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

(AFFILIATED TO THE UNITED NATIONS)

MEMOIRS

Twenty Third Post Graduate Course in Remote Sensing & Geographic Information System 2018 - 2019

Conducted at

Indian Institute of Remote Sensing (IIRS)

Indian Space Research Organisation

Dehradun, India

CSSTEAP GOVERNING BOARD MEMBERS

India
Chairman, CSSTEAP-GB
Dr. K. Sivan
Secretary, Department of Space
Antariksh Bhavan
New BEL Road
Bengaluru - 560 094,
India

Bangladesh
Mr. Shamsuddin Ahmed
Director
Bangladesh Meteorological Department &
PR of Bangladesh with WMO
Meteorological Complex, Agargaon
Dhaka-1207, Bangladesh

DPR Korea
Dr. Hong Yong IL
In Charge of S & T
Embassy of DPR Korea
First Floor, C-17, Lajpat Nagar-III
New Delhi-110024

Indonesia
Dr. Thomas Djamaluddin
Chairman, LAPAN
Indonesian National Institute of
Aeronautics and Space
Jl. Pemuda Persil No.1
Jakarta, Indonesia

Iran
Mr. Ali Sadeghi Naeini
Iranian Space Agency
No. 34- Sayeh Street
Afrigha Boulevard
Tehran, Iran

Kazakhstan
H.E. Mr. Bulat Sergazievich Sarsenbayev
Ambassador of Kazakhstan to India
Embassy of Kazakhstan
61 Poorvi Marg, Vasant Vihar
NEW DELHI-110057

Kyrgyz Republic
Prof. Abdykalykov Akymbek Abdykalykovich
President
International University for Innovation
Technologies
720048, Bishkek 1/17, Gorky Street
Kyrgyz Republic 720048

Malaysia
H. E. Dato Hidayat Abdul Hamid
High Commissioner
Malaysia High Commission
50M, Satya Marg, Chankyapuri
New Delhi - 110 021,
India

Mongolia

Myanmar
Dr. Kyi Thwin
Acting Rector,
Myanmar Aerospace Engineering
University,
Meiktila, Mandalay Division
Myanmar

Nauru
Mr. Charan Kamal Singh Bhalla
Hony. Consul General of Nauru
S-327, Greater Kailash-I
New Delhi - 110 048,
India

Nepal
Mr. Hari Odari
Minister Counsellor
Embassy of Nepal
Barha Khamba Road
New Delhi - 110 001,
India

Philippines
H.E (Mrs) Ma.Teresita C. Daza
Ambassador of Republic of Philippines
Embassy of Republic of Philippines
50N, Nyaya Marg
Chanakyapuri
New Delhi - 110 021

Republic of Korea
Mr. Ok-Kyu Lee
Principal Engineer
International Relation Team
Korea Aerospace Research Institute
45, Eoeun-Dong,
You Seong-Gu
Daejeon - 305 333
Republic of Korea

Sri Lanka
Mr. S. Panawennage
Director General & CEO
Arthur C Clarke Centre for Modern
Technology
Katubedda, Moratuwa,
Sri Lanka

Uzbekistan
Dr. Kamol M. Muminov
GB CSSTEAP Member
Ulugh Beg Astronomical Institute of the
Uzbekistan Academy of Sciences
33, Astronomicheskaya Str.,
Tashkent 100052,
Uzbekistan

Thailand
The Executive Director
Geo-Informatics and Space Technology
Development Agency
Government Complex,
Building B, 6-7th Floor
120 Moo 3 Chaeng Wattana Road
Lakshi, Bangkok 10210
Bangkok 10900, Thailand

UN-OOSA
Dr. (Mrs) Simonetta Di Pippo (Observer)
Director
UN Office for Outer Space Affairs
Vienna International Centre
PO Box 500, A-1400
Vienna, Austria

ITC, The Netherlands
Prof. Dr. Ir. A. (Tom) Veldkamp (Observer)
Rector, ITC
Faculty of Geo-information Science and
Earth Observation
of the University of Twente
PO Box 217, 7500 AE Enschede
The Netherlands

Secretary
Dr. A. Senthil Kumar
Director, CSSTEAP
Indian Institute of Remote Sensing
Campus
PB No.222, No.4, Kalidas Road
Dehradun - 248 001, India

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

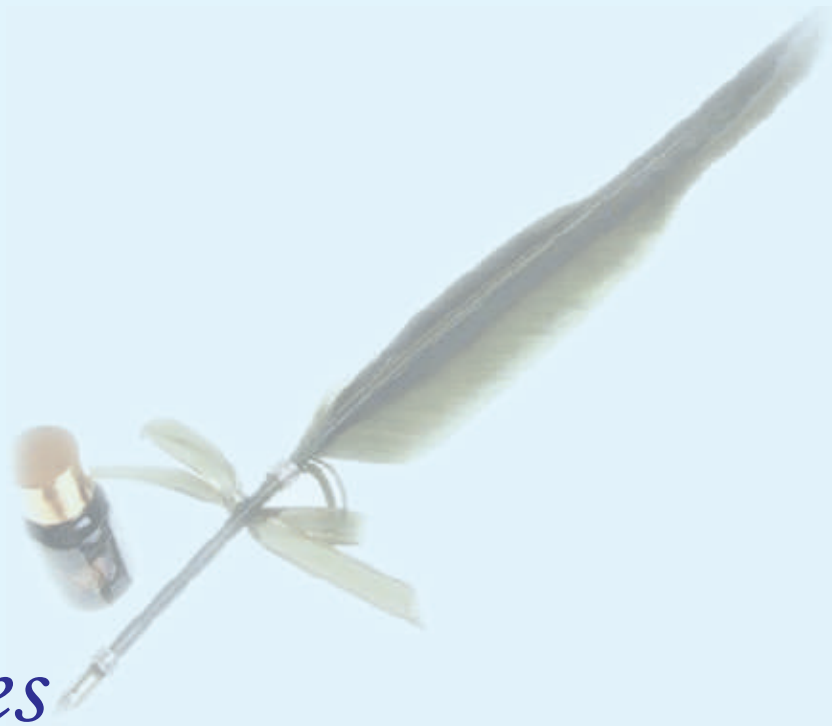
MEMOIRS

TWENTY THIRD POST GRADUATE COURSE IN REMOTE SENSING &
GEOGRAPHIC INFORMATION SYSTEM
JULY 2018 TO MARCH 2019

Conducted at

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

CONTENTS



Messages

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

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

(Affiliated to the United Nations)

Dr. K. Sivan
Chairman, CSSTEAP GB/
Secretary, DOS

ISRO Headquarters
Antariksh Bhavan, New BEL Road
Bangalore 560 094, India
Ph: +91-80-23415241,22172333
Fax: +91-80-23415328
E-mail: chairman@isro.gov.in

Message

It gives me great pleasure in noting that 23rd Post Graduate course on Remote Sensing and Geographic Information System (RS&GIS) of the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) is successfully concluding and 24 participants from 11 countries are benefitted from this program. I heartily congratulate all the participants for successfully completing the course.

Remote Sensing and Geospatial technologies are used in variety of areas, such as, planning and management of natural resources, infrastructure development, disaster management etc. With the availability of Earth Observation data from various platforms and sensors, the scope of exploring newer areas of remote sensing applications are widening.

The CSSTEAP and host institution IIRS, deserve special appreciation, particularly for taking up diverse capacity building activities in the Asia-Pacific region. I also would like to convey special appreciation to the faculty and the staff of both the institutions who have taken keen interest to conduct such courses.

I am sure that the expertise gained and pilot projects implemented, would also help the participants to initiate major projects and research programme in their respective countries. I am sure that the benefits of these technologies will help their countries in many ways.

I wish to congratulate all the participants for a successful and result oriented career and also expect them to enable the use of space applications for national, development.

Dated : March 29th, 2019

(कै. शिवन/K. Sivan)

नेपाल राजदूतावास
Embassy of Nepal
Barakhamaba Road, New Delhi-110001
Tel. :23327361/23476200 Fax : 23326587

Message

CSSTEAP is completing 23rd Course on Remote Sensing and Geographical Information System this month. I deem it as yet another important accomplishment in the action-packed calendar of the Centre. More satisfying is the fact that the Course was conducted by the distinguished Indian Institute of Remote Sensing, Dehradun, this region's highly sought after Institute and a centre of excellence in this particular area of education. I wish to extend warmest congratulations to all the participants on successful completion of the Course and on being awarded Post Graduate Diploma Certificate. No doubt that this is going to be a big achievement in their professional life.

Space science has not only become an essential contributor to growth, development and prosperity in modern times but has also been a tool of humanity's survival. It is helping us be better informed about the world and universe, environment, natural resources and human settlements, thereby greatly contribute to making a well informed decisions and formulating most suitable policies. Today, remotely sensed data serve as a source of reliable and timely information needed for sustainable management of natural resources and for environmental protection. I fully believe that through this Course on RS & GIS, the participants have acquired the requisite skill and expertise in this vital faculty of knowledge and are now well prepared to venture into the world of actual application of expertise to the betterment of human society.

I have been informed that 24 participants from 11 counties of the Asia-Pacific region have completed the Course. An international assemblage like this can also help in building and expanding a network among the professionals.

I would like to once again congratulate CSSTEAP, Director Dr. A. Senthil Kumar and the Course Coordinator as well as IIRS Dehradun and the Course participants. I believe the Centre would continue with its great work of disseminating knowledge and expertise through training, education and capacity building programmes and the professionals in the regions would continue to benefit. I also wish the participants best of professional advancement ahead.

March 5, 2019

Hari Prasad Odari
Counsellor (Political)

EMBASSY OF THE REPUBLIC OF THE PHILIPPINES
फिलीपीन्स गणराज्य का दूतावास
NEW DELHI

Message

I wish to extend my warmest congratulations to the Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) for the successful completion of its 23rd Course on Remote Sensing and Geopgraphic Information System (GIS). I also wish to congratulate the 24 candidates from different countries of the Asia Pacific region who participated and completed this course.

Since CSSTEAP's founding in 1995, the Centre has opened its doors to collaboration with member countries, contributing to regional development in various aspects of space science and technology.

The Phillippines is one of the countries which has been benefitting from the educational programmes and trainings offered by the Center. These capacity building efforts of CSSTEAP help enhance and develop the skills and expertise of its participants from the Asia-Pacific region in space science, environment and atmosphereic sciences, satellite communications, Remote Sensing and Geographic Informtion System (RS&GIS) among others.

I wish the CSSTEAP continued success in all its future undertakings.

06 March 2019

MA. TERESITA C. DAZA
Ambassador

50-N Nyaya Marg, Chanakyapuri, New Delhi-110021 India
Tel. No.: (+91-11) 2688-9091 Fax No.: (+91-11) 2687-6401
www.newdelhipe.dfa.gov.ph

สำนักงานพัฒนาเทคโนโลยีอวกาศและภูมิสารสนเทศ (องค์การมหาชน)
กระทรวงวิทยาศาสตร์และเทคโนโลยี
Geo-Informatics and Space Technology Development Agency (Public Organization)
Ministry of Science and Technology

GISTDA 5309 / 667

March 19, 2019

Message

On behalf of the Geo-Informatics and Space Technology Development Agency - GISTDA, I would like extend my sincere congratulation to the 24 participants who successfully completed the 23rd Course on Remote Sensing and Geographical Information System of CSSTEAP during July 2018 - March 2019, In present, the world is facing the problem with natural disasters, pollutions, man-made disasters and etc. While the space technology is one of important and powerful tools to contribute the solutions to mitigate the problem. With the expertise to CSSTEAP, the course provides fundamentals, modelling, applications, and best practices on RS and GIS for natural resources, environment matters and urban resources management. The participants would gain the knowledge and experience for challenging in their career.

I would like to congratulate the Centre for Space Science and Technology for Asia and the Pacific - CSSTEAP on its vision on the importance of Space and Atmospheric Science and conducting this course. CSSTEAP is one of the key successes for accomplishing the Sustainable Development Goals to Asia - Pacific region with the confidence and security.

Finally, I wish all of you success.

(Dr. Anond Snidvongs)
Executive Director
Geo-Informatics and Space Technology Development Agency

Strategy Office
Tel: +662-141-4509
Fax: +662-143-9603

www.gistda.or.th
ศูนย์ราชการเฉลิมพระเกียรติ 80 พรรษา 5 ธันวาคม 2550 เลขที่ 120 หมู่ 3 อาคารรัฐประศาสนภักดี ชั้น 6 และชั้น 7 ถนนแจ้งวัฒนะ แขวงทุ่งสองห้อง เขตหลักสี่ กรุงเทพฯ 10210
The Government Complex Commemorating His Majesty The King's 80th Birthday Anniversary, 5th December, B.E. 2550 (2007)
120 Ratthaprasasanabhakti Building 6th and 7th Floor, Chaeng Wattana Road, Lak Si, Bangkok 10210, THAILAND
E-mail : info@gistda.or.th
Tel. +66 (0) 2143 8877, +66 (0) 2141 4949 Fax +66 (0) 2143 9586-7

भौतिक अनुसंधान प्रयोगशाला
(भारत सरकार, अन्तरिक्ष विभाग की यूनिट)
नवरंगपुरा, अहमदाबाद – 380 009, भारत

Physical Reserach Laboratory
(A Unit of Dept. of Space, Govt. of India)
Navrangpura, Ahmedabad 380 009, India

डॉ. अनिल भारद्वाज, एफएनए, एफएएससी, एफएनएएससी
Dr. Anil Bhardwaj, FNA, FASc, FNASc
निदेशक / Director

Message

I am very happy to learn that the 23rd PG Course on Remote Sensing (RS) and Geographic Information System (GIS) conducted by Indian Institute of Remote Sensing (IIRS), Dehradun (India) from July 1, 2018, is scheduled to be completed by March 31, 2019 with the participants of 24 students from 11 countries of the Asia-Pacific Region.

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

8/3/2019

Date : 8, March 2019

डॉ. अनिल भारद्वाज
Dr. Anil Bhardwaj
निदेशक / Director

ई–मेल/E-mail: abhardwaj@prl.res.in / bhardwaj_SPL@yahoo.com फोन/Phone: +91-79-26314855 फैक्स/Fax: +91-79-26300374


AS - 2

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 beenaccorded 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 theCentre by endorsing a cooperation agreement

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

Governing Board Members during 23rd GB Meeting chaired by Dr. K. Sivan, Chairman CSSTEAP GB

through which the Centre was established. The technicalactivities of the Centre are guided by an International Advisory Committee (AC) consisting of subject experts that critically reviews the curricula, technical facilities, expertise in terms of faculty, etc.

The course curricula developed by the Centre and endorsed by the United Nations are adapted for the educational programmes. The educational programmes of the Centre are oriented towards the 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 knowledge and 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. These educational programmes have benefited many scientists/engineers who will be the future policy &decision makers in several countries.

CSSTEAP conducts all of its educational programmes in close collaboration with one of the DOS institutions and thus has direct access to their physical facilities and intellectual capabilities. In addition to providing facilities, infrastructure and skilled manpower, the Government of India, through the Department of Space provides most of the funding. Funding grants for international travel of participants, subject experts, tuition fees and scholarships of participants 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, Small Satellite 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 organizes workshops & 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

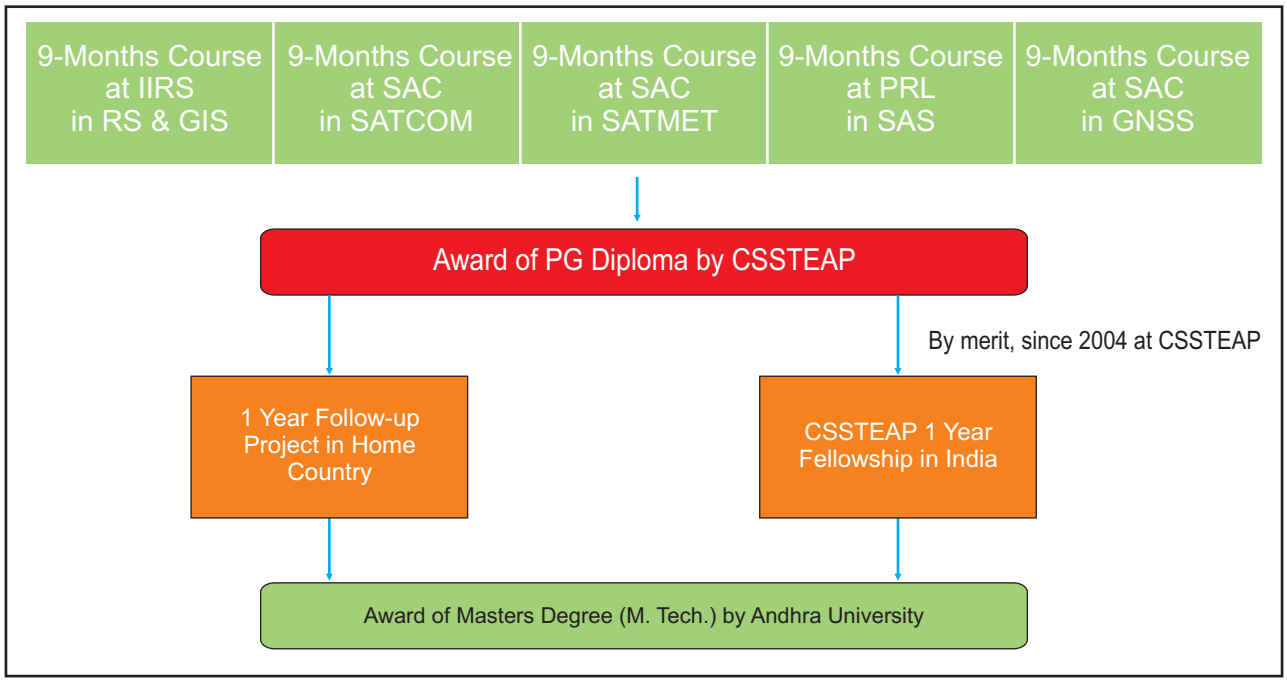


Fig. 1: Structure of PG diploma educational programmes at CSSTEAP

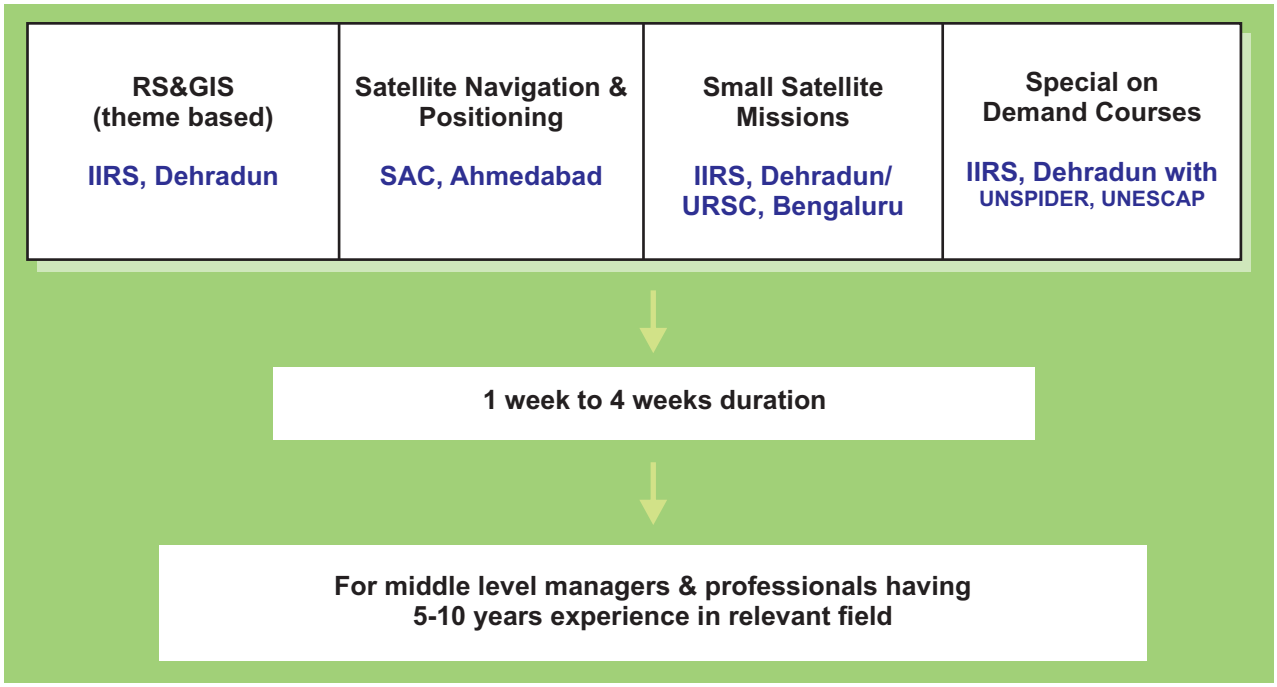


Fig. 2: Short-term training programmes at CSSTEAP

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 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.

