

COURSE REPORT



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

(Affiliated to the United Nations)

IIRS Campus, 4 Kalidas Road, Dehradun, India

URL: www.cssieap.org

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International Training Course on Hyperspectral Remote Sensing and its Applications

1.0 Background

The advent of Hyperspectral Remote sensing in the early 1980s is one of the most significant breakthroughs in remote sensing for Earth Observation. Hyperspectral Remote sensing also known as imaging spectrometry is emerging as a promising technology for detection and identification of minerals, terrestrial vegetation, man-made materials and backgrounds. The word "hyperspectral" is used to distinguish sensors with many-tens or hundreds of bands *cf.* to traditional multispectral sensors. Hyperspectral sensors collect data in a series of narrow and contiguous wavelength bands at 10 to 20 nm intervals. The spectra for a single pixel in hyperspectral data appears similar like a laboratory quality spectra collected by a spectro-radiometer which can be used for understanding the spectral characteristics of the material.

The development of terrestrial imaging spectroscopy started in the late seventies by NASA's Jet Propulsion Laboratory (JPL) and government of Canada/private partnership (Department of Fisheries and Ocean/Moniteq) leading to the Airborne Imaging Spectrometer (AIS) in the U.S.A. and the Fluorescence Line Imager (FLI) in Canada with first data acquisitions in 1983 and 1984, respectively. IMS-1 launched in 2008, is India's first micro-satellite having HySI payload. In the same year a similar sensor with improved spatial resolution was flown on Chandrayaan-1 mission. Today many ground-based and airborne hyperspectral systems are available and it provides ample opportunities for the use of hyperspectral data in various application areas.

Several hyperspectral tools for data processing and analysis are developed for information extraction. These tools include algorithms for data handling, data pre-processing and information extraction. Especially the latter area has seen a significant advancement over the last decade. With algorithms, such as spectral matching and derivative approaches, wavelet-based procedures, spectral un-mixing/end member selection, kernel-based classification/detection approaches and vegetation transfer modelling inversion it is possible to extract information. Focus is on combing the spectral and spatial information which will further enhance the exploitation of hyperspectral data. The current trends are towards automation of the whole processing chain and make use of parallel processing and grid-computing capacity, enabling cost-effective and timely data processing. From the various researches carried out using hyperspectral RS data that imaging spectroscopy has significantly advanced the use of remote sensing in different applications, especially the capability to extract quantitative information. This technology has been used for mineral exploration, identification and mapping of abundances of specific minerals, ecosystem monitoring, monitoring of coastal and inland waters, mapping the variability of soil properties, insect damage etc. Imaging spectroscopy can also be used for mapping of snow parameters important for characterizing the snow.

2.0 Objectives

The overall objectives of this training course were

- Generate awareness among users/researchers/professionals about the concept of Hyperspectral Remote Sensing, and
- Disseminate knowledge and practical applications on use of Hyperspectral data.

3.0 Target Beneficiaries

Participants were post graduate in science or graduate in engineering or equivalent qualification in relevant to the field of study with 5-10 years of experience in teaching/research on professional experience in the field of Remote sensing technology or environment.

4.0 Course Inauguration

The course was inaugurated by Dr. Y. V. N. Krishna Murthy, Director CSSTEAP. Dr. S.K Saha Dean (Academics) welcomed the Chief Guest and the participants. Dr. Sarnam Singh, Course Director (CSSTEAP RS&GIS) highlighted about CSSTEAP and its activities and also about the significance of Hyperspectral Remote Sensing and this course in particular. Mrs. Shefali Agrawal, Course coordinator briefed the participants on the course structure. Dr. Y. V. N. Krishna Murthy, Chief Guest of the function in his address highlighted the importance of Hyperspectral sensors and its significance and future Hyperspectral imaging missions of India. It was attended by the faculty, staff and course participants of various courses of IIRS and CSSTEAP.

5.0 About Participants

The course was conducted during 3rd-28th June 2013 with 19 participants joining the course, from 7 countries in Asia Pacific Region namely Bangladesh, India, Mongolia, Myanmar, Nepal, Uzbekistan, and Vietnam. The participants

were from different thematic disciplines and organizations. The detail of participants with their affiliations are given in Annexure I.



Inaugural Address by Dr. Y.V. N. Krishna Murthy

6.0 Course Structure

The course was designed in a modular structure and provided a blend of theory, and practical experience. It consisted of three modules. The training material consisting of lecture notes, presentation slides, practical handouts etc were provided to the participants on a CD. The lecture and practical topics covered are given in Annexure II.

- Module-I:** It covered the fundamentals of Hyperspectral Remote sensing, basic spectroscopic principles, emerging hyperspectral sensors, data quality issues, spectral characteristics of various land cover features, data preprocessing, atmospheric corrections, ground data collection and spectral library creation, hyperspectral data processing for feature extraction. Each participant was provided with individual computer with required image processing software such as ENVI, ERDAS Imagine and ViewspectPRO.
- Module II:** It covered applications of hyperspectral remote sensing in agriculture & soils, forestry, atmosphere and geology, snow, ice and glacier studies, planetary science. To familiarize with the ground based instruments like Spectro-radiometer and Sun photometer, two field visits: Dehradun and surrounding regions and Poanta were organized during the course. Ground based spectra of various features were collected using spectro-radiometer for hyperspectral data processing like spectral similarity analysis and classification.
- Module III:** In the last week the participants carried out a small case study in the area of their interest and presented their results in the following application areas:

| S.No. | Name of the Participant | Project Title |
|-------|-------------------------------|---|
| 1. | Mr. Md. Shafiul Alam | Mangrove Tree Species Identification and Assessment of Classification Algorithm Results using Hyperion Data |
| 2. | Mr. Sukumar Dutta | Crop Identification Using Hyperion Data of Meerut Area in India |
| 3. | Md. Shahjahan Ali | |
| 4. | Mr. Umesh Kumar Mandal | |
| 5. | Mr. A.S. Madhusudana Charyulu | Study of Trace Gases Released in Volcanic Eruption Using Hyperspectral Sounder Data |
| 6. | Mr. Birendra Kumar Das | A Controlled Experiment with Spectral Un-mixing |
| 7. | Ms. Elvira Basalyamova | |
| 8. | Mr. C.R. Paramasivam | Hyperspectral Remote sensing Applications in Mineral Identification |
| 9. | Ms. Oyuntugs Batbayar | |
| 10. | Mr. Dharmendra Singh | Assessment of Classifiers ability in classifying Hyperspectral Data at different Climatic Conditions. |
| 11. | Ms. Poonam S. Tiwari | Spectral Processing of CHRIS Proba data for a part of Seville, Spain |
| 12. | Dr. Tanuku Venkateswara Rao | Land use/Cover Classification using Hyperion Sensor Imagery for a part of Dehradun City |
| 13. | Dr. Vaibhav Garg | Snow Grain Size Mapping using Hyperspectral Remote Sensing data |
| 14. | Dr. Sao Hone Pha | Detection of Mustard Crop Stress using EO-1 Hyperion Data |
| 15. | Dr. Le Thi Thu Hien | |
| 16. | Ms. Lola Sichugova | Vegetation species classification using Hyperspectral Data |
| 17. | Mrs. Ho Thi Van Trang | |
| 18. | Mr. Nguyen Manh Hung | Land use land cover classification of Hanoi city using Hyperspectral Remote Sensing data |
| 19. | Mrs. Nguyen Thi Ngoc Nga | |



Course participants attending lecture session



Participants in the field for collection of Spectra using Spectro-radiometer



7.0 Faculty

Experienced faculty from IIRS (Dehradun); Space Application Center (Ahmedabad), ADRIN (Hyderabad), IIT-Bombay (Mumbai), Indian Agricultural Research Institute (New Delhi), DEAL (Dehradun); Anna University (Chennai), SASE (Chandigarh), delivered lectures and hands on training in the course. The list of faculty and their details are given in Annexure II.

8.0 Feedback

All the participants appreciated the course, its organization, knowledge gained etc. and expressed that it provided them a comprehensive overview of hyperspectral remote sensing technology and its applications. They highly appreciated the quality of information content, delivery and practical exercises.

9.0 Valedictory Function

The valedictory function was held on 28th June and Director CSSTEAP and Director IIRS, Dr. Y. V. N. Krishna Murthy awarded the certificates to the participants. In his valedictory address he reiterated on the future Indian and global initiatives on Hyperspectral imaging, challenges in developing smarter, adaptable, and more robust data processing capabilities in order to retrieve information about the imaged terrain at a greater accuracy with the help of various applications.



Director, CSSTEAP awarding certificates to the participant



Inauguration of the course by Dr. Y.V. N. Krishna Murthy, Director, CSSTEAP and IIR and other dignitaries

10.0 Conclusion

The international training course on "Hyperspectral Remote Sensing and its Applications" was successfully conducted during the period 3-28th June, 2013. Faculty from ISRO, leading academic & National institute organisation like IITs, IARI, SASI delivered the lectures. Overall participants appreciated the course.



