CSSTEAP Newsletter

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Centre for Space Science & Technology Education in Asia & the Pacific

(CSSTEAP)

(Affiliated to the United Nations)

on a mission of capacity building, the initiative of the United nations, for Asia and the Pacific Region in Space Science and Technologym through Excellence in Education, Training and Research.

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Director, CSSTEAP, India

Governing Board Members and Special Invitees during 24th Governing Board Meeting
at New Delhi, December 2, 2019

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Director's Message

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) has been making important contributions in terms of empowering scientists and engineers in Asia Pacific region in the frontier areas of Space Science and Technology and their Applications since its inception in 1995. In particular, the prime focus has been on long-term and short-term programs for mid-career professionals by inviting them to its 9-month long Post Graduate (PG) courses and short courses spanning for about 2-4 weeks. The PG courses are offered covering the wide spectrum of Geospatial Technologies and Applications - Remote Sensing and Geographic Information Systems, Satellite Communications & Global Positioning Systems, Satellite Meteorology & Global Climate, Space & Atmospheric Science and Global Navigation Satellite System, approved by UNOOSA as potential subjects for societal benefit applications. Short courses cover typically different themes of Remote Sensing and GIS applications, Small Satellite Missions, Numerical Weather Prediction models and Navigation and Satellite Positioning System on regular basis. The Centre also organizes short courses & awareness programmes from time to time based on the request of user departments.

CSSTEAP has been involved in supporting efforts by UN-OOSA capacity building initiatives. In 2019 again, it participated in two special programs: a) With a request from UN-SPIDER, the Centre has conducted one week off-campus customised training course in Myanmar on “Earth Observation for Multi-hazard Risk Assessment and Emergency Response” during March 11-15, 2019 and b) supported another programme by SAARC Disaster Management Centre on the "Utilisation of Space-based and Geospatial Information for Achieving the Targets of the Sendai Framework for Disaster Risk Reduction” from 4 to 8 December, 2019 in Ahmedabad, India. In addition, as per recommendation by its Governing Board, the Centre has initiated a global webinar on “Application of Remote Sensing in Hydro-meteorological and Geological disasters in September 2019 which attracted 148 participants from 12 countries. The Center has participated in UNCCD-COP-14 meeting held during Sept. 2-3, 2019 in New Delhi.

In all its programs, CSSTEAP concentrates on providing strong hands-on experience to apply the methods learnt in class rooms into practical case studies with maximum thrust to work with data of the participants' respective countries. I am happy to note that the course participants of PG courses have taken up this challenge to carry out a pilot project as part of the course curriculum. This certainly builds up confidence among participants to apply the methods studied to undertake future projects in their home country for their national development. This Newsletter consists of an overview of pilot projects carried out by the participants, besides other relevant information on different activities of CSSTEAP.

Dr. A. Senthil Kumar
Director

About **CSSTEAP**

Considering the importance and use of space science, technology and applications in promoting social and economic development, the United Nations, through its Office for Outer Space Affairs (UN-OOSA), facilitated the establishment and operation of the Regional Centres for Space Science and Technology Education. In its resolution 45/72 of December 11, 1990, the United Nations General Assembly (UN-GA) endorsed the recommendation of the Committee on the Peaceful Uses of Outer Space (COPUOS) to establish Regional Centres for Space Science and Technology in developing countries. Under the auspices of the United Nations, through its Office for Outer Space Affairs (UN-OOSA), seven Regional Centres for Space Science and Technology Education have been established in the regions that correspond to the United Nations Economic Commissions for Asia and the Pacific (India and China), Africa (Morocco, Nigeria) and Latin America and the Caribbean (with offices in Brazil and Mexico) and Jordan for the West Asia region. The Centres are affiliated to the United Nations through UN-OOSA. The Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP) was the first centre globally established on November 1, 1995 in India with an objective to impart education/training in the areas of RS&GIS, Satellite Communications, Satellite Meteorology and Global Climate, Space and Atmospheric Science, Navigation and Satellite Positioning System and Small Satellite Missions using modern infrastructure, technology and training tools and practices. The Centre has announced a new Post Graduate course on Global Navigation Satellite Systems (GNSS) from 2015 and is hosted by Space Applications Centre, ISRO Ahmedabad.

The Centre's headquarter is located in Dehradun, India, and its programmes are executed by faculty of the Department of Space (DOS) at campuses in Dehradun, Ahmedabad and Bengaluru. The Centre has arrangements with Indian Institute of Remote Sensing (IIRS), Dehradun for RS & GIS course; with Space Applications Centre (SAC), Ahmedabad for Satellite Communication (SATCOM), Satellite Meteorology and Global Climate (SATMET) and Global Navigation Satellite System (GNSS) and Navigation and Satellite Positioning Systems (NAVSAT) short courses; with Physical Research Laboratory (PRL), Ahmedabad for Space & Atmospheric Science course and UR Rao Satellite Centre (URSC), Bengaluru for short course on Small Satellite Missions. The Centre also has agreement with the Government of India by which it has been accorded specific privileges and international status to the centre, similar to the privileges enjoyed by UN specialized agencies. Under the agreement the Centre also has access to facilities, infrastructure and expertise of DOS/ISRO institutions, including IIRS, SAC, PRL and URSC. The Centre has a Governing Board consisting of signatories from 17 countries from Asia-Pacific region and two observers, (UN-OOSA & ITC, The Netherlands). The Centre has formal UN affiliation with UN-OOSA for developing the CSSTEAP model and extending support in terms of expert advice, technical assistance, relevant documentation and future directions. The countries have agreed to the goals and objectives of the Centre by endorsing a cooperation agreement through which the Centre was established. The technical activities of the Centre are guided by an International Advisory Committee (AC) consisting of subject experts that critically reviews the curricula, technical facilities, expertise in terms of faculty, etc.

The course curricula developed by the Centre and endorsed by the United Nations are adapted for the educational programmes. The educational programmes of the centre are oriented towards the dissemination of knowledge in relevant aspects of space science and technology. The centre offers Post Graduate level courses in five areas. The model of the PG courses is designed as to emphasize university educators, researchers and application scientists on the development and enhancement of knowledge and skills coupled with a application project. The successful completion of the 9-month PG-Phase of the programme leads to the award of a Post Graduate Diploma by the centre. For the participants who successfully finish their PG course and are interested in continuing for a Master of Technology (M.Tech) degree, the centre offer the opportunity to do so, in collaboration with Andhra University (AU), Visakapatnam, India. This gives an opportunity to the scholar to apply their knowledge and training received to deal with a 'real life' problem, where inputs from space technology can be used. Besides the Post Graduate level courses, the Centre also conducts short courses, workshops, awareness programmes on specific themes in the four areas, highlighting how space-based information can be used for national development. These educational programmes have benefited many scientists/engineers who will be the future policy & decision makers in several countries.

CSSTEAP conducts all of its educational programmes in close collaboration with one of the DOS institutions and thus has direct access to their physical facilities and intellectual capabilities. In addition to providing facilities, infrastructure and skilled manpower, the Government of India, through the Department of Space provides most of the funding. Funding grants for international travel of participants, subject experts, tuition fees and scholarships of students and the management of the centre are mainly provided by Department of Space on behalf of Host country. UN-OOSA also provides funding for travel of the participants. Other agencies financially contribute include are UN Agencies like UNSPIDER, Beijing, China; UN-ESCAP in Bangkok, Thailand, UNESCO and UNDP.

Educational Programmes

The Centre offers post-graduate (PG) level training in five areas of specialization namely:

1) Remote Sensing and Geographic Information Systems (RS & GIS),
2) Satellite Communication (SATCOM),
3) Satellite Meteorology and Global Climate (SATMET)
4) Space and Atmospheric Science (SAS), and
5) Global Navigation Satellite Systems (GNSS)

Till date the Centre has conducted 58 PG Courses: 23 in RS & GIS, 11 each in SATCOM, SATMET and SAS, and 2 in GNSS. Currently 24th RS & GIS course at Dehradun, 12th SATCOM and 3rd GNSS courses at SAC, Ahmedabad are in progress. In addition, the Centre has also conducted many short courses (regular and demand based) and workshops in the past 24 years. These programmes have benefitted 2314 participants from 36 countires from Asia-pacific region and 20 countries from outside Asia-pacific region.

Till date PG courses have benefitted 966 participants while Short Courses have benefitted 1200 participants and Webinar has benefitted 148 participants.

Highlights

PG COURSES COMPLETED

RS & GIS: 23rd PG Course RS& GIS at IIRS, Dehradun during July 1, 2018 - March 31, 2019
(23 participants from 11 countries)

SATMET: 11th Post Graduate Course in Satellite Meteorology and Global Climateduring August 1, 2018 - April 30, 2019
(13 participants from 8 countries)

SAS: 11th Post Graduate Course in Space and Atmospheric Science during August 1, 2018 - April 30, 2019
(13 participants from 5 countries)

PG COURSES ONGOING

RS & GIS: 24th PG Course RS& GIS at IIRS, Dehradun during July 1, 2019 - March 31, 2020
(22 participants from 10 countries)

SATCOM: 12th Post Graduate Course in Satellite Communication at SAC, Ahmedabad during August 1, 2019 - April 30, 2020
(16 participants from 8 countries)

GNSS: 3rd Post Graduate Course in Global Navigation Satellite Systems at SAC, Ahmedabad during August 1, 2019 - April 30, 2020
(14 participants from 7 countries)

SHORT COURSES COMPLETED

Space Weather: on Space Weather during Nov 14-27, 2019
(27 participants from 12 countries)

Disaster Risk Reduction (DRR): on Application of Geospatial Technologies for Disaster Risk Reduction with special emphasis on floods and forest fires during May 20-31, 2019 (23 participants from 5 countries)

Weather Forecasting using Numerical Weather Prediction Models: July 1-12, 2019 (26 participants from 9 countries)

8th Small Satellite Mission (SSM): on Small Satellite Missions during Nov 25 - Dec 6, 2019 (26 participants from 7 countries)

Webinar: on Applications of Remote Sensing in Hydro Meteorological and Geological Disasters during Sep 17-20, 2019
(148 participants from 12 countries)

Dr. S.P. Aggarwal
Programme Coordinator, CSSTEAP

23rd POST GRADUATE COURSE ON REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM (RS & GIS)

The twenty-third PG course on Remote Sensing and Geographic Information System of CSSTEAP commenced on July 1, 2018 at Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun, one of the host institutions of CSSTEAP. Total twenty-four participants from eleven countries of Asia-Pacific Region viz., four participants from India, three participants each from Tajikistan and Thailand, two participants each from Vietnam, Mongolia, Uzbekistan, Bangladesh and Nepal and one each from Bhutan, Lao PDR and Myanmar are attending the course. The participants enrolled were from varied educational background like Agriculture and Soils, Marine and Atmospheric Sciences, Geoscience and Geo-Hazards, Geoinformatics, Urban and Regional Studies, Water Resources, Satellite Image Analysis and Forestry and Ecology.

The course started with an 'Induction week' where the participants were exposed to geographic perspective of India, social systems, customs and festivals of India, overview of space science, technology and applications, etc. Module-1A covered basically the fundamentals of RS&GIS with theory, practical and tutorials. The participants had several field excursions for ground truth collection and for interpretation and analysis of satellite data. Module-1B participants were introduced to the recent trends in RS & GIS and Environmental assessment and Monitoring with special emphasis on Sustainable

Valedictory Function of 23rd RS and GIS Courses at IIRS, Dehradun

Development Goals (SDGs). Participants were given an overview on how space technology can be useful in addressing SDGs.

In Module-II course participants had chosen one of the eight electives i.e. Agriculture & Soils, Forestry & Ecology, Geosciences & Geohazards, Marine & Atmospheric Science, Water Resources, Urban & Regional Planning, Satellite image analysis & photogrammetry and Geo-informatics, based on their academic qualification, technical requirement of their parent organization and their professional experience. In present batch 7 participants had opted for Water Resources, 4 for Satellite Image Analysis, 3 each for Geoinformatics and Forestry & Ecology, 2 each from Geosciences & Geo-hazards, Marine & Atmospheric Science and Urban & Regional Studies, 1 for Agriculture & Soils.

The core components of course syllabus were covered by the faculty of IIRS and additional lectures by guest faculty on specialized topics was also arranged for the academic benefit of the course participants. The subject experts were invited from various organizations. The participants had an opportunity to have guest lectures delivered from Dr. George Joseph (Honorary Distinguished Professor (ISRO) on 'Science of Remote Sensing'; Dr. V. Gopalakrishnan, Asso. Director, Policies, ISRO on 'Space Law'; Dr Shirish Ravan, Senior Programme Officer United Nations Office for Outer Space Affairs (UNOOSA) on Overview of Sustainable Development Goals" and interact with Dr. T Syed Ahmed of United Nations Economic ad Social Commission for Asia and The Pacific (UNESCAP).

Module-III of three months duration, consisted of execution of a pilot project based on the knowledge gained during the course by utilizing space inputs. Good quality project work was carried out by the participants which was evaluated by a panel of experts. Some of the notable areas of the pilot project carried out by participants were on Snowmelt Runoff Modeling, Remote Sensing Based Reservoir Sedimentation Assessment, Soil salinity and waterlogging assessment using Remote Sensing & GIS, Monitoring urban change using LiDAR data, Utilizing geo-social media as a proxy for improved flood monitoring, Rice crop inventory using Temporal Sentinel SAR data, Soil erosion risk assessment using RS and GIS, High resolution tree biomass mapping using object based image analysis and Cartosat-2S data, Time series interferometry analysis for deformation monitoring using scatterer based technique, Integration of Remote Sensing with Geophysical Techniques for Ground Water Exploration, Urban flood hazard assessment, Detection and mapping of sea grass using satellite imagery and ground data, Investigation of tropical

cyclogenesis using NWP model and forecast and SAR data processing for oil spill detection to name a few.

As part of the course curricula the participants were taken for technical visits to Andhra University, Visakhapatnam and NRSC Shadnagar, NRSC-Balanagar and NRSC-Training Facility in Hyderabad. Participants visited ISRO, URSC in Bangalore during September 16 to October 3, 2018. At IMGEOS course participants had an opportunity to see the state-of-art multi-mission ground segment processing enterprise for earth observation satellites and also witnessed real time acquisition of EO data at Shadnagar, Hyderabad. The participants were also shown the virtual reality facility at NRSC, Shadnagar Campus. At Andhra University, course participants were taken to Andhra University where they attended lectures on specialized topics (on rainwater harvesting, flood mitigation and coastal hazard vulnerability and GIS modelling), met Vice Chancellor of Andhra University and also their documents were verified for finding M.Tech eligibility. During technical visits, participants also had an opportunity to visit cultural & natural landscape in Visakhapatnam, and Hyderabad and have an understanding of Indian culture, heritage and traditions.

The participants of the course during their stay were given an opportunity to participate in workshops, tutorials and conferences. Important of them are:

- ISPRS Technical Commission V Symposium on "Education & Outreach - Geospatial technology - Pixel to People" at Indian Institute of Remote Sensing, Dehradun, India during Nov 20- 23, 2018. The participants had an opportunity also to attend pre-symposium tutorials on the emerging topics like Big Data Analytics, Ground-Based 3D Modeling, and Citizen Science.
- Participated in the post-symposium tutorials organized under ISPRS WG III/10, GEOGLAM, ISRS Joint International Workshop on "Earth Observations for Agricultural Monitoring" on UAV Remote Sensing for Agriculture, on topics like Machine Learning Tools, Satellite Observations of Fire and SAR for Rice during 21-22 February, 2019 at New Delhi.
- IIIRS Academia Meet (IAM) organized on March 14, 2019 at IIRS Campus.

On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year etc. In addition to the academic activities special English language classes were also conducted for first three months for the participants to help in understanding the subjects taught in classes with more clarity.

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11TH POST GRADUATE COURSE IN SATELLITE METEOROLOGY AND GLOBAL CLIMATE (SATMET-11)

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations is imparting training in various disciplines including "Satellite Meteorology and Global Climate (SATMET)". The Eleventh Post Graduate Courses on Satellite Meteorology and Global Climate under the aegis of the UN affiliated CSSTEAP, is being conducted at Space Applications Centre (Bopal Campus), Ahmedabad during August 1, 2018 to April 30, 2019.

Thirteen participants from Eight countries in Asia-Pacific region have undergone this course. They are mostly operational forecasters, meteorologists, and researchers in their own country. After they learn about satellite meteorology, they will impart training to their own officers in this subjects once they go back. The participants are from the countries like Bangladesh, India, Kyrgyzstan, Maldives, Mongolia, Myanmar, Philippines , Tajikistan.
The course commenced on August 1, 2018 at the Bopal Campus of Space Applications Centre (SAC), Ahmedabad. A joint inaugural function of the two courses i.e. the Satellite Meteorology and Global climate conducted by Space Applications Centre and the Space and Atmospheric Sciences conducted by Physical Research Laboratory was held at K.R. Ramnathan Auditorium, PRL on 6th August 2018. This function was presided over by Shri D K Das, Director SAC & Dr. Anil Bhardwaj, Director PRL, Dr. A. Senthil Kumar, Director CSSTEAP, and Senior Officers from SAC and PRL graced the function.

The valedictory function of this course was held on 29 April 2019. Sri A. S. Kiran Kumar, Ex-Chairman ISRO has delivered the valedictory address to the participants. Other dignitaries Shri D K Das, Director SAC, Dr. Anil Bhardwaj, Director PRL, Dr. A. Senthil Kumar, Director CSSTEAP and Senior Officers from SAC and PRL also graced this function.

A thoroughly detailed syllabus on the basis of Grenada and Frascati documents of UN-OOSSA was adopted for the course. The Board of Studies (BoS) Committee of Satellite Meteorology & Global Climate constituted by Director, CSSTEAP had modified the syllabus.

This SATMET-11 course has 2 semesters spread in 3- modules. The 1st module covers the fundamentals of Satellite Meteorology and Global climate, and 2nd module deals with Advance Concept of Satellite Meteorology, e.g., Geophysical Parameter Retrieval and Satellite Products and their application in NWP etc. The 3rd module, called Pilot project module (duration: 3 months) the participants have to do project on a topic relevant to their own country under the guidance of an expert scientist from Space Applications Centre, Ahmedabad.

During Module I and Module II there were theory classes in the morning and practicals in the afternoon sessions. There were tutorials; weather discussion climate seminar and the

performance of the participants were assessed through written, interactive sessions and practicals exercises. On successful completion of the Phase I, the participants will be given the PG diploma, and they can complete their PHASE-II project work in their own county for one year, and the work can be submitted to Andhra University for the award of M. Tech.

A one-week orientation module, covering various topics related to Space Technology, with special emphasis on Remote Sensing & GIS, Satellite meteorology, Satellite Communications and Space Sciences was introduced. Special lectures were delivered by eminent scientists in this module. The idea was to make all the course participants aware about the capabilities of Space Technology and related applications in various fields.

Few new practicals in Temperature and humidity profiles from Sounder data (INSAT-3D/3DR), GPS Meteorology, Scatterometer Applications, Humidity profiles form SAPHIR sensor onboard Megha Tropiques, SARL/Altika data Processing and related applications are incorporated from this course onwards, which was highly appreciated by the SATMET-11 students.

Faculty

Faculty members for this course were drawn mostly from the Atmospheric and Oceanic Sciences Group (AOSG), SAC, Ahmedabad. A few scientists from the other Groups of Space Applications Centre, the Physical Research Laboratory, experts from India Meteorological Department (IMD) and Andhra University etc. also delivered lectures.

In addition to class room lectures during the morning hours, practicals using satellite data were conducted in the afternoon. The main work-horse for the practicals were data from INSAT and NOAA satellites. Microwave Data Sets Mega Tropiques SAPHIR, SARAL/ALTIKA SSM/I, TRMM and GCM outputs etc. were extensively used by the course participants. During the first module the emphasis was on data / image interpretation with many case studies on clouds, tropical cyclones etc. The second module consisted basics of geophysical parameter retrieval, assimilation of Satellite Data in NWP, validations and their applications.

Special Facilities

SATMET-11 course was held in the spacious SAC (Bopal) Campus. A special SATMET Laboratory with modular structure, uninterrupted power supply and networking was commissioned for the course with twenty PC's and a Server. This facilitated easy access to various

satellite data sets, software etc. to each participant, particularly during their three months pilot project phase. Special terminals for e-mail purposes were provided, both in office and at hostel, which helped the participants in data downloading, browsing and also to remain in touch with their families/office.

A versatile software package " Python, Matlab etc" on each terminal provided much needed standardization in data processing (INSAT-3D/3DR, Megha Tropique, SCATSAT-1, NOAA, MODIS etc.) to all the participants. This would help them immensely in the continuation of the project back home. A set of three volumes of lecture notes prepared especially for the SATMET course comprised the main resource material. These were distributed in the beginning itself to all the participants, and updated notes were also provided.

A separate CSSTEAP Network was installed with access from Class room, laboratory and hostel. With this network the students could access the study materials (Class room lectures) both in word and in presentation form, this facilitated them to recall the class room lectures again and benefited particularly the students with English language problem. Special English classes were held by professionals near SAC Bopal campus.

Hostel accommodation was arranged in the International hostel with good living facilities and with attached Kitchenette. Canteen facility was provided to the participants in both Technical campus and Hostel. For entertainment DTH system was provided to them in their rooms. The participants used the recreation and gym facilities made available in the hostel area. Centre also provided medical facilities for minor ailments. There were no major health problems reported by the participants during the nine-months course.

Seminar, Tutorials and Map Discussions

Each participant gave a number of seminars during the course, related to climate and meteorological problems affecting their region and also the topics related to their Pilot Projects. This exercise helped them greatly to improve their presentation skills. They also got an excellent exposure to working with numbers during the Tutorial sessions where a number of simple, yet conceptual problems were discussed and solved in the class. Participants enjoyed these sessions meant to enhance the problem solving capabilities.

A weekly Map discussion of the current Weather over Indian and the Asia-Pacific using Satellite

images, weather charts and model forecasts available from various sources was conducted during the first three months. This gave them a good exposure to various web sites providing operational satellite data and forecasts and also helped them to keep track of various important meteorological events over their own region. The active south-west monsoon conditions over India and Gujarat, in particular, gave a good feel of heavy monsoon spells to the participants and made the weather discussions very educative, informative and lively.

Technical Visits

During the 9 months Course, the participants visited some of the important Institutions / Laboratories in the country to have a first-hand experience of the utilization of satellite data in an operational environment. The technical tours included visits to:

- Doppler Weather Radar (DWR), Chennai
- Andhra University, Visakhapatnam.
- Satish Dhawan Space Centre, Sriharikota
- National Remote Sensing Centre, Hyderabad
- Indian National Centre for Ocean Information Services (INCOIS) and Tsunami warning Centre, Hyderabad
- IMD New Delhi

These tours were so designed that the participants not only had an opportunity to visit excellent facilities of ISRO and other National Organisations, but also get familiarised with the cultural heritage, diversity and natural scenic beauty of various parts in India, including the famous Taj Mahal.

Pilot Projects

The candidates learnt a lot during the 3 months Pilot-Project-about formulation of a problem of relevance to their country, specifying and acquiring data, execution, and communication both orally and in writing. The variety of coverage of themes can be appreciated from the list of Projects given in this Memoir.

The Pilot Project could be listed in following broad topics:

- Assimilation of satellite data and impact studies of Severe Weather model.
- Sounding products using INSAT-3D / AIRS and MODIS data-validation/ Applications.
- Cryo-sphere (assessment of change) over Kyrgyzstan.
- Mesoscale convective studies using satellite data., SAPHIR / MT Validation.
- Now-casting/Rainfall and tropical cyclone studies using satellite data.
- Radio Occultation and Applications.

The topics for one-year Project work were identified after several discussions with the participants. The field of interest of the participants, the needs of the sponsoring organisations and the facilities available in the countries of participants for supporting the project work were taken into account while deciding the project.

Dr. B. Simon
Course Director

Dr. Sanjib K Deb
Associate Course Director

Dr. Kaushik Gopalan
Course Coordinator

11TH POST GRADUATE COURSE ON SPACE AND ATMOSPHERIC SCIENCE (SAS-11)

The Eleventh Post Graduate Course on Space and Atmospheric Science (SAS-11) began on August 1, 2018, at Space Applications Centre (Bopal Campus). There were 13 participants: 3 from India, 2 from Myanmar, 6 from Mongolia, and 1 each from Nepal and Uzbekistan. A joint inaugural function of this course, hosted by Physical Research Laboratory (PRL), and the Eleventh Satellite Meteorology and Global climate course (SATMET-11), conducted by Space Applications Centre (SAC), was held at K.R. Ramanathan Auditorium, PRL on August 6, 2018. Shri D.K. Das (Director, SAC), Dr. Anil Bhardwaj (Director, PRL), Dr. Senthil Kumar ((Director, CSSTEAP, Dehradun) and senior officers from SAC and PRL graced the function.

Joint Valedictory Function of SAS-11 and SATMET-11 Courses at SAC, Ahmedabad

The course started with introductory lectures common and useful to both SAS and SATMET participants. In this common module, very interesting talks were given by the faculty members from PRL, SAC and IIRS. The regular course began immediately after the common module was over. The course was spread over two semesters. Faculty members included eminent Scientists/ Engineers from PRL and other Institutions in India. Subjects covered in the 1st semester were Earth's Atmosphere and Climate Change, Ionosphere and Radio Communication, Planetary Science and Exploration, Ground-Based Experiments for Near-earth Environment, and Space Instrumentation. Classroom lectures were delivered during the morning hours and relevant practicals were conducted in the afternoon sessions. For each of these subjects, there were tests, assignments and short seminars which were graded and used for internal assessment of the students. Lectures for the first semester ended on November 1, 2018. Final examinations for the first semester were conducted during the period November 5-14, 2018.