Till date 158 PG participants (76 in RS & GIS; 41 in SATCOM; 20 in SATMET and 21 in SAS) from 16 different countries have been awarded M.Tech. degree. (Fig. 3)

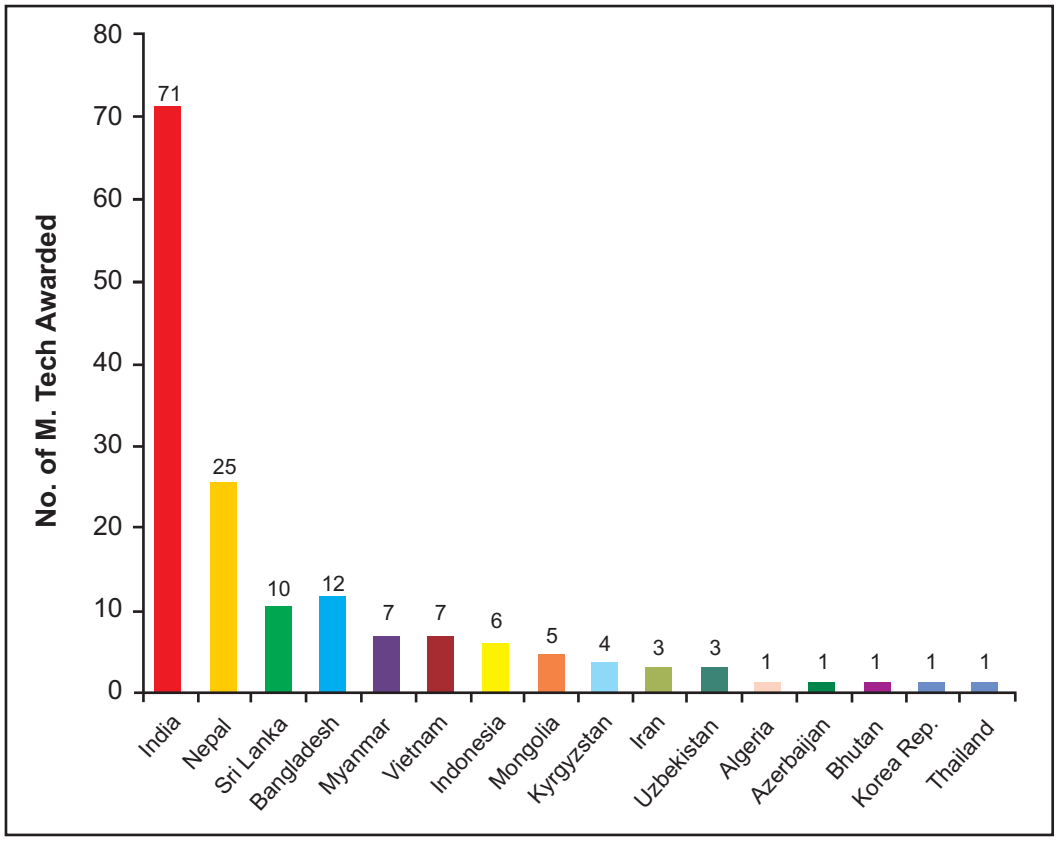


Fig. 3. Status of M. Tech. degree awarded

Remote Sensing and GIS course

The RS & GIS course is directed towards mid-career professions includinguniversity 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 & GIS applications 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 55 PG Courses: 22 in RS&GIS, 11 in SATCOM, 11 each SATMET and SAS and 02 in Global Navigation Satellite System. Currently 23rd RS&GIS course at Dehradun, 11th SATMET course at SAC, Ahmedabad and 11th SAS course at PRL, Ahmedabad are in progress. In addition, the Centre has conducted 54 short courses and workshops in the past 23 years. These programmes have benefited some 2090 participants from a total of 36 countries in the Asia-Pacific region and 29 participants from 19 countries outside Asia Pacific 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 being followed 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 and institutions 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 their countries 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, five alumni 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 science and technology in natural resources management, improved meteorological, communications studies etc., in Asia-Pacific region is being done by the Centre. The Centre initiated research activities in the form of Phase-II of PG course i.e., M.Tech research work by eligible PG participants. The Centre has taken initiative to facilitate its alumni 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 2018-19, total six participants have been supported with CSSTEAP M.Tech fellowship namely three participants from India, Two from Bangladesh and one from Sri Lanka. To generate awareness among users, researchers, engineers, professionals, decision makers and academicians,in year 2018, the Centre organized2 short courses on specialized areas of Remote Sensing & its applications:

1. Geospatial Modelling in Forestry and Ecology for Climate Change Response Studies during April 16 to April 27, 2018)
2. Disaster Risk Reduction (DRR) with Special Emphasis on Floods and Earthquakes during May 28 to June 22, 2018

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 fewfellowships / 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 Centers CSSTEAP 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 2018, CSSTEAP have arranged Lectures on

1. "Overview of Sustainable Development Goals (SDGs)" by Dr. Shirish Ravan, UNOOSA through Skype on October 8, 2018.
2. "Building Space Application Capacity for Disaster Risk Reduction" by Dr. Sanjay Srivastav, UNESCAP through Skype on June 14, 2018.

In addition, during 2019 CSSTEAP is also planning to conduct Global Webinar series (CEOS/GEO/UN) with RCs on SDGs.

CSSTEAP has also introduced Space Law concepts and arranged a guest lecture on

1. "Space Law: Intl. Treaties & Regulations" by Mr. Gopala Krishnan, ISRO HQ. on October 27, 2018.

CSSTEAP has supported SAARC with Resource Person on EO data for rapid response & open source data portals for DM for SFDRR during 2018 on a workshop on Utilization of Space based & Geospatial information for achieving the targets of the Sendai Framework for DRR".

Besides above, CSSTEAP has supported offshore training programmes jointly organized by UNOOSA/UN Habitat one at China and Two at Myanmar on Disaster Risk Reduction and Damage Assessment.

Participants of DRR with special emphasis on Floods and Earthquakes

Capacity Building in RS & GIS and its Applications: IIRS Initiatives

Capacity Building in RS & GIS and its Applications: IIRS Initiatives

Dr. Prakash Chauhan
Director, IIRS

Introduction

Indian Space Research Organisation (ISRO) under the Department of Space, Govt. of India, has created a world-class space infrastructure primarily for education, outreach and research in the broad field of Remote Singh & GIS. With a modest beginning in mid-seventies by designing and launching a few experimental satellites, India today has a large constellation of satellites dedicated towards Earth Observation (EO), communication and broadcasting, meteorology, navigation and space science missions. ISRO has a vibrant Earth Observation (EO) programme of satellite missions evolved through National Natural Resources Management System (NNRMS) and providing mainstream data for natural resources and disaster management. Indian Remote Sensing Satellite (IRS) system commissioned with the launch of IRS-1A (Indian Remote Sensing Satellite-1A) on 17th March 1988 set the era of operational EO programme not only for natural resources survey and management but also for infrastructure development planning, disaster risk management, environmental applications, etc. With the completion of three decades of several successful IRS missions, a range of EO data in terms of spectral bands, spatial and temporal resolutions, swath and stereo-capability have now become available and used for generating geo-information (GI) at different scales for characterizing spatial processes and developing applications for socio-economic benefits. Currently IRS is the largest civilian remote sensing satellite constellation in the world providing imagery in a variety of spatial, spectral and temporal resolutions through series of satellites like Resourcesat, Oceansat, Cartosat, SARAL and INSAT-3D.

Indian Institute of Remote Sensing (IIRS), Dehradun is one of the units of ISRO to realize the Indian space vision, as a key player, in capacity building for successful implementation of EO programme for societal benefits. While nurturing its primary endeavor to develop capacity among 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. IIRS is a premier institute with internationally acclaimed expertise in the area of training, education and research in use of geospatial technology for applications covering agriculture, soil, geology, water resources, forestry and ecology, environment, urban development, groundwater and mineral prospecting,

watershed management and monitoring, drought and flood assessment, ocean resources and disaster management, leading to livelihood security and understanding the impact of climate change. IIRS alumni include global leaders in geospatial technology.

The institute is involved in research activities on high resolution satellite image analysis, 3D visualization, real world landscapes 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 to understand atmosphere and climate, mineral prospecting, hydrological processes, soil erosion, wildlife habitat and bio diversity analysis. IIRS houses prominent facilities like Atmospheric CO_2 measurement network, observatory for aerosol climatology, carbon flux towers for measuring energy, water vapour and CO_2 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 post graduate 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.

IIRS Academia MEET 2019

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 five 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.

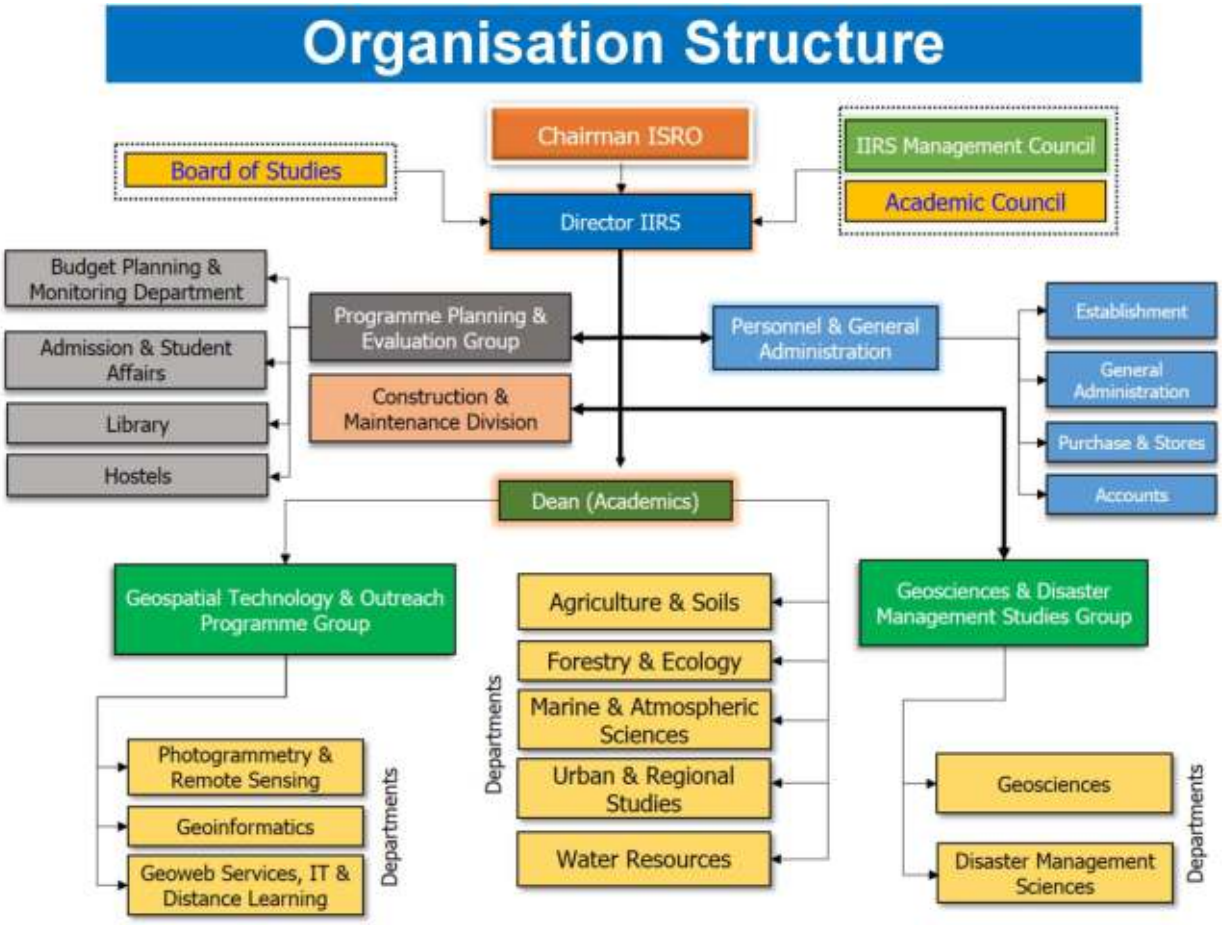
Objectives

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 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 Academic Council and Board of Studies. Dean (Academics) is responsible for implementation of academic programmes.



A highly motivated and dedicated team of about 70 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 2-8 weeks 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 18 months duration being conducted in collaboration with the Faculty of Geo-information Science & Earth Observation (ITC) of the University of Twente (UT), The Netherlands.

CSSTEAP hosted at IIRS Campus 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), Dehradun; Space Application Centre (SAC), Ahmedabad; U R Rao Satellite Centre (URSC), Bengaluru and Physical Research Laboratory (PRL), Ahmedabad. The Centre

conducts Post- Graduate in five disciplines viz., Remote Sensing & Geographical Information System (RS & GIS), Satellite Communication (SATCOM), Satellite Meteorology and Global Climate (SATMET) and Global Navigation Satellite System (GNSS). Centre also conducts regular course of two weeks on Small Satelite Missions (SSM). In addition various theme based short courses of 2-4 weeks duration are also conducted by the centre. The Centre has been conducted 55 PG Courses and 54 short courses in the past 23 years. These programmes have benefited about 2090 participants from a total of 36 countries in the Asia-Pacific region and 29 participants from 19 countries outside Asia Pacific region have also benefited from these educational programmes.

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 Enscheda, 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

ITEC passing out ceremony-February 2019

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

The Institute has trained 11753 professionals (till March, 2019), including 1197 professionals from abroad representing over 96 countries mainly from the Asia, Africa and South America. Further, over 94, 000 students/ researchers/ faculty from 920 universities/ institutes spread across the country have also benefited through satellite/internet -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 the user. IIRS distance learning program initiated in 2007 and successfully conducted 43 programs in the last twelve years where more than 94,000 participants are trained. The first course was attended from twelve universities and the number of institutions /universities increased manifold. The forty-third course has just endedon 19 March, 2019 in which 1052 participants from 156 network institutions have participated in the live interactive program. 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.

23rd RS&GIS CSSTEAP participants in ISPRS TC V 2018 at IIRS, Dehradun

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 - Sustainable Agriculture; Forest Resources and Ecosystem Analysis; Geosciences; Urban & Regional Studies; Marine and Atmospheric Sciences; Water Resources; and Satellite Image Analysis & Photogrammetry, Geoinformatics	24 months	40
2.	**M.Sc. in Geo-Infromation Science & Earth Observation (Affiliated with ITC, University of Twente, The Netherlands)** Specialization in - Geoinformatics	18 months	10
3.	**Post-Graduate Diploma in Remote Sensing and GIS** 8 Specializations - Sustainable Agriculture; Forest Resources and Ecosystem Analysis; Geosciences; Urban & Regional Studies; Marine and Atmospheric Sciences; Water Resources; and Photogrammetry and Remote Sensing, Natural Hazards and Disaster Risk Management	10 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	10
5.	**Certificate Course in Remote Sensing** Remote Sensing and Image Interpretation (for Indian User participants)	8 weeks	5
6.	**International Programme - Certificate Course in Remote Sensing, Geoinformatics (Sponsored by ITEC, Govt. of India)** Remote Sensing (with emphasis on Digital Image Processing); Geoinformatics	8 weeks	40
7.	**NNRMS, ISRO-Sponsored Certificate Course in Remote Sensing and GIS for University Faculty** 8 Specializations - Cartography and Mapping; GIS Technology and Advances; Soils & Land Use Planning; Forestry/ Ecology /Wildlife / Env. Sciences; Geosciences; Coastal & Ocean Sciences; Urban and Regional Planning; Water Resources	8 weeks	64
8.	**Awareness Programme** Remote Sensing - An Overview for Decision Makers	1 week	10
9.	**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 Short Course on Geospatial Modelling in Forestry and Ecology for Climate Change Studies

Course Report

23rd 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

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

The twenty-third PG course on Remote Sensing and Geographic Information System of CSSTEAP commenced on July 1, 2018 at Indian Institute of Remote Sensing (IIRS), ISRO, Dehradun, one of the host institutions of CSSTEAP. Total twenty-four participants from eleven countries of Asia-Pacific Region viz., four participants from India, three participants each from Tajikistan, Thailand and Vietnam, two participants each from Mongolia, Uzbekistan, Bangladesh and Nepal and one each from Bhutan, Lao PDR and Myanmar are attending the course. The participants attending the course were from varied backgrounds 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 PG Diploma course has two phases, Phase-I (Module-IA, Module-I B, Module-II and Module-III.) involves 9 months teaching at the IIRS and culminates today with the award of PG Diploma and Phase-II will be carried out by course participants in their home country on a dissertation research work of one year which will lead to the award of M.Tech. Degree by Andhra University after its successful completion.

