CENTRE FOR SPACE SCIENCE AND TECHNOLOGY EDUCATION IN ASIA AND THE PACIFIC

(AFFILIATED TO THE UNITED NATIONS)

MEMOIRS

Twenty Fourth Post Graduate Course in Remote Sensing & Geographic Information System 2019 - 2020

Conducted at

Indian Institute of Remote Sensing (IIRS)

Indian Space Research Organisation

Dehradun, India

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CENTRE FOR SPACE SCIENCE AND TECHNOLOGY
EDUCATION IN ASIA AND THE PACIFIC (CSSTEAP)
(AFFILIATED TO THE UNITED NATIONS)

MEMOIRS

TWENTY FOURTH POST GRADUATE COURSE IN REMOTE SENSING &
GEOGRAPHIC INFORMATION SYSTEM
JULY 2019 TO MARCH 2020

Conducted at

Indian Institute of Remote Sensing (IIRS)
Indian Space Research Organisation (ISRO)
Dehradun, India

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Governing Board Members and Special Invitees during 24th Governing Board Meeting
at ISRO Hqrs, Bengaluru on December 02, 2019

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Message

It is a great pleasure that the 24th Post Graduate Course on Remote Sensing and Geographic Information System (RS & GIS) at Indian Institute of Remote Sensing (IIRS), Dehradun, India under the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) affiliated to the United Nations has been successfully concluded. In this context, I would like to thank to the Director, Scientists and Staffs of CSSTEAP-Dehradun for conducting this course efficiently. I would also like to give my warmest congratulations to the all participants for their devotion and successful completion of the· course. It is a good news for us that 22 participants from 10 different countries have attended in the session 2019-2020. I believe that participants have developed their technical skill and enhanced knowledge in using the remote sensing technology and analyzing data through the GIS tool. I expect that all participants will be able to contribute a lot to their respective working fields in their countries.

In this opportunity, I like to offer my sincere thanks to the Department of Space, Indian Space Research Organization and the Government of India for providing this opportunity to the participants of Asia and Pacific Region with the aim to explore the knowledge and skills in applications of earth observation technologies and geo-information science for societal benefit. I look forward to providing similar contribution from the Government of India and all other relevant stakeholder organizations in future.

At last, I wish the successful future of the participants and all others of CSSTEAP-Dehradun.

जय हिन्द

डी के दास / D K Dass
निदेशक / Director

सत्यमेव जयते

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Message

It is heartening to note that 24th Post Graduate Course of Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) on Remote Sensing and Geographic Information System (RS & GIS) has been successfully conducted at Indian Institute of Remote Sensing (IIRS), Dehradun, with participation of 22 candidates from 10 countries. I extend warmest congratulations to all the participants for successfully completing the course.

Satellite Remote Sensing and Geospatial technologies have grown by leaps and bounds during the past few years and are being extensively utilized for socio-economic development, environmental security and sustainable development. It is quintessential for developing countries to have access to space technology and human expertise for deriving its benefits.

I extend my appreciation to CSSTEAP and IIRS for conducting this comprehensive course that would enable countries in Asia Pacific region to build capability in Remote Sensing & Geographic Information System and to educate participants on applications of space technology for societal benefits.

I truly believe that the expertise gained by the participants will enhance the capabilities of member countries in different areas of space science and technology.

I, once again congratulate all the participants and wish continued success in their future endeavors.

Place: Ahmedabad
Date : March 6, 2020

(डी के दास)
(D K Das)

भौतिक अनुसंधान प्रयोगशाला
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Dr. Anil Bhardwaj, FNA, FASc, FNASc
निदेशक / Director

Message

I am very happy to learn that the 24th Post Graduate Course on Remote Sensing (RS) and Geographic Information System (GIS) conducted by Indian Institute of Remote Sensing (IIRS), Dehradun (India) from July I, 2019, is scheduled to be completed by March 31, 2020.This course has the participation of 22 students from 10 countries of the Asia-Pacific region.

The use of RS and GIS has become essential for planning, managing and forecasting of natural resources and environmental protection for sustainable development of emerging countries. I hope that the participants will be able to utilize the knowledge and experience gained from this course in the socio-economic development of their home countries.

I thank the faculty and staff of IIRS and CSSTEAP for the successful organization of this course and I wish all the participants the very best in their future endeavours.

Date : 8, March 2019

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CSSTEAP: A Brief

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

Dr. A. Senthil Kumar
Director, CSSTEAP

Introduction

Geospatial information technologies have contributed significantly to the socio-economic development planning in most developed and developing countries. The Sustainable Development Goals (SDGs) that comprise the 2030 Agenda for Sustainable Development combined with the targets of the Sendai Framework for Disaster Risk Reduction and the commitments of the Paris Agreement for Climate Change contribute collectively to the overall global development goals, which are expected to be realized on national, regional and global scales. Space-based data and geospatial information are essential for implementation, monitoring and realization of these goals.

Focusing attention on Asia and the Pacific(AP) region of the globe, this region has become a hub of innovation which is transforming the way in which people live, work, and relate to one another. Recent advancement in digital innovation such as artificial intelligence, big data analytics, the internet of things and cloud computing show promise to bring new and innovative solutions to pressing regional problems. Faster and more versatile digital connectivity, satellite-derived data, geographic information systems and spatial analysis have become increasingly accessible and available, generating more evidence-based data to support real-time decision-making. Geospatial information has also increasingly been incorporated in development planning, which has led to more accurate monitoring and evaluation of development interventions. As a result, geospatial information applications have come to play a more prominent role in the implementation and realization of the 2030 Sustainable Development Agenda (SDGs).

Despite advances in the availability and quality of space-derived information, several gaps and challenges remain for their effective use at the AP regional and national level. A lack of capacity and resources in terms of finance, space-derived data, knowledge and expertise, specific tools and well trained human resources is a common problem. Many developing countries in the AP region still do not have the capacity to utilize, analyze and interpret space-derived data. Other challenges include issues related to policies, procedures, guidelines and standards for acquiring, sharing and utilizing space-derived products and services, and the lack of procedural harmony between agencies and countries. A comprehensive training and education in Remote Sensing & Geographic Information System (RS & GIS) would enable developing countries to build a capability in the field, and to educate and stimulate participants in other disciplines as well.

Considering the importance and use of space science, technology and applications in promoting social and economic development, the United Nations, through its Office for Outer Space Affairs (UN-OOSA), facilitated

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

The Centre's headquarter is located in Dehradun, India, and its programmes are executed by faculty of the Department of Space (DOS) at campuses in Dehradun, Ahmedabad and Bengaluru. The Centre has arrangements with Indian Institute of Remote Sensing (IIRS), Dehradun for RS & GIS course; with Space Applications Centre (SAC), Ahmedabad for Satellite Communication (SATCOM), Satellite Meteorology and Global Climate (SATMET) and Global Navigation Satellite System (GNSS) and Navigation and Satellite Positioning Systems (NAVSAT) short courses; with Physical Research Laboratory (PRL), Ahmedabad for Space & Atmospheric Science course and UR Rao Satellite Centre (URSC), Bengaluru for short course onSmall 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 UNspecialized agencies. Under the agreement the Centre also has access to facilities, infrastructure andexpertise of DOS/ISRO institutions, including IIRS, SAC, PRL, NRSC and URSC. The Centre has a Governing Board consisting of signatories from 17countries from Asia-Pacific region and two observers,(UN-OOSA & ITC, The Netherlands). The Centre has formal UN affiliation with UN-OOSA for developing theCSSTEAP model and extending support in terms of expert advice, technical assistance, relevantdocumentation and future directions. The countries have agreed to the goals and objectives of the Centre by endorsing a cooperation agreement through which tCentre was established. The technicalactivities of the Centre are guided by an International

Dr. K. Sivan, Chairman, ISRO/Secretary, Department of Space and
present Chairman CSSTEAP Governing Board during 24th GB Meeting at Bengaluru

Governing Board members during 24th GB Meeting chaired by Dr. K. Sivan, Chairman CSSTEAP, GB

Advisory Committee (AC) consisting of subject expertsthat 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 theeducational programmes. The educational programmes of the Centre are oriented towards the disseminationof knowledge in relevant aspects of space science and technology. The Centre offers Post Graduate levelcourses 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 knowledgeand skills coupled with an application project with a small component (3 months) in India and major one(one year) in their home country with a view to transfer the technology in their home organization. Thisgives 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, theCentre also conducts short courses, workshops, awareness programmes on specific themes in the fourareas, highlighting how space-based information can be used for national development. Theseeducational 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 andthus 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 ofthe funding. Funding grants for international travel of participants, subject experts, tuition fees and scholarships ofparticipants 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:

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

Apart from these, Centre conducts short courses on different themes of Remote Sensing and GIS, SmallSatellite Missions and Navigation and Satellite Positioning system on regular basis. The structure of PG Diploma and the short term programs is given in (Fig. 1 & 2). The Centre also organizesworkshops & awareness programmes from time to time The educational programmes are conducted in English and for participants who need help to improve their English language skills, facilities are made available upon their arrival in campus. The courses are taught in smart classroom environments with the use of modern teaching methods and tools, and also include multimedia tutorials for self-study. Practical are given in the laboratories and skill development environments of the DOS institutions. In each of the host institutions, most of the faculty are drawn from the host institutions (about 80% of the teaching time). Whenever desirable or needed, faculty is drawn from other

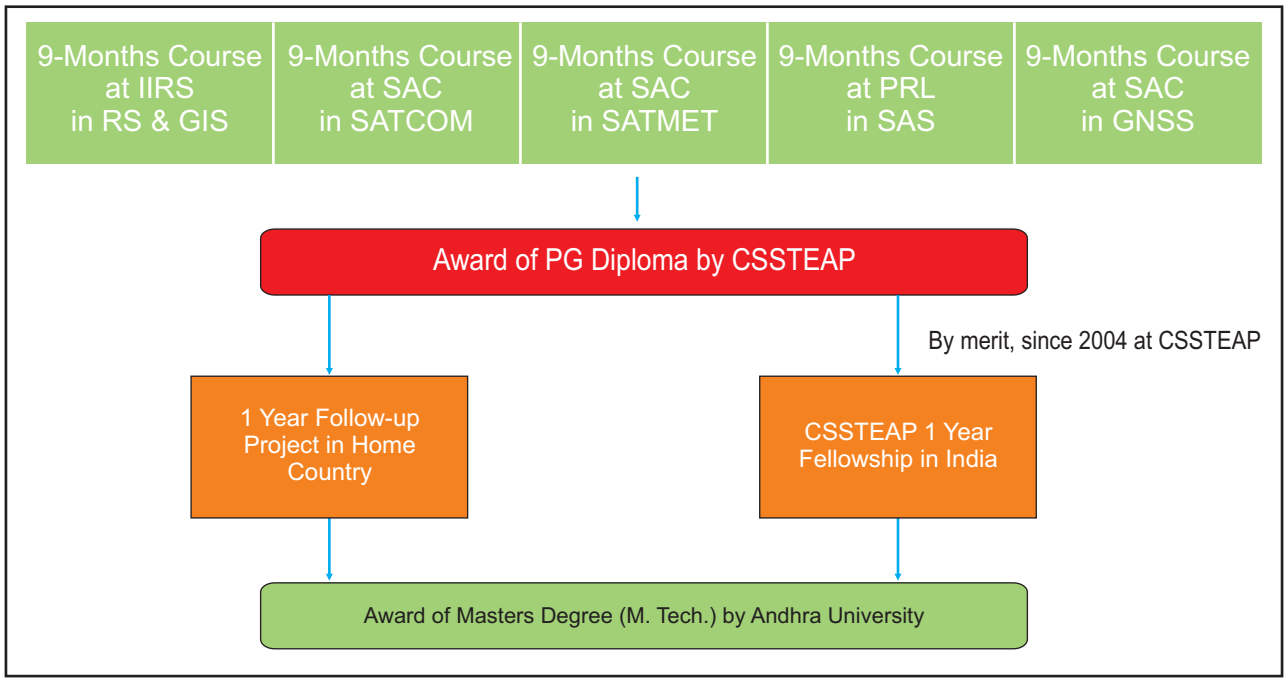

Fig. 1: Structure of PG diploma educational programmes at CSSTEAP

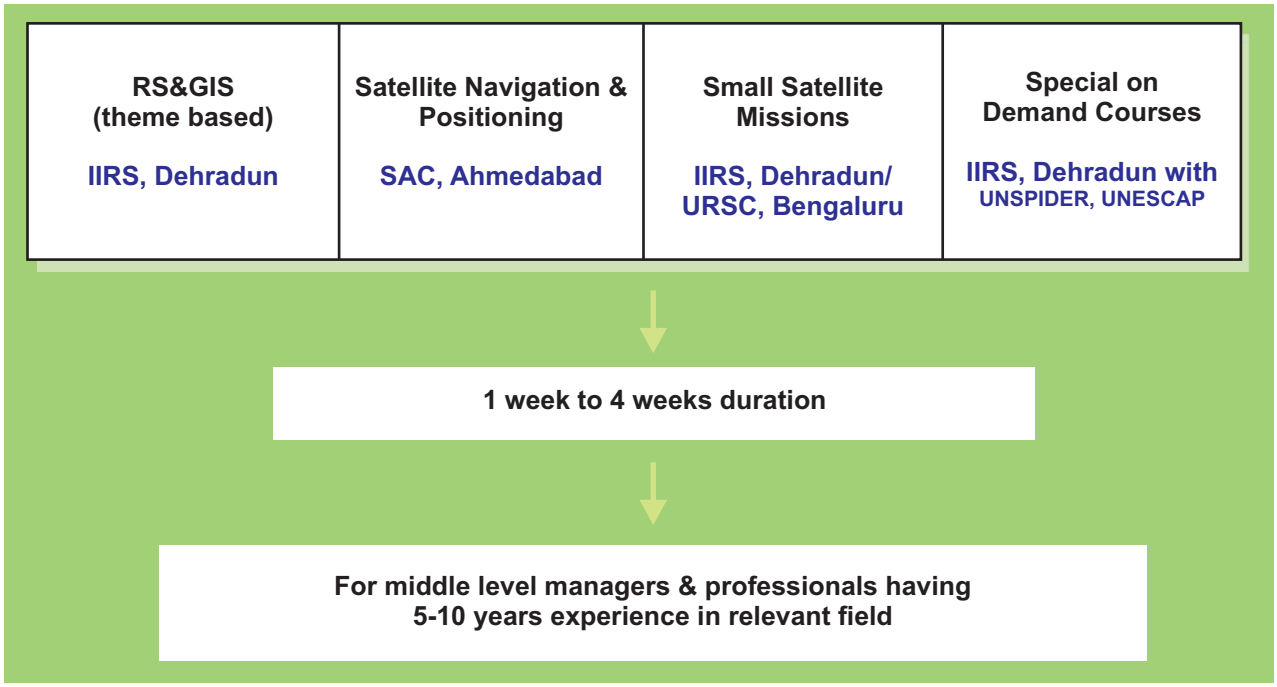

Fig. 2: Short-term training programmes at CSSTEAP

DOS/ISRO institutions, or professional, scientific or academic institutions in India (~10%) or from institutions or organizations outside India, from the Asia-Pacific Region as well as globally (~ 5%). In order to provide wider exposure to the participants in their respective fields, the Centre provides opportunities for technical visits to scientific institutions, laboratories and national symposia in India. The successful completion of the 9-month PG-Phase of the programme leads to the award of a Post Graduate diploma by the Centre. For the participants who successfully finish their PG course and are interested in continuing for a Master of Technology (M.Tech.) degree, the Centre offers the opportunity to do so, in collaboration with Andhra University (AU) in Visakhapatnam, India. To this end, the student has to complete a 1-year research project in an application of space science or technology. This project has to be approved by CSSTEAP and AU, and the research is supervised by designated academic staff of CSSTEAP, AU and the institution where the research is carried out. In most cases the 1-year project is carried out at the home institution of the student concerned. Since 2004 onwards every year selected meritorious PG participants in RS & GIS are being given fellowships to complete their M.Tech. thesis work at CSSTEAP.

