CSSTEAP Newsletter

JANUARY, **2019** | VOLUME **22** | ISSUE **1**

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.

CSSTEAP Governing Board

Chairman
Dr. K Sivan
India

Members

Mr. Shamsuddin Ahmed
Bangladesh

Dr. Hong Yong IL
DPR Korea

Dr. Thomas Djamaluddin
Indonesia

Mr. Ali Sadeghi Naeini
Iran

H.E. (Mr.) Bulat Sergazievich Sarsenbayev
Kazakhstan

Prof. Abdykalykov Akymbek Abdykalykovich
Kyrgyz Republic

H.E. Dato Hidayat abdul Hamid
Malaysia

Mongolia

Dr. Kyi Thwin
Myanmar

Mr. Charan Kamal Singh Bhalla
Nauru

Mr. Hari Odari
Nepal

H.E (Mrs) Ma.Teresita C. Daza
Philippines

Mr. Ok-Kyu Lee
Republic of Korea

Eng. S. Panawennage
Sri Lanka

The Executive Director
Thailand

Dr. Kamol M. Muminov
Uzbekistan

Observers
Dr. Simonetta Di Pippo
UN-OOSA

Prof. Dr. Ir. A. (Tom) Veldkamp
ITC (The Netherlands)

Secretary

Dr. A. Senthil Kumar
Director, CSSTEAP, India

Governing Board Members and Special Invitees during 23rd Governing Board Meeting
at New Delhi, December 10, 2018

CONTENTS

Director's Message

The Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) has been contributing significantly in empowering scientists and engineers in Asia Pacific countries in the frontier areas of Space Science and Technology and their Applications since its inception in 1995. In particular, its contributions have been focused on Post Graduate (PG) Courses in Remote Sensing and Geographic Information Systems, Satellite Communications & Global Positioning Systems, Satellite Meteorology & Global Climate, Space & Atmospheric Science and Global Navigation Satellite System, which are well recognized by UNOOSA as potential subjects for societal benefit applications. The Centre also conducts short courses on different themes of Remote Sensing and GIS applications, Small Satellite Missions and Navigation and Satellite Positioning system on regular basis. The Centre also organizes short courses & awareness programmes from time to time based on the request of user departments.

During the Year 2018, the Centre has conducted three PG courses and two short courses in which a total of 206 participants from 21 different countries are benefitted. Total six participants have been supported with CSSTEAP M.Tech fellowship; three participants from India, two from Bangladesh and one from Sri Lanka. CSSTEAP two special programs a) supported the regional training and workshop for South Asian organized by the United Office for Outer Space Affairs (UNOOSA), through its UN-SPIDER programme, and b) the Disaster Management Centre of the South Asia Association for Regional Cooperation (SAARC DMC) on the "Utilization of Space-based and Geospatial Information for Achieving the Targets of the Sendal Framework for Disaster Risk Reduction from 4 to 8 December in Ahmedabad, India.

As the main purpose of the PG courses is to empower the participants in Space Science and Technology and Application, it is important that at the end of the 9-month long program, participants should have hands-on experience to apply the methods learnt in the class rooms. I am happy to note that the course participants of PG courses have taken up this challenge to carry out a pilot project as part of the course curriculum. This certainly builds up confidence among participants to apply the methods studied to undertake future projects in their home country for their national development. This Newsletter consists of an overview of pilot projects carried out by the participants, besides other relevant information on different activities of CSSTEAP

Dr. A. Senthil Kumar
Director

About **CSSTEAP**

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

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

The course curricula developed by the Centre and endorsed by the United Nations are adapted for the educational programmes. The educational programmes of the centre are oriented towards the

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

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

Educational Programmes

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

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

Till date the Centre has conducted 55 PG Courses: 22 in RS&GIS, 11 in SATCOM, 11 each SATMET and SAS and 02 in Global Navigation Satellite System. Currently 23rd RS&GIS course at Dehradun, 11th SATMAT course at SAC, Ahmedabad adn 11 SAS course at PRL, Ahmedabad are in progress. In addition, the Centre has conducted 54 short courses and workshops in the past 23 years. These programmes have benefited some 2090 participants from a total of 36 countries in the Asia-Pacific region and 29 participants from 19 countries outside Asia Pacific have also benefited from these educational programmes.

Till date 158 PG participants (76 in RS & GIS; 41 in SATCOM; 20 in SATMET and 21 ins SAS) from 16 different countries have been awarded M.Tech. degree.

Highlights

PG COURSES COMPLETED

RS & GIS: 22nd PG Course RS & GIS at IIRS, Dehradun during July1, 2017 - March 31, 2018
(22 participants from 12 countries)

SATCOM: 11th PG course in Satellite communications at SAC, Ahmedabad during August 1, 2017 - April 30, 2018
(21 participants from 9 countries)

GNSS: 2nd PG course in Global Navigation Satellite Systems at SAC, Ahmedabad during August 1, 2017 - April 30, 2018
(12 participants from 5 countries)

PG COURSES ONGOING

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

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

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

SHORT COURSES COMPLETED

Disaster Risk Reduction (DRR) course at CSSTEAP, IIRS during May 28 - June 22, 2018 with "Special Emphasis on Floods & Earthquakes"
(18 participants from 07 countries)

Geospatial Modelling Course Short Course on Geospatial Modelling of Forestry and Ecology for Climate Change Studies (16-27 April 2018)

7th Small Satellite Mission 26th November - 7th December 2018 at IIRS
46 participants from 16 countries

22nd POST GRADUATE COURSE ON REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM (RS & GIS)

The twenty-second PG course on Remote Sensing and Geographic Information System of CSSTEAP commenced on July 1, 2017 at Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun, one of the host institutions of CSSTEAP. Total twenty-two participants from eleven countries of Asia-Pacific Region viz. three participants from Mongolia, four from Viet Nam, three each from Bangladesh, Indian and Mongolia, two each from Sri Lanka and Tajikistan and one each from Kazakhstan, Kyrgyzstan, Nepal, Lao PDR and Myanmar are attending the course. The participants attending the course were from varied backgrounds like Hydrology, Forestry & Ecology, Fisheries and Marine Science, Meteorology, Urban and Rural Planning, Agricultural Science, Geoinformatics, Surveying, Cartography, Geology and Mining, and Disaster Management.

The course started with an 'Induction week' where the participants were exposed to geographic perspective of India, social systems, customs and festivals of India, overview of space science, technology and applications, etc. Module-1A covered basically the fundamentals of RS&GIS with theory, practical and tutorials. The participants had several field excursions for ground truth collection and for interpretation and analysis of satellite data. Module-1B of Semester-I, of one month duration was on recent trends and advances in RS & GIS and environmental analysis & management including climate change. In Module-II course participants had chosen one of the eight electives i.e. Agriculture & Soils, Forestry & Ecology,

Geosciences & Geo-hazards, Marine & Atmospheric Science, Water Resources, Urban & Regional Planning, Satellite image analysis & photogrammetry and Geo-informatics, based on their academic qualification, technical requirement of their parent organization and their professional experience. In present batch 5 participants each had opted for Urban & Regional Planning, 4 each for Satellite image analysis & photogrammetry and Water Resources; 3 for Forestry & Ecology, two each for Geoinformatics and Marine & Atmospheric Science and one each for Agriculture & Soils and Geosciences & Geo-hazards.

Module-III of three months duration, consisted of execution of a pilot project, based on the knowledge gained during the course by utilizing space inputs. Good quality project work has been carried out by the participants which have been evaluated by a panel of experts. Some of the notable areas of the pilot project carried out were: Urban Storm water Modelling; Property Taxation using high resolution data; Geospatial technologies for assessment of urban green space; Spatio temporal study of land cover dynamics in peri-urban area; Geospatial Modelling and Web Mapping for Groundwater Assessment; Glacier dynamics studies using geospatial technologies; Flood mapping and monitoring using RS and GIS and Reservoir sedimentation assessment through remote sensing.

As part of the course curricula the participants were taken for technical visits to Andhra University, Visakhapatnam and National Remote Sensing Centre (NRSC), Hyderabad during December 03, to 11, 2017. At IMGEOS course participants had an opportunity to see the state-of-art multi-mission ground segment processing enterprise for earth observation satellites and also witnessed real time acquisition of EO data at Shadnagar, Hyderabad. The participants were also shown the virtual reality facility and National

Participants attending classes

Participants carrying laboratory exercises

Participants on field excursion

Veledictory function of 22nd Post Graduates Course on Remote Sensing & Geographic Information Systems (RG & GIS)

Participants attending 38th Asian Conference on Remote Sensing

Database for Emergency Management (NDEM) facility at NRSC, Shadnagar Campus. At Andhra University, course participants were taken to Andhra University where they attended lectures on specialized topics (on rainwater harvesting, flood mitigation and coastal hazard vulnerability and GIS modelling), met Vice Chancellor of Andhra University and also their documents were verified for finding M.Tech eligibility. During technical visits, participants also had an opportunity to visit cultural & natural landscape in Visakhapatnam, and Hyderabad and have an understanding of Indian culture, heritage and traditions.

The participants of the course also participated in the 38th Asian Conference on Remote Sensing held at New Delhi during 23-27 October, 2017 and also participated in one day pre-symposium tutorial on Agricultural Monitoring on 22nd October, 2016. During the ACRS meet participants also had an opportunity to visit famous Taj Mahal (UNESCO World Heritage Site) at Agra. Participants also got opportunity to participate in the User Interaction Meet during February 2018 at IIRS Dehradun. On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year, 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.

C.M. Bhatt
Course Coordinator
cmbhatt@iirs.gov.in

Dr. Arijit Roy
Course Director
arijitroy@iirs.gov.in

11th POST GRADUATE COURSE IN SATELLITE COMMUNICATIONS (SATCOM-11) AND SECOND GLOBAL NAVIGATION SATELLITE SYSTEMS (GNSS-2) OF CSSTEAP

The Eleventh Post Graduate course on Satellite Communications (SATCOM-11) and Second Post Graduate course on Global Navigation Satellite Systems (GNSS-2) were started from August 1, 2017 and concluding on 30th April 2018. The courses were announced in the month of December 2016. A good number of applications were received from the entire region of Asia Pacific for both courses. Nineteen candidates from eight countries were selected for the SATCOM-11 course. Two participants from ASEAN countries are also joined SATCOM-11 course as part of Indo-ASEAN cooperation programme. Finally, twenty-one candidates from nine countries viz. Bangladesh, Bhutan India, LaoPDR, Mongolia, Myanmar, Nepal, Srilanka and Tajikistan joined the SATCOM-11 course. Similarly, total 12 candidates from five Asia Pacific countries, viz. Bangladesh, India, Mongolia, Srilanka and Tajikistan were joined GNSS-2 course. Both courses were commenced on August 1, 2017 at SAC Campus, Bopal, of Space Applications Centre (SAC), Ahmedabad.

The Joint Inaugural function of SATCOM-11 and GNSS-2 was held on 1st August 2017 at Bopal Campus, SAC. Shri Tapan Mishra, Director, SAC, Dr. S P Aggarwal, Programme Coordinator, CSSTEAP, Shri D K Das Associate Director, SAC and SMC members, Focal Persons, Participants of SATCOM-11 and GNSS-2 courses, Faculty and other staff members attended the Inaugural Function.

After, the traditional rituals, Shri D K Das Associate Director, SAC, formally welcomed the course participants. He highlighted the

activities and achievements of SAC and the pivotal role played by SAC to ISRO space programmes, which makes the India as a space faring nations among the world. He also emphasised the importance of Satellite Communications and Global Navigation Satellite Systems in Asia-Pacific countries and how they are getting benefitted with these courses. He wished that the both courses will be great success.

Dr. Raghunadh K Bhattar, Course Director introduced both SATCOM-11 and GNSS-2 courses and elaborated the structure and composition of the courses. Further, he brought out the facilities and opportunities available in the courses and re-iterated the hard work need to be put in by the course participants.

Shri Tapan Misra, Director, SAC, said in his inaugural address, that Navigation technologies are emerging in a big way and SAC/ISRO significantly contributing to the regional navigation in India's main land and surroundings by establishing the NavIC. SAC is also developing the NavIC receivers and using it in critical applications. He also emphasized the developments in Satellite Technologies, such as High throughput satellites etc., and the role played SAC.

Dr. S.P. Aggarwal, Programme Coordinator, CSSTEAP, explained the CSSTEAP programmes and briefed about the opportunities and avenues available in these courses. He also narrated the role played by the CSSTEAP in capacity building of Satellite Technologies especially Satellite Communications and Global Navigation Satellite Systems technologies in Asia-Pacific region.

Mr. Vishal Agarwal, Course Coordinator, GNSS-2, proposed the vote of thanks and Mr. V.N.Parekh, Course Coordinator, SATCOM-11 anchored the function.

The syllabus of the SATCOM-11 and GNSS-2 courses were divided into two Semesters covering different aspects of Satellite Communications, Satellite Positioning and Navigation and a Pilot project respectively. Participants were also required to make seminar presentations periodically on various topics given to them. This exercise was carried out to improve their presentation skills.

Faculties for the SATCOM-11 and GNSS-2 courses were drawn mainly from well-known academic institutions in India, experienced retired ISRO Scientists, Scientists/ Engineers working at different ISRO Centers, a few experts from Indian SATCOM & Navigation industries, Research labs, Communications and Broadcasting and Air Port Authority of India etc.

Detailed lecture notes, subject references and reading materials were distributed to the participants. Library facilities and Internet facilities were made available to the participants. Various Laboratories and Earth Station facilities available at SAC were provided for hands on experience in working with different communication and navigation systems. Question bank and study material on each paper was made available to the participants for preparation of examination as far as possible. A separate CSSTEAP network was commissioned with access from class room, laboratory and hostel building. With this network the students were able to access the study materials, question bank and exchange mails and check the notices. Air conditioned Lecture room with multimedia presentation facility was used for regular lectures. Audio-Video lectures are made available to the participants. This facility was used extensively for viewing the recorded lectures at their own pace and understand the essence of lectures from the hostel. The facility greatly benefitted the participants, who are not very

comfortable with English language.

Canteen facilities were provided to the participants in the same campus. Hostel accommodation was arranged in the International Hostel with good living facilities with attached Kitchenette. For entertainment, DTH system was provided to them in their rooms. Hostel is equipped with Wi-Fi facility for the benefit of students. The participants are making use of recreation and Gym facilities in the hostel area extensively. Initial medical checkup was done for each participant. Centre has provided medical facilities for minor ailments. There were no significant major health problems reported by the participants during the course.

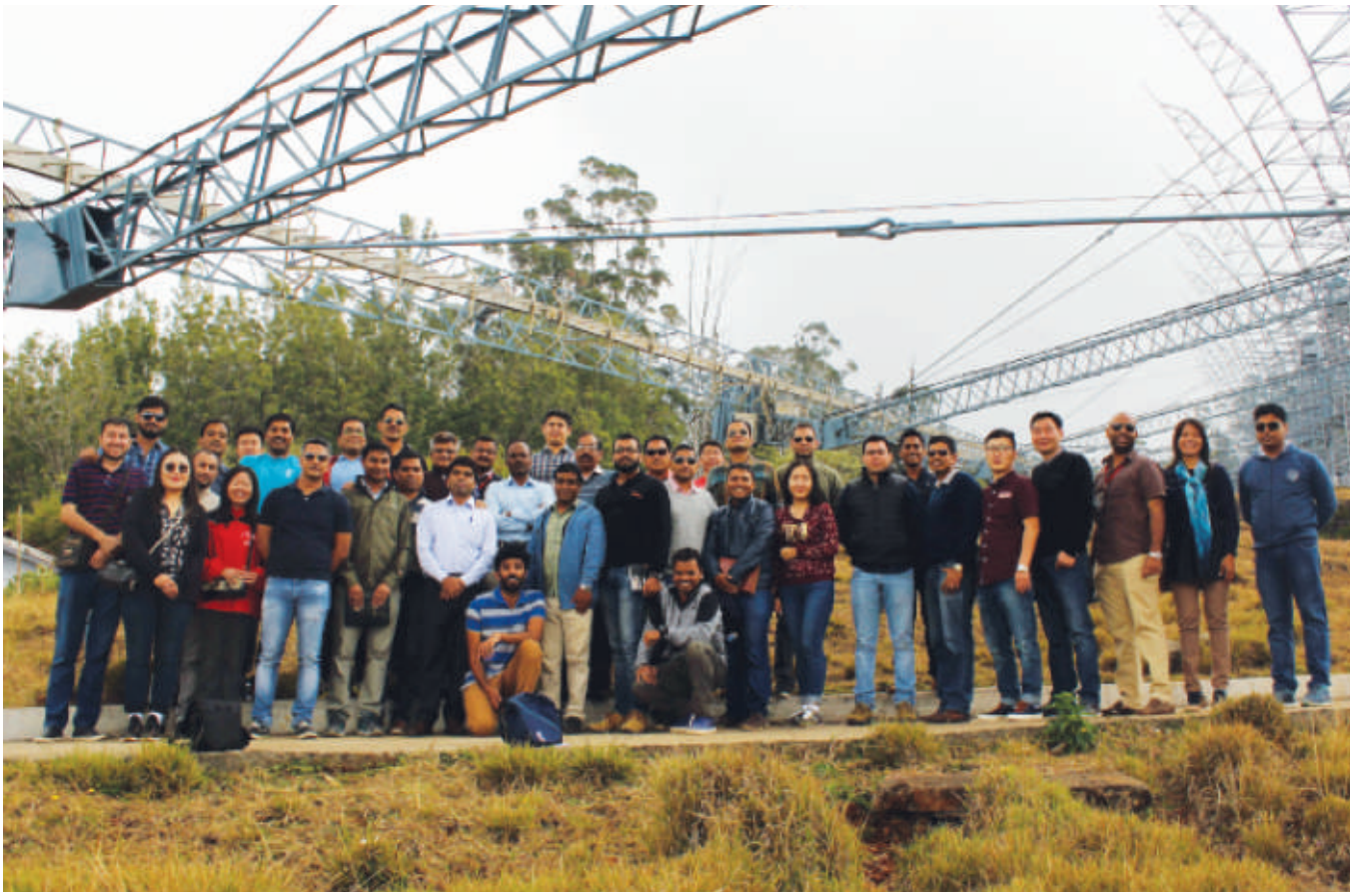
A number of combined Study tours to different centers of ISRO and reputed SATCOM and Navigation establishments were organized to give the participants a glimpse of existing facilities in SATCOM & GNSS areas, so that they can go back and build their own systems for their countries.

The places visited include:

- Master Control Facility (ISRO) – Hassan
- Radio Astronomy Centre, Ooty
- UR Rao Satellite Centre (URSC) Bengaluru
- ISRO Satellite Integration and Test Establishment (ISITE) – Bengaluru
- ISRO Telemetry Tracking and Command Network (ISTRAC), ISRO - Bailalu
- National Atmospheric Research Laboratory, Gadanki,Tirupati
- Satish Dhawan Space Centre , Shriharikota
- Andhra University, Visakhapatnam
- Delhi Earth Station/SAC (ISRO) – New Delhi
- Network Operation Control Centre (NOCC, DOT), New Delhi
- National Physics Laboratory, New Delhi
- CSSTEAP HQ, Dehradun

To evaluate the progress of participants, internal assessment through assignments, tests and viva voce were carried out at periodic intervals apart from the semester examination. The Scientists/ Engineers involved in the experiments for different papers did evaluations on the practical abilities of the participants.