Mr. Vinay Kumar
Team Member
vinaykumar@iirs.gov.in



Mrs. Shefali Agrawal
Course Coordinator
hefali_a@iirs.gov.in



Dr. Sarnam Singh
Course Director
samam@iirs.gov.in

List of the Participants

| S.N. | Name | Country | Photograph |
|------|--|------------|---|
| 1. | Mr. Md. Shafiul Alam Assistant Professor Department of Geography and Environmental Studies University of Rajshahi, Rajshahi 6205, Bangladesh Email: shafiul.geo@gmail.com; shafiulkjp@gmail.com | Bangladesh |  |
| 2. | Mr. Sukumar Dutta Senior Engineer Bangladesh Space Research & RS Organization (SPARRSO), Agargaon, Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh Email: duttasukumar@yahoo.com; admin@sparrso.gov.bd | Bangladesh |  |
| 3. | Md. Shahjahan Ali Scientific Officer SPARRSO, Agargaon, Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh Email: admin@sparrso.gov.bd; fazlul_sparrso@yahoo.com | Bangladesh |  |
| 4. | Mr. A.S Madhusudana Charyulu Research Scholar Department of Physics Andhra University Visakhapatnam 530003 Email: madhu.acharyulu@gmail.com; madhu.acharyulu@yahoo.co.in | India |  |
| 5. | Mr. Birendra Kumar Das Scientist/ Engr 'SE' ADRIN, Dept. of Space Diamond Point, Secunderabad Hyderabad Email: birenkdas@gmail.com | India |  |
| 6. | Mr. C.R. Paramasivam Research Scholar Centre for Geoinformatics and Planetary Studies (CGIPS), Department of Geology, Periyar University, Salem, Tamil Nadu Email: paramasivam@hotmail.com; pusivam@gmail.com | India |  |
| 7. | Mr. Dharmendra Singh NFDMC, Forest Survey of India Kaulagrah Road, Dehradun, Uttarakhand 248195 Email: dsbaghel01@gmail.com | India |  |

| S.N. | Name | Country | Photograph |
|------|---|------------|---|
| 8. | <p>Ms. Poonam S. Tiwari Scientist-'SE' Photogrammetry & Remote Sensing Department Indian Institute of Remote Sensing 4 Kalidas Road, Dehradun 248 001 Email: poonam46@yahoo.com</p> | India |  |
| 9. | <p>Dr. Tanuku Venkateswara Rao Dept. of Geo-Engineering AU College of Engg., Andhra University Visakhapatnam Email: tanukuvenkatesh@yahoo.com</p> | India |  |
| 10. | <p>Dr. Vaibhav Garg Scientist-'SD' Water Resources Department Indian Institute of Remote Sensing 4 Kalidas Road, Dehradun 248 001 Email: vaibhav@iirs.gov.in; vaibi.vaibi@gmail.com</p> | India |  |
| 11. | <p>Ms. Oyuntugs Batbayar Asst. Teacher Dept. of Geophysics & Geo-information, School of Geology & Petroleum Engg., Mongolian University of Science & Technology (MUST) PO Box 2118, UB-15160, Ulaanbaatar, Mongolia Email: tugs0114@yahoo.com</p> | Mongolia |  |
| 12. | <p>Dr. Sao Hone Pha Associate Professor Mandalay Technological University Dept. of Remote Sensing, Patheingyi Township, Mandalay Division, Ministry of Science & Technology, Myanmar Email: saohonepha76@gmail.com</p> | Myanmar |  |
| 13. | <p>Mr. Umesh Kumar Mandal Associate Professor Tribhuvan University Central Dept. of Geography, Kirtipur Kathmandu, Nepal Email: umesh_je@hotmail.com; umesh.mandal@gmail.com</p> | Nepal |  |
| 14. | <p>Ms. Elvira Basalyamova Engineer The State Enterprise Institute Hydroengeo Olimar Street, 64, Tashkent, Uzbekistan 100041 Email: hydrous@rambler.uz; ut_eil@mail.ru; basalyamova@gmail.com</p> | Uzbekistan |  |

| S.N. | Name | Country | Photograph |
|------|---|------------|---|
| 15. | Ms. Lola Sichugova Astronomical Institute of the Uzbekistan Academy of Sciences 33 Astronomicheskaya str, Tashkent, Uzbekistan 100052 Email: slola@gmail.com, aida.282@bk.ru | Uzbekistan |  |
| 16. | Mrs. Ho Thi Van Trang Deputy Director Technological Research Center for Remote Sensing Science National Remote Sensing Center No 108 Chua Lang street, Dong Da District, Hanoi, Vietnam Email: hvtrangrsc@gmail.com | Vietnam |  |
| 17. | Dr. Le Thi Thu Hien Deputy Head of Dept. Inst. of Geography, VAST Vietnamese Academy of Science & Technology (VAST), 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam Email: hientuanphuong@yahoo.com; hientuanphuong@gmail.com | Vietnam |  |
| 18. | Mr. Nguyen Manh Hung Researcher Vietnam National Satellite Center (VNSC), Vietnam Academy of Science & Technology (VAST), Satellite Technology Applications Department, 3rd Floor 2A Building 18 Hoang Quoc Viet, Cau Giay, Hanoi, Vietnam Email: nmhung@vnsc.org.vn; manhhung10986@gmail.com | Vietnam |  |
| 19. | Mrs. Nguyen Thi Ngoc Nga Deputy Head of Division Vietnam Institute of Architecture, Urban & Rural Planning (VIAP) Ministry of Construction (MOC) No. 10 Hoa Lu Street, Le Dai Hanh Ward, Hai Ba Trung District, Hanoi Vietnam Email: ngocnga371973@yahoo.com; ngocnga371973@gmail.com | Vietnam |  |

Topics and Details of Faculty

| S.No. | Topic | Faculty | |
|---------------|--|--|---|
| Guest Faculty | | | |
| 1. | Principles of Spectroscopy in Optical & Thermal Region | Dr. D. Ramakrishnan, Associate Professor Department of Earth Sciences, Indian Institute of Technology, Powai, Mumbai 400 076, India. Email: ramakrish@iitb.ac.in |  |
| 2. | Hyperspectral Imaging Sensors and ISRO initiatives towards Hyperspectral Imaging sensors | Shri. D.R.M. Samudraiah Ex Deputy Director(SEDA) Space Application Centre, Ahmedabad-380 015 Email: drms@sac.isro.gov.in | |
| 3. | Hyperspectral Remote Sensing Data Processing : Data Dimensionality reduction techniques | Dr. P. Srinivas, Scientist-SG GSD, ADRIN Deptt. of Space, 203 Akbar Road, Tarbund, Manovikas Nagar, Secunderabad-9, Hyderabad Email: psrinivas123in@yahoo.com |  |
| 4. | Hyperspectral Remote sensing applications in Agriculture and Principles of BRDF | Dr. R.N. Sahoo Senior Scientist, Division of Agricultural Physics, IARI, New Delhi-110 012; Email: rnsahoo@iari.res.in, rnsahoo.iari@gmail.com |  |
| 5. | Hyperspectral Remote sensing applications in mineral exploration | Dr S. Sanjeevi, Professor Department of Geology, Anna University, Chennai, Tamilnadu, India Email : ssanjeevi@annauniv.edu |  |
| 6. | Hyperspectral Remote sensing applications in Planetary exploration | Dr. Prakash Chauhan, Head, MPSPG- EPSA, Space Applications Centre (SAC) Jodhpur Tekra, Ambawadi Vistar P.O. Ahmedabad-380015 Email Id: prakash@sac.isro.gov.in |  |
| 7. | Hyperspectral Remote sensing applications in Snow, Ice and Glacier Studies | Dr. H. S. Negi, Scientist 'D' Snow & Avalanche Study Establishment, Him Parisar, Sector-37A, Chandigarh 160 036, India. e-mail: hs.negi@sase.drdo.in, negi_hs@yahoo.com |  |

| S.No. | Topic | Faculty | |
|---|--|---|---|
| 8. | Hyperspectral IR sounding and retrieval of Atmospheric parameters | Dr. P. K. Thapliyal Scientist-SF Atmospheric Sciences Division Atmospheric & Oceanic Sciences Group Space Applications Centre, ISRO Ahmedabad e-mail: pkthapliyal@sac.isro.gov.in, pkthapliyal@gmail.com |  |
| 9. | Hyperspectral Imaging: concepts & its characteristics | Dr. A. K. Sahay Scientist 'G' Thermal Imaging group IRDE, Raipur Road, Dehradun-248008, Uttarakhand, INDIA e-mail: aksahay@irde.drdo.in | |
| Faculty from Indian Institute of Remote Sensing | | | |
| 10. | Assessment of Soil quality and Land degradation from hyperspectral remote Sensing | Dr. S. K. Saha, IIRS, Dean (A) and Group Director ERSS Email: sksaha@iirs.gov.in |  |
| 11. | <ul style="list-style-type: none"> Spectrometry of vegetation and Spectral indices related to Hyperspectral Remote sensing Vegetation Species Mapping using Hyperspectral Remote Sensing | Dr. Sarnam Singh Programme Coordinator, CSSTEAP Scientist Forestry & Ecology Department Email: sarnam@iirs.gov.in |  |
| 12. | <ul style="list-style-type: none"> Spectral properties of Rocks and minerals Hyperspectral Remote sensing for mineral mapping | Dr. P.K. Champati Ray Head Geosciences and Geohazards Department Email: champati_ray@iirs.gov.in |  |
| 13. | <ul style="list-style-type: none"> Principle of Hyperspectral remote sensing Atmospheric Correction of Hyperspectral data Hyperspectral Image classification algorithms | Mrs. Shefali Agrawal Head Photogrammetry and Remote Sensing Department Email: shefali_a@iirs.gov.in |  |
| 14. | Hyperspectral Remote sensing applications in Forestry | Dr. Hitendra Padalia Scientist Forestry and Ecology Department Email: hitendra@iirs.gov.in |  |