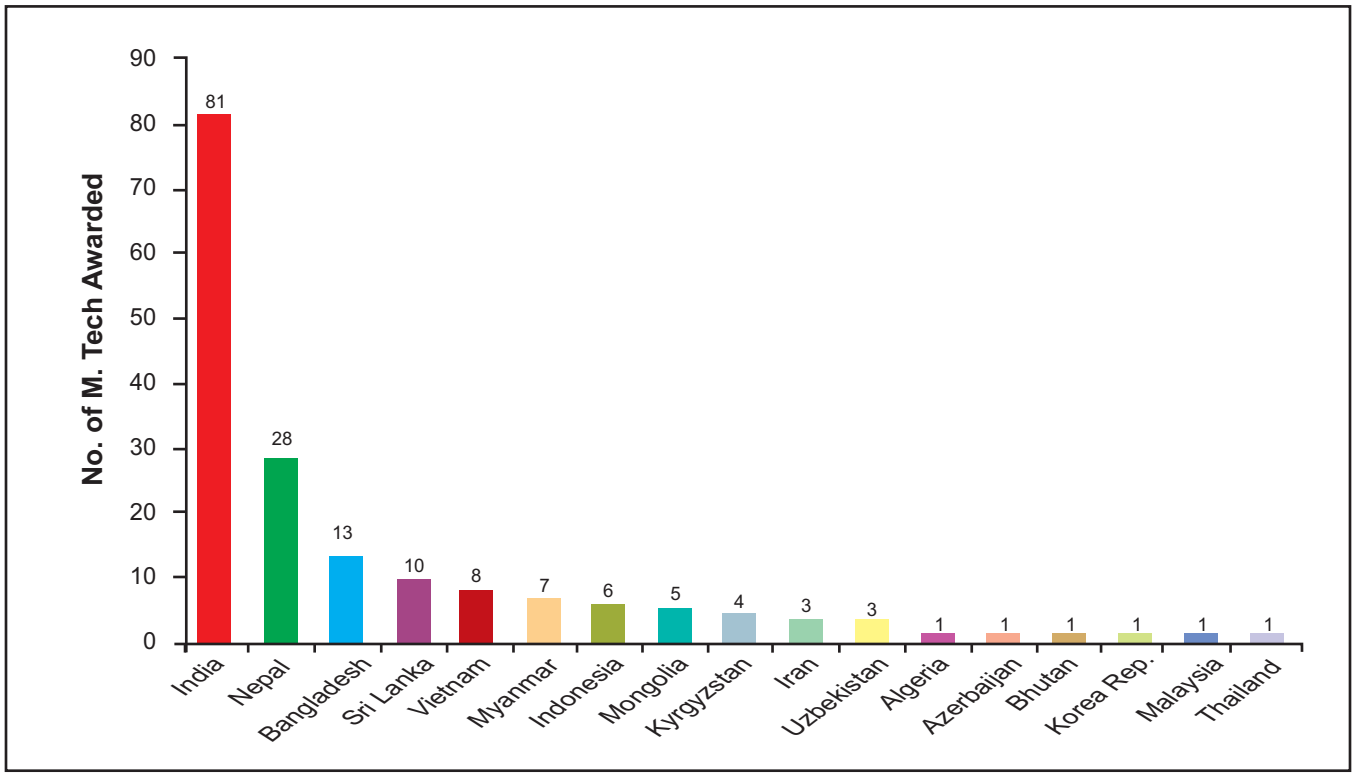

Fig. 3. Status of M. Tech. degree awarded

Remote Sensing and GIS course

The RS & GIS course is directed towards mid-career professions including university educators and researchers, natural resources managers to learn about environmental management and to support disaster management. The Post Graduatecourse is divided into two semesters (semester-I of four months and semester-II of five months includingthree months pilot project work). Semester-I covers principles of RS, photogrammetry, image analysis, GISand GPS, recent trends in RS & GIS technology, satellite meteorology, earth processes, natural disaster andenvironmental analysis, monitoring and analysis. Each of the course participants chooses one optionalthematic application discipline in semester-II based on his/her academic qualification, professionalexperience and requirement of his/her parent organization. The thematic optional streams cover RS & GISapplications to (i) Agriculture and Soils, (ii) Forestry Ecosystem Assessment & Management, (iii)Geosciences & Geo-hazards, (iv) Water Resources, (v) Urban & Regional Studies (vi) Marine & AtmosphericScience, (vii) Satellite Image Analysis & Photogrammetry and (viii) Geoinformatics. This also consists of apilot project which forms the basis for a one year project to be carried out in their home country of the

courseparticipant. A new thematic area in technology Satellite Image Analysis & Photogrammetry was added from theyear 2012.

Achievements

Till date the Centre has been conducted 61 PG Courses: 24 in RS&GIS, 12 in SATCOM, 11 each SATMET and SAS and 03 in Global Navigation Satellite System. Currently 24thRS&GIS course at Dehradun, 12thSATCOMand 03rd GNSS course at SAC, Ahmedabad are in progress. In addition, the Centre has conducted 61 short courses including webinar and workshops in the past 24 years. These programmes have benefited some 2394 participants from a total of 36 countries in the Asia-Pacific region and 35 participants from 20 countries outside Asia Pacific region have also benefited from these educational programmes.

The Centre has played a major role in the development of curricula of four courses which are currently beingfollowed by all the UN-Regional Centres. All course materials are published by the Centre in the form of hard-copy lecturevolumes and CDs. The Centre further publishes conference proceedings and other outreach documents, suchas general information brochures, course announcement brochures, newsletters and memoirs- marking the endof every PG course. A half yearly newsletter is published regularly and sent to all alumni and to persons andinstitutions associated with the Centre. CSSTEAP has scientific and research collaborations with University ofIllinois, USA; TWAS-UNESCO; ICIMOD, Nepal for cooperation and mutual assistance in the areas of educationand research.

In order to obtain first hand feedback, understand the alumni role in promoting space technology in theircountries and to develop a network & establish meaningful linkages between CSSTEAP & its alumni,CSSTEAP has taken initiative to hold alumni meets in different countries of the region. In this direction, fivealumni meets have been successfully conducted: in Kathmandu (Nepal); Dhaka (Bangladesh); Colombo (SriLanka); Thimpu (Bhutan) and Yangon (Myanmar).

Pilot research case studies in the form of student project work showing the potential application of space scienceand technology in natural resources management, improved meteorological, communications studies etc., inAsia-Pacific region is being done by the Centre. The Centre initiated research activities in the form of Phase-II ofPG course i.e., M.Tech research work by eligible PG participants. The Centre has taken initiative to facilitate itsalumni to do higher studies leading to Ph. D. degree and M. Sc. and Centre provides support in terms of expertfaculty to guide the student for analyses and logistics (accommodation, research lab, library access, etc.). During the 2019-20, total six participants have been supported with CSSTEAP M.Tech fellowship namely

Participants of DRR Course with special emphasis on Floods and Forest Fires, 2019

three participants from India, one from Nepal.

To generate awareness among users, researchers, engineers, professionals, decision makers and academicians,in year 2019, the Centre organizedashort course on specialized areas of Remote Sensing & its applications:

- Application of Geospatial technologies for Disaster Risk Reduction (DRR) with Special Emphasis on Floods and Forest Fires during May 28 to 31, 2019 (23 participants from 05 countries).

The Centre has established international linkages with various organizations viz., UN-OOSA, UN-SPIDER, SAARC, UN-ESCAP, UNESCO, UNDP, COSTED, WMO, START-SASCOM, NAM S& T, TWAS towards few fellowships / travel support/ sponsor short courses. There are also linkages with other Universities / Institutes(Institute of Space and Astronautical Science (ISAS), Japan; University of Illinois; Frieburg University, Germany;SSNEOG, Australia; EUMETSAT, U.K ; Onera, France; University of Colorado, University of Reading, U.K;NOAA-USA, University of Wisconsin, USA; University college of London, U.K; University of Hannover,Germany, etc.) for Guest Faculty and scientific exchange programmes. In India, apart from DOS/ISRO CentersCSSTEAP has linkages with many universities and academic institutions for imparting education/training.

As mentioned in the introduction about the 2030 Agenda for Sustainable Development that includes 17 Sustainable Development Goals (SDGs). Building on the principle of “leaving no one behind”, the new Agenda emphasizes a holistic approach to achieving sustainable development for all. CSSTEAP is also committed to achieve the SDGS and has plans to include SDGs in CSSTEAP core courses. In the year 2019-20, CSSTEAP has arranged alecture by Dr.Keran Wang,Chief Space Application Section (SAS), Information and Communications Technology and Disaster Risk Reduction Division (IDD), UN ESCAP, Bangkok on “ESCAP Programme in Space Application for SDGs implementation”during his visit to CSSTEAP Headquarters, Dehradun on Jan. 28, 2020.

CSSTEAP for the first time conducted a Webinar serieson Application of Remote Sensing in Hydro meteorological and Geological disasters during Sept. 17-20, 2019 attended by 148 participants from 12 countries.

CSSTEAP has also provide support for regional workshop and capacity-building programme on the "Role of

RS & GIS Course participants with former Chairman ISRO Dr. A.S. Kiran Kumar
during Vikram A. Sarabhai Centenary Programme at IIRS

Earth Observation in Multi-Hazard Disaster Risk Assessment and Monitoring Targets of the Sendai Framework" under the umbrella of the SAARC Disaster Management Center and the United Nations Office for Outer Space Affairs (UNOOSA), through its UN-SPIDER programme attended by 25 participants from disaster management authorities and space agencies in SAARC Member States, academic institutes, and regional and international organizations during Dec. 04 -08, 2019.

On a request from UN-SPIDER for Institutional Strengthening Mission CSSTEAP has supported and conducted a one week customized training program on Post Rapid Disaster Assessment of Natural Disasters" during March 11- 15, 2019 organized at Emergency Operation Centre (EOC), NaypiDaw, Myanmar attended by 50 participants from Myanmar.

Participants of 24th RS&GIS PG Diploma Course with Dr. R.R. Navalgund,
Former Vikram Sarabhai Distinguished Professor


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Capacity Building and Learning Opportunities at IIRS

Capacity Building and Learning Opportunities at IIRS

Dr. Prakash Chauhan
Director, IIRS

Introduction

The Indian Institute of Remote Sensing (IIRS), a Unit of Indian Space Research Organization (ISRO), Govt. of India is striving continuously for the capacity building in the field of Remote Sensing (RS), Geographical Information System (GIS) and their applications through training, education and research. IIRS is playing a key role since five decades of its establishment in the country and Asian region in capacity building of various target groups, ranging from fresh graduates, engineers and postgraduate students to policy makers. The institute also hosts and conducts the training and educational programmes on RS & GIS offered by the Centre for Space Science & Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations. The Institute is playing a major role in capacity building activities which can be primarily grouped into Training & Education, Research and Outreach.

As an integral part of capacity building, the institute undertakes applied research in Remote Sensing & Geoinformation science, technology and applications and also participates in various research programmes of ISRO. Currently, microwave, hyperspectral and high resolution EO data processing and their applications is the main research focus. Various state-of the-art laboratories, field-based instrumentations and observatories networks help meeting the research goals and objectives. IIRS houses prominent facilities like atmospheric CO2 measurement network, observatory for aerosol climatology, carbon flux towers for measuring energy, water vapour and CO2 exchanges, field observatory for soil erosion and runoff assessment, laser-profiling, AWS, field observatory for hydrological modelling, besides full-fledged DIP and GIS labs etc.

While nurturing its primary endeavour to build capacity amongst the user community by training mid-career professionals, the Institute has enhanced its capability and evolved many training and education programmes that are tuned to meet the requirements of various target groups, ranging from fresh graduates to policy makers including academia. As a follow up of the National Meet held on September 07, 2015. IIRS is also given a special responsibility of Capacity Building needs for effective governance using space technology based tools in Ministries and Department under Central & State governments. To widen its outreach, IIRS has started live and interactive distance learning programme (DLP) in 2007. Further, graduate and postgraduate students from

universities spread across the country have also benefitted through EDUSAT-based distance learning programmes being offered by the Institute till date. Today, more than 990 institutions/ organizations are networked with IIRS.

The institute is involved in research activities on high resolution satellite image analysis (space, aerial and terrestrial), 3D visualization of real world mobile applications, hyperspectral RS data analysis, photogrammetry, microwave data analysis, snow melt runoff, landslide hazard modeling, carbon flux measurement and modeling, data assimilation, statistical & numerical modeling in understanding atmosphere and climate, mineral prospecting, hydrological process, soil erosion, wildlife habitat and bio diversity analysis are providing wide opportunities to students. IIRS houses prominent facilities like Atmospheric CO2 measurement network, observatory for aerosol climatology, carbon flux towers for measuring energy, water vapour and CO2 exchanges, field observatory for soil erosion and runoff assessment, laser-profiling, AWS, field observatory for hydrological modeling, besides full-fledged DIP and GIS labs etc.

The Institute campus also houses the headquarters of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations and first of its kind established in the region in 1995. IIRS provides support to conduct all its remote sensing and GIS training and education programmes at postgraduate level. The headquarters of Indian Society of Remote Sensing (ISRS), one of the largest non-governmental scientific society in the country, is also located in the Institute campus.

Dr. Keran Wang, Chief SAS, IDD, UNESCAP meeting Director, IIRS

IIRS : History & Achievement

Formerly known as Indian Photo-interpretation Institute (IPI), the Institute was founded on 21st April 1966 under the aegis of Survey of India (SOI). It was established with the collaboration of the Government of the Netherlands on the pattern of Faculty of Geo-Information science and Earth Observation (ITC) of the University of Twente, formerly known as International Institute for Aerospace Survey and Earth Sciences, The Netherlands. The original idea of setting the Institute came from India's first Prime Minister, Pandit Jawaharlal Nehru, during his first visit to The Netherlands in 1957.

The Institute's building at Kalidas Road, Dehradun was inaugurated on May 27, 1972. Since its founding, the Institute has been playing a key role in capacity building in remote sensing and geoinformatics technology and their applications for the benefit of the user community from India and abroad. Keeping pace with the technological advances, the institute has enhanced its capability with time, to fulfil the increased responsibility and demand from Indian and International community.

Today, it has programmes for all level of users, i.e. mid-career professionals, researchers, academia, fresh graduates and policy makers. The sustained efforts by its dedicated faculty and management have made the institute remain in the forefront throughout its journey of about four and a half decades from a photo-interpretation institute to an institute of an international stature in the field of remote sensing and geo-information science.

Vision

Achieve excellence and remain in the forefront for capacity building in Remote Sensing and Geoinformatics and their applications”

Mission

Transfer technology through capacity building and research in the field of Remote Sensing and Geoinformatics for sustainable development.

Objectives

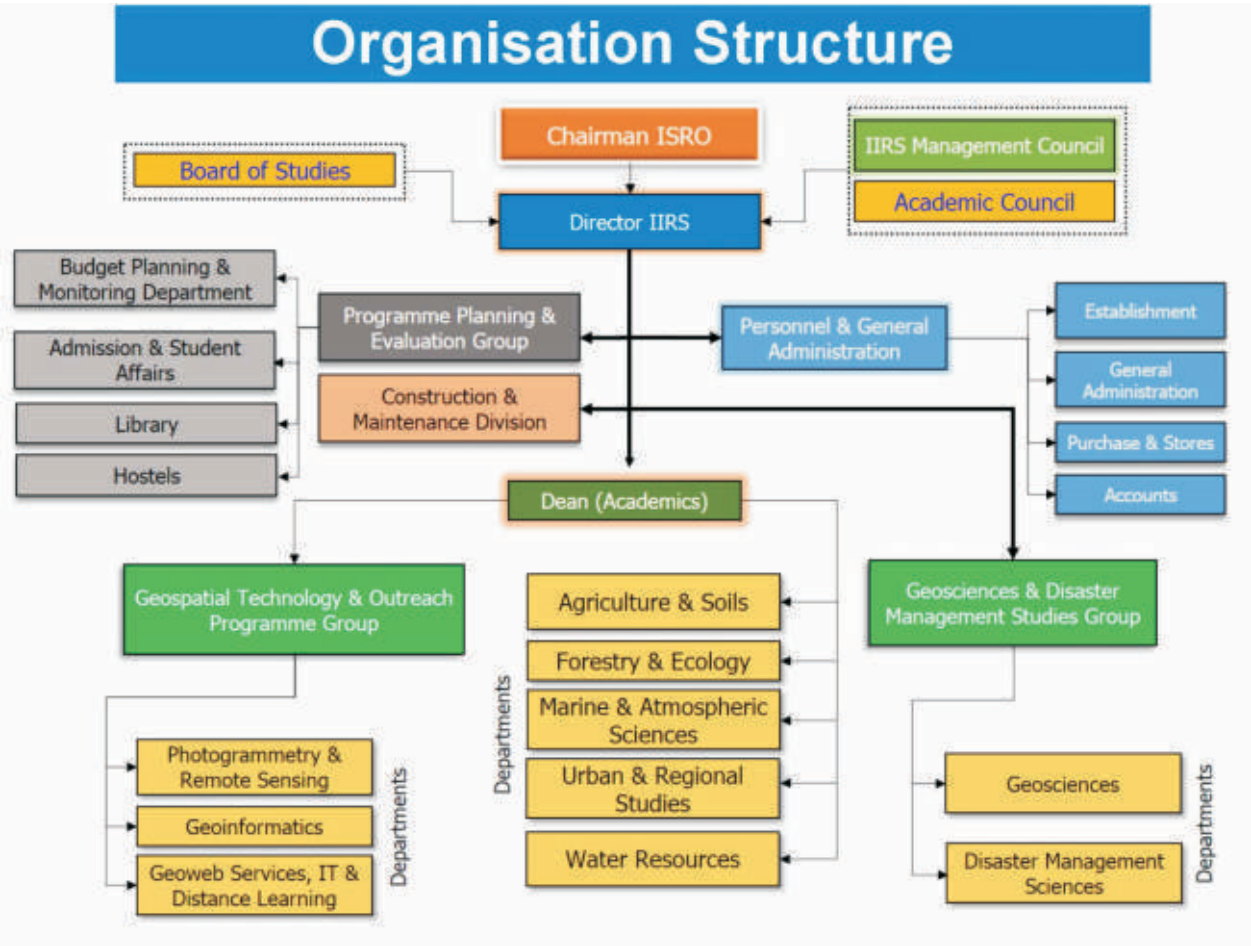
Capacity building in the field of remote sensing and Geoinformatics through:

1. Quality education and training programmes as per the need of stakeholders, through regular feedback and updation.
2. Ensure quality of education and training programmes through regular evaluation of the student performance, improved infrastructure and linkage with institutes of high repute.
3. Ensure quality of trainers / faculty through regular training/seminar/publication in peer review journals.