As a part of the nine months PG course each student is required to work on a pilot project. This Pilot project is oriented towards the twelve months dissertation work at participant`s own country after PG diploma. The topics for the Pilot project were identified after several sessions of discussions with the participants. Project guides from SAC have been identified for providing technical guidance. The participants submitted the pilot project report on the selected topic



under the guidance of the SAC expert.

The Success of conducting smoothly both Post Graduate course on Satellite Communications and Global Navigation Satellite Systems at Space Applications Centre, Ahmadabad was primarily due to sincere efforts put in by a large number of dedicated staff at SAC.

Now-a-days, it is a established fact that, education is considered as something which should facilitate in overall and complete, mental and physical, development of the students. The understanding of any subject is incomplete without its practical exposure as it is often said that "Everything which is learned is not contained in books". Also, an exposure of the diverse Indian culture can go a long way in getting the shades of life worth remembering and emulating. Going with these established principles of learning and exploring, educational and study tours were organized to various ISRO and other reputed organizations in southern and northern parts of India. As CSSTEAP is affiliated to United Nations (UN) and UN international organization has an objective to solve economic, social, cultural, or humanitarian problems, the participants also got an opportunity to see and understand the cultural heritage of India in between the study tours. These were part of the course curriculum and it enabled the participants to consolidate the knowledge gained through the regular classroom teachings. The educational tours provided a unique opportunity to the participants to witness and relish one of the best facilities in the world. The state-of-the-art facilities at various centers of Indian Space Research Organization (ISRO) were witnessed by all the participants and they were particularly impressed by the visits to actual users of the space technology.

The study tour also include IIRS Dehradun, Which is the Head Quarters for CSSTEAP and Andhra University, which gives them the M.Tech degree. CSSTEAP participants also were taken to Sardar Vallabhai Patel International Air Port, Ahmedabad, PRL and BISAG in Gandhinagar to show the activities carried over there to enhance their outlook to practical aspects.

Dr. Raghunath K. Bhattar
Course Director
SAC, Ahmedabad

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

Mr. Vishal Agarwal
Course Coordinator
GNSS
SAC, Ahmedabad

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

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

The course started with an 'Induction week' where the participants were exposed to geographic perspective of India, social systems, customs and festivals of India, overview of space science, technology and applications, etc. Module-1A covered basically the fundamentals of RS&GIS with theory, practical and tutorials. The participants had several field excursions for ground truth collection and for interpretation and analysis of satellite data. Module-1B of Semester-I, of one month duration was on recent trends and advances in RS & GIS and environmental analysis & management including climate change. In Module-II course participants had chosen one of the eight electives i.e. Agriculture & Soils, Forestry & Ecology, Geosciences & Geo-hazards, Marine & Atmospheric Science, Water Resources, Urban & Regional Planning, Satellite image analysis & photogrammetry and Geo-informatics, based on their

Participants attending lectures in CSSTEAP Classroom

Participants carrying out practical's

academic qualification, technical requirement of their parent organization and their professional experience. In present batch 7 participants each had opted for Water Resources, 4 for Satellite Image Analysis, 3each for Geoinformatics and Forestry & Ecology, 2 each from Geosciences & Geo-hazards, Marine & Atmospheric Science and Urban & Regional Studies, 1 from Agriculture &Soils.

Module-III of three months duration, which consists of execution of a pilot project based on the knowledge gained during the course by utilizing space inputs is in progress and will complete on March 31, 2019. This module equips participants with advanced knowledge and experience in application of EO data and GIS technology in selected mathematic discipline.

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

23rd RS and GIS Participants Visit to FRI, Dehradun

Students during Field work and data collection

heritage and traditions.

The participants of the course also participated in Symposium on Education & Outreach "Geospatial technology: Pixel to People" at Indian Institute of Remote Sensing, Dehradun, India during Nov 20-23, 2018. Four pre-symposium tutorials on the emerging topics are planned: Big Data Analytics, Ground-Based 3D Modeling, Citizen Science and its applications and Space Education for Educators as part of APRSAF. Participants visited Andhra University and Rushikulya Beach, Vishakhapatnam. They also visitedCharminar, Hyderabad. Participants visited Nandi Hills in Bangalore. On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year etc. In addition to the academic activities special English language classes were also conducted for first three months for the participants to help in

Shashi Kumar
Course Coordinator
RS&GIS
shashi@iirs.gov.in

C.M. Bhatt
Course Director
RS&GIS
cmbhatt@iirs.gov.in

11th POST GRADUATE DIPLOMA COURSE ON SATELLITE METEOROLOGY AND GLOBAL CLIMATE (SATMET-11)

The Eleventh Post Graduate Course on Satellite Meteorology and Global Climate under the aegis of the UN affiliated CSSTEAP, is being conducted at Space Applications Centre (Bopal Campus), Ahmedabad during August 1, 2018 to April 30, 2019. This report contains the activities carried out during last five months i.e. August to December 2018.

Thirteen participants from eight countries in Asia-Pacific region have been undergoing this course. They are mostly operational forecasters, meteorologist, and researchers in their own country. After they learn about satellite meteorology, they will impart training to their own officers in these subjects once they taken back. The participants are from the countries like Bangladesh, India, Kyrgyzstan, Maldives, Mongolia, Myanmar, Philippines, and Tajikistan.

A joint inaugural function of the two courses: (i) Satellite Meteorology and Global climate conducted by Space Applications Centre (SAC) and (ii) Space and Atmospheric Science conducted by Physical Research Laboratory (PRL) was held at K. R. Ramanathan Auditorium of PRL on 6th August, 2018. Shri D.K. Das, Director of SAC, Dr. Anil Bhardwaj, Director of PRL, Dr. Senthil Kumar, Director of CSSTEAP, Dehradun and senior officers from SAC and PRL graced the function. The following figure shows the group photo of joint inaugural function held at PRL Ahmedabad.

Group photo of joint inaugural function of SATMET-11 and SAS-11 courses held on August 06, 2018 at PRL Ahmedabad

Dr. Anil Bhardwaj welcomed the participants, presented a brief overview of PRL and gave the students an idea of what to expect from this course. The participants from distant countries and varied cultures gave a brief introduction about themselves, their professional background and their aspirations from the course. Dr. Senthil Kumar gave an overview of the CSSTEAP Programs. Shri D K Das gave the inaugural address and observed that this is not only a golden opportunity to learn advanced subjects like Satellite Meteorology and Space Science, but also to learn about India and her diverse cultures. He also emphasized on "Vasudhaiva Kutumbakam", meaning "the world is one family". The common orientation module of both the courses began in the afternoon of August 06, 2018 at PRL Ahmedabad.

This SATMET-11 course has 2 semesters spread in 3-modules. The 1st module covers the fundamentals of Satellite Meteorology and Global climate, and 2nd module deals with Advanced Concept of Satellite

Few glimpses of the joint inaugural function held at PRL Ahmedabad on August 06, 2018

Meteorology, e.g., Geophysical Parameter Retrieval and Satellite Products and their application in NWP etc.

Special Lecture on Space Law

On 28 November 2018, a special lecture on "Space Law: International Treaties and Regulations", by Dr. V. Gopalakrishnan of ISRO Head Quarter Bengaluru was conducted at SAC Bopal Campus for CSSTEAP SATMET-11 and SAS-11 students. This lecture was very informative for the participants.

Meeting of CSSTEAP participants with Dr. Shirish Ravan, UN-OOSA

An interaction meeting of CSSTEAP participants with Dr. Shirish Ravan, Senior Programme Officer, United Nations (UN), Office for Outer Space Affairs (OOSA), Vienna was organized on 06 December 2018 at SAC Bopal Campus.

After initial interaction with participants, he informed

Glimpses of special lecture on "Space Law: International Treaties and Regulations", by Dr V. Gopalakrishnan and group photo along with him and few other faculty members.

participants about the triggering effect of UN-CSSTEAP courses originated in India during 1995 and how UN-OOSA is guiding in different matters of UN courses running in India every year under CSSTEAP. He delivered a talk on "Linking Space Innovation and Infrastructure to 2030 Agenda for Sustainable Development". He also emphasize the necessity of redesigning of course contents with an aim to meet the goal of 2030 Agenda for Sustainable Development. The interaction meeting was very informative for the students viz. regarding their courses, why they

Glimpses of interaction meeting of CSSTEAP students with Dr Shirish Ravan of UN-OOSA

are undergoing this UN-course and how this will be helpful for their countries etc.

Dr. B. Simon
Course Director

Associate
Course Director

Dr. Kaushik Gopalan
Course Coordinator

DISASTER RISK REDUCTION (DRR) WITH SPECIAL EMPHASIS ON FLOODS & EARTHQUAKES, CSSTEAP-IIRS

SHORT COURSES

Considering the importance of space technology in addressing the priorities outlined by Sendai framework for Disaster Risk Reduction 2015-2030 and its significance particularly in context of Asia Pacific Region, being recurrently affected by severe disasters a short course of four weeks on "Disaster risk reduction (DRR) with special emphasis on Floods & Earthquakes" was conducted at CSSTEAP, IIRS during May28-June22, 2018. The course was aimed to generate awareness among the users/ researchers/ professionals/ decision makers/ academicians on the applications of Geospatial Tools in Disaster Risk Reduction (DRR).

The course was attended by 18 participants from 07 countries (Bangladesh, India, Kazakhstan, Myanmar, Nepal, Tajikistan and Vietnam) of Asia Pacific region. The overall objective of the course was towards familiarizing the participants with disaster risk reduction concepts, institutional mechanisms, application of geospatial information technologies for pre- and post-disaster monitoring and mitigation such as early warning, hazard, vulnerability and risk assessment, damage assessment and disaster risk reduction measures and involve

Course participants of short course on DRR and CSSTEAP/IIRS officials

them to carry out a mini project which will help in implementing DRR in their country.

The course designed was modular in structure and provided a balanced treatment of classroom lectures, practical/hands on sessions and field visits. There were 28 Lectures and 11 practicals and 2 field visits during the training program. In addition to the regular lectures by faculty from IIRS, experts from various organizations within India and abroad were also invited to deliver lectures on specialized topics so that the participants could benefit diverse information directly from experts working on the subject.

A formal feedback was taken at the end of the course. In general, all the participants rated the course as very good to excellent in terms of objective, course program design and

Participant receiving certificate and souvenir

implementation. Sh Savin Bansal, Additional Secretary, Disaster Management, Govt. of Uttarakhand was the chief guest of the valedictory function and distributed certificates to the participants during the function held on June 22, 2018.

C.M. Bhatt
Course Coordinator
cmbhatt@iirs.gov.in

Dr. R.S. Chatterjee
Course Director
rschatterjee@iirs.gov.in

GEOSPATIAL MODELLING IN FORESTRY AND ECOLOGY FOR CLIMATE CHANGE STUDIES

SHORT COURSES

This training course was organized by the Centre for Space Science and Technology Education in Asia and Pacific (CSSTEAP) and conducted by the Forestry and Ecology Department of Indian Institute of Remote Sensing, ISRO, Dehradun during April 16-27, 2018. A total of 18 participants from 8 countries, viz., Bangladesh, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Sri Lanka and Tajikistan, participated in the course. The overall objective of this training course was to generate awareness among researchers, professionals, decision-makers and academicians on the recent advances in geospatial modelling in forestry and ecology for climate change response studies.

The course comprised of lectures, hands-on and field visit. The major topics covered in lectures were: Geospatial modelling in forestry and ecology; Climate change impacts on ecosystems; Intergovernmental Panel on Climate Change (IPCC); Biodiversity characterization at landscape level and its use in climate change studies; Modelling biodiversity distribution: Spatial biodiversity model in R computing environment; Phenological responses to climate change in Himalayan Forests; Modelling carbon fluxes in Indian subcontinent and its relation to climate change; Land use and land cover change prediction modelling for climate change studies; Species distribution modelling for climate change studies; Modelling ecological corridors and connectivity for climate change studies; Impacts of climate change in modelling biological invasion due to invasive species; and Overview of GCMs and RCMs in developing AR5 RCPs (IPCC scenarios). Hands-on were carried out on Familiarization with GIS software; Identification of changes in long-term phenology using geospatial techniques for climate change response in Himalaya; Modelling change in species distribution due to projected climate change using SDM; and LULC change prediction modelling using IDRISI. One-day field visit was carried out in Mussoorie forest division. The participants also carried out a one-week mini project. The course was widely appreciated by the participants.

Dr. Arijit Roy
Course Director

Dr. Subrata Nandy
Course Coordinator

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), Bangalore and Indian Institute of Remote Sensing (IIRS), Dehradun. This year the course commenced on 26th November 2018 at CSSTEAP, IIRS Dehradun and 46 participants from 16 countries of Asia pacific and ASEAN region attended the course. The Course was inaugurated on 26th November by the chief guest Dr. G.N.V. Prasad, Ex-Dy. Director Management & Information System Area, UR Rao Satellite Centre (URSC). Dr. A. Senthil Kumar, Director, CSSTEAP, Dr. S.K. Srivastav, Dean Academic, IIRS and Deputy Project Director, ASEAN and Dr. S.P. Agarwal Programme Coordinator, CSSTEAP also attended the inaugural function. The Inaugural presentation was made by the chief guest, followed with presentations by Faculty of Scientists and Engineers in a structured time table. The presentations covered:

- 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, videos and videoconference with URSC. A Quiz program on Space systems and space events was conducted for the more involvement of participants which has given very good response. Assignments related to orbits and various sub-systems were given to participants and it was well responded. At the end of the first weekend an educational tour was planned to Mussorie. The Valedictory function was presided by Dr. S.V. Sarma, Dy Director U R Rao Satellite Center Bangalore, Dr. A. Senthil Kumar, Director CSSTEAP, Dr. S.P. Agarwal, Programme Coordinator, CSSTEAP, all the participants, faculty along with the Course Director and Course coordinator. The Certificates were given away by the chief guest of the function and Director CSSTEAP. Course material and the Mementos (T-Shirts) were given to the participants by Programme Coordinator, CSSTEAP and Course Director.With this the short course on Small Satellite Mission came to end successfully.

Dr. Ashutosh Srivastav
Course Coordinator
asrivastava@iirs.gov.in

Dr. P. Murugan
Course Director
murgan@isac.gov.in

PILOT PROJECT ABSTRACTS

Project Abstracts of 22nd Post Graduate Course on Remote Sensing and Geographic Information System

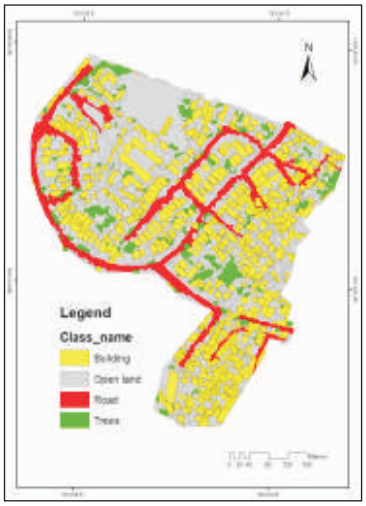
1. Urban Storm water Modelling in parts of Dehradun city using Geospatial Tools.
2. Property Taxation using high resolution data.
3. Geospatial technologies for assessment of urban green space.
4. Spatio temporal study of land cover dynamics in peri-urban area of Dehradun, India.
5. Geospatial Modelling and Web Mapping for Groundwater Assessment: A study for Dhaka City, Bangladesh
6. GIS Solution of Multi-Depot Capacitated Vehicle Routing Problem (VRP) for Solid Waste Collection using Heuristic Algorithm
7. Analysis of Shadow Effects on Land Cover Features Using High Resolution Hyperspectral Data
8. Assessment of Biophysical parameters: LST for wildfire risk in part of Mongolia
9. Land use/cover change modelling and prediction in the Manner dist. Sri Lanka
10. SAR remote sensing for flood monitoring of Kaziranga National Park - Assam India
11. Validation of model simulated solar flux at ground with satellite data/ground observation.
12. Utility of medium resolution satellite data for coastal environment monitoring.
13. Glacier dynamics studies using geospatial technologies.
14. Flood mapping and monitoring using RS and GIS.
15. Reservoir sedimentation assessment through remote sensing and hydrological modelling.
16. Impacts of urbanization on hydrology using geospatial technology.
17. Biodiversity characterization using spatial biodiversity model (SBM) in R statistical comparing environment for Nepal Himalaya (A case study for Myagdi, Kaski and Lamjung Districts in Nepal
18. Mapping forest cover and treecover using high resolution SAR in Vietnam
19. Forest above ground biomass estimation using machine learning regression algorithm in Yok Don National Park, Vietnam
20. Variation in accumulation area ratio of glacier using RS and GIS glacier health perspective
21. Crop inventory & cropping pattern analysis, Using Remote sensing data.

Urban Storm Water Modeling in Parts of Dehradun City Using Geospatial Tools

The urbanization processes give rise to impervious surface and regarded as the major cause of flooding or water logging in urban areas and have changed their dimensions over the time. The urban flooding in cities is mainly in the form of flash floods and water logging of streets due to high-intensity short-spell rainfall. Hence,due to rapid urbanisation and massive transformation of Land Use/Land Cover (LU/LC), thewater logging or the urban flooding has become regular affair in many parts of the city. Therefore, a study is necessary to assess and predict urban flood extent based on storm water inundation modeling for the city. The flood intensity increases for different return periods of rainfall events due to rise in the level of water accumulation. The present study is an attempt to understand the vulnerability associated with water-logging conditions in urban areas of Dehradun city. Cartosat-1 satellite stereo data has been used to extract the elevation information for entire catchment area for watershed delineation and slope estimation.The IKONOS MSS and PAN fused product was used to generate detailed temporal LULC map for the study area using object based classification technique. The vulnerability of the city towards the flooding problem has been assessed in GIS platform using Storm Water Management Model (SWMM). Initially, a runoff potential map which signifies the areas of high to low runoff zones for Dehradun city has been generated based on Natural Resources Conservation Service (NRSC) Curve Number (CN) method. It was assessed that a very heavy rainfall incident of 400 mm in 24 hours can cause runoff of 389.56 mm. Based on runoff potential, a micro-watershed within the city area was identified for detailed study based on SWMM model. The SWMMsoftware has been used to estimate the runoff depth, extent, peak flow and intensity of flooding taking into consideration the elevation, slope, LU/LC, rainfall conditions and designed Storm Water Drainage (SWD) infrastructure of the city. The model is calibrated according to conditions of the study area and then simulated for the highest rainfall day of 2003 (IMD rainfall data) by the incorporation of all the desirable inputs based on dynamic flow routing technique. The study validates the utility of geospatial techniques in understanding the urban flooding in Dehradun city caused due to heavy rainfall events and thus helpful to urban planners towards managing the SWD systems.