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| S.No. | Topic | Faculty | |
|-------|--|---|---|
| 15. | <ul style="list-style-type: none"> Working Principle of Spectroradiometer and Procedures of Spectral Data Collection Fusion of Hyperspectral remote sensing data | Mr. Vinay Kumar, Scientist Photogrammetry and Remote Sensing Department Email: vinaykumar@iirs.gov.in |  |
| 16. | Hyperspectral Remote Sensing Data Processing (Pixel Purity Index, n-Dimensional visualizer, End Member selection) | Ms Richa Upadhyay Scientist Geosciences and Geohazards Department Email: richa@iirs.gov.in |  |
| 17. | Hyperspectral Data Pre-processing: atmospheric corrections (using FLAASH) | Ms. Manu Mehta Scientist Photogrammetry and Remote Sensing Department Email: manu@iirs.gov.in |  |
| 18. | Hyperspectral data Browsing Hyperspectral Data Processing (Data Dimensionality reduction) | Mr. Kamal Pandey Scientist DIP& FM Department Email: kamal@iirs.gov.in |  |
| 19. | <ul style="list-style-type: none"> Hyperspectral Data Processing for Agriculture applications Hyperspectral Data Processing for Soils resource characterization | Ms. Mamta Kumari Scientist Agriculture and Soils Department Email: mamta@iirs.gov.in |  |

International Training Course on Navigation and Satellite Positioning System

1.0 Background

With increasing use of GPS receivers in various applications, satellite navigation is fast becoming a part of everyday life. Global Navigation Satellite Systems (GNSS) provide three basic services: Position, Time, and Frequency. The GLONASS constellations, operated by the Russian Federation, are being modernized and upgraded to provide full fledged service equivalent to the GPS constellations, operated by the United States. The European Galileo system and China's COMPASS/BeiDou have also started launching their satellites. In addition to these four global systems, in next few years there will be three overlapping regional systems from India, China, and Japan in the region of Asia and the Pacific. With all these constellations the number of navigation satellites is expected to exceed 100 in the next five years. The worldwide investment in Global Navigation Satellite Systems utilization is very high and is comparable to the investments in satellite communications or satellite remote sensing applications. Such new developments lead to the establishment of the International Committee on Global Navigation Satellite Systems (ICG), inter alia, to implement recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III).

In addition to satellite based navigation, the location based services are useful to the public in many ways because it enables individuals to get information on nearest hospitals, police stations, emergency services etc. It is also very useful for disaster management. It is also used for tourism and sales promotions. Users of this service include common people, corporate, and the scientific community. To provide this service, trained workforce is required in industry, manufacturing, sales and value addition. They should have basic knowledge in functioning of satellite-based navigation systems and training in RF receiver and antenna, DSP and VLSI technology. In addition trained individuals with basic knowledge is also required in related application and utilization fields like GIS, remote sensing, aircraft and ship navigation, etc. where satellite navigation systems are used. To meet this perceptible need, CSSTEAP organized an International training course of four weeks duration on Navigation and Satellite Positioning System.

2.0 Objectives

The overall objectives of this training course were to make the participants aware of the potential of satellite navigation technology and its applications with a particular emphasis on societal-based services. The participants are exposed to relevant technologies, so as to get an in-depth understanding how these technologies can be used in an operational scenario. With the training received it is expected that the participants will have adequate skills to apply the knowledge acquired in their own country to support organizations/managers involved in providing value added services in addition to the basic satellite based navigation service.

3.0 Target beneficiaries

The Course was targeted to middle and senior level technology managers, researchers and professionals working in the domain of GNSS and Remote sensing technology and their applications. It was hoped that concerned governments, departments as well as NGOs/stakeholders could benefit from this course. This course also will benefit academic institutions, space agencies, institutions responsible for regional capacity building in space technology.

4.0 Course Inauguration

The formal inaugural the course was held on June 17, 2013 at SAC Bopal campus. Mr. V.S. Palsule Director, DECU, Dr. Y.V.N. Krishnamurthy, Director, CSSTEAP and Mr. A. P. Shukla, adviser to the course from SAC, participants of the course attended the inaugural session. Dr. Raghunadh K. Bhattar, Course Director NAVSAT introduced the course and the academic profile of the students. Each of the participants introduced, their organization and nature of work carried by them. Dr. Y.V.N. Krishnamurthy, briefed about CSSTEAP and its activities. Mr. V.S. Palsule, in his briefing to students highlighted activities of Space Applications Centre both in communication as well as remote sensing areas. He also briefed about the activities carried out in the Developmental Education and Communication Units.



Participants during inaugural function at SAC, Ahmedabad

5.0 About participants

Sixteen participants from ten countries of Asia Pacific region namely Bangladesh, India, Indonesia, Kyrgyzstan, Mongolia, Myanmar, Nepal, Tajikistan, Thailand and Vietnam attended this training course. The participants are

from different organizations like, operational agencies, research institutions, academic institutions etc. The list of participants and their affiliations are listed in Annexure -III.

6.0 Course Structure

The course was designed to provide the basic principle and applications. The syllabus was balanced between theory, practical and field visits. The details of faculty and topics are provided in ANNEXURE-II. The training course schedule was covered in four weeks:

In the first week the participants were introduced to evolution of Navstar, GPS concept from transit, overview of satellite communication Navigation, Satellite Navigation Payloads, GPS/Glonass, Galileo/COMPASS, IRNSS. About GNSS Signals was discussed in the 2nd week covered topics such as Satellite orbital dynamics, GPS orbits, Satellite & user position algorithms, GPS PRN sequence, GPS signal spectrum, autocorrelation and cross correlation of GPS signals, GPS Signal structure & Navigation Data, Error sources, etc. In the 3rd week they were exposed to Receiver Signal Processing & Differential Positioning and topics were GPS Augmentation, Differential GPS concepts GPS receiver signal processing GNSS data Formats – RINEX, DGPS and in the last week GNSS data processing and applications for Scientific and commercial uses were discussed. Application areas were - Surveying with GPS, GNSS applications, GPS for atmospheric studies, perceptible water vapor, Applications in aviation: (automation approach and landing using GPS), Applications for vehicle tracking, Location based Services, Surveying and mapping, Mobile Mapping, Earth rotation measurement, seismology (Tectonic plate movement) and GNSS altimetry

6.1 **Lectures :** The lectures were conducted in the class room with multimedia projection system and were covered by different lecturers followed by practical/assignment.

6.2 **Practical :** Practical exercises and demonstrations were conducted generally in the second half of the day. Experiments with different types of GNSS receivers in stand alone mode and integrated with communications systems were conducted. Computer-based exercises using MATLAB simulation were conducted.

a) **Demonstration of Satellite Tool kit (STK):**

The STK (or Satellite Tool Kit) software suite by AGI (or Analytical Graphics, Inc, US) was used for planning, analysis, and design of complex aerospace systems; real-time space operations; and 3-D situational awareness and decision support. Combining independently validated and verified analytical algorithms with a complex geometry engine. STK was the premier tool to analyze or operate integrated land, sea, air, and space elements for Space Control, Space Operations, etc. (b) **Experiment on Navigation signal properties:** Students simulated the codes similar to those used in GPS. They were familiarized with the salient features of these codes, particularly in terms of auto and cross correlations. (c) **Experiment on RINEX File format:** The GPS receivers store the data in standard formats like RINEX (Receiver Independent Exchange Format). This experiment aims to explain the RINEX format for the Navigation and observation files. Furthermore, the participants in this experiment estimated the satellite position, user position and the ionospheric delay utilizing the data in the file using MATLAB, (d) **Time domain representation of GPS signals GPS signal spectrum and their power level:** They were familiarized with the salient features of the codes like relative repetition rate, sampling, modulation effect and effect of noise. They also converted the signal into frequency domain to have an idea of the spreading and dispreading of the data as a result of multiplication with the code. (e) **Experiment to demonstrate the operation of Dual Frequency GPS Receivers:** This experiment enabled the participants to understand the operation of dual frequency GPS receiver and its advantages over the single frequency receiver. The required post-processing was demonstrated to show the different capabilities of such kind of receivers like ionospheric delay estimation and estimation of scintillation index etc. (f) **Operational LBS Demonstration:** The objective of this experiment is to show the students the aspects of developing Software to Integrate Location Based Services with Position. This included a case study demonstrating step by step procedures to address the issues of developing the definition of the problem, selecting algorithm, managing database and interfacing. (g) **Distress Alert System:** A low cost and affordable to fisherman with an inbuilt GPS to position and time information during distress alert system (DAT) was demonstrated. This DAT also can be used in emergencies like fire, boat sinking, man overboard, medical help with manual activation, etc.