The Organisational Structure

Considering the imminent need towards focused efforts in Training and Education for efficient utilization of the ISRO's forthcoming advanced Earth Observation Systems, IIRS has been given the status of a Unit of ISRO with effect from 30th April 2011. It is headed by the Director who reports to Chairman, ISRO/Secretary, Department of Space. The overall activities of the institute are guided by Management Council, while the academic programmes are guided by a Management Council and Board of Studies. Dean (Academics) is responsible for implementation of academic programmes.

A highly motivated and dedicated team of about 74 multidisciplinary scientists and engineers contribute towards realizing the Institute's objectives.



Capacity Building Programmes of the Institute

The training and education programmes of the Institute are designed to meet the requirements of various target/user groups, i.e. for professionals at working, middle and supervisory levels, fresh graduates, researchers, academia, and decision makers. The duration of courses ranges from one-week to two-years.

The training programmes conducted by the Institute are broadly grouped into (1) Postgraduate Diploma programmes, (2) Certificate programmes (including NNRMS-ISRO sponsored programme for University faculty), (3) Awareness programmes, (4) Special on-demand/ tailor-made courses. The Postgraduate Diploma programmes are of 10 months duration; the Certificate Programmes are of 8 weeks duration; the Awareness programmes for Decision Makers are of 1 week duration; and Special courses are of 28 week duration.

The education programmes conducted by the Institute include: (1) M.Tech, course of 24 months duration being conducted in collaboration with Andhra University, Visakhapatnam; and (2) M.Sc. course of 24 months duration being conducted in collaboration with the Faculty of Geo-information Science & Earth Observation (ITC) of the University of Twente (UT), The Netherlands.

In addition, the Institute also provides support to the Centre for Space Science and Technology Education in Asia and The Pacific (CSSTEAP), affiliated to the United Nations, to conduct the RS & GIS training & education programmes at postgraduate level. IIRS hosts Headquarters of Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP), affiliated to the United Nations in its campus. CSSTEAP has mandate for capacity building in Asia-Pacific Region countries. CSSTEAP takes the advantage of the technical manpower and the facilities of four major centres of DOS/ISRO viz., Indian Institute of Remote Sensing (IIRS), Space Application Centre (SAC), U R Rao Satellite Centre (URSC) and Physical Research Laboratory (PRL). The Centre conducts Post- Graduate and short courses in five disciplines viz., Remote Sensing & Geographical

Information System (RS & GIS), Satellite Communications (SATCOM), Satellite Meteorology and Global Climate (SATMET), Space & Atmospheric Science (SAS) and Global Navigation Satellite System. The Centre has conducted several short courses and workshops in the past. These programmes have benefitted around 2394 participants from 36 countries in the Asia-Pacific Region. In addition to that, 35 participants from 20 countries outside Asia-Pacific Region also have benefitted. CSSTEAP maintains an interface with the ISRO Centres and United Nations Offices to conduct these courses.

The research and pilot projects carried out by the officer trainees and students of various courses are mainly focused towards exploring the potentials, including developing new methods and applications, of Indian EO data. Apart from regular programmes, special/ tailor-made courses are designed and conducted to explore the use of new sensors launched on Indian EO satellites and also based on the need of the stakeholder/ user departments.

The international partner of IIRS, The University of Twente (UT) is known as 'the enterprising university' in The Netherlands. Established in 1961 at Enschede, UT is one among the top 25 of the 250 biggest European universities. Education and research at UT takes place in its six faculties/institutes with the focus on nanotechnology, information technology, biomedical technology and technical medicine, sustainable energy and smart devices, governance, behavioural sciences and geo-information science/earth observation. ITC (http://www.itc.nl/), a leading international institute focusing on capacity building and institutional development in the field of geo-information science and earth observation, is embedded as the sixth faculty of UT since 1st January 2010.

Andhra University (AU), established in 1926, has five constituent colleges Colleges of Arts and Commerce, College of Science and Technology, College of Engineering, College of Law and the College of Pharmaceutical Sciences. The five colleges' together offer about 300 courses at undergraduate and postgraduate levels, besides research programmes leading to Ph.D degree. The Centre for Remote Sensing and Information System in the Department of Geo-Engineering, with whom IIRS is partnering for M.Tech Programme in Remote Sensing and GIS is one of the Centres of Excellence in the AU. The Master's Degree programmes are run in collaboration with (1) Andhra University, Visakhapatnam, India (for M.Tech. Degree in Remote Sensing & GIS). Both the capacity building partners of IIRS, i.e. Andhra University (http://www.andhrauniversity.info/) and University of

ITEC passing out ceremony-February 2020

Twenty (http://www.utwente.nl/), are the premier education and research institute in India and The Netherlands, respectively.

The Institute has trained 12442 professionals (till February, 2020), including 1239 professionals from abroad representing over 97 countries mainly from the Asia, Africa and South America. Further, over 1.2 lakh students/ researchers/ faculty from more than 1050 universities/ institutes spread across the country have also benefited through satellite-based distance learning programmes being offered by the Institute since 2007. .

IIRS Outreach Programme- EDUSAT and e-learning

The initial focus of IIRS was to use EDUSAT/INSAT 4CR satellite for distance learning but extended the scope to use broadband internet so that access to large number of institutions/universities /individuals with little cost to the user. IIRS distance learning program initiated in 2007 and successfully conducted 57 programs in the last thirteen years where more than 1.2 lahks participants are trained. The first course was attended from twelve universities and the number of institutions /universities increased manifold. IIRS program is unique and interactive and demand is increasing not only universities but among research institutions, user departments and individuals.

Further to enhance the outreach of geo-spatial science and technology, IIRS has developed e-learning contents and LMS for different certificate courses in Remote Sensing and geo-spatial technology (http://elearning.iirs.gov.in). The e-learning courses are self-paced and learner centric courses. The syllabus of the courses are as per latest developments and trends in geo-spatial science and technologies with specific focus on Indian case studies for geo-spatial applications. The learning is made available through interactive 2D and 3D animations, audio, video for practical demonstrations, software operations with free data applications. The learning methods are implemented to make it more interactive and learner centric application with practical examples of real world problems.

In the year 2019, as per the suggestion of IIRS Management council and further with approval of Chairman ISRO, 'Live & Interactive course' on 'Basic RS, GIS & GNSS' was approved by AICTE as a credit course, AICTE approved 'e-Learning' course on 'Basic RS&GIS & GNSS' was also hosted on SWAYAM Portal. Under this programme workshops and webinar series was also conducted for CEOS-WGCapD & CSSTEAP.

IIRS Academia Meet (IAM) 2020

Distribution of e-learning hours for available courses under IIRS e-learning programme.

Subject	e-learning hours	
	Theory	Practical
Image Statistics	3	2
Basic Remote Sensing	19	3
Photogrammetry and Cartography	12	2
Digital Image Processing	14	7
Geographical Information System	19	7
Global Navigation Satellite System	4	2
Customization of Geospatial Tools	3	5
Applications of Geospatial Technologies-Theory	4	-

The capacity building programmes conducted by IIRS are listed in the following Table.

Various capacity building Programmes at IIRS

S.No.	Programme	Duration	No. of Seats
1.	**M.Tech. in Remote Sensing & GIS (Affiliated with Andhra University)** Specializations in Agriculture & Soils; Forest Resources & Ecosystem Analysis; Geosciences; Natural Hazards and Disaster Risk Management, Urban & Regional Studies; Marine & Atmospheric Sciences; Satellite Image Analysis & Photogrammetry; Water Resources; Geoinformatics	24 months	40
2.	**M.Sc. in Geo-Infromation Science & Earth Observation (Affiliated with ITC, University of Twente, The Netherlands)** Specialization in - Geoinformatics	22 months	10
3.	**Post-Graduate Diploma in Remote Sensing and GIS** 9 Specializations - Agriculture & Soils; Forest Resources & Ecosystem Analysis; Geosciences; Natural Hazards and Disaster Risk Management; Urban & Regional Studies; Marine and Atmospheric Sciences; Satellite Image Analysis & Photogrammetry; Water Resources and Spatial Data Science.	11 months	48
4.	**Post-Graduate Diploma in Geo-Information Science and Earth Observation (Affiliated with ITC, University of Twente, The Netherlands)** Specialization in - Geoinformatics	10 months	11
5.	**Certificate Course in Remote Sensing** Remote Sensing and Image Analysis (for Indian User participants)	8 weeks	20
6.	**International Programme Certificate Course in Remote Sensing, Geoinformatics (Sponsored by ITEC, Govt. of India)** Remote Sensing with special emphasis on Digital Image Processing; Geoinformatics	8 weeks	40
7.	**NNRMS- ISRO-Sponsored Certificate Course for University Faculty** 10 Specializations - GIS Technology and Advances; RS & GIS Applications in Water Resources; RS & GIS Applications in Forest Resources & Ecosystem Analysis; RS & GIS Applications in Urban & Regional Planning; Satellite Image Analysis & Photogrammetry; RS & GIS Applications in Geosciences; RS & GIS Applications in Agriculture & Soils; RS & GIS Applications in Coastal & Ocean Sciences; Geocomputation & visualization in Web Platforms; Natural Hazards and Disaster Risk Management	8 weeks	64
8.	**Awareness Programme** a) Remote Sensing An Overview for Decision Makers b) Usefulness of Remote Sensing & GIS for Environmental Study	 4 days 1 week	 15 50
9.	**Special Courses** a) Remote Sensing & GIS Application in Hydrological Modelling b) Ground-based Subsurface Imaging for Enhanced Earth Observation Applications in Geosciences c) Big Geodata Processing d) Microwave Remote Sensing Applications in Agriculture	 2 weeks 1 weeks 4 weeks 2 weeks	 20 20 05 20
10.	**Tailor-Made On-Demand Courses**	1 to 8 weeks	Variable

The IIRS-Management Council

The activities of the Institute are guided by the IIRS-Management Council (IIRS-MC). It has the following role:

- To review the institute's programmes (ongoing and new initiatives);
- To review the annual budget proposals and manpower requirements; and
- To provide overall direction for the development of the Institute.

The Academic Council

The academic programmes of the institute are guided by an Academic Council consisting of leading experts in the field. The Academic Council has the following terms of reference:

- To provide the overall guidance to the academic programmes of the Institute and suggest revisions as and when required;
- To review and implement the recommendations of the Board of Studies;
- To advise on the research and faculty improvement programmes; and
- To recommend pedagogy, quality and standards, admission and evaluation policies and academic equivalencies.

The Board of Studies

The Board of Studies (BoS) consisting of domain experts reviews and approves the course curriculum and syllabus of different academic programmes designed by the faculty in consultation with the external experts from academia and industry. The BoS has the following terms of reference:

- To review the course contents and curricula based on the latest developments in the RS & GIS technology and applications;
- To review the quality and contents of lecture materials, practicals and tutorials; and
- To analyse the effectiveness of teaching methods, conduct of examinations and students' feedback of the courses.

Participants of 24th RS&GIS PG Diploma Course with Dr. Keran Wang, Chief SAS, IDD, UNESCAP

Course Report

24th Post Graduate Course on Remote Sensing & Geographic Information System (RS & GIS)

Dr. S.P. Aggarwal
Programme Coordinator
CSSTEAP
spa@iirs.gov.in

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

Hari Shankar
Course Coordinator
RS &G GIS
harishankar@iirs.gov.in

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

The course started with an 'Induction week' where the participants were exposed to geographic perspective of India, social systems, customs and festivals of India, overview of space science, technology and applications etc. A local trip was also organized for the awareness within and around the Dehradun city for the participants. Thereafter, participants have gone through the main academic programme which comprises of two semesters. Semester-1 consists of module-IA and module-IB which is common to all course participants while Semester-2 consists of specialization module-II and module-III for pilot project work. Module-IA covered the fundamental concepts of Remote Sensing (RS) and Geographic Information System (GIS) technology with lecture, practical, tutorial and field excursions. The participants had several field excursions for ground truth collection and for interpretation and analysis of remote sensing satellite data. Module-IB covered the recent trends in RS & GIS and Environmental assessment and Monitoring with special emphasis on Sustainable Development Goals (SDGs). Participants were given an overview on how space technology can be useful in addressing SDGs.

Based on their academic background, technical requirement of their parent organization and their professional experience, in Semester-2 (Module-II) course participant has chosen one of the eight available electives i.e. Agriculture & Soils, Forestry & Ecology, Geosciences & Geohazards, Marine & Atmospheric Science, Water Resources, Urban & Regional Planning, Satellite image analysis & photogrammetry and Geo-informatics. In current 24th batch, 7 participants had opted for Satellite image analysis & photogrammetry, 5 participants for Water Resources, 4 for Geoinformatics, 3 each for agriculture and Soils, 2 for Marine & Atmospheric Science and 1 for Geosciences & Geo-hazards. The core components of course syllabus were covered by the faculty of IIRS and additional lectures by guest faculty on specialized topics were also arranged for the academic benefit of the course participants.

Module-III which is of three months duration, the participants worked on a pilot project, based on the knowledge gained during the course by utilizing space inputs. The details of the topics varied from aerosol variability, landslide mapping and monitoring, hydrological modelling and early warning, soil erosion risk assessment, heat stress analysis, ground water depletion, soil moisture estimation etc. Details of topics are given in subsequent sections.

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

Three special lectures were also organized during their stay for benefit of the participants a) ESCAP Programme in Space Applications for SDGs implementation by Dr. Keran Wang, Chief, Space Applications Section (SAS), (IDD), UN ESCAP, Bangkok on January 28, 2020 b) Remote Sensing of Physical Oceanography by Dr. R.R. Navalgund, former Vikram Sarabhai Distinguished Professor, ISRO on March 5, 2020 and c) ISRO data products and services from Dr. Aparna, GD, NDC, NRSC on March 5, 2020.