The SAS-11 participants attended the 15th International Symposium on Equatorial Aeronomy (ISEA-15), hosted by Physical Research Laboratory (PRL), Ahmedabad, India during October 22 26, 2018.

Course Participants with Shri A S Kiran Kumar, Former Chairman ISRO during ISEA-15 International Symposium

This symposium allowed them to know the current status of research in the field of space physics, in general, and equatorial aeronomy, in particular. Several of the topics covered in ISEA-15 were taught as part of the curriculum of UN Space and Atmospheric science course and so the SAS-11 participants benefitted a lot from this opportunity.

As a part of the programme, the students were taken on a scientific tour during the period November 15-27, 2018, to selected national centres of excellence in Space and Atmospheric Science. We visited Alibag Magnetic Observatory run by Indian Institute of Geomagnetism, National Remote sensing Centre (NRSC) and TIFR balloon facility at Hyderabad, National Physical Laboratory (NPL) at Delhi and Andhra University, Vishakhapatnam for the mandatory document verification.

Course Participants visited NRSC, Hyderabad

Classes for the second semester began on December 3, 2018, and ended on January 22, 2019. There were 4 theory papers covering topics on Sun and Space Weather, Stellar and Galactic Astronomy, Electronic Devices and Detectors for Space Instrumentation, and Space Exploration.

Final examinations for the second

semester were held during January 25-February 1, 2019. Immediately thereafter, the students participated in ISRO- STP (Structured Training Programme) at PRL during February 4-8, 2019. The theme of this STP was "Recent Advances in Scientific Research in the Earth, Planetary and Space Sciences using Ground and Space-based data: Global Perspectives". This STP covered a variety of fascinating topics on Earth, Planetary and Space Sciences and utilization of ground and Space-based observations. After attending the STP programme, the students went on a scientific tour to Udaipur Solar Observatory and the infra-red observatory at Mt. Abu during February 10-14, 2019. From February 15, 2019, pilot projects started. Each student chose a topic of her/his research interest and pursued the research under the guidance of a faculty of PRL. The pilot project topics were as follows:

1. Solar Cycle and seasonal variations of the critical frequency and height of maximum ionization of F2-layer over Ahmedabad
2. Remote Sensing of the Moon
3. Analytical modelling of the solar coronal magnetic field
4. Long term trends of temperature and pressure data in Mongolia
5. Long term trends of precipitation in Mongolia
6. Surface ozone in an urban atmosphere
7. Asteroids and Comets
8. Space debris and their impacts
9. Investigation of Thermophysical Properties of Lunar Analogues by Laboratory Measurements
10. GEANT4 simulation for the Silicon detectors in Δ-E mode
11. Modal and structural analysis of quadrupole mass spectrometer
12. Study of the solar origin of low-frequency radio bursts observed by the e-CALLISTO network
13. Classifying Supernovae using their optical spectra

Participants visited Qutub Minar (UNESCO World Heritage Site) at Delhi

The pilot projects were evaluated on April 12, 1919, when each student gave a short presentation of her/his project work in front of an expert committee.

A Joint Valedictory Function of the two courses was held on Monday, April 29, 2019, at Bopal Campus, SAC. Shri A. S. Kiran Kumar (Prof. Vikram Sarabhai Professor, ISRO HQ), the Chief Guest, presented the certificates to the participants.

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24th POST GRADUATE COURSE ON REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM (RS & GIS)

The twenty-fourth Post Graduate (PG) course on Remote Sensing and Geographic Information System of CSSTEAP commenced on July 1, 2019 at Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun. IIRS is one of the host institutions of CSSTEAP situated in Dehradun, capital city of Uttarakhand state of India. Total twenty-two participants from ten countries of Asia-Pacific Region viz., three participants each from India, Myanmar and Mongolia, five participants from Sri Lanka, two participants each from Bhutan and Tajikistan, and one participant each from Bangladesh, Nepal, Kazakhstan and Kyrgyzstan are attending the course. The participants enrolled are from varied educational background like Agriculture and Soils, Marine and Atmospheric Sciences, Geoscience and Geo-Hazards, Geoinformatics, Urban and Regional Studies, Water Resources, Satellite Image Analysis and Forestry and Ecology.

The course started with an 'Induction week' where the participants were exposed to geographic perspective of India, social systems, customs and festivals of India, overview of space science, technology and applications etc. A local trip was also organized for the awareness within and around the Dehradun city for the participants. Thereafter, participants have gone through the main academic programme which comprises of two semesters. Semester-1 consists of module-IA and module-IB and are common to all course participants while semester-2

Educational tour of 24th RS and GIS Course Participant to Ramoji Film City, Hyderabad

consists of specialization module-II and module-III for pilot project work. Module-IA covered the fundamental concepts of Remote Sensing (RS) and Geographic Information System (GIS) technology with lecture, practical, tutorial and field excursions. The participants had several field excursions for ground truth collection and for interpretation and analysis of remote sensing satellite data. Module-IB is specifically designed to cover the advance topics in RS & GIS and environmental analysis and management.

Based on their academic background, technical requirement of their parent organization and their professional experience, in semester-2/module-II, every course participant has chosen one of the eight available electives i.e.

Agriculture & Soils, Forestry & Ecology, Geosciences & Geohazards, Marine & Atmospheric Science, Water Resources, Urban & Regional Planning, Satellite image analysis & photogrammetry and Geo-informatics. In current 24th batch, 7 participants had opted for Satellite image analysis & photogrammetry, 5 participants for Water Resources, 4 for Geoinformatics, 3 each for agriculture and Soils, 2 for Marine & Atmospheric Science and 1 for Geosciences & Geo-hazards.

The core components of course syllabus were covered by the faculty of IIRS and additional lectures by guest faculty on specialized topics were also arranged for the academic benefit

of the course participants. The subject experts were invited from various organizations. The participants had an opportunity to have guest lectures delivered from Dr. Keran Wang, Chief, Space Applications Section (SAS), (IDD), UN ESCAP, Bangkok on 'ESCAP Programme in Space Application for SDGs implementation'; Dr. A.V Kulkarni, DCCC, IISc, Bangalore and Dr. Ashish Mishra, KDMIPE, ONGC, Dehradun at CSSTEAP HQ, Dehradun.

Module-III of three months' duration, consisted of execution of a pilot project based on the knowledge gained during the course by utilizing space based assets is in progress and will be completed on March 31, 2020. This module equips participants with advanced knowledge and experience in applications of EO data and GIS technology in selected thematic discipline.

As part of the course curricula, a technical visit for all course participants was arranged to NRSC Outreach Facility-Jeedimetla, NRSC-Balanagar, and NRSC-Shadnagar, Hyderabad; Andhra University, Visakhapatnam; Historical monuments in Delhi; and Tajmahal, Agra. At IMGEOS, course participants had an opportunity to see the state-of-art multi-mission ground segment processing enterprise for earth observation satellites and also witnessed real time acquisition of EO data at Shadnagar, Hyderabad. The participants were also shown the virtual reality facility at NRSC, Shadnagar Campus. At Andhra University, course participants attended lecture-series on specialized topics in the field of rainwater harvesting, flood mitigation and coastal hazard vulnerability and GIS modelling, and met Vice Chancellor of Andhra University and also their documents were verified for finding M.Tech eligibility. During technical visits, participants also had an opportunity to visit marine, coastal and terrestrial ecosystem of in and around Visakhapatnam- ; Ramoji film city, Hyderabad; Akshardham Temple, India Gate, Delhi; Taj Mahal, Agra; and have an understanding of Indian culture, heritage and traditions.

The participants of the course will be given an opportunity to participate in IIRS Academia Meet (IAM) organized on March 3, 2020 at IIRS campus, Dehradun and also had a fruitful meeting with Dr. Keran Wang, Chief, Space Applications Section (SAS), (IDD), UN ESCAP, Bangkok at CSSTEAP HQ, Dehradun on January, 2020.

On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dandia, Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year, Holi etc. In addition to the academic activities special English language classes were also conducted for first three months for the participants to help in understanding the subjects taught in classes with more clarity.

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12TH POST GRADUATE COURSE ON SATELLITE COMMUNICATION (SATCOM-12) AND 3RD POST GRADUATE COURSE ON GLOBAL NAVIGATION SYSTEMS (GNSS-3)

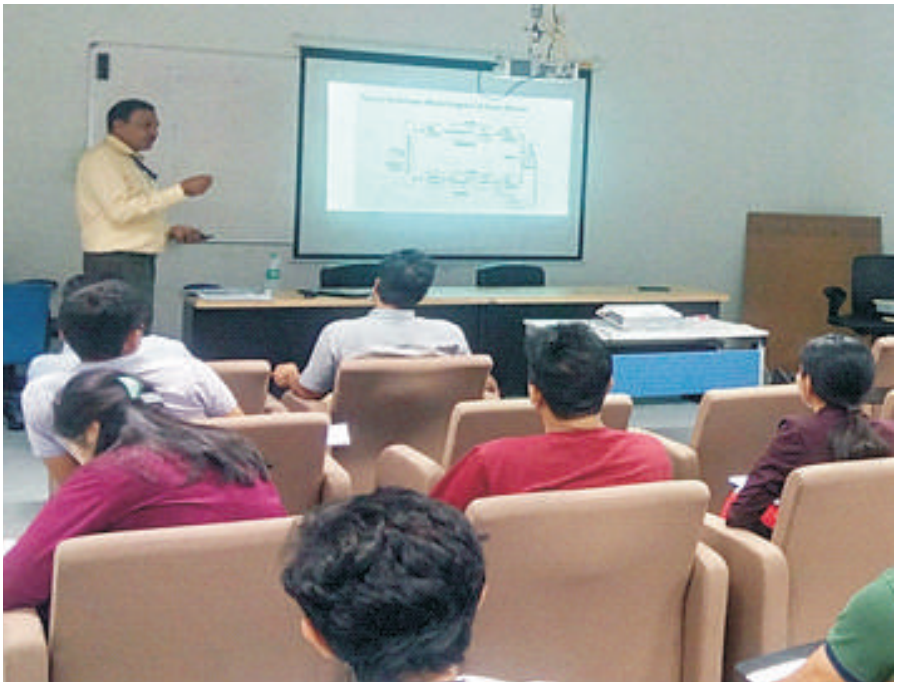
The Twelfth Post Graduate Course on Satellite communication (SATCOM-12) and the Third Post Graduate Course on GNSS (GNSS-03) under CSSTEAP have started at Space Applications Centre (SAC), Ahmedabad from 01st August, 2019. 16 students from 8 different countries are participating this year in SATCOM-12 while 14 students from 7 different countries are participating in GNSS-03.

Director, SAC, inaugurated the courses in presence of Associate Director-SAC, Director CSSTEAP and Program Coordinator-CSSTEAP and other distinguished guests.

SATCOM-12 and GNSS-03 have completed Semester-I and Semester II by February, 2020, comprising of Theoretical Classes and laboratories.

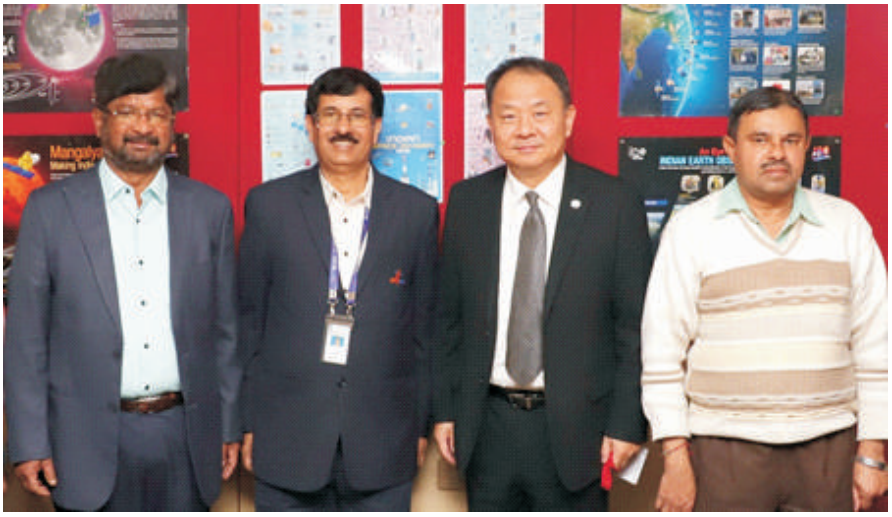
The students have also participated in educational tours to North and South India. All India

Inauguration of GNSS-03 and SATCOM-12 Courses at SAC, Ahmedabad



SATCOM-12 participants attending a classroom lecture

GNSS-03 and SATCOM-12 participants with other CSSTEAP officials at Doordarshan



Dr. Karen Wang with Director CSSTEAP, Director SAC and Associate Director SAC

Course Participants during 4th ISSE National Conference-2019 at Space Applications Centre, Ahmedabad

Radio, Doordarshan, National Physical Laboratory, MCF-Hassan, ISTRAC, ISITE and Indian Satellite Launching site at SDSC-SHAR were in the list of places visited by the students.

Dr. Karen Wang, Chief, Space Applications Section (SAS), Information and Communications Technology and Disaster Risk Reduction Division (IDD), UN ESCAP, visited SAC and interacted with the course students and the officials in January, 2020.

The students also attended the 4th ISSE National Conference (INAC-4) at SAC, Ahmedabad.

Students have also visited other places of interest like Taj Mahal at Agra, Qutab Minar and Lotus Temple in Delhi, Halebeedu, Belur and Shravanabelagola in Karnataka.

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Course Director
SAC, Ahmedabad

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SPACE WEATHER

SHORT COURSES

Space weather plays a very important role in life on Earth and affects almost all aspects of modern society. A clear understanding of space weather has become a necessity for modern civilization. With this view in mind, the Centre for Space Science and Technology Education in Asia and Pacific region (CSSTEAP) organized a short course on “Space Weather” conducted at Physical Research Laboratory (PRL), Ahmedabad during 14-27 November, 2019 for the participants from Asia-Pacific region.

The inaugural ceremony was held at PRL on 14th November; 27 members from 12 countries took the course. Classes were held from 9-30 to 4-30 every working day at Nano-SIMS hall. A total of 25 lectures were delivered by PRL's expert faculty on Solar sources of space weather, Propagation of the electromagnetic and charged particles through the heliosphere, The response of Earth's

Participants at GONG site, USO

Group Photo after Valediction Function

magnetosphere, ionosphere and thermosphere to Space Weather, Solar influence on middle atmospheric processes, and Effect of Space Weather on electronic and communications systems.

For a better understanding of the theory, there were practical sessions on Measurement of the speed of coronal mass ejection, Measurements of Sunspots (number, area and rotation), Measurement of the geomagnetic field, Radio sounding of the ionosphere, Measurements of TEC and scintillation using GPS, and Study of optical signatures of space weather events.

As a part of the programme, the participants were taken to Udaipur and Mount Abu for a very short scientific tour. They visited the site of Global Oscillation Network Group (GONG) at Udaipur Solar Observatory or USO. The GONG site is part of a global network to make continuous observations of the Sun and provides rich information about solar activity. The participants got exposure regarding the working of the GONG instrument and the data products from GONG.

They also visited the e-CALLISTO site at USO. Callisto stands for Compound Astronomical Low-Frequency Low-Cost Instrument for Spectroscopy and Transportable Observatory. The e-CALLISTO system is a valuable new tool for monitoring solar activity and for space weather research. e-CALLISTO is used for the observations of solar radio bursts and radio frequency interference monitoring for astronomical science.

The trip to USO ended with a visit to MAST, the Multi-Application Solar Telescope installed on the island in Lake Fatehsagar to observe the photospheric and chromospheric layers of the sun. The working principle and design of the main telescope and the imaging instruments were explained to the students. The adaptive optics system, developed in-house, for compensating atmospheric seeing was also shown and explained.

At Mt Abu Observatory, the students learned in detail about the functioning of 1.2 m telescope and the back-end instrumentation. They observed the rings of Saturn through the telescope.

The short course ended on 27th November with a colourful valediction ceremony. Feedback from the participants was very positive.

APPLICATION OF GEOSPATIAL TECHNOLOGIES FOR DISASTER RISK REDUCTION (DRR)

SHORT COURSES

A Special Course on "Application of Geospatial Technologies for Disaster Risk Reduction (DRR) with Special Emphasis on Floods and Forest Fires" for CSSTEAP has been conducted from 20.05.2019 to 31.05.2019. The course has been organised by CSSTEAP and conducted by IIRS. The course has been attended by a total of 23 participants from 5 different countries: 6 Participants from India, 8 from Kazakhstan, 2 from Mongolia, 4 from Nepal & 3 from Tajikistan.

Group photo of course participants and officials of IIRS, Dehradun

The course had a healthy mix of theory lectures in the forenoon sessions followed by practical/ hands on/ demonstrations in the afternoon sessions. The lectures have been taken by subject matter inputs from IIRS & 4 Guest faculty from NRSC, UNESCAP, NESAC ect. The lectures ranged from Basic Concepts of Remote Sensing and Image Interpretation, Innovations in Big Data Ecosystem for impact based, risk informed flood forecasting, Role of International Charter and Sentinel Asia in DRR, Over view of Indian Space program and Space based Location Service for DRR. Among the main areas covered in fold hazard were Optical and microwave remote sensing for flood inundation mapping, monitoring and impact assessment, SDG and its role in DRR & Sendai Framework, Application of DEM in hydrological studies, Basic Hydrology Concepts and Introduction to hydrological modelling, DSC for flood early warning, Flood frequency analysis and flood routing as well as Flood early warning using integration of meteorological and hydrological models. In forest fire the lecture included Basics of forest type and cover and its distribution in Asia and India, Thermal Remote Sensing for forest fire detection, Role of remote sensing and GIS in forest fire detection, assessment and monitoring, UAV and its application in Disaster Monitoring and Mitigation, Forest fire risk assessment and modelling and Models for forest fire spread and damage prediction and finally Disaster Management System Based on Web-GIS service.

The practical exercises' and hands on were on Visualization and image interpretation, image analysis, feature extraction and image classification, GIS spatial data analysis, Flood inundation mapping and damage assessment, DEM hydro-processing (water shed delineation) and DEMO on flood modelling, Forest fire burnt area mapping and Forest fire risk assessment using satellite information. The course was highly appreciated by the participants and all have been very satisfied with the programme design, methodology of teaching & practical session, reading materials & the hospitality of IIRS.

WEATHER FORECASTING USING NUMERICAL WEATHER PREDICTION MODELS

SHORT COURSES

Numerical Weather Prediction (NWP) is the quantitative forecast of weather or climate based on a model or a set of models derived from our BEST understanding of the physical processes that govern the atmosphere or the climate.

Today the skill of NWP forecast is significantly improved, but still the science of NWP is constantly evolving with innovations in computer technology, improvement in our understanding of physical processes and most importantly availability of new observations (terrestrial, airborne and space-based platforms).

Large number of activities such as transportation, agriculture, national planning, warning against extreme weather conditions, solar and wind power sectors requires weather prediction in advance. Now-a-days 90% of the total data used in the operational NWP models comes from space borne observing systems.

In the last 10-years or so SAC ISRO has created a store house of Indian satellite database from various ISROs meteorological/ earth observation missions and are operationally available in the MOSDAC data centre.

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations is imparting

Valedictory function at SAC Ahmedabad

training in various disciplines at different centres of ISRO. The third Short course on Weather Forecasting using Numerical Weather Prediction Models under the aegis of the UN affiliated CSSTEAP, is being conducted at Space Applications Centre (Bopal Campus), Ahmedabad during July 01, 2019 to July 12, 2019.

Participants: Total 26 participants

Twenty-six participants from nine countries in Asia-Pacific region have undergone this course. They are mostly operational forecasters, meteorologists, and researchers in their own country. Bangladesh 3, India -12 (IAF-4 /Navy-2/ NRSC-3/ CUSAT-1/ IITBHU-1/ National Solar Institute-1), Kazakhstan- 4, Kyrgyzstan -1, Maldives -1, Mongolia -2, Myanmar-1, Thailand-1, Nepal-1.

Objectives: The overall objectives of this training course is to generate awareness among users/ researcher/professionals/academicians on fundamentals of NWP and data assimilation.

Exposure: The participants were familiarized with the use of state-of-art numerical model Weather Research and Forecasting (WRF) along with its assimilation systems.

Morning session: 2 theory lectures of 1hr 30 min each,

Topic covered:

- History of NWP, NWP model type, resolution and boundary conditions,
- Space based observations for weather and climate (optical and microwave)
- Data Assimilation : Basic concepts, Optimum interpolation, variational method, ensemble and hybrid data assimilation, forecasting processes, forecast verification, observation pre-processing, modeling of observations and background errors covariance, rainfall assimilation, radiance assimilation, AOD assimilation, Dust storm forecasting, assimilation of land surface parameters.
- Physical processes and parameterization,
- Numerical methods to solve the weather prediction equations,
- Multi-model super ensembles forecast techniques,

Afternoon session: practical of 3hrs-30 min. Topic covered

- Grid Analysis Display System (GrADS),
- Setting up and running WRF model,
- Setting up assimilation system,
- Assimilation of conventional data in WRF assimilation system,
- Radiance data assimilation for tropical cyclone forecasting,
- Assimilation of land surface data in WRF model.

8th SMALL SATELLITE MISSION (SSM)

SHORT COURSES

Small Satellite Mission, a two week short term course for participants from Asia Pacific Countries was conducted jointly by UR Rao Satellite Centre (URSC) Bangalore and Indian Institute of Remote Sensing (IIRS) Dehradun at IIRS. This year the course commenced on 25th November 2019 at CSSTEAP, IIRS Dehradun and 26 participants from 7 countries of Asia pacific region attended the course. The Course was inaugurated on 25th November. The presentations were made by scientists and engineers in a structured time table on following broad topics:

- Benefits of Space Technology
- India's Space Capabilities
- Technology involved in small satellites
- Various sub-systems of the small satellites
- Orbit Dynamics and Determination of small satellites
- Applications of small satellites
- Management of small satellites

Apart from the related topics, launch opportunities and technical part on procurement of satellite subsystems or system

Valedictory Function of 8th SSM course at IIRS, Dehradun

were delivered. For the demo sessions, with explanation (discussions) and relevant video clippings were screened. These lectures were supported by demos and videos. A Quiz program on Space systems and space events was conducted for the more involvement of participants which has given very good response. Assignments related to orbits and various sub-systems were given to participants and it was well responded. At the end of the first weekend an educational tour was planned to Mussorie. The Valedictory function was presided by Director IIRS, Dr. Prakash Chauhan, Dean Academics, Dr. S.K. Srivastav, Programme Coordinator, CSSTEAP, all the participants, faculties along with the Course Director and Course coordinator. The Certificates were given away by the Director IIRS. Course material was given to the participants by Dean Academics, Programme Coordinator, CSSTEAP and Course Director. With this the short course on Small Satellite Mission came to end successfully.

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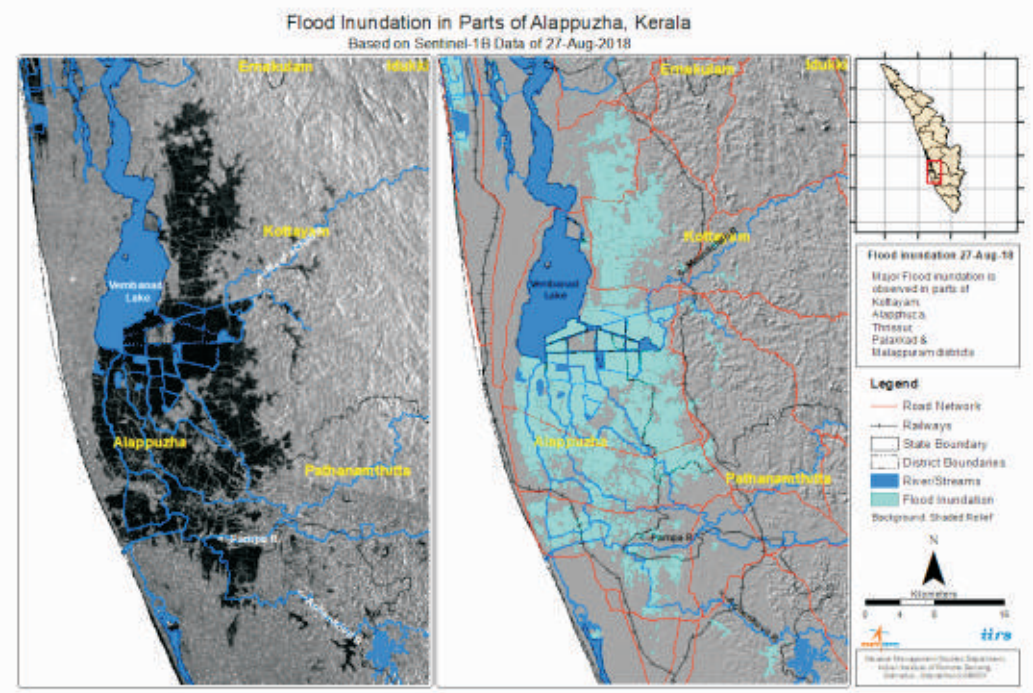
WEBINAR: APPLICATION OF REMOTE SENSING IN HYDRO-METEOROLOGICAL AND GEOLOGICAL DISASTERS

SHORT COURSES

CSSTEAP supported by IIRS organized for the first time a webinar on "Application of Remote Sensing in Hydro meteorological and Geological disasters" during 17th - 20th September 2019 for international participants (http://www.un-spider.org/news-and-events/events/webinar-application-remote-sensing-hydro-meteorological-and-geological). The webinar covered lectures on themes like Space Applications in DRR and International cooperation, Geo-spatial applications in Hydro-meteorological Disaster and Geological Disaster and Demonstration on Rapid damage assessment during disasters. The webinar was offered live at 0600 UTC and recording was played at 1300 UTC to benefit participants as per their time zones. Lectures were tailored to suit the needs of academicians, scientists, researchers and professionals, including CSSTEAP alumni, interested in application of remote sensing in hydro-meteorological and geological disasters. The webinar was attended by 148 participants from 12 countries. The participants were also awarded certificates for attending the webinar.



