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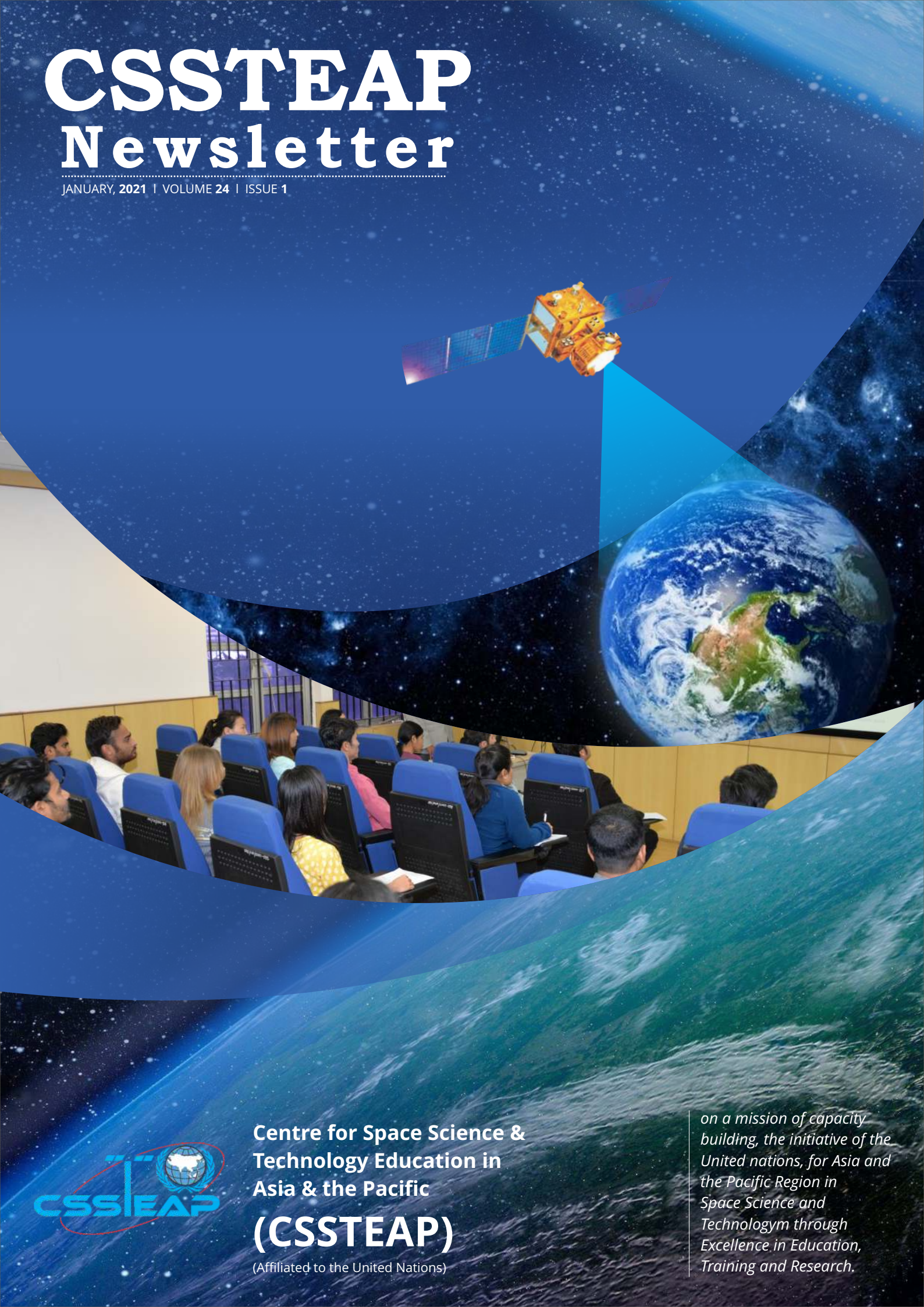

Centre for Space Science & Technology Education in Asia & the Pacific

(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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Dr. Prakash Chauhan
Director, CSSTEAP, India

Governing Board Members and Special Invitees during 25th Governing Board Meeting
Through Virtual Mode, December 21, 2020

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Director's Message

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) has completed its 25 years and contributing significantly in capacity building in the frontier areas of Space Science and Technology and their Applications since its inception in 1995 in Asia Pacific region. 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 offered, covers the wide spectrum of Space Science and 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 in the Asia-pacific region. Short courses cover typically different themes of Remote Sensing and GIS applications, DRR, Small Satellite Missions, Numerical Weather Prediction models and Navigation and Satellite Positioning System on regular basis etc. 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.

To commemorate 25 years of CSSTEAP, a virtual meet was organized on November 02, 2020. It was graced by founder Chairman of CSSTEAP-GB, Dr. K. Kasturirangan and the present Chairman, CSSTEAP GB Dr. K. Sivan, GB members, former Directors of CSSTEAP, Directors of Host Institutions, MEA, Officials of ISRO headquarters including Scientific Secretary & Chairman Coordination Committee, Director, EDPO etc. and Programme Coordinator, CSSTEAP and other course officials participated in the deliberations.

Year 2020 was a challenging Year as Covid-19 pandemic affected entire world. Three PG Diploma courses namely; Remote Sensing and GIS, Satellite Communications and GNSS were completed in the year 2020. Since Covid-19 pandemic situation is not conducive for in person courses, it was decided to postpone the three CSSTEAP PG diploma courses namely RS and GIS, Satellite Meteorology & Global Climate and Space & Atmospheric Sciences courses planned for year 2020 to be conducted in year 2021. In view of the demand of these courses, three short courses on above themes were organized through online mode. The overwhelming response of participants shows the importance of CSSTEAP courses among participants of Asia-Pacific region.

CSSTEAP alongwith UNOOSA through UNSPIDER also organized a Massive Open Online Course(MOOC) on Geospatial Applications for Disaster Risk Management. This course was attended by 11892 (6870 in Track-1 and 5022 in Track-2) participants from 148 countries across the globe.

I am sure that in 2021, we would be able to organize our regular PG courses in person at Dehradun and Ahmedabad along with online courses and 2nd phase of MOOC.

At CSSTEAP we are committed to provide best possible education, in the chosen fields of space science and technology, to gain good understanding, while focusing to develop practical skills to apply the theoretical knowledge to 'real-world' issues.

Dr. Prakash Chauhan
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 11 December, 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), six 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. Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP) is the first Centre and was established on November 1, 1995 in India and has been Centre for Space Science and Technology Education in Asia and the Pacific imparting 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'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 these five areas. The model of the PG courses is designed to emphasize

university educators, researchers and application scientists on the development and enhancement of knowledge and skills coupled with an application project.

CSSTEAP Headquarters, Dehradun (India)

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 those eligible students who successfully finish their PG course and whose academic qualifications satisfy Andhra University norms and are interested in continuing for a Master of Technology (M.Tech) degree, the Centre offers the opportunity to do so, in collaboration with Andhra University (AU) in Visakhapatnam, 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.

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:

a) Remote Sensing and Geographic Information Systems (RS & GIS)
b) Satellite Communications (SATCOM)
c) Satellite Meteorology and Global Climate (SATMET)
d) Space and Atmospheric Science (SAS)
e) Global Navigation Satellite Systems (GNSS).

Besides the Post Graduate level courses, the Centre also conducts short courses, workshops, awareness programmes, Webinar and MOOC on specific themes in the above 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.

Centre has conducted 61 PG courses 24 in Remote Sensing & Geographic Information System (RS & GIS), 12 in Satellite Communications (SATCOM), 11 each in Satellite Meteorology & Global Climate (SATMET), Space & Atmospheric Science (SAS) and 03 in Global Navigation Satellite Systems. The Centre has also conducted several short courses and workshops in past 24 years. These programmes have benefitted 2613 participants from 36 countries from Asia-pacific region and 22 countries from outside Asia-Pacific region. PG Courses have benefitted 1018 participants while Short Courses have benefitted 1447 participants and Webinar has benefitted 148 participants.

Till date 181 participants from 17 countries have been awarded M. Tech. Degree in the 5 disciplines (85 participants in RS & GIS; 49 in SATCOM; 22 in SATMET, 23 participants in Space Science and 02 in GNSS).

COMMEMORATION OF
25 years of CSSTEAP

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) affiliated to the United Nations, which was established on November 01, 1995 completed its 25 years on November 01, 2020. Over the 25 years, the Centre has focused on education and research in the area of space technology and applications and has emerged as a Centre of Excellence. The Centre has been fulfilling its objective of capacity building, enhancing national and international capacity in the Asia-Pacific region. More than 2600 participants from 58 countries have been benefited from these programs.

To mark this occasion, the Centre celebrated its journey towards Excellence, commemorated the 25 years of achievement, and organized a Virtual Meet – Celebrating 25 years of Excellence on November 02, 2020. Dr. K. Kasturirangan, the first Chairman of the CSSTEAP GB was the Chief Guest of the Meet. Dr. K. Sivan, Chairman, CSSTEAP GB/ISRO was the Guest of Honour. Dr. Sivan welcomed the Chief Guest of the function, all the GB members and special invitees. He expressed his gratitude to Dr. Kasturirangan who has played a key role in establishing the Centre and nurturing it. He also acknowledged that over these years, CSSTEAP and UNOOSA cooperation has also grown steadily through hosting of joint workshops, sharing of best practices, offshore training programmes and designing newer courses.

Dr. Simonetta Di Pippo, Director, UNOOSA, Observer of CSSTEAP Governing Board and Chairman, CSSTEAP Advisory Committee sent her recorded message, which was played for the audience. In her message she complimented the CSSTEAP for its achievements.

Dr. Prakash Chauhan, Director, CSSTEAP/IIRS welcomed the Chief Guest of the function, Dr. K. Kasturirangan, the founding Chairman CSSTEAP GB, Dr. K. Sivan, Guest of Honour, Chairman, CSSTEAP GB & ISRO, Governing Board members, Centre Directors, Joint Secretary, D&ISA, MEA, Vice Chancellor, Andhra University, past Directors of CSSTEAP, special invitees and CSSTEAP alumni. He made a brief presentation on the Journey of 25 years.

Dr. K. Kasturirangan, Chief Guest in his address congratulated all and recalled his memories about how they dealt with the key challenges in the early stage during the establishment of the Centre and dealing with United Nations Office of Outer Space Affairs (UN-OOSA), Government of India's agencies. He complimented on the progress made by the Centre and wished that the next 25 years are going to be even more eventful for this centre, gaining more visibility and recognition.

The Chief Guest also unveiled the CSSTEAP souvenir, containing the journey of CSSTEAP, messages from dignitaries, Centre details and achievements, and glimpses of all major events of CSSTEAP.

The Governing Board members, who attended the virtual meet namely Mr. Shamsuddin Ahmed, Director, Bangladesh Meteorological Department & PR of Bangladesh with WMO, H.E. Mr. Yerlan Alimbayev, Ambassador of Kazakhstan, Prof. Abdykalykov A Abdykalykovich, President, International University for Innovation Technologies, Kyrgyz Republic, H.E. Dato Hidayat Abdul Hamid, High Commissioner of Malaysia, Mr. Hari Odari, Minister-Counsellor, Embassy of Nepal, Mr. Joon Lee, Principal Researcher of

Space Policy Team, Korea Aerospace Research Institute (KARI), Rep. of Korea, Eng. Mr. S. Panawennage, Director General & CEO, ACCMT, Sri Lanka, Dr. Tanita Suepa,GISTDA, Thaliand, Dr. Kamol Muminov, Ulugh Beg Astronomical Institute of the Uzbekistan Academy of Sciences, Uzbekistan.

Mr. Sandeep Arya, Joint Secretary, D&ISA, Ministry of External Affairs, Govt. of India, Sri R Umamaheswaran, Scientific Secretary, ISRO, Directors of Host Institutions : Sri P. Kunhikrishnan, Director, URSC, Dr. D.K. Das, Director, SAC, Dr. Anil Bhardwaj, Director, PRL, Sri Shantanu Bhatawdekar, Director, EDPO/ISRO Hq. Prof. P.V.G.D. Prasad Reddy, Vice Chancellor, Andhra University also addressed the audience and congratulated all and expressed their happiness that Centre has become a role model and they will continue to provide support to CSSTEAP.

The former Directors of CSSTEAP namely Prof. B.L. Deekshatulu, Dr. George Joseph, Dr. V.K. Dadhwal, Dr. P.S. Roy, Dr. YVN Krishna Murthy and Dr. A Senthil Kumar shared their reminiscences and conveyed their best wishes to CSSTEAP. Prof. Karl Harmsen sent his message by email. It was read by Director, CSSTEAP.

The CSSTEAP alumni of different courses were invited to give their feedback and they expressed their gratitude to the Centre for enriching them and helping them in their career. Dr. S.P. Aggarwal, Programme Coordinator, CSSTEAP presented vote of thanks. The programme was a great success and was applauded by all attendees.

Milestones

1995 — Establishment of CSSTEAP

1996 — First PG Course in RS & GIS

1997 — First PG Course in SATCOM

1998 — First PG Course in SATMET & SAS

2012 — First Short Course in SSM

2015 — First PG Course in GNSS

2017 — First Off-campus Course

2019 — First Webinar Series

2020 — First Online Short Course/MOOC

Silver Jubilee Celebration

New Director of CSSTEAP

Dr. Prakash Chauhan has taken over charge as Director, CSSTEAP from Dr. A. Senthil Kumar, w.e.f. April 01, 2020 in addition to his current duties of Director, Indian Institute of Remote Sensing (IIRS), Dehradun.

Dr. Chauhan joined Indian Space Research Organisation (ISRO) in 1991 as scientist and since than working for the applications of remote sensing technology for natural resources management for ocean and land resources. He initiated research activities for planetary remote sensing at Space Applications Centre to study solar system objects mainly Earth's Moon and Mars, through Indian planetary missions.

His major achievements are in the area of earth observation applications including development of algorithms for ocean colour parameter retrieval, marine living resource assessment, aerosol remote sensing for space based air quality monitoring, river and reservoir water level estimation using space borne altimeters and coastal zone management. He has done lead work in using the hyperspectral data for lunar surface composition mapping using HySI and Moon Mineralogical Mapper (M3) instruments of Chandrayaan-1. He has been the Principal Investigator for Infrared Imaging spectrometer (IIRS) instrument on-board Chandrayaan-2 mission. He also led a team of scientists for scientific analysis of data from Mars Orbiter Mission (MOM) instruments. He has published more than 100 research papers in both National and International Journals.

He has also served as Chair for CEOS working group on Capacity Building and Data democracy (WGCapD) for the year 2018-19. He is executive member of International Ocean Colour Co-ordination Group (IOCCG) and representing ISRO. He has also represented ISRO at CEOS as Co-Chair for Ocean Colour Virtual Constellation (OCR-VC). He had been member of prestigious NASA-ISRO Planetary Science working group. He has been conferred with many prestigious awards.

CSSTEAP welcomes Dr. Prakash Chauhan as the new Director of CSSTEAP!

Highlights

PG COURSES COMPLETED

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)

ONLINE SHORT AND MOOC COURSES COMPLETED

RS and GIS: on RS & GIS Technology and Applications during November 16-27, 2020 (68 participants from 16 countries)

Satellite Meteorology: on Meteorological Satellites Physical Principle, Retrieval and Applications during November 23 - December 05, 2020 (63 participants from 13 countries)

9th Small Satellite Mission (SSM): on Small Satellite Missions during December 14-25, 2020 (27 participants from 11 countries)

Space and Atmospheric Sciences (SAS): on Space and Atmospheric Sciences during December 7-14, 2020 (61 participants from 11 countries)

A Maasive Open Online Course (MOOC Course): on Geospatial Applications For Disaster Risk Management during October 13, 2020 to January 31, 2021 (11892 participants from 148 countries)

Dr. S.P. Aggarwal
Programme Coordinator, CSSTEAP

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 have successfully completed 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. 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-1A and module-1B and are common to all course participants while semester-2 consists of

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

specialization module-2 and module-3 for pilot project work. Module-1A 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-1B of one month duration was specifically designed to cover the advance topics in RS & GIS and environmental analysis and management.

"Participants of 24th RS & GIS course at NRSC Outreach Facility-Jeedimetla, Hyderabad

Based on their academic background, technical requirement of their parent organization and their professional experience, in semester-2/module-2, every course participant has chosen one of the eight available specializations 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-3 of three months duration, consisted of execution of a pilot project based on the knowledge gained during the course by utilizing space based 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 Hydrological modelling using SWAT Model, Aerosol variability modelling, GIS customization for license documentation process in urban planning, Spatio-temporal variation of heat stress index, change detection analysis of mining area, fuzzy machine learning for bi-sensor temporal data processing, estimation of crop evapotranspiration using RS based energy balance approach, RS & GIS based hydrological and hydrodynamic modelling, LULC change detection, different classification approaches for airborne hyperspectral data, landslide hazard zonation mapping with GIS and DInSAR techniques, soil moisture estimation over vegetated land using SAR data, ground water depletion monitoring using grace and InSAR data, glacier dynamic study using geospatial data, comparative assessment of geostatistical and machine learning techniques for interpolation, automatic building extraction and characterization with active contour model, investigation of gaseous air pollutants using satellite observations, hydrological modelling of sub-watershed, geospatial approach of soil erosion risk assessment, near real-time flood mapping using google earth engine with GIS, satellite-based rainfall data analysis, flood inundation mapping using RS data to name a few.

Participants of 24th RS & GIS course at Andhra University, Vishakhapatnam

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 (NRSC-Shadnagar), 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, Hyderabad, Delhi and Agra, 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 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 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 SATELLITE SYSTEMS (GNSS-3)

Introduction: The 12th Post Graduate course on Satellite Communications (SATCOM-12) and 3rd Post Graduate course on Global Navigation Satellite Systems (GNSS-03), have been successfully conducted by Space Applications Centre (SAC), ISRO, Ahmedabad, from August 2019 to April, 2020. 16 candidates from 8 countries participated in SATCOM-12 and 14 candidates from 7 countries participated in GNSS-03. The courses formally started on August, 1, 2019, at Bopal Campus of SAC. The Joint Inaugural function of the two courses was held on 5th August 2019. It was inaugurated by Shri. D.K. Das, Director, SAC, in presence of Shri. N.M. Desai, Associate Director, SAC, Dr. A. Senthil Kumar, Director CSSTEAP and other distinguished members.

Academic Sessions: The updated academic syllabus, followed in each of these courses, focused more on fundamentals, on one

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

Demonstration at Delhi Earth Station, DES

Students' Interaction with Director, SAC

SATCOM-12 participants attending a classroom lecture

Visit to Taj Mahal, Agra

hand, while incorporating latest technologies, on the other. The first semester began on 01 August, 2019 and was 15 weeks long. It covered 5 technical papers with internal exams at the end of each and a weeklong semester examination at the end of the semester. It was followed by 1 week of educational tour to North India. The second semesters started on 25 November, 2019 and continued for 11 weeks. It consisted of 4 technical papers and ended on 06 February, 2020 with the completion of the second semester exam. The South India tour was conducted at the end of it. Each paper had an identified focal point. A pragmatic apportionment of the theoretical, practical and tutorial classes for each of the courses were done, putting emphasis on the effectual learning by the students.

SATCOM-12 and GNSS-03 combined, more than 150 experienced Scientists and Engineers working at different ISRO Centers were invited for lectures and about 30 lecturers were from either well-known academic institutions or from other similar governmental organizations. To encourage interaction with the industries, lectures from some well-known business houses were arranged as a part of the curriculum along with visits to local industries.

Following the two semesters, the students worked on their respective Pilot Projects. Pilot project topics were identified with adequate care to keep the work

South India Visit

Visit to Qutab Minar, Delhi

useful for the participant's organization. Individual project guides from SAC had been identified for technical guidance. At the end of the tenure, each participant submitted report on their pilot project which were reviewed and evaluated by subject experts.