Potential of High Resolution Satellite Images for Property Tax assessment

Property tax is a potentially attractive means of financing municipal governments in developing countries. At present in developing countries urban property taxes are extremely low. One of the biggest problems with property taxes is the high level of administrative costs to inspect properties and determine the new addition or home renovation. Now remotely sensed data are used for measuring social significant variables in urban and sub-urban context. This study has tried to link remotely sensed data and property related parameters. In order to assess property tax related key



The Overall Accuracy= 0.8875
Overall Kappa Statistics = 0.855

Fig. 1. Building Extraction by OBIA

factors, high resolution remotely sensed data IKONOS (PAN and MSS) and Google Earth images are used. This study has tried to find out key factors of property tax by using remote sensing applications and field visit. Here property tax has been estimated by using Unit Area Method and Annual Rental Value method. The study has tried to compare this result with remotely sensed result and actual tax collection by Municipal authority for selected samples. This study has also attempted trend analysis of property taxation for three years (2005, 2010 & 2017). To assess building information and property information Imageinterpretation and Object Based Image Analysis were used. Overall accuracy of OBIA was 88 % with overestimation o area and thus Property tax in comparison to manual interpretation. This was a pilot project and the study can be scaled up to the municipalities to understand the scenario in totality.

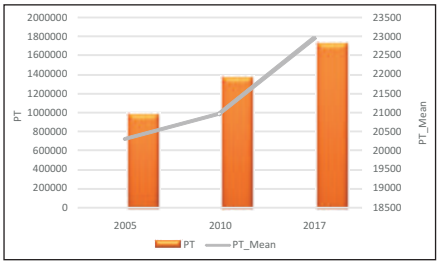
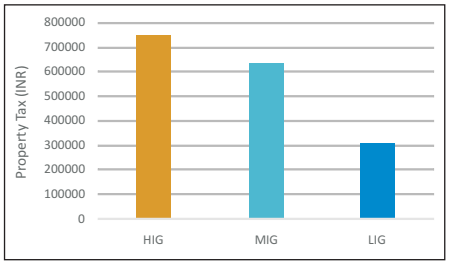


Fig. 2: Total Property Tax for selected samples



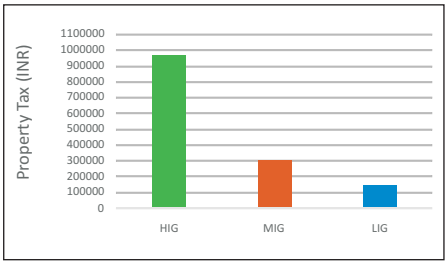
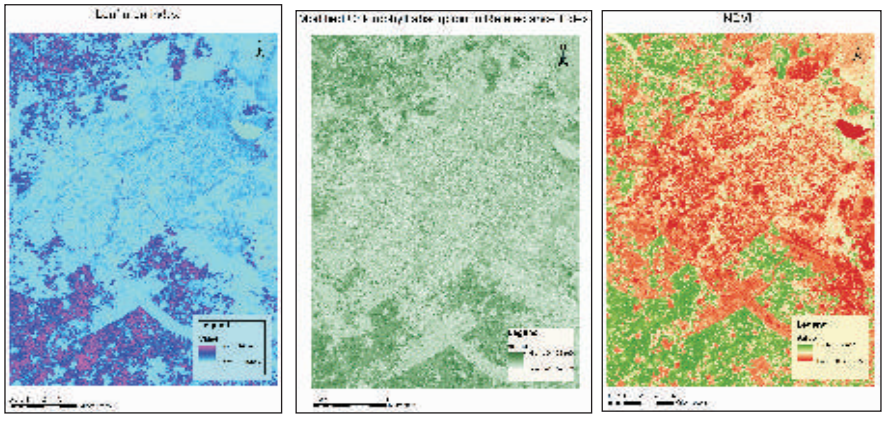


Fig. 3: Property Tax: Comparison of methods

Geospatial technologies for assessment of Urban Green Space

Urban green space provides many functions in urban context that benefits people quality of life. As modern urban life style is associated with chronic stress and insufficient physical activity, urban green space such as parks, avenue trees and residential greenery can be the place, which can provide psychological relaxation and stress elevation as well as playing great role in healthy life-style of population, reducing exposure to air pollutants, noise and excessive heat.There is no need to say thaturban green space is an important part of public open spaces and common services provided by a city and can serve as a health-promoting setting for all members of the urban community. Therefore, quality assessment of urban green space is highly important.

Hence, this study attempts measure chlorophyll content fluctuation in different types of urban green space as chlorophyll content is one of the major indicators of plant stress and health. In order to complete our objectives MCARI, Red-edge position index and NDVI was calculated using Sentinel-2 data for study area. As well as Leaf area index (LAI) was derived, which is one of important indicators of health of the vegetation. For validating chlorophyll content on sub-species level the fieldwork was conducted during which leaf samples for chlorophyll estimation from 16 plots twenty by twenty meters were collected for analysis. Each plot contains from 1 to 5 different species samples due to heterogeneity of urban green space. Then, following the methodology, spectrophotometer readings were taken and total chlorophyll was measured.In second part of our study Pleiades data was classified and urban green type map was created, which was used for further analysis and comparison with results received in the first part of our study.

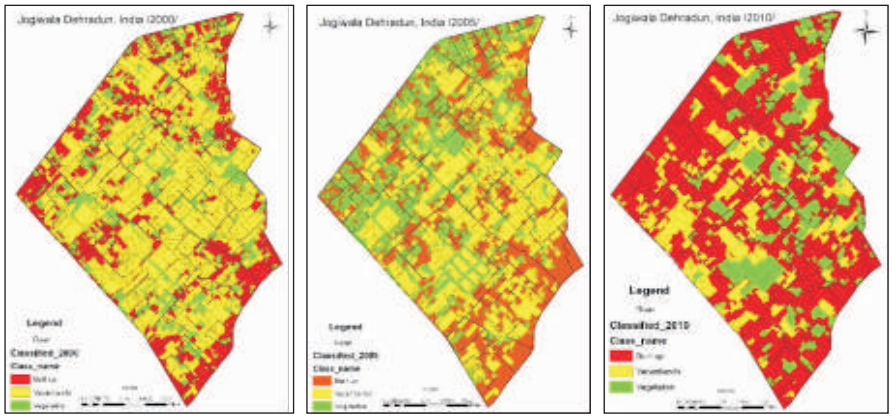


Spatio temporal Sutudy A Comparison of Land Cover dynamics in an Urban Areas, Dehradun, India

Urbanization is a process of moving population from rural to urban areas. Urbanization is desirable for human development.

However, uncontrolled urbanization has been responsible for many problems such as substandard living environment, acute problems of water both in quality and quantity, noise and air pollution, disposal of waste, traffic congestion etc.

To overcome these problems monitoring of the urban growth is inevitable. Urban growth can be assessed by manual surveying or by satellite remote sensing.

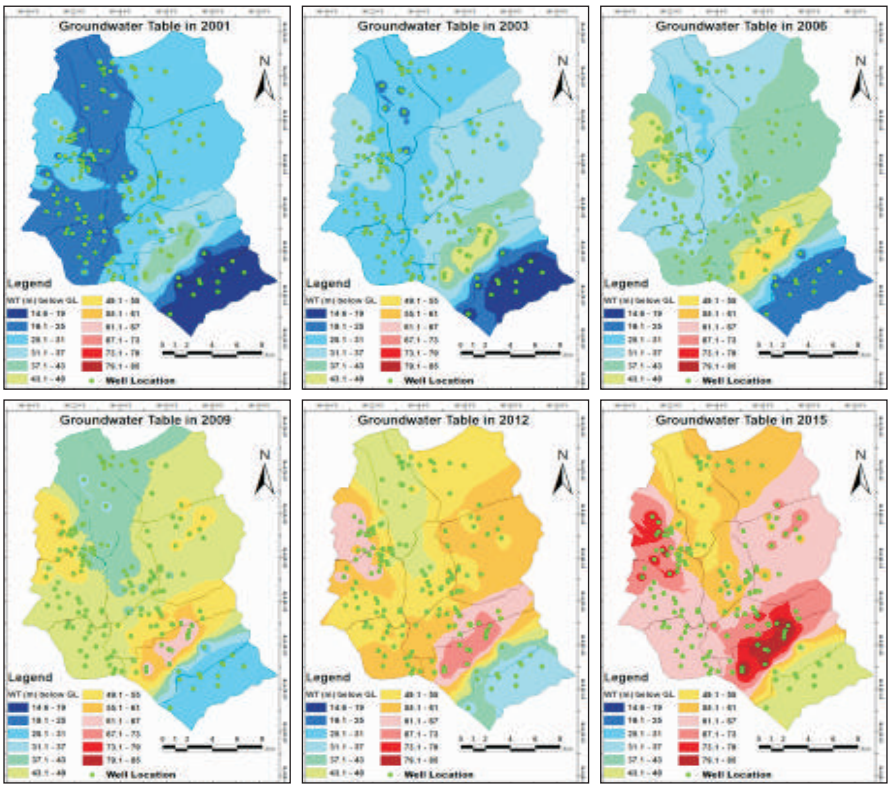


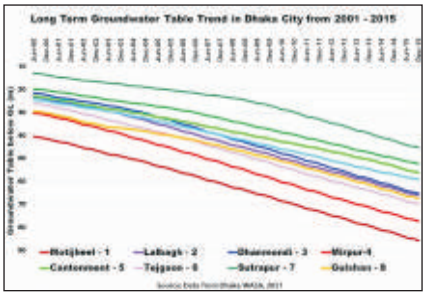
Land cover: Built-up (B), Vegetation (Veg), Vacantlands (Vac)

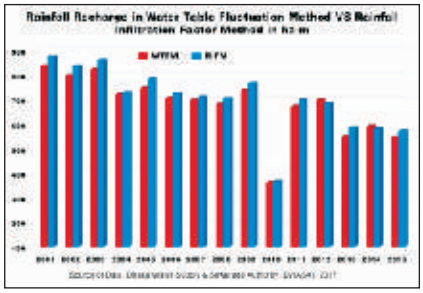
Satellite remote sensing is useful for monitoring of land cover change at high temporal resolution and at lower cost than traditional surveying methods. This study explores the application of geometrics in analysis,theinvestigation is based on the temporal satellite images for the year 2000, 2005and 2010.Because of the better road connectivity it has been observed the urban growth from 2000 to 2010 is distributed manner in Jogiwala, Dehradun.

Geospatial Modelling and Web Mapping for Groundwater Assessment: A study for Dhaka City, Bangladesh

With the rapid urbanization and population growth in Dhaka, the requirement for groundwater has increased significantly over the years. Due to the excessive and indiscriminate withdrawal of groundwater, the water table is continuously depleting during the last 15 years. This has become a serious issue for policy makers to save Dhaka city from its possible future failure in terms of human survivability and sustainability. These challenges set the urgency and great importance for extensive research on "Geospatial Modelling and Web Mapping for Groundwater Assessment in Dhaka City". The prime focus of this study is a holistic assessment of groundwater resources and analyse spatially







distributed water table trend in recent years. Groundwater recharge was estimated using Rainfall Infiltration Factor & Water Table Fluctuation methods (GEC1997 & 2015) and a distributed hydrological (VIC) model. The rainfall recharge correction factor for impervious surface has been taken as 0.24 to 0.58 in different zones using RS inputs from LULC, LST and Night-time Light Map. The average annual and Monsoonrainfall recharge are 9350 and 7400 hec-m. It is also observed that groundwater isdepleting at the rate of 3m annually. The groundwater recharge and water table depletion are shown in the graph.

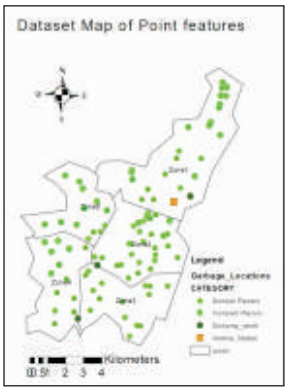
The annual groundwater draft& recharge are 54426 and 24765 hectare meter and stage development is 224% Considering the stage of groundwater development Dhaka city has been categorized as 'Over Exploited' with more than 3m depletion in every year as shown in the map below. All the input and results are published in the web using QGIS to Web, open layer and leaflet for future use.

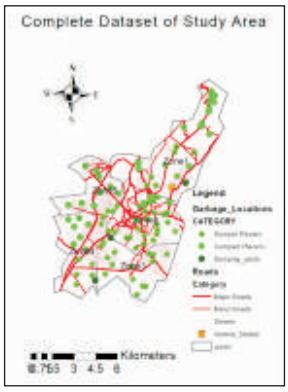
GIS Solution of Capacitated Vehicle Routing Problem with Time Windows for Solid Waste Collection using Heuristic Algorithm

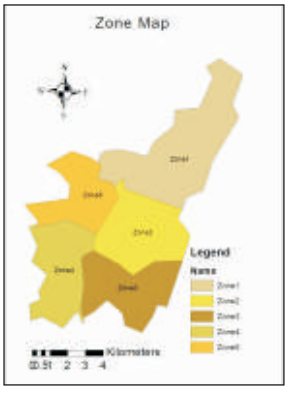
Uncontrolled growth of the urban population in developing countries in recent years has made solid waste management an important issue, so the system for collection of solid waste constitutes an important component of an effective solid waste management system.

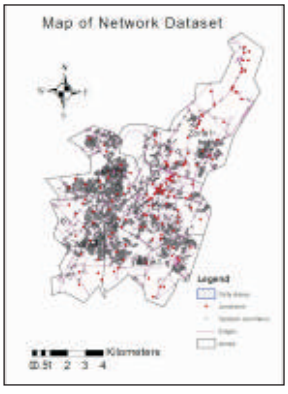
Dehradun city generates about 240 Metric Ton (MT) of solid waste per day. Waste collected at storage vats/containers is transported to disposal ground at Shishambada by Dehradun Municipal Corporation (DMC) departmental vehicles and hired vehicles. Collection, segregation and transportation of municipal solid waste in DMC area are unplanned and chaotic; there is no uniformity in the size of containers/open vats and the size and haulage capacity of transport vehicles. DMC allocates different types of collection vehicles to different types of containers/open vats depending on waste generation at a location and compatibility of the vehicles with the storage receptacles. It was, thus, a challenge to present an acceptable, realistic solution optimising the waste vehicle routes, thus cutting down on the transportation costs and increasing overall efficiency. ArcGIS Desktop has been used to determine least cost paths for collection and transportation of wastes.

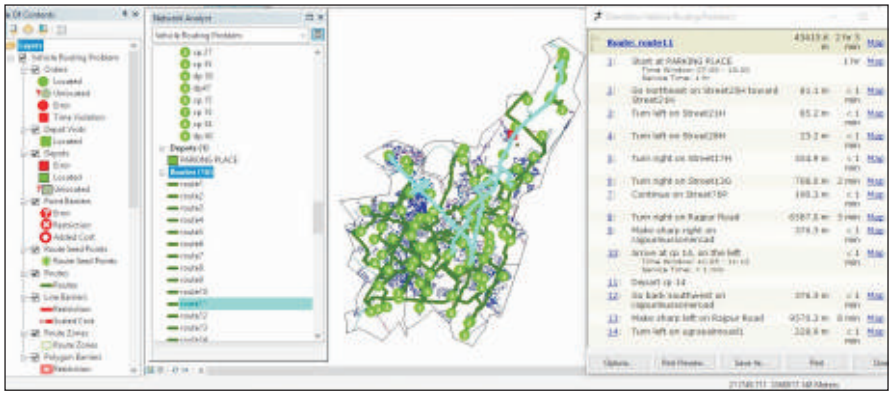
The present study describes an attempt is made to design and











develop an appropriate collection plan by Geographical Information System (GIS) software for the Dehradun city in Uttarakhand, India. This study used a GIS to model current and proposed collection patterns using Esri's ArcGIS Network Analyst software. Network analyst is used to solve the vehicle routing problem generating final route directions for every vehicle and calculating the best time for lunch break of drivers automatically. The users with Network Analyst extension are able to find efficient travel routes, determine which facility or vehicle is closest and Generate travel directions. ArcGIS Network Analyst extension route solver finds the best route for a single vehicle to visit many stops and the VRP solver finds the best routes for a fleet of vehicles to service many orders.

The Capacitated Vehicle Routing Problem with Time Window (CVRPTW) can be described as the combinatorial optimization transportation problem based on minimum cost route for a fleet of vehicles from the depot to a set of geographically scattered garbage locations.

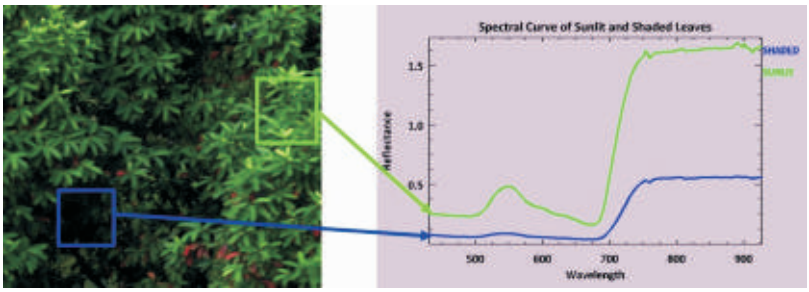
Multiple parameters like capacity of the sanitation bin, service time, waiting time, violation time, vehicle capacity, vehicle type, multiple dumping sites, trip duration, lunch break during the trip, time window at garbage locations ,dumping sites and parking place of the vehicles, time impedance, distance impedance, over time servicing have been considered to perform the CVRPTW. We have taken three dumping site locations, one parking place of all the vehicles and ninety two garbage locations, and different types of vehicles of varying capacity.

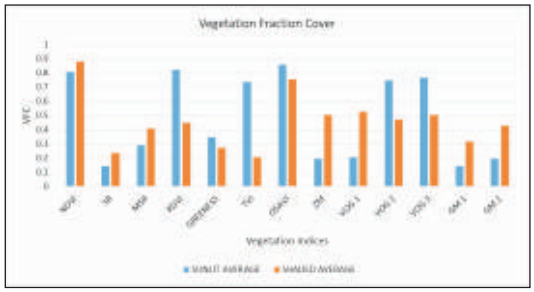
From the analysis it can be concluded that heuristics which work in the background gives the best result to minimize the total travel distance and total travel time.

Analysis of Shadow Effects on Land Cover Features Using High Resolution Hyperspectral Data

Hyperspectral remote sensing sensors are capable of acquiring images in hundreds of contiguous spectral bands with a narrow spectral bandwidth which allows species level feature identification and classification. Hyperspectral data with high spatial and spectral resolution sometimes fails to perform species level classification when there is shadow effect on land cover features. Shadows persuade to strong weakening of the signal that leads to reduction in information in any remote sensing image. This induces corruption of biophysical parameters derived from the pixel values as well as causing error in image interpretation and classification

This study is concerned with the analysis of shadow effects on land cover features using GBHRS (Ground Based Hyperspectral Remote Sensing) data. GBHRS data allows retrieval of shadows and features simultaneously. For this analysis, VNIR (Visible near Infrared) range of GBHRS data is used and sensor error correction has been carried out for removal of noisy





bands and the data is converted into reflectance. The reflectance spectra of sunlit and shaded leaves were analyzed and the reflectance of shaded leaves is notably found lower than the sunlit leaves. Various Vegetation Indices VI's like Simple ratio (SR), Normalized Difference Vegetation Index (NDVI) and Greenness Index (G) etc. were calculated from the data and comparative analysis for different VI's was performed. A small portion of the area which significantly indicated sunlit and shaded leaves of the same vegetation species was considered for further analysis. For analysis of effects of shadows on vegetation parameters, Vegetation Fraction Cover (VFC) was calculated using VI's and it was observed NDVI and G was not strongly influenced by shadows. Considering these analysis, land cover classification was performed using various classification approaches.