(b) **Experiment on Navigation signal properties:** Students simulated the codes similar to those used in GPS. They were familiarized with the salient features of these codes, particularly in terms of auto and cross correlations. (c) **Experiment on RINEX File format:** The GPS receivers store the data in standard formats like RINEX (Receiver Independent Exchange Format). This experiment aims to explain the RINEX format for the Navigation and observation files. Furthermore, the participants in this experiment estimated the satellite position, user position and the ionospheric delay utilizing the data in the file using MATLAB, (d) **Time domain representation of GPS signals GPS signal spectrum and their power level:** They were familiarized with the salient features of the codes like relative repetition rate, sampling, modulation effect and effect of noise. They also converted the signal into frequency domain to have an idea of the spreading and dispreading of the data as a result of multiplication with the code. (e) **Experiment to demonstrate the operation of Dual Frequency GPS Receivers:** This experiment enabled the participants to understand the operation of dual frequency GPS receiver and its advantages over the single frequency receiver. The required post-processing was demonstrated to show the different capabilities of such kind of receivers like ionospheric delay estimation and estimation of scintillation index etc. (f) **Operational LBS Demonstration:** The objective of this experiment is to show the students the aspects of developing Software to Integrate Location Based Services with Position. This included a case study demonstrating step by step procedures to address the issues of developing the definition of the problem, selecting algorithm, managing database and interfacing. (g) **Distress Alert System:** A low cost and affordable to fisherman with an inbuilt GPS to position and time information during distress alert system (DAT) was demonstrated. This DAT also can be used in emergencies like fire, boat sinking, man overboard, medical help with manual activation, etc.



Participants in lecture session



Participants performing analysis in Practical Session

Participants were divided into four groups. Each group gave seminar on real life use of navigation satellite based applications. The topics handled by them were: (a) Automatic Identification System (AIS) for Maritime Safety, (b) Vehicle Navigation, Tracking and Management, (c) Surveying and mapping using GNSS and (d) GNSS Based Search and Rescue

6.3 **Course material** : Each participant was provided with a book ("GNSS Global Navigation Satellite Systems, GPS, GLONASS, Galileo & More" By Hofmann-Wellenof, Lichtenegger and Wasle), a CD containing the study materials of the lecturers.

7.0 Faculty

The lectures, assignment delivered to the participants by faculty drawn from various Academic Institutions, Satellite Navigation System Operators, Government agencies and Industries. The list of faculty with their affiliation are given in Annexure-IV

8.0 Course Feedback and Recommendation:

Feedback was conducted at the end of the course to get feedback on academic & performance of the short course from the participants. The majority of the participants expressed that the training course was well organized and relevant to the need of the participants. All lecturers presented well and interactive, but the some of the participants felt that the lecture duration may need to be still more. A few participants expressed that the one month duration of the course was not sufficient. However, the participants feel that the course was useful and meet their expectations. Some of the participants were felt that the more practical need to be conducted. Participants said that the training facilities were adequate and they are willing to recommend this course to their colleagues.

9.0 Valedictory Function

The four week course on Navigation and Satellite Positioning System concluded on July 12, 2013. Dr. S. Kalyanaraman, Former Program Director IRS, ISRO was the Chief Guest. Mr. K.S. Parikh, Dy. Director, SATCOM and Navigation Applications Area, (SNAA), SAC welcomed chief guest, dignitaries, participants, and other invitees. Dr. Sarnam Singh, Program Coordinator, CSSTEAP in his address briefed on the activities of CSSTEAP and the students about the importance of Navigation and GNSS applications. On this occasion, Mr. V.S. Palsule, Director, DECU briefly mentioned the utilization of GNSS societal applications. Mr. A.S. Kiran Kumar, Director, SAC addressed the participants and mentioned about how the course will be helping the faculties also in updating the new technologies and beneficial to the organization. He also said that the learning process is to be continued for the professional growth.



Participants during valedictory function at SAC, Ahmedabad

Dr. Raghunath Bhattar Course Director NAVSAT presented the course report. He informed that the first week dealt on Introduction to GNSS in which overview of GPS, Galileo, compass, IRNSS with Introduction to MATLAB were covered. During the second week orbital dynamics of GPS orbit, Satellite & User position algorithms, concept of Fourier transformations, error source, new modulation schemes for navigation were covered. During the third week antennas, DGPS, GPS augmentation, GPS receivers were covered. In the last week applications relating to aviation, fleet monitoring, surveying, seismology etc were covered. Invited lectures were also delivered by scientists/engineers working at different ISRO Centres, experts from Indian Navigation system industries and Communications and aviation experts of Govt. of India. Dr. Kalyanaraman Chief Guest addressed the audience and emphasized the need and importance of satellite-based navigation in different areas such as air traffic control, maritime distress location, etc. He also distributed the certificates to all the participants.

10.0 Conclusion



Course Advisor
Mr. A.P. Shukla

Email : atulshukla@sac.dos.gov.in



Course Coordinator
Mr. P. Satyanarayana

Email : psatyanarayan@yahoo.com



Course Director
Dr. Raghunadh K Bhattar

Email : raghu@sac.isro.gov.in

List of the Participants

| S.No. | Name | Country | Photograph |
|-------|--|------------|---|
| 1. | Mr. Md. Omar Faruq, Asst. Meteorologist, Bangladesh Meteorological Department (BMD), Abhawa Bhaban, Agargaon, Sher-E-Bangla Nagar Road, Dhaka-1207, Bangladesh Email : omarfaruq_78@yahoo.com, info@bm.gov.bd | Bangladesh |  |
| 2. | Mr. Anit Sharma, 9 BRD, Air Force, Nagar Road, Pune - 411014 Maharastra, India | India |  |
| 3. | Mr. D. Paul Gunaseelan, 737SU, C/o 35WG PIN-93737 C/o-56APO India | India |  |
| 4. | Mr. Jacob K Palarnoottil 35 Wing, Air Force, C/ 56 APO PIN - 936835 India | India |  |
| 5. | Ms. Asri Susilawati Pusat Meterologi Publik, BMKG Jl. Angkasa- I No.,2 Kemayoran, Jakarta Pusat, Postal Code- 10720, Indonesia Email : asrisusilawat@gmail.com, achi_asri@yahoo.com | Indonesia |  |
| 6. | Ms. Chynkozho kyzy Kaukhar Bishkek, 720000, Kyrgyzstan Email : ch.kayhar@inbox.ru, skaiykov@mail.ru | Kyrgyzstan |  |
| 7. | Ms. Buyankhishig Ulziinyam School of Information and Communication Technology (SICT), Mongolian University of Science and Technology(MUST), 22th Khoroo, Bayanzurkh District, Ulaanbaatar-210351, P.O.Box-29, Mongolia Email : buyankhishig@sict.edu.mn, buynhishigo@yahoo.com | Mongolia |  |
| 8. | Ms. Tsogt Daglimaa Apt. 24-7, 120 Myangat, 1st Kheroo, Khan-Uul District, Ulaanbaatar City, Mongolia Email : dagnaa_616@yahoo.com, info@inspection.gov.mn | Mongolia |  |

| S.No. | Name | Country | Photograph |
|-------|--|------------|---|
| 9 | Ms. Narantuya Erkhembaatar School of Information and Communication Technology (SICT), Mongolian University of Science and Technology (MUST), 22th Khoroo, Bayanzurkh District, Ulaanbaatar-210351, P.O.Box-29, Morigolia Email : narantuya@sict.edu.mn, naraae@yahoo.com | Mongolia |  |
| 10. | Ms. May Thwe-Oo Faculty Residence Myanmar Aerospace Engineering University, Meikhtila, Myanmar Email : scholarmost@gmail.com, aythweaomtu@gmail.com | Myanmar |  |
| 11. | Mr. U Aung Ye Htun Faculty Residence Myanmar Aerospace Engineering University, Meikhtila, Myanmar Email : aythtun@gmail.com | Myanmar |  |
| 12. | Mr. Dhaka Ram Poudyal Satellite Service Directorate, Nepal Telecom, Sagarmatha Satellite Earth Station, Kathmandu, POB- 2693, Nepal Email: dhaka.poudyal@ntc.net.np, dhaka.poudyal@gmail.com | Nepal |  |
| 13. | Mr. Saroj Koirala, Lakeside Pokhara Sub-Metropolitan City, Ward No.6, Kashi District, Gandki Zone, Nepal Email : srj.krf@gmail.com, kohirala_saroj2001@yahoo.com | Nepal |  |
| 14. | Mr. Timur Mustaev 47 , Shevchenko Street, 734025, Dushanbe, Tajikistan Email : tmustaev@gmail.com | Tajikistan |  |
| 15. | Mr. Atipat Wattanuntachai 82, SOI TrarakobphoL1, Bangyeekhan, Bangplad, Bangkok, Thailand-10700 Email : atipat.wat@gmail.com | Thailand |  |
| 16. | Mr. Nguyen Ngoc Canh The Authority of Radio Frequency Management, 115 Tran Duy Hung Street, Ha Noi City, Viet Nam Phone: (O) +844-35564980, (R) +844-35595561 (M) +84979680624, Fax : +844-35564916 Email : ngcanh@gmail.com, canhnni@rfd.gov.vn | Vietnam |  |