PILOT PROJECT ABSTRACTS

Project Abstracts of 23rd RS & GIS Course

1. Semi-automatic Landslide Feature Extraction in Siwalik Hills of Nepal from Sentinel-2 image
2. Assessing Biodiversity Patterns from very High Resolution Satellite Data
3. Remote sensing and Hydromet Data based Glacier Dynamics of Fedchenko Glacier
4. Investigation of Tropical Cyclogenesis using NWP Model Analysis and Forecasts over the Bay of Bengal
5. Soil Erosion Risk Assessment using RS and GIS
6. Forest Fire Vulnerability Modelling
7. Integration of Remote Sensing and Geographic Information System with Geophysical Techniques for Groundwater Exploration-A Case Study of PYSD, Kimari and GNFC Area, Mussoorie, Dehradun
8. Monitoring Urban Change using LiDAR Data
9. Analyzing Urban Growth Pattern of Chiang Mai City, Thailand using Remote Sensing and Geographic Information System
10. Rice Crop Inventory Using Temporal Sentinel SAR Data
11. Snowmelt Runoff Modeling in TUUL River Basin, Mongolia
12. Remote Sensing based Resrvoir Sedimentation-A Case Study of Bargi Reservoir
13. Hydrological Simulation for Reservoir Sedimentation Assessment
14. Characterization of Crater Morphology and Mineralogy of Chandrayaan 2 Landing Site and its Terrestrial Analogue
15. Soil Characterization and Capability Assessment for Land Use Planning using RS and GIS
16. Mapping Of Biomass Using Very High Resolution Data
17. Flood Hazard Mapping in Parbati Valley
18. Soil Salinity and Water Logging Assessment using Remote Sensing and Geographic Informationn System (GIS)
19. Sar Data Processing for Oil Spill Detection
20. Time Series Interferometry Analysis for Deformation Monitoring using Scatterer based Technique
21. Urban Flood Hazard Assessment in Parts of Ambala City using Geospatial Technology
22. Water Balance Estimation in Chirchik River Basin
23. Detection and Mapping of Sea-grass Meadows Using Satellite Remote Sensing Data at Ritchie's archipelago, South Andaman
24. Utilizing geo-social media as a proxy for improved flood monitoring: A case study on Chennai floods, 2015

Semi-automatic Landslide Feature Extraction in Siwalik Hills of Nepal from Sentinel-2 image

Landslides in mountainous area are concern for many people as there occurs loss of lives and livelihoods along with frequent hazard incidents. Locating landslides and determining its extent is vital to carry out for estimating loss and damage and carry out mitigation works. This research aims to find out locations and area of landslides in Bheriganga and Lekhgau micro-watersheds in Surkhet District of Nepal, which lie in Siwaliks physiographic zone, using openly accessible remote sensing datasets (Landsat-8 and Sentinel-2) and ALOS-PALSAR DEM. The method used in this process is Object Based Image Analysis (OBIA) where pixels in an image are grouped into objects by segmentation process and the landslides features are extracted from those objects using rulesets. Multiresolution segmentation algorithm in eCognition software was applied to segment the image which is dependent upon the scale (20 determined by plateau objective function), shape (0.3) and compactness (0.5) parameters. Threshold value of 0.3 of NDVI was used to select potential image objects that may be part of landslides but this selection also includes false positives which were removed successively. Water bodies were removed taking NDVI (<0.1), mean slope (<15°) and mean NIR (>1000). River sand was separated using NDVI (<0.2), mean slope (<15) and mean red (>1000). Geometrical properties of image objects, length/width ratio, asymmetry and width, were considered for removal of roads. Similarly, vegetated shadow areas were removed using criteria of mean brightness, hillshade and flow direction. Agriculture and grasslands were removed using NDVI (>0.095), mean slope (<17) and mean red (1500-2500). Image objects whose slope measured 30°-45° and >45° were rocky areas and steep escarpment respectively. Remaining objects of potential landslides were taken as true landslides. There were altogether 301 landslides detected in the study area with size ranging from 750 m^2 to 87750 m^2. 164 landslides out of 301 were matching correctly with the reference landslide database (478 landslides).

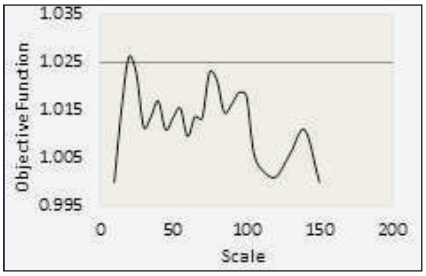


Fig. 1: Plot of objective function versus scale (curved line) with plateau function (straight line)

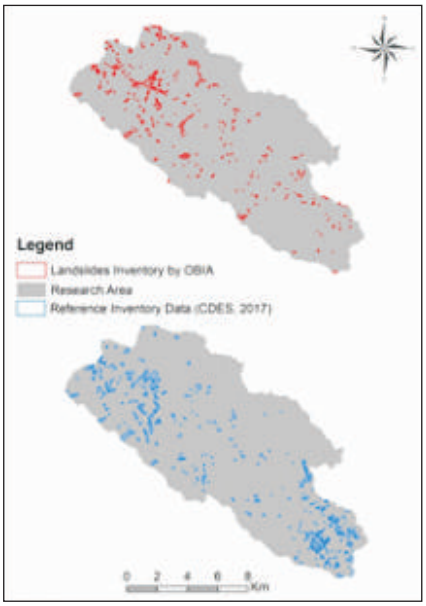


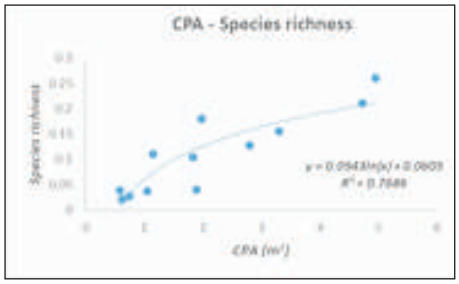
Fig. 2: Landslide inventory from OBIA and reference landslide database

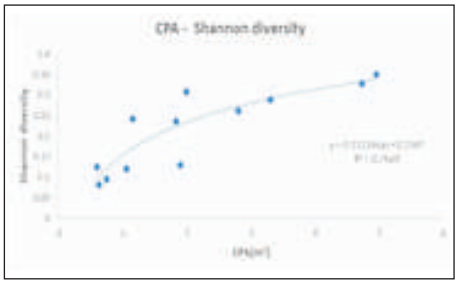
Assessing Biodiversity Patterns from very High Resolution Satellite Data

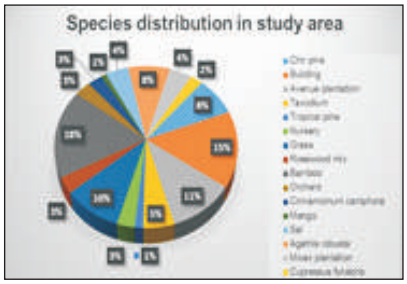
Forests are the most diverse terrestrial ecosystems and their biological diversity includes trees, but also other plants, animals, and micro-organisms. Several forest attributes, including size variability, amount of dead wood, and tree species richness, can be applied in assessing biodiversity of a forest ecosystem. Remote sensing offers complimentary tool for traditional field measurements in mapping and monitoring forest biodiversity.

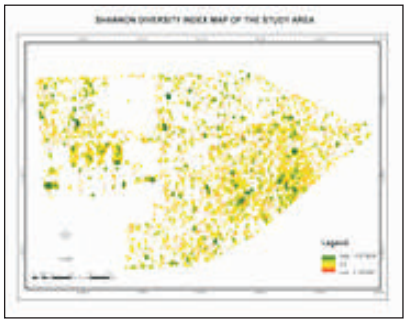
The objective of the study is to assess characterise biodiversity patterns of a very heterogenous and species rich forest ecosystem with very high resolution image from Cartosat -2S. We applied crown project area (CPA) approach

in estimating biodiversity indicators. The relationship between CPA and biodiversity index was established and validated using 29 trees recognized in the field. CPA was obtained using object-based image analysis and was compared with the manually delineated reference polygon to assess the accuracy. A non-linear regression model was adopted to derive the relationship between CPA and biodiversity index. This study showed that very high resolution image of crown project area (CPA) can be used to assess biodiversity of the study area. This approach is made possible because we employed cutting-edge image satellite with very high-resolution images (0.6 m resolution) of the canopy properties. The correlation coefficient of model obtained for CPA- with Species richness and Shannon diversity was 0.769 and 0.767. Generally, species richness and Shannon diversity was the best response measure to assess biodiversity from image analysis.



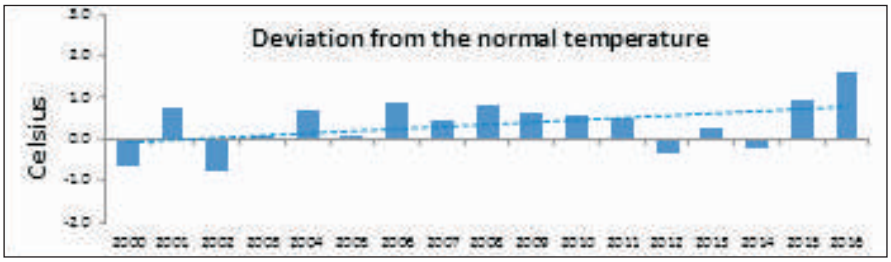


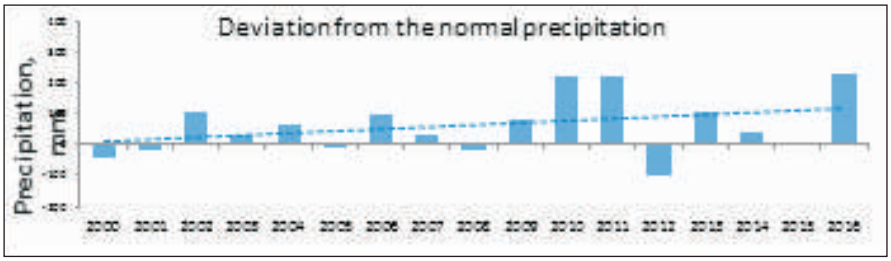




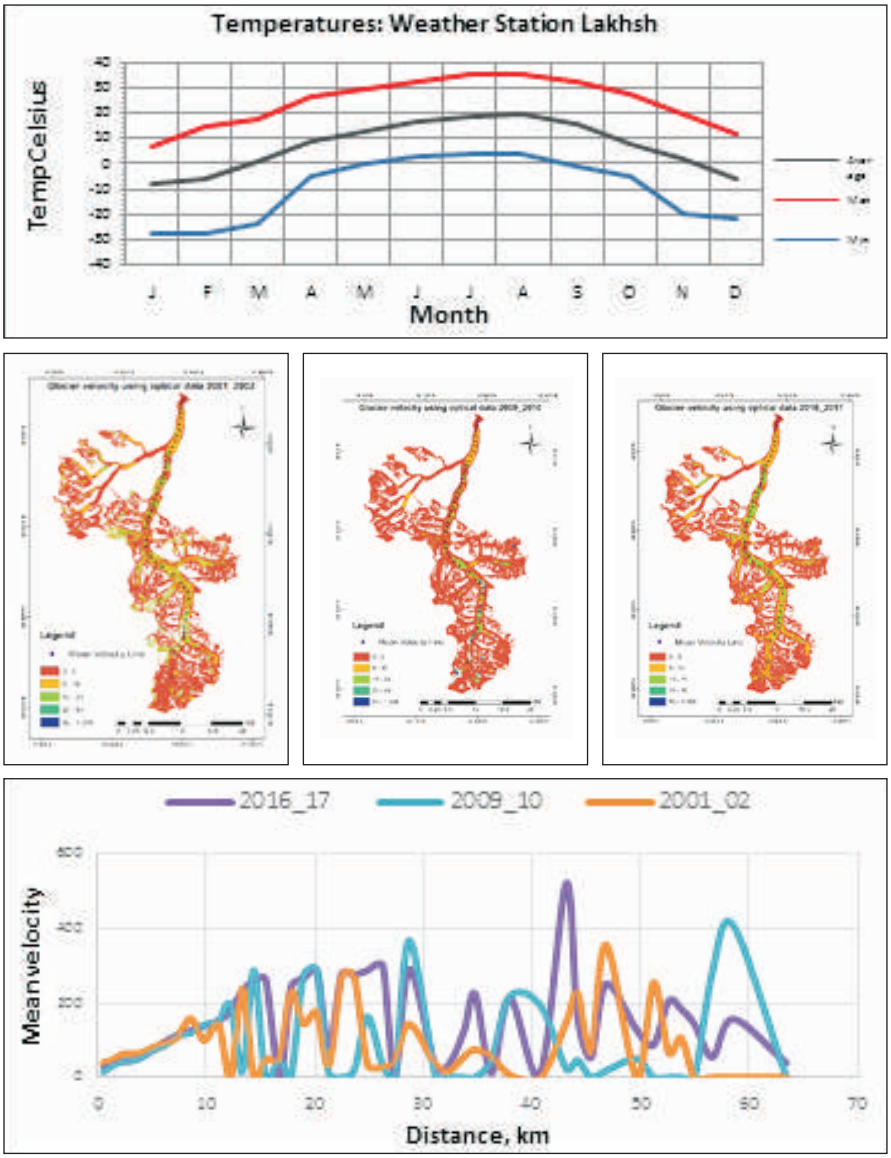
Remote sensing and Hydromet Data based Glacier Dynamics of Fedchenko Glacier

The mass balance of a glacier is a concept which is critical to all theories of glacier flow and behavior. In the year of 1910-1913, Fedchenko glacier has been separated into many parts and advanced outwards by 800-1000 m. In 1914, the glacier having 50 m thickness had blocked the valley of the river Balyandkiyk and rested against its right rocky slope. As a result, the river started flowing with high velocity under the ice. Once the glacier started melting, rivers overflowed and flooded the surrounding areas causes damage to the human life and properties. It is imperative to understand the velocity of the glacier in respect to its mass balance to safe guard the property and loss of life from its devastating effect. In this study, Landsat 4, 5, 7 and 8 images, Sentinel 1, hydromet data from 2000 to 2016 have been used for the analysis of Glacier





Fedchenko, having an area approximate to 952 km^2. Surface velocities were calculated using sub-pixel correlation of the acquired images, using the freely available software Co-registration of Optically Sensed Images and Correlation (COSI-Corr), which is downloadable from http://www.tectonics.caltech.edu/. In this algorithm, two images are iteratively cross-correlated in the phase plane on sliding windows, to find the best possible correlation. A detailed description of the algorithm is given by Leprince *et al.* (2007). After performing sub-pixel correlation, taking a sliding window of 64x32 pixels and a step size of two pixels we obtained three output images: a north/south displacement image, an east/west displacement image and a signal to-noise ratio (SNR) image that describes the quality of correlation. All pixels that have SNR < 0.9 and displacements >85m are discarded. According to Hydromet, here we see that in the winter season, the average and maximum temperature has increased during the study period, and in the same period the amount of precipitation has decreased along with the reduction in glacier as well.



Investigation of Tropical Cyclogenesis using NWP Model Analysis and Forecasts over the Bay of Bengal

A tropical cyclone (TC) is a warm-core intense low-pressure system around which air circulates in anti-clockwise direction in the northern hemisphere and in clock-wise direction in the southern hemisphere. TCs are one of the most devastating hazardous weather events in the world. Formation of TCs over Bay of Bengal (BoB) is significant due to long and low line coast and highly dense populated area with poor socioeconomic conditions. So, accurate predictions of genesis, intensity, track and landfall can reduce the loss of lives and property.

In the present study, Genesis Potential Parameter (GPP) has been used to predict the tropical cyclogenesis using the Numerical Weather Prediction (NWP) model analysis as well as forecasts (up to 96-hour). The National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) high resolution (0.250×0.250) data is used to detect the genesis of tropical cyclone before classified as a tropical cyclone (intensity ≥ 34 kt.) by the India Meteorological Department (IMD). In order to identify the genesis, a threshold value of the above discussed parameter is determined by maximizing the probability of detection (POD) and minimizing the false alarm ratio (FAR). The

threshold value has been computed using the data during the period 2015-17 and it applied to predict the tropical cyclogenesis of 4 tropical cyclones which formed over the BoB in the year 2018. The threshold value 60 is found as an optimum threshold to predict the cyclogenesis using GFS forecasts fields. To ensure that the model wind fields are realistic, the GFS wind fields is compared with the scatterometer SCATSAT-1 wind fields also. The result analysis shows that the tropical cyclogenesis can be predicted prior 24 to 60-hour of tropical cyclone formation.

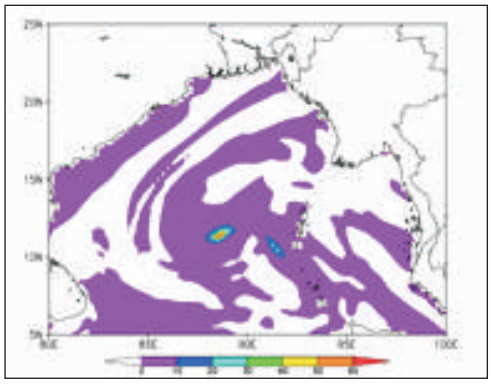


Fig. 1: Maximum GPP at 48-hour forecast on 09 NOV 2018 for Cyclone GAJA.

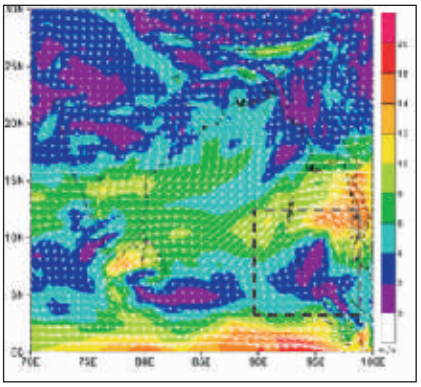


Fig. 2: The 850 hPa wind fields at 00 UTC of 09 NOV 2018 for Cyclone GAJA.

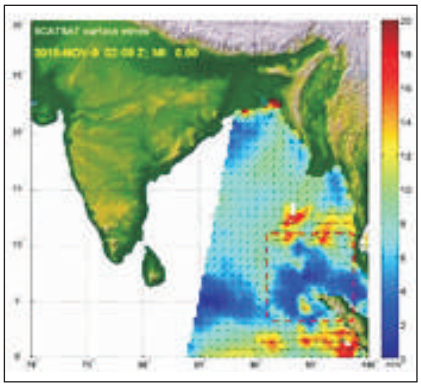
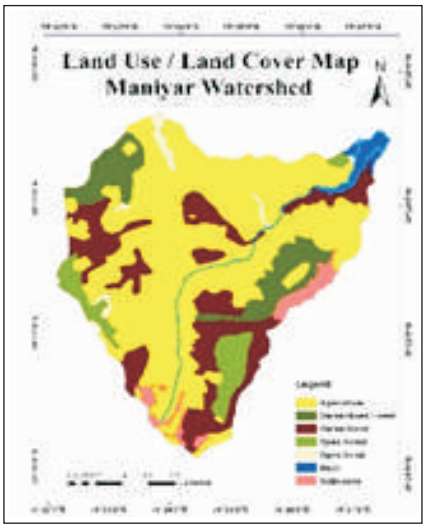
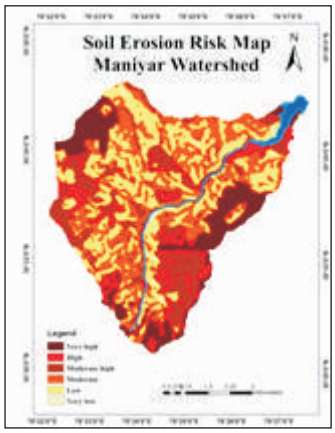


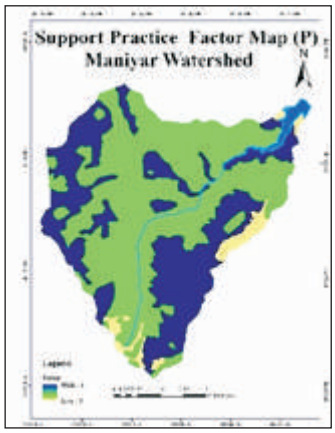
Fig. 3: The SCATSAT-1 surface wind fields at 02:05 UTC of 09 NOV 2018 for Cyclone GAJA. Source: https://mosdac.gov.in/scorpio

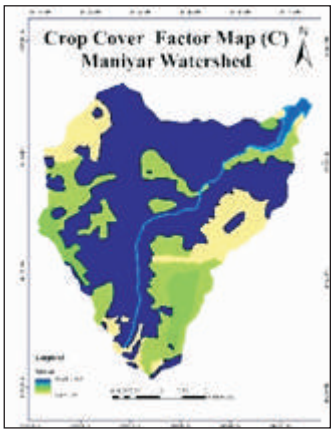
Soil Erosion Risk Assessment using RS and GIS

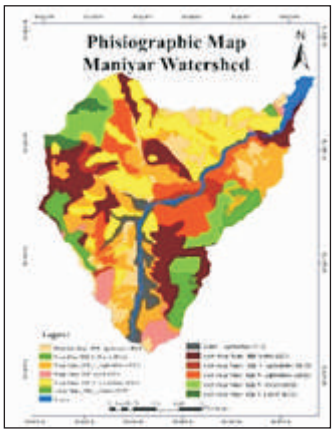
Soil erosion is a global environmental crisis in the world today that threatens natural environment and agriculture. The soil erosion risk assessment can be helpful for land evaluation in regions where soil erosion is the main threat for sustainable agriculture. Spatial distribution of soil erosion risk in the watershed was estimated by integrating various RUSLE factors (R, K, LS, C, P) in raster based GIS environment. RUSLE model factors maps were generated using remote sensing satellite data (IRS LISS IV and LANDSAT-8) and Digital Elevation Model. Visual land use land cover analysis revealed that Agriculture (59%) was the dominant land use system followed by Scrub land (18%) in the study area. Nearly 70% of the watershed is having steep to









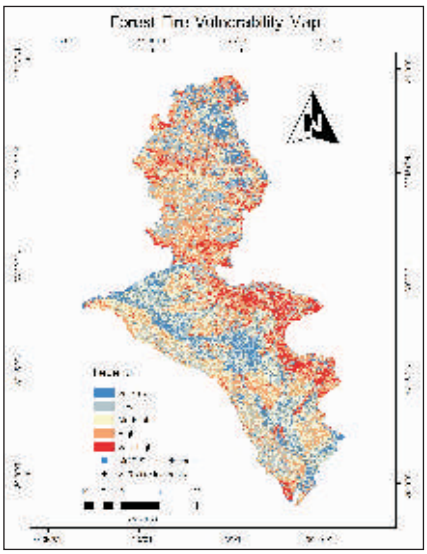


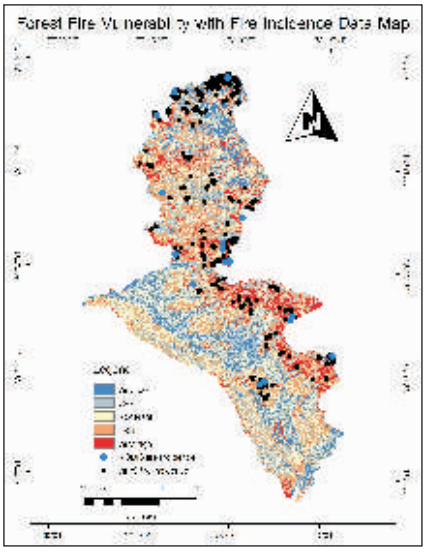
moderately steep slope (>40%). Soil erosion risk analysis showed that 15% of the total study area belonged to very low soil erosion risk class, 9% in low, 21% in moderate, 30% in moderate high, 24% in high and 1% area in very high erosion risk class. The average annual erosion rate was predicted to be 26.13 t/ha/yr. The predicted soil erosion rates were found to vary from 3.01 t/ha/yr in dense mixed forest cover to 38.69 t/ha/yr in open scrub land.

Forest Fire Vulnerability Modelling

Forest fire is regarded as one of the major disaster in many countries worldwide. It affect forest ecosystem by damaging the biodiversity, environment and wildlife. Forest fire, either natural or human induced, damage the fragile ecological and environmental stability of a region. It is difficult to predict forest fire, especially when forest fire is human induced, thus identifying the forest fire vulnerable area can help in effective planning of precautionary measure. Remote sensing due to its synoptic and high temporal coverage, RS & GIS technique has become an effective tool for mapping forest fire vulnerable areas. Human-made forest fires in the Himalayan state of Uttarakhand have been a regular and historic feature. Therefore, Dehradun district of Uttarakhand has been taken up for this study. This project probes to characterize the thermal, moisture and fuel type regime influencing forest fire and develop a forest fire vulnerability map by using RS & GIS technique.

A forest fire vulnerability map was generated considering the land cover type, terrain geomorphology (aspect, slope and elevation), anthropogenic factors, thermal regime and moisture regime. Different thermal (LST) and moisture indices such as NDWI, NDMI and NBRI derived from various sensor such as Landsat-8 OLI, Sentinel-2, MODIS and VIIRS were also tested during the study. Prepared forest fire vulnerability map were classified into five vulnerable zones viz. very low, low, moderate, high, and very high. The result of the study showed 35% of the Dehradun district under high and highly vulnerable area. The result of this study was corroborated with the fire incidence data from MODIS and VIIRS and showed appreciable reliability.