Educational Tour: Combined study tours, for SATCOM-12 and GNSS-03 students were conducted to reputed SATCOM and Navigation establishments and to different centers of ISRO. The educational tour to North India was conducted between November, 18, 2019 to November, 22, 2019. During the tour, the group visited Delhi Earth Station (DES) of ISRO and Network Operations Control Centre of DoT, where the students were acquainted with various activities that the respective centers are engaged in. The visit to All India Radio (AIR) and Doordarshan,

included demonstration of the ground segment, the telecommunication facilities, the production facilities including the studios. The students also had interactive sessions with the officials. At National Physical Laboratory (NPL) in Delhi, the time keeping activities by the atomic clocks were demsonstrated. The educational tour to South India was conducted between February, 09, 2020 to February 14, 2020. During the tour included visits to Master Control Facility (MCF) at Hassan, ISTRAC and ISITE at Bengaluru and SDSC at Sriharikota. Here, the students visited various facilities where they were explained about the ground activities being carried out for SATCOM and SATNAV operations. The group was also apprised of various on-going and forthcoming missions of ISRO. The state-of-the-art launching facilities at the SDSC, SHAR were witnessed by all the participants.

Visit to Places of Interest: During the tenure of the course, the participants were taken for a local sightseeing at Ahmedabad and Gandhinagar, which included, Gandhi Ashram, the heritage site of Adalaj step well and Akshardham temple. The students, also enjoyed few Indian festivals like Uttarayan, Deepavali and Holi. They also participated in the Dandiya dance during the Navaratri festival. During the educational tours, the students visited local places of interest like Lotus temple, Red fort and Mahatma Gandhi's Samadhi (Crematory) at Rajghat and the Taj Mahal at Agra. During the South tour, Hoysaleswara temples at Belur and Halebidu and the Shravanabelagola temple dating back to 980 AD were amongst the places of visit. These visits, facilitating exposure of the diverse Indian culture and providing opportunity to know the diverse culture, tradition and rich heritage of India, were very much appreciated by all the students.

Special Mention: In order to make the course more attractive and useful to the participants, an event called 'Student's Day' was conducted. In this, the students appeared in the role of the lecturer in the class to explain a curricular topic to their colleagues in the class, in presence of the relevant experts. Keeping the courses more cognizant towards the environment, most of the documents shared with the students were in digital form. CSSTEAP had also sponsored separate English classes and support for few candidates.

Dr. Keran Wang, Chief, Space Applications Section, IDRRD, UN-ESCAP, visited SAC, Ahmedabad on 29 January, 2020 and interacted with the students of the course as well as with the officials. The students also attended the National conferences of INAC-4, at SAC.

India was under complete lockdown at the time of the closure of the course. As a result, the foreign students could not get back right after the closure of the courses. During their extended stay in India, CSSTEAP continued to pay the subsistence allowance to the foreign participants, till the time of the departure. This immensely helped the students during this critical period.

Closure of the Course: Due to the prevailing lockdown condition due to the Covid-19 pandemic, the formal closure through valedictory function could not be done. On 30 April, 2020, the course was declared closed, as per the schedule. Sri D.K. Das, Director-SAC, Sri Nilesh Desai, Associate Director-SAC and Dr. Prakash Chauhan, Director, CSSTEAP had sent video messages for the students on this occasion, which were communicated to the students through electronic media.

Dr. Rajat Acharya
Course Director
SAC, Ahmedabad

Mr. V.N. Parekh
Course Coordinator
SATCOM
SAC, Ahmedabad

Mr. Vishal Agarwal
Course Coordinator
GNSS
SAC, Ahmedabad

ONLINE SHORT COURSE ON REMOTE SENSING & GIS TECHNOLOGY AND APPLICATIONS

SHORT COURSES

The online short course on Remote Sensing & GIS Technology and Applications was organized by CSSTEAP and conducted by Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun during November 16 - 27, 2020. IIRS is one of the host institutions of CSSTEAP situated in Dehradun, capital city of Uttarakhand state of India. The IIRS (established in 1966) is a key player for training and capacity building in geospatial technology and its applications through training, education and research in Southeast Asia. The training, education and capacity building programmes of the Institute are designed to meet the requirements of professionals at working levels, fresh graduates, researchers, academia, and decision makers. In this online course, total 68 participants from sixteen countries of Asia-Pacific Region viz., thirteen participants from Myanmar; seven participants each from India, Kazakhstan, Malaysia, and Nepal; five participants from Bangladesh; four participants from Sri Lanka; three participants each from Bahrain, Indonesia, and Mongolia; two participants each from Bhutan, Maldives, and Uzbekistan; and one participant

each from Lao People's Democratic Republic, Philippines and Thailand; have successfully completed the course. The participants enrolled were from varied educational background such as 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 overall objective of this two weeks training course was to generate awareness among users, researchers, professionals, decision-makers and academicians on the basics to recent advances in Remote Sensing (RS) and GIS technology and its wide spread applications.

The course started with an 'Inaugural function' where Director CSSTEAP and Director IIRS welcomed all the course participants undergoing this online training programme and addressed about the importance of RS and GIS technology and its applications in various domains of life. Thereafter, participants have gone through the main training programme which comprises of two weeks duration. In the first week of the training programme, the participants were familiarized with technological aspect of RS and GIS technology such as basic principles of RS and GIS, earth observation sensors & platforms, spectral signatures and visual image interpretation, digital image processing, Image classification techniques and Separability analysis, GIS database creation, and spatial data analysis. However, in the second week of training, the participants were familiarized with the various applications of RS and GIS technology specially in the field of agriculture & soils, forest resources & ecosystem analysis, geosciences, coastal & ocean sciences, urban & regional studies, water resources, geological disasters, and hydro-meteorological disasters.

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ONLINE 9th SHORT COURSE ON SMALL SATELLITE MISSION

SHORT COURSES

Small Satellite Mission, a two week short term course for participants from Asia-Pacific countries is being conducted jointly by UR Rao Satellite Centre (URSC) Bengaluru and Indian Institute of Remote Sensing (IIRS) Dehradun. This year the course commenced in online mode from 14th December 2020 to 25th December 2020 at CSSTEAP, IIRS Dehradun and 27 participants from 11 countries of Asia-Pacific region attended the course. The Course was inaugurated by Shri P. Kunhi Krishnan, Director, URSC on 14th December 2020. 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 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. The Valedictory function was presided by Director CSSTEAP, Dr. Prakash Chauhan, Mr. Sankaran, Dy. Director, Communication and Power Area (CPA), URSC, Dr. S. P. Aggarwal, Programme Coordinator, CSSTEAP, all the participants, faculties along with the Course Director and Course coordinator. The Certificates were sent to all participants by email. With this the short course on Small Satellite Mission come on end successfully.

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ONLINE SHORT COURSE ON SPACE AND ATMOSPHERIC SCIENCE

SHORT COURSES

A short course on "Space and Atmospheric Science" was conducted during December 7-14, 2020 by Physical Research Laboratory (PRL), Ahmedabad under the auspices of Center for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations. In view of the Covid-19 pandemic, the course was held online.

The objective of the course was to create an understanding of the basics and current research trends in the field of space and atmospheric sciences with major focus on (1) Structure of the Sun, Solar Eruptions (flares, CMEs), Space Weather forecasting, (2) Optical aeronomy, ionosphere, solar wind, magnetosphere, (3) Space Instrumentation, (4) Upper, Middle, Lower atmospheric dynamics and coupling, (5) Atmospheric composition and chemistry, (6) Aerosols and climate impacts. The lectures were delivered by experts from the Space and Atmospheric Sciences Division and USO (Udaipur Solar Observatory) of PRL.

Altogether 61 people from 11 countries (Bangladesh, Ethiopia, India, Lao PDR, Mongolia, Myanmar, Nepal, Sri Lanka, Thailand, Uzbekistan and Yemen) participated in this course. Feedback from the participants was very positive.

Online Valedictory session

Dr. J. Banerji
Course Director
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ONLINE SHORT COURSE ON METEOROLOGICAL SATELLITES: PHYSICAL PRINCIPLE, RETRIEVAL AND APPLICATIONS

SHORT COURSES

Satellite Meteorology is a very promising field of remote sensing for analyzing and monitoring of weather and climate related information of the complex system earth. The invention of weather satellites has opened a new area in weather forecasting. Satellite observations enable to continuously monitor the weather as well as climate regimes on the whole globe. Therefore, it provides a powerful tool in weather forecasting, climate assessment etc. Worldwide the researchers, academicians, decision makers and professionals are using techniques developed under this field for use in most important areas like agriculture, climate and atmospheric science, marine science, hydrology etc. The recent development and availability of huge satellite data, worldwide connectivity through internet, and high performance computing environment opens up new vistas for managing the natural resources of system earth.

In the last 10-years or so Space Applications Centre (SAC), ISRO has created a store house of Indian satellite database from various ISROs meteorological/ earth observation missions and are operationally available from MOSDAC data centre (https://mosdac.gov.in). 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 at different centres of ISRO. This is first online Short course on"

Meteorological Satellites: Physical Principle, Retrieval and Applications" under the aegis of the UN affiliated CSSTEAP conducted online at Space Applications Centre (Bopal Campus), Ahmedabad during November 23 to December 05, 2020.

The overall objective of the 2 weeks training course is to generate awareness among different users like researchers, professionals, decision-makers and academicians on the basics to recent advances in Satellite Meteorology, Physical principles, retrieval and its wide area applications with special emphasis on Indian Meteorological and Oceanographic satellites. The participants were familiarized with basic principles of Satellite Meteorology, Space based observations for weather & Climate, techniques for retrieval of different Atmospheric & Oceanic parameters from satellite data and data analysis. The participants were also familiarized with different applications for use of satellite data for cyclone track and intensity prediction, monsoon monitoring, Now-casting, Air-Sea interaction, Agro-meteorology, Fog monitoring, radio-occultation and hydro-meteorological disasters. This online course is conducted in such a way to cover the important topics related to this subject.

Retrieval parts

- Basic Principles of Satellite Meteorology
- Space Based Observations for Weather and Climate (IR & Microwave).
- Atmospheric Sounding (Temperature & Humidity retrieval)
- Use of Satellite data for Cyclone tracks and Intensity Prediction
- Atmospheric and Ocean Surface winds
- Sea-surface temperature from Satellite
- GPS Radio Occultation Technique

Applications Parts

- Now-casting using satellite data
- Applications of Satellite Data in NWP
- Applications of Satellite data in Monsoon Variability
- Air-Sea interactions
- Agro-Met Applications of Satellite data
- Hydrological Applications of Satellite data
- Applications of Scatterometer data.
- Fog monitoring using satellite data

Online demo:

MOSDAC data centre: All the sessions were very interactive with lots of questions from the participants and all faculties tried to clarify these online. In case of lengthy discussions, faculties e-mails were shared with them for further interactions. After the lecture sessions, presentation materials and lectures notes etc. were distributed among participants through e-mail. 2 theory lectures of 1hr 30 min each were conducted in the morning session of each day. Total 20 lectures session were conducted in two-weeks' time.

Participants: Out of 71 selected participants, 63 participants from 13 countries in Asia-Pacific region were attended regularly and successfully completed the course. They are mostly operational forecasters, meteorologists, and researchers in their own country. Country wise distribution of participants is shown in the table below-

		Participants
1	Bangladesh	3
2	Bhutan	2
3	Indonesia	4
4	India	28
5	Kazakhstan	5
6	Mongolia	3
7	Maldives	2
8	Myanmar	4
9	Malaysia	5
10	Nepal	1
11	Philippines	1
12	Thailand	4
13	Uzbekistan	1
		63

Dr. Sanjib K Deb
Associate Course Director
CSSTEAP, SATMET
SAC, ISRO Ahmedabad

A Massive Open Online Course (MOOC) on Geospatial Applications for Disaster Risk Management

During the challenging times of the COVID-19 outbreak, MOOCs are an effective way of reaching a large number of participants to share knowledge. The United Nations Office for Outer Space Affairs and the Centre for Space Science and Technology Education for Asia and the Pacific (Affiliated to the United Nations) launched a Massive Open Online Course (MOOC) on "Geospatial Applications for Disaster Risk Management". MOOC was free and with flexible online training programme aimed to strengthen efforts of disaster management professionals to contribute to achieving the targets of the Sendai Framework for Disaster Risk Reduction 2015-2030, the 2030 Agenda for Sustainable Development and the Paris Agreement stemming from the 21st Conference of the Parties of the United Nations Framework Convention on Climate Change.

MOOC consisted of two tracks (Track-1 Basic Module & Track-2 Advanced Module) with sub-

modules. Track-1 Basic Module was further subdivided into two modules and case studies i.e. Module 1: Overview of disaster risk management (DRM) & relevance of geospatial technologies and Module 2: Earth observation (EO) & disaster management followed by Case Studies: Hazard mapping; Post-disaster damage assessment & Vulnerability assessment. Track-2 Advanced Module was further subdivided into four modules i.e. Module 3: EO & geospatial intelligence for disaster management; Module 4: EO system & Hydro-meteorological disasters; Module 5: EO system & geological disasters and Module 6: EO system & environmental disasters. Track-1 was designed for professionals interested in enhancing awareness of the latest trends in disaster risk management and how geospatial and Earth observation technologies contribute to it. Candidates completing Track-1 were given option to leave the training programme or continue with Track-2. Track-2 was designed for professionals interested in sharpening skills in use of geospatial and Earth observation technologies in all phases of disaster management. Track 1 was a prerequisite for participating in Track 2. Candidates were provided with certificates on completion of respective tracks.

The two tracks of MOOC consisted of 20 Sessions which were taken by 18 Speakers from 12 Organizations working in the field of disaster risk reduction and having vast experience. The resource persons who shared their experiences were from United Nations Office for Outer Space Affairs, Austria; Centre for Space Science and Technology Education for Asia and the Pacific (Affiliated to the United Nations), India; United Nations Economic and Social Commission for Asia and the Pacific; Delta State University, United States of America; Ruhr-University Bochum (RUB), Germany; Joint Research Centre, Italy; University of Salzburg, Austria; International Water Management Institute, Sri Lanka; Indian Space Research Organisation, India; Central Building Research Institute, India; German Aerospace Center (DLR), Germany; Maxar Technologies, Singapore.

Participants from 148 countries participated in the MOOC About 11892 (6870 in Track-1 and 5022 in Track-2) participants who completed the course successfully were issued certificates.

Organized by

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Office for Outer Space Affairs
United Nations Office for Outer Space Affairs (UNOOSA)
Vienna International Centre
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A-1400 Vienna, Austria

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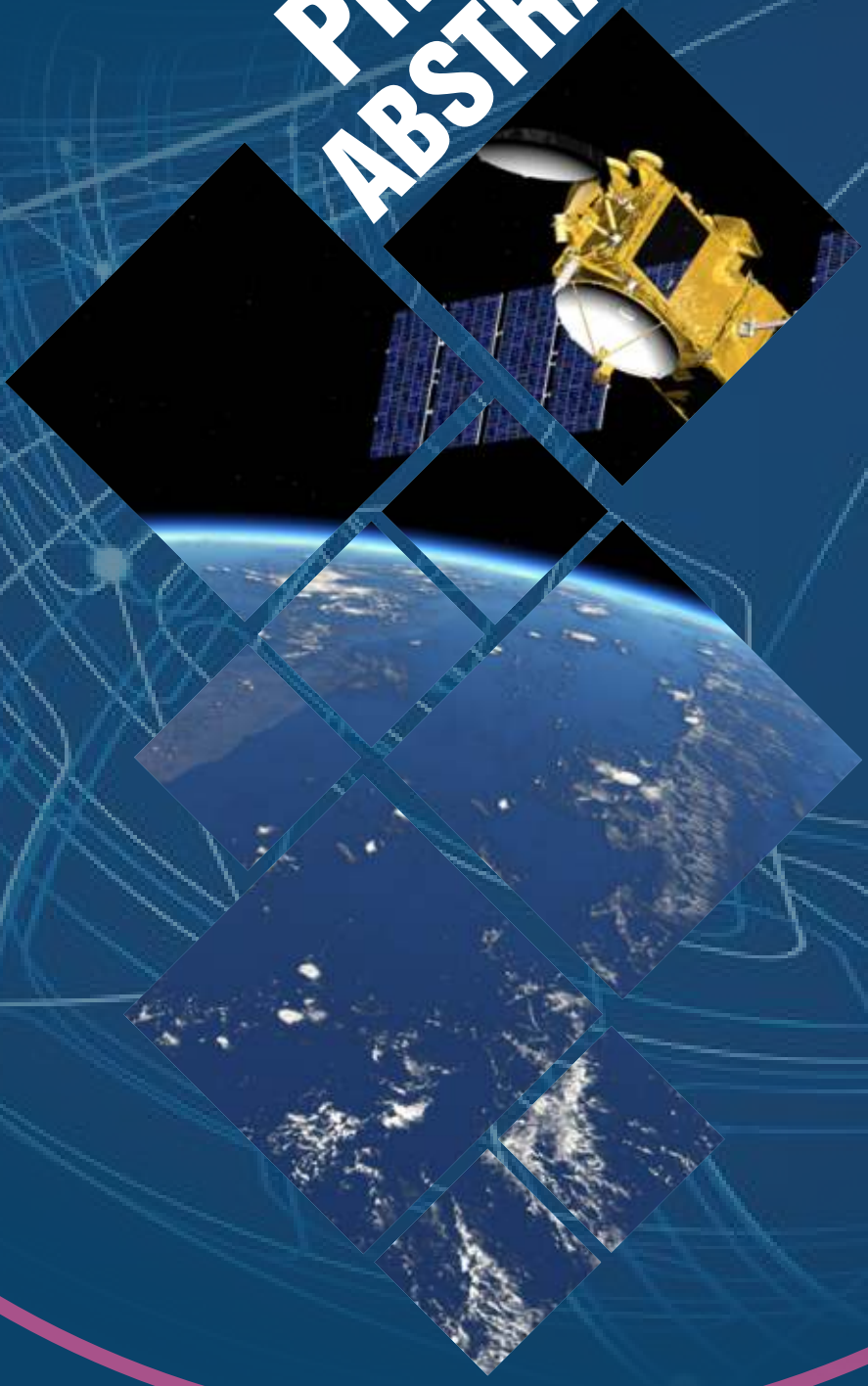
PILOT PROJECT ABSTRACTS