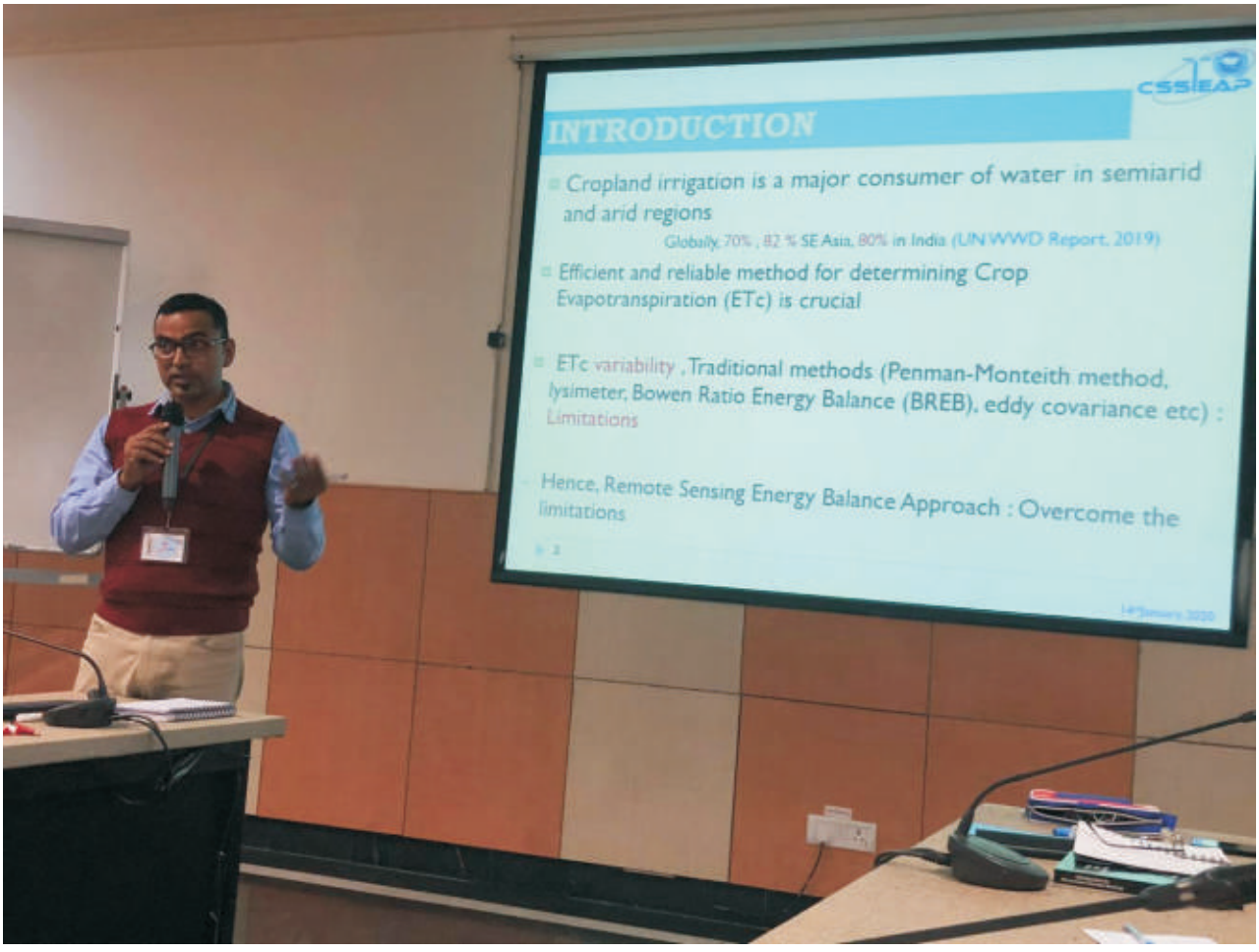
The participants of the course during their stay were given an opportunity to participate in IIRS Academia Meet (IAM) organized on March 3, 2020 at IIRS campus, Dehradun. The RS & GIS Course participants also witnessed Vikram A. Sarabhai Centenary Programme organized at IIRS during 4-10 October, 2019 and got opportunity to meet former Chairman ISRO Dr. A.S. Kiran Kumar.

In addition to the academic activities special efforts were also put for improving the level of competency of spoken English, understanding and writing skills in English of the participants to help the participants in understanding the subjects taught in classes with more clarity. Special English language classes after office hours were conducted in campus during the first three months. On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dandia, Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year, Holi etc.

The broad topics of the projects undertaken by the participants were:

- Decadal scale (2009-2018) aerosol variability over India during post-monsoon season - A case study using satellite and model reanalysis data
- Customization of GIS for License Documentation Process and for citizen participation in urban planning in Mongolian language
- Spatio-temporal variation of Heat Stress Index in Bangladesh
- Change Detection Analysis of Mining Area Using InSAR
- Fuzzy Machine learning for bi-sensor temporal data processing: A case study for forest vegetation species/specific crop mapping
- Estimation of Crop Evapotranspiration Using Remote Sensing Based Energy Balance Approach for Cropping Field of Morang District, Nepal
- Application of Remote Sensing and GIS in Hydrological and Hydrodynamic Modelling of Amochu Basin, Bhutan

- Land use land cover (LULC) change detection from 2005 and 2019: A case study in Colombo, Sri Lanka
- Classification of airborne hyperspectral data using different classification approaches
- Investigation of gaseous air pollutants over East-Kazakhstan region using in-situ and satellite observations
- Landslide Hazard zonation mapping with the GIS technique and monitoring landslide displacement with DInSAR technique
- Hydrological Modelling of Sub-watershed of Buir Basin using Remote Sensing
- Soil Moisture estimation in the presence of crop cover using multi-polarized Sentinel 1 SAR data
- Monitoring Ground Water Depletion and It's Impacts in and around Mehesana, Gujarat using GRACE and Interferometric SAR Data
- Glacier Dynamic Studies of Ala-Archa Valley of Kyrgyz Republic using Geospatial Data
- A Comparative Assessment of Geostatistical and Machine Learning Techniques to Derive Surface for Environmental Variables
- Automatic Building Extraction and Characterization with Active Contour Model - A Case Study in part of Colombo City, Sri Lanka
- Geospatial Approach of Soil Erosion Risk Assessment for Watershed Prioritization and Conservation Planning
- Near Real-Time Flood Mapping for Emergency Response by integrating Google Earth Engine with GIS
- Analysis of Long-Term Satellite-based Rainfall Data for Monsoon Season over Myanmar
- Flood Inundation mapping using Remote Sensing Data; A cause study of Hpa-An City, Myanmar



Course Participants

Sl.No.	Name	Country
1.	Mr. Mohammad Akram Hossain	Bangladesh
2.	Mr. Gautam Thapa	Bhutan
3.	Mr. Krishna Kumar Subedi	Bhutan
4.	Ms. Aditya Allamraju	India
5.	Mr. Jayendra Praveen Kumar Chorapalli	India
6.	Mr. Sunil Kumar	India
7.	Ms. Lyazat Kaskenova	Kazakhstan
8.	Mr. Emilbek Zholdoshbekov	Kyrgyzstan
9.	Mr. Angarag Altangerel	Mongolia
10.	Mr. Rentsendorj Odgerel	Mongolia
11.	Ms. Shinechimeg Altannavch	Mongolia
12.	Ms. Su Nandar Myint	Myanmar
13.	Ms. Thandar Aung	Myanmar
14.	Mr. Tun Tun Naing	Myanmar
15.	Mr. Rabindra Adhikari	Nepal
16.	Ms. Anuradha Anushika Silva	Sri Lanka
17.	Mr. Chinthaka Sajith Devinda	Sri Lanka
18.	Mr. Parape Vidanalage Indika Prabath Hapugoda	Sri Lanka
19.	Ms. Achini Punchihewa	Sri Lanka
20.	Mrs. Muthuhawadi Widanalage Iresha Lakmini Somawansha	Sri Lanka
21.	Mr. Anushervon Abdulimov	Tajikistan
22.	Ms. Pariso Abusaidovna Shokhumorova	Tajikistan

Brief outline of Course Curriculum - RS & GIS

<table>
<tr><td colspan="2">Semester-I: 4 months
(Compulsory) consists of 5 Theory papers (100 marks each) + 5 Practical papers (100 marks each)</td></tr>
<tr><td>(Module-IA)
(3 months)</td><td>(Module-IB)
(1 month)</td></tr>
<tr><td>Fundamentals of Remote Sensing & GIS
• Remote Sensing
• Image Interpretation & Analysis
• Photogrammetry
• Geoinformatics</td><td>• Recent Trends in RS and GIS & Environmental Assessment and Monitoring</td></tr>
<tr><td colspan="2">Semester-II: 5 months</td></tr>
<tr><td colspan="2">Module II (Optional Electives - one to be chosen) (2 months) consists of 4
Theory Papers (each of 100 marks) + 4 Practical Papers (each of 100 marks)</td></tr>
<tr><td>Agriculture & Soils
• Land Use & Soil Resources Management
• Agri-Informatics
• Environmental Soil Science
• Satellite Agrometeorology

Forest Ecosystem Assessment & Management
• Forest mapping & monitoring
• Forest inventory
• Forest informatics
• Forest ecosystem analysis

Geosciences & Geo-hazards
• RS for Earth & planetary sciences
• Data processing & analysis for Geosciences
• Applied & tectonic geomorphology
• Engineering geology & ground water

Urban & Regional Studies
• Fundamentals of urban & regional planning
• Urban and regional area analysis
• Urban resources services & facilities analysis
• Advanced urban and regional studies.</td><td>Marine & Atmospheric Science
• Coastal processes & marine ecology
• Atmosphere & ocean dynamics
• Satellite oceanography
• Satellite meteorology

Water Resources
• Water resources assessment
• Watershed analysis & planning
• Water resources development
• Water resources management

Satellite Image Analysis & Photogrammetry
• Remote Sensing-II
• Image processing-II
• Digital photogrammetry & mapping
• Surface generation techniques

Geoinformatics
• Spatial database architectures & modelling
• Programming in geodata modelling
• WebGIS and Geovisualization
• Spatial data quality and Geostatistics</td></tr>
<tr><td colspan="2">Module-III: Pilot Project Work (3 months)</td></tr>
<tr><td colspan="2">(Project work of 100 marks, Presentation/ defense 100 marks)</td></tr>
<tr><td colspan="2">• Project planning
• Post field analysis & report
• Pre-field interpretation & analysis
• Project seminar</td></tr>
</table>

List of Core Faculty

Name	Topics	E-mail	Photograph
Dr. Prakash Chauhan	• Remote Sensing of planetary sciences	director@iirs.gov.in	
Dr. A. Senthil Kumar	• Indian Satellite program & benefits	senthil@iirs.gov.in	
Dr. S.K. Srivastava	• Groundwater potential zoning	sksrivastav@iirs.gov.in	
Dr. Champti ray	• Geological disasters (landslides, earthquakes & volcanos) • Mathematical geology	champati_ray@iirs.gov.in	
Dr. Pramod Kumar	• Urban resource planning, urban landuse planning • Urban area analysis	pramod@iirs.gov.in	
Mrs. Shefali Agrawal	• Remote Sensing • Principles and applications of hyperspectral RS	shefali_a@iirs.gov.in	
Dr. R.S Chatterjee	• SAR interferometry and its applications • Ground water geology	rscharterjee@iirs.gov.in	
Dr. S.P Aggarwal	• Basics of hydrology • Watershed conservation planning & prioritization • Site suitability for water resources project • Irrigation water management • Climate change studies	spa@iirs.gov.in	
Dr. Suresh Kumar	• Soil resource mapping, Digital terrain analysis • Land evaluation,Watershed Management • Soil quality assessment, soil erosion	suresh_kumar@iirs.gov.in	

Name	Topics	E-mail	Photograph
Dr. Debashish Mitra	• Coastal Zone Management • Coastal geology and geomorphology • Coastal hazards and its mitigation • Coastal processes and modelling • Coastal pollution study through geospatial techniques • Coastal ecology and its conservation • Climate change impact on coastal zone	mitra@iirs.gov.in	
Dr. N.R Patel	• Crop yield modeling, production forecasting • Drought assessment and monitoring • Land surface process, carbon cycle & climate change • Retrieval of Agrometeorological Parameters Land surface process, carbon cycle & climate change	nrpatel@iirs.gov.in	
Dr. Anil Kumar	• Image Classification • ANN & Fuzzy, Classifier	anil@iirs.gov.in	
Dr. Hari Shanker Srivastav	• LULC analysis, Microwave RS in agriculture • Soil moisture estimation	harishankar_srivastava @iirs.gov.in	
Dr. A.K Mishra	• Ocean colour monitor & its application • Ocean remote sensing, satellite altimetry & scatterometry for ocean	mishra@iirs.gov.in	
Mrs. Minakshi Kumar	• Digital Image Analysis • Image Preprocessing and Enhancement techniques • Texture analysis, • Image segmentation • Object Based Image Analysis	minakshi@iirs.gov.in	
Dr. Arijit Roy	• Sampling techniques in forest inventory • Predictive modeling • Decision support systems • Climate change impacts on forests and biodiversity • Forest fire monitoring and early warning	arijitroy@iirs.gov.in	
Dr. Sandeep Maithani	• Settlement planning, Space use, ANN & CA in urban growth modelling • Urban hazard & risk assessment	sandeep@iirs.gov.in	

Name	Topics	E-mail	Photograph
Dr. Sameer Saran	• Spatial information system, spatial data modelling infrastructure, • Spatial decision support system, MCDM • Distributed GIS, interoperability, metadata stds & cataloging	sameer@iirs.gov.in	
Dr. Harish Karnatak	• Bhuvan overview, Geodata abstraction library, Iterations, functions & recursion • WebGIS services, Open source GIS	harish@iirs.gov.in	
Dr. Hitendra Padalia	• Role of EO data in sustainable forest management • Role of RS and GIS in Forestry and Ecology	hitendra@iirs.gov.in	
Mrs. Vandita Srivastava	• Spatial data analysis, vector & raster	vandita@iirs.gov.in	
Dr. (Mrs.) Poonam S. Tiwari	• Digital Photogrammetry • Close Range Photogrammetry	poonam@iirs.gov.in	
Dr. Yogesh Kant	• EO systems for climate change studies • Earth Radiation budget • Atmospheric Aerosol studies	yogesh@iirs.gov.in	
Mr. Ashutosh Bhardwaj	• Stereo photographs and its geometry • Stereo photogrammetry • Introduction to digital surface generation • Advances techniques in SAR interferometry	ashutosh@iirs.gov.in	
Dr. (Mrs.) Hina Pande	• Image transforms and fusion • Satellite Photogrametry • Sensor models and product generation	hina@iirs.gov.in	
Dr. Praveen K. Thakur	• Quantification of hydrological elements: Precipitation, WL/River Flow • Snow and glacier mapping and melt modelling • DEM derivatives & application in water Resources • Site suitability of hydro-power projects • Urban hydrology: water distribution and modelling • Flood and GLOF modelling; Flood early warning system	praveen@iirs.gov.in	
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Name	Topics	E-mail	Photograph
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Mr. Justin George	• Fundamentals of soils & pedogenesis • Land evaluation • land degradation • Hyperspectral RS in degradation mapping	ustin@iirs.gov.in	
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Guest Faculty

Dr Charan Singh	• "Principal and Approaches of Soil and Water Conservation Measures In Watershed"	Principal Scientist (Forestry) Division of Plant Science, ICAR-Indian Institute of Soil and Water Conservation,	
Dr. A.V Kulkarni	State of Himalayan Glaciers and Monitoring of glaciers dynamics	DCCC, IISc, Bangalore	
Dr. Ashish Mishra	Remote sensing for exploration of conventional and non-conventional hydrocarbon resources with emphasis on hyper-spectral remote sensing	KDMIPE, ONGC, Dehradun	

Pilot Projects of Students

Spatio-temporal variation of Heat Stress Index in Bangladesh

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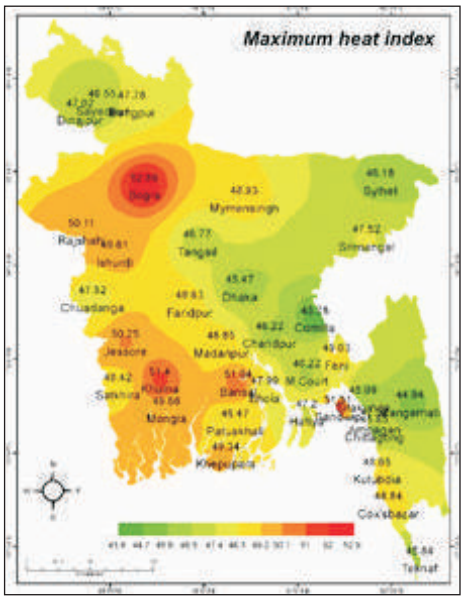
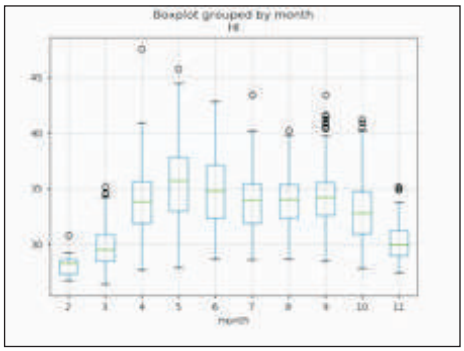
A B S T R A C T

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



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

To measure heat exposure, environmental health studies often use heat index, which incorporates both air temperature and moisture. However, the method of calculating heat index varies across environmental studies, which could mean that studies using different algorithms to calculate heat index may not be comparable. This study investigates heat stress index (HSI) algorithms found in the literature on data from several stations in Bangladesh.



This study automates the preparation of HSI for Bangladesh that could be used to trigger preparedness measures in a heat index early warning system (HIEWS) and explores the climate mechanisms associated with heat waves. The study area is divided into seven climatic sub-zones. Using a generalized data simulation, HSI calculation and climatic sub-zonation is performed for the detection of extreme HIS events(HSE) and their evolution, expansion, features in over Bangladesh and visualizing HSI and spatio-temporal variation of HI over the country. Daily average temperatures and relative humidity are used for calculating heat index over the country from 1981 to 2018. The highest HSI was found at Bogra district (52.86°C) which is situated at climatic sub-zone 'D', and lowest value of maximum HSI was found at Comilla district (43.78°C) which is situated at climatic sub-zone 'G'. The country average HSI was found to be 34.08°C. Most of the time heat exposure occurred south-west and north-west part of the country.The average values are shown us the tendency of heat index is increasing over the country.