Integration of Remote Sensing and Geographic Information System with Geophysical Techniques for Groundwater Exploration-A Case Study of PYSD, Kimari and GNFC Area, Mussoorie, Dehradun

Remote Sensing and Geographic Information System plays an important role in hydrogeological science, which provide aid in inferring, observing, accessing and safeguarding groundwater resources. The existence of groundwater depends on various theme namely; geomorphology, geology, slope gradient, drainage density, lineament, land use landcover, vegetation index and

topography. The selected themes were assigned weightage and rank based on their effective contribution toward occurrences of groundwater. The potential area for prospecting groundwater was generated using Weighted Index Overlay (WIO) algorithm.

The potential area in the region is further categorized into five distinct zone; very low, low, moderate, moderately high and high potential zone. Out of 19.7 sq.km of total basin area, 1.65% fall under very low category, 36% under low category, 55% under moderate zone, 7.6% under moderately high zone and 0.04% under high prospect zone of groundwater.

In general, PYSD, Kimari and GNFC area falls under low to moderately high zone of groundwater with GWPI of 4 to 6. To ascertain and to validate remote sensing and GIS, the follow up geophysical investigation using 2D ERT geoelectrical technique with dipole-dipole and pole-dipole and 1D VES with Schlumberger electrodes configuration technique were deployed. The survey is conducted in moderately high potential area based on topography and geological setting of the study area to ascertain the existence of groundwater as suggested using remote sensing and GIS techniques. PYSD, Kimari area occurs aquifers in shallow depth and GNFC area under deeper depth of groundwater under same potential zone.

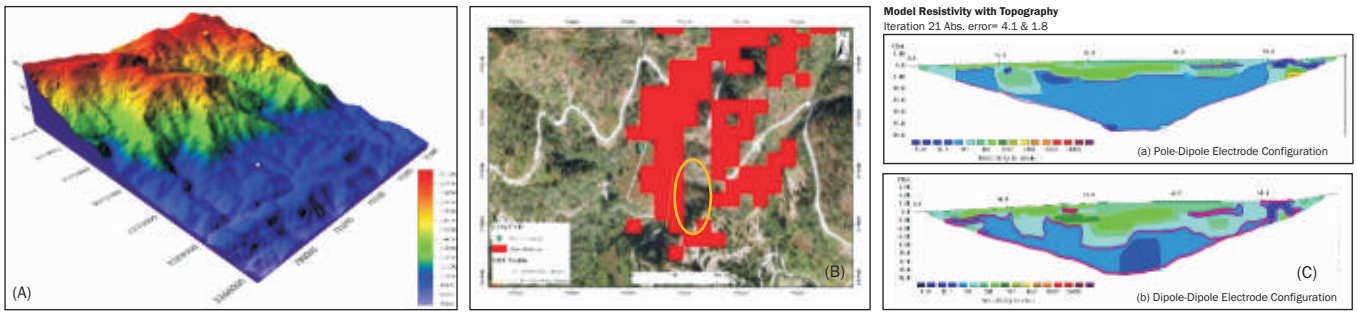
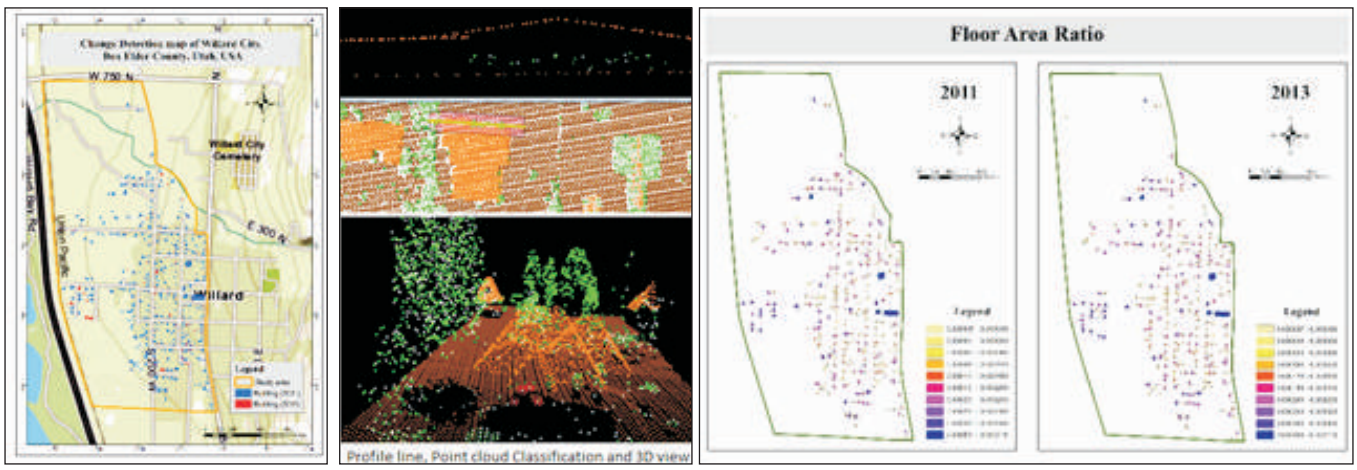


Fig. (1a): Hill shade **(1b):** PYSD potential area & **(1c):** 2D ERT section

Monitoring Urban Change using LiDAR Data

Building Density Information and Building change detection is fundamentally important for urban design, illegal building identification, urban growth monitoring, planning and management for urban environmental studies. The current project proposes an automatic LiDAR reclassification method from Light Detection And Ranging (LiDAR) point cloud data within the spatial limits of Willard City, Box Elder County, Utah in USA. In this method, the data are first preprocessed to identify and remove the noise points from two-year point cloud data (2011 and 2013). Automatic Non-Ground Point reclassification technique were used thereafter for



identifying building parameter such as height, size, area and elevation. The manual classification was further used for identification of right objects (building) to right class (building class). Here the most common indices or parameter for building density determination namely Building Coverage Ratio (BCR) and Floor Area Ratio (FAR) was used.

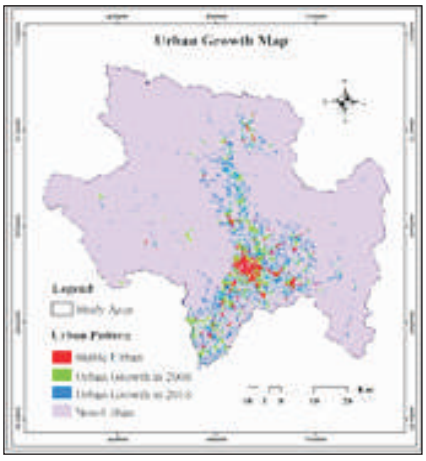
The classification result was assessed in term of accuracy by using confusion matrix in ArcGIS platform and obtained 99.5% accuracy with kappa coefficient of 0.92 and above. The BCR in year 2011 is 0.034 and 0.036 in year 2013. The FAR in the year 2011 is 0.00012 and 0.00037 in year 2013 respectively. The rate of construction of new buildings is higher than rate of demolishing, thus increasing the BCR and FAR from 2011 to 2013. The change detection has been carried out in term of number of new buildings in the year 2013 with 2011 buildings as a stable building and 27 new buildings are observed to be constructed in 2013 additional to the base year 2011 and 8 number of buildings were demolished in the year 2013.

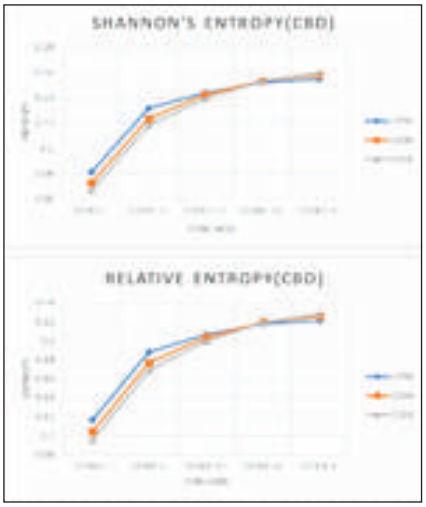
Analyzing Urban Growth Pattern of Chiang Mai City, Thailand using Remote Sensing and Geographic Information System

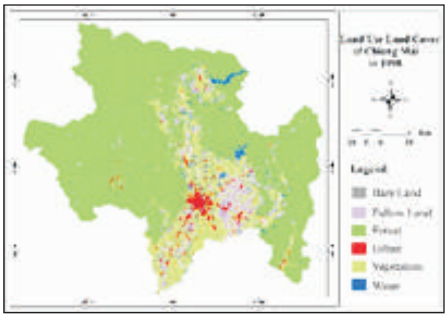
Urbanization is the gradual shift in relative population from rural to urban areas. Urban growth reflects a general increase in either land area or the population size of an urban area. Urban growth can be achieved through small scale development in a city or the expansion of a city through urban sprawl. The main sources of urban growth are due to rural urban migration and due to natural increases in population which are already residing in the urban area.

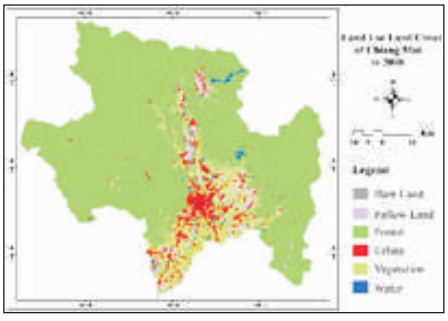
Therefore, remote sensing and GIS help in delineating the urban growth providing large extent coverage which is impossible in conventional method like surveying, etc. Landsat 8 OLI and Landsat 5 TM were used to mapped and to determine the urban growth pattern in the study area. The most advance techniques of classification were adopted in the current study using eCognition software, i.e. OBIA. The classification result was further assessed with 90 % accuracy with the kappa coefficient of 0.88.

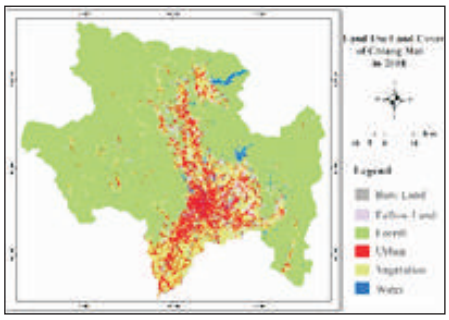
To analyzed the maximum urban growth, the Center Business District (CBD) and road were considered. Shannon's and Relative Entropy algorithm were used to determine how densely the urban is within the buffer zone of certain distance from either Center Business District (CBD) and road. The current study used how densely the built-up are occur nearby CBD and road periphery. The graphical representation shows both the Shannon and relative entropy are nearly to 0 in zone I (1km buffer) and increasing further which shows that the











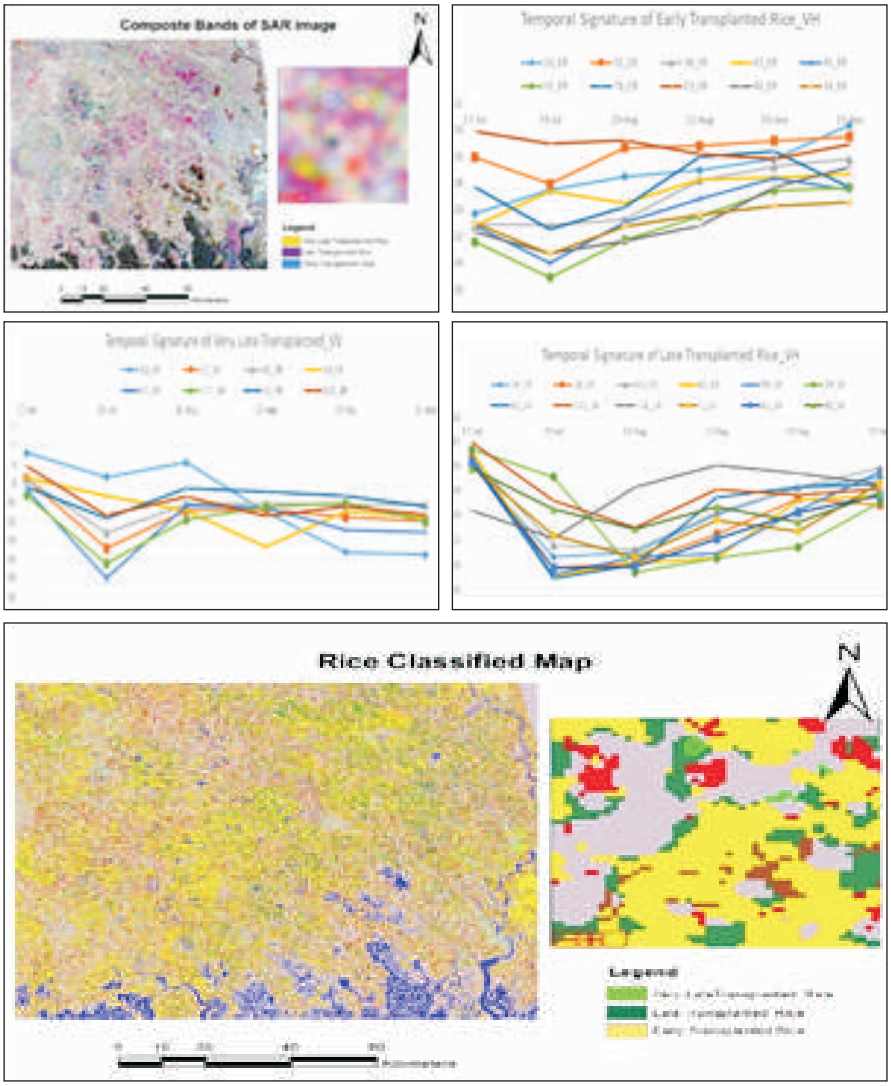
buildup are mostly occurs within Zone I followed by Zone II (2km buffer) and etc.

The current study area (Chiangmai), is a largest province in Thailand having total area of study area 5297.11 sq.km. The main cause of urbanization is due to abundant natural resources, culture and tourist attraction. The rate of urbanization is increased from 2.73% to 5.19% from 1998 to 2018 and non-urban decrease from 97.27% to 94.81% respectively.

Rice Crop Inventory Using Temporal Sentinel SAR Data

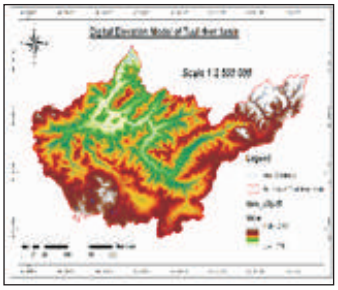
Identification of crop types is the first step of satellite remote sensing based crop mapping, monitoring and yield forecasting. Bangladesh is an agro-based country and rice is the main agricultural product. There are three rice seasons in Bangladesh, viz Aus, Aman and Boro. Aman rice is Kharif season crop, that time is the monsoon time of Bangladesh and covered by cloud. Microwave remote sensing has the advantages to penetrate clouds and to some extent rain. Multi-temporal SAR data can be used to retrieve the rice growing cycle based on the temporal variations in the SAR backscatter (σ°(dB)) signal. Prime focus of the study are extracting the temporal signature of rice types and classification of various rice types based on unique temporal signature in Jashore district of Bangladesh. Six dates and twelve dates interval Sentinel-1A data were downloaded from the European Space Agency (ESA) for Kharif seasons from 17 July 2018 to 15 September 2018.

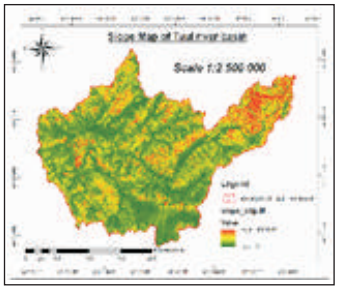
The pre-processing of Sentinel-1A data includes five main steps: Orbit file correction, speckle noise filtering, radiometric calibration, terrain correction and data conversion from sigma nought (σ°) values to dB values. These scenes were then stacked into a multi-temporal composite scene. Then temporal signature of various types of rice and others were extracted. SAR 3 dates composite image and temporal signatures of rice by VH polarization are shown in the figure. Then with the temporal signature, classified map ware prepared. Three types of rice were found, these are early transplanted rice i.e. transplanted mid July to end July, late transplanted rice i.e. transplanted early August and very late transplanted rice i.e. transplanted late August to early September, among them early transplanted rice covers the large area and very late transplanted rice covers very few areas. Classification map of rice area are shown in the figure.

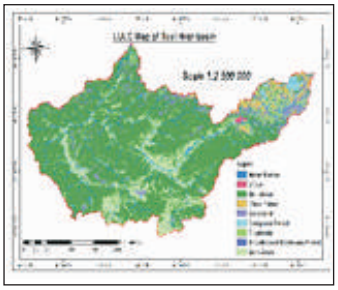


Snowmelt Runoff Modeling in TUUL River Basin, Mongolia

The TUUL River originates in the Khan-Khentein-mountain Nature Reserve, in the Erdene sum of Töv province, pass through central and northern Mongolia. It is 898 km long and the watershed area is 57,764 sq. km. The basin annual average precipitation amounts to 246.7 mm (in the vicinity of Ulaanbaatar city). It is estimated that 48.4% of annual average precipitation becomes evapotranspiration and 51.6% becomes surface water and groundwater recharge. The lowest temperature of -48.0 °C is recorded in the month of January. The highest temperature of 43 °C is recorded in the month of August. The annual mean daily temperature lies between -48°C to 43°C. In the present study, the hydrological simulation of Tuul River with emphasis on snowmelt was carried out using the Variable Infiltration Capacity (VIC) model. The model has been setup with data SRTM DEM, FAO soil texture, MODIS LULC, MODIS snow cover area, ground observed hydrological data of 02 and meteorological data of 10 stations. The general elevation of the land surface of the study area ranges from 776 m to 2793 m above mean sea level. The snowmelt runoff during time between April and June. Between 2004 and 2016, the range of long term snow cover ranges between 5 and 95% between October and April. The model simulates daily stream flow in mountainous and other types of basins where snowmelt is a major runoff contributor. The period 20112016 was used for calibration and validation of VIC. After calibration the value of R^2 between simulated and observed discharge was 0.75 for Tuul-Ulaanbaatar and 0.71 for Tuul-Altanbulag station. Average measured runoff is 16.5 (m^3/s), average computed runoff is 13.9 (m^3/s); and maximum measured runoff is 206.0 (m^3/s), maximum computed runoff is 237.5 (m^3/s) in Tuul-Ulaanbaatar station. Average measured runoff is 12.7 (m^3/s), average computed runoff is 19.2 (m^3/s); and maximum measured runoff is 124.2 (m^3/s), maximum computed runoff is 290.3 (m^3/s) in Tuul-Altanbulag station.







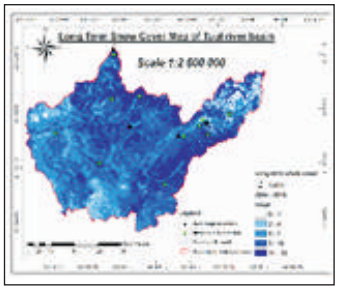
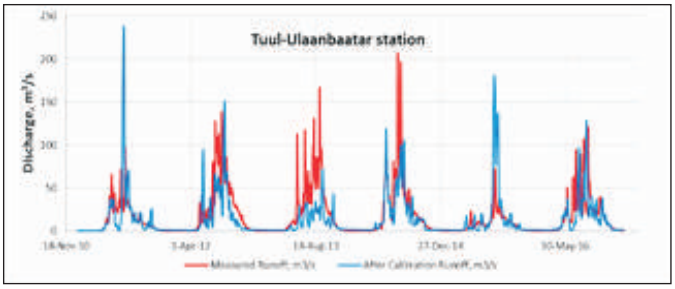


Fig. 1: Dem, Soil, Slope, Annual Precipitation, LULC and Long Term Snow Cover Maps



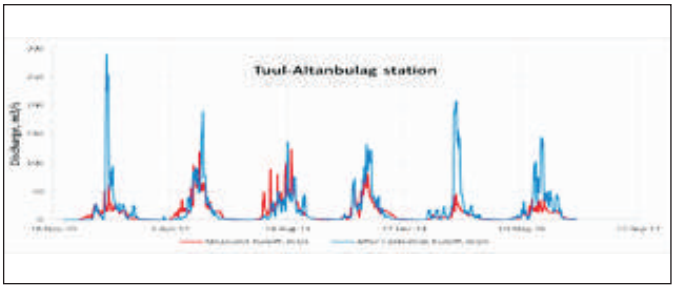


Fig. 2: Measurement and computed discharge in TUUL River basin (2011-2016)

Remote Sensing based Resrvoir Sedimentation- A Case Study of Bargi Reservoir

A reservoir is an important part of a water resources system. Temporal analysis of the sediment deposition pattern and evaluation of available storage capacity of reservoirs is an integral aspect of water resources management. The common techniques of quantification of sediment deposition in a reservoir, such as hydrographic surveys and the inflow-outflow methods, are time and cost consuming. Further, modelling of sediment deposition profiles using empirical and numerical methods requires a large amount of input data. Due to sedimentation, the water-spread area of a reservoir at various elevations keeps on decreasing. Remote sensing, through its synoptic attributes, provides a bird's view spatial and repetitive information on the water-spread area of a reservoir. By use of remote sensing techniques in conjunction with a geographic information system, the spatial and non-spatial attributes can be integrated to evaluate the water spread and sediment deposition pattern in a reservoir.

Temporal analysis of data can be used for assessment of reservoir sedimentation rates along with Area-Elevation-Capacity Curve using simple trapezoidal formula. For the assessment of Bargi reservoir sedimentation in present study multi-date Landsat satellite data is used for two periods i.e. 2005-2006 and 2016-2018. It was found that the reservoir has lost its capacity by 410 Mm^3 by the end of water year 2005 and 783.4 Mm^3 by 2017. The rate of sedimentation was estimated as 24.12 and 26.11 Mm^3/year by the end of 2005 and 2017, respectively. It was observed that rate of sedimentation is increasing between the years of analysis. On the other hand, the hydrological model can be used to simulate the sediment inflow in the reservoir. The SWAT hydrological model has been realized for catchment upstream Bargi Dam. The model inputs have been derived from various sources such as LULC, Soil and DEM. The meteorological data to force the model has been taken from India Meteorological Department for the period of 1951-2017. It was observed that the sediment inflow to the reservoir by the end of 2005 was 554.4 Mm^3 and 788.5 Mm^3 by the end of 2017. The analysis showed that the trapping efficiency of the reservoir is very high.

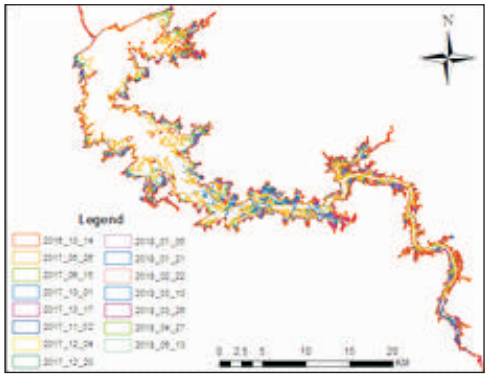


Fig. A: Water Spread Area Map from 2016 to 2018

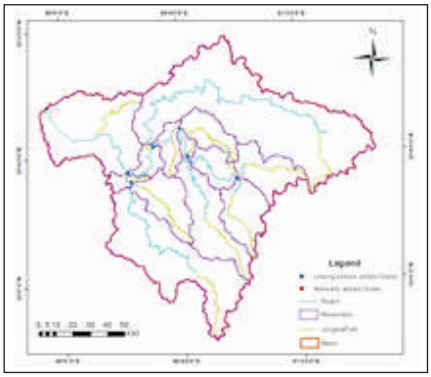


Fig. B: Narmada River Basin

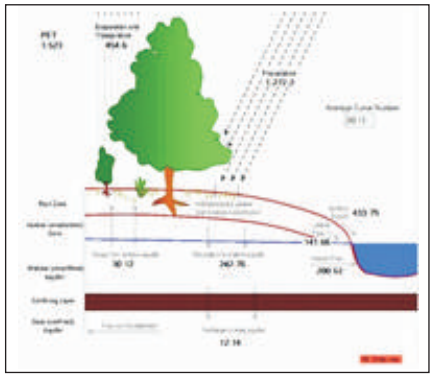


Fig. D: Hydrological Model

Hydrological Simulation for Reservoir Sedimentation Assessment

Reservoirs are vital elements of the hydrological cycles, utilized for water supply, irrigation and flood control. Periodic evaluation of the sediment deposition in reservoirs and the assessment of available storage capacity of reservoirs are important aspects of water resources management. The conventional techniques of reservoir sedimentation assessment, such as inflow-outflow methods and hydrographic surveys are costly and time-consuming. Further, modelling of sediment transport in reservoirs using empirical and numerical methods requires a large amount of input data. Satellite Remote Sensing (RS) provides synoptic, timely and

repetitive information on water-spread area of a reservoir at different elevations. By applying RS in combination with GIS, the temporal change in water-spread area can be analyzed to evaluate the sediment deposition in a reservoir. In this study, a RS approach and distributed hydrological model (SWAT) have been used for asssessing sedimentation in Tawa Reservoir, Madhya Pradesh State, Central India. Water-spread area of Tawa Reservoir at different elevations for the periods of 2005-2006 and 2017-2018 was extracted from multi-date Landsat data. The revised capacity of Tawa Reservoir between two successive elevations was computed using the Trapezoidal formula using calculated water-spread area and the availability of observed reservoir water level data. The Elevation-Capacity curves and tables are derived for estimating reservoir sedimentation. SWAT model with input data including DEM, meteorological data, land use-land cover and soil map used to estimate sediment transport to Tawa Reservoir from 1978 to 2017. However, sedimentation rate of Tawa Reservoir using RS approach are quite different with the result of estimation from SWAT model. The results gave the idea of using RS technique and hydrological model for reservoir sedimentation assessment but needs further study to validate.