Spatiotemporal Study of Land Cover Dynamics in Periurban Area of Dehradun, India

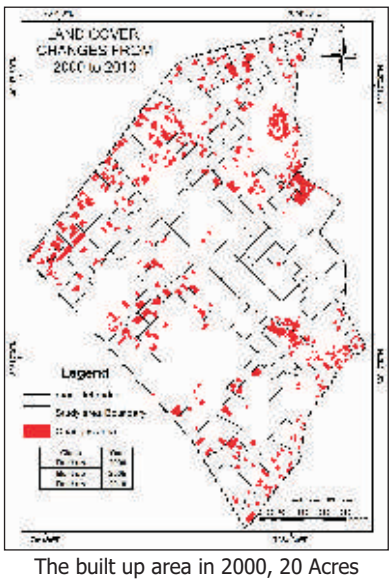
Urbanization is a process of moving population from rural to urban areas. Urbanization is desirable for human development.

However, uncontrolled urbanization has been responsible for many problems such as substandard living environment, acute problems of water both in quality and quantity, noise and air pollution, disposal of waste, traffic congestion etc.

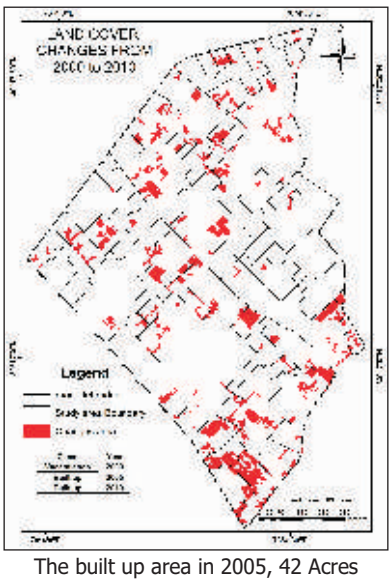
To overcome these problems monitoring of the urban growth is inevitable. Urban growth can be assessed by manual surveying or by satellite remote sensing.

Satellite remote sensing is useful for monitoring of land cover change at high temporal resolution and at lower cost than traditional surveying methods. This study explores the application of geomaticsin analysis peri urban growth of Dehradun city. Theinvestigation is based on the temporal satellite images for the year 2000,2005 and 2010.Because of the better road connectivity it has been observed the urban growth from 2000 to 2010 is distributed manner in Jogiwala, Dehradun.

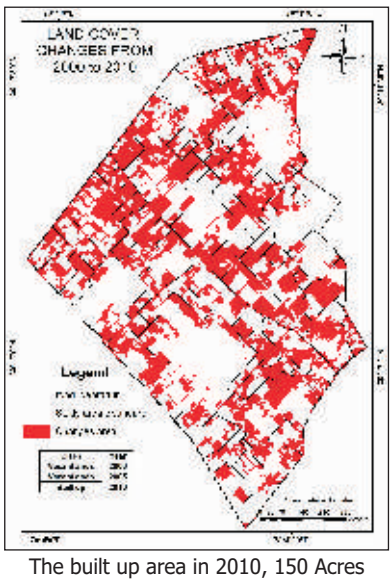
Total area of Jogiwala=240 Acres



The built up area in 2000, 20 Acres



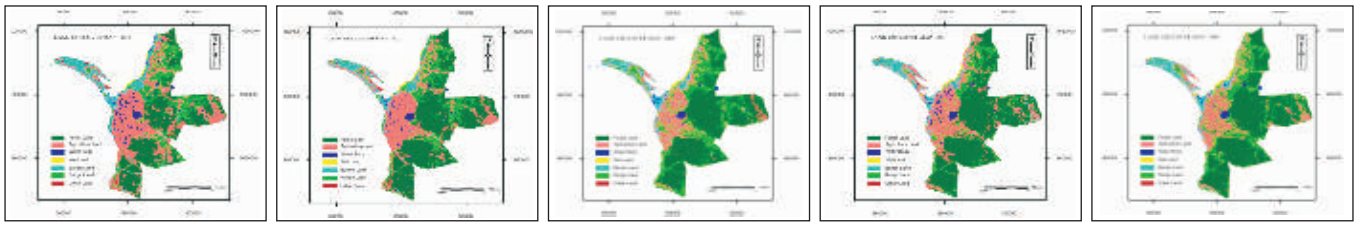
The built up area in 2005, 42 Acres



The built up area in 2010, 150 Acres

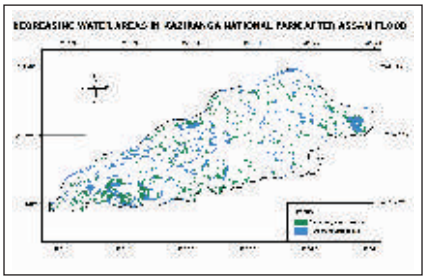
Land Use/cover Change Modeling and Prediction in the Mannar District, Sri Lanka

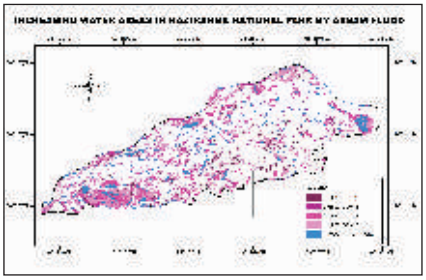
Land-use/land-cover (LU/LC) change is an important component of global environmental change. Land use/land cover mapping, change detection and prediction are essential for decision-making and implementing appropriate policy responses relating to land uses. To understand LU/LC change of Mannar district, Sri Lanka, seven different land cover/use categories have been used, named forest Land, agriculture, rangelands, wet land, water bodies, urban land and barren land and their spatial as well as temporal variability for the years 1994, 2001, 2009 and 2017 is studied, using the analysis of Landsat TM/ETM+/8 OLI images. Change detection involves quantifying temporal effects using multi temporal data sets. Techniques like Image Differencing, Image Ratioing, Principal Component Analysis (PCA) and post classification method were used to detect the changes. For post classification method, we have analyzed multispectral data using two different classifiers including Maximum Likelihood Classifier (MLC) and Support Vector Machine (SVM). The overall classification accuracies of Maximum Likelihood Classifier (MLC) and Support Vector Machine (SVM) were 90-93% and 97-99% respectively. Then Classification results indicate that SVM is more accurate than MLC. Support vector machine classification result was used for prediction of the 2030 scenario using CA-Markov model. The projected map of 2030, in comparison with 2017 LULC map, shows a significant decrease in forest area (267.68 km^2) which must be regulated in order to maintain a green environment, and increase in the urban area (8.23 km^2) which should be monitored to have sustainable development and control the eco-environment degradation. Wetland ecosystem also plays major roll of environmental sustainability. The model results show, significant decrease in wet land area (4.78 km^2) and 159.95km^2 areas will be converted to agriculture land.



SAR Remote Sensing for Flood Monitoring of Kaziranga National Park - Assam - India

Microwave remote sensing equipped with Synthetic Aperture Radar (SAR) system is an active microwave remote sensing technique with the capability of being independent of solar illumination. Due to the wavelength, the signal has limited interaction with the droplets in the cloud without obscuring observations. SAR sensors are able to detect flooding because flat surfaces reflect (acts as a specular reflector) the signal away from the sensor, decreasing the amount of returned radiation. The most important advantage of using SAR data is that land and water contrast can be easily distinguished. SAR system are capable of acquiring observations in both day-time and night-time and even under extreme weather conditions, it becomes the most





suitable instrument for high-resolution flood mapping from space.

Flood extent maps derived from SAR data can be used for disaster management activities: derivate hazard map within the scope of flood prevention activities, insurance risk management, spatial planning.

The prime focus of the present study is the flood identification and extent mapping for Kaziranga National Park, Assam state, India. This study is proposed to explore the potential of SAR data (ALOS-2 PALSAR-2) and its derived parameters for flood identification by using polarimetric decomposition technique and random forest (RF) algorithm to classify the water inundation areas.

Validation of Model Simulated Solar Flux at Ground with Satellite & Ground Observation Data

Solar energy is one of the important power source of renewable energy.With the increasing demand of energy consumption per capita there is growing need to harvest solar radiation in a proper manner to maintain a balance in conventional use of sources. Hence keeping the growing need in mind present research has been carried out to estimate the Solar flux using Solar-WRF model and matching with the known result obtained from INSAT-3D satellite solar insolation product and ground observation. Based on SOLARWRF simulations SWDOWN, SWDDNI and SWDDIFhave been derived from the model andfurther validation has beencarried out against ground based and satellite measurements of Global Horizontal Irradiance (GHI),Direct Normal Irradiance (DNI) and Diffused Horizontal Irradiance (DHI) respectively. It has been found that model and satellite overestimate the GHI and DNI. DHI is underestimated at twolocations viz; Murthal (LAT 29.0279, LON 77.05712) and Gurgaon(LAT 28.42486, LON 77.15593). DNI component shows large bias because of lack of proper aerosol data in model. DNI is the most important component for concentrated solar power technology, hence for present study we have used auxiliary relationship; DNI*exponential ^(-☐),where value of ☐ is obtained from INSAT -3D Aerosol Optical depth Product (AOD) for correcting the bias.

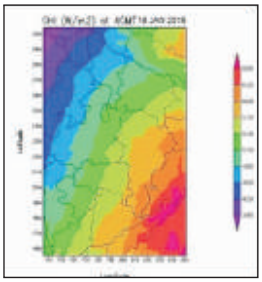


Fig. 1: Model Simulated GHI at 4GMT 16/1/2018

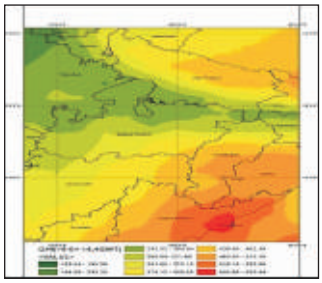


Fig. 2: Model Generated DNI at 4GMT 16/01/2018

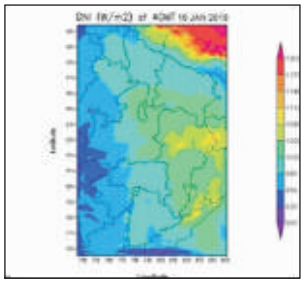


Fig. 3: INSAT-3D Insolation Product (GHI) 16/01/2018

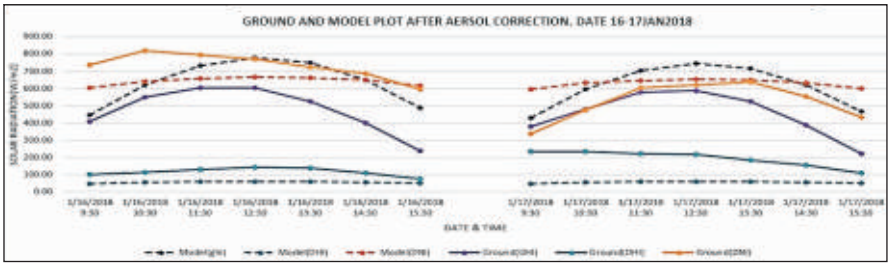


Fig. 4 : Ground & Model Plot after Aerosol Correction for Gurgaon Location

Utility of Medium Resolution Satellite for Coastal Environment Monitoring

Coastal development with respect to industry and farming exerts a major pressure on marine environment. Most of the thermal power plants which are located in coastal zone use sea water as coolant in their cooling systems. This water, which is used as a coolant is returned to the natural environment at a higher temperature. This changes in temperature affects coastal ecosystem. This study area was selected in the Norochcholai coastal region of Sri Lanka, which is having the power plant since 2011. Since medium resolution satellite data can be effectevely used for estimation of sea surface temperature (SST) and

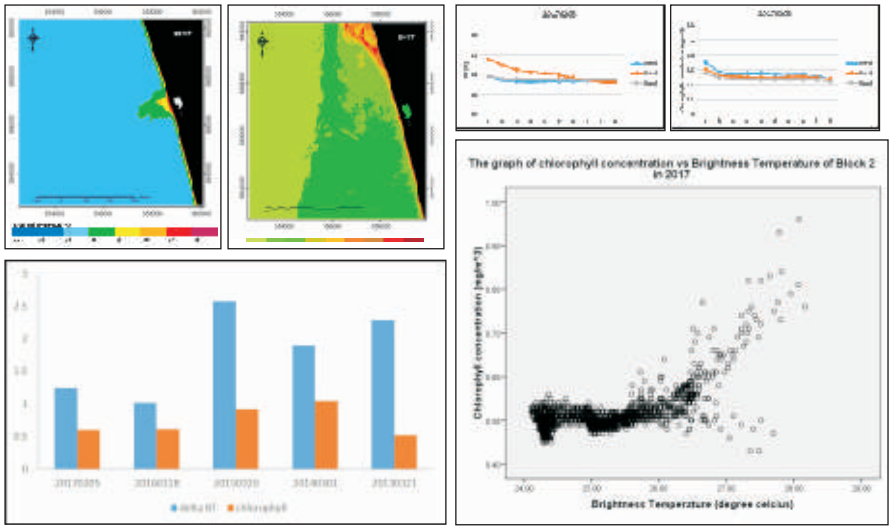
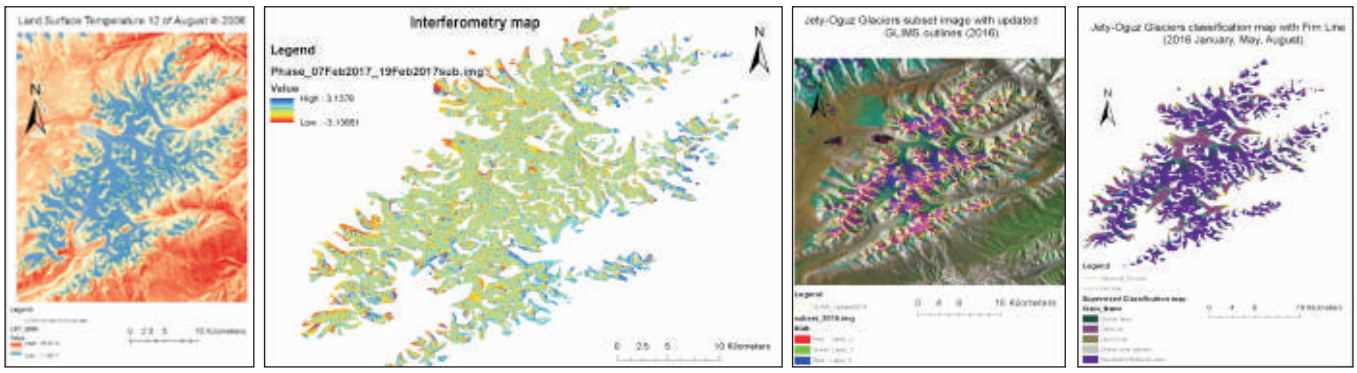


Figure: (left) Brightness Temperature in winter season of 2017, (right) Chlorophyll concentration in winter season of 2017

identification of heated effluent discharge, Landsat-5 Thematic Mapper (TM) and Landsat-8 TIRS sensors were used in this study. Due to lack of ground data, the brightness temperature was taken for the analysis instead of SST. Plume area shows significant temperature difference compared to unaffected area of northern and southern part of the plume. Analysis of SST and phytoplankton concentration has shown a moderate positive relationship. In this study, chlorophyll maps were generated using OC2 algorithm developed by NASA (2015) to analyze the influence of the heated effluent on phytoplankton. From the preliminary analysis it is observed that increase in temperature induces higher concentration of chlorophyll in the study area. But availability of nutrients and sunlight also play a major role in phytoplankton productivity. Since shallow coastal benthic environment of this area is comprised of submerged aquatic vegetation, including seagrass and macroalgae further investigation is highly needed to study the impact of thermal effluents on the coastal ecosystem.

Glacier Dynamic Studies using Geospatial Technology District Jety-Oguz, State Kyrgyzstan

Glacier dynamic changes for entire Jety-Oguz area, which covers a large part of the Central Tien Shan is always interesting and important for purpose of research. The water discharge from this heavily glaciered Jety-Oguzarea (Eastern Kyrgyzstan) is of high importance for the very arid area of Tarim Basin, located in Xinjiang (north-western China). In Kyrgyzstan, 1310 glaciers (>0.1 km^2), which covered 2055 ± 41.1 km^2 (~18% of the entire basin) in 1990. In general, debris-covered glaciers shrinks significantly less than clean-ice if compare and this can be seen from Landsat TM images. We analyzed and identified in the Jety-Oguz area Debris-covered is less than 10%. Land Surface Temperature (LST) the main target to show Debris-cover map for a glaciers. Estimation of LST can be done by using Thermal Band in Landsat 5 (TM). For updating glacier boundaries Band Ratio method was calculated using NIR/SWIR bands in Landsat time series satellite data. Glacier velocity was analyzed by using two images which is at 6 day to annual time interval to find movement of the glaciers, using Sentinel 1 (SAR) and Landsat-8 images. SAR images are also used for classification purposes using time series composite approach, where various glacier radar zones such as debris covered zone, bare ice zone, percolation-refreeze zone, wet snow zone etc. were identified and mapped.



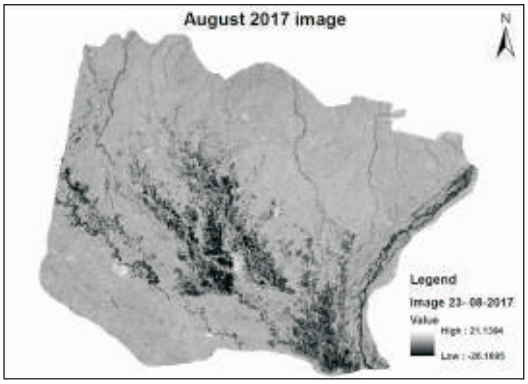
Flood Mapping and Monitoring using Remote Sensing & GIS

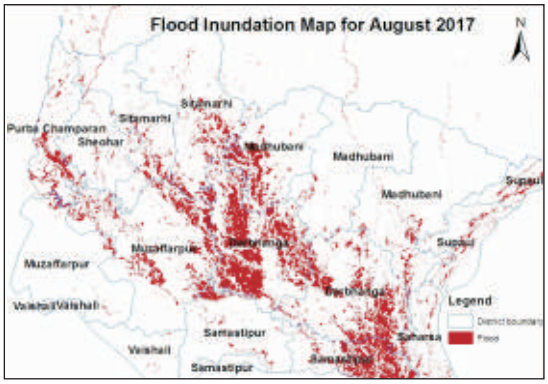
A flood is an unusually high stage in a river, normally the level at which the river overflows its bank and inundates the adjoining area. Floods mostly occur in the country during the west monsoon period spread from June to September.

Remote Sensing can provide information on flood area for different magnitudes of floods so that the extent of flooding can be related to the flood magnitude. Mapping and monitoring of flooded terrain are often difficult using optical remote sensing techniques for monsoon seasons. It is difficult to delineate the land water interface in the visible bands. Also the most important, cloud cover is often associated with the meteorological conditions that result in local flooding. Therefore, microwave Sentinel-1 and RISAT-1datafor monsoon period of year 2015, 2016 and 2017 has been used for flood inundation mapping for Sitamarhi district and its surrounding region of Bihar, India. SNAP software (Sentinels Application Platform) was utilized to pre-process the SAR imagery. The flood inundation maps are overlaid over the high resolution digital elevation model for the estimation of flood depth.

