	0.00	1511088.00	15%	722291.00	118320.00	0.00	840611.00	670477.00	788797.00
12	Air Conditioner (Heating & Cooling)	194518.00	293700.00	0.00	488218.00	15%	34286.00	46063.00	0.00	80349.00	407869.00	160232.00
13	Apple I-Pad	71250.00	0.00	0.00	71250.00	15%	15230.00	8403.00	0.00	23633.00	47617.00	56020.00
14	Aquarium	35630.00	0.00	0.00	35630.00	15%	7615.00	4202.00	0.00	11817.00	23813.00	28015.00
15	CISF Barrack	1114311.00	1371379.00	0.00	2485690.00	5%	82181.00	85891.00	0.00	168072.00	2317618.00	1032130.00

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2015

(Amount - ₹)

SCHEDULE 3 - FIXED ASSETS

DESCRIPTION		GROSS BLOCK				DEPRECIATION					NET BLOCK	
		Cost/valuation as at beginning of the year	Additions during the year	Sale/ Disposal	Cost/ valuation at the year-end	Rate (%)	As at the beginning of the year	During the year	Accumalated depreciation for the purpose of write off/ disposal	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
16	Mobile Set	48100.00	0.00	0.00	48100.00	15%	7293.00	1973.00	0.00	9266.00	38834.00	40807.00
17	Motorised Treadmill	126000.00	0.00	0.00	126000.00	15%	26932.00	14860.00	0.00	41792.00	84208.00	99068.00
18	SMF Batteries	625600.00	0.00	0.00	625600.00	15%	173006.00	67889.00	0.00	240895.00	384705.00	452594.00
19	Vending Machine	20500.00	0.00	0.00	20500.00	15%	5689.00	2222.00	0.00	7911.00	12589.00	14811.00
20	Water Dispenser	21200.00	0.00	0.00	21200.00	15%	5883.00	2298.00	0.00	8181.00	13019.00	15317.00
Capital Work in progress												
21	Residential complex	81109411.00	19997434.00	0.00	101106845.00	0%	0.00	0.00	0.00	0.00	101106845.00	81109411.00
TOTAL OF CURRENT YEAR		399767506.29	35653685.00	0.00	435421191.29		147230375.29	16859127.00	0.00	164089502.29	271331689.00	252537131.00
TOTAL OF PREVIOUS YEAR		348193594.29	55250898.00	3676986.00	399767506.29		133464176.70	17314933.59	3548735.00	147230375.29	252537131.00	214729417.59

For **D DAS & ASSOCIATES**
Chartered Accountants

Sd/-
(DEBAPRATIM DAS)
Partner

Date : 09.09.2015

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

Sd/-
(VIKAS KISHANWAL)
Accounts Officer

Sd/-
(DR. P.G. DIWAKAR)
Director

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31st MARCH 2015

(Amount - ₹)

SCHEDULE 4-CURRENT ASSETS, LOANS, ADVANCES ETC.	CURRENT YEAR		PREVIOUS YEAR	
A. CURRENT ASSETS:				
1) Cash Balances in hand	0.00	0.00	32.00	
2) Bank Balances: (with schedule Banks)				
a) On Current Accounts	235892213.51		148180146.21	
b) On Deposit Accounts	0.00	235892213.51	0.00	148180178.21
B. LOANS, ADVANCES AND OTHER ASSETS				
1) Advance to:				
a) Staff :				
TA/DA	40900.00		341331.00	
Contingency	68200.00		30825.00	
Others	1266661.00	1375761.00	1128361.00	1500517.00
b) Projects: (External)	3125149.00		3568549.00	
c) Projects: (Internal)	441585.00		574068.00	
d) Others	0.00	3566734.00	0.00	4142617.00
2) Income Accrued:				
a) Interest on Fixed Deposit	0.00		0.00	0.00
b) Grant-in-aid (DOS)	0.00	0.00	0.00	
3) Claims Receivable Recoverable	977444.00	977444.00		1320016.00
4) Deposits for:				
a) Telephone with BSNL:	65658.00		65658.00	
b) Satellite Datas with NRSC	3231153.00	3296811.00	3902113.00	3967771.00
TOTAL		**245108963.51**		**159111099.21**

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/-
(DR. P.G. DIWAKAR)
Director

Date : 09.09.2015

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2015

(Amount - ₹)

SCHEDULE 5 - GRANTS	Current Year	Previous Year
(Irrevocable Grants received)		
Central Government:		
a) Department of Space, Bangalore	102000000.00	73300000.00
b) North Eastern Council, Shillong	20000000.00	0.00
TOTAL	**122000000.00**	**73300000.00**

SCHEDULE 6 - INTEREST EARNED	Current Year	Previous Year
On term Deposits with Schedule Bank	0.00	854027.00
TOTAL	**0.00**	**854027.00**

SCHEDULE 7 - OTHER INCOME	Current Year	Previous Year
Miscellaneous Income	528773.30	277530.00
Maintenance Charges	44484.00	51706.00
Guest House Rent	28250.00	34290.00
TOTAL	**601507.30**	**363526.00**

SCHEDULE 8 - INCOME FROM SERVICE	Current Year	Previous Year
Project Adjustments	0.00	8154556.00
15% Charges from User Projects	0.00	7540714.00
Consultancy	44000.00	0.00
TOTAL	**44000.00**	**15695270.00**