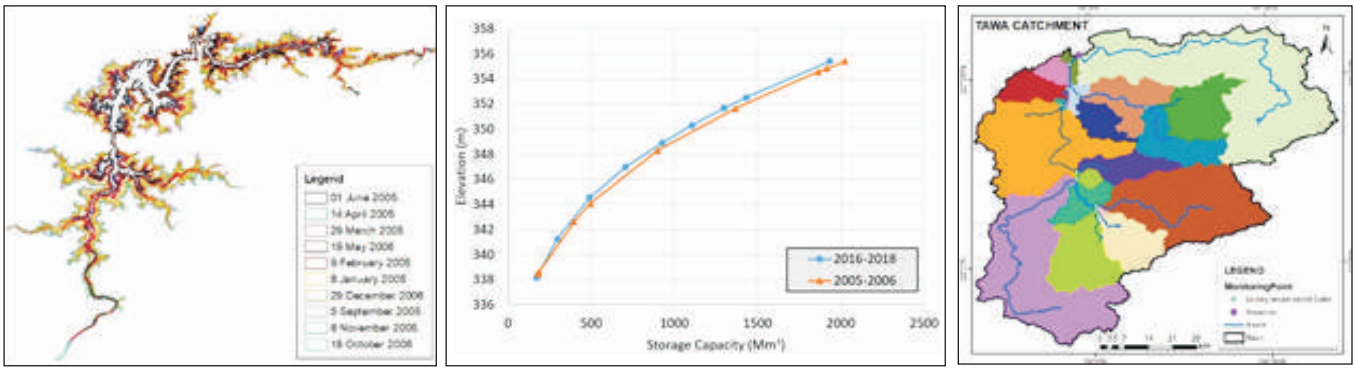


Fig: Water spread area for Tawa reservoir for 2005-2006 (left), Elevation-Capacity Curves (middle), Tawa catchment delineation from SWAT model (right)

Characterization of Crater Morphology and Mineralogy of Chandrayaan 2 Landing Site and its Terrestrial Analogue

The advancement in planetary remote sensing has opened new areas for lunar exploration. The imaging spectroscopy technique offers an opportunity to map and discriminate different minerals on the lunar surface which further helps to understand the origin, evolution process, and the crustal composition on the surface of the moon. In this research we have evaluated the utility of imaging spectrometry to study the spatial distribution of minerals around Moretus, Boguslawsky, and Manzinus craters located near the South Pole region of the moon and terrestrial analogue viz. Dhinodhar volcanic plug/dome located near Nani Aral village, in Kutch District, Gujarat. Moon Mineralogical Mapper (M^3) sensor onboard Chandrayaan 1 satellite with 85 bands and 140m spatial resolution was used for lunar craters whereas Landsat 8 and ALOS PALSAR DEM were used to

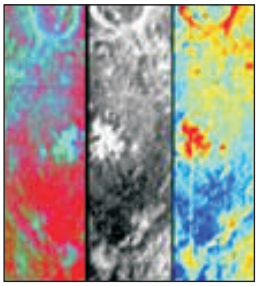


Fig. (a): Olivine/Pyroxene, Distribution, Moretus crater

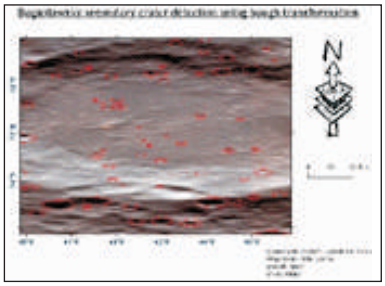


Fig. (b): Secondary Crater detection inside Boguslawsky floor

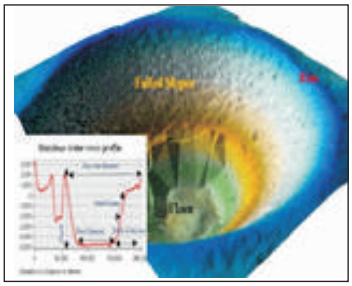


Fig. (c): Morphological Outline of an impact crater

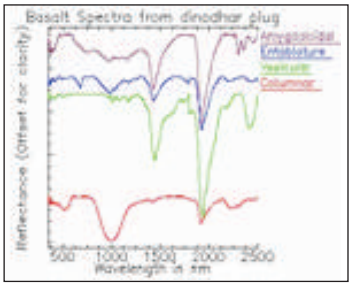
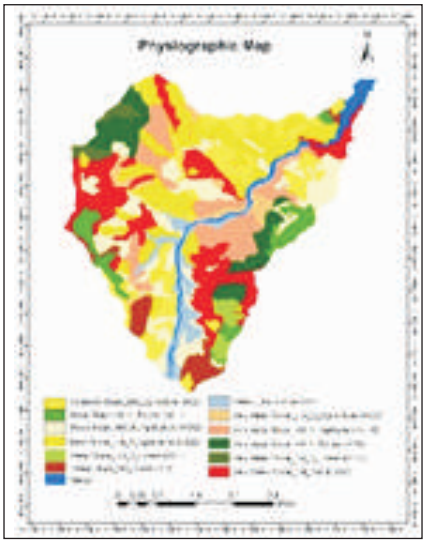


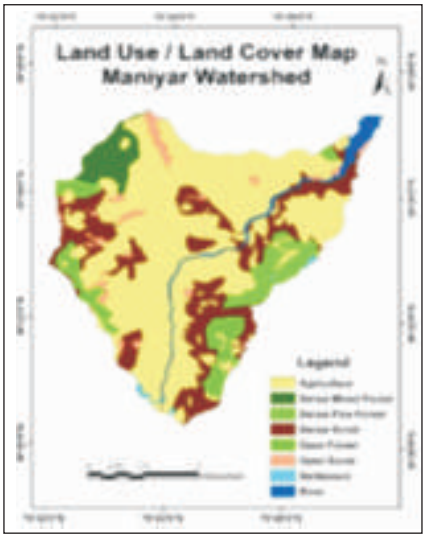
Fig. (d): Field Spectra of basalts, dinodhar Plug area

map structure and geology of Dhinodhar plug. data was used to analyze the surface mineral and geochemical composition based upon the diagnostic absorption bands of ferrous elements in crater materials. The crater centers were found to be richly concentrated by low Ca pyroxene minerals, concentration of which decreased away from the center. Therefore, it is a manifestation of high concentration of FeO near the crater center due to the characteristic ferrous absorption indicating less matured optical materials at the center with gradual decrease of the same, away from the center indicating low concentration of fresh ejecta materials along with matured soil/debris. In areas away from the crater center, and materials are interpreted as highly optically matured anorthositic debris dominated by plagioclase feldspar. Based on the application of Hough transformation (Paul Hough,1962), we were able to detect secondary craters within the primary craters. The morphometry, age, size and dimensions of the craters were calculated subequently. Field survey was carried out to dhinodhar plug in Kutch. Spectral analysis of the collected rock and soil samples depict 2.2 Al-O/OH or Mg-O/OH feature and possible pyroxene absorption feature near 1 micrometer implying basaltic materials and their weathering derivative. These ground-based spectra were correlated with the spectra of the Moretus central peak, formed as a result of cratering. The extraction of surface mineral information from earth analogues using imaging, spectroscopy is more difficult than of lunar craters due to influence of atmosphere vegetation cover degree of weathering and human activities.

Soil Characterization and Capability Assessment for Land Use Planning using RS and GIS

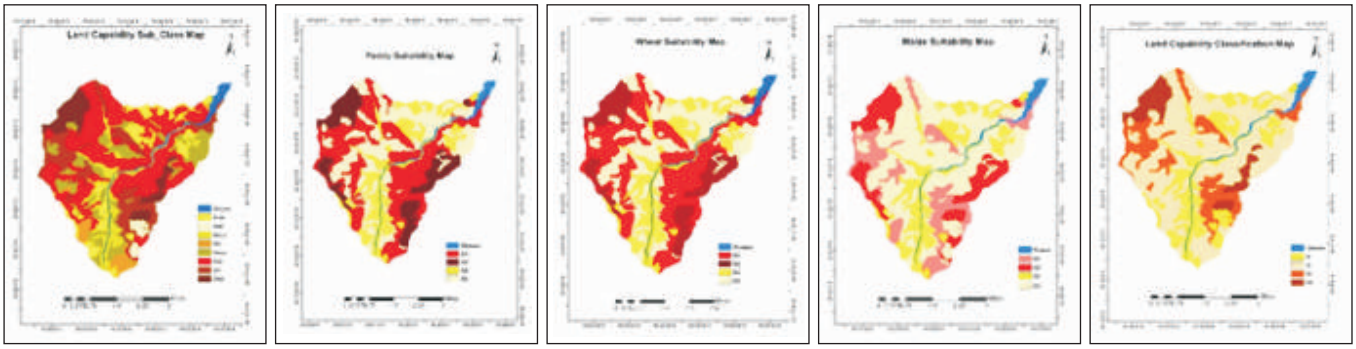
Land evaluation is aimed at assessment of land performance and its production potential for a specific purpose and land suitability is the systematic grouping of different kinds of land to sustain their productivity. To reduce the human influence on natural resources and to identify an appropriate land use, it is essential to carry out scientific land evaluations. Such kind of analysis allows identifying the main limiting factors for the agricultural production and enables decision makers to develop crop managements able to increase the land productivity. Objectives of this study was to develop a RS and GIS based approach for land use suitability assessment which will assist land managers and land use planners to identify areas with physical constraints for a range of





nominated land uses. The present study assessed land Suitability for maize, wheat, and paddy crops using FAO frame-work of land evaluation in Maniyaar Watershed of Tehri Garwal District, Uttrakhand, India. IRS LISS IV and two season Landsat 8 OLI data were used to prepare land use/land cover and Physiographic soil map of the watershed. Different land quality parameters, viz. soil texture, depth, erosion, slope, flooding and coarse fragments under various land units were evaluated for the crops. Visually Land Use Land Cover analysis revels that 58% area is under Agriculture, 15% under forest and scrub 21 %, settlement 3% and Stream 3%. The parameter wise suitability was assigned to

physiographic unit slight suitable (S1), moderate suitable (S2), marginal suitable (S3), currently not suitable (N1), and permanently not suitable (N2) and accordingly the map was generated and also the physiographic units of watershed were assigned to different classes (C) i.e., C-III (19%), C-IV (56%), C-VI (16%), and C-VII (9%) based on criteria for land capability classification for land use planning in hilly area.



Mapping Of Biomass Using Very High Resolution Data

Forest biomass is one of the key measurement for accounting carbon budget, monitoring carbon flux, and to study the climate change. The aboveground biomass (AGB) is the bio-physical parameter which is used to quantify the carbon content. Forest agencies also requires AGB information time to time for continuous monitoring of forest and future planning purpose. Remote sensing is proved to be a more proficient tool in AGB assessment. Hence, it is essential to develop a credible approach to estimate forest biomass and carbon stocks. This study applied Cartosat-2S satellite imagery combined with field-measured biomass using non-linear regression equation to estimate forest aboveground biomass (AGB) in Barkot reserve forest, Uttrakhand, India. The various parameters like Diameter at Breast Height (dbh), Tree height and Crown Projection Area (CPA) were taken from the field. The accurate CPA was extracted by multiresolution segmentation. The aboveground biomass was calculated using the volumetric equation for sal and teak, which was then converted to Biomass. The non-linear CPA- biomass model was developed for biomass mapping by correlation analysis between CPA and biomass. According to ESP tool, scale Parameter-18 was used for multiresolution segmentation. The overall accuracy of segmentation was achieved as 74.6%. Object-based classification was done on the segmented image by developing the ruleset based on NDVI, EVI, Red, and brightness values. Classification accuracy for different classes was 86.12%, which was found significant. The lowest biomass value ranged from 0.61- 3.81 ton per tree.

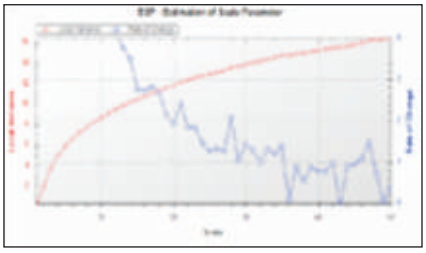


Fig. : ESP Estimation

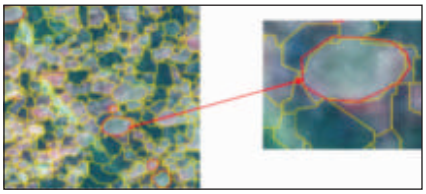


Fig. : Segmentation Accuracy

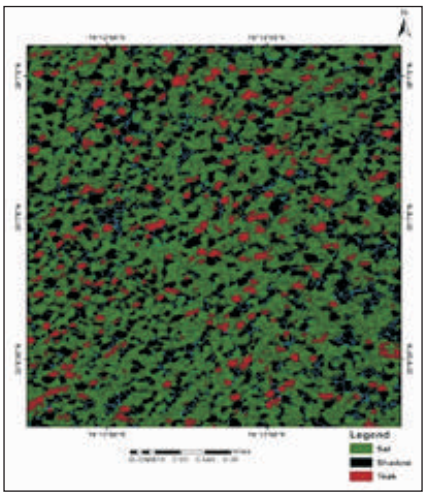


Fig. : Classified Map

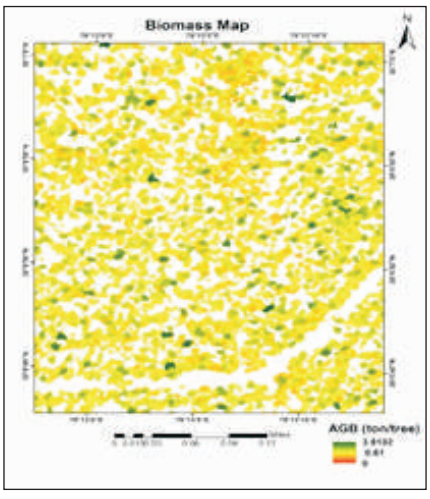
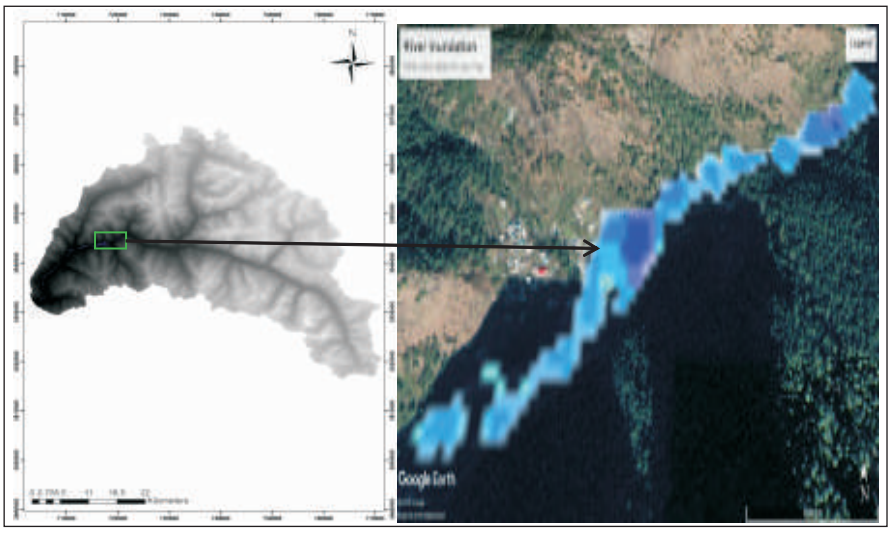


Fig. : Biomass Map

Flood Hazard Mapping in Parbati Valley

Flood is a natural disaster and causes loss of life and property destruction. The objective of this study was to analyze flood inundation area mapping at Parbati River in Himachal Pradesh area. The flooded areas along the main Parbati catchment area have been mapped based on the flow rates for different return periods using the HEC-RAS model, GIS for spatial data processing and HEC-GeoRAS for interfacing between HECRAS and GIS. The areas along the main Parbati in the study area were simulated to be inundated for 30, 50 and 100 years return periods. An inundation map displays the spatial extent of probable flooding for different scenarios and can be present either in quantitative or qualitative ways. The flood inundation maps for 30, 50 and 100 years return periods were prepared using ArcGIS. The major findings in the study revealed that low lying areas near Mankikarna, Bhuntar and Kasol got indudated for all the extreme flood event scenarios. Therefore, proper flood management can be adopted to reduce the adverse effects of flooding particularly in the low-lying flood prone areas.



Soil Salinity and Water Logging Assessment using Remote Sensing and Geographic Informationn System (GIS)

Soil salinization is far from being a uniform process. Salinity can develop both naturally and from human interventions in the water cycle through irrigation. Salinization means the excess amount of salt present in the soil. Salt only moves through the movement of soil moisture. Thus the time-depth behavior of salt is highly dynamic. Large number of measurements over a time period is necessary to diagnose salinity as it is hazardous to crop production.

Waterlogging refers to the saturation of soil with water. Soil may be regarded

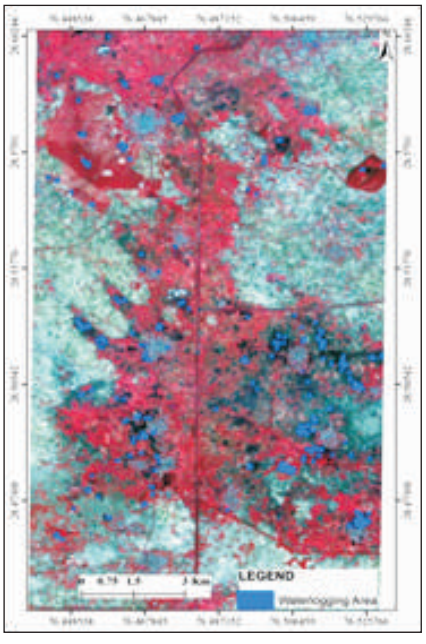


Fig. 1: Waterlogged area

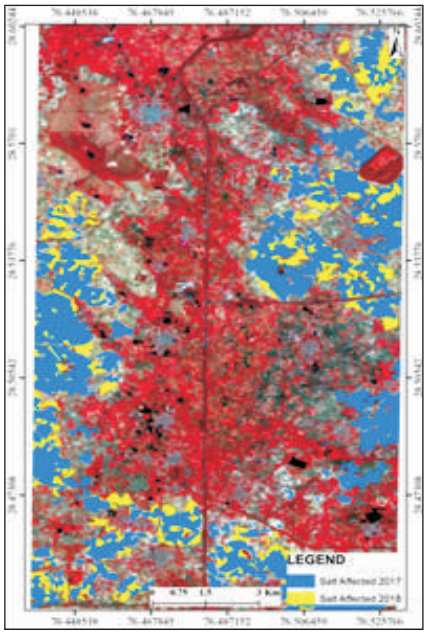


Fig. 2: Salinity Map 2017-2018

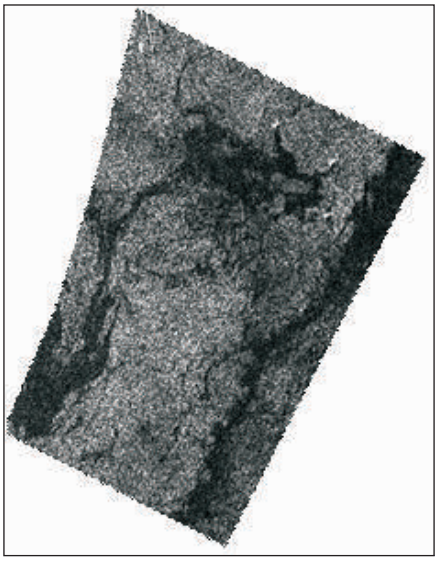
as waterlogged when it is nearly saturated with water much of the time such that its air phase is restricted and anaerobic conditions prevail. Waterlogging occurs in all or part of the soil profile saturated with water. The degree to which a soil becomes waterlogged depends on how much water enters the soil and how quickly it leaves it, either by deep percolation, lateral seepage or evapotranspiration.

Remote sensing and Geographic Information System can be used to generate waterlogging and salinity affected area using different type of indices. The current study used Landsat 8 OLI multispectral data acquired from space for deriving soil salinity and waterlogging affected area using band 3(Green), band 4 (Red) and Band 5 (NIR), respectively. The most common indices that were used for the current study is salinity index (SI) and Normalized Differences Water Index (NDWI). The salinity and waterlogging of 2 successive years from 2017 to 2018 were mapped and derived the changes.

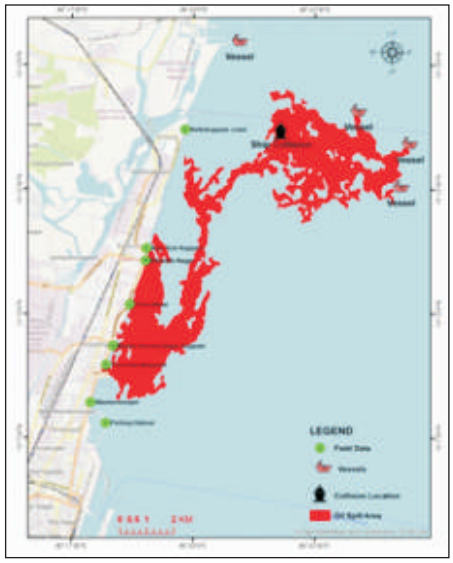
Out of 16845 hectares, 15.4% were affected due to salinization in 2017 and 12.4% in 2018.

Sar Data Processing for Oil Spill Detection

Manual mapping of the aerial extent of the oil slick is a difficult and cumbersome exercise. Remote sensing offers an ideal and efficient way to map the oil spill and monitor its spread through multi-temporal datasets. The aim of this study was to detect the oil spill area in the coast of Chennai where two ships MT Dawn Kanchipuram and MT BW Maple collided on 28th January 2017. A dual polarization (VH, VV) Sentinel-1 SAR satellite data acquired at 6.00 hours on 29th January 2017 was used to map the extent of spill. The radiometric normalization/ calibration, split, debrust, multilooking, filter and ellipsoid correction were implemented on the dual-polarized SAR data. After pre-processing of the data, oil spill area was detected using three approaches: Simple threshold, Oil spill detection tools in SNAP software and Object-based classification by contextual information. The study showed that the VH polarimetric combination has capability to detect bright targets like vessels, while the VV mode had shown the capability to detect oil spilled area. As an oil spill is physically a low backscatter area and appears as a dark area in SAR images, allows to some extent to estimate the size, location and dispersal of the oil spill. In the first oil spill detection approach, oil slick was assigned by pixels which their backscattering cofficient value is smaller than -22.0dB. In the second oil spill detection approach, three parameters: Background Window Size = 500, Threshold Shift = 3.5dB and Minimum Cluster Size = 1km2 were utilized to detect oil spill. The drawback of the first two methods was indistinguishable from oil spill and look-alike features. In the last approach, the oil slick was detected and distinguished from the look-alike by contextual information, such as collision location, ships location, wind direction, current direction. The final result was validated by field data collected near shoreline and oil streaks which were extracted from Sentinel-2 optical data.



Sentinel-1 SAR data (VV polarisation)



Oil Spill Map on 29/01/2019

Time Series Interferometry Analysis for Deformation Monitoring using Scatterer based Technique

Surface deformation is very common phenomena in and around mining areas and space based SAR technique is one of the promising tool to monitor the land deformation. Monitoring of land subsidence is required to prevent further damage to the mine surrounding built-up areas and other vulnerable structures and landforms. This will further help for providing information for improved future mine layout designs and for subsidence mitigation. This study involves time series SAR data processing using C and L band datasets for monitoring land deformation using advanced Differential Interferometric Synthetic Aperture Radar (DInSAR) algorithm referred as Persistent Scatterer (PS) InSAR technique. The advantage of using PSInSAR is that, it deals with both the decorrelation and atmospheric delay errors of conventional InSAR and provide the deformation history with subcentimeter accuracy. The study was carried out in one of the most popular and largest coal producing mining area of India i.e. Jharia coal field, situated in Dhanbad, Jharkhand, India. The main objective of this work is to analyse time series interferometric SAR data to detect surface deformation in and around Jharia coal field. The aim of this research is to present a cumulative displacement map using number of interferometric datasets and assess the geohazard activity in the study area. The data used in this study are Sentinel 1-A C-band (Aug. 2017 to Feb. 2018) and ALOS-2 PALSAR L-band (Oct. 2016 to Mar. 2019) to perform interferometric data processing and comparative analysis. A high rate of land deformation was observed in and around mining area and land deformation rate was observed almost ± 30 mm/year in this study

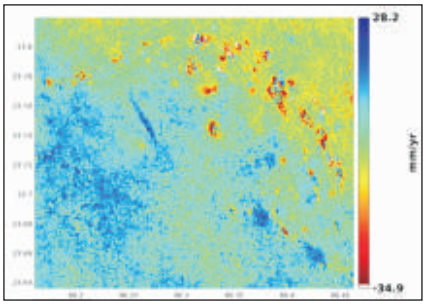


Fig. 1: Cumulative displacement map of Jharia Coalfield using ALOS-2 PALSAR data (Oct.2016 - Mar. 2018).

area. It was also observed from the time series analysis that L band outperformed C band for monitoring deformation rate in the mining areas.

In the study area, land subsidence rates in different mining sites was obtained from cumulative displacement map. As per the results the rate of subsidence observed in different mining sites varies from a few mm to tens of mm per year.