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.

In Module-IA participants were imparted information on Remote Sensing and Geographic Information System and their application in natural resource management, where the emphasis is on the development and enhancement of knowledge and skills through classroom lecture, tutorials, field visits, seminars and hands on session. The participants were taken to several field excursions for ground truth collection and for interpretation and analysis of satellite data.

In Module-IB participants were introduced to 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.

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

In 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 rice crop inventory, soil erosion risk assessment, assessing biodiversity patterns, urban flood hazard assessment, snowmelt runoff modeling, hydrological simulations, landslide mapping, utilizing geo-social media for improved flood monitoring etc.

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 from Asia Pacific Region. English language class after office hours were conducted in campus during the first three months with special emphasis on pronunciation/accent, grammar and vocabulary which was helpful to the participants in understanding the subjects taught in classes with more clarity.

As part of the course curricula the participants were taken for technical visits to Andhra University, Visakhapatnam, National Remote Sensing Centre (NRSC), Hyderabad and U R Rao Satellite Centre (URSC), Bengaluru during September 16 to October 3, 2018. During technical visits, participants also had an opportunity to visit cultural & natural landscape in Visakhapatnam, and Hyderabad and have an understanding of Indian culture, heritage and traditions. During first lap of the technical visit, course participants were taken to Andhra University where they attended lectures on specialized topics (on rainwater harvesting, flood mitigation and coastal hazard vulnerability and GIS modelling), met Vice Chancellor of Andhra University and also their documents were verified for finding M.Tech eligibility. During second lap of the technical visit, course participants were taken to National Remote Sensing Centre (NRSC), Hyderabad where the participants had an opportunity to see Integrated Multi-mission Ground Segment for Earth Observation Satellites (IMGEOS) facility and also witnessed real time acquisition of EO data at Shadnagar, Hyderabad. The participants were also shown State-of-art vicarious CalVal (Calibration/Validation) site at Shadnagar campus of NRSC. The participants were also shown the virtual reality facility and National Database for Emergency Management (NDEM) facility at NRSC, Shadnagar Campus, and outreach facility at Jeedimetla Campus. During the third lap of the technical visit, course participants were taken to U R Rao Satellite Centre (URSC) at Bengaluru which is the lead centre of the Indian Space Research Organisation (ISRO) responsible for design, development, assembly & integration of communication, navigation, remote sensing, scientific and small satellite missions.

The participants of the course during their stay also participated various conferences, workshops and tutorials. The participants participated in ISPRS Technical Commission V Symposium on "Education & Outreach - Geospatial technology - Pixel to People" at Indian Institute of Remote Sensing, Dehradun, India during Nov 20-23, 2018. Participants were given an opportunity to attend pre-symposium tutorials on the emerging topics like Big Data Analytics, Ground-Based 3D Modeling, Citizen Science and its applications and Space Education for Educators as part of APRSAF. The participants of the course were also given an opportunity for participating in the post-symposium tutorials organized under ISPRS WG III/10, GEOGLAM, ISRS Joint International Workshop on "Earth Observations for Agricultural Monitoring" on UAV Remote Sensing for Agriculture, on topics

like Machine Learning Tools, Satellite Observations of Fire and SAR for Rice during 21-22 February, 2019 at New Delhi. During ISPRS Workshop participants were also taken to Taj Mahal (UNESCO world heritage site) at Agra. The participants displayed their pilot project work through posters in IIIRS Academia Meet (IAM) organized on March 14, 2019 at IIRS Campus.

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

- Rice crop inventory using Temporal Sentinel SAR data
- Soil erosion risk assessment using RS and GIS
- Soil Characterization and Capability Assessment for Land use Planning using RS & GIS
- Forest Fire vulnerability modeling
- High resolution tree biomass mapping using object based image analysis and Cartosat-2S data
- Assessing biodiversity patterns from very high resolution data
- Integration of Remote Sensing with Geophysical Techniques for Ground Water Exploration in parts of Mussoorie
- Crater classification and surface composition around Chandrayaan-2 landing site and its terrestrial analogue
- Urban flood hazard assessment of Ambala city using geospatial technologies
- Analyzing Urban Growth Pattern of Chiang Mai City, Thailand using RS and GIS
- Investigation of tropical cyclogenesis using NWP model and forecast over Bay of Bengal
- Detection and mapping of sea grass using satellite imagery and ground data of Ritchie's archipelago, South Andaman
- Snowmelt Runoff Modeling in Tuul River Basin, Mongolia
- Flood hazard mapping in Parbati valley
- Remote sensing and hydromet data based glacier dynamics of Fedchenko Glacier
- Remote Sensing Based Reservoir Sedimentation Assessment - A Case Study of Bargi Reservoir
- Water Balance estimation in Chirchik river basin, Uzbekistan
- Soil salinity & waterlogging assessment using Remote Sensing & GIS
- Hydrological simulation for reservoir sedimentation assessment
- Time series interferometry analysis for deformation monitoring using scatterer based technique
- SAR data processing for oil spill detection
- Landslide mapping in Siwaliks of Nepal from optical imageries
- Monitoring urban change using LiDAR data
- Utilizing geo-social media as a proxy for improved flood monitoring

Course Participants

Sl.No.	Name	Country
1.	Mr. Md. Abdullah Aziz	Bangladesh
2.	Ms. Noyoftova Nigorbegim Niyatbekovna	Tajikistan
3.	Ms. Orifkhonova Shakhnoza Najimkhonovna	Tajikistan
4.	Ms. Phitchayalak Wongchingchai	Thailand
5.	Mr. Bichit Kumar Singh	Nepal
6.	Mr. Doan Quoc Vuong	Vietnam
7.	Mr. Sangay Gyeltshen	Bhutan
8.	Mr. Riddhish Chetan Soni	India
9.	Ms. Sri Pujitha V. Pukkella	India
10.	Ms. Wanwilai Khunta	Thailand
11.	Mr. Md. Abdul Hamid Mia	Bangladesh
12.	Mr. Sharad Bayyana	India
13.	Mr. Erdenebayar Bawuu	Mongolia
14.	Mr. Kyaw Min Hlaing	Myanmar
15.	Mr. Kenjaev Firuz Safarbekovich	Tajikistan
16.	Ms. Laylo Kamoliddinovna Zaridinova	Uzbekistan
17.	Mr. Sanjarbek Muratov	Uzbekistan
18.	Mr. Moun Moonmeungshand	Lao PDR
19.	Ms. Le Minh Thanh	Vietnam
20.	Ms. Nyamaa Tserendulam	Mongolia
21.	Mr. Nguyen Duc Loc	Vietnam
22.	Mr. Padam Bahadur Budha	Nepal
23.	Ms. Saranthorn Suthana	Thailand
24.	Mr. Jaya Surya Sattaru	India

Brief outline of Course Curriculum - RS & GIS (2018-2019)

<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	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	• Integrated Coastal zone management • Coastal dynamics & processes • Coastal geomorphology	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	• Photogrammetry, • Fuzzy, ANN Classification, Image segmentation	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	

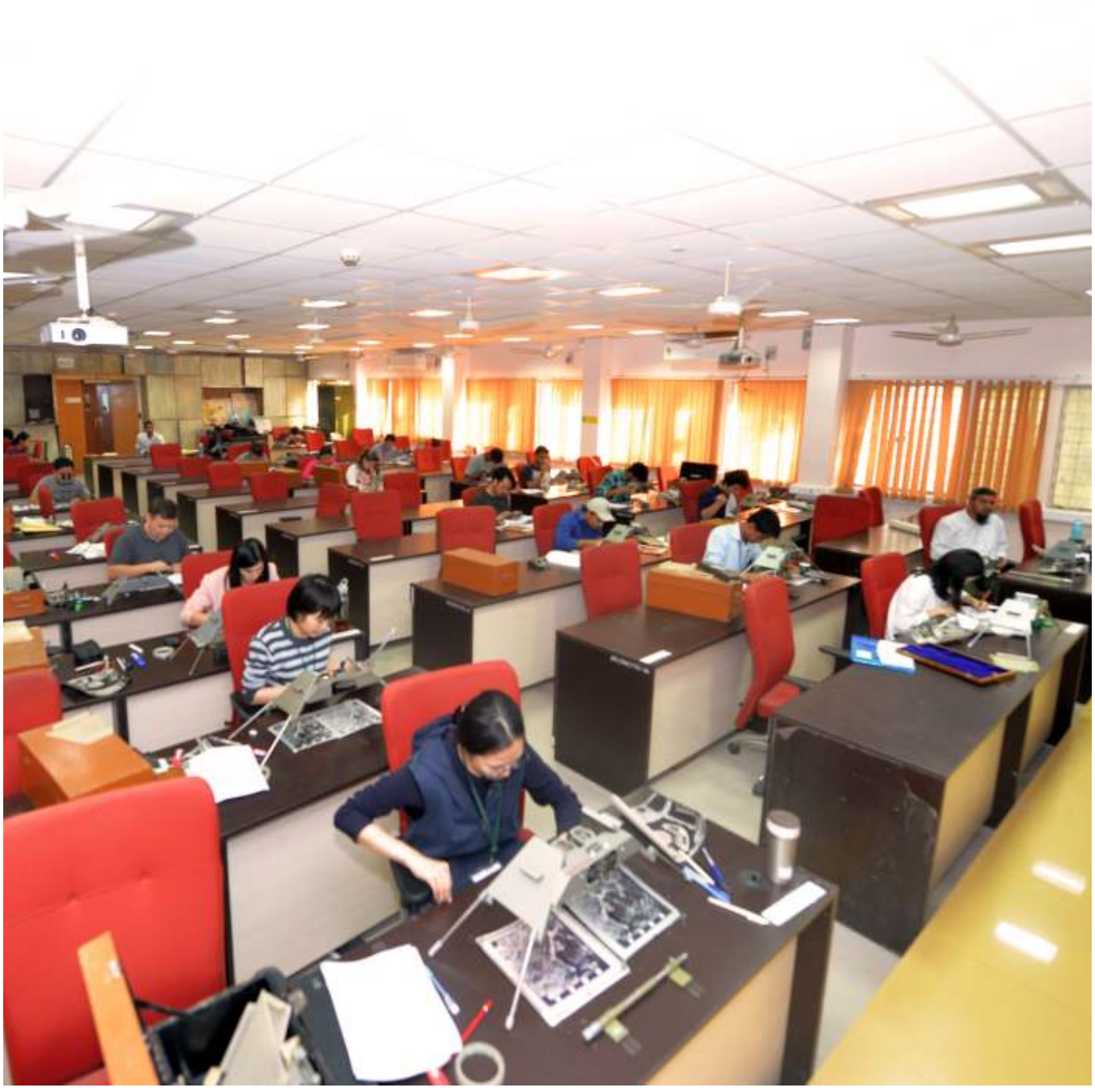
Name	Topics	E-mail	Photograph
Dr. Sameer Saran	• Spatial information system, spatial data modelling infrastructure, • Spatial decision support system, MCDM • Distributed GIS, interoperability, metadata stds & cataloging	sameer@iirs.gov.in	
Dr. Harish Karnatak	• Bhuvan overview, Geodata abstraction library, Iterations, functions & recursion • WebGIS services, Open source GIS	harish@iirs.gov.in	
Dr. Hitendra Padalia	• Spectral properties of vegetation • Utility of hyperspectral & SAR in forestry • Ecological niche concept, Species distribution modelling. • Biodiversity characterization and conservation prioritization • Fire ecology, fire detection and monitoring,burnt area mapping and recovery assessment, Risk zonation and danger rating, Forest fire alert systems • Environmental impact assessment, Strategic environmental assessment • Forest growth and yield prediction • Forest degradation assessment	hitendra@iirs.gov.in	
Mrs. Vandita Srivastava	• Spatial data analysis, vector & raster	vandita@iirs.gov.in	
Dr. (Mrs.) Poonam S. Tiwari	• Photogrammetry • Feature Extraction • DIP	poonam@iirs.gov.in	
Dr. Yogesh Kant	• Impact of climate change • EO systems for climate change studies	yogesh@iirs.gov.in	
Mr. Ashutosh Bhardwaj	• Photogrammetry, GPS	ashutosh@iirs.gov.in	
Dr. (Mrs.) Hina Pande	• Visual Interpretation, • Close Range Photogrammetry	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	
Mr. Chandra Mohan Bhatt	• Optical and microwave remote sensing of flood inundation • Disaster Risk Reduction & Management: Concepts & Overview • Earth Observation for Disaster Risk Reduction • Application of EO Data for Sustainable Development Goals (SDGs)	cmbhatt@iirs.gov.in	

Name	Topics	E-mail	Photograph
Mrs. Kshama Gupta	• Base Maps and Cadastral Maps for Urban and Regional Areas • Census Operation and Population Studies • 3D Modeling Techniques for urban Surface profiling • DEM/DSM Generation for Urban Areas, Modeling & Visualization • Geospatial Technologies for Urban Heritage and Conservation • Urban Climate : Factors Affecting Urban Climate, Impact of Urban Surfaces, Diseases and Human Health	kshama@iirs.gov.in	
Mr. Bhaskar R. Nikam	• Quantification of hydrological elements: Evapotranspiration • Soil erosion process and modelling • Irrigation water management, Performance evaluation, and conjunctive use planning • Drought assessment and monitoring	bhaskar@iirs.gov.in	
Mr. Kapil Oberai	• GIS data creation, optimization, Conceptual models of non-spatial information, relation algebra • Spatial databases, SQL spatial querying, Python imaging, connectivity, location based services & KML	kapil@iirs.gov.in	
Dr. Vaibhav Garg	• Quantification of hydrological elements: Runoff • Water body and Snow cover mapping • Reservoir sedimentation • Urban hydrology: storm drainage networks • Modelling climate change and impact of climate change on water resources. • Integrated water resources management	vaibhav@iirs.gov.in	
Dr. Subtrata Nandy	• Visual image interpretation for forest • Utility of VHR multi-spectral remote sensing • Growing stock, biomass/carbon estimation using optical data • LiDAR in forest inventory • Geospatial modelling, Multi-criteria decision making for forestry and ecological applications • Wildlife habitat suitability analysis • Forest ecosystem, Forest productivity estimation	nandy@iirs.gov.in	
Mrs. Manu Mehta	• Remote Sensing • Atmospheric Corrections	manu@iirs.gov.in	
Mr. Vinay Kumar	• Hyperspectral Remote Sensing and data processing • Automated endmember extraction • Simulation of Hyperspectral data • Fusion of Hyperspectral and SAR data	vinay@iirs.gov.in	
Dr. (Mrs.) Suchita Srivastava	• Green house gasses & their atmospheric chemistry • Retrieval of temperature, trace gases & ozone	shuchita@iirs.gov.in	
Dr. Shovan Lal Chattoraj	• Types of mineral deposits • RS application in engineering geology	shovan@iirs.gov.in	

Name	Topics	E-mail	Photograph
Mr. Ashutosh K Jha	• Agent based modelling, database connectivity, spatial variation models, dependence measures, Geo-visualization, files objects & classes, metrics & linear algebra,	akjha@iirs.gov.in	
Mr. Prasun Kumar Gupta	• h/w, s/w requirements for GIS, database design using UML, attribute & positional uncertainty, basic programing concepts, web programing	prasun@iirs.gov.in	
Mrs. Charu Singh	• Rainfall retrieval & monsoon studies • Tropical dynamics ENSO etc	charu@iirs.gov.in	
Mr. Kamal Pandey	• Strings, tuples, dictionaries, GDAL, customizing, open source GIS s/w, server side scripting, web mapping using open layers, data quality & sources of error in GIS	kamal@iirs.gov.in	
Mr. S. Raghavendra	• Statistics, GPS • LiDAR	raghav@iirs.gov.in	
Mr. Shashi Kumar	• Overview of SAR Remote Sensing • SAR Imaging Modes and Data Format • Radiometric Normalisation and Orthorectification of SAR data • Polarimetric SAR Remote Sensing and Applications • SAR Interferometry, Data Processing and Applications for Height and Displacement Measurement	shashi@iirs.gov.in	
Mr. Hari Shanker	• Network analysis, spatial data quality • Spatial variation models & dependence measures	harisankar@iirs.gov.in	
Mrs. Richa Sharma	• Spectroscopy of minerals, hyperspectral RS mineral exploration • RS for geology, DIP	richa@iirs.gov.in	
Ms. Pooja Jindal	• Meteorological satellites & sensors • Assessment of cyclones, atmospheric humidity	pooja@iirs.gov.in	
Mr. Aprit Chouksey	• Quantification of hydrological elements: interception and Soil Moisture • Water Balance studies • Integrated watershed management • Waterlogging and salinity • Trend analysis of hydro-meteorological data	arpit@iirs.gov.in	