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

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A B S T R A C T

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

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

The simulated flow resulting from the HEC-HMS model was evaluated with the observed flow data. And, the model efficiency was verified using Nash-Sutcliffe efficiency coefficient and Coefficient of determination R2. The hydrological model efficiency from calibration and verification were 0.72 and 0.65 respectively. The averaged Curve Number (CN) of the basin is 87.

Key Words: Remote Sensing, GIS, HEC-HMS, HEC-RAS Modelling, Model efficiency, Flood

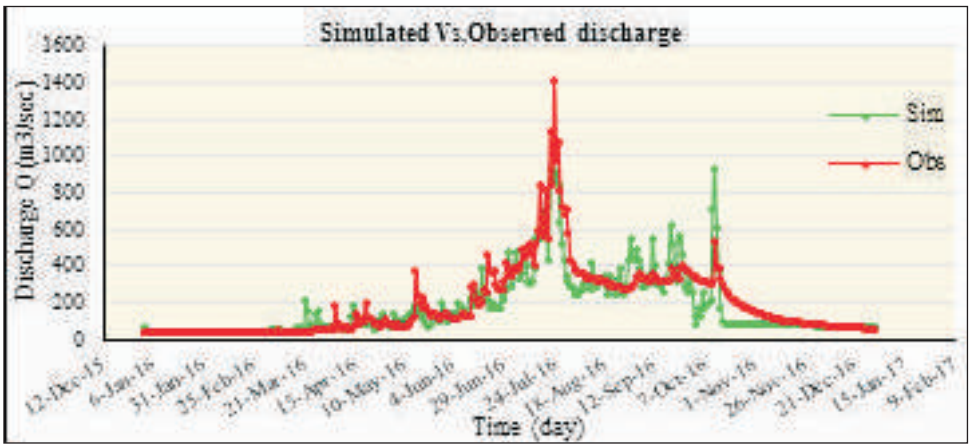

Fig. 1: Model Calibrated output and observed flow

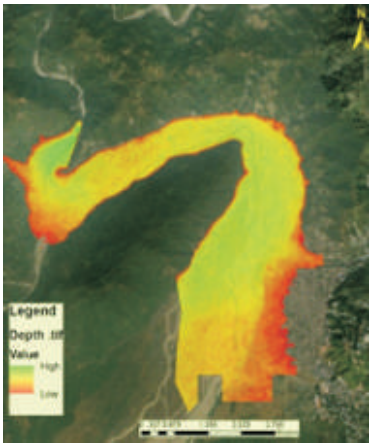

Fig. 3: Study Area, the Amochu Basin

Classification of airborne hyperspectral data using different classification approaches

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A B S T R A C T

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

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

Keywords: Hyperspectral, AVIRIS-NG, SAM, SVM, Spectral-spatial, object based Classification.

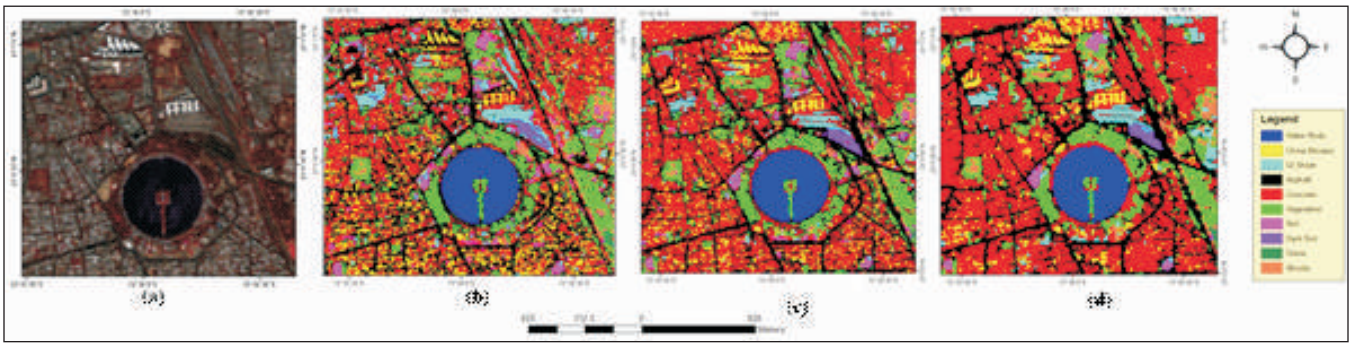

Fig.1: (a) FCC image of AVIRIS-NG Data (b) SAM Classified image (c) SVM Classified image (d) Spectral-spatial based classified image.

Soil Moisture estimation in the presence of crop cover using multi-polarized Sentinel 1 SAR data

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

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

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

Keywords: soil moisture, agriculture, Sentinel-1, backscatter, semi-empirical, two-way attenuation

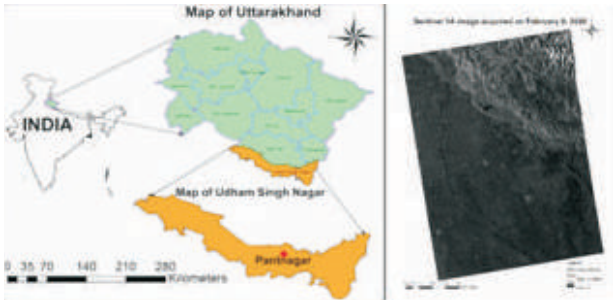

Fig. 1: Location Map of the study area & Sentinel 1A SAR image acquired on February 9, 2020

Fig. 2: Ground truth data collected during field campaign

Fig. 2: Laboratory processing and analysis

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

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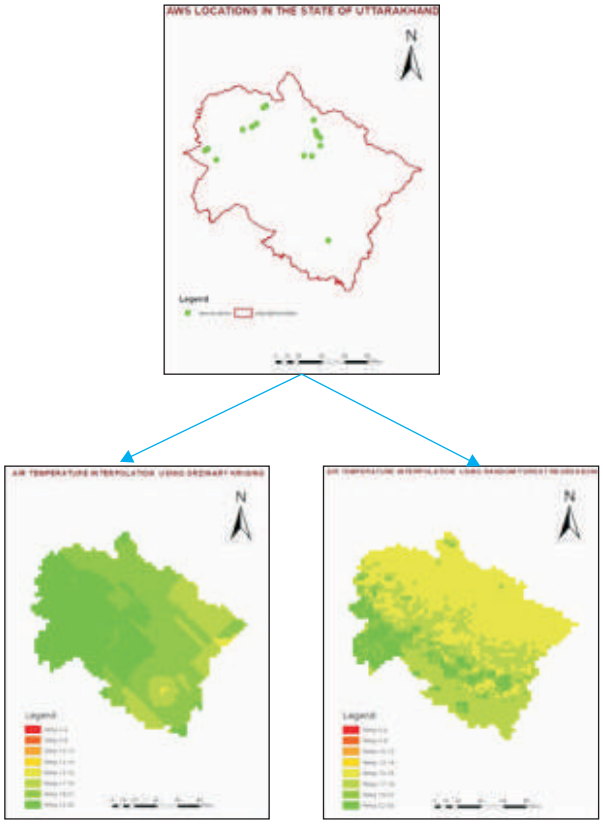
A B S T R A C T

The project explains the concept of Spatial Interpolation and how to carry out spatial interpolation of a continuous variable using Geostatistical and Machine Learning techniques when the data is limited. Spatial Interpolation is the process of estimating the value of continuous target variable at unknown locations based on the values at known sample locations whereas Supervised Machine Learning is a task of learning a function that maps an input to an output based on training input features and output labels. Air Temperature is an important climatic variable that controls several environmental processes and plays a crucial role in global change studies. So accurate estimation of air temperature and its spatio-temporal variability are important in several Earth and Environmental sciences. Usually, air temperature is measured at Automatic Weather Stations (AWS) at different heights and these provide very limited information about spatial patterns at regional or global scales because they are less in number. Hence Spatial Interpolation of daily air temperature is carried out to predict the values at unknown locations and the results of geostatistical and machine learning techniques were compared for Uttarakhand state in India. Daily temperature from 16 Automatic Weather Stations located in different parts of Uttarakhand state is considered as the primary dataset for Geostatistical techniques. MODIS Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Digital Elevation Model (DEM), Distance from the nearest Water Body datasets are considered as input features and the daily temperature is considered as output label for the Machine Learning based approach. Geostatistical techniques like Simple Kriging and Ordinary Kriging was performed for the temperature recorded from 16 AWS on a particular date and these results were compared with the Machine Learning based techniques such as Linear Regression, Lasso Lars Regression, Gradient Boosting Regression and Random Forest Regression on the same date. The spatial distribution of daily temperature was estimated with the greatest accuracy of 96% by Machine Learning models when compared with Kriging based approaches. The concept of spatial Interpolation was preserved during the training of a ML model by considering the distances among the Automatic Weather Stations and their respective daily temperature. The features used for the machine learning models are also listed depending upon their importance while training the model. A continuous surface for daily temperature was created for all Geostatistical and Machine Learning Models for the Uttarakhand State.



Landslide Hazard zonation mapping with the GIS technique and monitoring landslide displacement with DInSAR technique

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

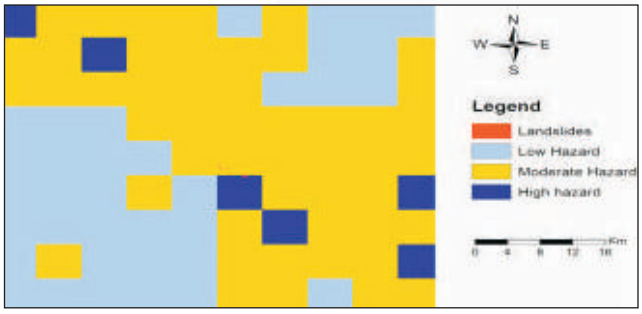

Fig. 1: Landslide Hazard Zonation Map

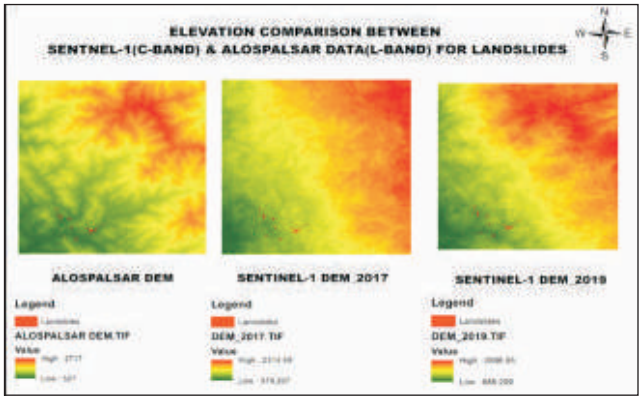

Fig. 2: Elevation Comparison Map

Investigation of gaseous air pollutants over East-Kazakhstan region using in-situ and satellite observations

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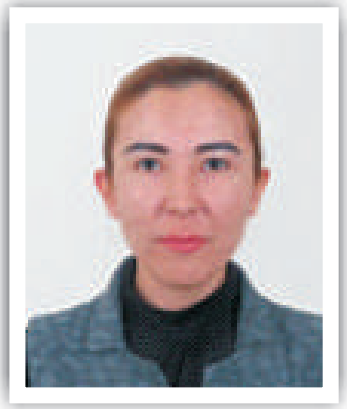

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Kazakhstan region (Ust-Kamenogorsk, Semey, Glubokoe, Altai) during 2016 and over the city of Ridder during 2018. This study utilized the data from environmental monitoring of the Republican State Enterprise “Kazhydromet” and satellite data from Atmospheric Infrared Sounder (AIRS) during 2005-16. The diurnal variation of CO showed two peaks over all observational sites with the first peak at 08:00 hrs and the second at approximately 20:00 hrs. CO showed maximum concentration during winter and minimum during summer over all the observational locations. During winter, maximum CO concentration was observed over Ust-Kamenogorsk city (1078.5±573 ppbv) and minimum over Semey city (506.4±42 ppbv). The lowest CO concentration was observed during summer (163.9±52 ppbv) over Altai city. This may be attributed to shallow boundary layer over Kazakhstan during winter time. The diurnal variation of O3 showed daytime broad peak from about 1000 hrs to 1600 hrs. However, its daily amplitude varied over several months. Ozone seasonal variations showed highest during the summer (56.1±2.0 ppbv) over Glubokoe city and lowest during the winter season (14.1±0.9 ppbv) over Ridder city during the observation period. This is due to unavailability of sufficient solar radiation due to cloud cover during winter. Satellite data from AIRS have been used to calculate the linear trends over these locations during 2005-2015. At surface (925 hPa), AIRS CO and ozone showed decreasing trend over all the observational sites.

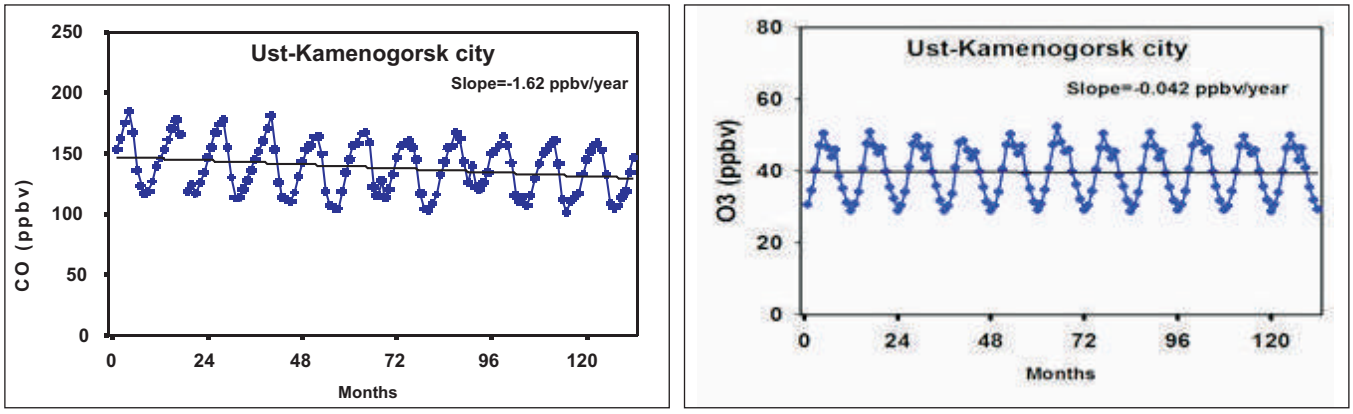

Fig. 1: Trend analysis satellite observations trace gases CO and O3

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

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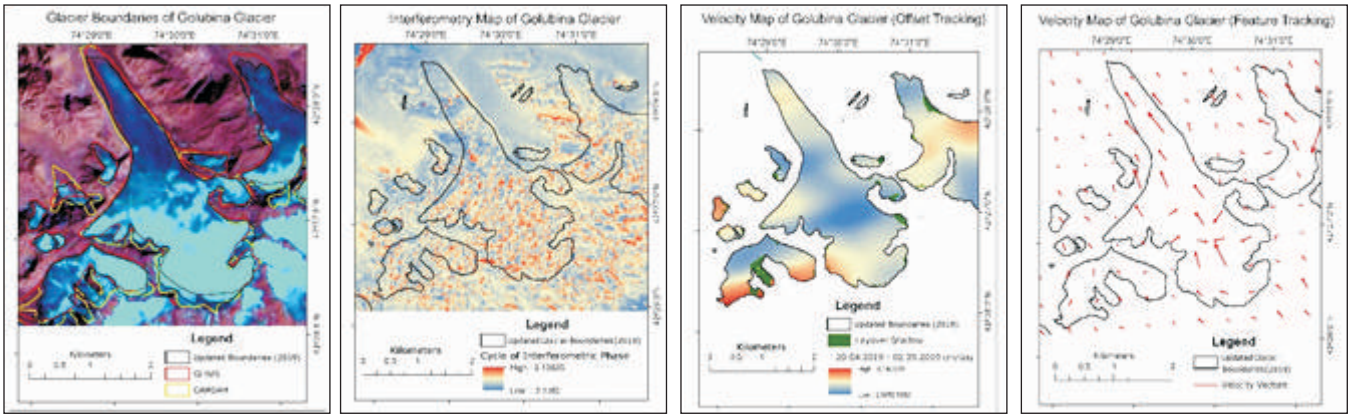
Glaciers are the largest freshwater resources. Glacier dynamics studies in terms of their retreat and mass change are important from climate change and its impact point of view. The glaciers of Kyrgyz Republic, which are located in Tien Shan and Pamir-Alay mountains, are vital in water supply in arid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