For **D DAS & ASSOCIATES**
Chartered Accountants

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Partner

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NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2015

(Amount - ₹)

SCHEDULE 9 - ESTABLISHMENT EXPENSES				
	Current Year		Previous Year	
a) Salary & Allowances [29602986+2038453]	31641439.00		27888225.00	
b) Honorarium	116500.00		148060.00	
c) Employer Contributions	1277946.00		1024312.00	
d) Wages	2484081.00		2522952.00	
e) LTC	1327532.00		842794.00	
f) Leave Encashment	179266.00		51946.00	
g) Children Education Allowance	208666.00		30000.00	
h) Outsourced DEO	1682902.00		1342509.00	
i) Outsourced Electrician	1771659.00		1036661.00	
j) Outsourced Worker for Various Services	2489566.00		1463311.00	
k) Expenses for pension, gratuity & Leave encashment	2105857.00		17903317.00	
l) NER-DRR (Salary)	4296579.00		1286677.00	
m) CISF Salary	11835081.00		4292535.00	
n) Proir Period Expenses	1503700.00		0.00	
TOTAL		**62920774.00**		**59833299.00**

SCHEDULE 10 - OTHER ADMINISTRATIVE EXPENSES ETC.				
	Current Year		Previous Year	
1) Postage, Courier & Telephone Charges	937948.00		546620.00	
2) Bank Charges	11396.00		8173.00	
3) Electricity & Power Charges	2169069.00		1719073.00	
4) Hospitality	52350.00		227667.00	
5) Printing & Stationery	877789.00		1095485.00	
6) Advertisement & Publicity	493619.00		316241.00	
7) Hiring of Vehicles	2830718.00		3090854.00	
8) Travelling & conveyance	1502191.00		1861986.00	
9) Professional Charges	291943.00		335163.00	
10) Project expenses [In house]	21565.00		117221.00	
11) Rent	842234.00		660000.00	

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
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SCHEDULE FORMING PART OF INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st MARCH 2015

(Amount - ₹)

	Current Year		Previous Year	
12) Repair & Maintenance	1320872.00		1627707.00	
13) Books & Periodicals	33383.00		24809.00	
14) Training / Seminar & Workshop	266853.00		69310.00	
15) Medical Expenses	441534.00		514730.00	
16) Prior Period Expenses	131168.00		4077270.50	
17) Other Charges	178921.00		482582.00	
18) POL	590630.00		604542.00	
19) Consignment clearing charges	181778.00		0.00	
20) Hindi week Celeberations	0.00		66559.00	
21) AMC	1588732.00		1868228.00	
22) Fooding & Lodging	78906.00		287843.00	
23) Sattelite Datas	87260.00		0.00	
24) Miscellaneous Expenses	147508.00		0.00	
25) Repair & Maintenance of Vehicles	210706.00		15801.00	
26) Operation Charges & maintenance of Canteen	353806.00		29380.00	
27) ICRB Exam	280320.00		145540.00	
28) IGU Workshop	0.00		667181.00	
29) Research Paper Expenses	0.00		15613.00	
30) NER-DRR Expenses	762841.00		170281.00	
31) CISF Expenses	3038644.00		2408780.00	
32) Computer consumables	1344.00		58171.00	
33) Supply of Water	3900.00		77500.00	
34) Geopastial Technology Training	0.00	19729928.00	150312.00	23340622.50
TOTAL		**19729928.00**		**23340622.50**

For **D DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
NORTH EASTERN SPACE APPLICATIONS CENTRE

Sd/-
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Partner

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(VIKAS KISHANWAL)
Accounts Officer

Sd/-
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Director

Date : 09.09.2015

NORTH EASTERN SPACE APPLICATIONS CENTRE

Government of India, Department of Space,
UMIAM – 793 103, MEGHALAYA

SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31st MARCH 2015

SCHEDULE 11 - SIGNIFICANT ACCOUNTING POLICIES

1. ACCOUNTING CONVENTION

The Financial statements have been prepared on the basis of historical cost convention and on the 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 30.09.14 – 100% as the applicable rate.

Assets acquired after 30.09.14 – 50% as the applicable rate.

4.2 Depreciation has been provided on WDV Method as per the rate prescribed in the Income Tax Act 1961. **(Schedule 3)**

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 unutilized balance is reflected as Current Liabilities.

For **D DAS & ASSOCIATES**
Chartered Accountants

for and on behalf of
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NORTH EASTERN SPACE APPLICATIONS CENTRE

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SCHEDULES FORMING PART OF THE ACCOUNTS FOR THE YEAR ENDED 31st MARCH 2015

SCHEDULE 12 - NOTES ON THE ACCOUNTS & CONTINGENT LIABILITIES

NOTES ON THE ACCOUNTS

a) The previous years figure was re-arranged/regrouped wherever necessary to make them comparable

b) Pension, Gratuity and Leave Encashment Liability has been provided till 31.03.2015

c) Schedules 1 to 12 are annexed to and form an integral part of the Balance Sheet as at 31st March 2015 & Income & Expenditure Account for the year ended 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

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(DR. P.G. DIWAKAR)
Director

Date : 09.09.2015

North Eastern Space Applications Centre

Government of India, Department of Space, Umiam 793103, Meghalaya
www.nesac.gov.in