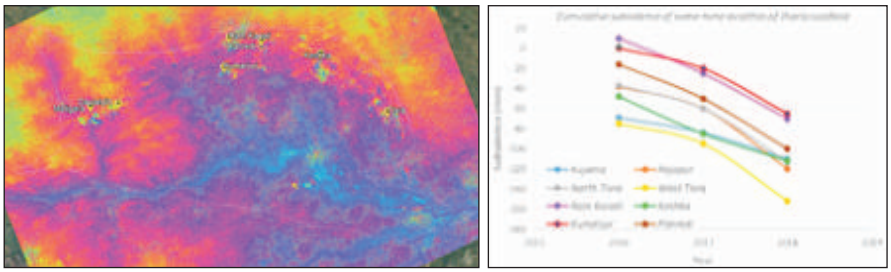
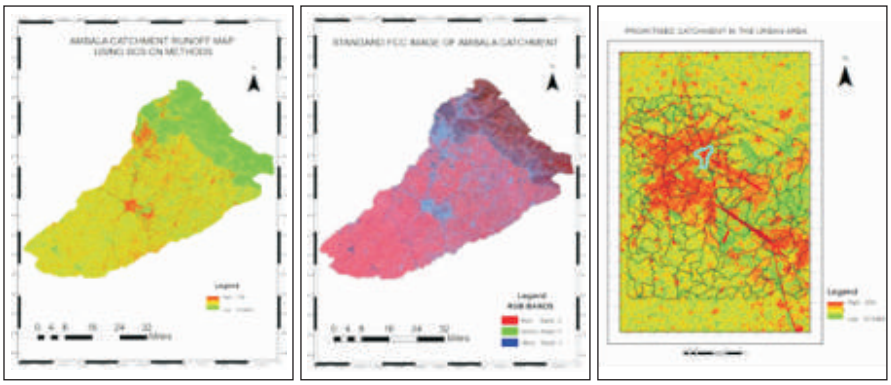


Fig. 2: Subsidense rate, deformotion time series plot in localities.

Urban Flood Hazard Assessment in Parts of Ambala City using Geospatial Technology

Urban flooding is one among the prominent hazard being faced by many cities across the world. These events are rising due to increase in impervious surfaces caused by rapid urbanization as well as due to variations in rainfall events. The extreme or prolonged rainfall event gives rise to urban flooding and water logging in urban areas when the storm water drainage facilities can no longer sustain the volume of runoff. It is therefore important to study various aspects of urban flooding due to increase in intensity as well as the frequency of flood events and their effects on human health, living conditions, infrastructure damage and the economy as a whole. Ambala city, Haryana state, India is drained by

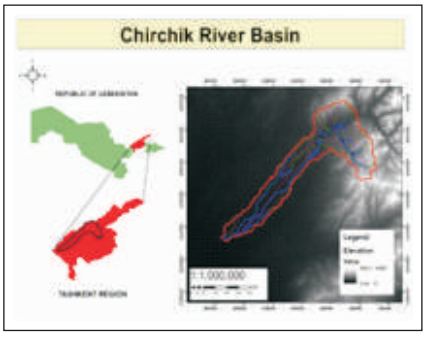
tributaries of Ghaggar river, particularly the Tangri and its tributaries and it has witnessed floods with varying magnitude with different rainfall events for the past couple of decades. The present study is an endeavour to assess the urban flood hazard in identified micro-watersheds in Ambala city. The watershed boundary encompassing the Ambala city along with its river system was delineated using ALOS PALSAR (spatial resolution, 12.5m) digital elevation model (DEM) with HEC-GeoHMS plug-in and ArcGIS 10.3 environment. The land use/ land cover (LULC) map was generated from Sentinel-2A data with supervised classification technique. Using the Natural Resources Conservation Service (NRCS) Curve Number technique, the runoff potential map was generated which signifies the areas with high and low runoff potential zones for the Ambala city and surroundings. The Ground Control Points (GCPs) were collected by carrying out Differential Global Positioning System survey (DGPS) at various locations in the city. The WorldView-3 stereo data was used to generate DEM (spatial resolution, 0.6 m) and later to delineate micro-watersheds in the city. The drainage map was procured from Public Health Engineering Department, Ambala. This high-resolution DEM is overlaid over runoff map to identify the micro-watersheds with high runoff potential for the detailed study using Storm Water Management Model (SWMM). The high-resolution DEM and drainage network map for identified high runoff zone within the city was used in the SWMM to setup the model. Through SWMM, the peak flow, intensity and extent of flooding, runoff depth is estimated using the DEM, LULC, rainfall data and other field data. The study is useful in understanding the use of geospatial technologies in studying the urban flood hazard assessment.

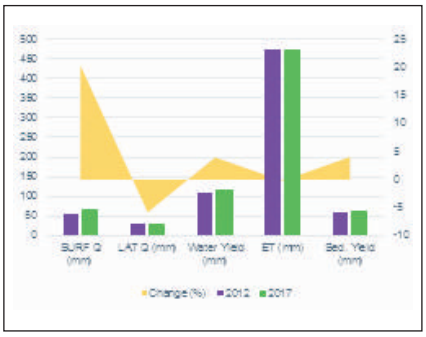


Water Balance Estimation in Chirchik River Basin

Accurate and detailed information of water balance, and its dynamic nature is needed to develop strategies for sustainable use and management of water resources. In this concern, studying of effect of land-use and climatic condition on stream hydrology can be addressed by the application of spatially distributed hydrologic models. One of the models that have been regularly used at the watershed scale is Soil and Water Assessment Tool (SWAT). Which produce hydrographs in addition to water yields can be operated at various time steps and changing quantities of parameters. Soil and Water Assessment Tool (SWAT) model was used to study the water balance of the Chirchik River Basin, Uzbekistan.

The Soil and Water Assessment Tool (SWAT) was tested on daily and monthly basis for estimating water balance components as surface runoff, precipitation, evapotranspiration and water available water yield watershed. All the input data for the SWAT model was extracted using the standard procedures. The Sequential Uncertainty Fitting (SUFI-2)

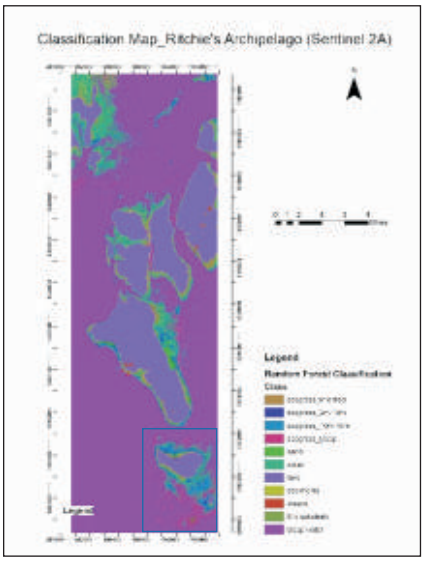


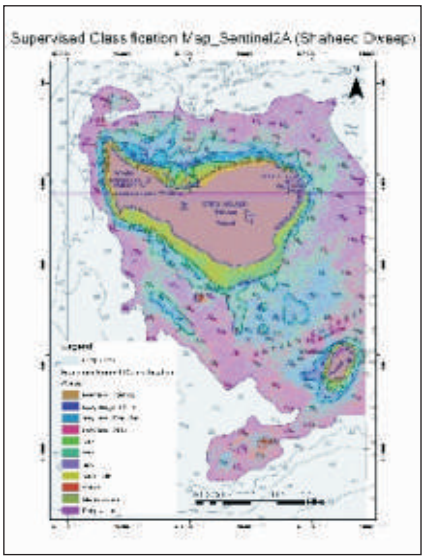


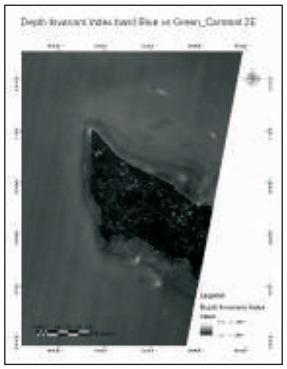
method within SWAT Calibration and Uncertainty Procedures (SWAT-CUP) was used to identify the most sensitive streamflow parameters. Parameters in the model were calibrated and simulated results were validated for two time periods: first 2009-2011 and 2012-2013, second 2013-2015 and 2016-2017 in term of observed discharge data. Graphical and statistical methods of tests revealed that the observed and simulated monthly surface runoff for the calibration and validation period matched quite good. Statistical model performance measures, the coefficient of determination (R2) and Nash-Sutcliffe Efficiency (NSE) were used to evaluate the correlation between the observed and simulated monthly streamflow. The result shows a good agreement between the observed and simulated flow. Both NSE and R2 were found to be greater than 0.7 for the calibration and validation period. The results show that surface runoff and water yield at the watershed outlet will significantly increase by converting bare land and grassland to impervious surfaces.

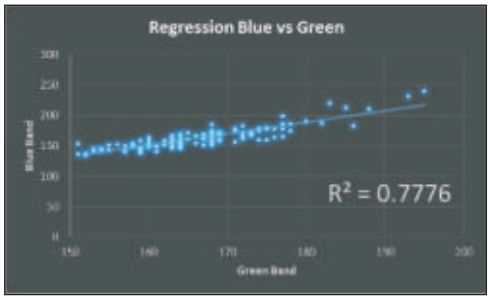
Detection and Mapping of Sea-grass Meadows Using Satellite Remote Sensing Data at Ritchie's archipelago, South Andaman

Seagrasses are marine monocotyledonous plants, growing in shallow coastal environments usually on soft sediments substratum. An essential ecological niche, supporting very specific and ecologically important organisms in the marine food chain and regulating the health of the ocean as well as the coast, they have been considered under goal no.14 “Life under water” under United Nations Sustainable Developments Goals (SDGs). Substratum Mapping of these coastal habitats using remote sensing techniques provides significant support towards the quantitative and qualitative analysis of the benthic community structure resourceful towards their conservation. This study is an attempt to detect and map the extent of potential seagrass beds off Ritchie's archipelagos, part of Andaman group of islands in collaboration with Wildlife Institute of India (WII) which are primary feeding grounds of a threatened species Dugong dugon. Very High-Resolution satellite imageries from Sentinel-2A and Cartosat-2E were used after efficient atmospheric correction to obtain water leaving radiance. Water column correction was applied to enhance the reflectance from the shallow benthic environment to help in characterization of seagrasses from various benthic features. Supervised classification was

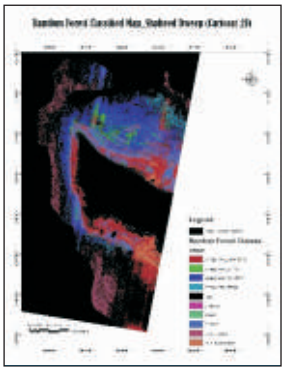








Depth Invariant Index Regression between blue and green band of Cartosat-2E

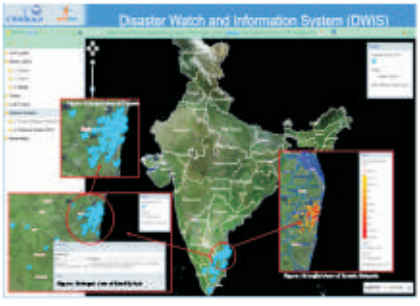


performed with three different models i.e. Random Forest, Support Vector Machine and K-Nearest Neighbor, with support of field data collected by WII team, as training sets. Random Forest method of supervised classification showed most reliable results with 0.98 (Sentinel-2A) and 0.86 (Cartosat-2E) training data accuracy, successfully detecting the seagrasses at locations used as test sites up to the depth of 20m, which has been validated with respect to NHO bathymetry charts. The classified output maps have been shared with WII which is to be validated in the upcoming season of field survey and to be incorporated in the management plan of Rani Jhansi National Park which encompasses the Ritchie's Archipelago. Mapping the extent of seagrasses around these islands using remote sensing is one of the initial studies carried out over these islands which has been useful in estimating the extent of the feeding grounds of D. dugon aiding to the conservation efforts of this monotypic species.

Utilizing geo-social media as a proxy for improved flood monitoring: A case study on Chennai floods, 2015

Social media plays an important role in disseminating spontaneous information during natural disasters/ emergencies. It is a source of Volunteered Geographic Information (VGI) that can complement and supplement Remote Sensing data for mapping during disaster events. Continual and proximate monitoring of disasters such as floods from pre-stage to post stage is essential which can be attained by Geo-social media. Social sites such as Twitter has Application Programming Interface (API) for collecting data from web as JSON (JavaScript Object Notation). In the present study, a model is tested on the Tweets of Chennai floods in 2015 using the techniques such as Natural Language Processing (NLP), Valence Aware Dictionary for Sentiment Reasoning (VADER), Naive Bayes classification. Around 22,424 tweets were collected for selected dates during the month of November and December, 2015 using Twitter Python Libraries.

The collected tweets contains messages asking for help, relief measures and expressing gratitude. VADER algorithm which is a lexicon and rule-based sentiment analysis tool is used for removing the more positive tweets (positive polarity score > 6.0) which is considered to be noise. Among the filtered data the Non-georeferenced tweets are geoparsed using TomTom place APIs that resulted in 191 final Tweets and are published in an interactive Web portal developed using GeoExt open libraries for visualisation and information dissemination. Tweet map shows that the majority of the tweets are from the regions of Chennai, Kancheepuram, Thiruvallur and contain messages asking for help, relief measures and expressing gratitude. A point density map is generated from the tweets for identifying flood hotspots. The entire process has been made automated using python script for collecting, filtering and generating hotspots. The prototype model developed and tested for Chennai can be used for any disaster events in real time to get information and can be integrated with other geospatial inputs for quick relief and rescue operations.



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Tropical Cyclone Structure Analysis using Satellite Observations

The accurate estimation of wind structure of tropical cyclones is highly important as they are used as input in various cyclone prediction models. The satellite observations play an important role in the estimation of these parameters. In the present study, wind products obtained from SCATSAT-1 and SMAP (Soil Moisture Active Passive Radiometer) satellites over the tropical cyclones formed in the North Indian Ocean (40°-100°E and 0°-30°N) during the period 2017-2018 have been analysed. The structural parameter of cyclones (center, Rmax, Vmax and critical wind radius) were computed and compared with the best track data obtained from India Meteorological Department (IMD) and Joint Typhoon warning Centre (JTWC).

The cyclone wind structural parameters from the 40 wind passes over six NIO (North Indian Ocean) cyclones (Marutha, Mora, Ockhi, Titli, Gaja & Phetai) obtained from SCATSAT-1 and SMAP were analysed and compared w.r.t. best track data. The maximum wind speed values measured by SCATSAT-1 were found to be over-estimated for 10 (ten) cases and under-estimated for 2 (two) cases out of 25 cases. However, For SMAP 3 (three) cases out of 15 were over estimated and 2 (two) cases out of 15 were under-estimated. The SMAP was able to capture the high winds upto 45 m/s which can not be estimated by SCATSAT-1 satellite.

The INSAT-3D TIR-1 data over the TCs have also been analysed. The relationship between brightness temperature (BT) values estimated by INSAT-3D TIR-1 channel and wind speed measured by SCATSAT-1, SMAP and RAPIDSCAT were analysed.

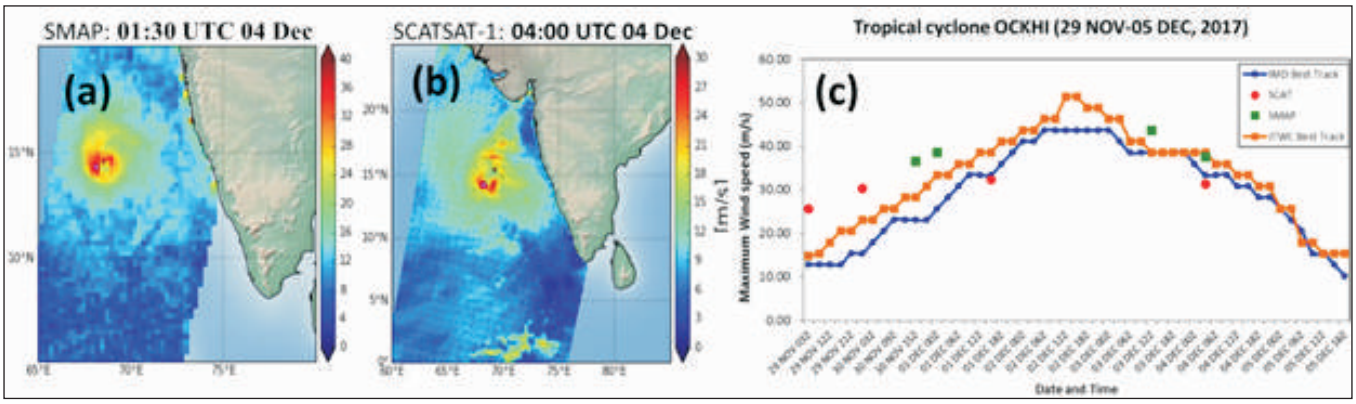


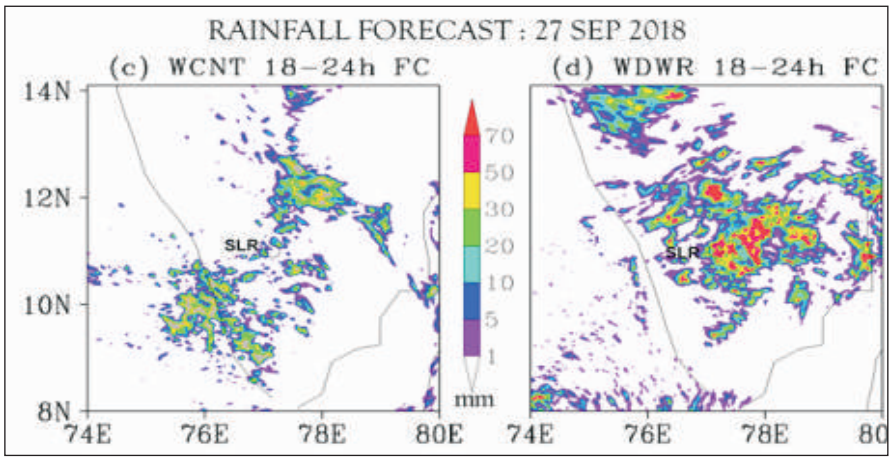
Fig. 1: Wind passes over tropical cyclone OCKHI obtained from (a) SMAP and (b) SCATSAT-1. (c) Comparison of maximum wind speed estimated by SCATSAT-1 and SMAP w.r.t. IMD and JTWC best track for TC OCKHI.

High Resolution Rapid Refresh (HRRR) Data Assimilation of DWR Observation for Extreme Weather Event

The Numerical Weather Prediction (NWP) has been recognised as the front-runner in the operational weather forecasting. With the advent of the NWP models, reliable and accurate weather predictions are possible with high confidence. The disruption of normal life and loss of vital national assets due to extreme weather events over Indian region are well known. The

precise initial condition and its error distribution in the NWP model are few major constraints to improve accuracy of the weather predictions.

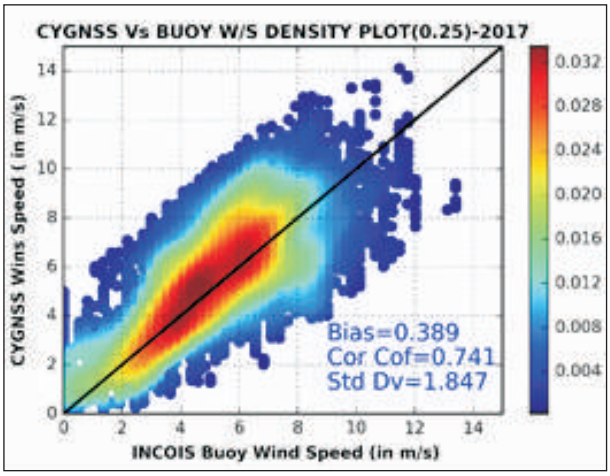
The utilization of high frequency and resolution ground observations from Doppler Weather Radar (DWR) are still limited to improve the skill of the NWP model. In this project, high temporal frequency Sulur DWR observations are assimilated using High Resolution Rapid Refresh (HRRR) method in the Weather Research and Forecasting (WRF) model to improve model initial conditions for forecasting heavy rainfall event. The role of observation error and background error have been studied to demonstrate efficient use of DWR observations for extreme weather event. With the assimilation of DWR observations, the WRF model is able to predict selected rainfall event with less temporal, spatial and intensity error.



Demonstrating CYGNSS Scalar wind Product Potential through Comprehensive Validation with Scatterometer and in-situ Buoy Data

Ocean winds play a vital role in the Ocean-Atmosphere System. They are the largest source of momentum which transport heat, aerosols and moisture through the system. This, in-turn, affects the constantly changing weather pattern and the relative slow changes in the climate. The Cyclone Global Navigation Satellite System (CYGNSS) is a part of NASA's Earth System Science Pathfinder mission, consisting of constellation of eight small satellites at LEO with objective to take frequent ocean surface speed wind measurements in all precipitating conditions in particular during tropical cyclones.

In the validation process quality-controlled data of CYGNSS wind speed (WS) obtained from different algorithms ie. using



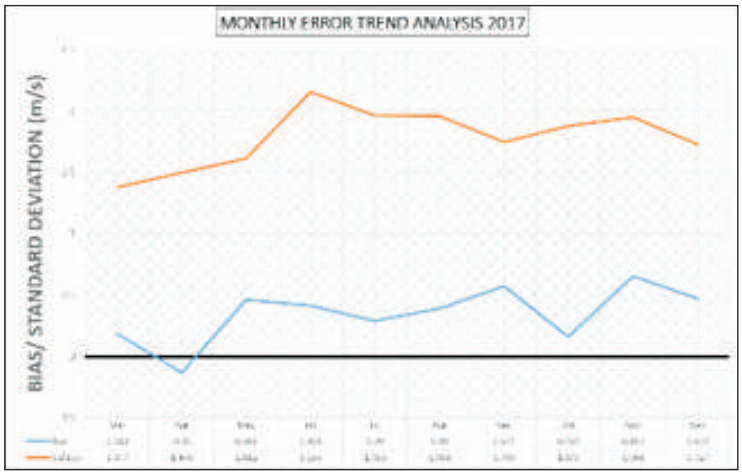


Fig. 1: (a) Density Scatter Plot of CYGNSS and INCOIS buoy collocated at 25 km and 30 min. window size for the year 2017. (b) Monthly error trend analyses of CYGNSS Wind Speed against INCOIS buoy WS for the year 2017.

Minimum Variance estimator (MVE), Normalised Bistatic Radar Cross Section and Leading Edge Slope Method in different sea Conditions-fully developed sea and young sea (during cyclone), were validated with collocated in-situ INCOIS buoy and SCATSAT winds speeds. The period of study was year 2017.

The analyses were done month-wise as well as annually; in addition to this, biases and standard deviations (SDEV.) were calculated. Fig.1a shows density scatter plot along with the bias (0.389 m/s) and SDEV. (1.847 m/s) of CYGNSS MVE WS w.r.t. buoy WS. Similarly, density scatter plots of the CYGNSS WS against SCATSAT have been analyzed. Monthly error trend analyses of CYGNSS MVE WS show SDEV. of 1.38 m/s (minimum, March) and 2.16 m/s (maximum, June) (fig. 1b).

For assessing CYGNSS performance during high wind conditions, comparison is being done of the CYGNSS WS from the above-mentioned different algorithms against IMD best track data of cyclones- Marutha, Ockhi and Mora, and analyzed alongside independent comparison of SCATSAT WS during these cyclones.

Night Time Fog Detection using MODIS Data Over Kyrgyzstan

Fog is a meteorological phenomenon which reduces the ground level visibility to less than 1000 meters. Apart from the hazardous effect on aviation as well as land/water transportation system due to low visibility, it is having lots of socio-economic impact. In recent past, the crashing of aircraft and vehicular accidents in Kyrgyzstan leading to large number of causalities due to heavy fog has created lot of impetus for its regular detection, monitoring and forecasting. Onset of fog takes place in winter time due to decrease in surface temperature, increase in pollution level, low wind condition and surface level inversion. Because of the low density of surface observations for different meteorological parameters like visibility, relative humidity and surface wind etc. remote sensing techniques has been used to detect fog and low clouds and monitoring its evolution both temporally and spatially over large area. In the pilot project, MODIS AQUA and TERRA night time data for Thermal InfraRed (TIR) and Mid-InfraRed (MIR) Channel with spatial resolution of 1km, has been used for fog detection over Kyrgyzstan. The bi-spectral temperature difference (BTD) method has been used to detect fog and low clouds detection for January 2018 , December 2018 and January 2019 and validated with in-situ visibility data.