Sentinel images (Fig.1) showed that the inundated areas (dark areas), which can be clearly delineated from the non-inundated areas in the Sentinel SAR image due to the surface roughness of land and smooth of water. From all Sentinel data sets, flood inundation layers were derived and area of inundation were calculated. Then the inundated areas were extracted from the SAR images by using thresholding methods. (Fig.2) shows inundation are aafter using the threshold method.

The flood depth calculated from the different of the flood maps by using ALOS PALSAR DEM in ArcGIS. The greatest depth of the flood was calculated in 2017 year, which is about >3meters.





Reservoir Sedimentation Assessment through Remote Sensing and Hydrological Modeling

The sedimentation of the reservoir is the gradual accumulation of incoming sediments as a result of erosion from upstream catchment. It results in reduction of useful storage capacity of the reservoir. Quantifying the reservoir sedimentation rate is essential for better water resources management. Temporal remote sensing data can be used for assessment of reservoir sedimentation rates and updation of Area-Elevation-Capacity Curve using simple trapezoidal formula.

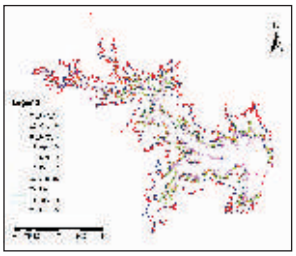


Fig. A: Water spread map 2015-2017

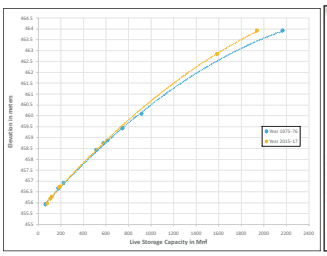


Fig. B: Comparisons of the Capacity Curve

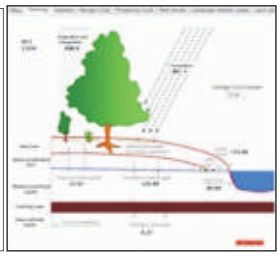


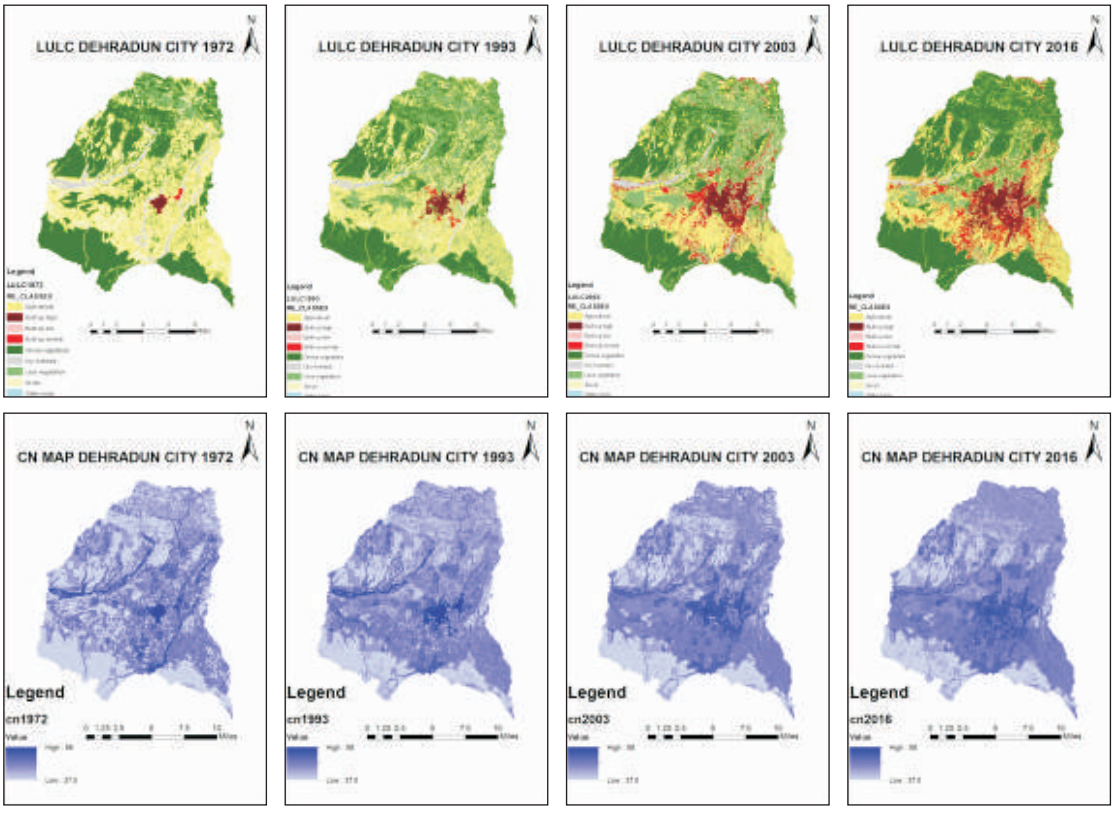
Fig. C. Hydrological model

For the assessment of Jayakwadi reservoir sedimentation in present study Landsat 8 OLI satellite data (30 m) is used for period of 2015-2017. The results of the analysis are shown below as Figure A & B. On the other hand, the hydrological model can be used to quantify the sediment inflow in the reservoir. The SWAT hydrological model has been realized for catchment upstream Jayakwadi Dam. The model inputs have been derived from various sources such as LULC (ISRO-GBP year 2005), Soil (NBSSLUP) and DEM (SRTM, 30 m). The meteorological data to force the model has been taken from NCEP/NCAR Reanalysis data for period from 1979-2014. The water balance results of pre-calibration phase are shown in Figure C. The sedimentation rate derived through remote sensing analysis and through Hydrological modeling are in agreement with each other.

Impacts of Urbanization on Hydrology using Geospatial Technology

Urbanization refers to the population shift from rural to urban areas, The rapid development of urbanization have greatly influenced hydrology, This Project probes into the impacts of urbanization on hydrologic with the support of RS, GIS and hydrological model, The research centers on the impacts of urbanization on urban runoff, urban flooding, Impact of LU/LC change on runoff potential

The study area for the analysis was delineated following the hydrological boundary of Dehradun city, A detailed LULC has been prepared from fused product of LANDSAT MSS, TM, ETM+, 8. Then Object based classification has then been performed on the fused product using the ERDAS IMAGINE 2014 software. The land use classes have been assigned according the NUIS scheme at level 9 the land use classes that have been considered are: Agricultural, Build up high, Build up low, Build up normal, Dense vegetation, Dry riverbed, Scrub, Less vegetation, Water body, Then use Runoff Computation Using SCS Model and Rational Method for calculator Urban Storm Runoff Volume.The urban area increased subsequently from4.20 Km² in 1972 to 11.82 Km² in 1993 then 50.36 Km² in 2003, and finally to 63.85 Km² in 2016. Similarly, the mean curve number values for subsequent years increased from 51.68 in 1972 to 53.58 in 1993 then 57.45 in 2003, and finally to 59.44 in 2016.



Biodiversity Characterization using Spatial Biodiversity Model (SBM) in R Statistical Computing Environment for Nepal Himalaya

A case Study for Myagdi, Kaski and Lamjung Districts in Nepal

Conserving biodiversity is an essential part of safeguarding the biological life support systems on Earth. Assessment of existing level and spatial patterns of biodiversity are essential for long-term and short-term management strategies. Appropriate assessment of biological richness (BR) is possible by taking into consideration of appropriate biodiversity surrogates. The main purpose of the study is to model and prioritize BR based on multi-criteria decision making technique for conservation planning and management decision.

The spatial biodiversity model was executed which allows to include more user defined landscape indices e.g. fragmentation, patchiness, porosity, interspersion, juxta position, human disturbance, terrain complexity, speciesrichness, ecosystem uniqueness and biodiversity value. The Landsat-8 OLI datasets of latest two different seasonswere used to generate the vegetation types/ Land Use and Land Cover (LULC) map which consist of 13 classes (fig.2) viz: Tropical Moist Deciduous Forest, Subtropical Broadleaved Hill Forest, Sub-Tropical Pine Forest, Montane Wet Temperate Forest, Himalayan Moist Temperate Forest, Sub-alpine Forest, Dry Alpine Scrub, Barren land, Agriculture, Built up area and Settlement, Waterbody, Snow and reject class (Shadow and Cloud). The overall accuracy of the classification is 82.61% and Kappa Statistics is 0.8013. The moving window size of 11x11 pixel was used to model fragmentation map using R statistical computing platform. A spatial model incorporating ground based biodiversity attributes of the landscape elements, LULC patterns, disturbance regimes of the landscape and terraincomplexity have been used to delineate the spatial pattern of BR. Based on natural breaks classification, fragmentation map (fig.3) and BR map (fig.4) are categorized into 4 classes as low, moderate, high and very highincluding non-forest area to quantify forest habitat fragmentation and increase in forest edge, and biodiversity rich area respectively. Ultimately, spatial regression analysis has been carried out for the validation of the output. Result of this study is expected to contribute insystematic inventory, conservation prioritization and management decision of the study landscape.

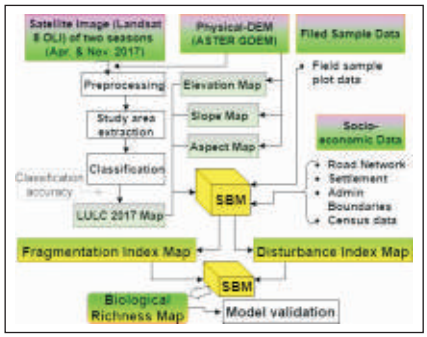


Fig. 1: Research flowchart

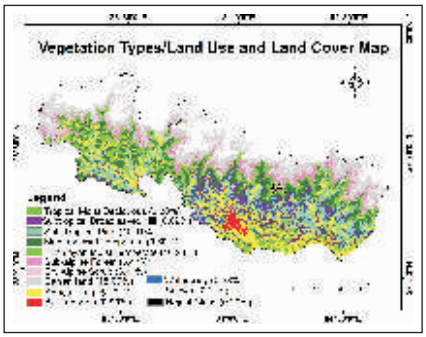


Fig. 2: Vegetation type / LULC Map with statistics

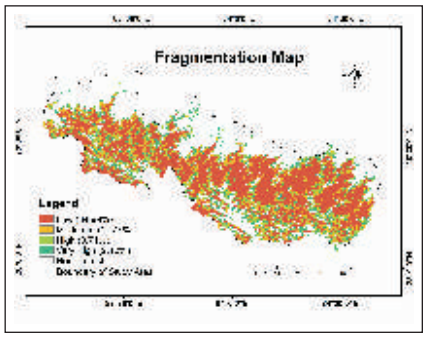


Fig. 3: Fragmentation (edge index) Map classified into low, moderate, high, very high, non-forest; where low class is dense forest and very high class is highly fragmented landscape.

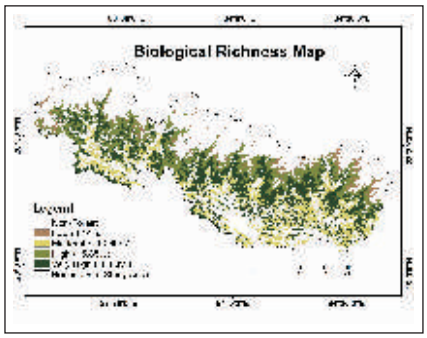
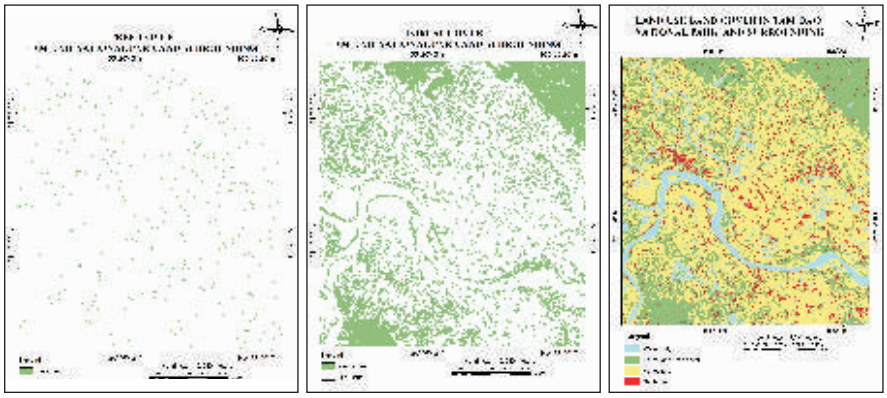


Fig. 4: Biological Richness Map of study area. The map is classified into non-forest, low, moderate, high, very high; where very high class is biodiversity rich area.

Mapping Forest and Tree Cover using High Resolution SAR

Mapping forest cover and tree cover from remotely sensed datasets is of great interest since they allow every country not only to monitor deforestation with up-to-date information, but also at low cost. In last decades, most of the researchers performed forest cover mapping using optical satellite sensors with various spatial resolution ranging from 1 meter to 30 meters. Vietnam supports luxuriant growth of tropical rain forests. Monitoring of these forests using optical remote sensing data is difficult due to frequent cloud cover. Microwave remote sensing is capable of providing earth observation even for cloud cover areas, and hence has potential for forest monitoring in Vietnam.

In this study, C and Lband Synthetic Aperture Radar (SAR) backscatter data from Sentinel-1A and ALOS PALSAR, respectively, have been processed, analysed and used for forest cover and tree cover mapping in VinhPhuc, Vietnam. ALOS PALSAR data has been used to extract backscatter plots for different classes in the study area and deciding thresholds for their classification. Interferometric coherence image was generated using Sentinel-1A pair belonging to May and June 2016. The forest cover map generated is shown in figure. Clearly, the combination of C coherence (useful of settlement mapping) and Lband SAR is useful for reliable classification forest and tree cover in the study area. Synergetic use of these datasets could be useful for forest and tree cover monitoring in tropical regions.



LULC | Forest Cover | Tree Cover

Forest Aboveground Biomass Estimation Using Machinelearning Regression Algorithm in Yok Don National Park, Vietnam

Forest carbon/biomass is a key indicator for carbon budget accounting, carbon flux monitoring and climate change studies. Hence, it is essential to develop a credible approach to estimate forest carbon stocks to determine a national reference scenario and develop a national REDD strategy in Vietnam. Our study applied remotely sensed data combined with field-measured biomass using machine learning regression algorithm to estimate above ground biomass (AGB) in Yok Don National Park, Vietnam. Spectral and texture variables were extracted from Sentinel-2 imagery (February 7, 2017). Random forest (RF) regression algorithm was applied to identify the correlation between spectral and texture variables and forest inventory data. The top 4 variables, including SWIR1 (band 11) mean, normalized green (NG), normalized difference infrared index (NDII), and SWIR2

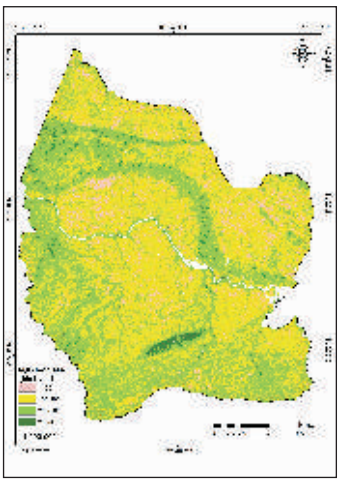


Fig. 1. Spatial distribution of AGB ($Mgha^{-1}$)

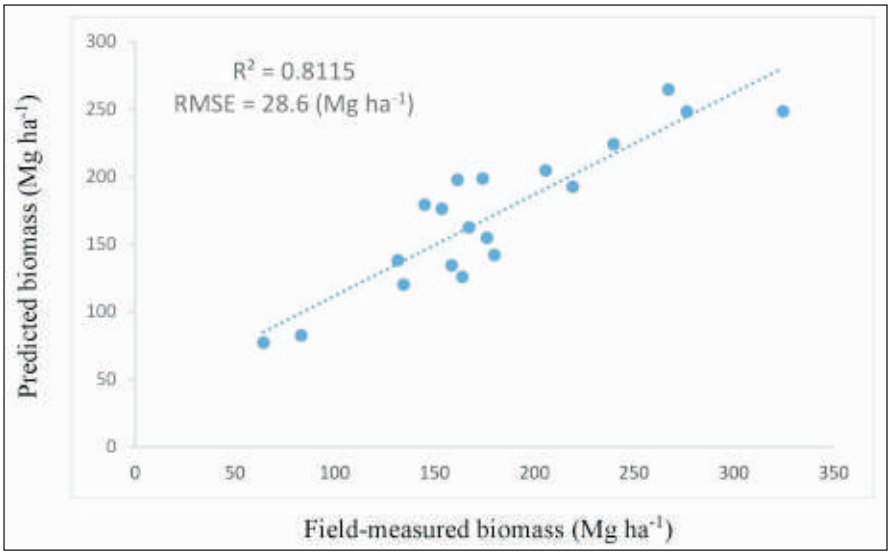
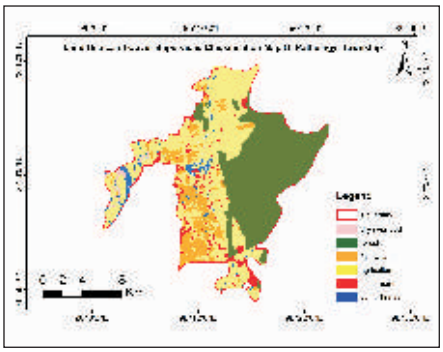


Fig. 2: Validation of the model

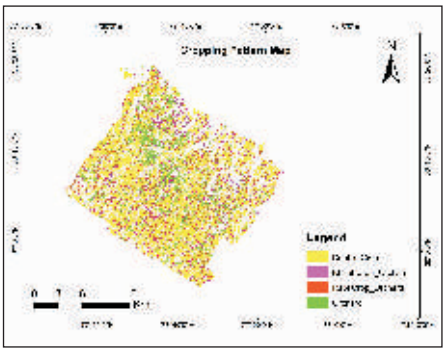
(band 12) mean, were identified as the best predictors for producing a multi-linear regression model to estimate AGB. The predicted biomass revealed a good correlation (R2=0.93 and root mean square error (RMSE)= 34.7 Mg ha^{-1}) with field-observed biomass. The model was validated yielding R2=0.81and RMSE=28.6 Mg ha^{-1}. The findings demonstrated that RF regression algorithm has the potential to predictforest AGB accurately by integrating satellite imagery and field inventory data.