Topics and Details of Faculty

| S.No. | Topic | Faculty | Photograph |
|-------|--|--|---|
| 1. | <ul style="list-style-type: none"> • Overview of Satellites Navigation • GNSS applications | Shri. K.S. Parikh, DD, SNAA/SAC, Ahmedabad Email : parikhks@sac.isro.gov.in |  |
| 2. | <ul style="list-style-type: none"> • GNSS Monitoring Facilities • The Architecture of the European Global Navigation Satellite System - GALILEO and COMPASS | Shri. A.P. Shukla Deputy Project Director, IRNSS-CT Group Head, DCTG/SNAA/SAC, Ahmedabad - 380 015 Email:atulshukla@sac.isro.gov.in |  |
| 3. | <ul style="list-style-type: none"> • GPS for atmospheric studies. | Shri. Abhineet Shyam Scientist/Engineer, GRD AOSG/EPSSA/SAC, Ahmedabad Email:abhineetshyam@sac.isro.gov.in |  |
| 4. | <ul style="list-style-type: none"> • Concept of Fourier transform, autocorrelation and cross correlation of GPS signals | Shri. Ankesh Garg Engineer, SNTD DCTG/SNAA/SAC, Ahmedabad Email : ankesh@sac.isro.gov.in |  |
| 5. | <ul style="list-style-type: none"> • Basics of MATLAB - • Coordinate systems and transformation | Dr. Ashish Shukla, Scientist/Engineer, SNTD DCTG/SAC, Ahmedabad, Email : ashishs@sac.isro.gov.in |  |
| 6. | <ul style="list-style-type: none"> • GNSS Frontend | Shri. M.L. Badheka Scientist/Engineer, SNTD DCTG/SNAA/SAC, Ahmedabad Email : mlb@sac.isro.gov.in |  |
| 7. | <ul style="list-style-type: none"> • Time Scale | Shri Alak Banik, Group Director, ODCG/SNPA, Ahmedabad, Email : alak@sac.isro.gov.in |  |
| 8. | <ul style="list-style-type: none"> • GPS PRN sequence (C/A & P code generation and their correlation properties) • GNSS - Threats (Spoofing and Jamming) | Shri. Deval Mehta, Head, SCTD, DCTG/SNAA/SAC, Ahmedabad Email : m_deval@sac.isro.gov.in |  |

| S.No. | Topic | Faculty | Photograph |
|-------|--|---|---|
| 9. | <ul style="list-style-type: none"> • Surveying with GPS | Mr. P. Jayaprasad Scientist/Engineer, OSD AOSG/EPASA/SAC, Ahmedabad Email: jayaprasadp@sac.isro.gov.in |  |
| 10. | <ul style="list-style-type: none"> • STK Demo | Shri Nishkam Jain Engineer, SNTD DCTG/SNAA/SAC, Ahmedabad Email : nishkamjain@sac.isro.gov.in |  |
| 11. | <ul style="list-style-type: none"> • Over view of GPS and GLONASS • Experiment on Navigation signal properties • Time domain representation of GPS signals-GPS signal spectrum and their power level (LAB session) • Experiment on RINEX File format • Sub-Carrier Modulation and BOC Signal | Mr. Rajat Acharya, SAC, Ahmedabad. Email : rajat_acharya@sac.isro.gov.in |  |
| 12. | <ul style="list-style-type: none"> • GNSS Antennas | Shri. Rajeev Jyoti Group Director, ASG, SAC, Ahmedabad Email : rajeevjyoti@sac.isro.gov.in |  |
| 13. | <ul style="list-style-type: none"> • Over view of IRNSS | Shri. S.Sarkar SCI/ENGR-G GD SNSICG/SNPA/SAC, Ahmedabad Email : s_sarkar@sac.isro.gov.in |  |
| 14. | <ul style="list-style-type: none"> • Overview of satellite Communication | Shri Virender Kumar Group Head, SSTG/SNAA/SAC, Ahmedabad - 380 015 Email: virender@sac.isro.gov.in |  |
| 15. | <ul style="list-style-type: none"> • Distress Alert Transmitter (DAT) for Search and Rescue Experiment | Shri. S N Satashia, Head, SATD SSTG/SNAA/SAC, Ahmedabad. Email : satashia@sac.isro.gov.in |  |
| 16. | <ul style="list-style-type: none"> • Summary of Navigation Payloads | Shri. Surinder Singh SCI/ENGR-G, GD RFSG/SNPA/SAC, Ahmedabad Email : surinder@sac.isro.gov.in |  |

| S.No. | Topic | Faculty | Photograph |
|-------|---|---|---|
| 17. | <ul style="list-style-type: none"> GNSS altimetry | Dr. Rashmi Sharma Scientist/Engineer, OSD AOSG/EPISA/SAC, Ahmedabad Email : rashmi@sac.isro.gov.in |  |
| 18. | <ul style="list-style-type: none"> Over view of GNSS Simulators | Shri. Mohanchur Sarkar, Scientist/Engineer, SCTD/DCTG/SNAA/SAC, Ahmedabad Phone : +91-79-26912489 Email : msarkar@sac.isro.gov.in |  |
| 19. | <ul style="list-style-type: none"> Experiment on DGPS | Ms. Sunanda Trivedi Scientist/Engineer, HRDPD SPDCG/SIPA/SAC, Ahmedabad Email : sunanda@sac.isro.gov.in |  |
| 20. | <ul style="list-style-type: none"> New Modulation Schemes | Ms. Saumi S Scientist/Engineer, SNTD DCTG/SNAA/SAC, Ahmedabad Email : de_saumi@sac.isro.gov.in |  |
| 21. | <ul style="list-style-type: none"> Laboratory Visit (GAGAN-Lab) | Shri. P.V. Khekafe, Scientist/Engineer, SNTD DCTG/SAC, Ahmedabad. Email : satnav@sac.isro.gov.in |  |
| 22. | <ul style="list-style-type: none"> GPS Signal structure & Navigation Data Satellite & user position algorithms. | Shri. Yagnesh Patel Scientist/Engineer, SNTD DCTG/SNAA/SAC, Ahmedabad Email : yagnesh67@sac.isro.gov.in |  |
| 23. | <ul style="list-style-type: none"> Indoor Navigation | Shri. P.K. Srinivasan Scientist/Engineer, AES EOCG/SNAA/SAC, Ahmedabad Email : pks@sac.isro.gov.in |  |
| 24. | <ul style="list-style-type: none"> Earth rotation measurement, seismology (Tectonic plate movement) | Shri Hrishikesh Kumar SCI/ENGR-SC, EPSA-MPSG-GSD Email : hrishikesh@sac.isro.gov.in |  |

| S.No. | Topic | Faculty | Photograph |
|-------|--|--|---|
| 25. | <ul style="list-style-type: none"> • Applications for vehicle tracking | <p>Mrs. Pushpalata B Shah Head DWD ATDG/EPISA/SAC, Ahmedabad Email : pushpa@sac.isro.gov.in</p> |  |
| 26. | <ul style="list-style-type: none"> • Evolution of Navstar, GPS concept from transit, timation • Fundamentals of Orbital Dynamics, GPS orbits • GPS Error Budget • Tutorials on fundamentals of SATNAV • GPS Augmentation • Principle of Differential GPS • Principle of WAAS, LAAS & AGPS | <p>Dr. M.R. Sivaraman B-31, Someswara Row Houses, Part-II, Opp. Star Bazar, Satellite Road, Ahmedabad dr.manjeri.r.sivaraman@gmail.com</p> | |
| 27. | <ul style="list-style-type: none"> • Mobile Mapping | <p>Dr. P.M. Udani, Director, ISTAR Institute Of Science & Technology for Advanced Studies & Research Email : prafuludani@yahoo.co.in</p> |  |
| 28. | <ul style="list-style-type: none"> • Mapping, Location based Services and other value added services | <p>Shri I.C. Mateida 24, Ankit Society, Oppo. Swaminarayan Temple, off K K Nagar, Ghatalodia, Ahmedabad - 380061 Email: matieda@hotmail.com matieda@yahoo.com</p> |  |
| 29. | <ul style="list-style-type: none"> • Operational LBS Demonstration | <p>Shri Suhas H N Senior Project Leader Accord Software and Systems Pvt. Ltd., 37, K. R. Colony, Domlur Layout, Bangalore - 560 071, INDIA suhas.hn@accord-soft.com</p> |  |
| 30. | <ul style="list-style-type: none"> • Applications in aviation: (automation approach and landing using GPS) | <p>Shri. Surendra S Sunda Manager (COM-E) Airports Authority of India SAC GAGAN Lab Ahmedabad - 380 015 Email : ssunda@sac.isro.gov.in</p> |  |
| 31. | <ul style="list-style-type: none"> • GNSS Receiver Signal Processing • Demonstration of Software Receiver | <p>Dr. Vyasraj G Senior Manager-GNSS Technology & Aerospace Engineering Accord Software & Systems Pvt. Ltd. 37, Krishna Reddy Colony, Domlur Layout Bangalore - 560071, India Email : vyas@accord-soft.com</p> | |
| 32. | <ul style="list-style-type: none"> • Time keeping with GPS | <p>Dr. Amitava Sengupta Head, Time & Frequency Division National Physical Laboratory, DR K S Krishnan Road New Delhi- 110012 E-mail : sengupta@nplindia.org</p> |  |