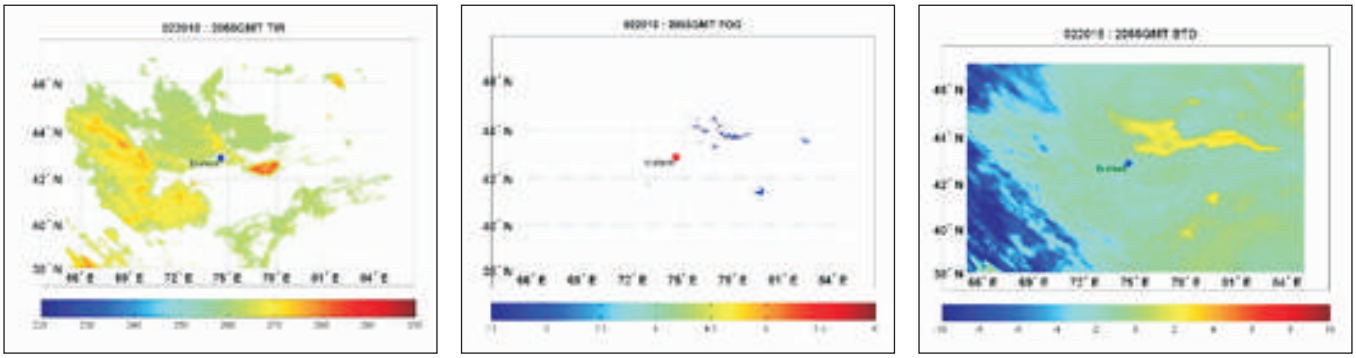
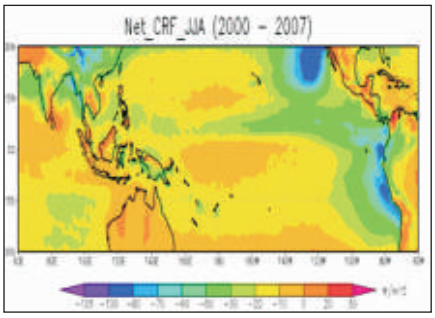


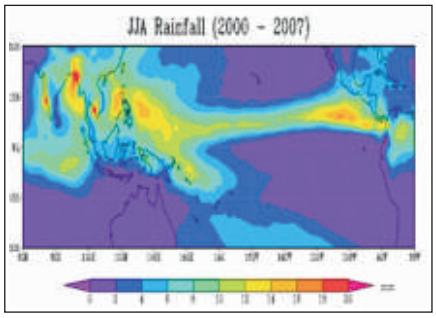
Fig. 1: The TIR BT, BTD and fog map over 02 January 2018 at 2055UTC

Radiative Forcing by Different Cloud Regimes

Clouds play a major role in the radiation balance of the Earth Atmosphere system. Cloud physical properties such as cloud cover amount, cloud top height, cloud optical depth, cloud droplet size and cloud phase (liquid/solid) affect the radiation balance of the earth-atmosphere system. Tropical belt is well known for different cloud regimes such as low level marine stratus over Cold Ocean upwelling regions, deep convective clouds over the Inter Tropical Convergence regions, etc. Four typical regions with the presence of different cloud types are identified during June to August months over the tropics using 8-year (2000-2007) International Satellite Cloud Climatology (ISCCP) monthly cloud data. The NCEP reanalysis atmospheric data is used to find out the possible reasons behind the formation of these unique clouds over these regions. The CERES top of atmosphere shortwave, longwave and net cloud radiative forcing data are used to study the radiative forcing of the clouds over these unique regions. Results suggests that the low level marine stratus clouds exert a net radiative cooling where as high level optically thin cirrus clouds exert a net warming effects to the earth-atmosphere system. The shortwave cooling and longwave warming effects of the tropical deep convective clouds cancels out on average sense. Clouds over the Indian summer monsoon regions exerts a net radiative cooling which is in contrast to the other deep convective clouds of the tropical belt.



Eight year (2000-2007) average top of atmosphere Net Cloud Radiative Forcing (Wm-2) from CERES during June to August months



Eight year (2000-2007) average rainfall (mm) from GPCP during June to August months.

Nowcasting Heavy Rainfall events using satellite data

In recent years, flash flood events have become one of the biggest issues in the world. Nowcasting, which refers to forecasting for a very short time range (up to 6 hours) is useful for predicting the development and dissipation of flash floods and heavy rainfall events. Satellite data, acquired from geostationary satellites provide valuable inputs for nowcasting of heavy rainfall due to their high spatio-temporal resolution. Satellite-based analysis shows that in comparison to cloud top temperature, cloud top cooling rate (CTCR) is a better indicator for extreme rain producing events over this region. CTCR can be very useful for identifying vigorous cloud growth if cloud-top parcels are much warmer than the environment. Thus, a model for Nowcasting of Extreme orographic Rain (NETRA) has been developed based on the premise that the updrafts characterizing orographic lifting bear a strong relationship to the spatial distribution of CTCR pixels. In the present study NETRA has been applied for predicting heavy rainfall events over Mongolian region using INSAT-3D satellite sequence of images. NETRA comprises of three major components: first is computation of CTCR from half-hourly satellite data, second is calculation of

thresholds, and third is the process of choosing those pixels which have a potential for causing flash floods. The result of this study is demonstrated for a very heavy rainfall over South Mongolian region on 12th August 2018. The figures below show that the CTCR is very high (1K/min) for the area surrounding AIRAG station, which reported more than 100mm of rainfall. Also, the number of alerts bears a good match with the rainfall recorded at 9 stations. This model shows good potential for very short term prediction over Mongolian region.

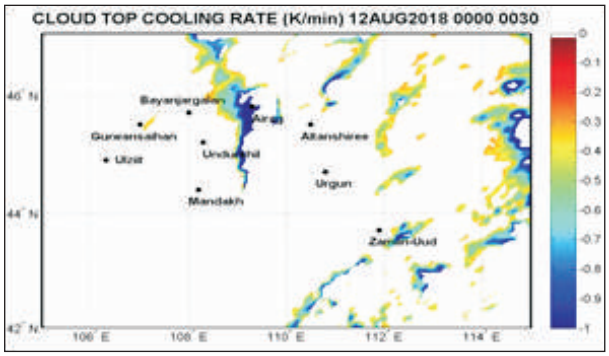


Fig. 1: Cloud top cooling rate over study region

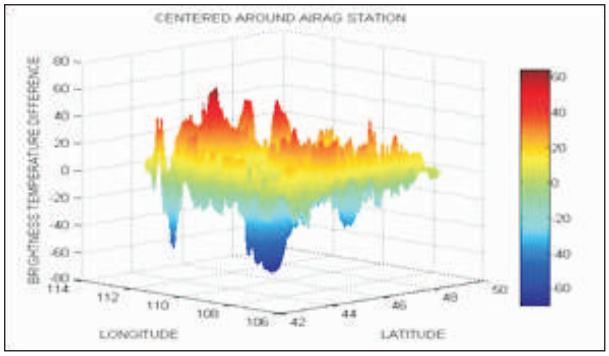


Fig. 2: Cloud top cooling rate in Airag station (3D plot)

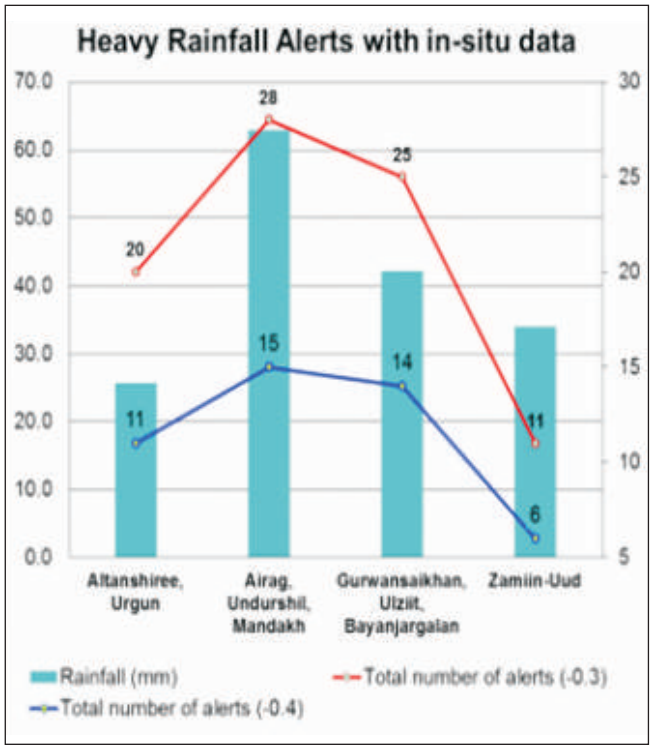


Fig. 3: Comparison of Heavy Rainfall Alert with in-situ data

IMSRA Rainfall estimation, validation and variability over Indian region during GAJA Cyclone

Accurate rainfall estimation is very important for many applications, such as water resource management for agriculture and power, and flood and drought monitoring. The objective of this study is to evaluate the potential of satellite-based rainfall retrieval using INSAT-3D Multispectral Rainfall Algorithm (IMSRA) rainfall products over Indian region (Tamil Nadu) during GAJA cyclone in November 2018. Severe Cyclonic Storm GAJA was the fifth named cyclone of the 2018 North Indian Ocean cyclone season. GAJA cyclone moved to Tamil Nadu on 16th of November, 2018. At least 45 people were killed and about 250,000 people were evacuated to relief camps. IMSRA retrieved rainfall products has been developed by the Indian Space Research Organization (ISRO)

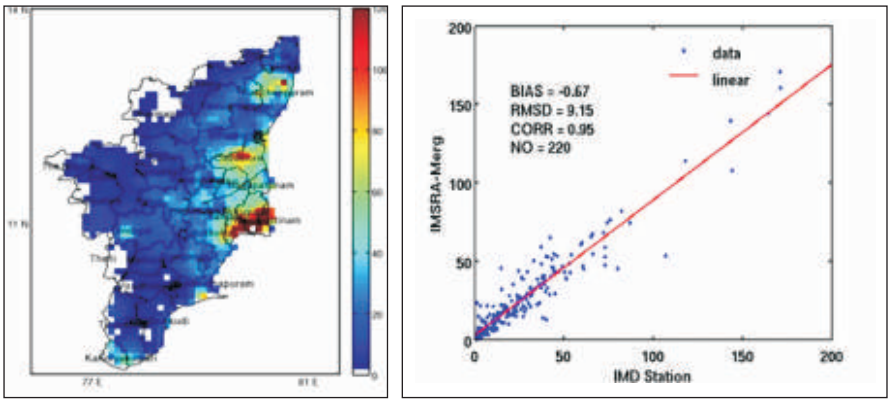
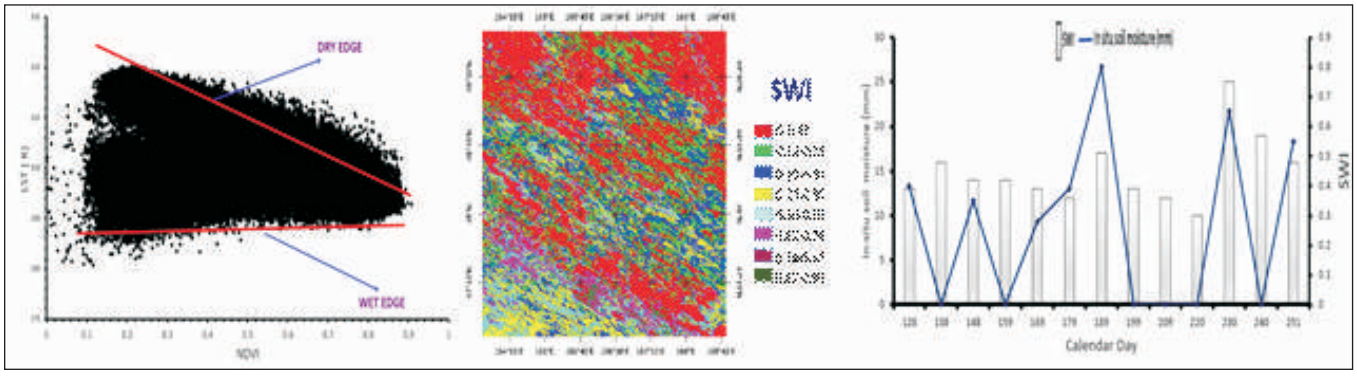


Figure shows the estimated rainfall from IMSRA-Merged (a) and its scatter plot with IMD station (b) over Tamil Nadu on 16 November 2018.

(Gairola et al. 2015). Thermal IR (TIR1) channel from INSAT-3D satellite data is used for rainfall estimation. The IMSRA estimated rainfall is also merged with the daily accumulated rainfall obtained from 32 IMD ground stations in Tamil Nadu on daily basis. The results are compared with two independent global multi-satellite rainfall products, namely the Integrated Multi-satellite Retrievals for GPM (IMERG) and Global Satellite Mapping of Precipitation (GSMAP) products, and their validation is performed with conventional rain gauge observations. The comparison between IMSRA-Merged and IMD station data gave a correlation coefficient of 0.95 with a bias of -0.67 and a root mean square error (RMSE) of 9.15, while between GSMAP-Gauge and IMD station data gave a correlation of 0.55 with a bias of 0.33 and a RMSE of 24.37 on 16 November 2018. Also, the comparison of IMSRA-Merged with GSMAP-Gauge showed a correlation of 0.68 and an RMSD of 17.37. The statistical results showed good correlations between merged IMSRA, IMERG and GSMAP-Gauge product, while the merged IMSRA gave much better correlation than IMERG and GSMAP on comparison with ground-based measurements during GAJA cyclone.

Estimating surface soil wetness over agriculture landscape in Mongolia

Terrestrial surface exhibits extreme spatio-temporal moisture variations which controls fundamental hydrological processes and limits crop productivity. Remote sensing (RS) provides exceedingly powerful means for estimation of surface soil moisture at spatial scale especially rainfall deficit country like Mongolia for water security and guided irrigation. In the present study to estimate surface soil moisture indicator at moderate and high spatial resolution, Land Surface Temperature (LST) and Normalized Difference Vegetation Index (NDVI) have been used. The 'triangle' based model has been used to estimate surface Soil Wetness Index (SWI) based on coupling of optical RS and thermal observations. Two-dimensional scatters between NDVI and LST were generated to obtain a SWI from time series of MODIS Terra (Figure 1a) and LANDSAT-8 over study region in Mongolia. In 2-D scatter dry and wet edges represent low and high surface soil wetness at different NDVI classes respectively. The upper limit of LST is obtained from 'dry edge' while the lower limit of LST is obtained from 'wet' edge for the study region as shown in Figure 1a. The dry and wet edges may not be fully determined if the area of interest does not include a full range of land surface types and conditions (e.g. dry bare soil, saturated bare soil, water stressed vegetation and well-watered vegetation). Hence in this study agricultural dominated Darkhan-Uul province of Mongolia was selected that includes all types of land cover types. The estimated SWI varied between 0.2 to 0.4 for May to June and gradually increases up to 0.7 for



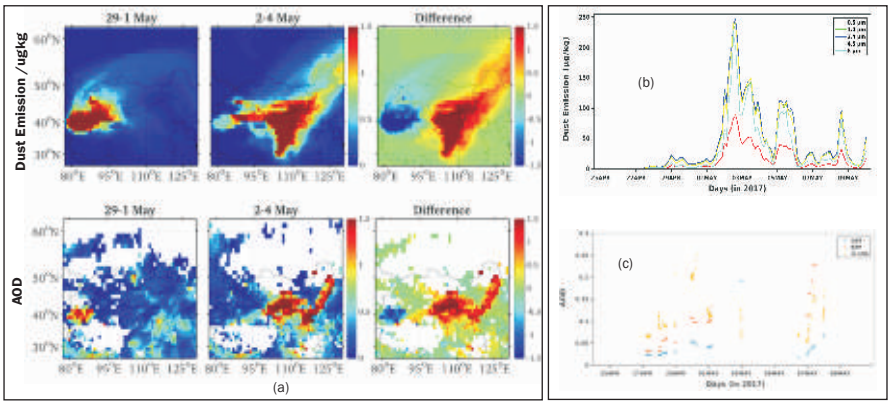
(a) (b) (c)

Fig. 1: (a) Scatter between NDVI & LST (b) Spatial distribution of SWI (c) Temporal variation of SWI with in situ soil moisture over study area at Mongolia

August month followed by gradual decrease in the month of September. The estimated temporal SWI during agricultural season is able to pick surface soil moisture variability as measured in ground from May to September (Figure 1c). The present study demonstrated the technique of using surface temperature vegetation index triangular space to derive a soil wetness index as surrogate for volumetric surface moisture content in cropped soils at field and landscape scales over selected agricultural regions of Mongolia. This study showed that the validity of surface moisture indicator estimates largely depends on dynamic ranges of LST and NDVI, which often may not be sufficient as a result of restricted sampling window size due to low swath in case of finer resolution sensors.

Aerosol simulation over Mongolia using WRF-Chem model: Source Analysis and Impact

Dust storms frequently occur throughout the desert regions of the world, especially during springtime, injecting large amounts of mineral dust aerosols into the atmosphere. Dust aerosols have a wide range of potential consequences for ambient air quality, global climate and atmospheric chemistry. The purpose of this study is to simulate aerosols over Mongolia during a dust storm event using numerical model. A very severe dust storm that affected China and Mongolia during May 2017 is analyzed. The Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) is used to simulate the meteorological and chemical conditions over Mongolia. The model domain extends from 77° E to 131° E (200 grid points) and from 26° N to 62° N (200 grid points) at a horizontal spatial resolution of 30×30 km2. The model simulation is run for 15 days starting from 25 April 2017 at 00:00 UTC. The initial and boundary conditions for the meteorological fields are obtained from the National Center for Environmental Predictions (NCEP) Final Analysis (FNL) fields at a spatial resolution of 1°×1°. The chemical fields are initialized from the Model for Ozone and Related Chemical Tracers (MOZART-4) analysis. During this event, hot and dry conditions with strong northwesterly winds were predominant over the Gobi Desert. There was also formation of a very strong low-pressure system over the Central Mongolia during 2-4 May 2017, which caused the dust particles to get transported from the Gobi Desert to Mongolia and Northern China. The model simulated Aerosol Optical Depth (AOD) forecast and MODIS Daily Global AOD product averaged before (29Apr-1May) and during dust storm (2May-4May) show similar spatial distribution with model overestimating slightly (figure-a,b). The difference plot shows that the origin of dust storm was over the south-west Gobi Desert in China, and it eventually transported to southern and eastern Mongolia. The comparison of model forecasted AOD with AERONET observations gives a good correlation of ~0.73 and an error of ~0.21 over Dalanzadgad (43°34'N 104°26'E) during the study period (figure-c). Overall, the WRF-Chem model is able to simulate the spatial distribution of dust storm over Mongolia.



Study of Tilted Clouds using Microwave Brightness Temperature Observations

Global Precipitation Measurement (GPM) mission's core observatory is equipped with two key precipitation measuring sensors (i) Dual-frequency Precipitation Radar (DPR) and (ii) GPM Microwave Imager (GMI). DPR is a dual frequency Ku (13.6 GHz) and Ka (35.5 GHz) band precipitation radar. Both Ka and Ku radar beams provide measurement at spatial and vertical resolutions of 5km and 250km respectively. Whereas, GMI is a 13 channels conically scanning microwave imager, which measures vertical and horizontal polarized brightness temperature in frequency range from 10GHz to 183GHz. The coinciding observations of precipitation and vertical structure of clouds from the GMI and the DPR respectively are utilized to identify and analyse the vertically tilted cloud structures. The identification and analysis of such clouds are important in estimating precipitation at ground, validation of precipitation from GMI and DPR and in improving the precipitation estimation accuracy. The signatures of vertically tilted clouds are prominently noticed in the vertical profile of reflectivity from DPR. The reflectivity profile of the tilted cloud observed by DPR is shown Figure 1(a) and the corresponding surface rain in Figure 1(b). GMI 18.7GHz brightness temperature that primarily responds to the surface rainfall found displaced from 89GHz brightness temperature that responds to the cloud ice (Figure 2) because of the tilted structure of cloud.

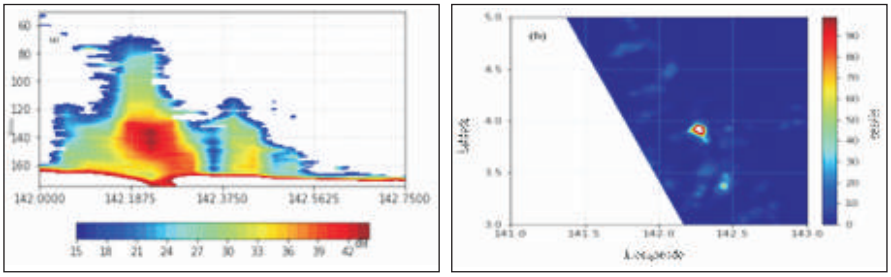


Fig. 1: An example of tilted structure of cloud (a) vertical profile of DPR reflectivity and (b) surface rain.

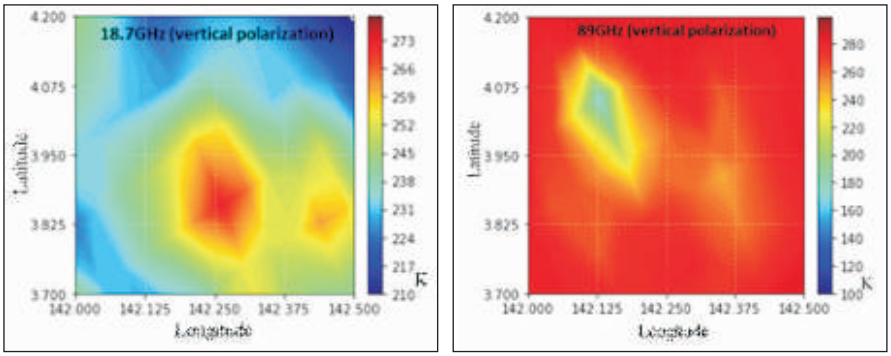


Fig. 2: The spatial distribution of GMI 18.7 GHz and 89 GHz frequencies brightness temperature observation during tilted cloud.

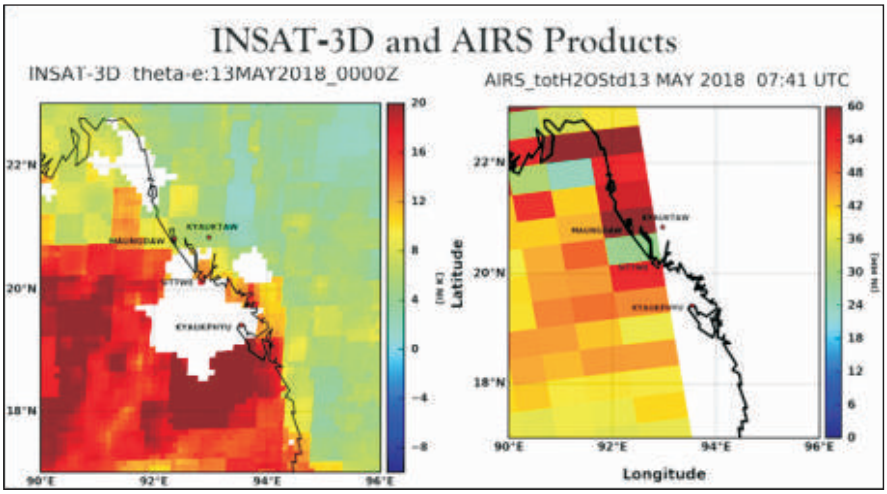
Hyperspectral Sounders AIRS / IASI / CrIS and Geostationary INSAT-3D Sounder: Validation and Applications over Myanmar

India launched the INSAT-3D satellite on 26th July 2013 to become the second country in the world after USA carrying onboard an atmospheric sounder in geostationary orbit. INSAT-3D has six channels Imager and 18 infrared channels Sounder. INSAT-3D sounder provides a unique opportunity to have hourly measurement of temperature and moisture profiles over clear regions of India and a few neighbouring countries.

INSAT-3D sounder provides invaluable information of atmospheric structure with high temporal resolution. The atmospheric structure available in terms of temperature and moisture profile helps in understanding and predicting atmospheric stability. The state of atmospheric stability is studied by

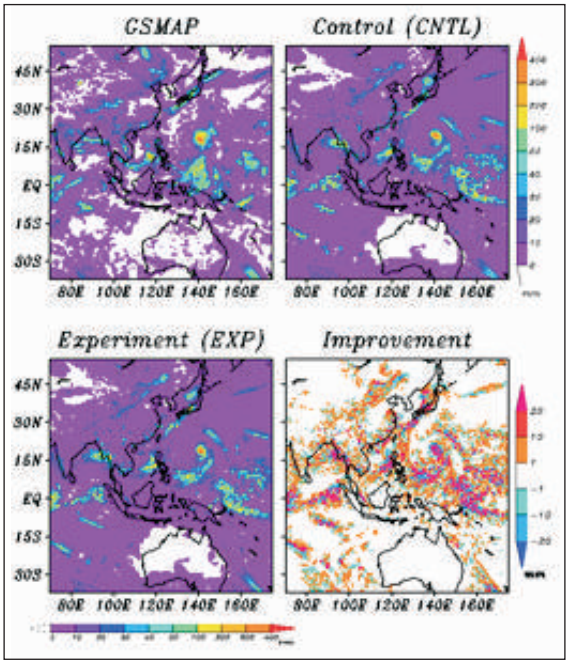
using parameters such as Total / Layer Precipitable Water (TPW/LPW), Convective Available Potential Energy (CAPE), Convective Inhibition (CIN), along with various stability indices such as Lifted Index (LI), K Index (KI), Total Total Index (TTI) and Theta-e etc.

In addition, hyperspectral sounder like Atmospheric Infrared Sounders (AIRS), onboard EOS-Aqua, Infrared Atmospheric Sounding Interferometer (IASI) onboard MetOp, Cross-Track Infrared Sounder (CrIS) on board JPSS satellites provide fine-resolution data even during cloudy conditions in combination with microwave sounder. Hence for the present study we used a combination of both, INSAT-3D sounder as well as hyperspectral sounder. The product from these sounders are used with an aim to enhance sufficient lead time in forecasting application over various locations of Myanmar. INSAT-3D data will be validated with AIRS, IASI and CrIs over Myanmar as no Radiosonde station is available over Myanmar.