Crop Inventory & Cropping Pattern Analysis using Remote Sensing Data

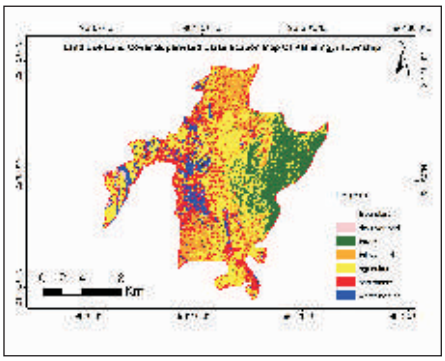
Agricultural sustainability has the highest priority in all countries, whether developed or developing. A cropping system is defined as the cropping pattern and its management to derive benefits from a given resource base under a specific environmental condition whilecropping pattern is the yearly sequence and spatial arrangement of crops. This pilot project is aimed at use of multi-date satellite data for deriving the seasonal cropping inventory maps and deriving the remote sensing based cropping pattern and its indicators during Kharif and Rabi season 2016-17 in Behat area in Saharanpur, Uttar Pradesh, India and Land Use Land Cover (LULC) map of 2017 (summer season) of Patheingyi Township, Mandalay Division in Myanmar. Landsat 8 OLI satellite data was used for this study and the ancillary data used in this study were Toposheet and Ground Control Points (GCPs) which was acquired during field visit. The crop inventory, cropping pattern, and LULC of study area were analyzed through digital image processing, visual interpretation and NDVI based classification using windows platform of ERDAS Imagine, ArcGIS and ENVIsoftware



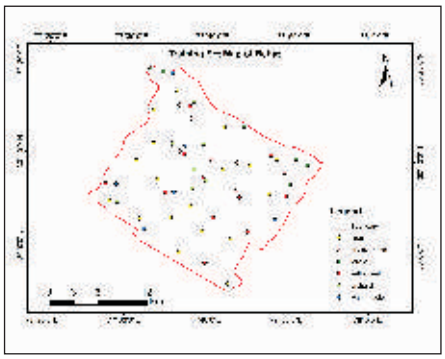
Visual Classification of Patheingyi Township



Cropping pattern of Behat



Supervised Classification of Behat



Training Map of Behat

Project Abstracts of 11th Post Graduate Course in Satellite Communications

1. Study & Design of SATCOM Network for Meteorological Data Acquisition & Dissemination.
2. Study and Performance Analysis of DVB-S2X Based GEO Satellite in Q-Band.
3. Design of Space Based AIS Receiver.
4. Design & Development of Ferrite Waveguide Switch.
5. Feasibility Study for Re-Configurable High Power Cavity Filters.
6. High Frequency, High Efficiency Power Combiners using Spatial Combining Technique.
7. Design of Real Time River Monitoring System by VSAT.
8. System Study and Analysis of Signal Monitoring Satellite.
9. Network Design for Two Way Vessel Tracking System.
10. System Study and Development for Second Generation Distress Personal Locator Beacon Transmitter for MEOSAR Satellites.
11. Study and Design of Rural Communication Subnet & Govt. Private Subnet via SATCOM Network for Lao PDR.
12. Ka Band Satellite Network Planning for Mongolia.
13. Analysis of Hybrid Terrestrial Mobile and Satellite Networks. Its Simulation of Propagation Effects for Mongolia.
14. Study and Implementation of JPEG2000 Image Compression Algorithm.
15. Design and Implementation of Transmission Chain for Personal Locator Beacon for Fisherman.
16. 60 Channel Digital Trans multiplexer: Algorithm Design Simulation and Verification.
17. Study and Design of Digital Radio Broadcasting System for Radio Nepal.
18. Study and Simulation of PAPR Reduction Techniques of OFDM Signal over Satellite.
19. Design and Implementation of HEVC / H.265 Main Still Picture Profile.
20. Implementation and Performance Analysis of LDPC codes for DVB-S2X in Ka Band.
21. Automatic Water Level Monitoring & Flood Warning Generation & Dissemination System for Tajikistan.

Study & Design of SATCOM Network for Meteorological Data Acquisition & Dissemination

In order to understand our atmosphere and earth environment properly and to predict its immediate future, a large number of observations are necessary at frequent intervals. There are many meteorological and other parameters, which can only be satisfactorily measured in situ.

When the collection of data is required from a remote location or when the terrain is difficult to access, these systems become expensive or altogether impractical. Under such circumstances, only a satellite based systems offer a large range and reliability allowing the sensor link to become cost effective since it is independent of the distance from the central receive station. In these satellite data collection systems, a suitable instrument station measures physical parameters in situ and the satellite periodically collects the data.

A system for such a measurements namely Automatic Weather Station (AWS) can continuously record weather data like temperature, atmospheric pressure, wind speed and direction, rainfall relative humidity, solar radiation etc. It is a low cost, compact, modular, rugged system and capable of operating with minimum power from battery and solar panel for extended periods in field condition. Its features include easy programming of sensors, front panel display, archival of one-year data. A GPS integrated with AWS provides accurate time for transmission of data. Weather data from a large numbers of Automatic Weather Station located across the country could be collected through the Data Relay Transponder on board satellites. The weather information collected by AWS could be disseminated to various users through organization website and mobile app, radio and TV broadcasting using various terrestrial networks.

Within the topic of research, focus is on to study and design of satellite communication network using AWS in accordance with radio communication standards and technical requirements.

Study and Performance Analysis of DVB-S2X Based GEO Satellite in Q-Band

Exploration of higher spectrum bands has become essential to meet the demand of growing data rate and bandwidth. The GEO satellites operating at lower bands are already showing signs of spectrum saturation. In search of additional spectrum, the next option is the Q-band. As operating frequency is increased, the attenuation and scintillation effects of atmospheric gas, clouds and rain become more severe. On the other hand, the development of DVB-S2X standard has enabled to provide large capacity gains through efficiently using the spectrum.

The main aim of this project is to study the different channel impairments incurred while operating the GEO satellites in Q-band. Simulate the model in MATLAB, and analyse the results. Then, use DVB-S2X standard with different mitigation techniques, like different MODCODs, and analyse in MATLAB Simulink.

Finally, evaluate the total system capacity considering Adaptive Coding and Modulation which allows highest data rate instantaneously for a given link budget.

Design of Space Based AIS Receiver

The 'Automatic Identification System' (AIS) is a maritime safety system imposed on all ships by the 'International Maritime Organization' (IMO). AIS was primarily developed to provide ship's identification and location information to avoid collisions at sea. AIS follows SOTDMA (Self Organized TDMA)

access scheme, using frequencies in VHF band, with communications range typically 20 to 40 nm. AIS information can also be used by government/ security agencies to ensure effective surveillance in the oceans, for the purpose of national security. LEO satellites may be used to detect low power AIS signals, hence the term 'Space based AIS' is used. Satellite based AIS system has various technical challenges i.e. message collisions at satellite receiver, relatively high carrier Doppler, lower SNR and longer propagation channel delay, in view of large footprint area of the satellite.

Space Based AIS receiver system receives multiple messages from different SOTDMA cells in its 'Field of View'. The more cells that are in view, higher the chance of a message collision. My project work involves 'Study and Simulations' of AIS messages and their propagation impairments at the satellite receiver. In my dissertation work I will address the mitigation techniques for above propagation impairments and message collision avoidance. I shall also implement new frequency and message protocol (AIS 3/ Message 27)', allocated by ITU for AIS for better collision avoidance.

Design and Development of Ferrite Waveguide Switch

Ferrite switch is a very critical component used in Microwave radars to protect the sensitive receiver from any leakage which may come from the transmit path when the high power microwave energy is being transmitted to the antenna.

Between 1950 and 1965, there was a spate of intense activity to investigate the theory and applications of ferrite materials at microwave frequencies with an aim to realize passive nonreciprocal devices. Consisting of metallic oxides having a spinel structure and a general chemical formula XFe2O4, where X represents a bivalent metal such as magnesium, nickel or cobalt, the ferrites display an interesting microwave propagation characteristics. The high resistivity of the oxide components together with the ferromagnetic properties of the iron component classifies the ferrites as ferromagnetic dielectrics. Because of their high magnetic susceptance at low frequencies, the ferrites furnish a microwave medium whose properties may be varied over a large range, by magnetizing the ferrite with a controlled static magnetic field.

Ferrite switches are desirable due to their high reliability and low loss, as they contain no moving parts or thermal noise sources. Ferrite latching switches are functionally equivalent to conventional (fixed-bias) circulators, but with a selectable direction of circulation. RF energy can be routed with low insertion loss to either of two outputs, depending on the polarity of the control pulse. Hot switching is possible, as the ferrite switch will not be damaged by the application of power during a switching event, which is of the order of few µs. Once the control pulse is sent to the switch, it is latched to the selected state indefinitely, without the need for further commands or applied power.

Feasibility Study for Reconfigurable High Power Cavity Filters

The market driver of communication satellite industry is cost per bit. The cost of the satellites can be significantly brought down if the payloads are flexible with respect to coverage, power and frequency. Based upon the pre-defined application requirements, the transponder frequency and bandwidth is fixed during development phase itself by designing the input and output filters according to the specifications. Therefore, payload doesn't offer any flexibility of changing these parameters during its in-orbit service life.

Flexibility requirement becomes even more vital, especially, in cases of Satellite relocation (to meet ITU obligations to address interference related notifications), change of application(s), traffic flexibility between beams etc. Therefore, flexible payloads are receiving much attention in recent years owing to the increased need of changing the transmission characteristics of

satellite during in-service use. The solutions proposed in recent years are characterized by complex and difficult implementations in general, with an increased mass and volume with respect to non-reconfigurable counterparts. In this Pilot project, study and the feasibility of developing output filters that can be reconfigured on-board for both centre frequency and bandwidth in Ku-band. It can be further extended towards realising hardware and testing to prove the design and technology.

A new concept of on-board reconfigurable filters has been recently proposed, whose main feature is reduced overall volume (practically comparable to that of a fixed tuned filter), still offering a noticeable tuning range and limited unloaded Q degradation. These achievements have been obtained by using di-electric sliding rods as tuning elements for both cavities and coupling irises; moreover, rods are driven by electrically controlled stepper micro-motors. These concepts will be further improved and realised in Final M.Tech Dissertation.

High Frequency, High Efficiency Power Combiners using Spatial Combining Technique

There are many applications where combining of multiple RF channels are required. There are various techniques to achieve the same which can be used in Corporate Power Combining, Chain Coupled Power Combining, Radial Power Combining or Spatial Multiport Power Combining techniques. However, Spatial Power Combining (SPC) technique provides enhanced efficiency in comparison with other power combining techniques. In SPC, input sources are distributed in space and excite signal inside a specially designed space intended for power addition resulting in preferred high reduction in combining loss. It offers various other advantages like combining efficiency in spatial power combining technique and is independent of number of inputs at a particular frequency. Also, phase noise from amplifiers is uncorrelated, thus better output SNR is achieved.

Scope of this Project is to demonstrate power combining modules using a High Combining Efficiency, Spatial Multiport Power Divider and Combiner network at Q and W band. 4-way SPC at Q band will be designed in the initial phase of the project followed by design of 8-Way SPC at Q band and 4-Way SPC at W band in final phase of the project. The scope also includes learning different EM softwares like High Frequency Structure Simulator (HFSS) and CST etc.,

Q and W bands are potential candidates for future Satellite Communication applications, but have limitation in available power due to non-availability of suitable high power amplifier. The problem can be addressed by spatially combining multiple power modules coherently with increased power combining efficiency. Integrated modules can be used in future high frequency Q and W Band Payloads.

Design of Real Time River Monitoring System by VSAT

Water is an important natural resource which needs constant quality monitoring for ensuring its safe use. This study includes a river water flow & quality monitoring system based on wireless sensor networks. Many a time, the river passes through an inaccessible terrains and in situ monitoring of such data is still a challenge and requires substantial amount of efforts.

In this proposal we are proposing a VSAT system which helps in continuous and remote monitoring of the water quality data in India, especially of Transnational Rivers at critical locations. As these rivers can be used as a weapon by the enemy country, hence it's monitoring is important for the safety of country. To achieve this, we have to estimate the water parameters like flow rate, pH, dissolved oxygen, turbidity, conductivity etc, at first as the variations in these values and parameters point towards the presence of pollutants. At present, water parameters are detected by chemical test or laboratory test, where the testing equipments are stationary and samples are provided to testing equipments. Thus the current water quality monitoring

system is a manual system and is tedious process and very time consuming. In order to increase the frequency, testing equipments can be placed in the river water and detection of pollution can be made remotely.

So, it is proposed to have a Real Time Sensor-Based River Monitoring System which mainly comprises of a signal conditioning and processing, wireless communication and the power modules. The data collected by these sensors are processed & combined and then transmitted to Data monitoring station by using VSAT network, where the data can be displayed in visual format on a server PC and is also analysed with standard values and also a database can be created. If the obtained values are not within the threshold values, an automated warning system can generate an SMS alert to the local authorities. Aim of this project is to obtain the water monitoring system in real time and provide a better river monitoring parameters for critical locations.

System Study and Analysis of Signal Monitoring Satellite

Electromagnetic Interference (EMI) problems have been increasing with the proliferation of mobile electronic systems, wireless communication systems, and computer networks. As the numbers of sources are increasing exponentially, interference issues are also getting increased accordingly. Such interfering sources may completely disrupt the functioning of a desired link. Thus, there is a critical requirement to isolate the desired RF sources from the interfering RF sources.

Aim of this project is to study and analyze various sources of EM emissions which are distributed across the area of interest through a Signal Monitoring Satellite (SMS).

The project is planned to be executed in two stages wherein the first stage is to study the various types of RF sources, which can be monitored, along with its characteristics for implementing best suited identification techniques through Signal Monitoring Satellite. The study is limited to radar and communication links that are operating at 0.5 to 4 GHz frequency band. After the study and analysis of characteristics of interfering sources, orbit optimization of the ideal satellite will be determined in second stage of the pilot project. During this stage minimum receiver sensitivity, minimum antenna gain and receive antenna tilt requirements will also be evaluated through simulation. Proof of Concept model/ algorithms will be simulated/ implemented through Systems Tool Kit (STK) software and MATLAB software.

Network Design for Two Way Vessel Tracking System

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 2.5 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.

This project aims to develop a geostationary satellite-based network through which fishing boats can be tracked and monitored whilst at sea using ruggedized and marine grade terminals fitted in the boats.

The proposed network will allow the fishermen to send emergency messages as well as short text messages to the hub. The network will also feature limited voice calling facility between hub and user terminal as well as broadcast/ unicast of weather warning messages from the hub to terminals.

During the pilot project comparative study of TDMA and CDMA access schemes for selection of optimum access scheme, study of low bit rate voice codecs and satellite link budget calculations for the proposed network will be undertaken. In the subsequent stage, identification of efficient network protocols with better network management features, hub configuration and complete network design will be carried out. For the purpose of the project, parameters of a high power geo-stationary satellite have been considered for development of the network design.

System Study and Development for Second Generation Distress Personal Locator Beacon Transmitter for MEOSAR Satellites

International Cospas-Sarsat Program's existing Low Earth Orbit Search and Rescue (LEOSAR) and Geostationary Earth Orbit SAR (GEOSAR) satellites with first generation beacon will be coming to its end-of-life towards 2020. Presently, all distress beacon transmitters across the world are using first generation based beacon for operation. After 2020, the secondary payloads mounted on GPS, Galileo, and GLONASS satellites (MEOSAR) will operate with the second generation beacons for search and rescue operation.

Aim of this project is to study in detail the second generation 406MHz beacon standard along with its comparative study with the first generation beacon. The project proposes the system development for personal locator beacon (PLB) transmitter with incorporation of return link for acknowledgement which can be used for personal distress alert compatible with future MEOSAR satellites. The return link facility, which is a new in the second generation beacon will be realized and performance will be evaluated for fisherman.

Study and Design of Rural Communication Subnet & Govt. Private Subnet via SATCOM Network for Lao PDR

Rural communication has become one of the basic focuses of development in the developing countries. Lao PDR has several rural areas, where 70% of the population lives, deprived of basic ICT (Information & Communication technology) facilities. Further, nearly three-quarter of Lao PDR terrain is covered with mountains and forests. Therefore, Satellite communication network is most required for effective communication in this region. Government is working to connect the rural areas and to provide the basic ICT facilities through satellite. The government is also aiming to establish a satellite communications network in Laos for the delivery of integrated Communication services, data, voice and video to the rural communities.

In this project, Study and Design of Rural Communication Subnet to provide telephone services in the rural areas (Mobile backhaul) and Government Private Subnet to provide data, voice and video services between government departments and rural areas through Lao satellite will be carried.

In the first phase, the communication requirements will be analysed to bring out the different satellite parameters for the various network segments. In the second phase, the actual design and realization of the satellite network for Rural Communication Subnet and Government Private Subnet will be carried out.

Ka Band Satellite Network Planning for Mongolia

Ka band systems including HTS (High Throughput Satellites) bring larger bandwidths, more spot beams (referred to as high frequency reuses), higher throughputs and new gateway, payload designs that combined with the use of new ModCod techniques, as compared to the wider coverage areas and low frequency reuse of Ku-band payloads. Besides this, delivering on its promises of low cost, highly efficient communications, but demanding new and innovative capacity managements and planning that address the complex issues associated with Ka band or high capacity systems.

Currently in Mongolia, two satellites are being used for satellite communications: Intelsat 906 (@64E) in the C band and Apstar-5 (@138E) in the Ku or C band. A number of Mongolian organizations and companies are currently using these foreign communications satellites for various purposes. In order to meet high bandwidth demands of the modern users, we face some challenges in Ka-band satellite network planning and its usage.

This project will focus on planning a high speed broadband network in case of Mongolia by using Ka band satellite. First, we will introduce about the usage and demands of space technology in Mongolia. After that, we will discuss technical considerations for network planning, planning for space segment and ground segment. In the analysis, we will show Ka band capacity planning in case of Mongolia, using the "SatSoft" software and required link analysis/calculations. Finally, we will address broadly Ka band challenges and their mitigation techniques.

Analysis of Hybrid Terrestrial Mobile and Satellite Networks. Its Simulation of Propagation Effects for Mongolia

The aim of this project is, analysis of hybrid terrestrial and satellite network for Mongolia and study of propagation effects for Mongolian region. In this world, with growing use of smart devices, the load on the fixed and mobile terrestrial network is increasing rapidly to provide high bandwidth data services. But terrestrial networks are limited to some rural remote area and unreached region. The telecommunication networks of the future are believed to involve systems that will work on different technologies, such as Wi-Fi, WiMAX, 2G/3G, LTE, and satellite. In order to efficiently orchestrate the working of the different technologies, the idea of hybrid networks is being strongly considered.

Hybrid terrestrial/satellite network is important to achieve service portability and continuity across composite networks with ubiquitous access, involving any network, any technology and any domain.

In particular, the satellite network can provide the best and most economic coverage for low-density populations, while the terrestrial network or the ground component can provide the highest bandwidth and low cost coverage for high-density populations in urban environments.

The trend in near future will be a combination of terrestrial and satellite networks for global coverage.

Mongolia is a country having huge territory, but less population density and nomadic lifestyle. Therefore, the aim of this project work is to make analysis, simulation and development of hybrid and integrated terrestrial/satellite network for Mongolia.

The complete project is divided into two parts Pilot project and Final Project.

In the Pilot project, studies related to hybrid terrestrial and satellite network will be done. Link budget analysis, study of existing networks,

their limitations and solution to overcome these limitations will be taken up. Based on the studies, finalization of general architecture of hybrid network will be done. The studies related to propagation effects will also be carried out.

In final project, detailed architecture design and simulations of hybrid network for Mongolia will be carried out. It will also consist of detailed modelling of propagation effects over Mongolian region.

Hence, this project covers possible roles of the satellite component in hybrid terrestrial/satellite and full coverage of wide country to deliver advanced telecommunication services to low-density population and nomad civilization from anywhere, anytime even in remote areas of Mongolia.