Name	Topics	E-mail	Photograph
Mr. K. Shiva Reddy	• GIS data models, conceptual model of spatial information • Internet technology & WebGIS, Web GIS services	shivareddy@iirs.gov.in	
Dr. Pratima Pandey	• Glaciology, climate tectonic relationship • Landform dynamics	pratima@iirs.gov.in	
Ms. Asfa Siddiqui	• Basics of Urban and Regional planning • Urban land Use/Land Cover • Renewable/Non-renewable Energy Sources: Solar potential estimation • Hyperspectral RS for urban areas • Thermal RS for Urban Areas • Ambient Air Quality Assessment for Urban Area	asfa@iirs.gov.in	
Mr. Suresh Kannaujiya	• Geophysics, geophysical methods for exploration & integration with RS data fusion for geological applications	skannaujiya@iirs.gov.in	
Mr. Prabhakar Alok Verma	• Interpolation methods, attribute & positional uncertainty, error & uncertainty propagation, Taylor series, spatial sampling & modelling	prabhakar@iirs.gov.in	
Mr. Justin George	• Fundamentals of soils & pedogenesis • Land evaluation • land degradation • Hyperspectral RS in degradation mapping	ustin@iirs.gov.in	
Mr. Yateesh Ketholia	• Geomorphic process costal & kart • Hydrocarbon resources & mode of occurance	yateesh@iirs.gov.in	
Mr. Abhishek Danodia	• Fundamentals and Importance of Agrometeorology • Precision agriculture • Cropping System analysis • ICT Applications in Agriculture: Basics of DBMS, Yield gap analysis, Decision support systems, SDSS	abhidanodia@iirs.gov.in	
Mr. Pankaj Dhote	• Hydrograph analysis • Streamflow measurement • Watershed morphological analysis • Groundwater modelling • Flood hydrology, routing • Flood mapping, monitoring and damage assessment	pdh@iirs.gov.in	
Dr. Taibanganba Watham	• Spectral vegetation indices • Digital image interpretation • Statistical treatment of forestry inventory data • Carbon flux monitoring using eddy flux studies • Wetland habitat monitoring and conservation planning • IPCC climate change scenarios	taibang@iirs.gov.in	

Name	Topics	E-mail	Photograph
Dr. IshwariDatt Rai	• Phenology for vegetation differentiation • Biodiversity Information Systems, Global Biodiversity information facility • Forest ecosystem structural and functional analysis • Definitions and concepts of Landscape ecology • Forest ecosystem and climate linkages	ishwari@iirs.gov.in	
Dr. Sanjeev Kumar Singh	• Tropical Cyclone • Numerical Weather Prediction	sksingh@iirs.gov.in	



Pilot Projects of Students

Rice Crop Inventory Using Temporal Sentinel SAR Data

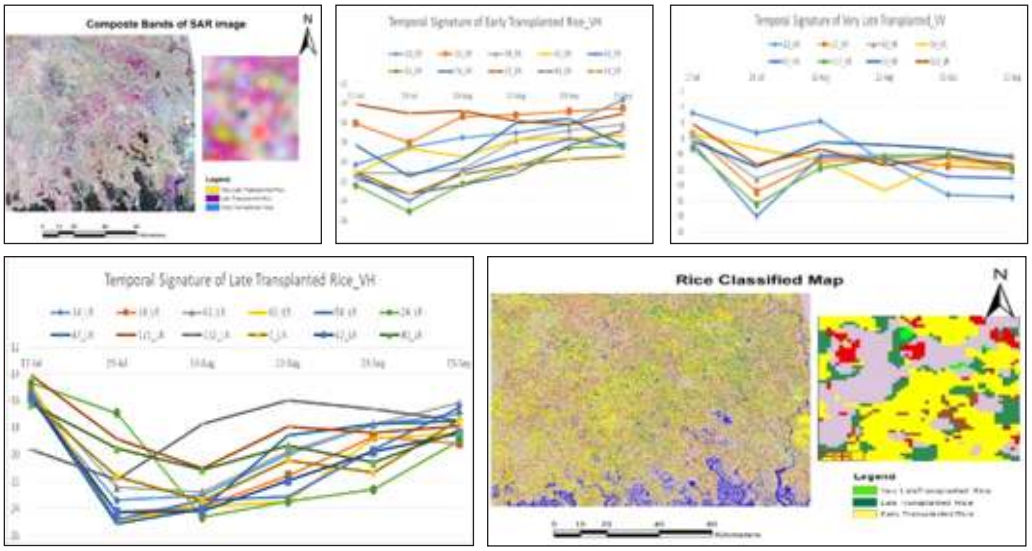
Md Abdullah Aziz
Bangladesh Rice research Institute
Gazipur, Bangladesh
Tel: +8801712571316;
E-mail: mdabdullahaziz@gmail.com

Supervisors
Dr. DipanwitaHaldar
Mr. Abhishek Danodia
Agriculture and Soils Department,
IIRS,Dehradun

A B S T R A C T

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

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

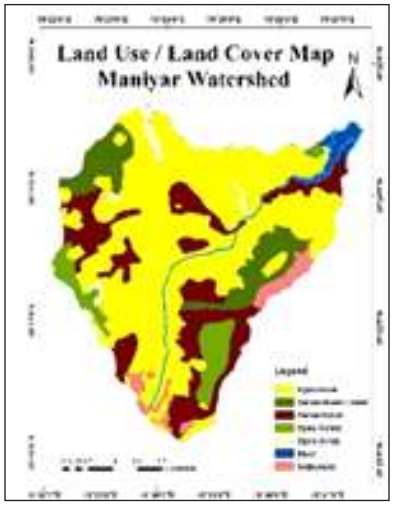


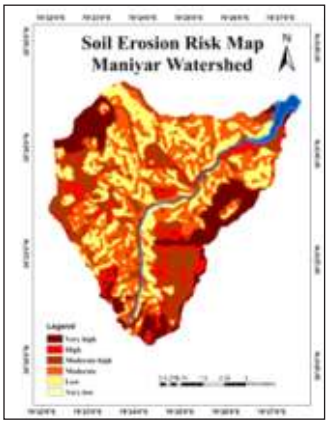
Soil Erosion Risk Assessment Using RS and GIS

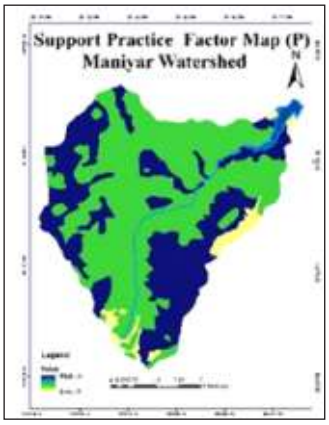
Ms. Noyoftova Nigorbegim
Scientific Researcher
Soil Science Institute, Tajikistan
Tel: +992 938470590
E-mail: nigor.n.n@mail.ru

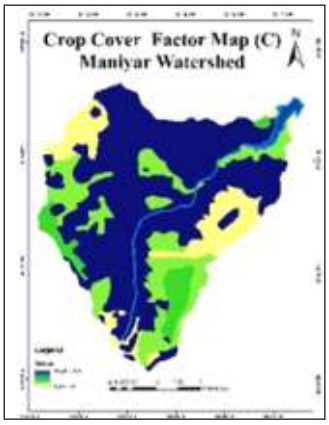
Supervisor
Mr. Justin George K
Dr. Suresh Kumar
Agriculture and Soil Department
IIRS, Dehradun

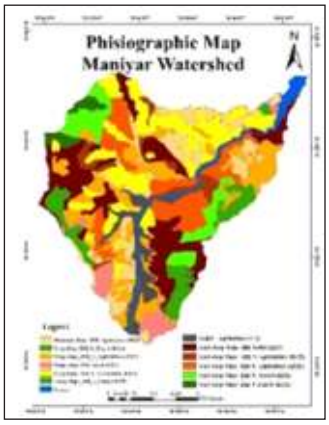
Soil erosion is a global environmental crisis in the world today that threatens natural environment and agriculture. The soil erosion risk assessment can be helpful for land evaluation in regions where soil erosion is the main threat for sustainable agriculture. Spatial distribution of soil erosion risk in the watershed was estimated by integrating various RUSLE factors (R, K, LS, C, P) in raster based GIS environment. RUSLE model factors maps were generated using remote sensing satellite data (IRS LISS IV and LANDSAT-8) and Digital Elevation Model. Visual land use land cover analysis revealed that Agriculture (59%) was the dominant land use system followed by Scrub land (18%) in the study area. Nearly 70% of the watershed is having steep to moderately steep slope (>40%). Soil erosion risk analysis showed that15 % of the total study area belonged to very low soil erosion risk class, 9% in low, 21% in moderate, 30% in moderate high, 24% in highand 1% area in very high erosion risk class. The average annual erosion rate was predicted to be 26.13 t/ha/yr. The predicted soil erosion rates were found to vary from 3.01 t/ha/yr in dense mixed forest cover to 38.69 t/ha/yr in open scrub land.











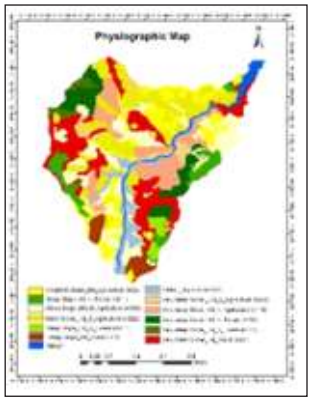
Soil Characterization and Capability Assessment for Land Use Planning Using RS and GIS

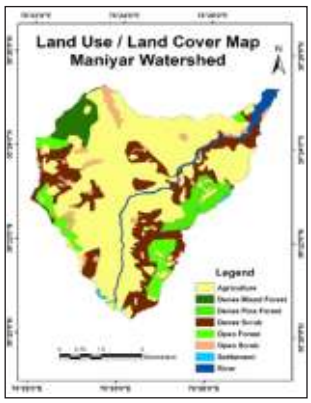
Ms. Orifkhonova Shakhnoza
Researcher
Soil Science Institute of Tajikistan
Tel: +992-938699508
E-mail:orifkhonova2016@mai.ru

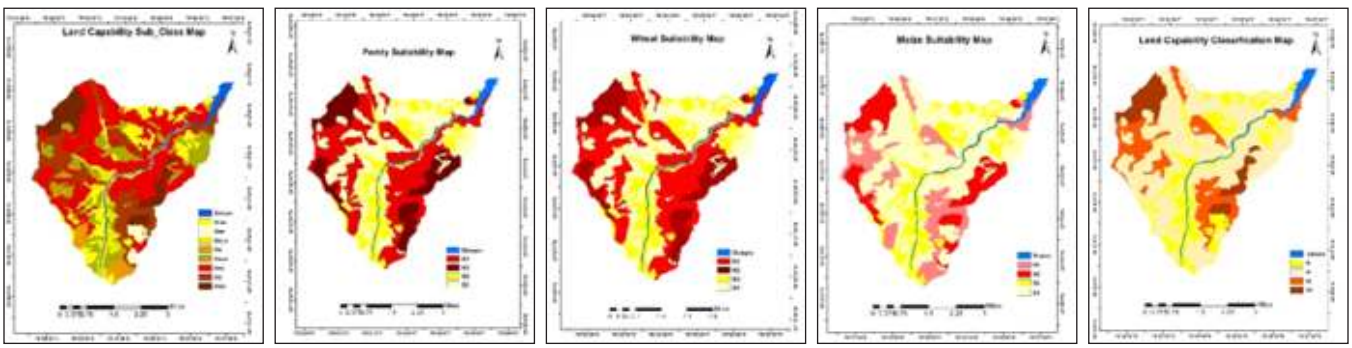
Supervisor
Mr. Justin George
Soil and Agriculture Department
IIRS, ISRO, Dehradun

A B S T R A C T

Land evaluation is aimed at assessment of land performance and its production potential for a specific purpose and land suitability is the systematic grouping of different kinds of land to sustain their productivity. To reduce the human influence on natural resources and to identify an appropriate land use, it is essential to carry out scientific land evaluations. Such kind of analysis allows identifying the main limiting factors for the agricultural production and enables decision makers to develop crop managements able to increase the land productivity. Objectives of this study was to develop a RS and GIS based approach for land use suitability assessment which will assist land managers and land use planners to identify areas with physical constraints for a range of nominated land uses. The present study assessed land Suitability for maize, wheat, and paddy crops using FAO frame-work of land evaluation in Maniyaar Watershed of TehriGarwal District, Uttrakhand, India. IRS LISS IV and two season Landsat 8 OLI data were used to prepare land use/land cover and Physiographic soil map of the watershed. Different land quality parameters, viz. soil texture, depth, erosion, slope, flooding and coarse fragments under various land units were evaluated for the crops. Visually Land Use Land Cover analysis revels that 58% area is under Agriculture,15% under forest and scrub 21%, settlement 3% and Stream 3%.The parameter wise suitability was assigned to physiographic unit slight suitable (S1), moderate suitable (S2), marginal suitable(S3), currently not suitable (N1), and permanently not suitable (N2) and accordingly the map was generated and also the physiographic units of watershed were assigned to different classes(C) i.e., C-III (19%), C-IV (56%), C-VI (16%), and C-VII (9%) based on criteria for land capability classification for land use planning in hilly area.







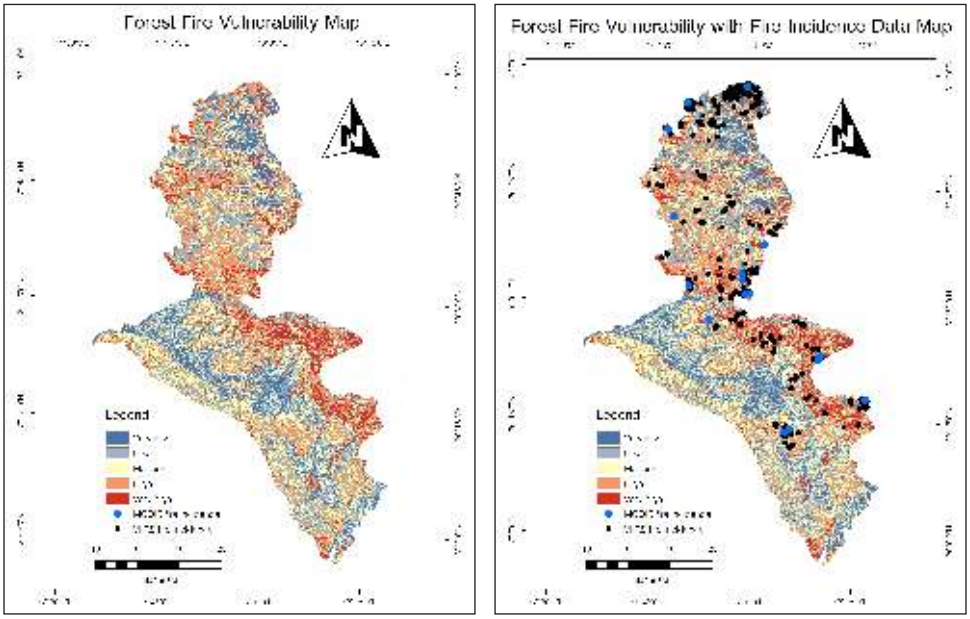
Forest Fire Vulnerability Model

Ms. Phitchayalak Wongchingchai
Chiangmai National Park and Protected Area Innovation Center, Thailand
Tel: +917060011563
E-mail: phitchatam@gmail.com

Supervisor
Dr. Taibanganba Watham
Forestry and Ecology Department
Indian Institute of Remote Sensing, Dehradun

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

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



Mapping of Biomass Using very High Resolution Data

Mr. Bichit Kumar Singh
Conservation Officer
Biodiversity Research and Conservation Society, Nepal
Tel: +977-9845231298
E-mail: singhbichit89@gmail.com

Supervisor
Dr. Subrata Nandy
Forestry & Ecology Department,
IIRS, ISRO, Dehradun

A B S T R A C T

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

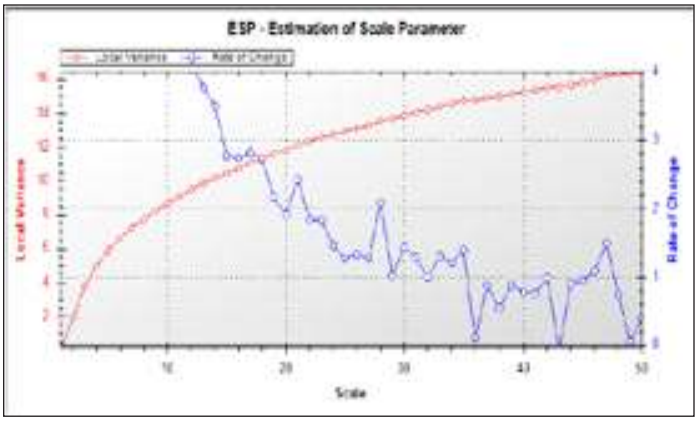


Fig.: ESP Estimation

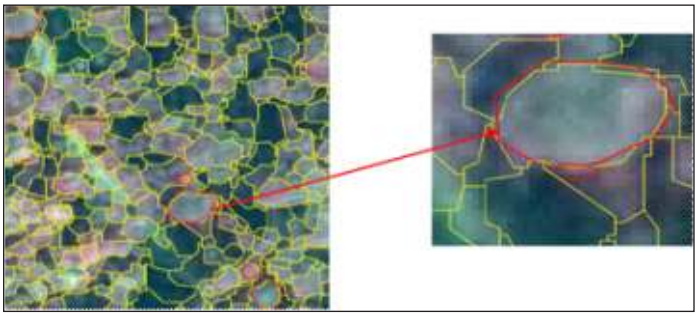


Fig.: Segmentation Accuracy

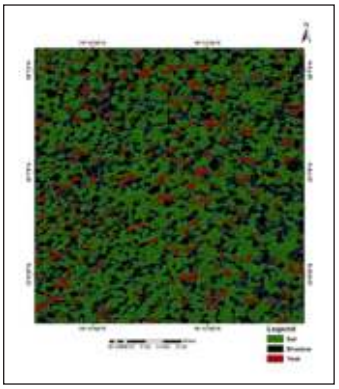


Fig.: Classified Map

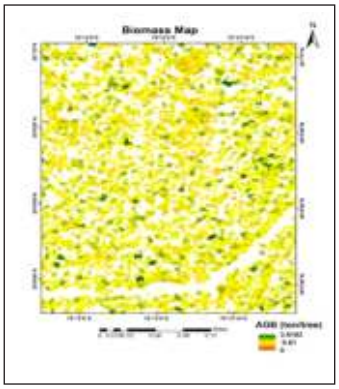


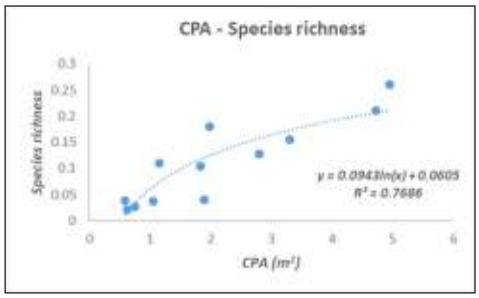
Fig.: Biomass Map

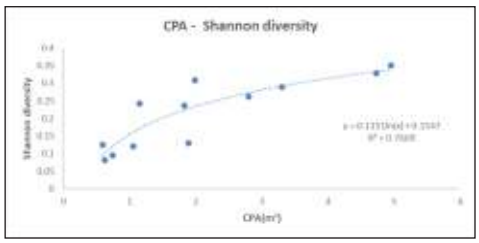
Assessing Biodiversity Patterns from Very High Resolution Satellite Data