Change Detection Analysis of Mining Area Using InSAR

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A B S T R A C T

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

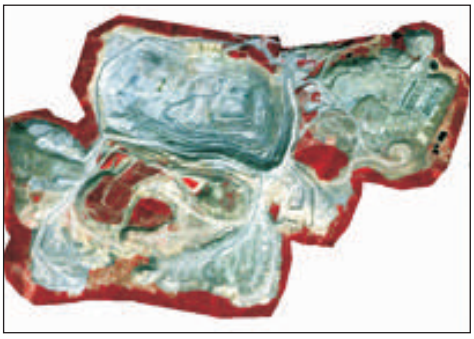


Fig. 1: Optical data sentinel 2

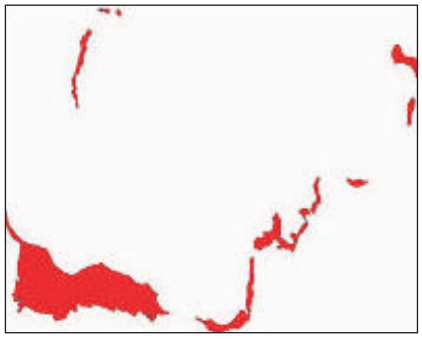


Fig. 2: changed area (2017-2019)

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

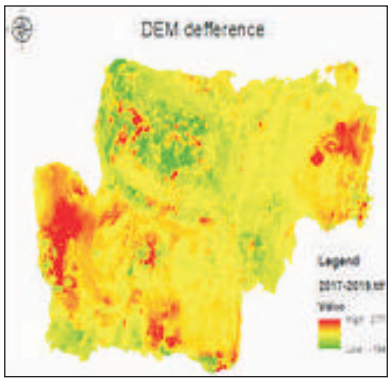
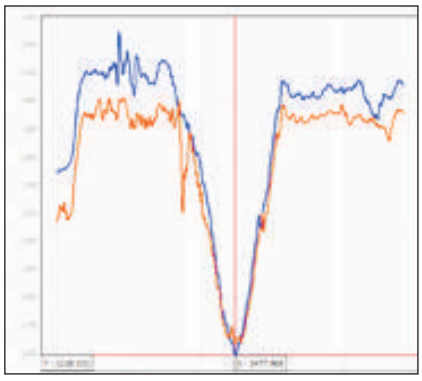


Fig. 4: DEM defference (2017-2019)



profoli line of sight (2017-2019

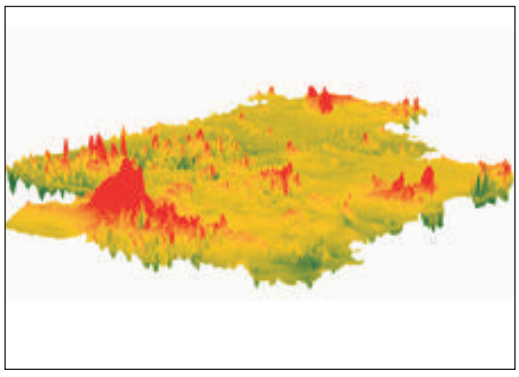


Fig. 3: 3D analysis

Customization of GIS for License Documentation Process and for citizen participation in urban planning in Mongolian language

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

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

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

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

Print out of Building's Management

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

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

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A B S T R A C T

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

Khalkh river one of the largest rivers in the eastern part of Mongolia, originates at 1273m above the sea level at Xiangang ridge and flows in the Buir lake. Catchment area of this river is around 78,360 km2, of which 7,440 km2 is in the territory of Mongolia. Length of Khalkh river is 435 km, of which 264 km flows in Mongolia.

Buir lake is a freshwater lake that lies on the borders of Mongolia and China. Among the lakes in the eastern part of Mongolia, it is the largest lake by volume of freshwater and unique in physical geography and ecologically. Annually ice cover over the Buir lake is more than 160 days. The average precipitation is 240 mm/year, inflow from Khalkh river in the lake is around 13m3 /s. Total evaporation of Buir lake 900 mm/year. The surface runoff contribution to the Buir Lake is mainly due to rainfall and snowfall in the Khalkh river basin and ranges from 0.464 to 1.838 km3.

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

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

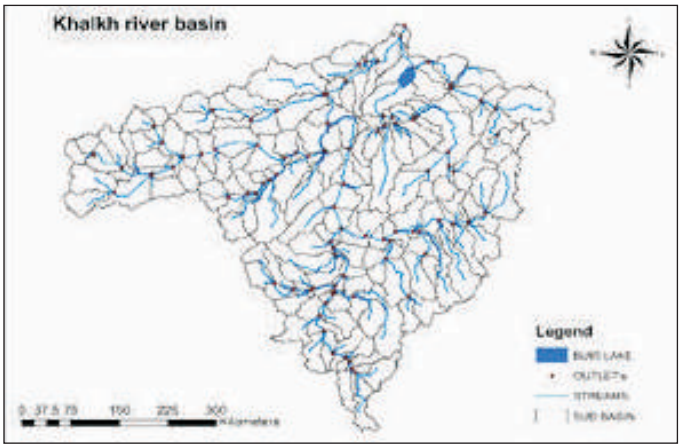

Fig. 1: Buir Sub-watershed

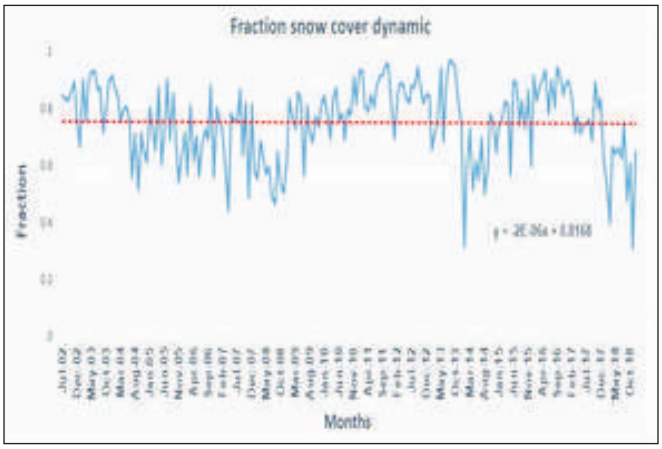

Fig. 2: Fraction snow cover dynamic

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

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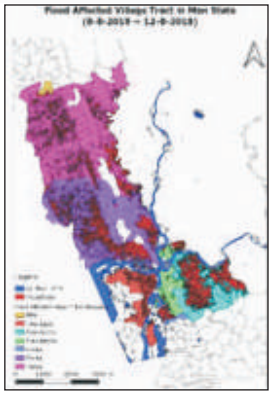
Remote Sensing and Geographic Information System play an important role in disaster management sector, which provide the timely scientific information. Flood is the frequently occurring disaster and it may cause huge damage for the human life and their properties.



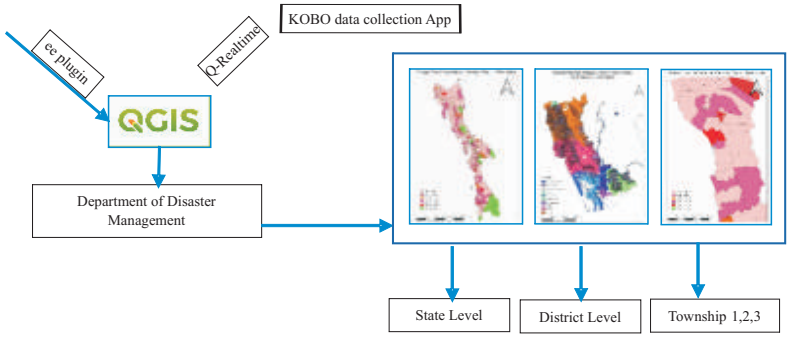
Myanmar is a flooded prone country which is necessary to provide near real-time flood maps during flood response period. Therefore, disaster respond can be done successfully.

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

In this project, Sentinel-1 SAR images are mainly utilized due to advantages of 6 days revisiting period and cloud penetration capabilities. It has 4 polarizations VV, VH, HH, HV among which VV is more adequate for flood mapping. Initially the pixels of VV component image are classified into water and non-water classes. Then, permanent water bodies are subtracted from the above generated layer which delineates the flooded area. Sentinel 2 images will also be used in unavailability of Sentinel-1 data. The cloud masked NIR (0.841 ~ 0.876 nm) and SWIR (1.628~1.652 nm) are used for calculating normalized difference Water Index (NDWI) from which permanent water bodies are subtracted to generate flood plain layer. And when, both the images are unavailable, ground data is collected by KOBO application. The above methodology is applied for Southern Myanmar flood occurred during August, 2019. The resulting flood layer used along with demographic and administrative boundary maps to calculate the affected area of village tracts, and estimate the total affected population.

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

Keywords: flood, SAR, NDWI, ee plugin, Q-Realtime, QGIS



ABSTRACT

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

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A B S T R A C T

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

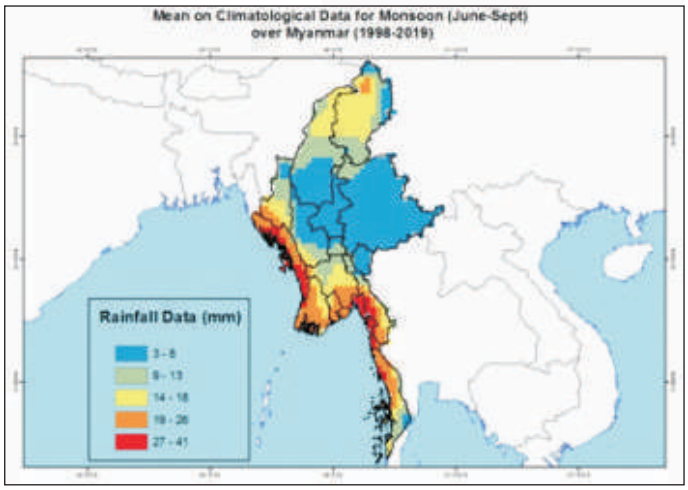
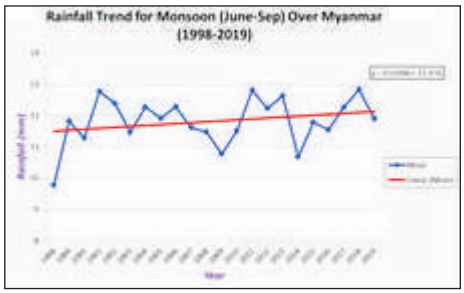


Fig. 1: Climatological Data for Monsoon (June-September) over Myanmar (1998-2019)

In this study, the detailed rainfall climatology of Myanmar has been studied based on 22 years of TRMM 3B43 V7 monthly rainfall data 0.25° x 0.25° (1998-2019) of the country for the summer monsoon months (May-October) and (JuneSeptember). TRMM monthly data obtained from combined sensors and ground gauges have been compared to ground measurements. The ground data used for validation were obtained for six stations on southern zone (Mon and Kachin States) of Myanmar. Based on the climatological rainfall distribution, standard deviation and topography, this analysis is focused on five homogeneous rainfall regions: Northern Zone (Kachin), Coastal Zone (Rakhine), Eastern Zone (Shan) and Southern Zone (Mon and Kayin).

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



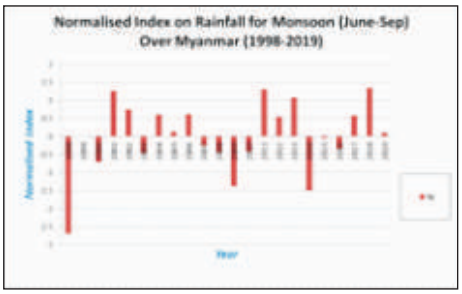


Fig. 2(a): Rainfall Trend over Myanmar **2(b):** Estimation of Flood and Drought Years over Myanmar

Flood Inundation mapping using Remote Sensing Data; A cause study of Hpa-An City, Myanmar

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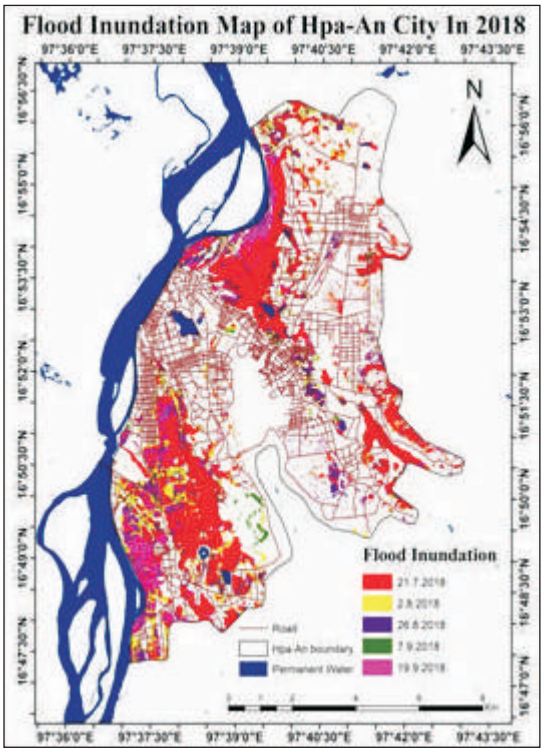
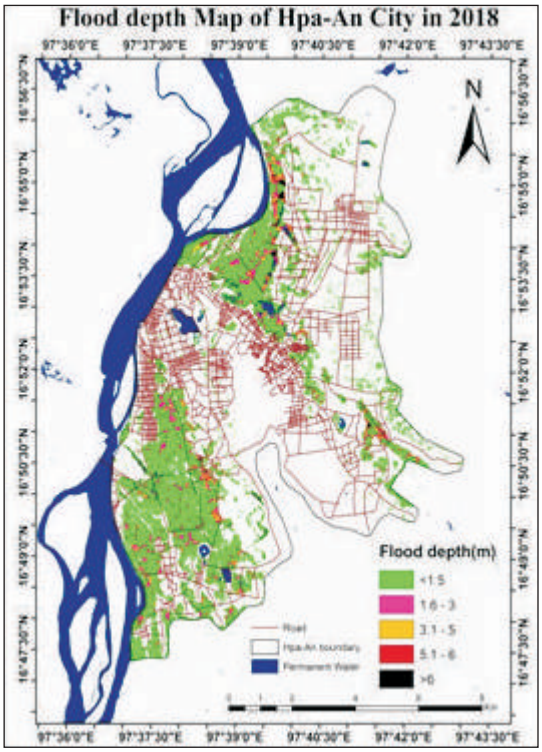
Flooding is one of the major hazards and the most devastating natural disasters in the world. During the last decades, floods led to loss of lives and properties, damage to critical infrastructures, economic losses and health related problems such as outbreak of water, the situation is not so different in Hpa-An City, Myanmar. In the present study attempt has been made to map flood inundation of 2018 flood events in Hpa-An City, Myanmar using Sentinel-1 data. FwDET tool which calculates water depth by subtracting the calculated flood water elevation (above mean sea level) from topographic elevation at each grid cell within the flooded domain has been applied to estimated flood water depth. The present case study efficiently provides synoptic assessment of flood water extent and depth. Limitations include challenges in obtaining high-resolution DEMs and increases in uncertainty when applied for highly fragmented flood inundation domains.





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

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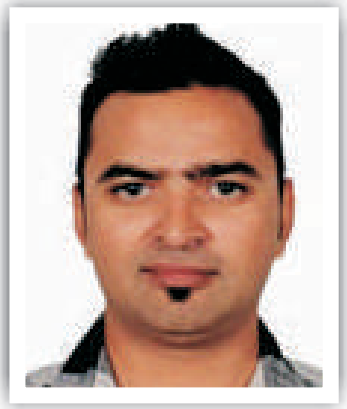

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ABSTRACT

Estimation of evapotranspiration is significantly important in cropping field because it determines the crop water requirement and is the main component of water balance, irrigation scheduling, water management, water budgeting and hydrological cycle. The objective of this research is to estimate actual crop evapotranspiration of the cropping field by remote sensing energy balance approach using modified Priestley-Tailor Model (Modified PT). The outputs were generated for six geometrically and atmospherically corrected images from Landsat 8 Operational Land Imager and Thermal Band Infrared Sensors extended period from November 2018 to April 2019, having an image per month of the winter cropping season (Wheat and mustard as major crops) in Morang District of eastern Nepal. Parametrization of various pre-requisite parameters were done and various remote sensing derived products were developed using Landsat-8 data i.e. land surface temperature; normalised difference vegetation index and percentage of vegetation, surface albedo, net radiation soil heat flux. and model evaporative fraction. Finally, instantaneous evapotranspiration is generated for each images. It was observed that land surface temperature of the study area reaches maximum at 36.7 degree centigrade on 11th of April 2019 and minimum 21.8 degree centigrade on 21st January 2018 this was because of the higher emissivity from land surface during the end of the cropping season and winter period. Ground heat flux is also follow the similar trends having minimum at 13.25 W/m2 January 2018 and maximum at 43.59 W/m2 in April 2019. The average latent heat flux with in the cropping season varies between 31.29 W/m2 to 58.34 W/m2 with respective crop evapotranspiration of 1.22 mm/day to 2.01 mm/day. This research conclude that spatial and temporal variation of crop evapotranspiration can be well mapped using modified PT method in the terai region of Nepal. Further, with the ground measurement of the ET and validation for the entire terai region of the country would be the future research extension in Nepal.