Study and Implementation of JPEG2000 Image Compression Algorithm

This project involves the study and implementation of JPEG2000 standard and develop the software based JPEG2000 compression. JPEG2000 (JP2) is an image compression standard. The main compression technique used in JPEG200 is wavelet transform. Wavelet transform is a mathematical tool for performing signal analysis in wavelet domain. Wavelet transformation has a good time-frequency resolution. Common applications of wavelet transform include compression of speech, audio, image and video, etc., JPEG2000 was standardised by the Joint Photographic Experts Group committee in 2000 with the intention of improving their original discrete cosine transform-based JPEG standard (created in 1992) with wavelet-based methods. Besides a significant increase in compression performance of JPEG2000 compared over JPEG, the main advantage offered by JPEG2000 is the greater flexibility of the scalable coding system. The code stream of JPEG2000 offers different scalable streams such as spatial scalability, temporal scalability and SNR scalability. For this pilot project, discrete wavelet transform will be implemented on an image with optimum number of wavelet decomposition levels and applies a suitable quantization method and reconstructed image quality will be evaluated on PSNR and MOS scales.

In M.Tech dissertation, JPEG2000 standard will be implemented in software with all features and different scalable streams. The decoder algorithm will also be implemented in software and reconstructed image will be evaluated for both subjective and objective quality.

Design and Implementation of Transmission Chain for Personal Locator Beacon for Fisherman

This project addresses the principle and design aspects of Personal Locator Beacon (PLB) for the protection of fisherman in distress in sea. PLB is carried on the body by user or person and transmits a signal when the person is in distress. This signal is used to provide an alert and facilitate location of the person by COSPAS-SARSAT, the international satellite-based search-and-rescue detection and distribution system. The beacons associated with the COSPAS-SARSAT program only operate in the 406.0 MHz to 406.1 MHz frequency band to transmit their digital messages to satellites. This frequency is restricted in the International Telecommunication Union (ITU) Radio Regulations to low power satellite emergency position-indicating beacons in the mobile satellite service.

In this project, the transmission portion of a 406 MHz COSPAS-SARSAT personal locator beacon has been designed by using AX8052F143 Ultra Low Power Advanced Narrow band RF microcontroller. The requirements and design trade-offs of the AX8052F143 based UHF Transmitter has been analysed especially in Oscillator, User Interfaces, Power Amplifier, Antenna and power supply system and then implemented on hardware.

60 Channel Digital Trans multiplexer: Algorithm Design Simulation and Verification

Transmultiplexer (TMUX) design is one of the important subsystem in multi-user communications systems. It is traditionally used for conversion between time-division multiplexing format (TDM) to frequency-division multiplexing (FDM) format. This project focuses on the design of near perfect reconstruction transmultiplexer systems based on cosine-modulated filter banks. Under the same scheme of cosine-modulation, the mathematical derivation of equations for multi-channel transmultiplexer systems are derived, however the main difference is the prototype filter. This approach uses an all-real, one-stage, filtering scheme and fast discrete cosine transforms. The algorithms will be simulated and verified in the MATLAB for the implementation of a prototype 60 channel transmultiplexer. A comparative analysis and verification is included to confirm the validity of the theory.

Study and Design of Digital Radio Broadcasting System for Radio Nepal

Nepal is a land-locked and hilly country with diverse topology located on the southern part of the Asia. Today, we are in the verge of a revolution in radio broadcasting since digital radio Broadcasting is just around the corner. This new Digital Radio Broadcasting Service will ultimately replace the current analog modulation (AM) and Frequency Modulation (FM) radio services that have filled the audio broadcasting since the 1920s for AM and the 60s for FM. Due to the advancement of digital technology and smart hardware devices, people want enhancement in infotainment along with stereo quality of sound or 5.1 surround sound in AM, FM broadcasting. Nowadays the frequency spectrum is scarce resource. With new digital radio broadcasts, it should be possible to broadcast more number of programs using one frequency. This is only possible by moving towards the digital broadcasting.

Therefore, this project focus on the new world-wide radio broadcast specifications called Digital Radio Mondiale (DRM) for the long, medium and short wave bands in Nepal. The goal of this pilot project is to develop a flexible and efficient audio and data broadcasting with DRM. Better sound quality and more reliable reception in combination with additional service information make DRM a promising successor to analogue AM/FM. Also broadcasting the warning/alert messages for the people in emergency/disaster situations is the most preferred option in this new standard.

Thus, this project is intended to study & design overview of the system architecture, including the components for multiplexing, modulation, source coding and channel coding. The feasibility to establish network of the digital radio broadcasting using Digital Radio Mondiale (DRM) standard in Nepal using existing frequency band in effective manner is explored.

Study and Simulation of PAPR Reduction Techniques of OFDM Signal over Satellite

The Satellite applications has been emerging from fixed services to mobile services. The Geosynchronous Satellite Orbit (GSO) as well as Non-Geosynchronous Satellite Orbit (NGSO) network are promising to provide satellite based multimedia services and Internet based applications through Mobile Satellite Services (MSS). These applications demand much spectral efficient bandwidth for which the conventional multiplexing techniques can not fulfilled in mobile environment. Orthogonal Frequency Division

Multiplexing (OFDM) can be a viable solution which use orthogonal subcarriers for data transmission with efficient usage of available spectrum. OFDM signal has ability to combat the problem arises due to varying multipath distortion as well as inter-symbol interference (ISI).

Although OFDM is attractive in mobile multimedia communication over satellite, it bears a limitation called Peak to Average Power Ration (PAPR) which may reduce the gain that can be achieved by OFDM signal. PAPR can cause the transmitter's power amplifier to run within a non-linear operating region. The main objective of this pilot project is to study the comparative analysis of different approaches that can reduce PAPR generated by OFDM Signal and study for simulation of end to end transmitter-channel-receiver model for performance of OFDM signal with various modulation schemes.

Design and Implementation of HEVC / H.265 Main Still Picture Profile

Due to the ever increasing demand for high quality video content and increasing higher and higher spatial resolutions, the Joint Collaborative Team on Video Coding (JCT-VC) reviewed the previous coding standard, H.264/Advanced Video Coding (AVC). The result of which is the H.265/High Efficiency Video Coding (HEVC) standard. The HEVC improves the H.264 by an amount of 50% reduction in bit rate at the same video quality.

This project addresses the Design, Analysis and Implementation of an HEVC/H.265 Main Still Picture Profile with emphasis on Entropy Coder. HEVC uses the Context Adaptive Binary Arithmetic Coding (CABAC) for entropy coding.

The pilot project primarily involves the study, design and implementation of Binary Arithmetic Encoder and Decoder. Later, the dissertation project will address the study and implementation of Main Still Picture Profile of H.265/HEVC. In particular, CABAC will be implemented for better throughput speed in parallel-processing Architectures, compression performance and to reduce its context memory requirements and improvements.

Implementation and Performance Analysis of LDPC codes for DVB-S2X in Ka Band

Error correction is a vital requirement for communication systems to increase the throughput with less signal power. LDPC (Low Density Parity Check) is a channel coding technique that improves the end-to-end reliable data transmission over a noisy channel and provides performance, which is very close to the Shannon limit. Hence LDPC codes have been adopted by many communication standards including DVB-S2/S2x (Digital Video Broadcasting-Satellite). DVB-S2X is an extension of the DVB-S2 standard that provides improved performance. DVB-S2X mainly introduces additional elements such as different roll-off options, finer gradation and extension of number of modulations and coding modes etc.

The propagation of Ka-band (27GHz - 40 GHz) is more affected by weather impairments (rain fade) than lower frequencies bands such as Ku band and C band. However, with the growing bandwidth requirements, it is envisaged that future satellite communication systems will adopt Ka-band. Hence, a suitable and efficient channel coding techniques need to incorporated in Ka-Band communication.

This research is focused on LDPC coding techniques, improvements, comparative study and performance evolution for DVB-S2x standard. In the pilot project, the encoding and decoding of LDPC codes will be carried out and BER performance evaluation in AWGN noise will be accomplished.

Automatic Water Level Monitoring & Flood Warning Generation & Dissemination System for Tajikistan

Due of the abnormal heat that is observed in Tajikistan, melting of glaciers is increasing in mountainous areas. This, in turn, causes mudslides and floods, as well as rising water levels on the rivers of the country.

Residents of many areas of Tajikistan are awfully waiting for the spring, which brings with it not only the awakening of nature, but also mudflows and floods. As a result of the descent of mudflows, it is covered with stones and mud with a mass, as a result, roads, power lines, houses are destroyed, and the people themselves will suffer. This is the situation in all regions of Tajikistan. Observations in rivers, lakes and other types of water resources are observed manually. This, in turn, makes it impossible to measure water resources in hard-to-reach places where there is no communication to transmit information to the Data Collection Center. The measurement of water levels can be divided into 2 groups: Imaging and Non-imaging radar.

The main purpose of this project is to use Non Imaging Radar over river (bridge/tower) where water flows. Study and Design of data transfer techniques by VSAT to satellite and from satellite to Gateway (Agency of Hydrometeorology Republic of Tajikistan) will be addressed. This in turn will provide an opportunity to establish radars in those places where there is no mobile communication or any other terrestrial communications.

Collect all data at the Data Collection Center and, as far as possible, share the data with the other countries in real time, where the water flows from Tajikistan to other neighboring countries. First of all, this observation will allow the Hydrologists to observe, analyze and predict the approach of danger on the basis of our observations and prevent floods

Project Abstracts of 2nd Post Graduate Course in Global Navigation Satellite Systems

1. Survey Grade Positioning Receiver Using Code Phase
2. Time Dependent Static Observation and its Variability
3. Design & Development for Improving the Time to First Fix for GNSS Systems
4. Software Based GNSS Receiver Development
5. Effect of Ionospheric Perturbations on IRNSS Receivers at Sea
6. Acquisition &Tracking Strategies for Open Service BPSK(R) & BOC Modulated GNSS Signals Using MATLAB
7. Anti-Spoofing Techniques in GNSS
8. Timing Applications of GNSS
9. Study & Analysis of Time Synchronization for Fiber Optic Network
10. Study & Monitoring of Ionospheric Variation in Mongolian Region Using GNSS
11. Estimation of Regional Geoid Model with Different Spectral Combinations and Implementation in GNSS Receivers for Improved Vertical Accuracy
12. Monitoring Water Parameters of River Using Satellite Remote Sensing and GNSS in Tajikistan

Survey Grade Positioning Receiver Using Code Phase

Survey of Bangladesh is the national surveying and mapping organization of Bangladesh. For the surveying and mapping, the position need to be determined within a few centimetres or millimetres is required. Survey Grade positioning receiver which refers to real time kinematic (RTK) receiver works as a stop and go method where the coordinates of points are available in real time. In this method there should be a base receiver and the rover and in between the base and rover there should be a radio communication link. The base receiver will provide the measurements to rover that computes its position and display the coordinates. The receiver position can be estimated with centimetre level precision once the unknown phase ambiguities can be determined to their correct integer cycles. Now a day CORS (Continuously Operating Reference Station) is used as the reference station of network based survey grade positioning receiver. High accuracy positioning with GPS are mostly required for surveying and mapping.

Survey of Bangladesh is preparing Digital topographical and thematic maps of different scales by using aerial photograph and satellite imagery. GPS is used in all kinds of maps. We have six permanent GNSS-CORS stations in six divisional cities and also have a proposal to increase the stations. The pilot project will help me to find out accurate positioning by the practical knowledge.

Time Dependent Static Observation & its Variability

Static GPS survey technique is the most reliable technique applied for establishment of permanent reference stations and GPS network for various precise applications. The present work aims to study the Time dependent Static Observation & its Variability on GPS accuracy. At this study, the field experimental work will be carried out according to the static DGPS technique observing for different time period (1-24 hours) for reference establishment. The static observation for rover establishment will be collected in multiple epoch intervals (1 - 60 seconds). The present work will assess the accuracy performance of the reference station in respect of the different time interval with respect to precise ephemeris and IGS stations. The rover accuracies will be estimated using base stations in different epoch interval. This study will propose the base for setting observation criteria for the required accuracy.

Design and Development for Improving the Time to First Fix for GNSS Systems

Amongst GNSS receiver design criteria such as accuracy, sensitivity, channels etc., the Time to First Fix (TTFF) is an important criterion, which defines how fast a navigation solution is available to the user since receiver power on. TTFF is defined as the time that a receiver takes to acquire and track a minimum of four satellites and extract the necessary information from the demodulated navigation data bits. There are various applications which required less TTFF especially in defenceapplications. This project is mainly about study of factors and existing techniques which affects TTFF and tries to improve it.

Software Based GNSS Receiver Development

The GNSS(Global Navigation Satellite Systems) is one of the fast emerging fields and has an wide range of civilian as well as military applications which includes mobiles, transport (rail, road, air), surveying, agriculture and many more. The basic requirement for the use of GNSS is to have a receiver that determines the user position, velocity, and precise time (PVT) by processing the signals broadcasted by GNSS satellites. Because the satellites are always in motion, the receiver has to continuously acquire and track the signals from the satellites in view, in order to compute an uninterrupted solution. So, the pilot project aims at the acquisition, tracking of a single GNSS (GPS/NAVIC) satellite SPS signal.

The project will be further extended for tracking and acquisition of SPS signals from different satellites in view and determines the user position, velocity and time. Also the project make study of the various parameters such as accuracy, resistance to multipath, cost etc. that are vital in receiver development for various applications.

Effect of Ionospheric Perturbations on IRNSS Receivers at Sea

Indian Regional Navigation Satellite System (IRNSS) is an independent regional navigation satellite system being developed by India. It is designed to provide accurate position information service to users in India as well as the region extending up to 1500 km from its boundary, which is its primary service area. An Extended Service Area lies between primary service area and area enclosed by the rectangle from Latitude 30 degreesouth to 50 degree North, Longitude 30 degreeeast to 130 degreeeast. The IRNSS System is expected to provide a position accuracy of better than 20m in the primary service area with more than 95% of confidence. However, the performance of these receivers is sensitive to the ionospheric conditions. Particularly, during the perturbed condition of the ionosphere, the performance shows an abrupt degradation compared to that during the nominal condition.

This pilot project is aimed at studying the effect of equatorial ionospheric perturbations on IRNSS receivers, particularly in terms of its accuracy and continuity. The study would include, but not limited to the following aspects of an IRNSS receiver at sea, specifically during perturbed ionosphere.

(a) Aspects of Ionosphere grid corrections.

(b) Availability and continuity, particularly at the fringes of service area.

(c) Mitigation techniques or improvement factors.

The pilot project will be based on real data as well as on simulated data of IRNSS simulators available at SAC, Ahmadabad.

Acquisition and Tracking Strategies for Open Service BPSK (R) & BOC Modulated GNSS Signals using MATLAB

Multiple GNSS systems have evolved globally which provide navigation solutions globally/regionally. The basic modulation scheme used in GNSS signal is Binary Phase Shift Key (BPSK), however, the Binary Offset Modulation (BOC) has enabled the use of same legacy frequency for transmission of different navigation signals on the same frequency. Almost all the GNSS constellations (GPS, GALILEO etc.) use either or both the modulation schemes including the Indian Regional Navigation Satellite

System (NaVIC) by ISRO.

Acquisition process involves finding the GNSS signal after it has experienced delay in code-phase and Doppler while travelling in space. The initial task of any GNSS receiver is to acquire and identify the signal by comparing it with replica of code and carrier generated locally. Classical acquisition involves different techniques like serial search, parallel frequency search and parallel code phase search. After successful acquisition of the signal, the tracking loops take over the task of tracking the acquired signal from particular satellite. Usually receivers are implemented with multiple channels for simultaneous tracking of multiple SVs for achieving PVT calculations. The characterisation of various parameters for tracking loops (loop bandwidth, dampening ratio, integration time and early-late chip spacing) is of great importance as these determine the suitability of the receiver for particular application.

The scope of the project includes generation of simulated GNSS (BPSK & BOC) open service signals. The scope also includes implementation of different acquisition strategies such as serial search, parallel frequency and parallel code phase search. Study the effect of performance due to variation in code and carrier tracking loop parameters. Analyse acquisition and tracking of BOC modulated open service signals for development of future GNSS modulation schemes.

Anti Spoofing Techniques in GNSS

With the development of GNSS, the position, navigation and time (PNT) services, provided by GNSS, have a large influence in our daily life. Nowadays, various applications such as aircraft navigation and landing systems, electrical power distribution grids, digital communication networks, stock exchange transactions, police and rescue services and many more are relying on GNSS signals. With the increased use of GNSS, the security of these services is becoming more and more important. However, as the signals become extremely weak when they reach the earth, they are vulnerable to interference. In addition, because the working frequency band, the modulation type, the civilian pseudo-random noise (PRN) codes and data information are public, GNSS signals can be easily forged. These counterfeit signals are termed as spoofing interference. Among all the types of interference, spoofing is most harmful, because it can fool the target receiver into reporting wrong position or time results without perception, which may lead to serious consequences. As such, anti-spoofing techniques have become a hot research topic within the GNSS discipline.

The aim of this project is to provide a review of recent research in the field of GNSS anti-spoofing techniques on the receiver side. The vulnerability of GNSS receivers to spoofing attacks is studied, and the anti-spoofing algorithms around the base band digital signal processing layer and the information processing layer of the receiver are discussed. The limitation, cost and applicability of these anti-spoofing methods are investigated and the trend of anti-spoofing research in the future is analysed.

Timing Applications of GNSS

Typically applications for timing use GPS as a precise, traceable, high availability, and free traceable source of synchronization. Heart of satellite based navigation system is timing by precise clocks. In Global Navigation Satellite System (GNSS,) mainly consisting of GPS, GLONASS, Galileo and Beiduo, timing plays a vital role also. Coordination of the time scales of all these systems are very important for the optimum utilization of GNSS. It has some stringent requirements. Coordination among different constellations is also a serious issue.

Study & Analysis of Time Synchronization for Fiber Optic Network

Time synchronization is to be maintained within any network, be it Power grid maintenance, banking environment or be it any terrestrial network. Effective time synchronization is very important, especially where multiple events are taking place in the network. For example, in a client-server system, one server is interacting with many clients, forming a huge network, many tasks need to be performed. This involves time-stamping to mark the execution of events which may not be accurate enough owing to the constantly varying drift between the computer clocks. So the goal here is to obtain as much accurate values as one can with respect to real time signals. It is important to pre-schedule the events and sort them in sequence to meet the required targets. Time needs to be synchronized, whether a wired or wireless network, in order to attain optimal stability.

Today's high speed optical networks are expanding to meet continuously growing demand for data capacity. The optical network products include high performance modulator/ demodulator along with clock and data recovery circuits operating up-to 100 Gbps and beyond. Synchronization between network nodes is very much required to ensure that data streams are received and transmitted correctly to prevent data collision. As data rates are increasing and Modems are working at higher speed, obviously network synchronization is required to achieve within nanoseconds accuracy.

As it is also known that, it is impossible to control the clocks since they are continuously drifting apart in time. This may be due to voltage fluctuations, temperature and other environmental factors. Adding on, the drift may be positive or negative. Similarly clocks always have some offset too with respect to real time. All these factors, in effect limit the possibility of secure and reliable communication within a network. Taking these factors into account, synchronizing time especially in complex networks is a matter of major concern.