International Training on Flood Risk Mapping & Modeling & Assessment

1.0 Background

Asia is the most disasters prone region in the world. The recurrence of the extreme precipitation anomalies that result in floods or droughts is a normal component of natural climate variability. The adverse effects of floods and droughts often entail far-reaching socio-economic and environmental implications, and may include loss of life and property, mass migration of people and animals, environmental degradation, and shortages of food, energy, water and other basic needs. The degree of vulnerability to such natural hazards is high in developing countries where necessity tends to force the poor to occupy the most vulnerable areas. The vulnerability of developed countries increases with economic growth and the accumulation of property in flood-prone areas and in highly urbanized settings. The strategic goals of the Hyogo Framework for Action (HFA) call for more effective integration of disaster risk consideration into sustainable development policies, planning and programming at all levels, with an emphasis on disaster prevention, mitigation, preparedness, and vulnerability reduction; and for the development and strengthening of institutions, mechanisms, and capacities at all levels (UN-ISDR, 2005). Utilization of space technology, including earth observation satellites are proving to be useful instruments for natural disaster management. Earth observation satellites contribute to providing significant and unique solutions in all disaster management areas: disaster mitigation, disaster preparedness, disaster relief and also disaster rehabilitation. Such solutions are already an integral part of disaster management activities in many developed and even developing countries. Even though national capabilities in the use of space technologies in developing countries are increasing at a significant rate there is still a definite need to support in a more direct way the transfer of these available technologies, while at the same time proposing methodological tools and approaches that are customized and appropriate to the specific needs of the country. Based on observations and recommendations of several technical advisory missions organised under the framework of UN-OOSA in several countries under international capacity building programme it was conceived by the UN-OOSA/UNSPIDER Beijing together with CSSTEAP (affiliated to the United Nations) to organize this short course along with UNESCAP Bangkok and International Water Management Institute (IWMI) Colombo/New Delhi with view to share latest developments in using space-based information for flood risk mapping and modelling. The initiative was supported, implemented, and realized by the IIRS (ISRO).

2.0 Objectives

The main objectives of this 5 days training was to allow disaster management communities with easy, quick and accurate access to flood-related information and dissemination through the support of space agencies such as International disaster charter and research/academic institutions for improved understanding on flood risk monitoring, modeling and planning, rapid response system during recovery phase in the Asia Pacific countries.

3.0 Target Beneficiaries

This training was designed for the disaster manager with flood hazard in his/her sphere of responsibility. Although the focused area is the South Asia Region, participants from areas outside this region was also encouraged to join the course. Participation of flood management authorities, the development and planning authorities, water engineers and flood control professionals, national agencies officials and staff in urban planning, and water resource development and management was encouraged. The event was meant to benefit basin river authorities, officials and personnel of relief and rehabilitation agencies, the United Nations and similar international bodies, and NGOs involved in flood mitigation.

4.0 Inauguration

The training programme was inaugurated by Dr. YVN Krishna Murthy, Director, CSSTEAP on July 22, 2013. Inaugural Session was also addressed by Dr. Shirish Ravan, Head UNSPIDRR/ UNOOSA Beijing



Dr. YVN Krishna Murthy Director, CSSTEAP addressing during inauguration function

and Dr. Wai Leong Timothy Loh, UNESCAP, Bangkok and Dr. Bharat Sharma, IWMI, New Delhi and Dr. Giriraj Amarnath, IWMI, Colombo. Faculty of the IIRS also attended the inauguration.

5.0 About Participants

This 5 days training programme on "Flood Risk Mapping, Modelling and assessment using Space technology" is designed for the disaster managers/Engineers with flood hazard in his/her sphere of responsibility. Total 19 participants from 11 countries attended the training programme. The majority of participants were from departments involved in flood disaster risk reduction and management. The list of countries and departments are given in Annexure V. Most of the participants were from Department and Ministries concerned with Disaster, Risk and Mitigation.



Mr. Timothy Loh, UNESCAP addressing the participants during the inauguration

6.0 Course Structure

- **Fundamental of remote Sensing and GIS:** Physics of remote Sensing, Sensors, platforms, Orbits, GPS, GIS database creation, data integration, spatial analysis.
- **Flood inundation mapping and damage assessment:** Principal of optical and microwave remote sensing for flood inundation mapping and monitoring. EO Systems for flood inundation mapping and monitoring. Techniques of flood inundation mapping and monitoring using multi satellite, multi date and Multi sensor data. Flood depth and duration analysis using space based information. GIS data integration for Damage assessment.
- **Flood hazard, vulnerability and risk Analysis:** Definition and assessment of Flood hazard, vulnerability and flood risk using Space based information and GIS. Element at risk, Risk Analysis.
- **Global Flood detection system:** Near real time flood data availability, Multi resolution data processing and flood inundation map preparation. International charter on flood disaster.
- **Climate Change and Flood disaster:** Climate Change and Disaster Risk Reduction: Space Technology Initiatives, Challenges and opportunities, Adaptation and mitigation.
- **Rapid Flood Mapping:** Success stories and case examples of rapid flood mapping from INDIA, China and Thailand.
- **Flood modelling:** Understanding the HEC Tools. Data base creation for flood modelling using RS and GIS. Data assimilation to HEC model, Flood simulation and flood hydrograph generation at different location.



Participants along with other Guests

The training programme included the theory lectures and hands on exercises sharing by the experts from IWMI, UN-SPIDER, Indian Institute of Remote Sensing (IIRS), Indian Space Research Organisation (ISRO), Geo-Informatics and Space Technology Development Agency (GISTDA), Thailand and National Disaster Reduction Centre of China. A computer lab with high end computers and RS&GIS analysis software was set up in a hotel outside the campus of the IIRS. The theory lectures covered the topics namely, climate change and disaster risk reduction, adaptation to enhanced floods, concepts of Flood inundation mapping, operational flood alert system of ISRO, monitoring and Damage assessment using Space technology, global flood detection system and flood inundation modeling using HEC tools etc. The hands on sessions were offered by IIRS and IWMI on the flood inundation mapping using multi-resolution satellite data and flood inundation modeling using HEC tools. The participants also visited the downstream area of the recent floods in Northern India (Kedarnath) that caused heavy losses of life and damage to the property a month ago. The Central Water Commission (Government of India) demonstrated the Acoustic Doppler Current Profiler (ADCP) that collects flood level and discharge of the river and transmits the data through telemetry system to the servers for flood analysis and decision making. The

participants were given an opportunity to visit River Ganga to observe the flood waters in and around Rishikesh. The high rainfall in the upper reaches of the catchment of Ganges has created havoc to life and property.

7.0 Faculty

Experts were invited to deliver lectures and conduct hands on exercises from UNSPIDER, IWMI, UNESCAP, GISTDA, ISRO (IIRS and NRSC), NDRC and China. The topic covered by each expert is given in Annexure VI.

8.0 Feedback

The selection of participants was done based on the organisations/ individuals that are involved in disaster management activities. The right target group was the key for generating great interest of the participants in the training programme. It was recommended to organize such type of courses more frequently and for longer duration. Dr. Shirish Ravan, UNSPIDER suggested that UN-OOSA would like to conduct more such courses on disasters in the coming years.



Course participants attending the lecture session

9.0 Valedictory

The valedictory function was held on July 26, 2013. Dr. S.K. Saha, Dean (Academics) Indian Institute of Remote Sensing, Dehradun was the Chief Guest and distributed the certificates to the participants. In the feedback by the participants they appreciated the course content, relevance and organisation. The case studies shown were highly appreciated.

10.0 Conclusion

The design, structure and deliberations of training programme was highly appreciated by the participants. Hands on exercise on flood inundation mapping, modelling provided a working skill and experience to the participants. Field work of recent flood affected area and demonstration of latest field instruments added extra knowledge to the course participants.