Project Abstracts of 24th RS & GIS Course

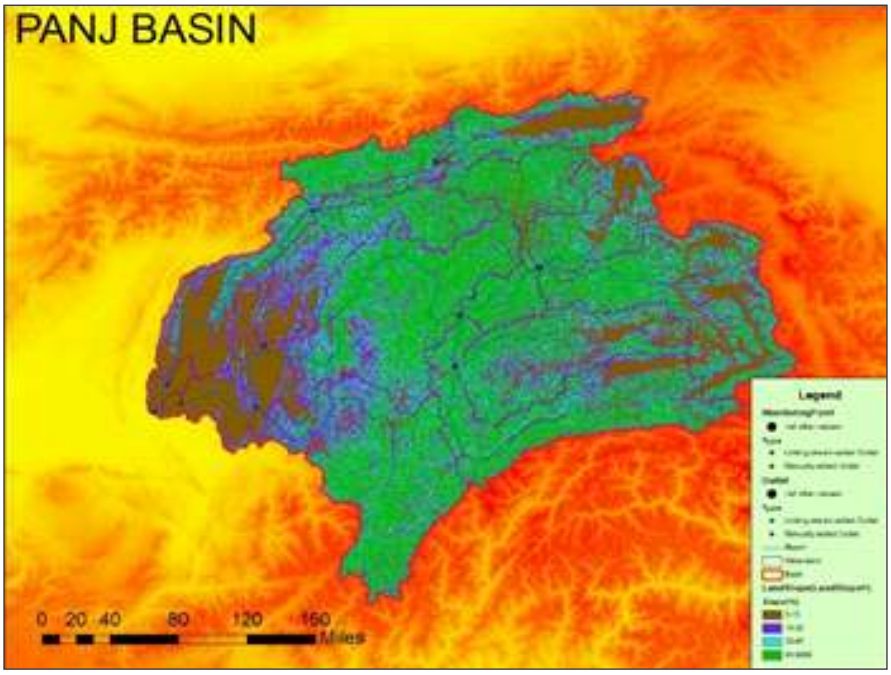
1. Hydrological Modelling using SWAT Model on the PANJ River Basin
2. Decadal - scale (2009-2018) Aerosol Variability over India during Post-monsoon season - A Case Study using Satellite and Model Reanalysis Data
3. Customization of GIS for License Documentation Process and for Citizen Participation in Urban Planning in Mongolian language
4. Spatio-temporal Variation of Heat Stress Index in Bangladesh
5. Change Detection Analysis of Mining Area using InSAR
6. Fuzzy Machine Learning for bi-sensor Temporal Data Pprocessing: A Case Study for Forest Vegetation Species/specific Crop Mapping
7. Estimation of Crop Evapotranspiration using Remote Sensing based Energy Balance Approach for Cropping Field of Morang District, Nepal
8. Application of Remote Sensing and GIS in Hydrological and Hydrodynamic Modelling of Amochu Basin, Bhutan
9. Land use Land Cover (LULC) Change Detection from 2005 and 2019: A Case Study in Colombo, Sri Lanka
10. Classification of Airborne Hyperspectral Data using Different Classification Approaches
11. Landslide Hazard Zonation Mapping with the GIS Technique and Monitoring Landslide Displacement with DInSAR Technique
12. Soil Moisture Estimation in the Presence of Crop Cover using Multi-polarized Sentinel-1 SAR Data
13. Monitoring Ground Water Depletion and It's Impacts in and around Mehesana, Gujarat using GRACE and Interferometric SAR Data
14. Glacier Dynamic Studies of Ala-Archa Valley of Kyrgyz Republic using Geospatial Data
15. A Comparative Assessment of Geostatistical and Machine Learning Techniques to Derive Surface for Environmental Variables
16. Automatic Building Extraction and Characterization with Active Contour Model - A Case Study in part of Colombo City, Sri Lanka
17. Investigation of Aaseous Air Pollutants over East-Kazakhstan Region using in-situ and Satellite Observations
18. Hydrological Modelling of Sub-watershed of Buir Basin using Remote Sensing
19. Geospatial Approach of Soil Erosion Risk Assessment for Watershed Prioritization and Conservation Planning
20. Near Real-Time Flood Mapping for Emergency Response by Integrating Google Earth Engine with GIS
21. Analysis of Long-Term Satellite-based Rainfall Data for Monsoon Season over Myanmar
22. Flood Inundation mapping using Remote Sensing Data: A Case Study of Hpa-An City, Myanmar

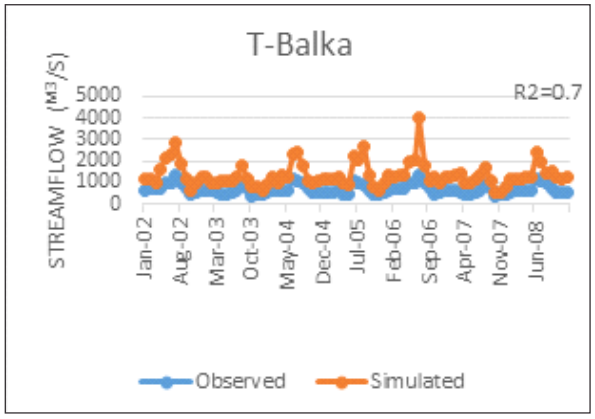
Hydrological Modelling using SWAT Model on the PANJ River Basin

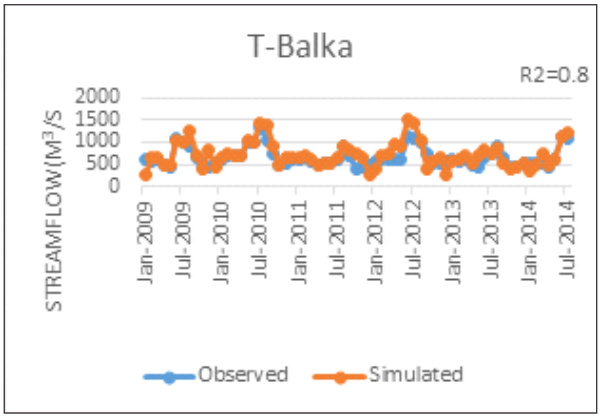
The hydrological modelling is applied by SWAT model (Soil and water assessment tool) in the Panj river basin. The total area of the basin is 160288.2 km^2. The basin is located in the south part of Tajikistan and north part of Afghanistan.

The main objective of the work is to monitor the prediction of the steam flow in the river from rainfall and snow cover over the period of time in the basin.

Meteorological data from 7 stations have been used in the model for two period of times 2002-2008 and 2009 – 2014. The model calibrated 2002 – 2008 and validated 2009 – 2014. The results show that calibrated and validated of the model with the high value of the R^2=0.7 and 0.8 for monthly simulation. The calibrated model can be used for further analysis of the affects of the climate, water quality analysis and sediment analysis.



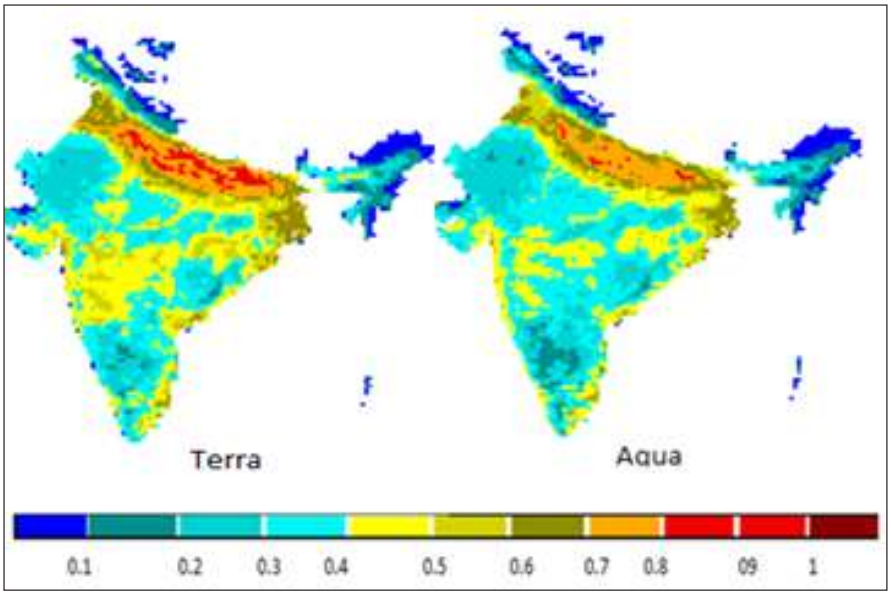




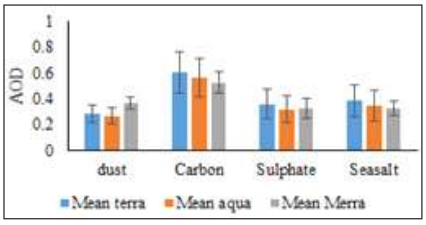
Decadal - scale (2009-2018) Aerosol Variability over India during Post- monsoon Season - A Case Study using Satellite and Model Reanalysis Data

Atmospheric aerosols which could be suspensions of liquid or solid particles in air can be of natural or anthropogenic origin. These are known to have both direct and indirect impacts on the Earth's climate. The direct impacts include modification of the Earth's radiation budget, while indirect impacts are observed as the alteration of cloud microphysical properties. Remote sensing of aerosols is able to provide a synoptic view of aerosol properties over space and time though associated with retrieval uncertainties.

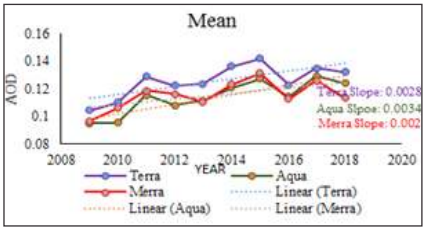
In this study, spatio-temporal variability of aerosol optical depth has been studied using the



Post monsoon decadal aerosol optical depth (AOD) variability over Indian region from MODIS Terra/ Aqua



Decadal AOD over different aerosol type dominated zones over Indian region (Post-monsoon)

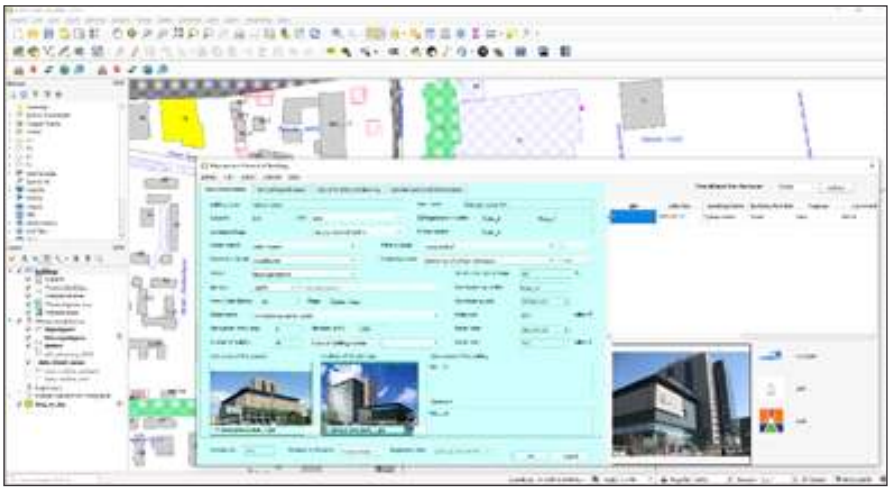


Trends of AOD over Indian region from MODIS Terra/Aqua and Merra

satellite retrievals as well as model re-analysis products over the Indian region. Post-monsoon season was chosen for this analysis. MODIS (Moderate Resolution Imaging Spectro-radiometer) daily Level 2 datasets from Aqua/Terra satellites were used with the spatial resolution of 10 km. The results were compared with those from MERRA (Modern-Era Retrospective analysis for Research and Application) Reanalysis data which was available monthly, at a spatial resolution of 1/2 degree latitude and 2/3 degree longitude. A zonal scale analysis was also done based on the dominance of carbonaceous aerosols, sulphates, seasalt and dust over the entire Indian region. Bias and correlation analysis was performed for both MODIS Aqua/Terra with respect to MERRA datasets in order to compare the results from these products. Linear trends over the decadal period from all the three data products were found to be increasing. Zonal scale linear trends are also presented.

Customization of GIS for License Documentation Process and for Citizen Participation in Urban Planning in Mongolian Language

Remote Sensing and Geographic Information System plays an important role in urban and development planning field data collection and construction license documents release. These days the world is rapidly urbanizing. Every government and private construction need planning permission. Because nowadays the world has too many problems for basic human needs. If anyone build new building or rebuild they must think about these needs.



In the present study, a model is tested on urban development geodatabase of Ulaanbaatar in Mongolia. Around 50'000 buildings center of city and zip code, road, river and administrative boundaries in the Ulaanbaatar city.

To help to license documentation process, the fast mobile data collection solution for construction services has been identified and plugin has been developed to integrate it with QGIS. The plugin is built using python and its Graphic User Interface (GUI) has been developed using PyQT5. The PostgreSQL database and PostGIS spatial and geographic objects program was used in the urbanization database for processing and logging urban planning information.

Customers can send their feedbacks and user can edit an urban database using that comments. This will create a city-planning plan with the participation of the citizens as they will be included in the Urban Planning Database preparation.

Print out of Building's Management

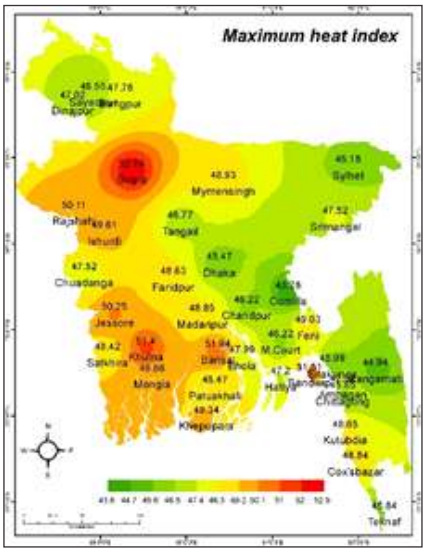
- Map of selected building number.
- Map of Planning area of General Architect of Capital city

Spatio-temporal Variation of Heat Stress Index in Bangladesh

Global climate change is already increasing the average temperature and direct heat exposure in many places around the world. Continuous exposure to heat stress due to combined effect of high temperatures and high humidity may lead to severe health impacts. This may vary from minor discomfort to even death. Death rates have found to have increased by about 20% during heat waves, as a result public-health interventions are required to prevent heat-related deaths. Heat waves were responsible for 4 of the 10 deadliest natural disasters in 2015, with South Asian heat waves ranking third and fourth by mortality.

Predictability of these heat waves exists from weather to seasonal time scales, offering opportunities for a range of preparedness measures. Heat waves are associated with an absence of normal pre-monsoonal rainfall brought about by anomalously strong low-level westerly winds and weak southerlies, detectable up to approximately 10 days in advance.

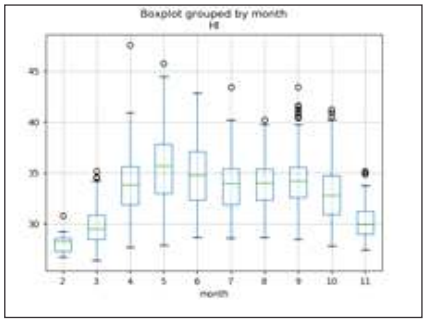
To measure heat exposure, environmental health studies often use heat index, which incorporates both air temperature and moisture. However, the method of calculating heat index varies across environmental



studies, which could mean that studies using different algorithms to calculate heat index may not be comparable. This study investigates heat stress index (HSI) algorithms found in the

literature on data from several stations in Bangladesh.

This study automates the preparation of HSI for Bangladesh that could be used to trigger preparedness measures in a heat index early warning system (HIEWS) and explores the climate mechanisms associated with heat waves. The study area is divided into seven climatic sub-zones. Using a generalized data simulation, HSI calculation and climatic sub-zonation is performed for the detection of extreme HIS events(HSE) and their evolution, expansion, features in over Bangladesh and visualizing HSI and spatio-temporal variation of HI over the country. Daily average temperatures and relative humidity are used for calculating heat index over the country from 1981 to 2018. The highest HSI was found at Bogra district (52.86°C) which is situated at climatic sub-zone 'D', and lowest value of maximum HSI was found at Comilla district (43.78°C) which is situated at climatic sub-zone 'G'. The country average HSI was



found to be 34.08°C. Most of the time heat exposure occurred south-west and north-west part of the country.The average values are shown us the tendency of heat index is increasing over the country.

Change Detection Analysis of Mining Area using InSAR

Land use and land cover pattern have been changing rapidly due to the increasing population. Land cover is the observed biophysical cover on the earth's surface. Land use is characterized by arrangements, activities, and inputs. Peoples undertake a certain land cover type to produce, change, or maintain it. The surface of the earth is continuously changing at many levels. Those are local, regional, national, and global scales. Change of land use land cover can have significant impacts on the people, the economy, and the environment.

Mining is a very expensive source in an open pit. These activities go extreme level, it is extremely affected by the earth's surface elevation, and land cover pattern changes. Aim of this study, change detection analysis of Mongolian first copper mining area in 2017-

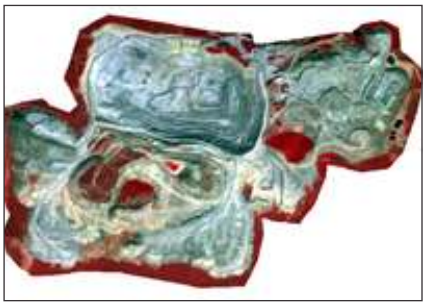
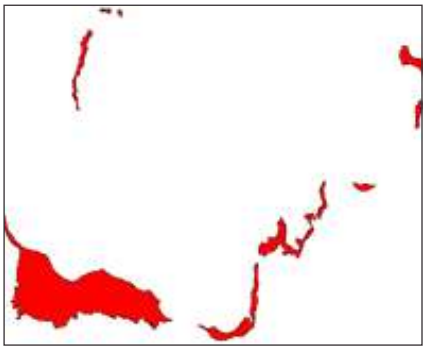


Fig. 1: Optical data sentinel 2



	M^2	KM^2
2017 total area	12807443.09	128.0744309
2019 total area	14142804.57	141.4280457
changed area	1335361.473	13.35361473

Fig. 2: Changed area (2017-2019)

2019. In this case study use Sentinel-1A InSAR image [5x20m spatial resolution] and Sentinal-2A Optical image [10m resolution]. These are provided by the

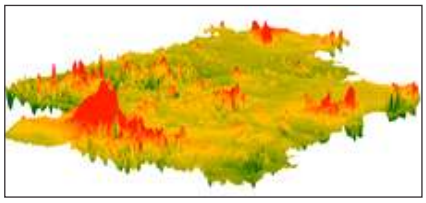


Fig. 3: 3D analysis

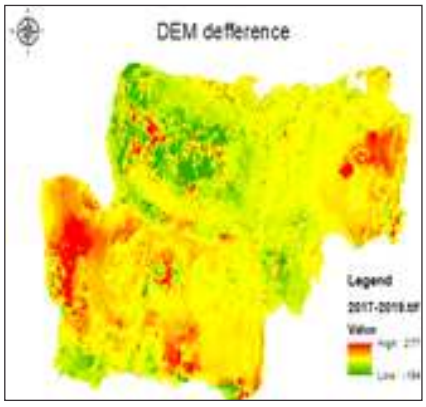
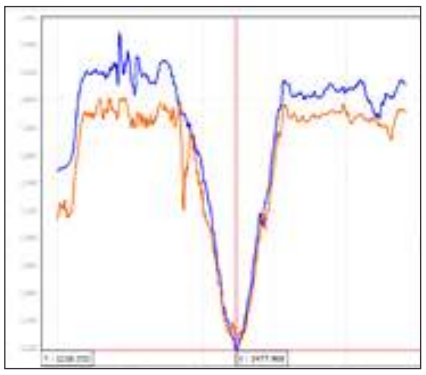


Fig. 4: DEM defference (2017-2019)



Profile line of sight (2017-2019)

European Space Agency(ESA). Interferometric Synthetic Aperture Radar (InSAR) is one of the powerful and accurate method to provide a Digital Elevation Model (DEM) in surveying and mapping. InSAR can analyze elevation changes, and optical data can analysis land use pattern changes.

Fuzzy Machine Learning for bi-sensor Temporal Data Processing: A Case Study for Forest Vegetation Species/ Specific Crop Mapping.

Bi-sensor temporal satellite images help in fulfilling required temporal dates to incorporate phenological/sessional variation in specific vegetation/crop type's identification and mapping. The reflectance of red edge region may vary with different vegetation species. It happens due to chlorophyll content in the leaves. This phenomenon can be incorporated into vegetation indices for better results. Fuzzy set theory plays a major role in the classification of the mixed pixel in image processing. This research work studies the identification of specific crops and different forest species types using bi-sensor temporal Sentinel-2 satellite images based on a fuzzy Modified Possibilistic c-Means (MPCM) classifier. MPCM classifier is capable to extract a single class from a given data.

The Mustard, Wheat crops and grass were classified in Vanasthali, Jaipur (India), study area (Fig. 1) and Rubber, Coconut, Pinus and Dilania retusa (Para) were identified and mapped in Indikada Mukalana forest area in Sri Lanka (Fig. 2). Supervised MPCM classification approach was adopted for the identification of these vegetation types that can deal with outliers, noises, single crop, and vegetation types extraction. The advantage of applying MPCM classifier was due to its capability of mapping single class as well as handles noise in the image. The output assessment was done through Mean Membership Difference (MMD) method for both areas. MMD value between Mustard was 0.007, Mustard and Wheat 0.077, Mustard and Grass 0.101. MMD values of Indikada Mukalana forest area within Rubber plants patch was 0.003, Rubber and other Forest area were 0.162, Rubber and Coconut were 0.474, Rubber and Pinus were 0.366, and Rubber and Para were 0.101.