There are different methods of Time synchronization. Now in this Pilot Project, detailed study and analysis will be done regarding how GNSS can help in Time synchronization of such high speed communication networks and also how the time derived from GNSS will be distributed to all the clients of network via different processes.

Study and Monitoring of Ionospheric Variation in Mongolian Region using GNSS

The Global Navigation Satellite System (GNSS) involves satellite, ground stations and user equipment all around the world. In today's scenario the Global Positioning Systems (GPS) of the United States of America and The Russian GlobalNavigation Satellite System (GLONASS) are the fully operational global navigation satellite system. Other countries with their regional satellite system like China's COMPASS and Beidou, European navigation satellite system GALILEO, IRNSS of Indian, QZSS of japan are under development and these are for GNSS.

Ionospheric disturbances constitute animportantlimiting factor which influence the precise positioning using global positioning system (GPS) measurements. Simultaneously, GPS observations are widely used to determine ionospheric disturbances with total electron content (TEC).

We setup a local GNSS Data Centre for Mongolian Academy of Sciences to receive, quality control and process the observation data coming from the recording stationscontinuously.

In this project, Study and Monitoring of ionospheric variation in Mongolian capital city and surrounding regionsusing continuous GNSS (ULAB station data) observations will be carried out at the Astronomical Observatory of Mongolia.

Estimation of Regional Geoid Model with Different Spectral Combinations and Implementation in GNSS Receivers, for Improved Vertical Accuracy

In present, GNSS is widely used for surveying purposes. A problem arises while taking orthometric heights which are more meaningful and physical. The orthometric height of a point is the distance H along a plumb line from the point to the geoid and it is generally known as "height above MSL ". It can be useful for all levelling works in surveying field. GNSS receivers give Z coordinates with respect to WGS84 which has only a mathematical meaning. If the geoid undulation is known orthometric height can be derived directly which has a physical meaning. The geoid undulations due to long wavelength gravity field variations are estimated by a global geopotential model (GGM), and the high frequency components are obtained through a regional topographic model. The remaining medium to short wavelength features of geoid undulations are estimates by stokes or Molodensky based approaches using gravity measurements. The requirement of dense and homogeneous gravity measurements is omitted by using the method called combined geoid determination. Objectives of this study are, Local Geoid determination for the area of interest using Earth Gravitational Model (EGM) 2008 and Shutter Radar Topographic Mission (SRTM) data using residual terrain modelling method. Estimation of a mathematical model so that values can be applicable throughout the terrain. Implementing above derived model in GNSS receivers and compare the improvement in vertical resolution.

Monitoring Water Parameters of River using Satellite Remote Sensing and GNSS in Tajikistan

Monitoring water level of rivers has become essential for studying the effects of global climate change and increasing population pressure on the fresh water resources. The traditional method of monitoring river water parameter is to use water level gauges or using positioning techniques. The traditional method to estimate water parameters is to carry field experiment using DGPS (static and kinematic mode) and process the dataset. But, non-availability of measuring instruments at desired locations imposes a serious constraints on basin scale hydrology study.

Moreover, during flood events these parameters are difficult to measure and sometimes gauging stations wiped out completely. Further, satellite remote sensing or altimetry can't provide water level information in real time. In case of floods and natural disasters, water level information in rivers and reservoirs etc., are highly required to be monitored in real time for corrective actions.

The purpose of this project is to study the GPS receiver and Satellite Remote Sensing data warning systems (Saral and Radar satellite altimeter) and analysing the data using Broadview Radar Altimetry Toolbox (BRAT) software to measure the water level, and width of the rivers.

In the Final project, the pilot project will be extended for developing the satellite based technology, in addition to the existing methodology for improving the current understanding of the available water resources and it proper dissemination

Meeting of CSSTEAP Governing Board

The 23rd meeting of CSSTEAP Governing Board (GB) was held at DOS Branch Secretariat, New Delhi on December 10, 2018. The meeting was chaired by Dr. K. Sivan, Chairman CSSTEAP GB and Secretary, Department of Space, Govt. of India and was participated by all the GB member and invited participants. The GB members included Mr. Shamsuddin Ahmed (Bangladesh), Prof. Dr. Erna Sri Adiningsih (Indonesia), Mrs. Annisa A Sophiany (Indonesia), Mr. Sergey Salvelyev (Kazakhstan), Prof. Abdykalykov Akymbek Abdykalykovich (Kyrgyz Republic), Mr. Ulugbeg Begaliev (Kyrgyz Republic), H.E DatoHidayat Abdul Hamid (Malaysia), Mr. Muhammad Azfar Abdullah (Malaysia), Mr. Hari Odari (Nepal), Mr. Charan Kamal Singh Bhalla (Nauru), Mr. Edwin Juan A Batalloves(Philippines),Dr.AnondSnidvongs (Thailand), Dr. ShirishRavan (UNOOSA, Vienna), Prof. Dr. Ir. A. (Tom) Veldkamp (ITC, Netherlands), Mrs. B.A.J Leurink (ITC, Netherlands), Mr. T.M. Loran (ITC, Netherlands), Dr. A Senthil Kumar (India). Other Participants included Dr. Anil Bhardwaj, Dr. Prakash Chauhan, Shri Shantanu Bhatawdekar, Mrs. Shankari Murali, Dr. D. Gowrisankar, Dr. S.P. Aggarwal, Mr. Imtiaz Ali, Dr. P. Murugan, Dr. K.R. Manjunath, Dr. Baby Simon, Dr. J. Banerji, Mr. C.M. Bhatt, Mr. Shashi Kumar, Sri Rajender Katariya, Mr. Krishan Gopal, Mr. Ashish Kumar Gupta & Associates and Mr. Mahendra Singh from India.

Dr. A. Senthil Kumar, Director, CSSTEAP welcomed the members and special invitees to the 23rd meeting of the CSSTEAP-GB. He mentioned that CSSTEAP is performing extremely well and established itself as a Centre of excellence with the support and guidance from GB members.

Dr. K. Sivan, Chairman, CSSTEAP-GB welcomed all the GB members, observers and special invitees to the GB meeting. He expressed his satisfaction on the commendable growth of the Centre in all spheres of activities related to capacity building in Asia Pacific region, under the able guidance of learned GB members. He expressed his extreme gratification that the Centre has completed 23 glorious years of commendable service of capacity building in Asia Pacific region. The chairman also commended the centre for the different short and long term courses in the different fields of space sciences.

Dr. A. Senthil Kumar, Director, CSSTEAP also mentioned that till date the centre has conducted 55 PG courses 22 in Remote Sensing & Geographic Information System (RS & GIS), 11 in Satellite Communications (SATCOM), 10 in Satellite Meteorology and Global Climate (SATMET), 10 in Space and Atmospheric Sciences(SAS) as well as 02 Global Navigation Satellite Systems. The Centre has also conducted successfully several short courses and workshops in past 23 years. These programmes have benefitted 2040 participants from 36 countries from Asia-Pacific and 19 countries from outside Asia-Pacific region. PG courses have benefited 916 participants while short courses have benefited 1124 participants. Director, CSSTEAP also apprised that till date 158 participants from 16 countries have been awarded M.Tech Degree in 4 disciplines (76 participants in RS & GIS; 41 in SATCOM; 20 in SATMET and 21 participants in Space Science). He informed that during the year 2017-2018, a total of 8 participants (3 in RS & GIS, 2 in SATCOM, 1 in SATMET and 2 in SAS) who were awarded M. Tech degree.

Dr. K. Sivan, Chairman, ISRO/Secretary Department of Space and present Chairman CSSTEAP Governing Board during the 23rd GB meeting at Delhi

Support to UN Activities by CSSTEAP

Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) supported the regional training and workshop for South Asian countries organized by the United Office for Outer Space Affairs (UNOOSA), through its UN-SPIDER programme, and the Disaster Management Centre of the South Asia Association for Regional Cooperation (SAARC DMC) on the "Utilization of Space-based and Geospatial Information for Achieving the Targets of the Sendai Framework for Disaster Risk Reduction" from 4 to 8 December in Ahmedabad, India. The one-day workshop and four-day training enhanced cooperation and sharing of best practices amongst disaster management agencies and experts in the South Asia region. About 30 officials from SAARC member countries representing key institutions involved in disaster risk reduction and emergency response participated in the program. The objective of the training program was to make participants aware of advances in Earth observation and geospatial technologies for disaster risk reduction and emergency response, especially for implementing Sendai Framework for Disaster Risk Reduction. Resource person from CSSTEAP, IIRS Dehradun highlighted the capacity building opportunities in the region for utilization of space based and geospatial information in disaster management to the South Asian countries through various long and short duration programs being conducted by CSSTEAP and IIRS. In addition to the sessions taken on EO data for Rapid response mapping and hands-on sessions to open source data portals and online data repositories access for flood disaster management.

Interaction Meeting with the GB and Non GB Members New Delhi: 11th May 2018

In reference to Action Item 22/6 "To organize an outreach program at New Delhi", identified during the 22nd Meeting of the CSSTEAP Governing Board held at Bengaluru on November 15, 2017. Interaction meeting with the GB Member and Non GB Member nations was organized at New Delhi on May 11, 2018. The meeting was attended by 24 members. Dr. A. Senthil Kumar, Director, CSSTEAP welcomed all the delegates from the GB Member & Non GB Member countries and other special invitees participating in the interaction meeting. Dr. Shirish Ravan, Senior Program Officer, UNOOSA appreciated the efforts of CSSTEAP in organizing the Interaction Meeting to familiarize about the CSSTEAP activities. He expressed his faith that this meet will help in popularizing CSSTEAP capacity building program. He also insisted to host the meeting before announcement of CSSTEAP program annually.

Important Visits to CSSTEAP

Chairman ISRO, Dr. K Sivan: 25th March, 2018

Chairman, ISRO interacting Interacting with CSSTEAP participants

Group photo with CSSTEAP participants

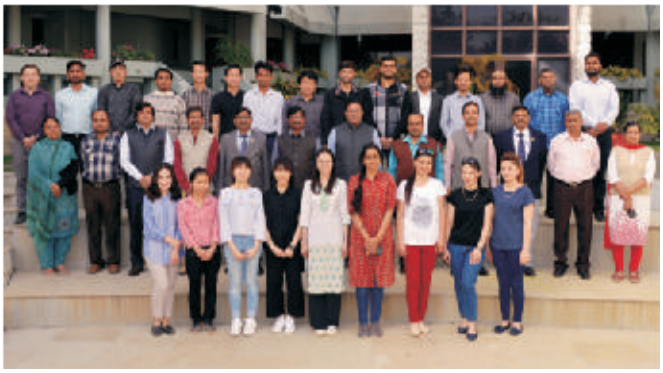
H.E. (Mrs) Ma. Teresita C. Daza, Ambassador, Embassy of Republic of Philippines, New Delhi: 4th May, 2018

H.E. (Mrs) Ma. Teresita C. Daza, Ambassador, Embassy of Republic of Philippines meeting with CSSTEAP/IIRS officials

Visiting satellite exhibition

Dr. George Joseph (Honorary Distinguished Professor) (ISRO): 17th July, 2018

Dr. George Joseph delivering lecture to CSSTEAP participants



Group photo with CSSTEAP participants

Special Guest Lectures Delivered at CSSTEAP

- "Science of Remote Sensing" - Dr. George Joseph (Honorary Distinguished Professor (ISRO). 17th July, 2018
- "Space Law"- Dr. V. Gopalakrishnan, Asso. Director, Policies, ISRO, 27th October, 2018
- "Overview of SDGs" - Dr. Shirish, Senior Programme Officer United Nations Office for Outer Space Affairs (UNOOSA), 8th October, 2018
- "Earth Observations & Early Warning Systems" Dr. R.R. Navalgund, Prof. Vikram Sarabhai Distinguish Professor, ISRO, 31st May, 2018
- "Building space applications capacity for achieving the Sendai targets related to disaster risk reduction" Sanjay K Srivastava, Chief, Disaster Risk Reduction, United Nations Economic and Social Commission for Asia and the Pacific, 14th June, 2018

RECENT LAUNCHES

PSLV-C43/HysIS

PSLV-C43 lifted off at 0957 hrs (IST) on November 29, 2018 from the First Launch Pad (FLP) of Satish Dhawan Space Centre SHAR, Sriharikota and successfully launched India's Hyper spectral Imaging Satellite (HysIS) and 30 international co-passenger satellites.

Polar Satellite Launch Vehicle (PSLV) is a four stage launch vehicle with alternating solid and liquid stages. PSLV-C43 is the Core Alone version of PSLV, without the six strap-ons.

HysIS, the primary satellite of PSLV-C43 mission, weighing about 380 kg, is an earth observation satellite configured around ISRO's Mini Satellite-2 (IMS-2) bus. The primary goal of HysIS is to study the earth's surface in the visible, near infrared and shortwave infrared regions of the electromagnetic spectrum. HysIS will be placed in 636 km polar Sun Synchronous Orbit (SSO) and the co-passenger satellites will be placed in 504 km polar SSO after restarting the fourth stage of PSLV (PS4) engines twice. The co-passengers of HysIS include 1 Micro and 29 Nano satellites from 8 different countries. These satellites have been commercially contracted for launch through Antrix Corporation Limited, the commercial arm of ISRO.

This is the 13th mission using PSLV-Core Alone variant. The satellites carried onboard will be injected into two different orbits.

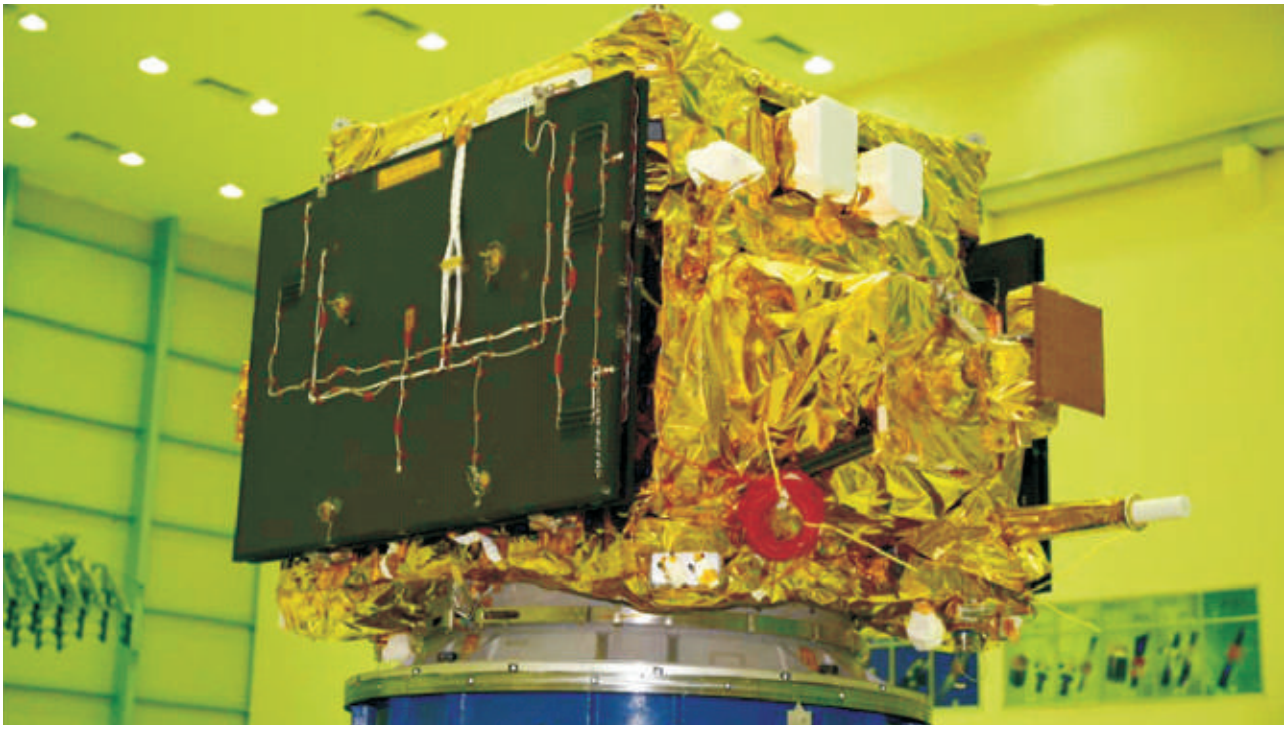
Major specifications

Mass ~380 kg Overall Size 2.158 m x 1.386 m x 1.121 m in Stowed Configuration Payload Hyperspectral Imager in VNIR and SWIR bands Power 730 W, 64 Ah Li-Ion battery

International Co-passenger Satellites

The co-passengers of HysIS include 1 Micro and 29 Nano satellites from 8 different countries. The total weight of 30 co-passenger satellites is 261.5 kg. All these satellites will be placed in a 504 km orbit by PSLV-C43. These satellites have been commercially contracted for launch through Antrix Corporation Limited, the commercial arm of ISRO.

Country	No. of Satellites
Australia	1
Canada	1
Columbia	1
Finland	1
Malaysia	1
Netherlands	1
Spain	1
United States of America (USA)	23



Glimpses of student activities at CSSTEAP

CSSTEAP Students Playing Snooker

Students in Gym at IIRS, Dehradun

Students in Library

Independence Day Celebration

Attending IIRS Academia Meet 2019

Celebrating Birthday

Demonstration of live satellite pass at NRSC Earth

Tug of War

At Canteen

Celebration Diwali

Celbrating the Festival of Dipawali

Participants Celebrating Eid-ul-Fitr

Ongoing Courses

23rd Post Graduate course on Remote Sensing & Geographical Information System (RS&GIS)	9 Months	1st July 2018 to 31st March 2019
11th Satellite Meteorology & Global Climate	9 Months	1st August 2018 to 30th April 2019
11th Space & Atmosphere Science (SAS)	9 Months	1st August 2018 to 30th April 2019
11th Post Graduate course on Satellite Communication (SATCOM)	9 Months	1st August 2017 to 30th April 2018

Future Courses

SHORT COURSES		
DRR Course (IIRS)	2 Weeks	May 20 to May 31, 2019
Webinar (CSSTEAP/UN/CEOS)	2 Weeks	April-August, 2019
NAVSAT Course (SAC)	2 Weeks	May-June, 2019 (To be decided)
Weather forecasting using NWP models (SAC)	2 Weeks	July 01 to July 12, 2019
Space Weather Courses (PRL)	2 Weeks	July-Oct, 2019 (To be decided)
Small Satellite Mission (IIRS/URSC)	2 Weeks	Oct, 2019
PG COURSES		
24th RS&GIS PG Course	9 Months	July 01, 2019 to March 31, 2020
12th SATCOM PG Course	9 Months	August 01, 2019 to April 30, 2020
3rd GNSS PG Course	9 Months	August 01, 2019 to April 30, 2020

EDITORIAL COMMITTEE

CSSTEAP Headquarter, IIRS Campus, 4, Kalidas Road, Dehradun 248001, INDIA.
Ph: 91-135 2740737, 2740787, Fax:+91-135-2740785
E-Mail: cssteap@iirs.gov.in, Website: www.cssteap.org

CSSTEAP Headquarters

IIRS Campus, 4, Kalidas Road, Dehradun-248 001, INDIA
Ph: 91-135- 2740737, 2740787, Fax: +91 - 135 - 2740785
E-mail: cssteap@iirs.gov.in, Website: www.cssteap,org

Printed at **Allied Printers**, Dehradun. 0135-2654505