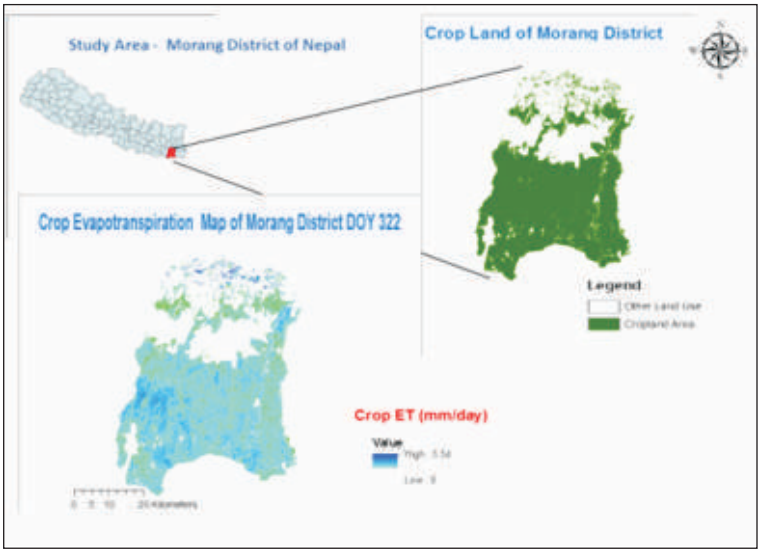

Fig 1: Study area and ET Map

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

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Terrestrial water storage (TWS) at high spatial and temporal resolution is deemed necessary for many hydrological and hydrogeological applications. Since its launch, Gravity Recovery and Climate Experiment (GRACE) satellite has been providing water storage change data at global and regional scales. Due to above reason, the application of GRACE data for local-scale water resources management has been limited. The research work was be able to downloading GRACE with a statistical method. In this work, empirical regression methods based on the relationship between GRACE and other hydrological fluxes were applied to downscale 1 degree gridded GRACE product to 0.25 degree data. The ground water level change results were quantified by calculation mass lost for four year interval. Statistical regression downscaling method can improve GRACE data resolution effectively.

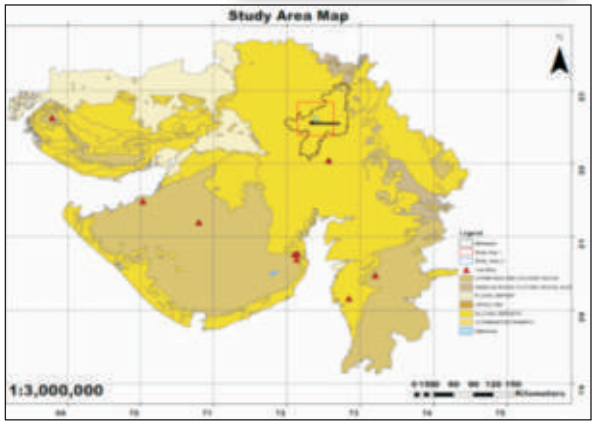

Fig. 1: Study area

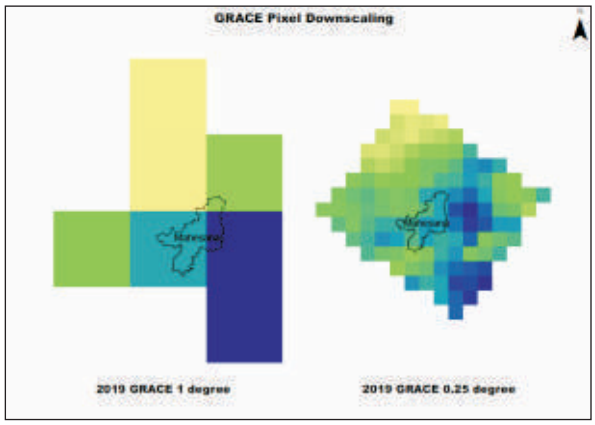

Fig. 2: GRACE data downscaling

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

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

Fuzzy Machine learning for bi-sensor temporal data processing: A case study for forest vegetation species/specific crop mapping

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A B S T R A C T

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

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

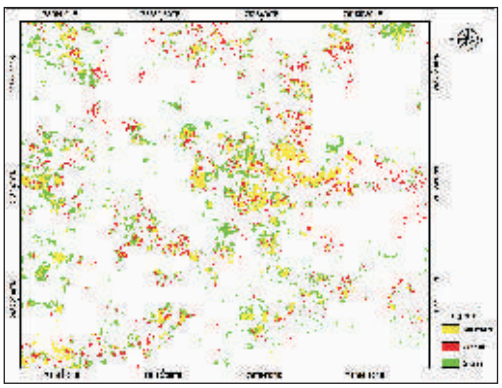

Fig. 1: Wheat, Mustard and grass mapped fields

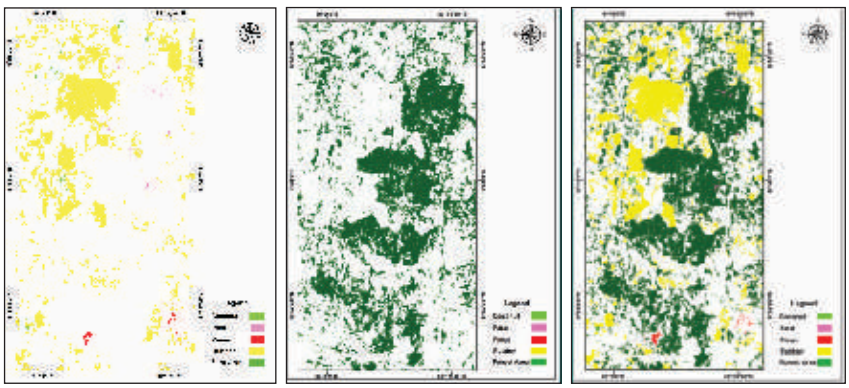

Fig. 2: Rubber, Pinus, Coconut, Forest area Mapped Fields

Land use land cover (LULC) change detection from 2005 and 2019: A case study in Colombo, Sri Lanka

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ABSTRACT

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

In this study an attempt is made to observe the changes in LULC features of Colombo, capital of the Sri Lanka. The Landsat multispectral data was used in this study and was acquired from 2005-2019. Three different ML classifiers Random Forest (RF), support vector machine (SVM) and artificial neural network (ANN) was performed for LULC classification on Landsat-2019 data and best classification algorithm observed for this study was identified. The multispectral data was classified according to using standard colour of LULC map in Sri Lanka, as base map according to this classification scheme into seven classes: urban, plantation, forest, paddy, grass, land scrub land and water. All the datasets from 2005-2019 (2005, 2008, 2011, 2015 and 2019) were classified using the best identified ML classifier and change detection was carried out. It was observed from the Landsat- 2019 classified data that ML classifier SVM outperformed (OA-92.500% kappa- 0.9124), RF (OA-85.2778%.kappa- 0.8280), and ANN (OA- 71.9403%.kappa- 0.6703) classifiers, so SVM was used for classifying data of other dates. The urban land use pattern were increased from 2005 to 2019 and paddy fields reduced. But there is no significant change observed in water and forests class.

Keywords: LULC, Landsat, SVM, RF, ANN and Change detection

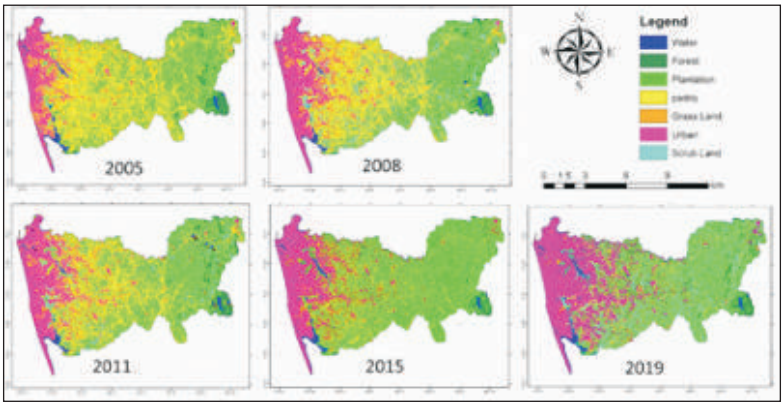

Fig.: LULC Classified maps from Landsat data (2005, 2008, 2011, 2015 and 2019)

Decadal scale (2009-2018) aerosol variability over India during post-monsoon season - A case study using satellite and model reanalysis data

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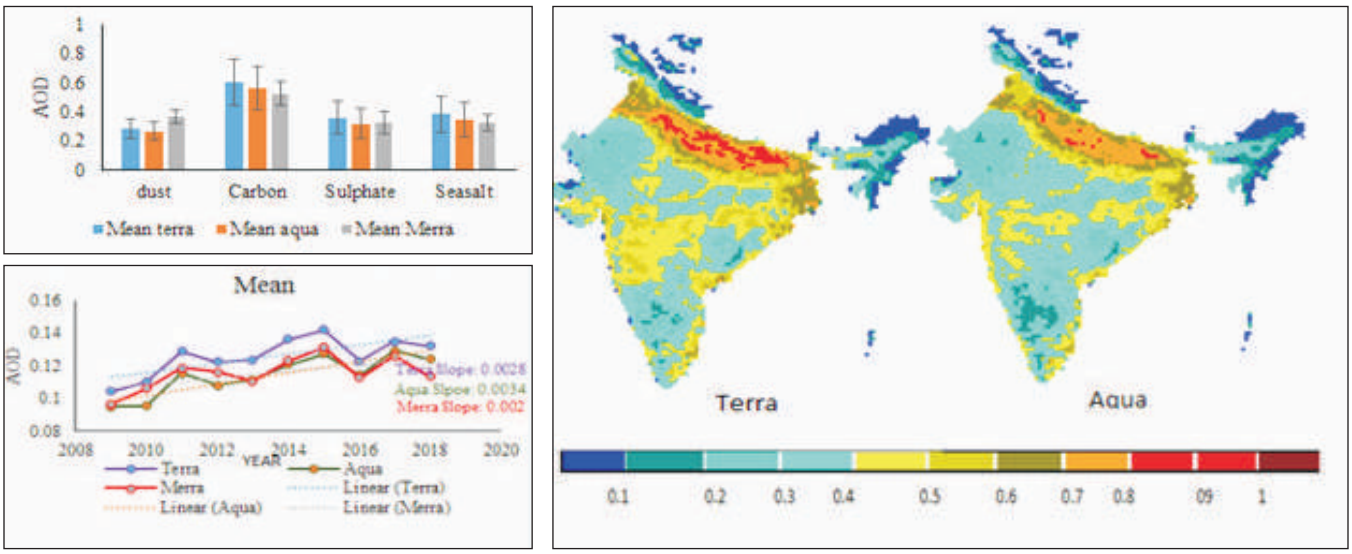
A B S T R A C T

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

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



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

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

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

The purpose of this study is to develop an approach for automatic extraction of buildings in urbanized and suburbanized areas using very high spatial resolution multispectral aerial images and LiDAR data set. The methodology focuses on improved building boundary polygonization from high resolution range and intensity data. The Active Contour (Snake) model is initialized and augmented by integrating with LiDAR data. Enhancement of building boundary polygonization is attempted by combined use of high resolution optical image and high density LiDAR point cloud. A rule-based procedure was employed to combine intensity and range information to automatically delineate building boundaries with 3D information. Broad zones of cultural sites was also done. Qualitative and quantitative measures are used for evaluating the performance of the proposed method.

Keywords: Automatic extraction, LiDAR, Active contour model

Fig. 1: Aerial image

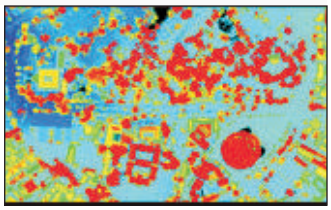

Fig. 1: Lidar Point cloud

Fig. 2: Supervised classified image

Fig. 4: Elevation threshold image

Fig. 3 : Only buildings

Fig. 4: After Morphological Operators

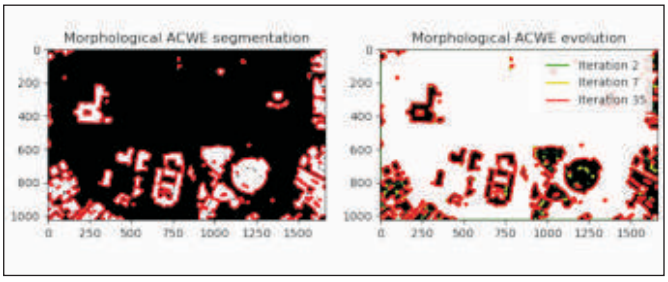

Fig.: 5 Building segmentation with active contour model

Hydrological modelling using SWAT model on the PANJ river basin

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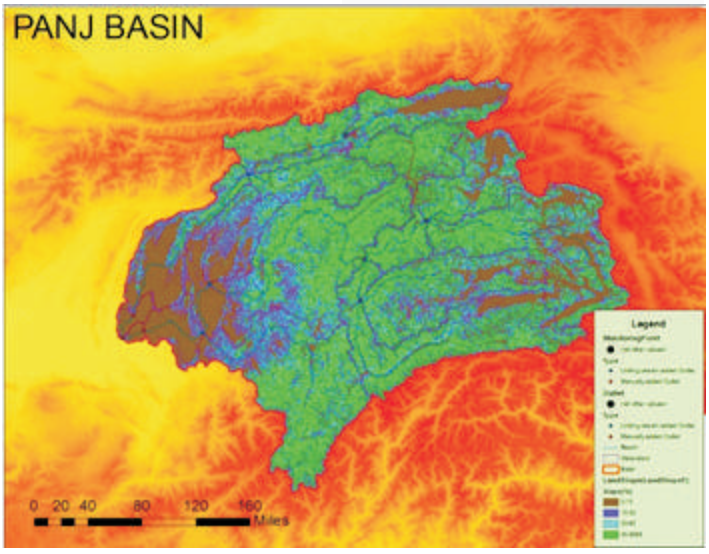
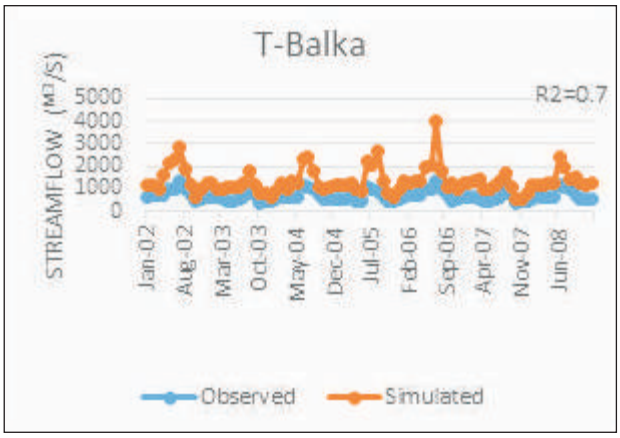
A B S T R A C T

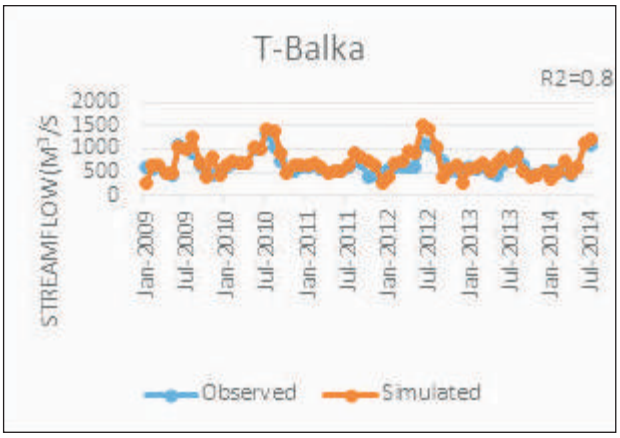
The hydrological modelling is applied by SWAT model (Soil and water assessment tool) in the Panj river basin. The total area of the basin is 160288, 2km^2. The basin is located in the south part of Tajikistan and north part of Afghanistan.