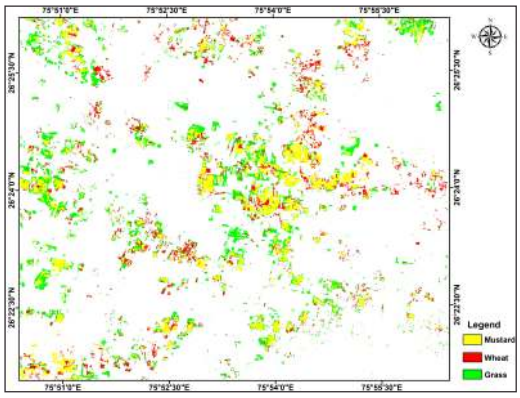


Fig. 1: Wheat, Mustard and grass mapped fields

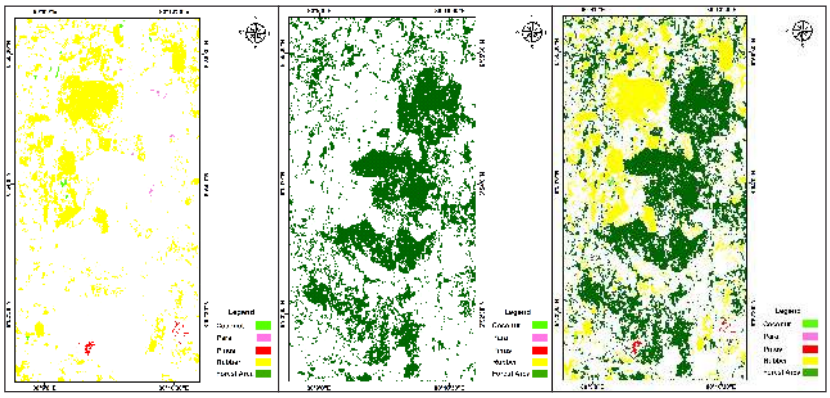


Fig. 2: Rubber, Pinus, Coconut, Forest area Mapped Fields

Estimation of Crop Evapotranspiration using Remote Sensing based Energy Balance Approach for Cropping Field of Morang District, Nepal

Estimation of evapotranspiration is significantly important in cropping field because it determines the crop water requirement and is the main component of water balance, irrigation scheduling, water management, water budgeting and hydrological cycle. The objective of this research is to estimate actual crop evapotranspiration of the cropping

field by remote sensing energy balance approach using modified Priestley-Tailor Model (Modified – PT). The outputs were generated for six geometrically and atmospherically corrected images from Landsat 8 Operational Land Imager and Thermal Band Infrared Sensors extended period from November 2018 to April 2019, having an image per month of the winter cropping season (Wheat and mustard as major crops) in Morang District of eastern Nepal. Parametrization of various pre-requisite parameters were done and various remote sensing derived products were developed using Landsat-8 data i.e. land surface temperature; normalised difference vegetation index and percentage of vegetation, surface albedo, net radiation soil heat flux. and model evaporative fraction. Finally, instantaneous evapotranspiration is generated for each images. It was observed that land surface temperature of the study area reaches maximum at 36.7 degree centigrade on 11th of April 2019 and minimum 21.8 degree centigrade on 21st January 2018 this was because of the higher emissivity from land surface during the end of the cropping season and winter period. Ground heat flux is also follow the similar trends having minimum at 13.25 W/m^2 January 2018 and maximum at 43.59 W/m^2 in April 2019. The average latent heat flux with in the cropping season varies between 31.29 W/m^2 to 58.34 W/m^2 with respective crop evapotranspiration of 1.22 mm/day to 2.01 mm/day. This research conclude that spatial and temporal variation of crop evapotranspiration can be well mapped using modified PT method in the terai region of Nepal. Further, with the ground measurement of the ET and validation for the entire terai region of the country would be the future research extension in Nepal.

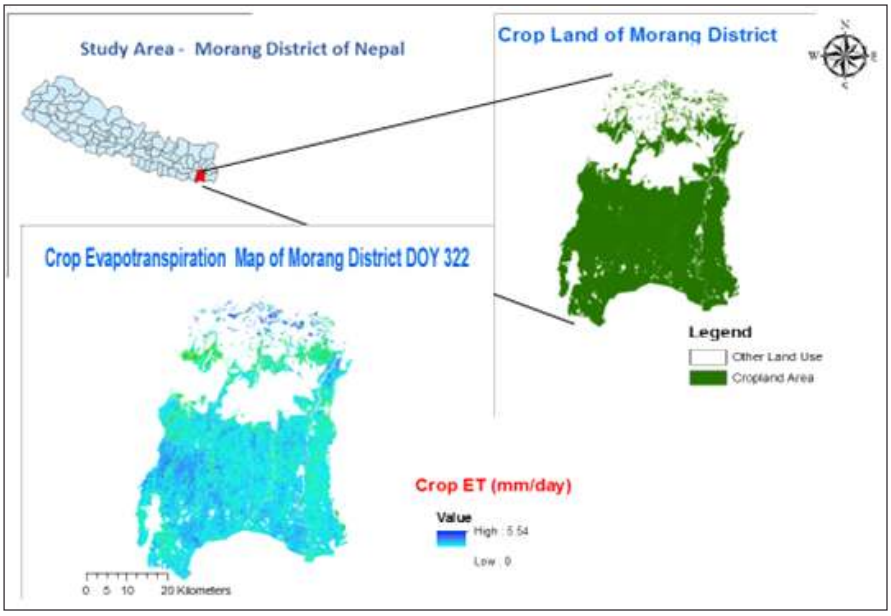


Fig. 1: Study area and ET Map

Application of Remote Sensing and GIS in Hydrological and Hydrodynamic Modelling of Amochu Basin, Bhutan

Flood throughout the globe is considered the most recurring and disastrous phenomenon among the natural hazards. Bhutan, in the southern low-lying regions are not exceptional to such natural disaster. Application of Remote Sensing and GIS is a valuable tool in simulating rainfall runoff and flood hazard mapping.

The geographical and hydrological

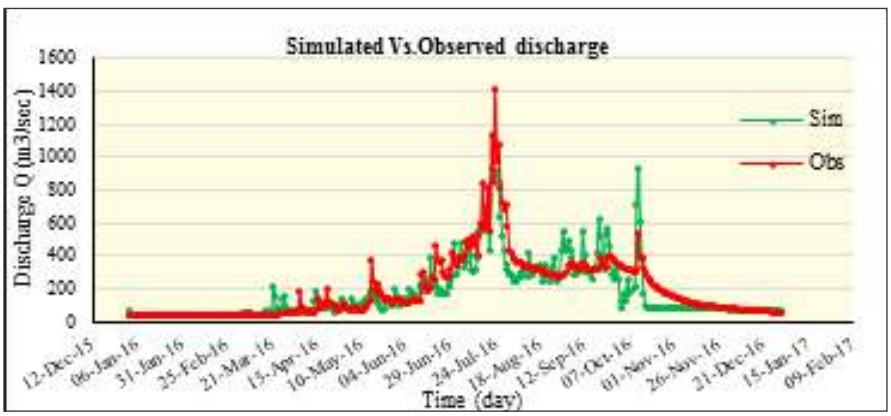


Fig. 1: Model Calibrated output and observed flow

settings of the Amochu River Basin, coupled with the climate change scenarios constitute to recurrent occurrence of flood, surpassing the levees/ embankment of Amouchu plain resulting in loss of lives and properties. Flood forecasting and flood hazard mapping and zoning are effective non-structural adaptation procedures in managing floods to reduce the risks and subsequent damages from floods. The present work attempts to simulate the rainfall-runoff generated from daily rainfall together with other basin parameters and review the 2D flood inundation scenarios in the low-lying areas. The simulation and optimization of surface runoff was carried out through application of HEC-GeoHMS and HEC-HMS models. The modelling approach incorporated SCS Curve Number method. Similarly, the hydrodynamic modelling for both steady and unsteady flow was determined through application of HEC-GeoRAS and HEC-RAS models.

The simulated flow resulting from the HEC-HMS model was evaluated with the observed flow data. And, the model efficiency was verified using Nash-Sutcliffe efficiency coefficient and

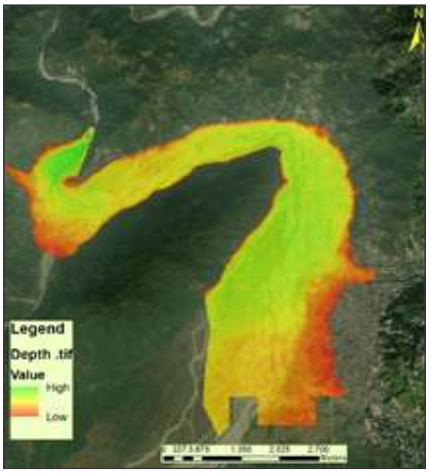


Fig. 3: Study Area, the Amochu Basin

Coefficient of determination R_2. The hydrological model efficiency from calibration and verification were 0.72 and 0.65 respectively. The averaged Curve Number (CN) of the basin is 87.

Land Use Land Cover (LULC) Change Detection from 2005 and 2019: A Case Study in Colombo, Sri Lanka

Monitoring and mapping landscapes of rapidly developing city can significantly contribute to understand the complex growth of urbanization. However, generating accurate and temporal Land use land cover (LULC) maps of such cities is a requirement as well as challenge due to spatial heterogeneity as well as fast dynamic land use practices. To monitor the changes occurring in Earth surface features it is required to perform change detection using temporal remote sensing data. Now-a day's many machine learning (ML) classifiers are used for generating LULC classified maps and identification of best technique is one of the major challenge. This study not only focuses on the comparison of some ML classification algorithms but monitoring and detecting changes using time series data.

In this study an attempt is made to observe the changes in LULC features of Colombo, capital of the Sri Lanka. The Landsat multispectral data was used in this study and was acquired from 2005-2019. Three different ML classifiers Random Forest (RF), support vector machine (SVM) and artificial neural network (ANN) was performed for LULC classification on Landsat-2019 data and best classification algorithm observed for this study was identified. The multispectral data was classified according to using standard colour of LULC map in Sri Lanka, as base map according to this classification scheme into seven classes: urban, plantation, forest, paddy, grass, land scrub land and water. All the datasets from 2005-2019 (2005, 2008, 2011, 2015

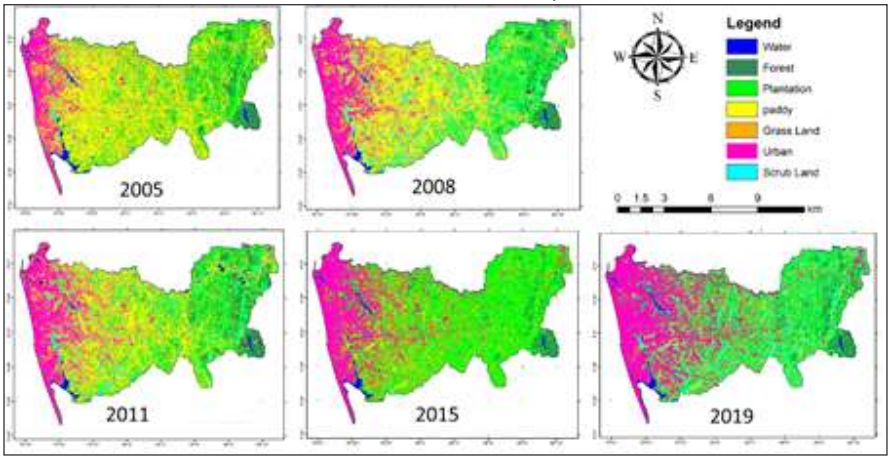


Fig. LULC Classified maps from Landsat data (2005, 2008, 2011, 2015 and 2019)

and 2019) were classified using the best identified ML classifier and change detection was carried out. It was observed from the Landsat- 2019 classified data that ML classifier SVM outperformed (OA-92.500% kappa- 0.9124), RF (OA- 85.2778%.kappa- 0.8280), and ANN (OA- 71.9403%.kappa- 0.6703) classifiers, so SVM was used for classifying data of other dates. The urban land use pattern were increased from 2005 to 2019 and paddy fields reduced. But there is no significant change observed in water and forests class.

Classification of Airborne Hyperspectral Data using Different Classification Approaches

Hyperspectral remote sensing data with very high spectral resolution (5-10 nm) provides accurate extraction of land cover features from earth surface. Hyperspectral data acquired using space based platform can separate spectrally similar features but have limited resolving power in spatial terms. Air-borne hyperspectral data contain both spatial as well spectral details. The conventional classification algorithms are being used for classifying hyperspectral data since last few decades. These classifiers enable species level or material level classification of land cover features but shows mixing of some classes and fails to give good accurate classified maps as these classifiers do not consider spatial information for classification. Spectral-spatial based classifier can resolve this issue by incorporating spatial information in the form of segmentation into pixel based classification producing enhanced classification.

The study area chosen was the part of Ahmadabad city in Gujarat, state of India having Latitudinal extent 22°59'56.23"N to 23°0'57.35"N and Longitudinal extent 72°35'38.10"E to 72°36'39.84"E. The data used was Airborne Visible/Infrared Imaging Spectrometer-Next Generation (AVIRIS-NG)" data with 5nm spectral bandwidth and super resolved 4.1 m spatial resolution. In this study different classifiers were used for classifying airborne hyperspectral data, out of them two are pixel based classifiers namely Spectral Angle Mapper (SAM) & Support Vector Machine (SVM) and another technique is Spectral-Spatial based techniques. For spectral-spatial based classification spectral and spatial processing was done by gradient calculation and segmentations after which combination of maps were generated to get the classified output. Finally comparative assessment was carried out and it was observed that spectral-spatial based classification technique gives the best result with higher accuracy.

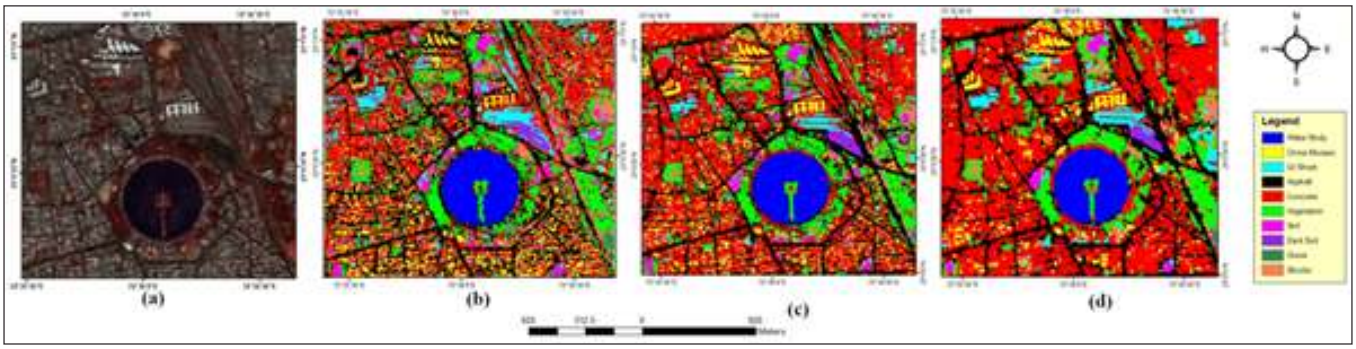


Fig. 1: (a) FCC image of AVIRIS-NG Data, (b) SAM Classified image, (c) SVM Classified image, (d) Spectral-spatial based classified image.

Landslide Hazard Zonation Mapping with the GIS Technique and Monitoring Landslide Displacement with DInSAR Technique

Many parts of the northern states of India namely Jammu & Kashmir, Himachal Pradesh and Uttrakhand are prone to landslides. The reason attributing to the vulnerability of these regions includes fragile geology, active tectonics, high relief, critical slopes, intense rainfall and the anthropogenic activities. A number of landslides triggering geo-environmental factors can be used for landslide hazard mapping based on the landslide inventory. One of the prominent zone prone to landslides lies along the Chowari main road which has been chosen as the study area. A weighted overlay method has to be employed for mapping hazard zonation areas, which then requires differential interferometry techniques to create vertical displacement map to measure mass displacement in the zones. The use of Sentinel-1 and ALOS PALSAR data facilitates the analysis approach which has been proposed for the landslide mapping in the Chowari region. Slow moving landslides are the major problems in the hilly region and it is hard to be described with the monitoring method. In this research, two techniques are used: first one is landslide hazard zonation mapping with the weighted overlay method in GIS and second one is the Differential Interferometry Synthetic Aperture Radar (DInSAR) technique is used to monitor the slow-moving landslides. The result of Landslides were compared with the help of Digital Elevation Model (DEM). Both temporal baseline and normal baseline play an important role in DInSAR process. In data downloading process best pairs have to be selected on the basis of two criteria, perpendicular baseline and time variation between two SAR image acquisitions. In DInSAR technique, interferograms are generated with the best image pairs which give the different variation in the position of landslide area in the form of phase difference. The SRTM DEM is used for topographic correction and Interferogram flattening. And subsequently, Goldstein filtering and multilooking techniques are used to remove noise factor. So accordingly three main hazard zones of landslides are shown in hazard zonation map. As per the result, the area is succeptible to landslides which varied in magnitude and was futher validated with the post landslides extracted from the Google Earth timeseries map. In DInSAR technique Alos Palsar data and Sentinel-1 were compared and found that Alos Palsar (L-Band) has higher degree of accuracy than Sentinel-1A (C-band) data.

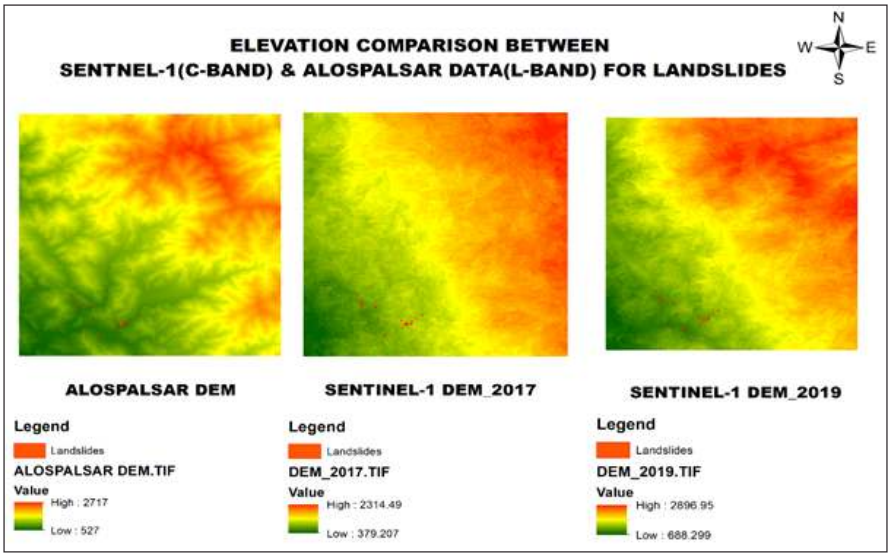


Fig. 1: Landslide Hazard Zonation Map

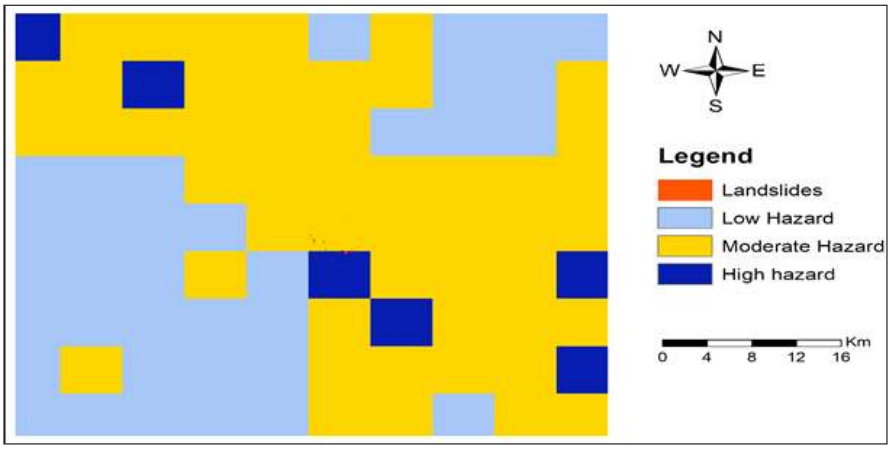


Fig. 2: Elevation Comparison Map

Soil Moisture Estimation in the Presence of Crop Cover using Multi-polarized Sentinel-1 SAR Data

Soil moisture is a significant parameter and the importance of its precise information is well-known and understood in various fields like agriculture, hydrology, meteorology, environmental studies etc. Soil moisture is very dynamic, both temporally and spatially, hence monitoring soil moisture dynamics from local to global scales is vital for a wide range of applications, and this can be measured using radar remote sensing at different temporal and spatial scales. The field of remote sensing of soil moisture has expanded greatly and the dedicated soil moisture satellite such as Sentinel-1 provides long-term perspectives for land surface monitoring.