Dr. S.P. Aggrawal
Course Coordinator











Dr. Sarnam Singh
Programme Coordinator

List of the Participants

| S.No. | Name | Country | Photograph |
|-------|--|----------|---|
| 1. | Mr. Jigme Chogyal Programme Officer Department of Disaster Management Ministry of Home & Cultural Affairs Thimpu, Bhutan Email: chogyal28417@gmail.com | Bhutan |  |
| 2. | Mr. Phirun Thin Executive Assistant National Committee for Disaster Management, New Building, St. 516, Sangkat Toul Sangke, Khan Ausey Keo, Phnom Penh, Cambodia Email: thin_phirun@nodm.gov.kh; samangkuth@yahoo.com | Cambodia |  |
| 3. | Mr. Wang Ping Research Assistant, National Disaster Reduction Center of China, Email: bitwp@126.com; wangping@ndrcc.gov.cn | China |  |
| 4. | Mr. Wen Qi Research Assistant, National Disaster Reduction Center of China Email: whistlewen@aliyun.com, whistlewen@yahoo.com.cn | China |  |
| 5. | Mr. Sunia Ratulevu Principal Administrator Ministry of Rural & Maritime Development Government Buildings, Box 229 Suva, Fiji Email: sunia.ratulevu@govnet.gov.fj; sn_ratulevu@yahoo.com | Fiji |  |
| 6. | Dr. Ashok Kumar Nayak Senior Scientist Directorate of Water Management (ICAR), Chandrasekharpur, Bhubaneswar 751023, Odisha Email: aknayak.dwm@icar.org.in | India |  |
| 7. | Dr. Ajay Kumar Pr. Scientist & Head ICAR, Research Complex for Eastern Region, ICAR Parisar, P.O. Bihar Veterinary College Patna- 800014, Bihar, India Email: ajaykumar1001@gmail.com | India |  |
| 8. | Mr. Jagdish Kumar Patra Scientist B Surface Water Hydrology Division National Institute of Hydrology, Roorkee, Uttarakhand, India Email: patra.nih@gmail.com | India |  |

COURSE REPORT

| S.No. | Name | Country | Photograph |
|-------|---|-------------|---|
| 9. | Mr. Mahesh Jampani 401/5, IWMI, ICRISAT Campus, Patancheru, Hyderabad - 502 324, Andhra Pradesh, India-(2014) E-mail: j.mahesh@cgiar.org Mahesh.jampani@gmail.com | India |  |
| 10. | Mr. Pankaj Mani CFMS, NIH Walmi Complex, Phulwarisharif Patna, Bihar- 801505 E-mail: mailofpmani@yahoo.com / cfmspafna@gmail.com | India |  |
| 11. | Dr. P.R.Ojaswi, ICAR E-2, 218, Kaulagarh Road, CSWCRTI, Dehradun 248001 E-mail: projasvi@gmail.com | India |  |
| 12. | Mr. Pramod Narayan Director Planning & Development Directorate Central Water Commission Wing-7, Ground Floor, West Block-II, RK Puram, New Delhi 66 E-mail: pns.cwc96@gmail.com | India |  |
| 13. | Ms. Nur Febrianti Researcher Remote Sensing for Flood Hazard & Risk Analysis Indonesia National Institute of Aeronautics & Space (LAPAN) Jl. Kalisari No. 8, Pekayon Pasar Rebo, Jakarta, Indonesia 13710 Email: nfebrianti@gmail.com; nurfebrianti@yahoo.com | Indonesia |  |
| 14. | Mr. Ravinath Babu Shrestha Department of Water Induced Disaster Prevention Pulchok, Lalitpur, Nepal Email: rmb41@rediffmail.com | Nepal |  |
| 15. | Mr. Kyaw Min Hlaing Office No.(5), Ministry of Transport, Department of Meteorology and Hydrology Nay Pyi Taw, Myanmar E-mail: kyawminhlaing.kmh@gmail.com; dg.dmh@mptmail.net.m | Myanmar |  |
| 16. | Mr. Bernard Alan Baluyut Racoma National Institute of Geological Science, op Garcia Corner Velasquez st, University of the Philippines, Diliman, Quezon City 1101 Philippines Valid Until: July 2014 E-mail: bbracoma@upd.edu.ph; ba.racoma@gmail.com | Philippines |  |

| S.No. | Name | Country | Photograph |
|-------|--|-----------|---|
| 17. | Mr. Indishe Prabath Senanayake Space Application Division Arthur C Clarke Institute for Modern Technologies Katubedda, Moratuwa 10400, Sri Lanka E-mail: indishe@gmail.com | Sri Lanka |  |
| 18. | Mr. Polpitiya Acharige Samira Anuradha Civil Engineer Greater Kandy Water Supply Project, National Water Supply & Drainage Board Pahala Kondadeniya, Katugastota, Sri Lanka Email: anuradhasamira@yahoo.com | Sri Lanka |  |
| 19. | Mr. To Trong Tu Researcher Remote Sensing Application Department, Space Technology Institute, 18 Hoang Quoc Viet Street, CauGiay, Hanoi, Viet Nam E-mail: info@sti.vast.vn; Tttu83_mdc@yahoo.com | Vietnam |  |

Topics and Details of Faculty

| S.No. | Topic | Faculty | Photograph |
|-------|---|---|---|
| 1. | EO systems for Floods | Dr. YVN Krishna Murthy Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email: director@iirs.gov.in |  |
| 2. | <ul style="list-style-type: none"> Climate Change and Disaster Risk Reduction: Space Technology Initiatives, Challenges and opportunities Use of Space Technology in Disaster Management in light of Hyogo Framework for Action 2005-2015: Building resilience of nations and communities to disasters | Dr. Shirish A Ravan UN-SPIDER, Beijing Email: s.ravan@unoosa.org |  |
| 3. | Introduction to RS and GIS | Mrs. Shefali Agrawal Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email: shefall_a@iirs.gov.in |  |
| 4. | <ul style="list-style-type: none"> Flood Inundation mapping, monitoring and Damage assessment using Space technology Flood hazard, vulnerability and risk Analysis | Dr. S.P. Aggarwal Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email: spa@iirs.gov.in |  |
| 5. | <ul style="list-style-type: none"> Global flood hotspot and risk assessment Global Flood Detection System - Lectures and Demo Global Flood Detection System - Lectures and Demo Hands on exercise on Flood Inundation Mapping using multi-resolution satellite data | Dr. Giriraj Amarnath International Water Management Institute, Colombo Email: a.giriraj@cgiar.org |  |
| 6. | Adaptation to enhanced floods in the Indus and the Ganges Rivers | Dr. Bharat Sharma International Water management Institute, New Delhi Email: b.sharma@giar.org |  |
| 7. | Mobile based Real time GIS data collection during flood disaster | Dr. Harish Karnataka Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email: harish@iirs.gov.in |  |
| 8. | Operational Flood Monitoring Systems and Rapid Mapping Implemented by ISRO | Dr. KHV Durga Rao National Remote Sensing Centre (ISRO) Email: durgarao_khv@nrsc.gov.in |  |

| S.No. | Topic | Faculty | Photograph |
|-------|---|---|---|
| 9. | Flood Inundation Modelling using HEC Tools- Lectures | Dr. Praveen Thakur Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email:praveen@iirs.gov.in |  |
| 10. | Hands on Exercise on flood mapping, monitoring and damage assessment using SAR Data | Dr. Praveen Thakur/ Arpit Chouksey Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email:praveen@iirs.gov.in |  |
| 11. | Flood Inundation Modelling using HEC Tools- Demo/Hands on | Dr. Praveen Thakur/ Dr. Vaibhav Garg Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email:praveen@iirs.gov.in |  |
| 12. | Hands on exercises on Flood Inundation Modelling using HEC Tools | Dr. Praveen Thakur/ Dr. Vaibhav Garg Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun Email:praveen@iirs.gov.in |  |
| 13. | Hands on exercise on Flood Inundation Mapping using multi-resolution satellite data | International Water Management Institute, Colombo Email:a.giriraj@cglar.org and Indian Institute of Remote Sensing (ISRO), 4 Kalidas Road, Dehradun | |
| 14. | Rapid mapping: Success Stories - Thailand floods | Mr. Anusorn Rungsipanich GISTDA |  |
| 15. | Rapid mapping: Success Stories - China floods | Mr. Wang Ping bitwp@126.com wangping@ndrcc.gov.cn |  |

Sub-regional Training on Development of Geo-Referenced Information Systems For Disaster Risk Management

1.0 Background

Sub-regional training on development of geo-referenced disaster risk management information Systems for SAAR countries was conducted jointly by Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) Dehradun, United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP) and Asian Institute of Technology (AIT) Bangkok during 26-29 August 2013 at Dehradun. The training was part of the United Nations Development Account (UNDA) project entitled "Improving Disaster Risk Preparedness in the Economic and Social Commission for Asia and the Pacific (ESCAP) region" and implemented by the United Nations Economic and Social Commission for Asia and the Pacific (UN-ESCAP). The overall goal of the programme was to strengthen the government capacities in the implementation of the Hyogo Framework for Action (HFA) through the use of geo-referenced information tools for effective disaster risk preparedness, and timely early recovery efforts in the Asia-Pacific region with a focus on countries with special needs (CSN). The training was conducted in collaboration with sub-regional organizations to build the experiences and lessons learned from work on disaster risk preparedness. The training was based under South Asian Association for Regional Cooperation's (SAARC) countries under Disaster Knowledge Network (SADKN), which is also in line with the framework of ESCAP-SAARC cooperation agreement. The South Asia Disaster Knowledge Network (SADKN) promotes knowledge, innovation and education to build a culture of safety and resilience at all levels. The SADKN portal serves as a tool to all the South Asian Association for regional Cooperation (SAARC) countries providing information and knowledge requirements on disaster risk reduction and disaster management.