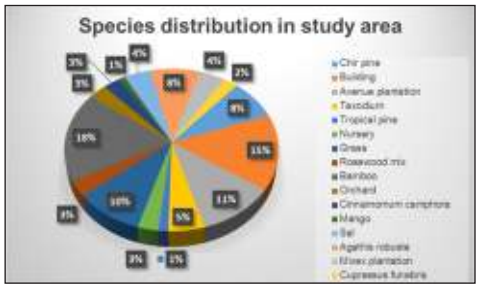
Mr. Doan Quoc Vuong
National Remote Sensing Department,
Ministry of Natural Resources and Environment, Viet Nam
Tel: +84 905 666 794
E-mail: vuongvnf@gmail.com

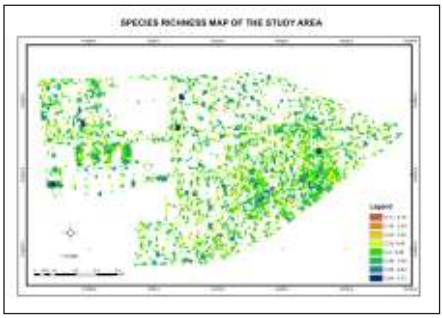
Supervisor
Dr. Ishwari Datt Rai
Forestry and Ecology Department,
IIRS, ISRO, Dehradun

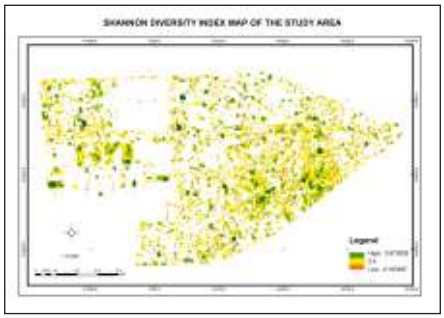
Forests are the most diverse terrestrial ecosystems and their biological diversity includes trees, but also other plants, animals, and micro-organisms. Several forest attributes, including size variability, amount of dead wood, and tree species richness, can be applied in assessing biodiversity of a forest ecosystem. Remote sensing offers complimentary tool for traditional field measurements in mapping and monitoring forest biodiversity. The objective of the study is to assess characterise biodiversity patterns of a very heterogenous and species rich forest ecosystem with very high resolution image from Cartosat - 2S. We applied crown project area (CPA) approach in estimating biodiversity indicators. The relationship between CPA and biodiversity index was established and validated using 29 trees recognized in the field. CPA was obtained using object-based image analysis and was compared with the manually delineated reference polygon to assess the accuracy. A non-linear regression model was adopted to derive the relationship between CPA and biodiversity index.This study showed that very high resolution image of crown project area (CPA) can be used to assess biodiversity of the study area. This approach is made possible because we employed cutting-edge image satellite with very high-resolution images (0.6 m resolution) of the canopy properties. The correlation coefficient of model obtained for CPA- with Species richness and Shannon diversity was 0.769 and 0.767. Generally, species richness and Shannon diversity was the best response measure to assess biodiversity from image analysis.











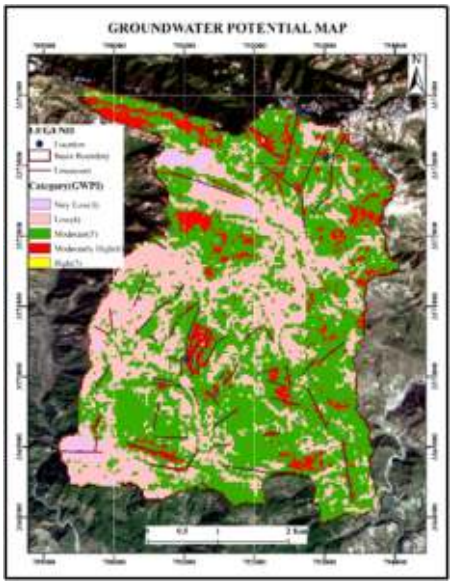
Integration of Remote Sensing and Geographic Information System with Geophysical Techniques for Groundwater Exploration-A Case Study of PYSD, Kimari and GNFC Area, Mussoorie, Dehradun.

Mr. Sangay Gyeltshen
ICT cum GIS Engineer,
APECS Consultancy Services, Bhutan
Tel: +975-17231599
E-mail: sangye89@gmail.com

Supervisor
Mr. Suresh Kannaujiya, Scientist 'SD'
Geoscience Department,
IIRS, Dehradun.

A B S T R A C T

Remote Sensing and Geographic Information System plays an important role in hydrogeological science, which provide aid in inferring, observing, accessing and safeguarding groundwater resources. The existence of groundwater depends on various theme namely; geomorphology, geology, slope gradient, drainage density, lineament, land use landcover, vegetation index and topography. The selected themes were assigned weightage and rank based on their effective contribution toward occurrences of groundwater. The potential area for prospecting groundwater was generated using Weighted Index Overlay (WIO) algorithm.



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

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

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

Crater Classification and Surface Composition around Chandrayaan 2 Landing Site and its Terrestrial Analogue

Mr. Riddhish Chetan Soni
Space Applications Centre
VEDAS Department
Tel: +919022980845, +918850934472
E-mail: rcsoni93@gmail.com

Supervisor
Dr. Shovan Lal Chattoraj
Geosciences Department
IIRS, Dehradun

The advancement in planetary remote sensing has opened new areas for lunar exploration. The imaging spectroscopy technique offers an opportunity to map and discriminate different minerals on the lunar surface which further helps to understand the origin, evolution process, and the crustal composition on the surface of the moon. In this research we have evaluated the utility of imaging spectrometry to study the spatial distribution of minerals around Moretus, Boguslawsky, and Manzinus craters located near the South Pole region of the moon and terrestrial analogueviz. Dhinodhar volcanic plug/dome located near Nani Aral village, in Kutch District, Gujarat. Moon Mineralogical Mapper sensor onboard Chandrayaan 1 satellite with 85 bands and 140m spatial resolution was used for lunar craters whereas Landsat 8 and ALOS PALSAR DEM were used to map structure and geology of Dhinodhar plug. data was used to analyze the surface mineral and geochemical composition based upon the diagnostic absorption bands of ferrous elements in crater materials. The crater centers were found to be richly concentrated by low Ca pyroxene minerals, concentration of which decreased away from the center. Therefore, it is a manifestation of high concentration of FeO near the crater center due to the characteristic ferrous absorption indicating less matured optical materials at the center with gradual decrease of the same, away from the center indicating low concentration of fresh ejecta materials along with matured soil/debris. In areas away from the crater center, and materials are interpreted as highly optically matured anorthositic debris dominated by plagioclase feldspar. Based on the application of Hough transformation (Paul Hough,1962), we were able to detect secondary craters within the primary craters. The morphometry, age, size and dimensions of the craters were calculated subsequently. Field survey was carried out to dhinodhar plug in Kutch. Spectral analysis of the collected rock and soil samples depict 2.2 Al-O/OH or Mg-O/OH feature and possible pyroxene absorption feature near 1 micrometer implying basaltic materials and their weathering derivative. These ground-based spectra were correlated with the spectra of the Moretus central peak, formed as a result of cratering. The extraction of surface mineral information from earth analogues using imaging, spectroscopy is more difficult than of lunar craters due to influence of atmosphere vegetation cover degree of weathering and human activities.

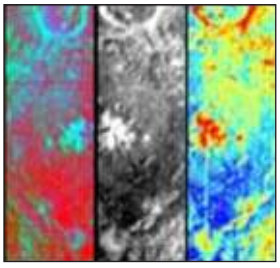


Fig. : (a) Olivine/Pyroxene, Distribution, Moretus crater inside Boguslawsky floor

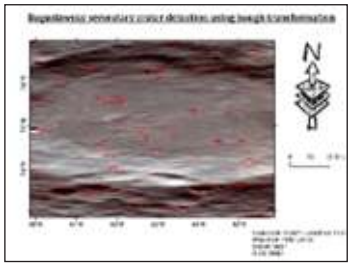


Fig. : (b) Secondary Crater detection

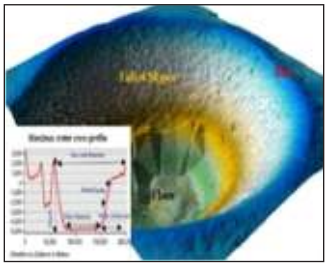


Fig. : (c) Morphological Outline of an impact crater

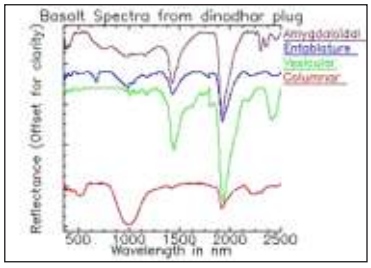


Fig. : (d) Field Spectra of basalts, dinodhar Plug area

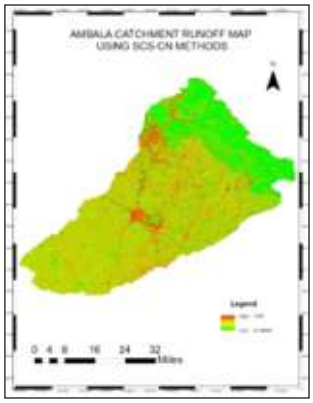
Urban Flood Hazard Assessment in Parts of Ambala City Using Geospatial Technology

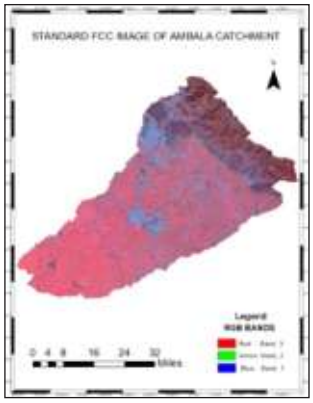
Ms. Venkata Sri Pujitha Pukkella
PGD student
23rd RS & GIS Course, CSSTEAP, INDIA.
Tel. +91 9110327145
E-mail: pujithakrishna15@gmail.com

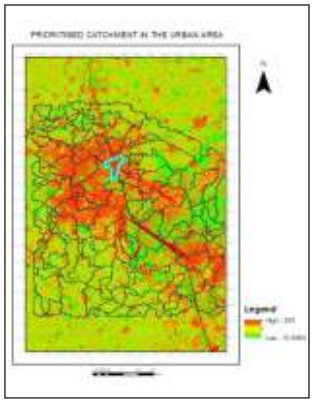
Supervisor
Shri Pramod Kumar
Group Head,
Urban and Regional Studies Department
Indian Institute of Remote Sensing
Dehradun.

A B S T R A C T

Urban flooding is one among the prominent hazard being faced by many cities across the world. These events are rising due to increase in impervious surfaces caused by rapid urbanization as well as due to variations in rainfall events. The extreme or prolonged rainfall event gives rise to urban flooding and water logging in urban areas when the storm water drainage facilities can no longer sustain the volume of runoff. It is therefore important to study various aspects of urban flooding due to increase in intensity as well as the frequency of flood events and their effects on human health, living conditions, infrastructure damage and the economy as a whole. Ambala city, Haryana state, India is drained by tributaries of Ghaggar river, particularly the Tangri and its tributaries and it has witnessed floods with varying magnitude with different rainfall events for the past couple of decades. The present study is an endeavour to assess the urban flood hazard in identified micro-watersheds in Ambala city. The watershed boundary encompassing the Ambala city along with its river system was delineated using ALOS PALSAR (spatial resolution, 12.5m) digital elevation model (DEM) with HEC-GeoHMSplug-inand ArcGIS 10.3 environment. The land use/ land cover (LULC) map was generated from Sentinel-2A data with supervised classification technique. Using the Natural Resources Conservation Service (NRCS) Curve Number technique, the runoff potential map was generated which signifies the areas with high and low runoff potential zones for the Ambala city and surroundings. The Ground Control Points (GCPs) were collected by carrying out Differential Global Positioning System survey (DGPS) at various locations in the city. The high resolution stereo data was used to generate DEM (spatial resolution,0.31m) and later to delineate micro-watersheds in the city. The drainage map was procured from Public Health Engineering Department, Ambala. This high-resolution DEM is overlaid over runoff map to identify the micro-watersheds with high runoff potential for the detailed study using Storm Water Management Model (SWMM). The high-resolution DEM and drainage network map for identified high runoff zone within the city was used in the SWMM to setup the model. Through SWMM, the peak flow, intensity and extent of flooding, runoff depth is estimated using the DEM, LULC, rainfall data and other field data.The study is useful in understanding the use of geospatial technologies in studyingthe urban flood hazard assessment.





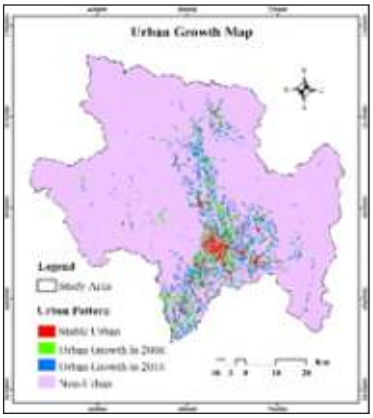


Analyzing Urban Growth Pattern of Chiang Mai City, Thailand Using Remote Sensing and Geographic Information System

Ms. Wanwilai Khunta
Research Assistant,
Geo-Informatics and Space Technology Centre
(Northern Region) Thailand
Tel: +88757151981
E-mail: wanwilai.kt@gmail.com

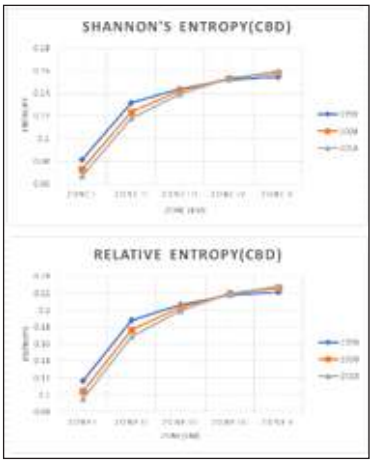
Supervisor
Dr. Sandeep Maithani
Urban and Regional Studies Department,
IIRS, Dehradun.

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

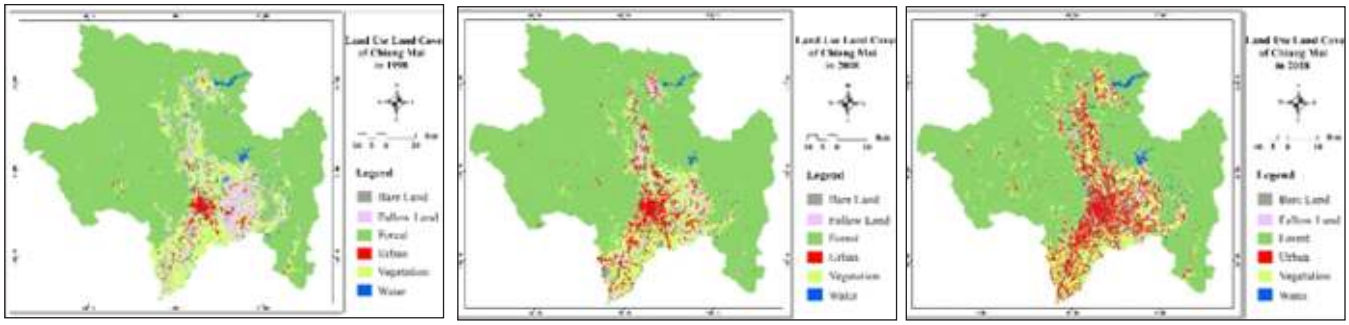


Therefore, remote sensing and GIS help in delineating the urban growth providing large extent coverage which is impossible in conventional method like surveying, etc. Landsat 8 OLI and Landsat 5 TM were used to mapped and to determine the urban growth pattern in the study area. The most advance techniques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

To analyzed the maximum urban growth, the Center Business District (CBD) and road were considered. Shannon's and Relative Entropy algorithm were used to determine how densely the urban is within the buffer zone of certain distance from either Center Business District (CBD) and road. The current study used how densely the built-up are occur nearby CBD and road periphery. The graphical representation shows both the Shannon and relative entropy are nearly to 0 in zone I (1km buffer) and increasing further which shows that the buildup are mostly occurs within Zone I followed by Zone II (2km buffer) and etc.



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



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

Md. Abdul Hamid Mia
Meteorologist
Bangladesh Meteorological Department, Dhaka, Bangladesh
Tel: +8801558311937
E-mail: abdulhamid14@gmail.com

Supervisor
Dr. Sanjeev Kumar Singh
Marine and Atmospheric Science Department (MASD)
IIRS, Dehradun

A B S T R A C T

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

In the present study, Genesis Potential Parameter (GPP) has been used to predict the tropical cyclogenesis using the Numerical Weather Prediction (NWP) model analysis as well as forecasts (up to 96-hour). The National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) high resolution (0.250×0.250) data is used to detect the genesis of tropical cyclone before classified as a tropical cyclone (intensity ≥ 34 kt.) by the India Meteorological Department (IMD). In order to identify the genesis, a threshold value of the above discussed parameter is determined by maximizing the probability of detection (POD) and minimizing the false alarm ratio (FAR). The threshold value has been computed using the data during the period 2015-17 and it applied to predict the tropical cyclogenesis of 4 tropical cyclones which formed over the Bo Bin the year 2018. The threshold value 60 is found as an optimum threshold to predict the cyclogenesis using GFS forecasts fields. To ensure that the model wind fields are realistic, the GFS wind fields is compared with the scatterometer SCATSAT-1 wind fields also. The result analysis shows that the tropical cyclogenesis can be predicted prior 24 to 60-hour of tropical cyclone formation.