This project work deals with an approach to incorporate the effect of crop cover in soil moisture estimation. Backscattering coefficient contains information of the crop as well as the soil underneath and therefore, in order to retrieve soil moisture from SAR backscatter, it is necessary to separate out the relative contributions of the soil underneath and the vegetation layer. The effect of crop cover on the sensitivity of SAR backscatter towards soil moisture is more severe, as the crop cover not only introduces its own backscatter contribution (σ° crop), but also introduces two-way attenuation in the radar backscatter from the soil surface.

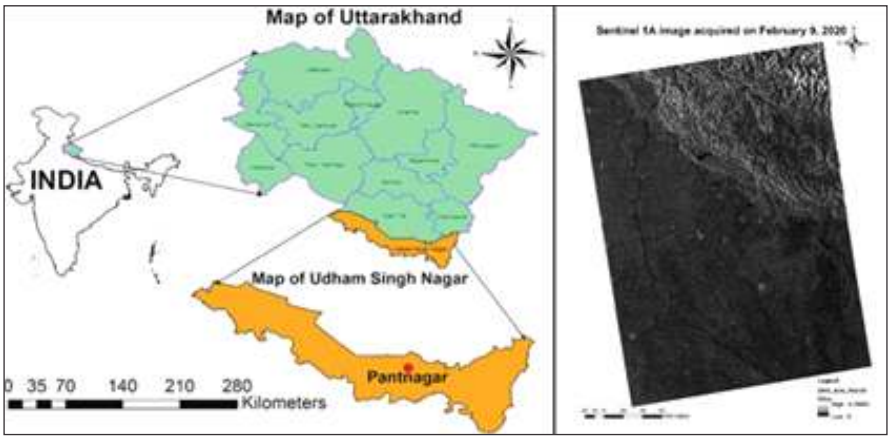


Fig. 1: Location Map of the study area & Sentinel 1A SAR image acquired on February 9, 2020

Fig. 2: Ground truth data collected during field campaign

Fig. 3: Laboratory processing and analysis

An attempt has been made here to incorporate the effect of crop cover in the soil moisture retrieval model. The aim of this study is to estimate and map soil moisture distribution over agriculture fields in the parts of Pantnagar and its surrounding areas using Sentinel-1 Synthetic Aperture Radar (SAR) image acquired on 9th February, 2020 by C-band (5.3 GHz) sensors. In-situ soil moisture measurements were carried out in about 110 test fields simultaneously with SAR data acquisition date.

Monitoring Ground Water Depletion and It's Impacts in and around Mehesana, Gujarat using GRACE and Interferometric SAR Data

Terrestrial water storage (TWS) at high spatial and temporal resolution is deemed necessary for many hydrological and hydrogeological applications. Since its launch, Gravity Recovery and Climate Experiment (GRACE) satellite has been providing water storage change data at global and regional scales. Due to above reason, the application of GRACE data for local-scale water resources management has been limited. The research work was be able to downloading GRACE with a statistical method. In this work, empirical regression methods based on the relationship between GRACE and other hydrological fluxes were applied to downscale 1 degree gridded GRACE product to

0.25 degree data. The ground water level change results were quantified by calculation mass lost for four year interval. Statistical regression downscaling method can improve GRACE data resolution effectively.

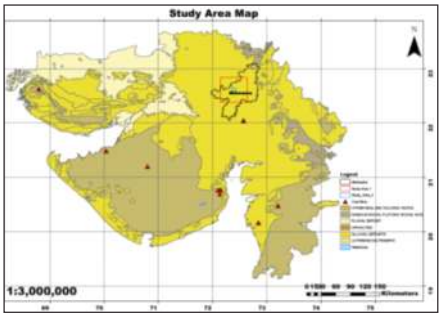


Fig. 1 : Study area

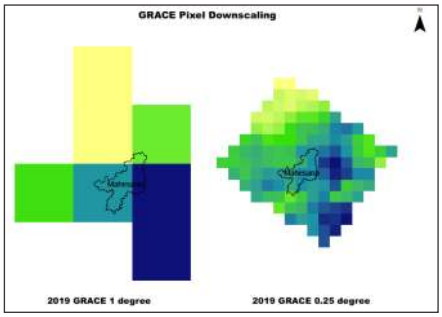


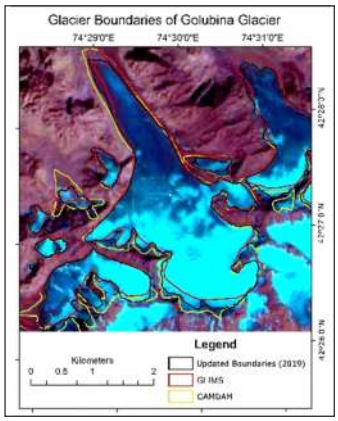
Fig. 2 : GRACE data downscaling

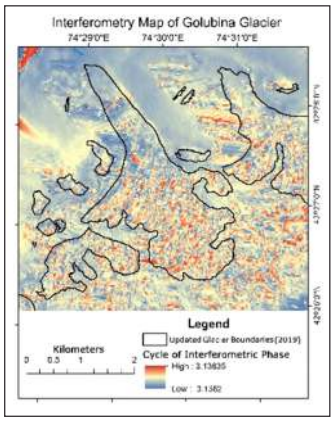
Common cause of land subsidence from human activity is groundwater extraction or oil mining. In Mehesana district, groundwater is a vital resource for urban and rural residential, agricultural and commercial water users. Approximately 90% of the total domestic water supplies in Mehesana are from groundwater. Therefore, this study aims to monitor land subsidence due to groundwater extraction using Differential InSAR & Persistent Scatter (PS) InSAR.

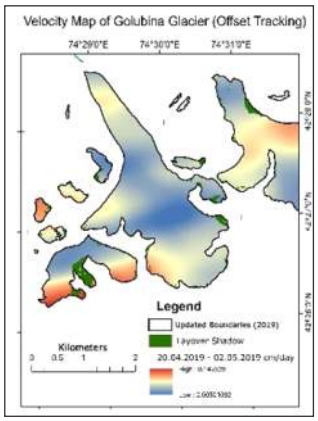
In the assessment DInSAR technique was used it identify the location which has showed slow subsidence in pre-monsoon season. Due to less phase signal information at the considerable point differential interferogram was created without phase unwrapping and standard filter methods were used to highlight phase signal. In most of cases flat and urbanized areas was given good results in DInSAR. Although phase fringes is unable to identify slow rate and small area deformation in DInSAR. PSInSAR is an extension to the conventional InSAR techniques, which addresses and overcomes the major limitations of repeat pass SAR interferometry (i.e., temporal and geometrical decorrelation and variations in atmospheric conditions). PSInSAR technique requires only selective pixels which are stable in phase throughout the acquisition time period of the images. Practically, phase stable (PS) pixels are represented by the static ground object such as buildings, roads, bare rocks, bridges and so on. The technique approached to identify single pixel deformation at the same region which had showed subsidence signals in DInSAR. The subsidence rate and time period was correlated with ground water level data in Mehesana district at pre-monsoon season.

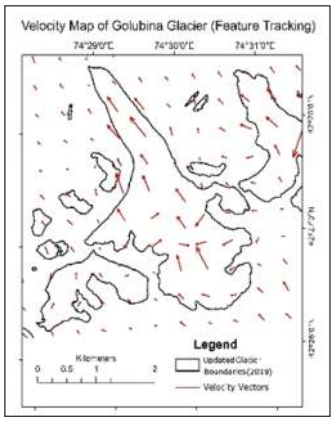
Glacier Dynamic Studies of Ala-Archa Valley of Kyrgyz Republic using Geospatial Data

Glaciers are the largest freshwater resources. Glacier dynamics studies in terms of their retreat and mass change are important from climate change and its impact point of view. The glaciers of Kyrgyz Republic, which are located in Tien Shan and Pamir-Alay mountains, are vital in water supply in arid Central Asian region as they release water during summer month when precipitation is low and water demand highest. The water released at the northern slope of Kyrgyz Ala-Too range,





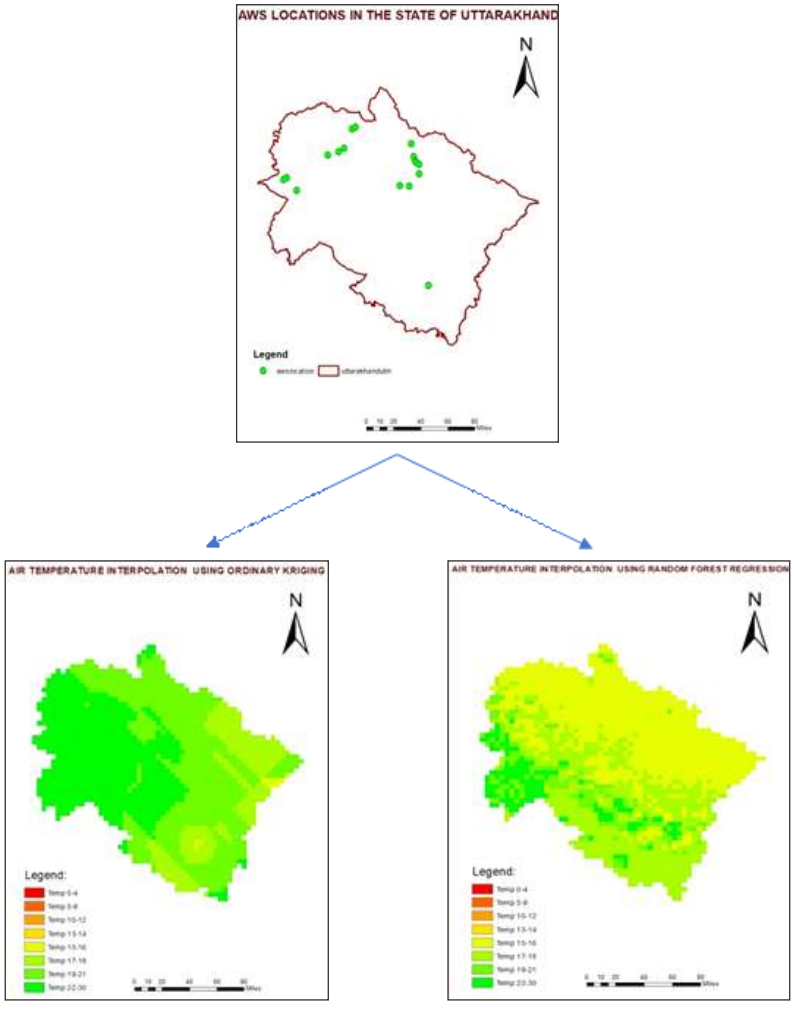




which located Ala-Archa valley drains into river Chu which is one of the main artery for the semiarid and arid lowlands in Kyrgyz Republic and Kazakhstan. In total, according to glacier inventory studies of CAIAG as of 2013-2016, there are 9959 glaciers in the Kyrgyz Republic with a total area of 6683.9 km². In the present study, the glacier boundaries in Ala-Archa River basin are updated for the year 2019 with the help of Google earth and high resolution image of Sentinel – 2. The area of 46 glaciers in Ala-Archa valley is 27.69 km² and extend over an altitude 3271-4716 m. Further, the surface velocity of the glaciers in the basin is estimated using different techniques such as feature tracking using the optical remote sensing data of Landsat series; Offset tracking and Differential Interferometric techniques using Sentinel -1 SAR data. Velocity of glaciers is estimated by offset tracking for winter, spring and peak ablation period at 12 days interval for both Sentinel - 1 ascending and descending tracks. The maximum velocity of the glaciers estimated was around 1.5 m/day from all the techniques. Later, the glacier radar zone mapping was done using the Sentinel-1 data. The glacier radar zone map helped in the glacier mapping, temporal changes of equilibrium snow line, bare ice, debris cover, wet and dry snow of accumulation zone. The temporal analysis of glacier velocity and radar zones will help in studying the impact of climate change on glacier retreat and mass balance change. It can be concluded that geospatial techniques can make the glacier change studies possible without field survey. However, to validate the results of the study the field survey is much required.

A Comparative Assessment of Geostatistical and Machine Learning Techniques to Derive Surface for Environmental Variables

The project explains the concept of Spatial Interpolation and how to carry out spatial interpolation of a continuous variable using Geostatistical and Machine Learning techniques when the data is limited. Spatial Interpolation is the process of estimating the value of continuous target variable at unknown locations based on the values at known sample locations whereas Supervised Machine Learning is a task of learning a function that maps an input to an output based on training input features and output labels. Air Temperature is an important climatic variable that controls several environmental processes and plays a crucial role in global change studies. So accurate estimation of air temperature and its spatio-temporal variability are important in several Earth and



Environmental sciences. Usually, air temperature is measured at Automatic Weather Stations (AWS) at different heights and these provide very limited information about spatial patterns at regional or global scales because they are less in number. Hence Spatial Interpolation of daily air temperature is carried out to predict the values at unknown locations and the results of geostatistical and machine learning techniques were compared for Uttarakhand state in India. Daily temperature from 16 Automatic Weather Stations located in different parts of Uttarakhand state is considered as the primary dataset for Geostatistical techniques. MODIS Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Digital Elevation Model (DEM), Distance from the nearest Water Body datasets are considered as input features and the daily temperature is considered as output label for the Machine Learning based approach. Geostatistical techniques like Simple Kriging and Ordinary Kriging was performed for the temperature recorded from 16 AWS on a particular date and these results were compared with the Machine Learning based techniques such as Linear Regression, Lasso Lars Regression, Gradient Boosting Regression and Random Forest Regression on the same date. The spatial distribution of daily temperature was estimated with the greatest accuracy of 96% by Machine Learning models when compared with Kriging based approaches. The concept of spatial Interpolation was preserved during the training of a ML model by considering the distances among the Automatic Weather Stations and their respective daily temperature. The features used for the machine learning models are also listed depending upon their importance while training the model. A continuous surface for daily temperature was created for all Geostatistical and Machine Learning Models for the Uttarakhand State.

Automatic Building Extraction and Characterization with Active Contour Model - A Case Study in part of Colombo City, Sri Lanka

Automatic extraction of buildings in urban scenes using geospatial techniques has become a subject of growing interest, particularly with the emergence of LiDAR systems since mid-1990. Recent developments in the field of remote sensing have introduced new sensor technologies in usage of LiDAR, SAR, and high-resolution optical data. Classification performance is expected to increase through combining these various data sources. 3D geoinformation plays a major role in generating useful information which could be used towards a variety of application fields e.g. architecture, urban and transport planning, surveying and mobile telecommunications. 3D models have become increasingly important in the field of city and regional management (tourism, telematics, civil protection, real estate management, and financial management).

The purpose of this study is to develop an approach for automatic extraction of buildings in urbanized and suburbanized areas using very high spatial resolution multispectral aerial images and LiDAR data set. The methodology focuses on improved building boundary polygonization from high resolution range and intensity data. The Active Contour (Snake) model is initialized and augmented by integrating with LiDAR data. Enhancement of

Fig. 1: Aerial image

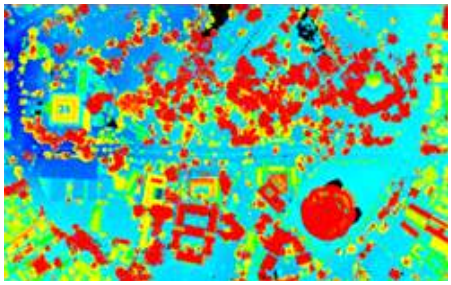


Fig. 1: Lidar Point cloud

Fig. 2: Supervised classified image

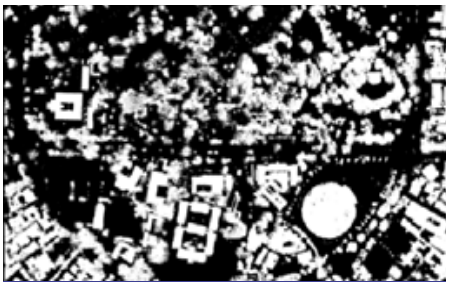


Fig. 4: Elevation threshold image

Fig. 3: Only buildings

Fig. 4: After Morphological Operators

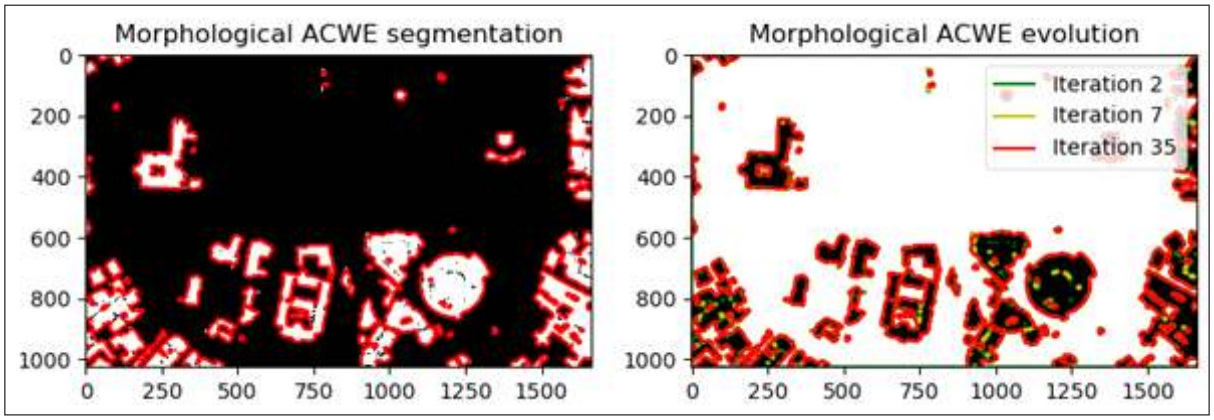


Fig. 5: Building segmentation with active contour model

building boundary polygonization is attempted by combined use of high resolution optical image and high density LiDAR point cloud. A rule-based procedure was employed to combine intensity and range information to automatically delineate building boundaries with 3D information. Broad zones of cultural sites was also done. Qualitative and quantitative measures are used for evaluating the performance of the proposed method.