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

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





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

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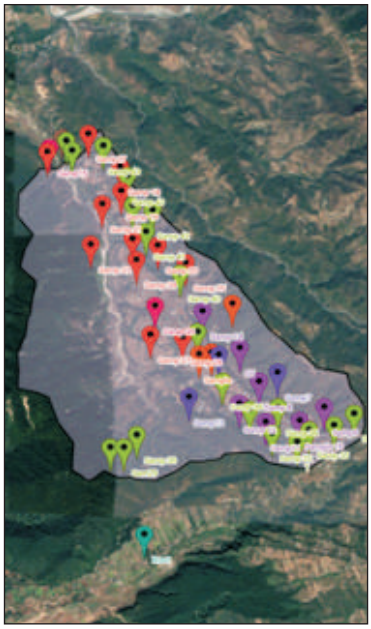
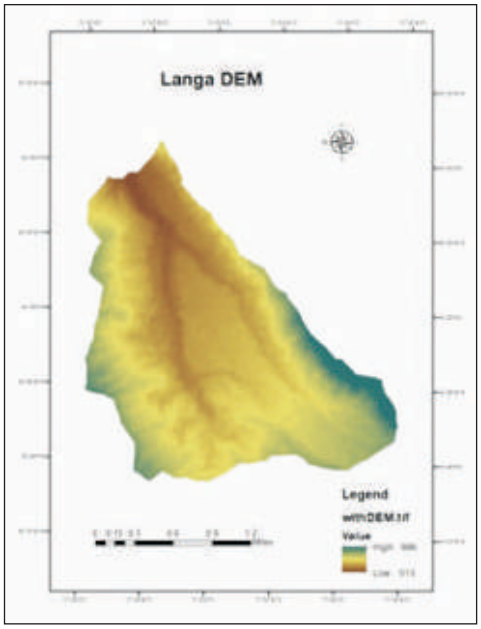
Quantification of soil loss is a significant issue for soil and water conservation practitioners and policymakers. A natural process affected by human activities as erosion causes soil or layers of soil to be moved or washed away. In addition to erosion, soil quality is affected by other aspects of agriculture.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

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

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

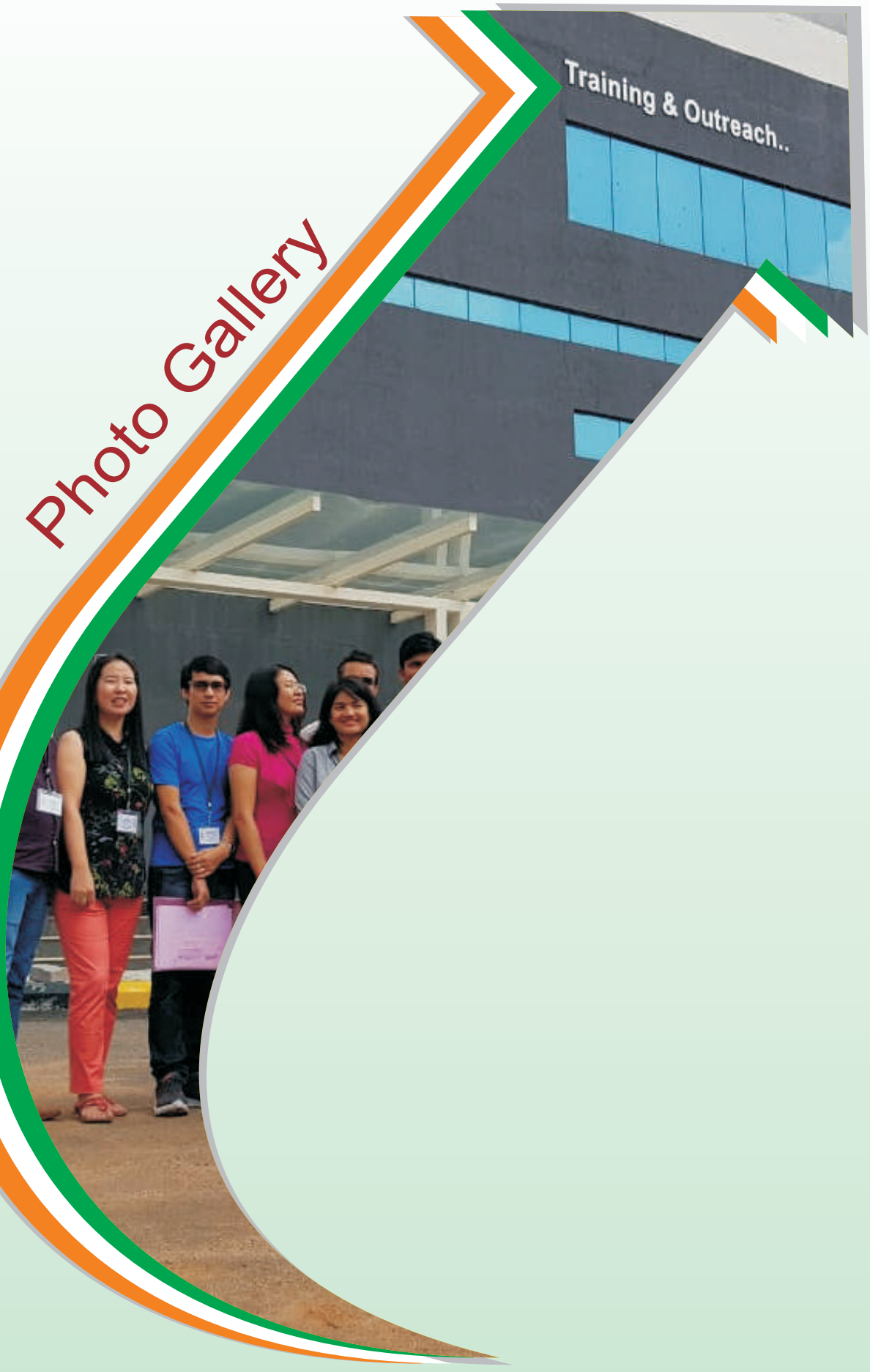


47 collected samples



DEM of Langa Watershed

Photo Gallery



Clockwise from Top

1. Participants with Dr. Kiran Kumar, Former Chairman ISRO
2 - Participants interacting with Dr. R.R. Navalgund
3 - Participants at NRSC Outreach Facility at Jedimetla, Hyderabad
4 - Participants at Vizag beach
5 - Dr. Keran Wang, UNESCAP interacting with participants

Clockwise from Top

6 - Group photo after pilot project synopsis presentation
7 - In ISRo Guest House at Delhi
8 - Celebrating Holi
9 - Celebrating Kazakhstan Nation Independence Day

Clockwise from Top

12 - Carrying field work
13 - Participating in Indian Republic Day functions
14 - Celebrating Brithday party at CSSTEAP Hostel
15 - Celebrating Diwali
16 - Visit to Earth Station at NRSC Sahdnagar

Impressions of Participants

In Remembrance

In today's trend, Remote Sensing and GIS is one of the most after-sought courses across the globe. Participants from 10 different countries were nominated to pursue their dreams and aspirations in application of Space Science through “Center for Space Science and Technology Education in Asia and the Pacific” (CSSTEAP). Whilst, the center of excellence 'Indian Institute of Remote Sensing' (IIRS) was the host Institution.

The 24th batch of PGD students in RS & GIS course came from diverse technical and non-technical background including engineers, researchers, officers, students and so forth. The amalgam of this diverse group made the 24th batch a unique batch in itself and we termed our group as “Fraternity”. With lots of zeal and yearning to learn more on space science, the participants started arriving to the temple of learning (IIRS) as early as 28th of June, 2019. Hereon, the Yamuna Hostel became home away home for the next nine months.

Passing through the busy traffic and narrow lane of Kalidas road there was sigh of relief as we reached and entered the serene and beautiful IIRS campus. Alas! a thought reverberated, if only the road connecting to IIRS was wide enough with better sign boards, to match the grandeur of IIRS, the institution of excellence.

Yamuna Hostel was all in one with all the basic amenities put in place, a perfect room size for single occupancy. The interior allocation and alignment of rooms to the exterior outlook of building was perfect interpretation of a good engineering.

Gazing at each other, sharing momentary gestures with brief introduction among us, all were friends thereon. Some names were difficult to pronounce while many were common and few names were extremely long.

The journey of nine months PG Diploma in Remote Sensing and GIS began with orientation programs for first one week followed by the regular classes. It was pure confinement to those who were office goers and having to attend the regular classes after a long time gap. Nevertheless, it was worth recalling those early school and college days. A new chapter, a new environment, a luxurious classroom and with lots of energy we began our course. For the first few days of our classes, it was often difficult to hide dozing off from the teachers as their microwave sensors were upon us. The course modules were attuned to a well-planned curriculum. The practical classes in the afternoon followed respective lecture of the morning session. Three months of our academic session was a smooth sail despite many back scattering and many attenuation while trying to understand space science. At times, the wavelength could reach and penetrate the subject matter well, but many a time it backscattered. Perhaps our systems and sensors were not perfectly harmonized like Push broom or Whiskbroom. While, many of our friends had great swath width like that of MODIS satellite and captured in detail. It was only through consistent effort of great scientists who made sure that the lectures delivered were understood beyond theoretical boundaries. To evaluate our depth of understanding on the subject matter, the faculty often remotely sensed us by means of class test and assignments. By then, it was October, it was time for us to pave towards our designated departments. Spending endless time together, the fondness among the family of twenty-two had grown stronger and parting to different departments was not very welcoming. Announcement of a week-long educational trip brought smiles on us. The onus of the trip to visit some of the other ISRO centers was on Dr. C.M Bhatt & Mr. Hari Shankar, our perfect guides for the trip. It was a well-organized educational trip. Beside learning and exposure to world-class data retrieving center and other ISRO institutions, we also had gala time. The last leg of our trip ended with visit to world heritage center, the epitome of love and dedication, the Taj Mahal.

Back to IIRS, everyone paved towards his or her own department. The group of twenty-two disintegrated into smaller groups, as small as one. With brief introduction of students and faculties of respective department, the usual trend of regular theory classes followed the practical session in the afternoon. The frequency of field visits increased as often as forth weekly. There were more interactions with other students from IIRS and over the time, the friend list kept on increasing both in real world as well in social media. The students started inviting us on all the occasions or festivals as one family, which meant, we made a place in their hearts. The song 'Sandeshi Aati Hai' presented by the 24th batch on Independence Day (15th of August, 2019) was a gesture of unity to the IIRS family.

By then, we had crossed the peak of 9 months' hydrograph. The remaining duration on the descending limb was allocated to the research work. In order to complete the project on time, this period was race against time. Everyone was engrossed with his or her own share of work. Doing a good research is not at all a smooth sail, often accompanied by mood swings depending on the progress.

As said “time flies” it was already March, 2020 with only couple of weeks remaining. Many of us were happy to be back home soon and at the same time sad to miss our fellow colleagues, faculties and the beautiful IIRS. Like honeybees, the last two weeks were the busiest week. However, it enlightened us on the importance of time management.

Not all those beautiful memories would have been possible without continuous guidance and support of our CSSTEAP Management. The entire team including the Director to the Office bearers stood by us firm and committed to make our nine months stay memorable. Thus, how can this memoir be complete without conveying our heartfelt and sincere gratitude to the Director Dr.

A. Senthil Kumar, Programme Coordinator Dr. S. P Aggarwal (your approach of delivering lecture is remarkable), Course Director Dr. C.M Bhatt, Course Coordinator Mr. Hari Shankar and to all the Officials of CSSTEAP and IIRS. You all have a special place in our hearts.

Thank you for everything

- Batch of 24th RS&GIS course

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Mr. Chintaka Sajith Devinda
Sri Lanka

Ms. Lakmani Somawansha
Sri Lanka

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Mr. Angarag Altangerel
Mongolia

Mr. Krishna Kumar Subedi
Bhutan

Mr. GautamThapa
Bhutan

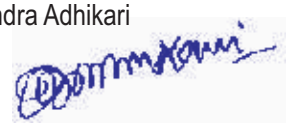
Ms. Shinechimeg Altannavch
Mongolia

Mr. Anushervon Abdulimov
Tajikistan

Mr. Emilbek Zholdoshbekov
Kyrgyzstan

Mr. Tun Tun Naing
Myanmar

Mr. Rabindra Adhikari
Nepal



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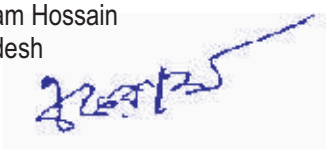
Ms. Allamraju Aditya
India

Mr. Jahendra Praveen Kumar Chorapali
India

Ms. Su Nandar Myint
Myanmar

Mr. Rentsendorj Odgerel
Mongolia

Mr. Akram Hossain
Bangladesh



Ms. Lyazat Kaskenova
Kazakhstan

Ms. Thandar Aung
Myanmar

Ms. Anuradha Anushika Silva
Sri Lanka

Threading Pearls of Wisdom

Accompanied by Director, a man with grace enters the hallway in gentle pace. Director introduces him as Professor R.R Navalgund, an eminent scientist "Father of Space Technology". And, to our utter surprise, his contributions to the Space Science were mind-boggling. His illustrative portfolios, accomplishments and associations qualifies him as one of the ***Ace*** in Space Science and Technology domain.

For all of us this was a lifetime opportunity to have direct face to face interaction. Like any notable distinguished persona, his self-introductory was short but precise, probably meant action speaks louder than the words.

Radiant and impulsive look, soothing voice and comforting words, the CSSTEAP participants shared project themes. Happily, he threw light on each of our project topics and shared valuable suggestions to the extent on lighter note disagreed to some of our reasoning and approach.

During the QNA, he shared couple of great thoughts. On the question raised by one of the CSSTEAP participant*"What are some of the cutting edge technologies of ISRO over NASA?"* With all humility, he responded NASA is better placed to ISRO with availability of fund, facilities, and needless to say, their hi-tech technologies. However, ISRO possesses great and committed mindset and dedicated professionals. Their engagement and commitment in Nation building is far enriching that ISRO possesses. He explained how ISRO rose to fame, the concepts and approach on Chandrayan mission and launching of Satellites. All the success of ISRO is purely on rigorous hard work and unwavering sacrifices of professionals against huge investment on the Launching Vehicles. He shared, once a student asked him "why does ISRO take longer time in getting satellites to its platform?" and he intricately explained the launching concept relating to **"Jugaad"** terminology.

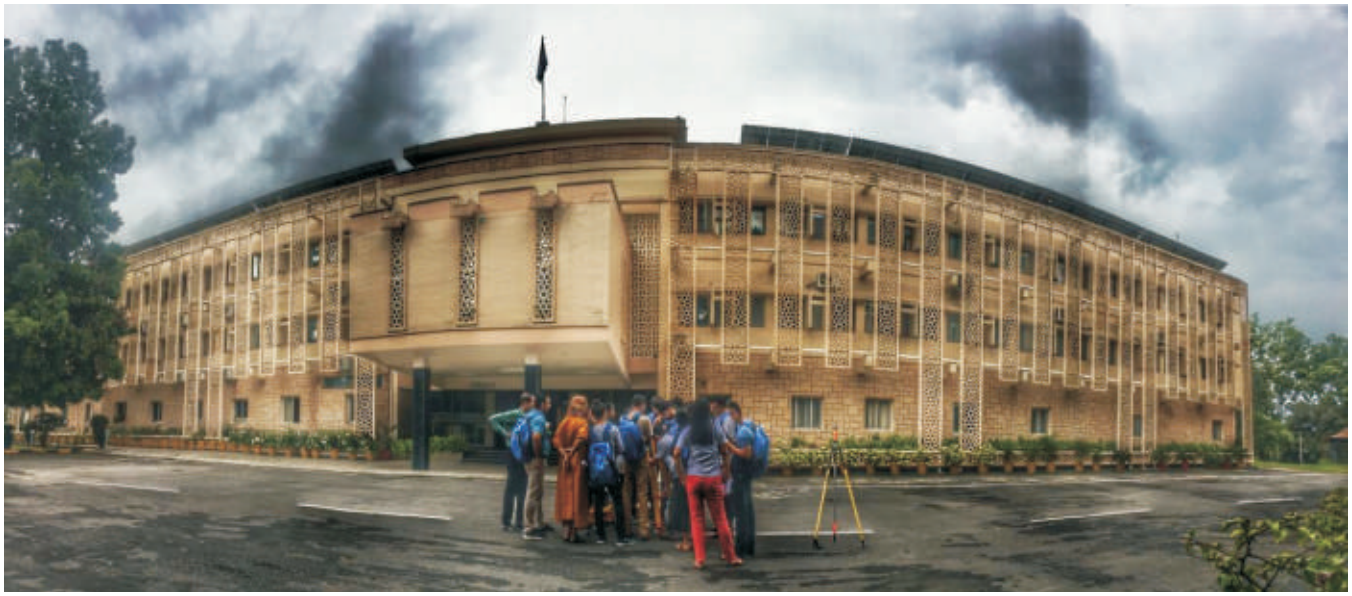
The final take away on the application of Remote Sensing was to apply this sensing technology very sensibly as it involves greater understanding of this evolving technology and conveyed "***Best wishes in your future Endeavors***"

We thank Professor Sir for sparing his valuable time and CSSTEAP for arranging the meeting.

Gautam Thapa (Bhutan)

Creativity Through Camera Lens By CSSTEAP Participant

Chinthaka Sajith (Sri Lanka)




EC100
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