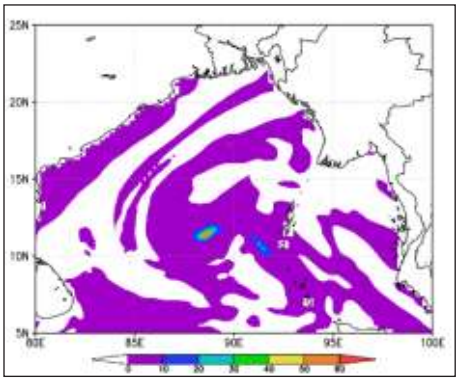


Fig. 1: Maximum GPP at 48-hour forecast based on 09 NOV 2018 for Cyclone GAJA.

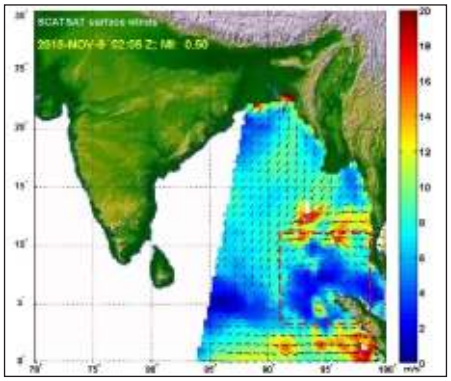


Fig. 2: The SCATSAT-1 surface wind fields at 02:05 UTC of 09 NOV 2018 for Cyclone GAJA. Source: https://mosdac.gov.in/ scorpio

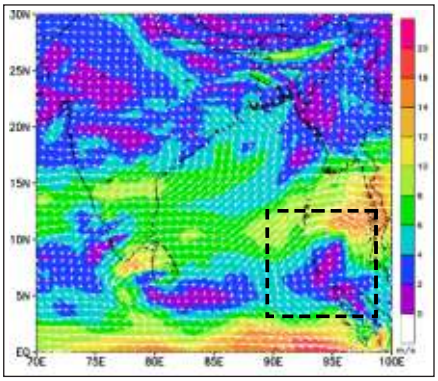
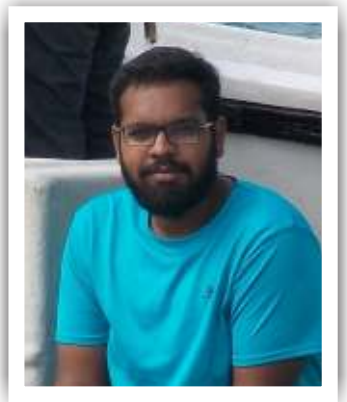


Fig. 3: The 850 hPa wind fields at 00 UTCof 09 NOV 2018 for Cyclone GAJA.

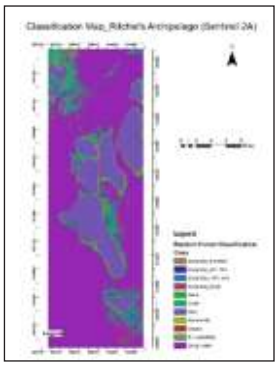
Detection and Mapping of Sea-grass Meadows Using Satellite Remote Sensing Data at Ritchie's archipelago, South Andaman

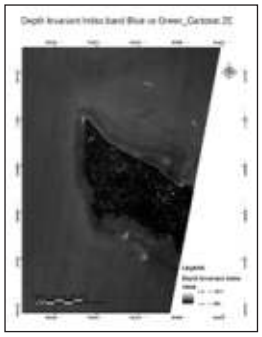
Mr. Sharad Bayyana
Project Assistant
Centre for Marine Living Resources and Ecology (MoES)
Ernakulam, Kerala, India
Tel.: +91 9476002744
E-mail: bsharad0404@gmail.com

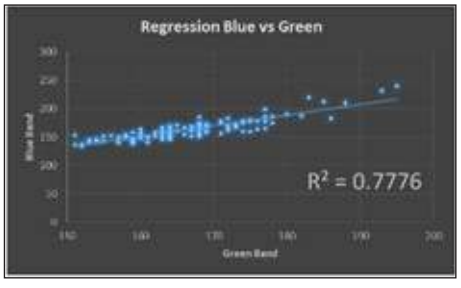
Supervisors
Dr. D. Mitra
IIRS, Dehradun
Dr. K. Sivakumar
WII, Dehradun



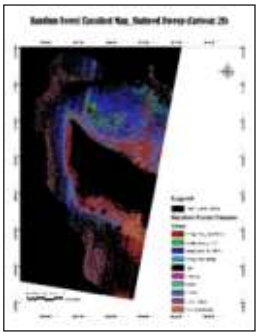
Seagrasses are marine monocotyledonous plants, growing in shallow coastal environments usually on soft sediments substratum. An essential ecological niche, supporting very specific and ecologically important organisms in the marine food chain and regulating the health of the ocean as well as the coast, they have been considered under goal no.14 “Life under water” under United Nations Sustainable Developments Goals (SDGs). Substratum Mapping of these coastal habitats using remote sensing techniques provides significant support towards the quantitative and qualitative analysis of the benthic community structure resourceful towards their conservation. This study is an attempt to detect and map the extent of potential seagrass beds off Ritchie's archipelagos, part of Andaman group of islands in collaboration with Wildlife Institute of India (WII) which are primary feeding grounds of a threatened species Dugong dugon. Very High-Resolution satellite imageries from Sentinel-2A and Cartosat-2E were used after efficient atmospheric correction to obtain water leaving radiance. Water column correction was applied to enhance the reflectance from the shallow benthic environment to help in characterization of sea grasses from various benthic features. Supervised classification was performed with three different models i.e. Random Forest, Support Vector Machine and K-Nearest Neighbor, with support of field data collected by WII team, as training sets. Random Forest method of supervised classification showed most reliable results with 0.98 (Sentinel-2A) and 0.86 (Cartosat-2E) training data accuracy, successfully detecting the seagrasses at locations used as test sites up to the depth of 20m, which has been validated with respect to NHO bathymetry charts. The classified output maps have been shared with WII which is to be validated in the upcoming season of field survey and to be incorporated in the management plan of Rani Jhansi National Park which encompasses the Ritchie's Archipelago. Mapping the extent of seagrasses around these islands using remote sensing is one of the initial studies carried out over these islands which has been useful in estimating the extent of the feeding grounds of D.dugon aiding to the conservation efforts of this monotypic species.







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



Snowmelt Runoff Modeling in TUUL River Basin, Mongolia

Mr. Erdenebayar Bavuu
Information and Research Institute of Meteorology,
Hydrology and Environment of Mongolia
Tel: +97698119336
E-mail: eegii_crepe1990@yahoo.com

Supervisors:
Dr. Praveen K. Thakur
Dr. Vaibhav Garg
Water Resource Department, IIRS, Dehradun

ABSTRACT

The TUUL River originates in the Khan-Khentein-mountain Nature Reserve, in the Erdene sum of Töv province, pass through central and northern Mongolia. It is 898 km long and the watershed area is 57,764 sq. km. The basin annual average precipitation amounts to 246.7 mm (in the vicinity of Ulaanbaatar city). It is estimated that 48.4% of annual average precipitation becomes evapotranspiration and 51.6% becomes surface water and groundwater recharge. The lowest temperature of -48.0°C is recorded in the month of January. The highest temperature of 43°C is recorded in the month of August. The annual mean daily temperature lies between -48°C to 43°C. In the present study, the hydrological simulation of Tuul River with emphasis on snow melt was carried out using the Variable Infiltration Capacity (VIC) model. The model has been setup with data SRTM DEM, FAO soil texture, MODIS LULC, MODIS snow cover area, ground observed hydrological data of 02 and meteorological dataof10 stations. The general elevation of the land surface of the study area ranges from 776 m to 2793 m above mean sea level. The snow melt runoff during time between April and June. Between 2004 and 2016, the range of long term snow cover ranges between 5 and 95% between October and April. The model simulates daily stream flow in mountainous and other types of basins where snowmelt is a major runoff contributor. The period 2011-2016 was used for calibration and validation of VIC. After calibration the value of R2 between simulated and observed discharge was 0.75 for Tuul-Ulaanbaatar and 0.71 for Tuul-Altanbulag station. Average measured runoff is 16.5 (m^3/s), average computed runoff is 13.9 (m^3/s); and maximum measured runoff is 206.0 (m^3/s), maximum computed runoff is 237.5 (m^3/s) in Tuul-Ulaanbaatar station. Average measured runoff is 12.7 (m^3/s), average computed runoff is 19.2 (m^3/s); and maximum measured runoff is 124.2 (m^3/s), maximum computed runoff is 290.3 (m^3/s) in Tuul-Altanbulag station.

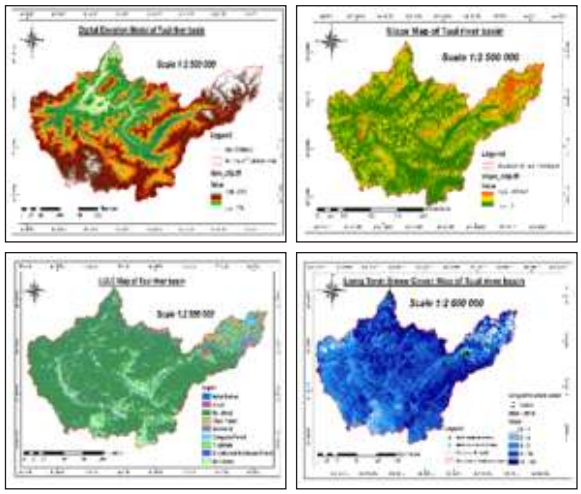


Fig. 1: Dem, Soil, Slope, Annual Precipitation, LULC and Long Term Snow Cover Maps

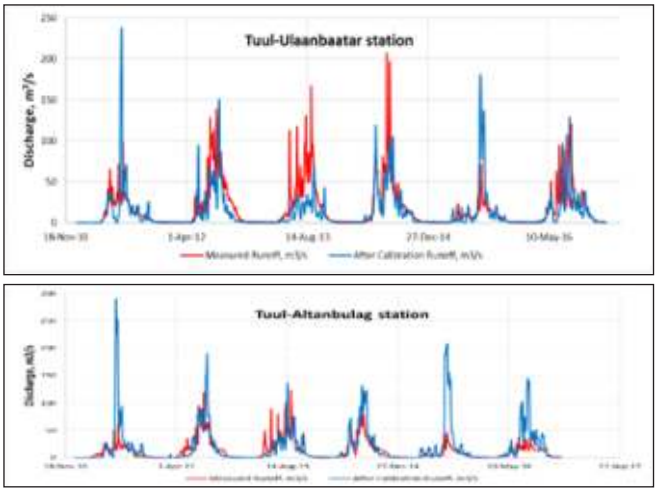


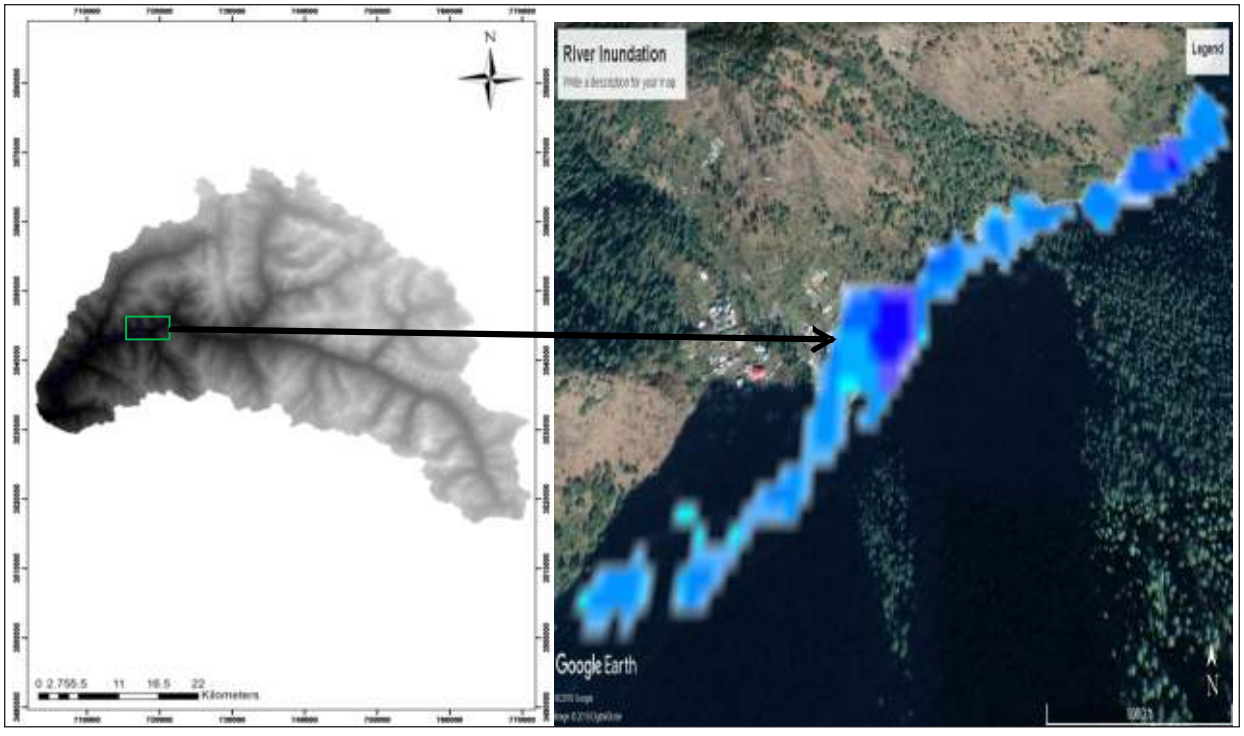
Fig. 2: Measurement and computed discharge in TUUL River basin (2011-2016)

Flood Hazard Mapping in Parbati Valley

Mr. Kyaw Min Hlaing
Department of Meteorology and Hydrology
Hydrology Division (DMH), Myanmar
Tel: +95-9-420704529
E-mail: kyawminhlaing.dmh@gmail.com

Supervisors
Mr. Pankaj Ramji Dhote
Scientist/Engineer-SD, WRD
Dr. S.P. Aggarwal
Group Head, WRD
IIRS, Dehradun

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

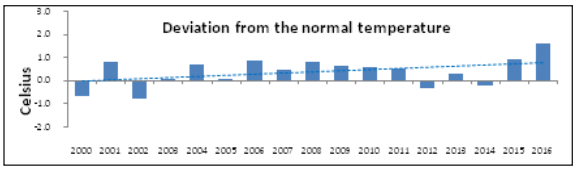


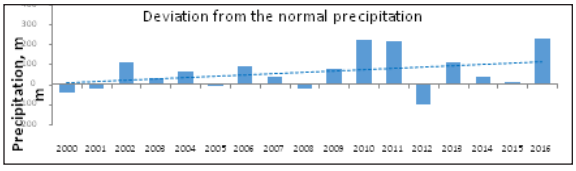
Remote Sensing and Hydromet Data Based Glacier Dynamics of Fedchenko Glacier

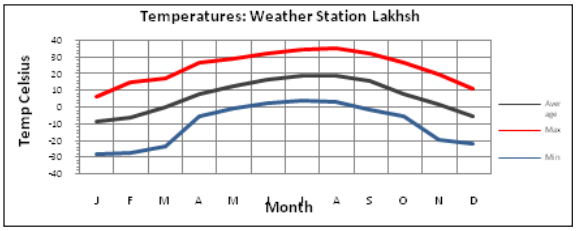
Mr. Kenjaev Firuz
Senior Specialist in Hydrology Department,
Agency for Hydrometeorology of Tajikistan
Tel: (+992) 9085854-54, 9173090-09;
E-mail: kfiruz.1994@mail.ru

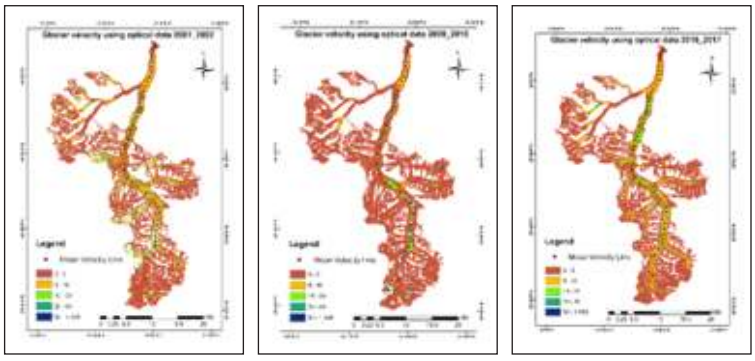
Supervisors
Dr. Praveen K. Thakur
Dr. Vaibhav Garg
Water Resources Department
IIRS, Dehradun

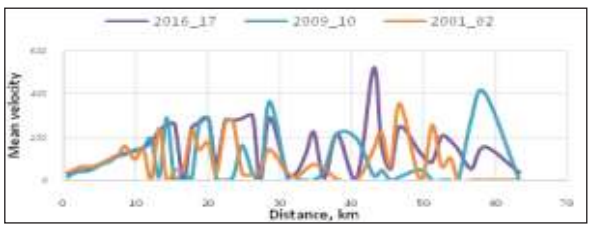
The mass balance of a glacier is a concept which is critical to all theories of glacier flow and behavior. In the year of 1910-1913,Fedchenko glacier has been separated into many parts and advanced outwards by 800-1000 m. In 1914, the glacier having 50 m thickness had blocked the valley of the river Balyandkiyk and rested against its right rocky slope. As a result, the river started flowing with high velocity under the ice. Once the glacier started melting, rivers overflowed and flooded the surrounding areas causes damage to the human life and properties. It is imperative to understand the velocity of the glacier in respect to its mass balance to safe guard the property and loss of life from its devastating effect. In this study, Landsat 4,5, 7 and 8 images, Sentinel 1, hydromet data from 2000 to 2016 have been used for the analysis of Glacier Fedchenko, having an area approximate to 952 km2. Surface velocities were calculated using sub-pixel correlation of the acquired images, using the freely available software Co-registration of Optically Sensed Images and Correlation (COSI-Corr), which is downloadable from http://www.tectonics.caltech.edu/. In this algorithm, two images are iteratively cross-correlated in the phase plane on slidingwindows, to find the best possible correlation. A detailed description of the algorithm is given by Leprinceet al.(2007). After performing sub-pixel correlation, taking a sliding window of 64x32 pixels and a step size of two pixels we obtained three output images: a north/south displacement image, an east/west displacement image and a signalto-noise ratio (SNR) image that describes the quality of correlation. All pixels that have SNR < 0.9 and displacements>85m are discarded. According to Hydromet, here we see that in the winter season, the average and maximum temperature has increased during the study period, and in the same period the amount of precipitation has decreased along with the reduction in glacier as well.