Investigation of Gaseous Air Pollutants over East-Kazakhstan Region using in-situ and Satellite Observations

Distribution of trace gases like CO and O3 have been investigate dover five cities of the East Kazakhstan region (Ust-Kamenogorsk, Semey, Glubokoe, Altai) during 2016 and over the city of Ridder during 2018. This study utilized the data from environmental monitoring of the Republican State Enterprise "Kazhydromet" and satellite data from Atmospheric Infrared Sounder (AIRS) during 2005-16. The diurnal variation of CO showed two peaks over all observational sites with the first peak at 08:00 hrs and the second at approximately 20:00 hrs. CO showed maximum concentration during winter and minimum during summer over all the observational locations. During winter, maximum

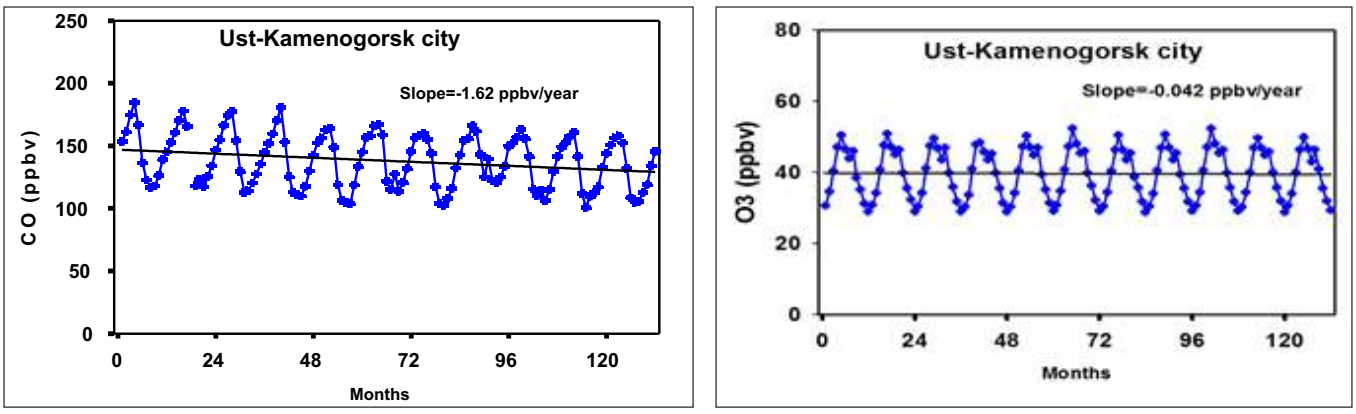


Fig. 1: Trend analysis satellite observations trace gases CO and O3

CO concentration was observed over Ust-Kamenogorsk city (1078.5±573 ppbv) and minimum over Semey city (506.4±42 ppbv). The lowest CO concentration was observed during summer (163.9±52 ppbv) over Altai city. This may be attributed to shallow boundary layer over Kazakhstan during winter time. The diurnal variation of O3 showed daytime broad peak from about 1000 hrs to 1600 hrs. However, its daily amplitude varied over several months. Ozone seasonal variations showed highest during the summer (56.1±2.0 ppbv) over Glubokoe city and lowest during the winter season (14.1±0.9 ppbv) over Ridder city during the observation period. This is due to unavailability of sufficient solar radiation due to cloud cover during winter. Satellite data from AIRS have been used to calculate the linear trends over these locations during 2005-2015. At surface (925 hPa), AIRS CO and ozone showed decreasing trend over all the observational sites.

Hydrological Modelling of Sub-watershed of Buir Basin using Remote Sensing

Geographical Information System (GIS) & Remote Sensing play an important role in providing the main data & suitable platform for creating, analyzing and modeling such geospatial data for a given catchment. Water is most important resources on the earth in the world. No life on earth can survive without water.

Khalkh river one of the largest rivers in the eastern part of Mongolia, originates at 1273m above the sea level at Xiangang ridge and flows in the Buir lake. Catchment area of this river is around 78,360 km^2, of which 7,440 km^2 is in the territory of Mongolia. Length of Khalkh river is 435 km, of which 264 km flows in Mongolia.

Buir lake is a freshwater lake that lies on the borders of Mongolia and China. Among the lakes in the eastern part of Mongolia, it is the largest lake by volume of freshwater and unique in physical geography and ecologically. Annually ice cover over the Buir lake is more than 160 days. The average precipitation is 240 mm/year, inflow from Khalkh river in the lake is around 13m^3/s. Total evaporation of Buir lake 900 mm/year. The surface runoff contribution to the Buir Lake is mainly due to rainfall and snowfall in the Khalkh river basin and ranges from 0.464 to 1.838 km^3.

In this work, the LULC of the Khalkh river basin is mapped using MODIS data. The temporal dynamics of snow cover in the catchment is mapped using MODIS snow cover products 2002– 2018. The daily snow cover products were improved by merging the MODIS Tera & Aqua data product. The temporal change in snow cover area was analyzed and hydrological behavior of the catchment is modeled using SWAT model.

SWAT (soil and water assessment tool) model is used in this project to estimate hydrological components of Buir sub-catchment. SWAT model is a unique model for prediction and monitoring from flowing water to the sub-catchments.

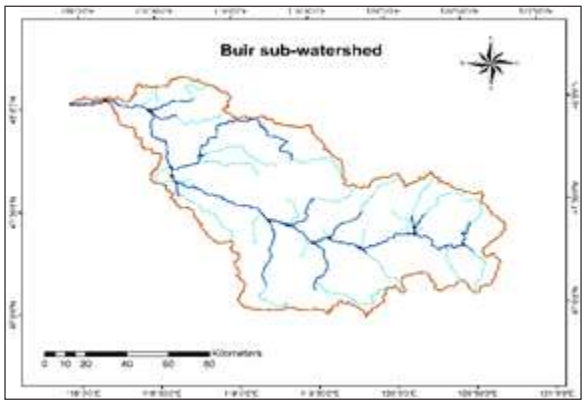


Fig. 1: Buir Sub-watershed

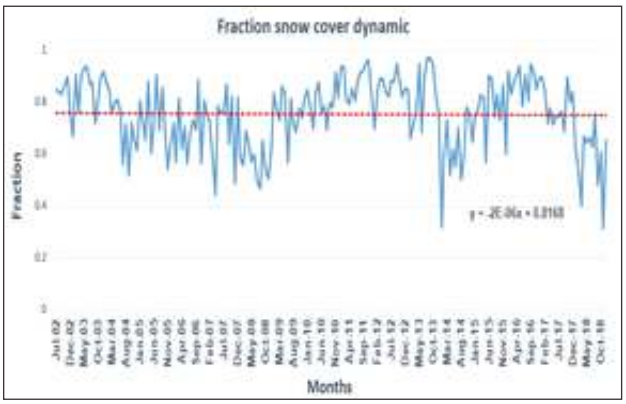


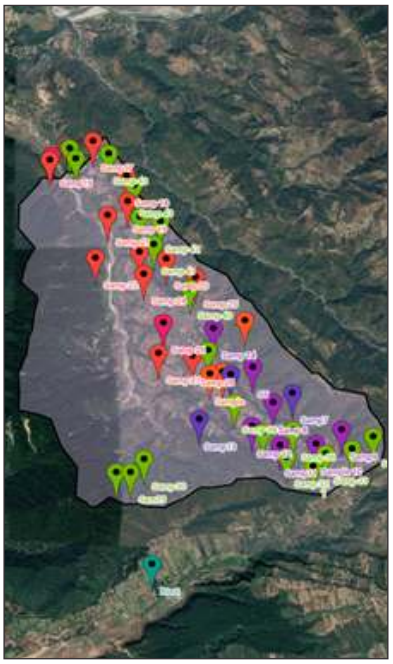
Fig. 2: Fraction snow cover dynamic

Geospatial Approach of Soil Erosion Risk Assessment for Watershed Prioritization and Conservation Planning

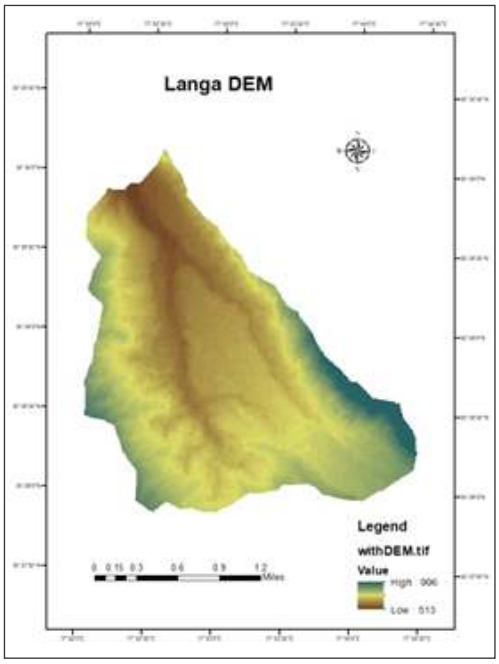
Quantification of soil loss is a significant issue for soil and water conservation practitioners and policymakers. A natural process affected by human activities as erosion causes soil or layers of soil to be moved or washed away. In addition to erosion, soil quality is affected by other aspects of agriculture. These impacts include compaction, loss of soil structure, nutrient degradation, and soil salinity. These are real and at times severe issues. The effects of soil erosion go beyond the loss of fertile land. Because of this, erosion is considered one of the most influential natural forces in nature.

This project presents a methodology that integrates the Revised Universal Soil Loss Equation (RUSLE) Model with a Geographical Information System(GIS) for simulating soil erosion risk within a small mountainous watershed of Langa village, Doon valley Dehradun, Uttarakhand, India. The spatial patterns of annual soil erosion rate were obtained from 47 samples taken from the study area. Several soil characteristics like pH, EC, soil texture and soil organic carbon were derived from the samples during the analysis.

The spatial erosion risk maps are generated using RUSLE Model and GIS can serve as effective tools in watershed prioritization and deriving strategies for land-use planning and management in the environmentally sensitive mountainous areas.



47 collected samples



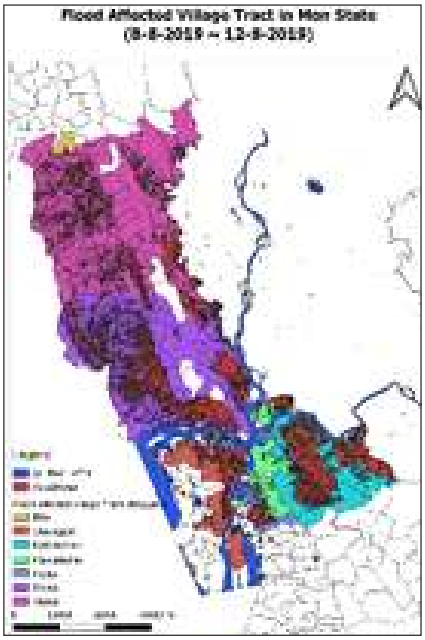
DEM of Langa Watershed

Near Real-Time Flood Mapping for Emergency Response by Integrating Google Earth Engine with GIS

Remote Sensing and Geographic Information System play an important role in disaster management sector, which provide the timely scientific information. Flood is the frequently occurring disaster and it may cause huge damage for the human life and their properties. Myanmar is a flooded prone country which is necessary to provide near real-time flood maps during flood response period. Therefore, disaster respond can be done successfully.

The main objective of this project is to generate the near real-time flood map for the township's disaster management committee by using QGIS with Google Earth Engine plugin, Q-Realtime plugin and Kobo data collection to get the ground data for filling the gap in data available occurred due to satellite passes and revisiting period.

In this project, Sentinel-1 SAR images are mainly utilized due to advantages of 6 days revisiting period and cloud penetration capabilities. It has 4 polarizations VV, VH, HH, HV among which VV is more adequate for flood mapping. Initially the pixels of VV component



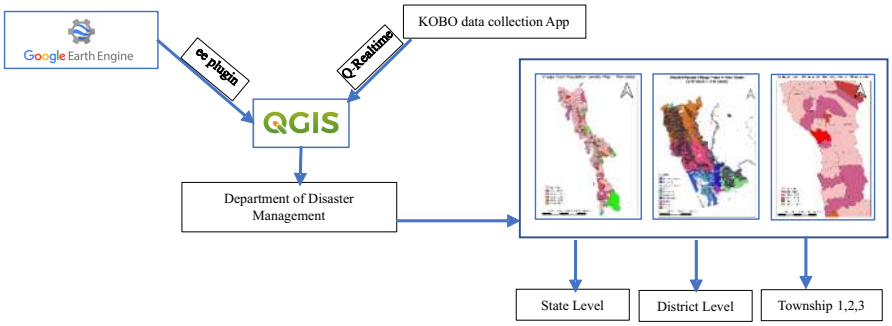


image are classified into water and non-water classes. Then, permanent water bodies are subtracted from the above generated layer which delineates the flooded area. Sentinel-2 images will also be used in unavailability of Sentinel-1 data. The cloud masked NIR (0.841 - 0.876 nm) and SWIR (1.628-1.652 nm) are used for calculating normalized difference Water Index (NDWI) from which permanent water bodies are subtracted to generate flood plain layer. And when, both the images are unavailable, ground data is collected by KOBO application. The above methodology is applied for Southern Myanmar flood occurred during August, 2019. The resulting flood layer used along with demographic and administrative boundary maps to calculate the affected area of village tracts, and estimate the total affected population.

These maps can be disseminated to the township level disaster management committee to support in decision making. Also, this methodology can be replicated to all other townships in Myanmar for near real-time flood mapping and disaster response.

Analysis of Long-Term Satellite-based Rainfall Data for Monsoon Season over Myanmar

Satellite based rainfall measurements have a wide range of applications in the fields of hydrology, rainfall trends, weather forecast, monsoon studies, climate studies etc., because at larger scales ground based rainfall measurement network is sparse and ground data sets are limited to observe the previous trends and analysing the past events. Satellite evaluation of rainfall distributions over vast areas helps to understand long-term anomalies and spatial distribution of the rainfall.

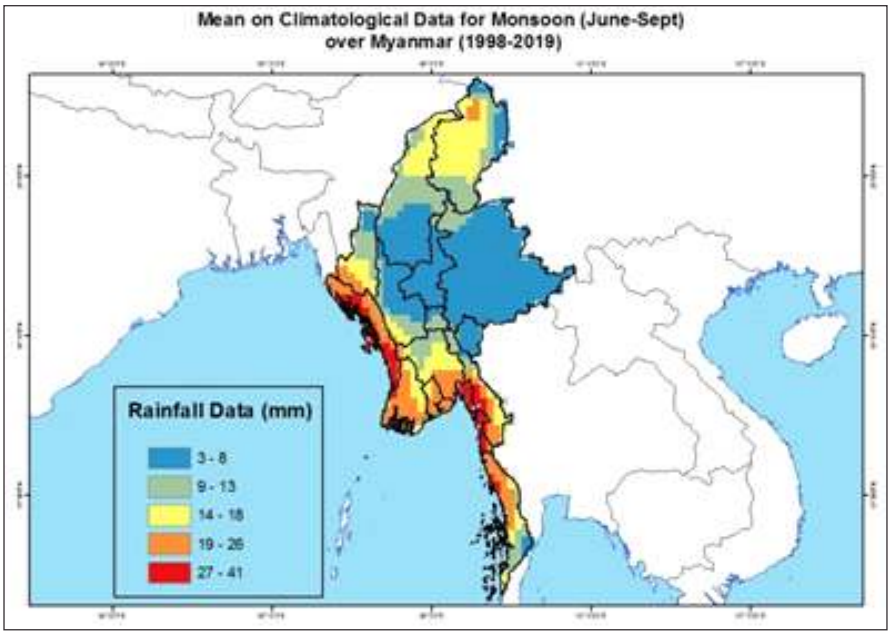


Fig. 1: Climatological Data for Monsoon (June-September) over Myanmar (1998-2019)

In this study, the detailed rainfall climatology of Myanmar has been studied based on 22 years of TRMM 3B43 V7 monthly rainfall data 0.25° x 0.25° (1998-2019) of the country for the summer monsoon months (May-October) and (June–September). TRMM monthly data obtained from

combined sensors and ground gauges have been compared to ground measurements. The ground data used for validation were obtained for six stations on southern zone (Mon and Kachin States) of Myanmar. Based on the climatological rainfall distribution, standard deviation and topography, this analysis is focused on five homogeneous rainfall regions: Northern Zone (Kachin), Coastal Zone (Rakhine), Eastern Zone (Shan) and Southern Zone (Mon and Kayin).

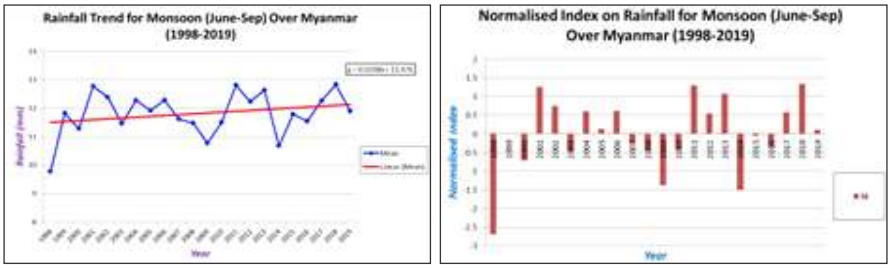
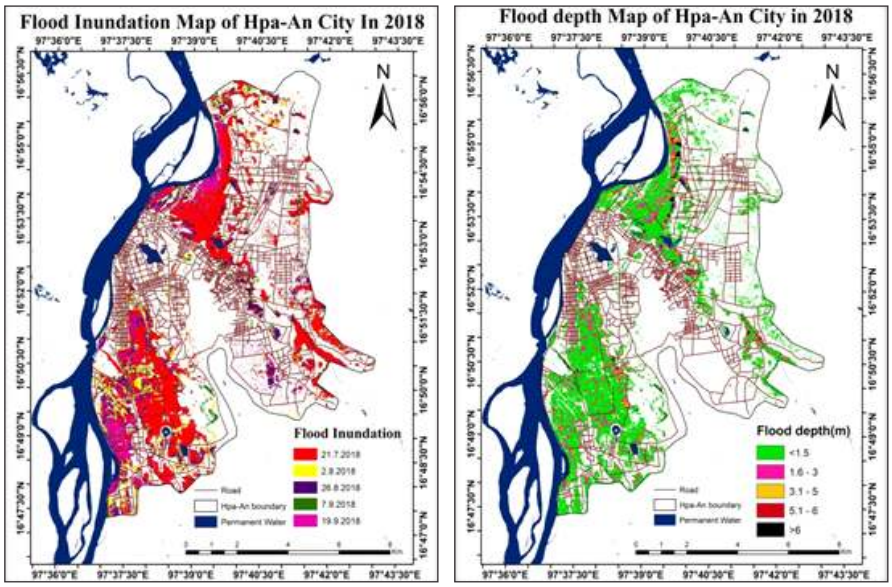


Fig. 2: (a): Rainfall Trend over Myanmar 2(b): Estimation of Flood and Drought Years over Myanmar

Different statistical characteristics of the seasonal, monthly and zonal rainfall, as well as the whole country's rainfall, have been estimated. Trend and periodicity of the rainfall series have been examined by different statistical techniques, indicating varaible trends over different study regions. It is also noted that the monsoon season rainfall over Myanmar is strongly correlated with the large scale global phenomenon such as El-Nino/La-Nina and Indian Ocean Dipole (IOD).

Flood Inundation Mapping using Remote Sensing Data; A Case Study of Hpa-An City, Myanmar

Flooding is one of the major hazards and the most devastating natural disasters in the world. During the last decades, floods led to loss of lives and properties, damage to critical infrastructures, economic losses and health related problems such as outbreak of water, the situation is not so different in Hpa-An City, Myanmar. In the present study attempt has been made to map flood inundation of 2018 flood events in Hpa-An City, Myanmar using Sentinel-1 data. FwDET tool which calculates water depth by subtracting the calculated flood water elevation (above mean sea level) from topographic elevation at each grid cell within the flooded



domain has been applied to estimated flood water depth. The present case study efficiently provides synoptic assessment of flood water extent and depth. Limitations include challenges in obtaining high-resolution DEMs and increases in uncertainty when applied for highly fragmented flood inundation domains.

Project Abstracts of 12th SATCOM COURSE

1. Wireless Sensors Data Collection and Transmission over MSS Terminal
2. Planning and System Design of High Throughput Satellite for Indian Ocean Region: Advantages and Challenges
3. Study and System Design of Ka Band High Throughput Satellite for VSAT Nnetwork in Nepal
4. Simulation and Study of Pseudo Wigner Distribution Algorithm for Elint Signal Processing
5. Developing Sensor Conditioning Circuit for Tidal Sensor to Support the Disaster Management using Automatic Identification System
6. Android based Application for Distribution of Atmospheric Data
7. Study and Design of Automated Tracking System for VSAT Terminal for Communication and Disaster Applications in Nepal
8. Study and Design of Hybrid Network of AWS in Myanmar
9. Feasibility Study and Analysis on Tracking of Coastal Vessels Assigning Unique MMSI Number
10. SATCOM on the Move System Architecture for Strategic Applications
11. Simulation and Study Quadrature Mirror Filter Bank Tree Algorithm for Elint Processing
12. Correlation between Relative Humidity (RH) and Temperature by using Wavelet
13. System Study and Analysis of Transfer of Crypto-keys over the Air for Shipborne Terminal
14. Study & Testing of Different Types of Inertial Navigation Systems Sensors

Wireless Sensors Data Collection and Transmission over MSS Terminal

Mobile satellite service has enabled the use of low power and battery operated user terminals (UTs) to provide data collection, supervisory control and data acquisition (SCADA) services from geographically dispersed locations and mobile platforms. These services are typically of low data rate, low duty factor and from unattended locations. Monitoring and actuation happens through smart nodes which are connected to a central control system. 2. This project is aimed to explore the low power sensor networks based on smart embedded wireless devices. For seamless and efficient networking of low power sensor nodes IP connectivity and suitable enabling protocols would be extremely important in Internet Of Things scenario. 6LoWPAN (IPv6 over Low-Power Wireless Personal Area Network) adaption layer enriches low power radios with IPv6. The sensor nodes connect to a base station using IEEE 802.15.4 radio standard. This project focuses on study and extraction of data from sensor nodes based on 6LoWPAN and transmission of data to a base station that will serve as a gateway for transmission of sensor data through satellite communication terminals. 3. This project and the developed application is intended to be an enabler to connect smart objects/ sensors in low power wireless links to satellite based networks in IoT scenario.