Impact of Data Assimilation of Conventional Observations on Heavy Rainfall Forecasts Over Southeast Asian Region

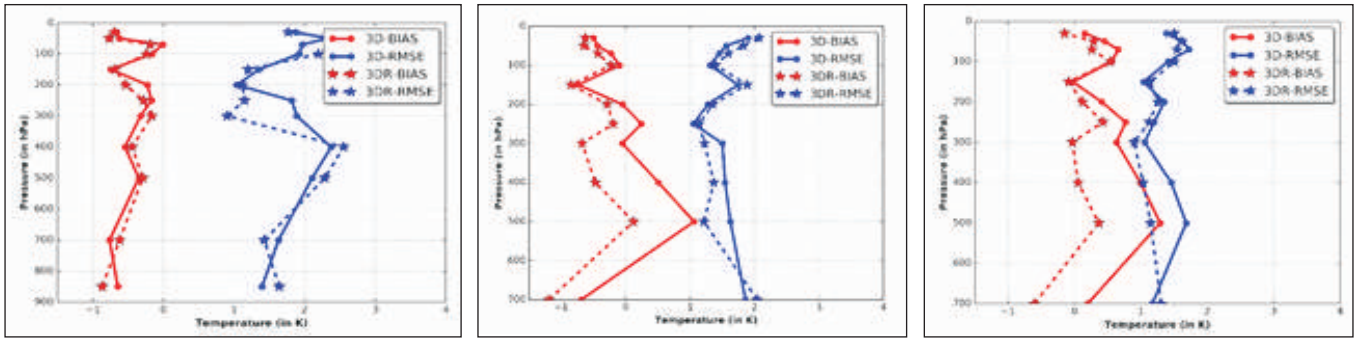
This study examines the impact of the assimilation of conventional observations on the prediction of heavy rainfall events over Southeast Asia using Weather Research and Forecasting (WRF) model and its three dimensional variational data assimilation (3DVAR) system. Six heavy rainfall events over the region of interest are considered for this study. For each event, two numerical experiments were performed, namely the CNTL and EXP. In the first experiment, namely the control simulation (CNTL), the GFS analyses are used as the initial and boundary conditions of the model. In the second experiment (EXP), the model integration was carried out by inserting additional observations in the model's initial conditions using the 3DVAR scheme. The observations from surface weather stations, buoy, ship, radiosonde, and satellite winds and oceanic surface winds are assimilated in the EXP experiments. After the successful inclusion of additional observational data using the 3DVAR data assimilation technique, the resulting reanalysis was able to successfully reproduce the structure of convective organization. The results demonstrate that the improved initial conditions of the WRF model using 3DVAR enhanced the location and amount of rainfall over the Southeast Asian region as shown in figure 1.



Validation of INSAT-3D/3DR Sounder profiles over Central Asia and nearby regions

To date, several satellites measurements are available which can provide profiles of temperature and water vapour with reasonable accuracies. However, the temporal resolution has remained poor, particularly over the tropics, as most of them are polar orbiting. Hence, the launch of INSAT-3D (Indian National Satellite System) by the Indian Space Research Organization (ISRO) on 26 July 2013 carrying an atmospheric sounder along with it made it possible to obtain profiles of temperature and water vapour over India with higher temporal and vertical resolutions and altitude coverage, besides other parameters. With the launch of the INSAT-3DR, the frequency on the weather monitoring of the atmosphere through the sounding system doubled. The study compared the INSAT-3D and INSAT-3DR data with radiosonde soundings over three stations (Kabul, Srinagar and Patiala.

Good correlation in temperature between INSAT-3D/3DR and in situ measurements is noticed up to lower stratospheric regions (bias of 1-2°K). There is a mean bias of 1020% in the humidity profile, outside the Indian monsoon months. The overall temperature retrievals exhibited small systematic errors (Biases) at almost all the levels. It is observed that temperature data from INSAT-3DR are of high quality and can be directly assimilated for better forecasts over India. Moreover, these profiles are available round the clock and can be effectively utilised by the meteorological section over Central Asia towards their day to day forecasting in real time with a frequency of sounder data available at 30 minutes' interval from INSAT staggered mode. INSAT-3D and INSAT-3DR have significant value in providing accurate weather forecast over India and neighbouring regions.



Project Abstracts of 11th Post Graduate Course in Space and Atmospheric Science

1. Solar Cycle and seasonal variations of the critical frequency and height of maximum ionization of F2-layer over Ahmedabad
2. Remote Sensing of the Moon
3. Analytical modelling of the solar coronal magnetic field
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Solar Cycle and seasonal variations of the critical frequency and height of maximum ionization of F_2-layer over Ahmedabad

Ionosphere primarily formed by the solar radiation shows regular daily, seasonal, solar cycle and latitudinal variations in the electron density. F_2 region is, in addition, greatly controlled by the transport of ionization. Large electromagnetic vertical uplift of plasma from the F_2 region near the magnetic equator and subsequent diffusion along the geomagnetic field lines result in peak ionization at locations $\pm 20^{\circ}$ magnetic latitude, known as Equatorial Ionization Anomaly.

Solar cycle and seasonal variations of f_oF_2 (critical frequency of F_2 layer related to the maximum electron density) and hpF_2, an indicator of the height of maximum ionization for Ahmedabad, have been studied earlier for a solar cycle. Here we analyse data for the period 1955-96 to examine the seasonal and solar cycle dependence of f_oF_2 and hpF_2.

To study solar cycle variations, analyses are made for a fixed solar hour and for each month separately. This eliminates the daily and seasonal variations in the parameters. Plots of the time variations of f_oF_2, hpF_2 for midday (mean of 11-13 hour local time) and Rz for the period 1955-96 show good correlation. Correlation coefficient values and linear fits have been obtained for each month describing the dependence of f_oF_2 and hpF_2 with Rz over Ahmedabad. Contour plots of the f_oF_2 and hpF_2 in the grid of months and years show both the seasonal and solar cycle variations.

Remote Sensing of the Moon

The Moon is an astronomical body that orbits planet Earth and is the Earth's only permanent natural satellite. It is the fifth-largest natural satellite in the Solar System. The Moon is thought to have formed about 4.5 billion years ago, not long after Earth. The most widely accepted explanation is that the Moon formed from the debris left over after a giant impact between the Earth and a Mars-sized body called Theia. Since its formation, the Moon has experienced impact cratering and volcanism throughout its geological history, which has resulted in the highly cratered surface and formation of vast lava plains. In this study, we have investigated the geology of an impact crater on the Moon known as Riccioli crater using LROC WAC data from Lunar Reconnaissance Orbiter (LRO) mission of NASA, which is currently orbiting the Moon. Riccioli crater, centred at (3.0° S and 74.3° W), is a large lunar impact crater of diameter 146 km and depth 2.3 km. It is located near the western limb of the Moon in the immediate vicinity of the Grimaldi basin. We have identified the various geological units of the Riccioli crater and mapped them using ArcGIS software. Subsequently, Crater Chronology technique has been used to determine the age of the Riccioli crater and the mare basalt unit partially covering its crater floor. It has been found that the Riccioli crater formed ~3.7 Ga ago and the volcanism occurred inside the crater up to ~3.3 Ga.

Analytical modelling of the solar coronal magnetic field

Study of the magnetic field in the solar corona is of significance as it becomes an integral part of studying transient events like Coronal mass ejections, Solar flares etc. Coronal mass ejection involves catapulting plasma from solar corona into the Interplanetary medium at very

high velocities. Solar flares are brightening of regions of solar disk resulting in Electromagnetic emissions in all possible wavelengths. All such events are accounted as different manifestations of processes which fundamentally involves a change in the magnetic morphology of the sun.

The fundamental difference between laboratory plasma and astrophysical plasma is that the Magnetic Reynolds Number is very high for astrophysical plasma which enables them to satisfy Alfven's Flux Freezing theorem, in which the identity of the magnetic field lines are preserved along the motion of the plasma as it evolves over time. This indicates that the dynamics of the plasma can be inferred from the dynamics of the magnetic field lines.

In the solar corona, the plasma β parameter (ratio of plasma pressure to magnetic pressure) is small, indicating that plasma pressure can be neglected in the corona. Thus, under equilibrium considerations, the Lorentz force (force due to magnetic interaction) is negligible which infers that the volume current density and Magnetic field are parallel to each other.

In this project, the equilibrium of coronal plasma is analytically modelled in 2D and 3D using appropriate equations. The magnetic field lines are obtained using Interactive Data Language (IDL) and Visualization and Analysis Platform for Ocean, Atmosphere and Solar Researchers (VAPOR).

Long-term trends of temperature and pressure data in Mongolia

Mongolia is a landlocked country in Central Asia and East Asia, located between China and Russia. The climate of Mongolia can be described to be severe and with strong regional and temporal variations. As part of this project, I have been doing an analysis of a long-term record of air temperature and atmospheric pressure data measured at 16 different stations of Mongolia from the year 1974 to 2015. The time-series of air temperature measured at 16 stations was analyzed. The highest annual temperature (+7.7°C) was measured at Khovd stations in the year 2014, while the lowest temperature (-4.6°C) was measured at Omnogovi station in the year 1984. The most important use of analyzing time series data is that it helps us to predict the future behaviour of the variable based on past experience. The short term changes in data are due to seasonal factors. A detailed analysis of both temperature and pressure data will be completed during the project.

Long-term trends of precipitation in Mongolia

Mongolia is situated in the central part of the Asian continent bounded on the north by Russia and on the east, south, and west by China. Mongolia has a high elevation with extreme continental climate conditions with a long cold winter and a short summer. Most of the precipitations occur in the summer season. About 85-90% of annual precipitations fall as rain in the summer season. Precipitation is highest in the north, which averages 200 to 350 millimetres (7.9 to 13.8 in) per year, and lowest in the south, which receives 100 to 200 millimetres (3.9 to 7.9 in). The southern Mongolia which is close to the Gobi desert receives very little or no precipitation during most of the months. As part of the project, the precipitation data recorded at 16 different stations in Mongolia during 1960-2017 have been analyzed.

Surface Ozone in an urban atmosphere

Ozone is a necessity for the survival of living being as well as a pollutant with adverse effects, depending upon its amount and altitudinal placement in the atmosphere. In the troposphere, ozone is a greenhouse gas and its higher levels can even have deleterious effects on human health and plants. Ozone in the troposphere is mostly due to anthropogenic activity. Tropospheric ozone budget is governed by photochemical production and loss, transport from the stratosphere, and surface deposition. The overall reaction for ozone production is given by:

$CO/CH4/NMOC + NO_x$ + hv--> O_3 + other pollutants

where: $NMOC$=non-methane organic compound, $NO_x = NO + NO_2$

The ozone analyser works on the basic principle of UV absorption (at 254 nm) and is given by Beer Lambert's law. The data used in this work is for the period January 15-25, 2019 from Ahmedabad, an urban region in western India. The data gives the diurnal variation of ozone during this period.

The diurnal variation has the following few distinct features typical of an urban atmosphere:

a) Noon-time maximum- anthropogenic production from pollutants.

b) Low values in the night time- the absence of sunlight which inhibits the ozone production and loss from chemical reactions and dry deposition.

c) Low values just after the sunrise- the destruction of ozone by sunlight.

Asteroids and Comets

The formation and evolution of the Solar System can be understood by studying the remnants of the early Solar system. The remnants could be comets, asteroids, Kuiper belt objects etc. The basic understanding of these smaller bodies in our Solar system, physical conditions of these bodies, chemical composition and the evolutions are the key to explore these bodies. There are differences between comets and asteroids on their composition and physical appearance. Apart from these bodies, there are other smaller bodies such as Trojan bodies corresponding to the Lagrangian points, that are present in the Solar System. These smaller bodies are studied through the telescopic observations, both ground and space-based. There are many dedicated missions that have been launched to understand these cometary and asteroid bodies. Details of physical conditions and chemical evolutions of a few of the asteroids and comets such as Ceres, Vesta, Eros etc. and comet 67P etc. have been carried out.

Space debris and their impacts

On Earth's orbit, other than controlled satellites several pieces of debris are orbiting, and they are travelling at over 27,000 km/h. Such space debris size from sub-micron/micron-sized particles to few centimetre particles, which can degrade sensitive spacecraft surfaces, solar panels, mirrors, optical sensors and thermal control surfaces. There are estimated to be over 128 million pieces of debris smaller than 1 cm (0.39 in) as of January 2019. There are approximately 900,000 pieces from one to ten cm. This space debris can collide with and destroy essential satellites,

knocking out communications and in turn creating even more debris. Such debris impact over any of the spacecraft surface area result in an impact crater. These sizes are 1-100μm. This project is aimed to understand the effects of space debris using the Matlab software.

Beyond 4 km/s (depending on the materials), an impact will lead to a complete break-up and result in melting of the projectile, and ejection of crater material to a depth of typically 2-5 times the diameter of the projectile. These impacts create a shock wave in the target material and lead to very high pressures (>100 GPa) and temperatures (>10,000 K). The impacting object and the target material are fragmented or vaporized. For impacts with velocities up to about 5 km/s most of the ejected material are solid fragments, above 2025 km/s the ejecta is completely vaporised, ejecta from impacts in the velocity range 5 20 km/s are a mixture of solid fragments and molten droplets.

Investigation of thermophysical properties of Lunar Analogues by laboratory measurements

The thermophysical behaviour of the uppermost layer of the lunar surface is highly complex and is not well understood. The principal reason for this is the inter-dependence of various physical properties and the extreme temperatures and vacuum conditions of the Moon. The thermophysical properties of the lunar surface layer show significant variation as a function of various parameters such as pressure, grain size, density/ porosity, stratigraphy, composition etc. In the present work, an attempt has been made to investigate the thermophysical properties of certain lunar analogous soils under laboratory conditions. The soil samples used for this work were terrestrial analogues of lunar basalt and anorthosites. Using a measurement setup based on transient line heat source method, the thermal conductivity and thermal diffusivity of the soil samples are obtained. Experiments were conducted for different grain sizes of both basalt and anorthosite samples. Results show a significant dependence of grain size on both thermal conductivity and thermal diffusivity values.

GEANT4 simulation for the Silicon detectors in ΔE-E mode

GEANT4 is a Monte Carlo based toolkit to simulate the interaction of particles through matter. Geant4 incorporates various physical interactions, user-defined geometries, event-tracking system etc. GEANT4 covers a wide range of interaction energies (eV to TeV range) from optical to -rays and charged particles. It allows the user to define the experimental geometry, sample composition, incident beam type and its energy with direction and also to include the fundamental physical processes.

A charged particle loses its energy in the detector by ionization at a rate determined in part by its velocity. The energy lost per unit distance is called as dE/dx. The ΔE-E technique for identifying the incident particle and measure its total energy involves a stack of two detectors of different thicknesses. The basic idea is that the incident particle deposits only a fraction of its energy in the first thinner detector whereas it is fully absorbed in the second thick detector, which is kept behind the first detector. Energy deposited in the detector of a given thickness depends on the mass of the particle. Thus, measuring the signal from both the detectors can provide information on the particle type and its energy.

The aim of the project is the data analysis of the energy loss in Silicon detector using Geant4 Simulation. Silicon detectors are very compact, demand low power, have high quantum efficiency and are insensitive to magnetic fields.

The project focuses on the detection of energy on the Silicon detector in the range of 10 keV and 100 MeV. Silicon detector thickness is varied from 10 Microns to 1500 Microns to see the cut-off energy of the particles vs detector thicknesses.

Modal and structural analysis of Quadrupole Mass Spectrometer

Simulation modelling is the process of creating and analyzing of a physical model to predict its performance in the real world. It analyses by applying the simulation software. Using simulation software, we can optimize geometry for weight & strength and accordingly select materials for further improvement. The part failure analysis, load analysis can be simulated which is very difficult to test in a real scenario. The structural modal analysis uses the overall mass and stiffness of a structure to find the various periods at which it will naturally resonate. Modal analysis is a powerful tool to identify the dynamic characteristics of structures. Every structure vibrates with high amplitude of vibration at its resonant frequency. It is imperative to know the modal parameters- resonant frequency, mode shape and damping characteristics of the structure at its varying operating conditions for improving its strength and reliability at the design stage. The goal of a modal analysis is to determine the natural mode shapes and frequencies of an object or structure during free vibration.

Design of quadrupole mass spectrometers (QMS) requires precise alignment of the various mechanical parts like ionizer, ceramic spacers, quadrupole rods, detectors etc. QMS operates inside Vacuum, at the level of < 10-5 Torr. Any misalignment in the assembly may result in the wrong interpretation of the results. The QMS assembly has been designed in the Open-Inventor software and structural analysis is being carried out. In order to understand the structural analysis, one cantilever was designed and analysis was obtained.

Study of the solar origin of low-frequency radio bursts observed by the e-CALLISTO

The radio emission during a solar flare is often called radio burst. During such burst, Sun's radio emission can increase up to millions of times the normal intensity so they can outshine the entire Sun at radio wavelength. The solar radio bursts are very effective probes of the physical state of the magnetized solar atmosphere where flares and eruptions initiate and evolve.

Our study mainly focusses on the identification of different types of radio bursts observed by the e-CALLISTO network from January 2013 to December 2014 which corresponds to the maximum phase of the solar cycle 24. We first examined quick-look data available at e-CALLISTO website and found several radio bursts of different types during this period. For the piolet project, we have selected 10 radio bursts that show complex structures, i.e., more than one type of radio burst occurred simultaneously. These representative events are found to be associated with GOES flares of classes C to X. For a detailed analysis, we constructed the high-resolution solar dynamical spectra of selected time and frequency ranges using Solar Software (SSW) and Interactive Data Language (IDL). We have compared the radio data with soft X-ray observations from GOES satellite. To investigate the solar source origin of the radio bursts, analyses of solar images in white light, magnetogram, and EUV have been carried out. The comparisons of multi-wavelength measurements yield insights about processes responsible for the energy release and magnetic restructuring.

Classifying Supernovae using their optical spectra

A supernova is an event that occurs when certain types of stars die. Supernovae may expel most of the material away from a star at velocities of the order of few thousands to 10s of thousands of km/s driving an expanding and fast-moving shock wave into the surrounding interstellar medium. This shock sweeps up an expanding shell of gas and dust, which is observed as a supernova remnant. Astrophysical consequences of these Supernova events impact significantly on nearby surroundings and the interstellar medium. Supernovae create, fuse and eject the bulk of the chemical elements produced by nucleosynthesis. Supernovae play a significant role in enriching the interstellar medium with the heavier atomic mass chemical elements. The expanding shock waves from supernovae can trigger the formation of new stars. Theoretical studies indicate that the basic trigger mechanisms for supernova events are barely two:

1. The sudden re-ignition of nuclear fusion in a degenerate star: a degenerate white dwarf may accumulate sufficient material from a binary companion, either through accretion or via a merger, to raise its core temperature enough to trigger runaway nuclear fusion, completely disrupting the star.
2. The sudden gravitational collapse of a massive star's core: the core of a massive star may undergo sudden gravitational collapse, releasing gravitational potential energy as a supernova.

While some observed supernovae are more complex than these two simplified theories, the astrophysical collapse mechanics have been established and accepted by most astronomers for some time.

Astronomers have classified Supernovae into two main classes, type I and type II, according to their optical spectra. If a supernova's spectrum contains hydrogen lines it is classified Type II; otherwise, it is Type I. In each of these two types there are sub-classes according to the presence of lines from other elements or the shape of the light curve.

In this project, the student will learn to classify supernovae using their optical spectra. GELATO, a template comparison software, have been used to compare optical spectra of supernovae with various template spectra of supernovae of known classes.

Meeting of CSSTEAP Governing Board

The 24th meeting of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) Governing Board (GB) was held at ISRO Hqrs, Bengaluru on December 02, 2019. The meeting was chaired by Dr. K. Sivan, Chairman CSSTEAP GB and Secretary, Department of Space, Govt. of India. The meeting was attended by the GB members and special invitees. The GB members included Mr. Dr. Amir Hossein Mirabadi (Iran), Prof. Abdykalykov Akymbek Abdykalykovich (Kyrgyz Republic), Mr. Ulugbeg Begaliev (Kyrgyz Republic), H.E Dato Hidayat Abdul Hamid (Malaysia), Mr. Nor'Azam Mohd Idrus (Malaysia), Mr. Hari Odari (Nepal), Mr. Charan Kamal Singh Bhalla (Nauru), Mr. Arvin R. de Leon (Philippines), Mr. Joon Lee (South Korea) Eng. Mr. Sanath Panawennage (Sri Lanka) Dr. Shirish Ravan (UNOOSA, Vienna), Dr. A Senthil Kumar (India). Other Participants included Mr. Umaaheshwaran, Dr. Nilesh Desai, Dr. P.G. Diwakar, Dr. Prakash Chauhan, Shri Shantanu Bhatawdekar, Mrs. Shankari Murali, Dr. D. Gowrisankar, Dr. S.P. Aggarwal, Dr. K.R. Manjunath, Dr. J. Banerji, Mr. Sanjib Kumar Deb, Mr. C.M. Bhatt, Mr. Vipul N Parekh, Mr Rajender Katariya, Mr. Krishan Gopal, Mr. Ashish Kumar Gupta & Mr. Harish Pandey from India.

Dr. A. Senthil Kumar, Director, CSSTEAP welcomed the members and special invitees to the 24th meeting of the CSSTEAP-GB. He mentioned that CSSTEAP is performing extremely well and established itself as a Centre of excellence with the support and guidance from GB members.

Dr. K. Sivan, Chairman, CSSTEAP-GB welcomed all the GB members, observers and special invitees to the GB meeting. He expressed that the Centre has completed 24 years since its establishment in 1995 and appreciated the commendable growth in all the domains of its capacity building activities in Asia Pacific region, under the able guidance of learned GB members. The Chairman also commended the Centre for the different short and long term courses in the different fields of space sciences and also for conducting a Global Webinar series on Space Applications in Disasters first of its kind amongst all Regional Centres affiliated to UNOOSA. Noting that the Centre has conducted 58 PG courses 61 short

courses and trained more than 2300 participants from 36 countries from Asia-pacific region and 20 countries from outside Asia-Pacific region.

Chairman, CSSTEAP GB further highlighted the achievements of ISRO in the last one year, ISRO has carried out 13 missions comprising of 6 launch vehicle missions and 7 satellite missions. Besides this, India's PSLV has launched 41 satellites of 4 countries (Lithunia, Spain, Switzerland and USA). GSLV Mk-II, with indigenous cryogenic upper stage, witnessed its 6th consecutive successful flight. India's heavy lift launch vehicle GSLV Mk-III with indigenous cryogenic engine has joined the elite group of operational launch vehicles.

India's totally indigenous mission “Chandrayaan-2” (comprising of an Orbiter, Lander & Rover) was successfully launched on July 22, 2019. Subsequent to completion of 5 earth bound orbit raising maneuvers and Lunar Orbit Insertion (LOI) maneuver, Chandrayaan-2 was successfully inserted into a Lunar orbit on August 20, 2019. All the payloads, on-board orbiter are providing valuable data for science experiments.

He informed the GB about UNNATI (UNispace Nanosatellite Assembly & Training by ISRO) programme, which is providing an excellent opportunity for the participant countries to strengthen their capabilities in Assembling, Integrating and Testing Nano satellites. 1st Batch of UNNATI programme have benefitted 29 Participants from 17 Countries.

Dr. Shirish Ravan, Head, UN-SPIDER Beijing Office and observer from the United Nations Office for Outer Space Affairs acknowledged the participation of all GB members in the 24th Meeting of the Governing Board of CSSTEAP. He apprised that CSSTEAP also supported off campus training program in Myanmar upon request of UNOOSA/UN-SPIDER. He requested similar contribution to other activities as the UN-SPIDER programme is planning to visit Afghanistan, Lao PDR, Mongolia, Nepal and Sri Lanka, and conduct regional events in South Asia, ASEAN and the Pacific region.

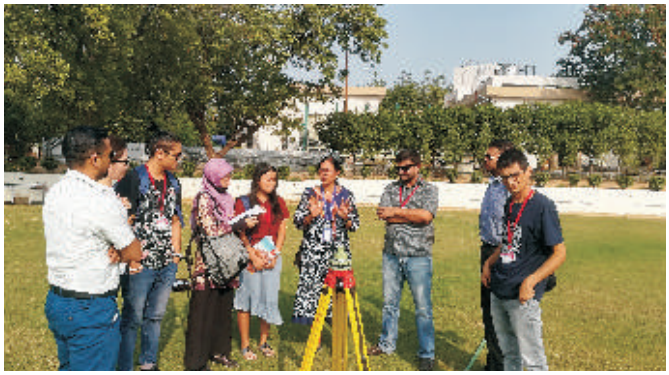
Dr. Amir Hossein Mirabadi (Iran), Prof. Abdykalykov Akymbek Abdykalykovich (Kyrgyz Republic), Mr. Ulugbeg Begaliev (Kyrgyz Republic), H.E Dato Hidayat Abdul Hamid (Malaysia), Mr. Nor'Azam Mohd Idrus (Malaysia), Mr. Hari Odari (Nepal), Mr. Charan Kamal Singh Bhalla (Nauru), Mr. Arvin R. de Leon (Philippines), Mr. Joon Lee (South Korea) appreciated the efforts made by CSSTEAP in recent years.

Eng. Mr. Sanath Panawennage (Sri Lanka) appreciated that the alumni of CSSTEAP are doing great job and holding important positions related to space technology in their respective countries. He also emphasized the role of space technology for achieving agenda 2030 on SDGs. H. E. Dato Hidayat Abdul Hamid, High Commissioner of Malaysia expressed his thanks to the Indian government and ISRO especially on the use of space technology and applications for peaceful purposes.

CSSTEAP GB approved the proposal of Dr. Prakash Chauhan as new director of CSSTEAP for the period of 3 years with effect from April 1, 2020.

The meeting was closed by Chairman, CSSTEAP-GB who thanked all the GB members for their active participation and involvement in improving the overall activities of CSSTEAP. He mentioned that CSSTEAP would continue to provide services in Asia-Pacific region and requested for all the countries to actively participate and send their scholars / professionals/ students.

Glimpses of student activities at CSSTEAP




CSSTEAP

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