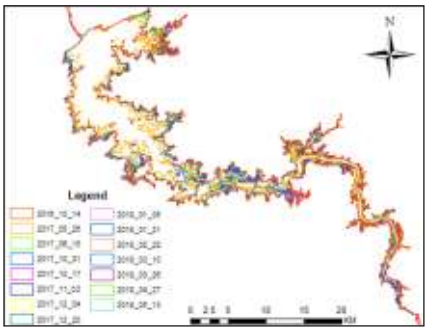
Remote Sensing Based Resrvoir Sedimentation-a Case Study of Bargi Reservoir

Ms. Laylo Zaridinova Kamoliddinovna
Hydrology Project of Uzbekistan "UZGIP"
Advanced Design Department
Tel: +998933956900, +998712231671
E-mail: Fedele_1991@mail.ru

Supervisors
Dr. Vaibhav Garg
Dr. Bhaskar Nikam
Water Resource Department,
IIRS, Dehradun

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

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



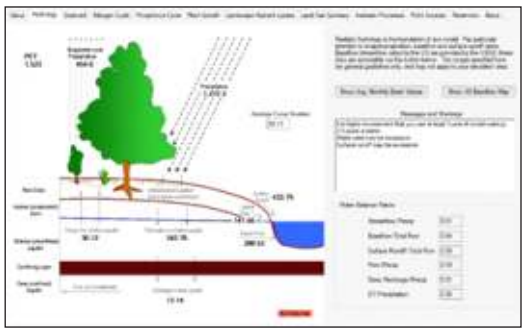


Fig A: Water Spread Area Map **Fig B.** Narmada River Basin **Fig D:** Hydrological Model from 2016 to 2018

Water Balance Estimation in Chirchik River Basin

Mr. Sanjarbek Muratov
Junior researcher
Irrigation and Water Problems Scientific Research Institute
H.3, Str. Asaka, M.Ulugbek District, Tashkent, 100000, Uzbekistan
Tel: +998 99 807 9039
E-mail: murotovs@gmail.com

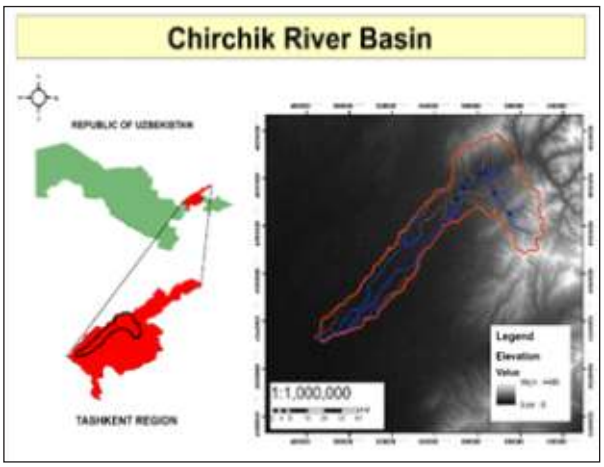
Supervisors
Dr. S.P. Aggarwal
Dr. Arpit Chouksey
Water resources department,
Indian Institute of Remote Sensing, Dehradun

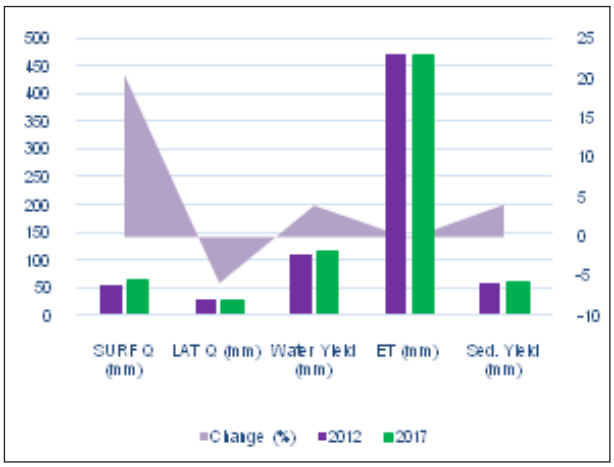
A B S T R A C T

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

The Soil and Water Assessment Tool (SWAT) was tested on daily and monthly basis for estimating water balance components as surface runoff, precipitation, evapotranspiration and water available water yield watershed. All the input data for the SWAT model was extracted using the standard procedures. The Sequential Uncertainty Fitting (SUFI-2) method within SWAT Calibration and Uncertainty Procedures (SWAT-CUP) was used to identify the most sensitive streamflow parameters. Parameters in the model were calibrated and simulated results were validated for two time periods: first 2009-2011 and 2012-2013, second 2013-2015 and 2016-2017 in term of observed discharge data. Graphical and statistical methods of tests revealed that the observed and simulated monthly surface runoff for the calibration and validation period matched quite good. Statistical model performance measures, the coefficient of determination (R2) and Nash-Sutcliffe Efficiency (NSE) were used to evaluate the correlation between the observed and simulated monthly streamflow. The result shows a good agreement between the observed and simulated flow. Both NSE and R2 were found to be greater than 0.7 for the calibration and validation period. The results show that surface runoff and water yield at the watershed outlet will significantly increase by converting bare land and grassland to impervious surfaces.

Keywords: SWAT, land use, water balance, hydrology, water cycle





Soil Salinity and Waterlogging Assessment Usingremote Sensing and Geographic Informationn System (GIS)

Mr. Moun Moonmeungshand
Technical Officer
Ministry of Science and Technology
Department of Technology and Innovation, Lao PDR
Tel: +8562077727065
E-mail: Mounmms94@gmail.com

Supervisors
Dr. Arpit Chouksey
Dr. Bhaskar R. Nikam
Water Resources Department
IIRS, Dehradun

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

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

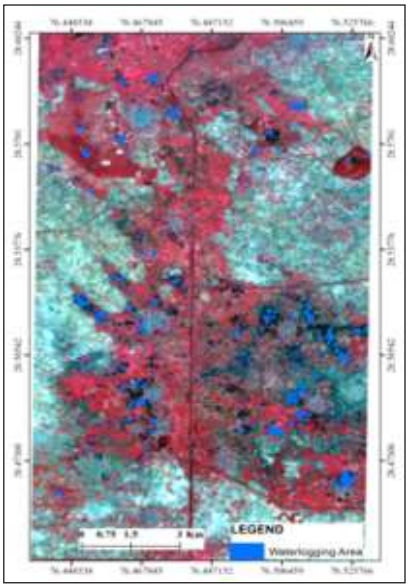


Fig. 1: Waterlogged area

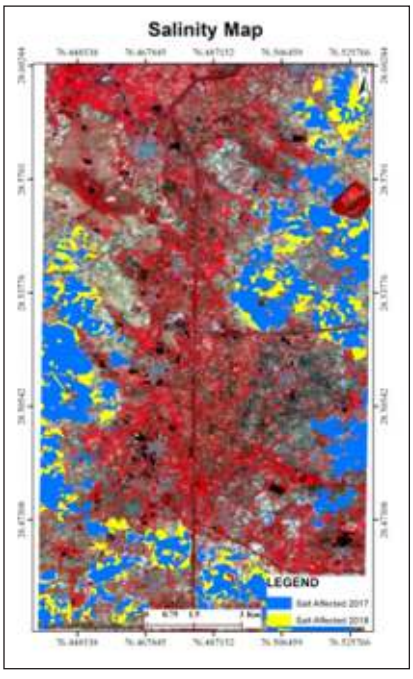


Fig. 2: Salinity Map 2017-2018

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

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

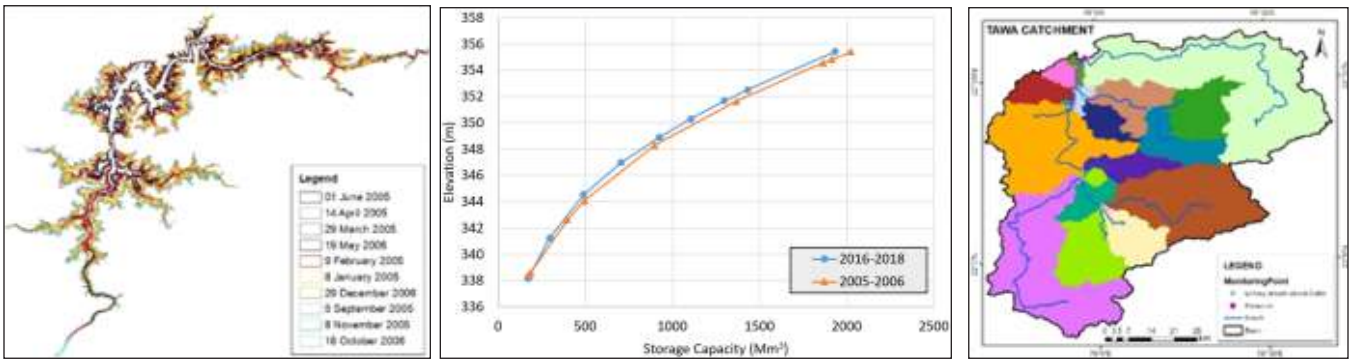
Hydrological Simulation for Reservoir Sedimentation Assessment

Le Minh Thanh
Engineer
National Remote Sensing Department
Hanoi, Vietnam
Tel: +84 974764720
E-mail: thanhlm.rsc@gmail.com

Supervisors
Dr. Vaibhav Garg
Dr. Bhaskar R. Nikam
Water Resources Department
IIRS, Dehradun

A B S T R A C T

Reservoirs are vital elements of the hydrological cycles, utilized for water supply, irrigation and flood control. Periodic evaluation of the sediment deposition in reservoirs and the assessment of available storage capacity of reservoirs are important aspects of water resources management. The conventional techniques of reservoir sedimentation assessment, such asinflow-outflow methods and hydrographic surveys are costly and time-consuming. Further, modelling of sediment transport in reservoirs using empirical and numerical methods requires a large amount of input data. Satellite Remote Sensing (RS) provides synoptic, timely and repetitive information on water-spread area of a reservoir at different elevations. By applying RS in combination with GIS, the temporal change in water-spread area can be analyzed to evaluate the sediment deposition in a reservoir. In this study, a RS approach and distributed hydrological model (SWAT) have been used for asssessing sedimentation in Tawa Reservoir, Madhya Pradesh State, Central India. Water-spread area of Tawa Reservoir at different elevations for the periods of 2005-2006 and 2017-2018 was extracted from multi-date Landsat data. The revised capacity of Tawa Reservoir between two successive elevations was computed using the Trapezoidal formula using calculated water-spread area and the availability of observed reservoir water level data. The Elevation-Capacity curves and tables are derived for estimating reservoir sedimentation. SWAT model with input data including DEM, meteorological data, land use-land cover and soil map used to estimate sediment transport to Tawa Reservoir from 1978 to 2017.However, sedimentation rate of Tawa Reservoir using RS approach are quite different with the result of estimation from SWAT model. The results gave the idea of using RS technique and hydrological model for reservoir sedimentation assessment but needs further study to validate.



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

Time Series Interferometry Analysis for Deformation Monitoring Using Scatterer Based Technique

Ms. Nyamaa Tserendulam
Specialist,
Geospatial Intelligence, Army Force, Mongolia
Tel: 976-99649972, 77807787
E-mail: nima_faith@yahoo.com

Supervisor
Mr. Vinay Kumar
Photogrammetry, Remote Sensing Department,
Indian Institute of Remote Sensing, Dehradun

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

In the study area, land subsidence rates in different mining sites was obtained from cumulative displacement map. As per the results the rate of subsidence observed in different mining sites varies from a few mm to tens of mm per year. Figure 2: Subsidense rate, deformotion time series plot in localities.

Keywords: InSAR; DInSAR; PSInSAR;Mining;land subsidence; deformation;

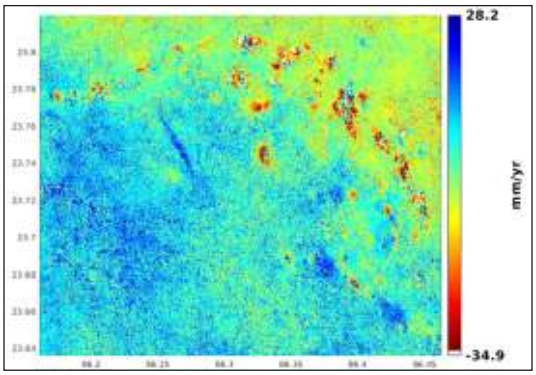


Fig. 1: Cumulative displacement map of Jharia Coalfield using ALOS-2 PALSAR data (Oct.2016- Mar. 2018)

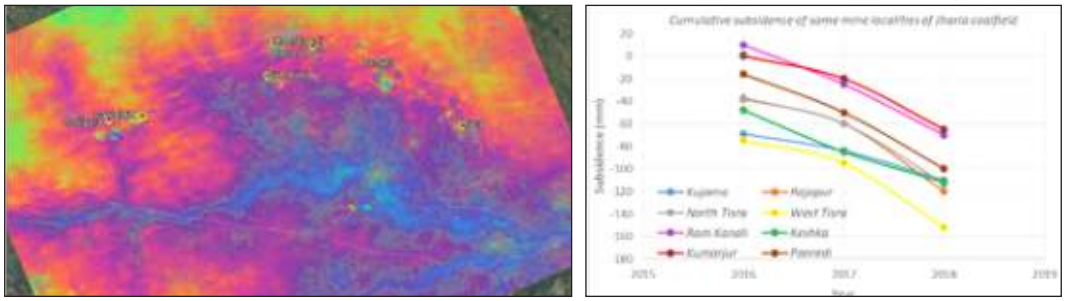


Fig. 2: Subsidense rate, deformotion time series plot in localities

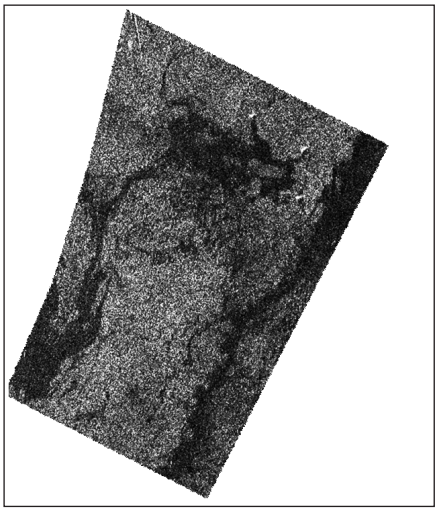
Sar Data Processing for Oil Spill Detection

Mr. Nguyen Duc Loc
Department of Surveying and Mapping,
Vietnam National University of Agriculture
Tel: +84-903428148
E-mail: nguyenducloc@vnua.edu.vn

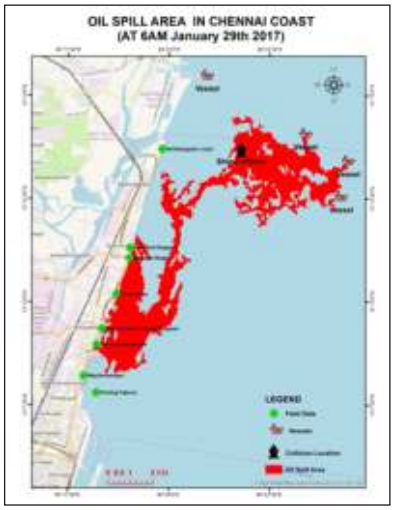
Supervisors
Mr. Shashi Kumar
Photogrammetry and Remote Sensing Department, IIRS
Mr. C.M. Bhatt
Diaster Management Studies Department
IIRS, Dehradun

A B S T R A C T

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



Sentinel-1 SAR data (VV polarisation)



Oil Spill Map on 29/01/2017

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

Mr. Padam Bahadur Budha
Greenhood Nepal, Kathmandu, Nepal
Tel.: +977-9841935849, +977-1-4489229
E-mail: padambudha88@gmail.com

Supervisor
Dr. Ashutosh Bhardwaj
Photogrammetry and Remote Sensing Department,
Indian Institute of Remote Sensing, Dehradun

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

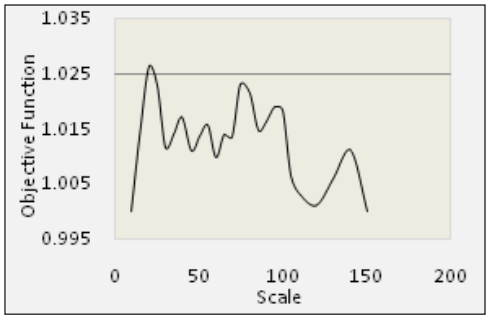


Fig. 1: Plot of objective function versus scale (curved line) with plateau function (straight line)

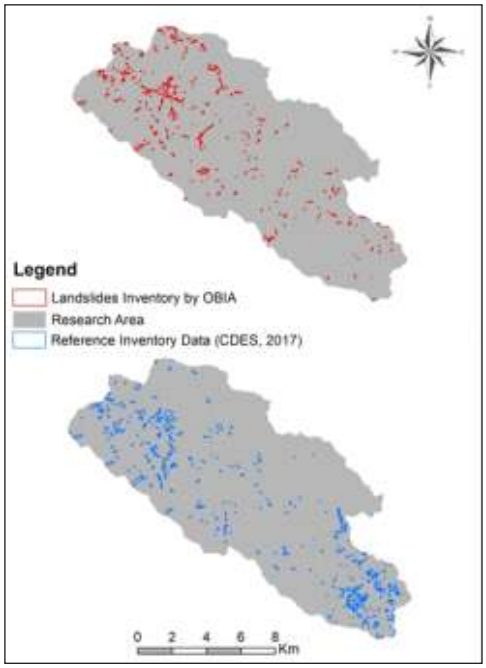


Fig. 2: Landslide inventory from OBIA and reference landslide database

A B S T R A C T

Monitoring urban change using LiDAR data

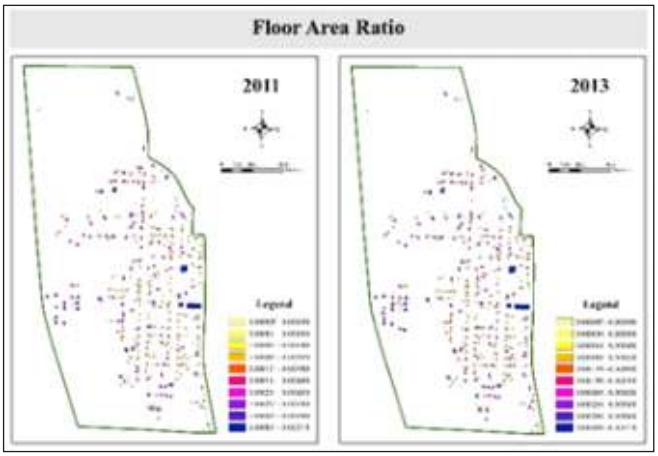
Ms. Saranthorn Suthana
Researcher
Geo-Informatics and Space Technology Centre (Northern Region)
Thailand
Tel: +66956763340
E-mail: b.suthana@gmail.com

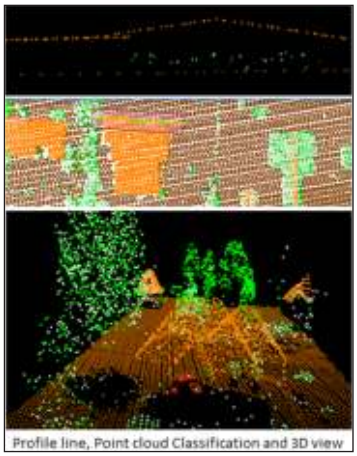
Supervisor
Mr. S. Raghavendra
Photogrammetry and Remote Sensing Department,
IIRS, Dehradun.