Planning and System Design of High Throughput Satellite for Indian Ocean Region: Advantages and Challenges

The sea is and has always been a major resource for food, transportation, and energy and border protection. From a defense standpoint, national security is dependent upon a strong naval presence and reliable maritime communication services. As commercial and naval vessels are at sea for long periods, they require reliable satellite communication systems to maintain contact with shore under any weather and sea conditions. Ships expect to have the same level of reliable online connectivity at sea covering from basic internet connectivity to advanced military applications and crew welfare services. Satellite thus becomes a very decisive way for providing global connectivity in the maritime domain for its high-quality performance and coverage. Further, the numbers of sensors and applications onboard ships are increasing day by day and the requirement of data is thus ever increasing.

In view of the likely congestion of bandwidth in near future and in order to offer broader transmission channel to various application, establish reliable link, provision of High Throughput Satellite is an implementable solution. Therefore, it becomes imperative to undertake a study towards Planning and System Design of High Throughput Satellite for the Indian Ocean Region.

The pilot project “Planning and System Design of a High Throughput Satellite for Indian Ocean Region: Advantages and Challenges” aims at studying the various aspects of Planning and System Design of High Throughput Satellite for Indian Ocean Region. It would include the study of payload architecture, link budget analysis and coverage analysis. The study will also evaluate the advantages and challenges offered towards implementation of the system and would also find out ways toward its solution.

Study and System Design of Ka Band High Throughput Satellite for VSAT Network in Nepal

Nepal, the landlocked country, is situated between India and China. Currently, various telecommunication providers, internet service providers (ISPs) are providing mobile communication and internet service in certain area of Nepal. In the era of advanced communication technology, there is an ever-increasing demand for providing user-specific broadband content to a large population in Nepal. Urban areas are connected via Optical fiber and Microwave communication links, but remote and isolated area are still not connected for broadband services and Telecom services too. Though ground infrastructure is directed towards supporting the high bandwidth needs in developed regions, the remote and isolated areas like Dolpa, Humla, Jumla, Kalikot, districts etc remain devoid of such services. Millions of tourists visit our country to see beautiful place like Annapurna base camp, The Mount Everest. But, due to lack of mobile connectivity, broadband connectivity, tourist and local people are facing so much difficulty. This demands have led to the evolution of High Throughput Satellite (HTS) systems to deliver uniform broadband connectivity to the developed as well as the unconnected and remote regions. HTS supports a vast range of user requirements like video-on-demand, high data rate corporate links, Terrestrial back-haul links from small user terminals. This project expounds system design of Ka band HTS with latest modulation schemes DVB-S2X, throughput in the ranges of Gbps, multi beam coverage, higher efficiency and small size user terminals based on the applications like cellular backhauling capabilities, high speed broadband connectivity like WIMAX, Internet of Things (IoT), telecentre etc.

Simulation and Study of Pseudo Wigner Distribution Algorithm for Elint Signal Processing

Gone are those days when battles are won by giving blood in battlefield, man to man war are almost over. In the modern era battles and war are won based on, how exactly you prepare yourself during peace time and how much information you possess about your enemy. Information can be the strength and weakness of your enemy, then accordingly you can prepare yourself by using this information in the battlefield and change the outcome of any battle within in no time.

How to know about your enemy is by a term called ELINT (Electronic Intelligence). ELINT is defined as information derived from intercept and analysis of radar (Non-Communication) signals. Various parameters are retrieved from those intercepted signals such as radio frequency, pulse repetition time, pulse duration, scan pattern information, effective radiated power, beam characteristics and direction of arrival of emitter and many more vital characteristics which are important in identifying the type and class of emitter. There are various algorithms that work on identifying theses parameters from the emitter and then process the information and present the information in a user understandable form.

The project describes the simulation and study of an ELINT algorithm in MATLAB for the detection and classification of Linear Frequency Modulated (LFM) types of ground-based emitters. This project basically focuses on preprocessing stage of emitted radar signal using the time-frequency algorithm i.e Pseudo Wigner-Ville Distribution (PWVD). This is one of the most useful and popular methods of time-frequency analysis in signal

processing. The output of this distribution is always real and produces cross-terms between each pair of signal components. In this project, MATLAB would be used to generate the LFM type of radar signal in burst mode and further response of PWVD algorithm would be analyzed to bringing out the benefits, if any associated with this algorithm in comparison to the other available algorithm.

Developing Sensor Conditioning Circuit for Tidal Sensor to Support the Disaster Management using Automatic Identification System

The geographical location of Indonesia is prone to natural disasters such as volcanic eruptions, landslide, forest fire, and tsunamis as reported by the Indonesian National Board for Disaster Management (BNPB). National Institute of Aeronautics and Space (LAPAN) and several disaster instances initiated a program for development Low Earth Orbit (LEO) constellation satellite for disaster management to address the problems. The main concept is using VHF Data Exchange System (VDES) especially VHF Data Exchange (VDE) to collect the data from the disaster sensors. Since Automatic Identification System (AIS) is a part of VDES, one method to prove the concept is trying to send the disaster sensor data through AIS. This project is developing a sensor conditioning circuit for interfacing disaster sensor and AIS transmitter which will serve the tidal sensor as a study case. It is needed to convince the concept can work by sending data from the disaster sensor through the AIS network to LAPAN-A2 and LAPAN-A3 satellite which carries an AIS payload receiver. The complete circuit is designed based on the Arduino microcontroller and the simulation results are presented. This project will also become the basis for developing a user terminal for VDE in future work.

Android based Application for Distribution of Atmospheric Data

Space weather has very interesting effects on humans, environment and technology in general. Scientists are exploring about the physical and chemical processes taking place in the upper atmosphere and beyond. One such type of data is Total Electron Count (TEC) that is measured by delays of the signals radiated by transmitters of navigational satellites. This project involves development of an android-based app for distributing the TEC data to user with a handheld terminal like a mobile. The TEC data is received at various grid location of GNSS and forwarded to centralized server, from where it is uploaded with GNSS signal to receivers. For distributing this data on an android device, certain data processing needs to be performed to make it suitable for the end user device. After getting an insight into the java language, application is developed using android SDK and the Android studio as integrated development environment.

Study and Design of Automated Tracking System for VSAT Terminal for Communication and Disaster Applications in nepal

Nepal is a mountainous region and it is very difficult to establish terrestrial communication system as compared to the satellite network. Nepal Telecommunication Company Ltd therefore provides communications services by establishing VSAT networks across the country. In far off regions, a small VSAT terminal is used to establish link with VSAT hub to access communication services.

Also, during the disasters, the VSAT terminals are used to provide emergency communication services, for which fast deployment of the VSAT antenna system & activating communications services in shortest possible time at a remote location is the critical requirement. It is therefore, necessary that a VSAT terminal employs autonomous tracking system associated with antenna system such that it autonomously points to the desired satellite, once the antenna system is deployed at a remote location. This project is aimed to study & design a generic algorithm for the autonomous tracking of the VSAT antenna system which is built with an electro-mechanical system, employing hardware such as servo motors, gearboxes, angle encoders, servo motor drives, motion controller as well as sensor components to detect platform orientations to actuate antenna's axes movement in both azimuth and elevation directions.

Study and Design of Hybrid Network of AWS in Myanmar

Weather has always been a major force of nature that has impact on living beings' daily life. Thus weather forecasting and monitoring is an essential task. In other word, weather data is crucial for all meteorological departments and weather data collection task plays main role in order to get the more accurate results in weather forecasting. Currently, to collect weather data in a specific location we use Automatic Weather Station (AWS). AWS are configured with different sensor to measure data of wind direction, wind speed, temperature, humidity, atmospheric pressure, rainfall amount, solar radiation, sunshine duration, visibility and cloud height, etc. Communication for data dissemination from the remote AWS stations can be done using radio, satellite or mobile network. The main objective of this study is to develop a new technology in collecting weather data in order to improve the weather data collection task in DMH, Myanmar. Therefore, this article is about the study and design of Hybrid Network of AWS in Myanmar. It will provide the information including design of Hybrid Network for data collection from the remote AWS station. At present, DMH (Department of Meteorology and Hydrology) in Myanmar uses only GPRS/GSM for data transmission. This study would explore the data transmission from remote AWS via satellite and advantage of using Hybrid Network.

Feasibility Study and Analysis on Tracking of Coastal Vessels Assigning Unique MMSI Number

India, with over 7500 kms long coastline and a large number of islands, has increasingly become susceptible to various kinds of threats and challenges emanating from the sea. Real time monitoring of complex maritime domain with vessels of varying tonnage from super tankers of over five lakh tons to small fishing boats of less than a tonne is a challenging task. Large vessels viz 300 Gross Register Tonnage and above, are being tracked and monitored under LRIT and AIS as per Safety of Life at Sea (SOLAS) guidelines given by International Maritime Organisation (IMO). It is estimated that over 2.8 lakh fishing boats operate from various fishing harbours and fish landing sites located along the country's vast coastline. As these boats are of very less tonnage they do not carry any device/ equipment through which the position of the boats can be monitored by shore authorities. From the view point of safety as well as security and to have a comprehensive awareness of the maritime domain, it is important that every small boat at sea is tracked and monitored by law enforcement agencies. As per Central Marine Fisheries Research Institute (CMFRI) Census, there are 3,288 marine fishing villages and 1,511 marine fish landing centres in 9 maritime states and 2

union territories. The total marine fishermen population was about 4 million. The length of the Indian coastline and density of the fishing boat around the major harbour and other strategic installations necessitates active patrolling and surveillance activities to ensure civilian integrity and curbing of illegal activities. Considering, the raise in the Maritime terrorism through hijacking minor boats and attacking cities and strategic installations like naval bases and petrochemical storages. Concerns on coastal vessel tracking peaked after the 26/11 terror strike in Mumbai in 2008. This project is aimed at studying the feasibility of assigning unique numbers to each fishing boats akin to MMSI number of AIS from the output of DAT 1G, DAT 2G and MSS terminal deployed on board fishing boats. Upon proving the concept through test data, implementation of integrated tracking of all fishing boats through uniquely assigned MMSI numbers (NMEA output) to the local coastal monitoring stations Geographical Information Systems (GIS) interface for real time tracking and immediate localized responses in the event of any eventualities. This project would also help in immediate SAR response, poaching prevention, monitoring of fishing ban compliance and coastal pollution tracking in addition to the security imperative of the project.

SATCOM on the Move System Architecture for Strategic Applications

Mobile broadband communications have become a significant need in both Government and commercial sectors. In the military domain, the ability to communicate while on the move presents a tremendous advantage on the battlefield and is a key component of the network centric architecture. Satellite communications On the Move (SOTM) technology provide on-the-move broadband communication services to land vehicles, aircraft, and ships, thereby enabling real time battlefield situational awareness including tracking, command and control, & intelligence backhaul. This project expounds the system architecture for a SOTM system for strategic applications. Starting with the history of SOTM, it explains the working and composition of SOTM from functional and spatial aspects. Further, it gives an insight into the key challenges of SOTM. Towards the design of a SOTM system for strategic purpose in Indian region, the requirements such as number and types of terminals, QoS parameters are derived. Thereafter, the network capacity requirements are analysed to present a comprehensive link design for an effective and efficient application of a SOTM system. Finally, the system design culminates into the desired payload architectures with end-to-end system trade-off studies.

Simulation and Study Quadrature Mirror Filter Bank Tree Algorithm for Elint Processing

Gone are those days when battles were won by giving blood in battlefield. Man to man wars are almost over. In the modern era battles and war are won that how exactly you prepare yourself during peace time and how much information you possess about your enemy. If you Know your enemy, you know about his strength and weakness then accordingly you can prepare yourself and by using this information in the battlefield you can change the outcome of any battle within in no time. How to know about your enemy is by a term called ELINT (Electronic Intelligence). ELINT is defined as information derived from intercept and analysis of radar (Non-Communication) signals. Various parameters are retrieved from those intercepted signals such as radio frequency, pulse repetition time, pulse duration, scan pattern information, effective radiated

power, beam characteristics and direction of arrival of emitter and many more vital characteristics which are important in identifying the type and class of emitter. There are various algorithms that work on identifying theses parameters from the emitter and then process the information and present the information in a user understandable form.

This project describes the simulation and study of an ELINT algorithm in MATLAB for the detection and classification of Linear Frequency Modulated (LFM) types of ground-based emitters. This project basically focuses on preprocessing stage of emitted radar signal using the time-frequency algorithm i.e. Quadrature Mirror Filter Bank Tree (QMFB). A QMFB tree consists of a number of layers of fully connected pairs of orthogonal wavelet filters (or basis functions) that linearly decompose the received waveform into tiles on the time-frequency plane. The tiles are used to refer to the rectangular regions of the time-frequency plane containing the basis energy. In this project, MATLAB would be used to generate the LFM type of radar signal in burst mode and further response of QMFB algorithm would be analyzed to bringing out the benefits, if any associated with this algorithm in comparison to the other available algorithm.

Correlation between Relative Humidity (RH) and Temperature by using Wavelet

Relative Humidity (RH) is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. RH depends on temperature and the pressure of the system of interest. Temperature directly relates to the amount of moisture the atmosphere can hold. The percentage of actual humidity divided by how much moisture the air can hold at a given temperature. RH is inversely proportional to the air temperature i.e. if temperature is increase the RH decrease and vice versa. RH does not tell how much water vapor is actually in the air, but it tells how close the air is to being saturated or full if RH is 100%. Wavelet analysis is an exciting new method for solving difficult problems in mathematics, physics, and engineering, with modern applications as diverse as wave propagation, data compression, signal processing, image processing, pattern recognition, computer graphics, the detection of aircraft and submarines and other medical image technology. Wavelets allow complex information such as music, speech, images and patterns to be decomposed into elementary forms at different positions and scales and subsequently reconstructed with high precision. Signal transmission is based on transmission of a series of numbers. This is a study about the relationship between Relative Humidity and temperature in environment. From the pilot project we can be found the variation of temperature and humidity of whole year. The data is collected daily from Khepupara, Bangladesh from Jan 01th to Dec 31th in 2019. Using simple wavelet transform model, we will try to correlate between RH & Temperature, find out the distribution curve and compere the characteristic change of RH and Temperature. Show the graphical representation of RH and temperature with time domain. The change of curve is not constant at whole year, in winter and summer session it changes dynamically. For a certain drift measurement wavelet transform is better than Fourier transform. So we prefer the wavelet transform for this dedicated job.

System Study and Analysis of Transfer of Crypto-keys Over the Air for Shipborne Terminal

Effective and secure communication links have always been a fundamental requirement for war ships, with modern fleets relying heavily on radio and satellite technologies. The Indian Navy's footprint has significantly expanded over the years in response to changing geo-economic and geo-strategic circumstances, and this could be possible only by having a secure and reliable satellite communication technology. Satellite communication has become one of the most popular next generation communication technologies for global communication networks in parallel to terrestrial communication networks. Few demanding applications of satellite communications used in today's contemporary age includes military intelligence, navigation & positioning, weather forecasting, digital video Broadcasting (DVB), and broadband internet services. Although, satellite communication is cost effective solution for long-distance communication applications, however while deploying security in satellite communication, it is common to face some challenges such as characteristic of the satellite link power control requirement and link availability are few among them. In this project, we aim to conceptualize an optimum link design employing suitable multiple access scheme to enhance the communication security for transfer of keys over the air.

Study & Testing of Different Types of Inertial Navigation Systems Sensors

In this pilot project, we study the possibility of using inertial navigation systems and sensors to solve the problem of mutual positioning in the areas of use of devices. Basic, existing approaches to inertial navigation systems of error are considered, the structure, structure of sensors, methods of application for their intended purpose in the required areas. Before starting to consider the possibilities of using inertial navigation sensors, we must first understand in more detail how they work, what advantages and disadvantages they have, and what approaches to their implementation already exist.

PROJECT ABSTRACTS OF 3rd GNSS COURSE

1. Study of Soil Moisture and Vegetation Phenology for Central Asian Region
2. Study, Analysis and Performance Evaluation for Existing NAVIC and Future Indian Navigation System
3. Analysis of ISM Band Interference on GNSS S-Band Signal
4. Design and Study of UHF/VHF Band Ground Terminal Antennas using Origami Techniques
5. Interference Detection and Mitigation in GNSS Receiver
6. Effect of Temporal Ionospheric Variations in Assessing the Planimetric Positional Accuracy using GNSS Data
7. Change Detection using GNSS, GIS and Remote Sensing: A Case Study in and Around Bopal, Ahmedabad
8. NAVIC based Personnel Tracking System for Indian Air Force
9. Algorithm Development for Controlled Approach and Landing of an Aircraft
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Study of Soil Moisture and Vegetation Phenology for Central Asian Region

Soil moisture is an essential parameter controlling many biophysical processes that impact water, energy, and carbon exchanges. Global Navigation Satellite System Reflectometry (GNSS-R) is one of the most promising innovative technique for measuring surface soil moisture at moderate spatial resolution required by hydrological, meteorological, ecological, and agricultural applications. However, accurate soil moisture retrieval from CYGNSS data is still a challenging task due to the fact that the radar backscatter is influenced by multiple parameters such as soil dielectric constant, surface roughness, and vegetation conditions. Research demonstrates the derived soil moisture from surface radar reflectivity from CYGNSS and SMAP data over Central Asia at different land covers, mainly covering cropland and grasslands and its relationship with phenology.

Study, Analysis and Performance Evaluation for Existing NAVIC and Future Indian Navigation System

The Navigation with Indian Constellation (NavIC), also known as Indian Regional Navigation Satellite System, is a regional navigation satellite system developed by Indian Space Research Organisation. Its service area covers from 30°E to 130°E and from 30°S to 50°N. The service area includes a primary service area serving about 1500 km around Indian landmass and the secondary service area extending this region up to about 4000 kms. This project is an effort to study, analyse and evaluate the performance of the existing NavIC system and recommend augmentations and revisions towards performance enhancement and subsequent expansion.

The first part of the project will contain a brief study and analysis of the existing NavIC constellation architecture, intended service areas and likely challenges for application in the extended service areas. This will include the performance assessment of the NavIC system from aspects of data quality, DOP and availability in the primary and secondary service areas in present configuration through simulations in STK software. The assessment will be undertaken in various locations in the Indian landmass as well as peripheries of both primary and extended service areas. Further, enhancements to the existing system will be proposed for better performance while keeping it regional. Towards this, various configurations in terms of satellite number and varied orbital parameters will be simulated. The effect of these simulations on system performance in extended regions will be analysed. In the second part of the project, a study on the designs of existing GNSS constellations i.e. GPS, GLONASS, Galileo and BeiDou will be carried out. An attempt will be made to analyse various issues if NavIC is extended as a global constellation similar to

GPS, Galileo and others. Attempt will also be made to come up with new or modified navigation message structure, orbital parameter design and other constellation parameters for an effective global navigation satellite system realisation. Necessary simulations related to the study will be carried out as the part of the project.

Analysis of ISM Band Interference on GNSS S-Band Signal

Indian Regional Satellite System (IRNSS) also known as Navigation with Indian Constellation (NavIC) provides navigational service to India and up to 1500m from its boundary. NavIC has 7 satellites, 3 satellites are in Geostationary Earth Orbit (GEO) and 4 are in Geosynchronous Earth Orbit (GSO). NavIC operates in dual-frequency, L5 (1176.45 MHz) and S-band (2492.08 MHz). NavIC S-band has a frequency range of 2483.778 to 2500.278 MHz, it has a bandwidth of 16.5MHz. ISM Band frequency range is 2400 MHz to 2483.5 MHz. Interference are undesired signals that may degrade the performance of a receiver. With S-band of NavIC and ISM band frequencies are close to each other, unwanted emission of ISM technologies creates interferences to the operation of the NavIC. These unwanted emissions consist of out-of-band emission and spurious emissions. This study aims to analyze the ISM band interference on GNSS S-band signal, the researcher will monitor/observe the degradation in the C/No created by different ISM devices, specifically in Wi-fi and Bluetooth technology. The devices will be placed 0.5m, 1m, and 3m apart from the NavIC receiver and compute the degradation created by each ISM devices to the NavIC receiver, also compare the Position Accuracy and TTFF in an environment with no interference and when interferences are present, and lastly identify what type of interferences does each ISM technology creates.

Design and Study of UHF/VHF Band Ground Terminal Antennas using Origami Techniques

Origami, which means “paper folding” in Japanese, has been used in a wide range of applications, such as, medical devices, space borne systems, and energy harvesting. Limited previous work has been performed on origami electromagnetic structures. Origami electromagnetic geometries have significant advantages for structures that need to fold in order to miniaturize their size, and unfold in order to operate. Axial-mode helical antennas are very suitable for space borne and airborne communications. Reconfigurable helical antennas based on shape memory alloy have also been developed. In this project, an origami reconfigurable axial-mode helical antenna is presented, which is also very well suited for space borne and airborne applications not only due to its electromagnetic performance but also due to its compatibility and deployability. First, an analytical method for designing origami helical antennas is presented. Design formulas for origami helical antennas, which are equivalent to the design empirical formulas of standard helical antennas, are derived. Second, a reconfigurable origami bifilar antenna is designed and its performance is validated using simulations and measurements. The proposed antenna is constructed on paper substrate thereby providing a light-weight, low-cost, multifunctional, compact, and possibly disposable design. This project presents an

origami reconfigurable helical antenna constructed with copper foil on stretchable and light weight composite material base. Total height of Antenna could be reduced by 83% from its unfolded state to folded state. Also the proposed antenna has a frequency configurability of up to 1.28 GHz at folded and unfolded states for varied purposes of wireless communications.

Interference Detection and Mitigation in GNSS Receiver

In GNSS receivers, interference is a major issue that renders whole system unavailable for usage. The interference signals may arise from various intentional sources such as jammers and un-intentional sources such as harmonics generated by TV/FM transmitters, DME/ TACAN pulses used in Aeronautical Radio Navigation Systems. To mitigate the interference signal, various mitigation techniques can be employed based on the type of the interference signal. Interference signals can be broadly classified as Narrow Band and Wide Band signals depending on their bandwidth. Narrow Band signals include CW, FM and Pulse signals. These can be mitigated using different techniques such as Notch Filtering & Pulse Blanking implemented in receiver. On the other side, wideband interference mitigation requires antenna arrays& complex baseband pre-processing using null steering/ beam-forming algorithms. To mitigate Narrow Band CW interferences, notch filter and pulse blanker can be implemented. The function of the notch filter is to remove only the interference frequency i.e. it is simply a band stop filter with a very narrow bandwidth with the notch frequency placed over the CW signal. The function of Pulse Blanker is to mitigate pulses (eg. DME/TACAN) by blanking the signal during their ON periods, so that receiver operation does not get affected. The objective of the project is to simulate the Pulse Blanking and Notch Filtering using Digital Signal Processing (DSP) techniques to cancel out Narrow-Band interferences from GNSS signal band. Performance and computational complexity comparison of the different algorithms will be evaluated and analysed through simulation using MATLAB.

Effect of Temporal Ionospheric Variations in Assessing the Planimetric Positional Accuracy using GNSS Data

A study has been carried out to assess the planimetric positional accuracy from differential GNSS positioning techniques by applying ionospheric correction and without ionospheric correction. The study also aims at closely monitoring the effect of ionospheric disturbances in a qualitative way.

One year GNSS data at three locations were analyzed at regular interval using two software modules. The differences in planimetric accuracy was analyzed with and without applying ionospheric correction keeping all other parameters same. It was found that there is large variations in planimetric location error in both methods. This will provide a qualitative measure of usage of this method to infer the temporal ionospheric variation. A detailed study in this direction will provide various avenues for GNSS application potential.

Precise Point Positioning (PPP) methods is used for post processing the daily data of the year of 2018 of three IGS site namely HYDE (Hyderabad), IISC (Bengaluru) and PBRI (Port Blair) of India by using both RTKLIB and Topcon Tools software.

Planimetric shift in metre of control coordinate with respect the

post processed coordinate is determined and shift along latitude and shift along longitude in metre is also determined with respect to post processed latitude and longitude by applying with and without ionospheric error in software. Reference coordinate was the coordinate of the IGS sites provided in the site as site coordinate.

Change Detection Using GNSS, GIS and Remote Sensing: A Case Study in and Around Bopal, Ahmedabad

Change detection in GIS is a method of understanding how a given area has changed between two or more time periods. Change detection is helpful for understanding the change in forest coverage, ice sheets, and land use. Change detection involves comparing changes between aerial photographs taken over different time periods that cover the exact same geographic area. The study aims to find the changes happened over a period of time from 2008 to 2018 especially to the settlements and infrastructure. Even though the study was carried out in manually digitizing, automatic change detection algorithms will be attempted to extract the changes of settlement in urban area. Geomatics techniques such as GNSS, GIS, GPS and Satellite Photogrammetry will add more insight in to these studies as well.

Navic based Personnel Tracking System for Indian Air Force

In today's world, enemy warfare is an important factor in any nation's security. One of the important and vital roles is played by the soldiers. There are many concerns regarding safety of soldiers. This requirement becomes more stringent in case of IAF premises which are spread across large area due to operational requirements and it becomes difficult to monitor the movement of various personnel inside the camp area. Tracking based applications have been quite popular in recent times. Most of them have been limited to commercial applications such as vehicular tracking (e.g. tracking of a train etc). However, not much work has been done towards design of a personal tracking system. This work is an attempt to design such personal tracking system. The objective of this paper is to design & develop a system which is capable of tracking and monitoring a person, object or any other asset of importance (called as target). The system uses a NavIC based receiver to determine the exact position of the target. The target is aided with NavIC receiver and GSM/WCDMA module. The NavIC receiver will obtain the location coordinates (latitude & longitudes) from NavIC satellites. The location information in NMEA format can be stored within tracking unit as well as can be formatted, decoded and sent to centralized server, through GSM/WCDMA modem. The PTS will be consisting of a microcontroller for integration GSM/WCDMA module and NaVIC receiver for location. Due to the use of open CPU development platform, no external microcontroller is required, with additional advantages of compact size, reduced design & development time and reduced cost. The proposed system will be able to track accurate position of target with position accuracy less than 30 meters. Thus the objective of this project is to track the real time position of target (any personnel specifically casual labors) moving across wide geographical area of any Air Force Station and provide the real time update of whereabouts of the target to central server (most likely Security Sections) through Air Force Network as a backbone.

Algorithm Development for Controlled Approach and Landing of an Aircraft

In Aviation aircraft landing is one of the most crucial and important phases of flight. To undertake landing of any flight, the aircraft and the landing airfield are equipped with state of the art equipment for landing i.e. MMR (Multi mode receiver) and ILS. The response of these equipment is not sufficient for the landing problem as they have few drawbacks within them. Also, it is a challenge for a pilot to carry out landing at some diversionary airfields or forward airfields where there is no provision of instrument based landing support system or ATC support. Humans have always been behind finding best or new solutions to improve the process of landing especially in challenging/emergency conditions. The classic instrument landing systems (ILS, MLS) does not provide flexibility of landing of aircraft in various conditions, unlike of those systems the new technology which is based on GNSS that provides an opportunity for a new approach to solving the problem of landing offering flexible solutions and application. The paper points to aiding to the pilot in the absence of classic ILS instruments i.e. basically landing in unknown terrain. These conditions arise mostly as performing an emergency landing at diversionary field or highways or landing at forward field where at least a PPK/DGNSS enabled receiver is available on the ground. This experiment can be further be used in providing improved position accuracy with the help of advance processing techniques using GNSS receiver in addition to existing ILS/INS instrument. In this paper a mathematical model of a system for automatic guidance for landing using GNSS has been presented. The system will have the capability to identify the track to be followed during various phases of the flight before touchdown. The flight track calculation for landing is based on few parameters such as two latitude & longitude set values i.e. runway threshold & runway end point, runway altitude and field minimum clearance height. These set of parameters will be communicated to aircraft from Ground Control Centre through a reliable VHF/UHF communication link. Simulations will be made for landing guidance system using the GNSS simulator. For simulations the programming package C/MATLAB / SIMULINK has been used.

Design Parameter for SBAS In Indonesia using Simulation

Indonesia is the world's largest archipelagic country which lies geographically near to the equator from latitudes 6°N to 11°S and from longitudes 95°E to 141°E. The nature of archipelago means that there is a large dependency on air transportation to move people across the country. Statistical data shows that there are as many as 115-million air passengers in 2018 in Indonesia. Currently, air transportation in Indonesia still uses ground-based navigation aids for airway navigation guidance. This has limitation such as inability to cover very large areas of airspace and inflexibility and inefficiency of aircrafts' routes. There is a need for more reliable and efficient air transportation system, and this can be achieved by using satellite-based augmentation system (SBAS). Furthermore, a need for SBAS in Indonesia also arises due to emerging markets and growing dependency on global navigation satellite system (GNSS) in various sectors. Looking at the country's location situated on equator where ionospheric condition is more dynamic, the existence of SBAS will be critical for various sectors' applications, especially the ones related to safety of life.

The project proposes to calculate and analyze various SBAS design parameters. Specifically, in this pilot project, the focus of work will fall on ground segment design, which is to find the best locations of reference stations that can meet several criteria with minimum number of stations. However, due to situational condition and limitation, only dilution of precision (DOP) value of reference stations will be calculated and analyzed.

NAVIC based Emergency Calling Kit for Indian Air Force Ground Vehicles

The pilot project entitled “NavIC based Emergency Calling Kit for Indian Air Force Ground Vehicles” is chosen for meeting the requirements of personnel of Indian Air Force in Road and personal safety. Victims involved in an accident or any emergency situation often may be in a state of shock or incapacitated or unable to provide accurate location details, especially on urban roads or remote locations. Timely help to the victims in such situations can avoid death, reduce the severity of injuries and human suffering. The NavIC based Emergency Calling Kit (ECK), fitted in a vehicle enables the user to transmit his position either manually or automatically to a control centre within few seconds of mishap. The objective of this project is to extend emergency call facility to the vehicles or personnel of Air Force Station within its own resources. In the event of an accident, ECK is expected to sense the occurrence of the accident, relay the location of the user to control centre, provide feedback to the victim with information such as 'expected time of help'. Therefore, it is also important for the ECK to be rugged and robust to survive the crash and be functionally active. The ECK configuration consists of a microcontroller for integration of various modules viz., motion sensor or a programmed IMU, a NavIC/ hybrid receiver for time/ location identification and GSM module to relay the time/ location of the victim to the emergency call centre. A web application located at the control centre should be able to identify the victim's location precisely, access victim's pre-fed database for details and dispatch a rescue team to the location. In addition, the ECK should be able to receive a feedback audio message from the control centre mentioning the response time like 'Help coming in 10 mins.

Simulation of Multipath Effects on GPS Signal and Test Setup Development using Re-radiation

GPS satellite broadcasting signals are subject to reflection and diffraction like any other type of electromagnetic waves. Multipath error results from interference between two radio waves which have travelled paths of different lengths between the transmitter and the receiver. GPS multipath is caused by the reception of signals arrived not only directly from satellites, but also reflected or diffracted from the local objects. Multipath results in an error in pseudo range measurements and thus affect the positioning accuracy, since the multipath signal takes a longer path than the direct signal. The project deals with the MATLAB simulation of the GNSS signal tracking and introduction of the known multipath signal to analyse the effects on the tracked signal. To verify the effects of multipath propagation on the tracked signal and the positioning performance, an experiment will be conducted under controlled conditions utilizing a re-radiation setup developed in house. Such re-radiation setup will also be used for testing of GNSS receivers in the absence of satellite signals such as indoor scenario.

Precise Estimation of River Height using GNSS

Water level monitoring is hugely beneficial for a wide variety of applications and industries. One of the most common uses of water level monitoring is the measurement of river water and its flow which can help to detect possible changes in the water flow or increased or decreased level of water volume which may indicate flow path changes or alert to potential surface flooding. In Tajikistan, there are many rivers. Among them two main rivers named Amu Darya and Panj are big rivers due to increase river height and its flow in theses rivers, it caused disaster every year in Tajikistan. To minimize such disaster and for human safety precise measurement of river height and speed of flow should be known. This project is aimed to find the precise estimation of river height and flow of current in river through GNSS. For this, the resources required are the two GNSS receivers and a one satellite. Using this we automatically find the river height when it increases and decreases. If the river height is increased, it is informed to people about this by alert message which will help in disaster management. In this project, precise estimation of river height is done by writing an algorithm and after that simulating this algorithm using MATLAB program.

An Analysis of Integrated Water Vapour Estimation from GNSS Receiver

The estimation of Integrated Water Vapor (IWV) from ground GNSS receivers has been well established for over 2 decades. Due to high temporal sampling and low cost, these estimates have been used extensively for meteorological and climate studies. Large networks of GPS receivers have been deployed and used for meteorological applications in Japan, Europe, and the USA, such as. Other agencies, including the Indian Meteorological Department, are experimenting with applications of GNSS-derived datasets. In this pilot project, we aim to get a strong understanding of meteorological applications of GNSS signals using International GNSS Service (IGS) stations derived from IWV estimates. First, we convert the Zenith Tropospheric Delay (ZTD) estimates provided by the IGS, and convert them to IWV using well-established ways. This process was made by using the Python programming language in a Microsoft Windows environment. In particular, we generate IWV estimates from 4 IGS stations: (1) CUUT, (2) CUSV (Thailand data) and (3) HYDE, (4) IISC(India). These stations were chosen as there are no IGS stations in Myanmar, and we chose to use well-established stations in South-east Asia as a substitute. The IWV estimations were generated for a period of 1 year. Data for more time periods will also be generated if done. The diurnal, seasonal and regional characteristics of IWV variation will be studied using the 4 stations. The impact of geographic conditions and local climate on the GPS-derived IWV estimates will also be analyzed. The correlations of the IWV with heavy rain events will also be studied in this project

Meeting of CSSTEAP Governing Board

The 25th meeting of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) Governing Board (GB) was held at CSSTEAP, Dehradun through virtual mode on December 21, 2020. The meeting was chaired by Dr. K. Sivan, Chairman, CSSTEAP GB and Secretary, Dept. of Space (DOS), Govt. of India. The meeting was attended by the GB members and invited dignitaries. The GB members included Mr. Shamsuddin Ahmed (Bangladesh), Prof. Abdykalykov Akymbek Abdykalykovich (Kyrgyz Republic), H.E. Mr. Yerlan Alimbayev (Kazakhstan), H.E. Dato Hidayat Abdul Hamid (Malaysia), Mr. Hari Odari (Nepal), Mr. Joon Lee (South Korea), Eng. Mr. Sanath Panawennage (Sri Lanka), Dr. Tanita Suepa (Thailand), Dr. Shirish Ravan (UNOOSA, Vienna), Dr. Prakash Chauhan (India). Other Participants included Mr. Uma Maheshwaran, Dr. Nilesh Desai, Mr. hantanu Bhatawdekar, Mrs. Shankari Murali, Dr. S.P. Aggarwal, Dr. K.R. Manjunath, Dr. J. Banerji, Mr. Sanjib Kumar Deb, Mr. C.M. Bhatt, Dr. Harish Karnatak, Mr. Hari Shankar, Dr. Puneet Swaroop and Mr. Rajender Katariya from India.

Dr. Prakash Chauhan, Director, CSSTEAP welcomed the members and special invitees to the 25th 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, Secretary, Dept. of Space (DOS), Govt. of India, representing India welcomed all the GB members and special invitees for 25th meeting of the Governing Board. He expressed his happiness that CSSTEAP has completed its glorious 25 years and has rendered remarkable services in the field of space based capacity building activities in the Asia Pacific region. The Centre celebrated the memorable occasion of 25 years completion by hosting an event on November 02, 2020 in the gracious presence of esteemed GB members and other invited dignitaries.

Governing Board Members and Special Invitees during 25thGoverning Board Meeting
Through Virtual Mode, December 21, 2020

Chairman, CSSTEAP GB informed the GB members that during the challenging times of COVID-19 pandemic, CSSTEAP has taken an innovative step and has organized three short courses through online mode and also in collaboration with UNOOSA conducted a Massive Open Online Course (MOOC).

Chairman, CSSTEAP GB further highlighted some of the significant achievements of ISRO during the last one year. He apprised the Board that during the last one year, ISRO has carried out 7 missions comprising of 3 launch vehicle missions and 4 satellite missions. Besides this, India's PSLV has launched 18 satellites of 6 countries (Israel, Italy, Japan, Lithunia, Luxembourg and USA). Space based Communication infrastructure has been further augmented with two advanced satellites to provide extended coverage and enhanced services. Earth Observation has been strengthened with all-weather imaging capability to improve agriculture, forestry and disaster management applications. The 2nd Batch of UNNATI programme has provided excellent opportunity for 30 officials from 16 countries to strengthen their capabilities in Assembling, Integrating and Testing Nano satellites.

Dr. Shirish Ravan, Head, UN-SPIDER Beijing Office of UNOOSA and observer on behalf of Director, UNOOSA welcomed and acknowledged the participation of GB members in the 25th Meeting of the Governing Board of CSSTEAP. He further appreciated the contribution of CSSTEAP through off campus training programs and Technical Advisory Missions (TAM) through UNSPIDER to mitigate disaster risks using space data and services. He also mentioned that to increase the outreach, CSSTEAP and UNOOSA designed and organised the first MOOC, through virtual mode, which received huge response.

Dr. Prakash Chauhan presented CSSTEAP activities for the year 2020 and future programmes. Chairman, GB and members applauded the commendable efforts of Director, CSSTEAP, Host institutions, faculty and staff of CSSTEAP.

Mr. Shamsuddin Ahmed, Bangladesh, H.E. Mr. Yerlan Alimbayev, Ambassador of Kazakhstan, Prof. A.A. Abdykalykovich, Kyrgyz Republic, Mr. Hari Odari, Nepal, H.E. Dato Hidayat Abdul Hamid, High Commissioner, Malaysia, Mr. Joon Lee from Republic of Korea, Mr. S. Panawennage, Sri Lanka and Dr. Tanita Suepa, GISTDA, Thailand congratulated CSSTEAP on completing 25 years for its achievement and expect more in the coming years. The members also appreciated the efforts of CSSTEAP for the launch of MOOC on disaster risk management and other online courses during this pandemic.

The meeting was closed by Chairman, CSSTEAP GB and he 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's at CSSTEAP

Future Courses

PG COURSES	
25th Remote Sensing and Geographic Information System	July 1, 2021 to March 31, 2022
12th Satellite Meteorology and Global Climate	August 1, 2021 to April 30, 2022
12th Space and Atmospheric Sciences	August 1, 2021 to April 30, 2022
SHORT COURSES	
Recent Advances in Space Applications for Forest Monitoring and Assessment	April 12 - 16, 2021
Space Technology for Disaster Management	April 19 - 30, 2021
Use of Space Technology for Weather and Climate Studies	May 17 - 31, 2021
Coastal Zone Management in Response to Natural Hazards & Climate Variability	June 14 - 25, 2021
10th Small Satellite Missions	November - December, 2021

EDITORIAL COMMITTEE

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