A B S T R A C T

Building Density Information and Building change detection is fundamentally important for urban design, illegal building identification, urban growth monitoring, planning and management for urban environmental studies. The current project proposes an automatic LiDAR reclassification method from Light Detection And Ranging (LiDAR) point cloud data within the spatial limits of Willard City, Box Elder County, Utah in USA. In this method, the data are first preprocessed to identify and remove the noise points from two-year point cloud data (2011 and 2013). Automatic Non-Ground Point reclassification technique were used thereafter for identifying building parameter such as height, size, area and elevation. The manual classification was further used for identification of right objects (building) to right class (building class). Here the most common indices or parameter for building density determination namely Building Coverage Ratio (BCR) and Floor Area Ratio (FAR) was used.

The classification result was assessed in term of accuracy by using confusion matrix in ArcGIS platform and obtained 99.5% accuracy with kappa coefficient of 0.92 and above. The BCR in year 2011 is 0.034 and 0.036 in year 2013. The FAR in the year 2011 is 0.00012 and0.00037 in year 2013 respectively. The rate of construction of new buildings is higher than rate of demolishing, thus increasing the BCR and FAR from 2011 to 2013.The change detection has been carried out in term of number of new buildings in the year 2013 with 2011 buildings as a stable building and 27 new buildings are observed to be constructed in 2013 additional to the base year 2011 and 8 number of buildings were demolished in the year 2013.



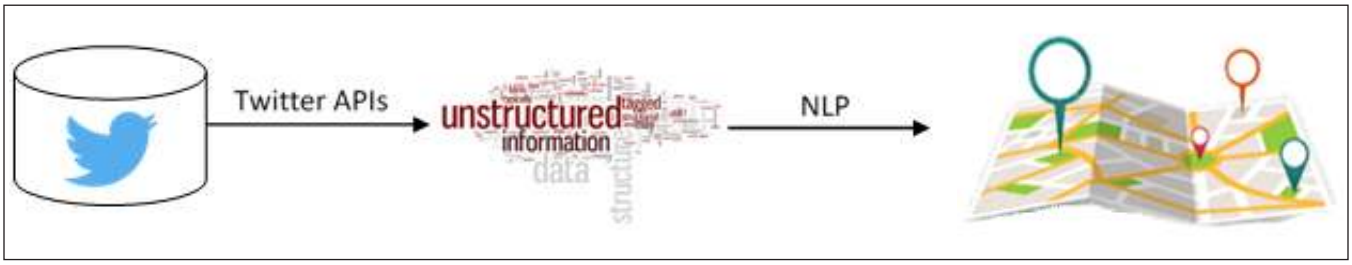

Profile line, Point cloud Classification and 3D view

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

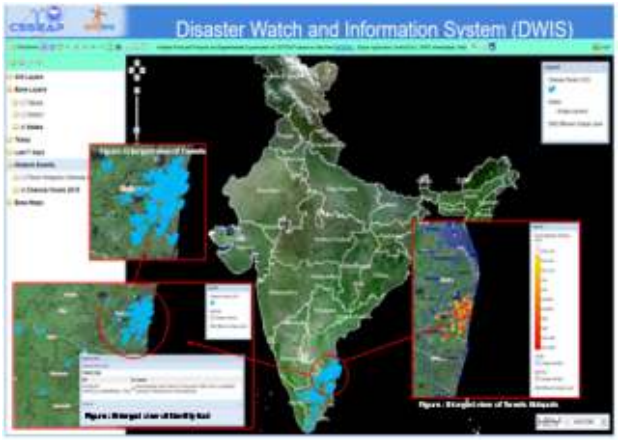
Mr. Sattaru Jaya Surya
B.Tech, Geoinformatics
Andhra University College of Engineering (A)
Visakhapatnam, Andhra Pradesh, India
Tel: +919505454907
E-mail: sjsurya0203@gmail.com

Supervisors
Dr. Sameer Saran
Geoinformatics Department, IIRS
Mr. C.M. Bhatt
Disaster Management Studies Department, IIRS

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

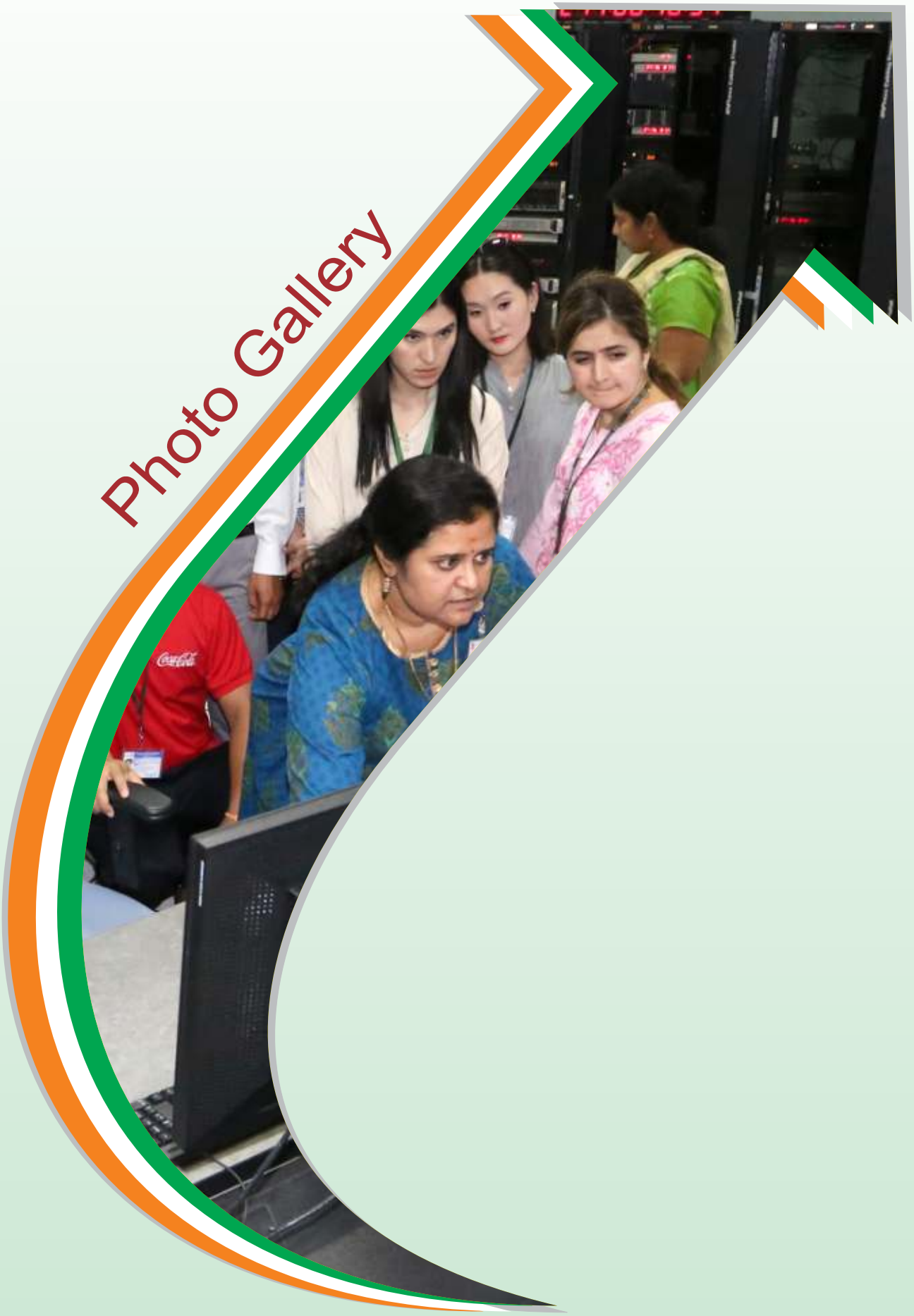


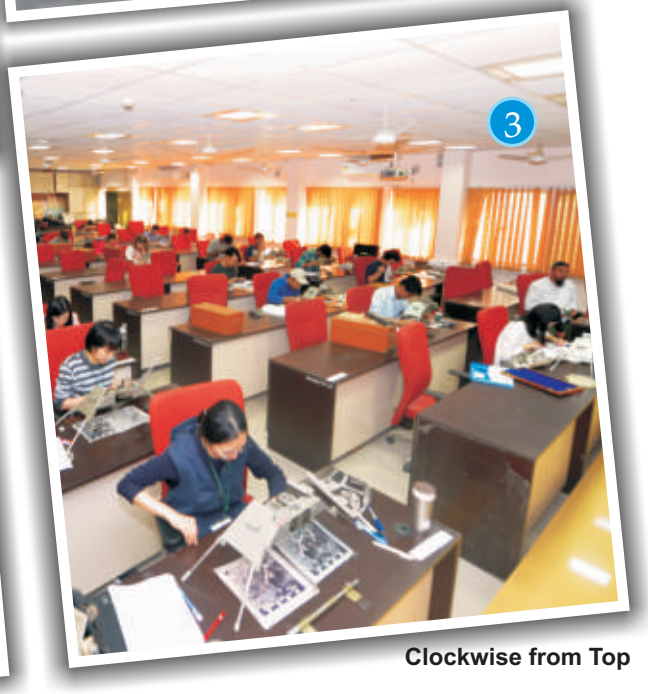
The collected tweets contains messages asking for help, relief measures and expressing gratitude. VADER algorithm which is a lexicon and rule-based sentiment analysis tool is used for removing the more positive tweets (positive polarity score > 6.0) which is considered to be noise. Among the filtered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




Hostel

Photo Gallery





Clockwise from Top

1 - Participants Visit Rishikesh
2 - Andhra University Visit, Visakhapatnam
3 - Participants at Practical Lab
4 - Nandi Hills Visit Bengaluru
5 - Visit to Shadnagar Earth Observation Facility-NRSC, Hyderabad

Clockwise from Top

6 - Playing Snooker
7 - Tug of War
8 - At Canteen
9 - Participants Visiting Taj Mahal
10 - Diwali Celebration

Clockwise from Top

11 - Independence Day Celebration
12 - Celebrating Birthday
13 - Field Data Collection
14 - Participant at NRSC Outreach Facility, Jeedimetla
15 - Demonstration of live satellite pass at NRSC Earth Observation Facility- Shadnagar
16 - Celbrating the Festival of Dipawali

Impressions of Participants

In Remembrance

We were all in different parts of the world and were engaged in our daily activities, but one letter changed our destiny, it was letters of adherence to the course that we all applied, wishing to see this magical country about which we heard from tales, films and works of art.The administration of the course was very punctual and friendly, and helped us in all processes, from the application procedures to reaching India.We were all a bit concerned, because we were leaving to live and study abroad for a long period, but fortunately all the concerns were in the past.As it turned out, the people of IIRS and the officials ofadministration are friendly and acted as guardians for us.

After reaching IIRS, we were greeted warmly and were taken to our hostel, where rooms were prepared for us with all the amenities.After unpacking things, we had the Indian kitchen foods in the dining room ofIIRS.The head of the institute guidedus about the institute, and told us its history. And also, we meet the faculties and showed alldepartments and laboratories.On 3rd July our classes started with our friends, who havecome from different countries. In the next three month we studied concepts and basic of remote sensing and GIS, with a bit pressure considering the wealth of knowledge provided to us in the schedule. Amidst the feeling of "going back to college again",one thing was gratifying, that there are so many festivals and holidays in India, where we and our friends could easily communicate and have fun, exchange opinions on our culture, traditions, and also celebrate birthdays and holidays of respective countries.

Day after day we settled down to a new location more easily, found common interests with our friends. We got the opportunity to attend international conferences and workshop which further helped us in polishing our skills in presentation and public speaking.We went on several field trips, where we studied the beauty and culture of India. Our educational trip to Visakhapatnam, Hyderabad and Bangalore was very memorable for us. One of our best experiences was getting to know the process of receiving satellite data at a ground station at NRSC Hyderabad. We were delighted with the beauty of the Indian Ocean and some historical sites during our excursion. Our next trip was to New Delhi, we explored the capital of India and visited historical sites such as Qutub Minar and Taj Mahal.

During the exam, we realized that life is a balance of ups and downs, when we have to face difficulties in order to know our strengths and weaknesses and learn to overcome obstacles.Our final module, the phase where we had to implement the things, we have learnt for the last six months in a practical way. We were given freedom to choose any topic that we were interested in. Our supervisors gave us dedicated and consistent support, generous guidance and advice. We have been facilitated with well-equipped labs and infrastructure. Open access to lab has been provided even at night times and weekends. This phase added unforgettable memories for us and provided with great opportunity to understand our knowledge.

We CSSTEAP students convey our thanks to Director CSSTEAP, Dr. A. Senthil Kumar and Director, IIRS Dr. Prakash Chauhan who have been taking care of our progress in the project and giving us valuable advices. We are very grateful to our Programme Coordinator Dr. S.P. Aggarwal, Course Director Mr. C.M. Bhatt and Course Coordinator Mr. Shashi Kumar for being helpful and supportive in every situation.

We all are very thankful to IIRS for adding spark and knowledge in our professional and personal life. This nine-month course made us realize that sky has no limit.

- Batch of 23rd RS&GIS course

Mr. Md. Abdullah Aziz
Bangladesh

Ms. Noyoftova Nigorbegim Niyatbekovna
Tajikistan

Ms. Orifkhonova Shakhnoza Najimkhonovna
Tajikistan

Ms. Phitchayalak Wongchingchai
Thailand

Mr. Bichit Kumar Singh
Nepal

Mr. Doan Quoc Vuong
Vietnam

Mr. Sangay Gyeltshen
Bhutan

Mr. Riddhish Chetan Soni
India

Ms. Venkata Sri Pujitha Pukkella
India

Ms. Wanwilai Khunta
Thailand

Mr. Md. Abdul Hamid Mia
Bangladesh

Mr. Sharad Bayyana
India

Mr. Erdenebayar Bawuu
Mongolia

Mr. Kyaw Min Hlaing
Myanmar

Mr. Firuz Kenjaev Safarbekovich
Tajikistan

Ms. Laylo Kamoliddinova Zaridinova
Uzbekistan

Mr. Sanjarbek Muratov
Uzbekistan

Mr. Moun Moonmeungshand
Lao PDR

Ms. Le Minh Thanh
Vietnam

Ms. Nyamaa Tserendulam
Mongolia

Mr. Nguyen Duc Loc
Vietnam

Mr. Padam Bahadur Budha
Nepal

Ms. Saranthorn Suthana
Thailand

Mr. Jaya Surya Sattaru
India


ISRO

TWENTY THIRD POST GRADUATE COURSE IN REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

1st JULY 2018 TO 31st MARCH 2019

1st Row (L to R):

Ms. Nyamaa Tserendulam (Mongolia), Ms. Le Minh Thanh (Vietnam), Ms. Phitchayalak Wongchinchai (Thailand), Ms. Wanwilai Khunta (Thailand), Ms. Saranthorn Suthana (Thailand), Ms. Sri Pujitha V. Pukkella (India), Ms. Orifkhonova Shakhnoza Najimkhonovna (Tajikistan), Ms. Laylo Kamoliddinovna Zaridinova (Uzbekistan), Ms. Noyoftova Nigorbegim Niyatbekovna (Tajikistan)

2nd Row (L to R):

Mrs. Meena Jethi (P.S.), Dr. Puneet Swaroop (Head, BPMD), Mr. Shashi Kumar (Course Coordinator, CSSTEAP), Dr. Arijit Roy (Head, DMS), Dr. S.P. Agarwal (Programme Coordinator, CSSTEAP), Dr. A. Senthil Kumar (Director, CSSTEAP), Dr. Prakash Chauhan (Director, IIRS), Dr. Hari Shankar Srivastava (Group Head, PPEG), Mr. C.M. Bhatt (Course Director, CSSTEAP), Dr. Sameer Saran (Head, GID), Dr. D. Mitra (Group Head, MASD), Ms. Shefali Agrawal (Group Head, GT&OP)

3rd Row (L to R):

Mr. Sanjarbek Muratov (Uzbekistan), Mr. Jaya Surya Sattaru (India), Mr. Erdenebayar Bawuu (Mongolia), Mr. Moun Moonmeungshand (Lao PDR), Mr. Nguyen DucLoc (Vietnam), Mr. Doan Quoc Vuong (Vietnam), Mr. Kyaw Min Hlaing (Myanmar), Mr. Sangay Gyeltshen (Bhutan), Mr. Kenjaev Firuz Safarbekovich (Tajikistan), Mr. Riddhish Chetan Soni (India), Mr. Bichit Kumar Singh (Nepal), Mr. Padam Bahadur Budha (Nepal), Mr. Md. Abdullah Aziz (Bangladesh), Mr. Md. Abdul Hamid Mia (Bangladesh), Mr. Sharad Bayyana (India)