2.0 Objectives

The key objectives of this training programme were: (a) to enhance the knowledge of the South Asia Disaster Knowledge network (SADKN) focal points to effectively incorporate geo-reference information into the SADKN information portal and (b) Utilizations of geo-spatial data and information services from various geo-portals for preparation of effective disaster management plans at regional and local level.

3.0 Target Beneficiaries

The target beneficiaries were managers and decision makers involved in the disaster risk reduction, management and mitigation, water resource managers, professionals involved in aerospace technologies, particularly web-designers/managers, remote sensing and geographic information system technologies from SAARC countries. A total 16 (sixteen) participants from SAARC member countries viz. India, Bhutan, Sri Lanka, Pakistan, Thailand, Maldives, Nepal, Bangladesh and Afghanistan participated in this training programme.

4.0 Course Inauguration

The training programme was inaugurated by Dr. Y.V.N. Krishna Murthy, Director CSSTEAP and IIRS in presence of Dr. Tae Hyung Kim, Economic Officer UN-ESCAP, Bangkok and other delegates from UN-ESCAP Bangkok, Asian Institute of Technology (AIT) Bangkok, CSSTEAP and IIRS. Dr. Sarnam Singh Programme Coordinator CSSTEAP welcomed all the participants, resource persons from India and abroad and faculty of IIRS. The inauguration session was also attended by Dr. S. K. Saha, Dean



Inauguration of the training programme

Academics IIRS, Dr. S.P.S. Kushwaha, Group Director PPEG IIRS, Group Heads and Heads of Departments of IIRS. In his inaugural address Dr. Krishna Murthy stressed upon the importance of geo-spatial technology for disaster risk reduction. He also briefed about ISRO disaster management support programme and many successful case studies where geo-spatial technology is used in India. He also focused on the importance of space based inputs and strengthening these geo-spatial products with ground observation data collected using portable devices like mobile have great applications in disaster management.



Course Participants alongwith faculty of the course

5.0 About the participants

The beneficiaries of this training programme were officials from SAARC member countries involved in disaster risk reduction and other related activities in their respective country. This capacity building programme was a comprehensive training for development, operation and management of geo-reference information system for SAARC sub-regional countries. Two officials from each SAARC country had participated whereas one official was a focal point for SADKN and the other officials were either from the Space Agency, Meteorological Department/agency or National Statistical Agency of SAARC countries. Two persons from SAARC disaster Management Center (SDMC), New Delhi also participated. Total 16 participants were present during the training programme. The detail list of participants with their country and affiliation is given in Annexure VII.

6.0 Course structure

The training programme was conducted in seventeen (17) technical sessions. Total 17 (seventeen) technical sessions were conducted with main emphasis on development of Geo-Portal for Disaster Risk Reduction (DRR), utilizations of web services and online applications tools for DRR. A special session was conducted by Mr. Tae Hyung Kim on "Improving Disaster Risk Management through Geo-referenced Information System in the ESCAP region". The representative of SDMC, New Delhi presented data access and sharing mechanism through SADKN to the participants in detail. The resource persons from UN-ESCAP Mr. Rajendra Aryabandu and Mrs. Madhavi Aryabandu also shared their expertise and conducted technical sessions on different themes of Geo-DRR. The capacity building activities of CSSTEAP/IIRS and AIT, Bangkok was presented by Dr. Sarnam Sing and Dr. Lal Samarakoon, respectively. Detailed technical sessions and hands-on exercises on Geo-DRM portal being developed under UN-ESCAP programme was conducted by a team from AIT Bangkok led by Dr. Lal Samarakoon. The technical session on Sub-regional Geo-DRM Information Systems also covered the training on WebGIS and open source software technology and their utilization for DRR.

The special sessions on Indian experiences on early warning system for disaster management and location based services and space based inputs for disaster management and its services through ISRO Bhuvan portal was presented by Dr. S.K. Srivastav, and Dr. Harish Karnatak from IIRS, respectively. A live demonstration on utilization of mobile based GIS for disaster management was also presented as a case study developed at IIRS by Dr. Harish Karnatak. The participants from member countries presented the status of their country, data availability and also the country specific requirements which should be part of proposed Geo-DRM portal. The participants also got awareness of Institutional, policy issues and networking requirement in SAARC countries for Geo-DRR data and information services.

The practical session were also conducted during the training programme. A remote practical lab was established by CSSTEAP by utilizing IIRS network and training lab resources. The hand-on exercises on online geo-portals and map resource were also carried out using high bandwidth internet connectivity established for

the training programme. The concluding session on "Way Forward..." was conducted by Mr. Rajendra Aryabandu, UN-ESCAP and Dr. Harish Karnatak, CSSTEAP/IIRS.

7.0 Faculty

The experts from the Information and Communication and Disaster Risk Reduction Division of the ESCAP along with their technical consultants from the Geoinformatics Center (GIC) at Asian Institute of Technology (AIT) in Bangkok, IIRS-ISRO, SAARC Disaster Management Center (SDMC) New Delhi, International Strategy for Disaster Risk Reduction (ISDR) and the office of the Coordination and Humanitarian Affairs (OCHA) were the resource persons for the training programme. The list of resource persons is given in Annexure VIII.



Course Participants during course work

8.0 Feedback

At the end of the training programme a feedback session was conducted by UN-ESCAP and CSSTEAP officials. The highlights of the training programme and feedback from participants was submitted to UN-ESCAP. The feedback received from participants was excellent for technical sessions, lab and internet arrangements, logistic etc., while some other issues on availability and data update mechanism of SADKN required technical and policy level revamping.

9.0 Valedictory Function

The valedictory function was conducted on 29th August 2013. The chief guest of the function was Dr. Y.V.N. Krishna Murthy Director CSSTEAP. The certificates of participation were distributed to all the participants. Dr. S.K. Saha, Dean Academics IIRS and Dr. Sarnam Singh Programme Coordinator CSSTEAP and Group Director, Group Head and Heads of the departments were also present on this occasion and ended with vote of thanks.



Participant receiving Course Certificates .
from Director, CSSTEAP

10.0 Conclusion

The sub-regional training on development of geo-referenced information systems for disaster risk management for SAARC was successfully completed at CSSTEAP Dehradun. The overall response from the participants was very good. It was suggested by the participants that CSSTEAP should conduct more such extensive and technical training programme on disaster management and related areas:



Dr. Harish Karnatak
Team Member



Dr. Sarnam Singh
Programme Coordinator

List of the Participants








| S.N. | Name | Country | Photograph |
|------|--|-------------|---|
| 1. | Mr. GH. Farooq Baghlani Acting Head National Emergency Operation Center (Head Officer), Afghanistan National Disaster Management Authority (ANDMA), Kabul, Afghanistan Email: gfarooq@gmail.com | Afghanistan |  |
| 2. | Mr. Probir Kumar Das Programmer (ICT) Department of Disaster Management, Ministry of Disaster Management and Relief 92-93 Mohakhali C/A, Disaster Management and Relief Bhaban, Dhaka 1212, Bangladesh Email: Kumar_Probir@yahoo.com | Bangladesh |  |
| 3. | Dr. Jnanendra N Biswas Additional Secretary M/o/Disaster Management and Relief, Bangladesh, Bangladesh Secretariat, Dhaka, Bangladesh Email: drjnbiswas16@gmail.com | Bangladesh |  |
| 4. | Mr. Pema Thinley ICT/GIS Officer SADKN Focal Point, Department of Disaster Management, Ministry of Home and Cultural Affairs (MOHCA), PO Box No. 1493, Thimphu, Bhutan Email: pemaddm@gmail.com | Bhutan |  |
| 5. | Mr. Til Bdr. Gurung ICT/GIS Associate Department of Disaster Management Ministry of Home and Cultural Affairs (MOHCA), PO Box No. 1493, Thimphu, Bhutan Email: tilbdrgurung2013@gmail.com | Bhutan |  |
| 6. | Mr. Arnob Bormudoi Research Associate Geoinformatics Center Asian Institute of Technology P.O. Box 4, KlongLuang, Pathumthani-12120, Thailand; E-mail : bormudoi@gmail.com | India |  |
| 7. | Mr. Arpit Chouksey Scientist-SC Indian Institute of Remote Sensing 4 Kalidas Road, Dehradun Email: arpit@irs.gov.in | India |  |
| 8. | Mr. Kamal Pandey Scientist-SC Indian Institute of Remote Sensing 4 Kalidas Road, Dehradun Email: kamal@irs.gov.in | India |  |

COURSE REPORT

| S.N. | Name | Country | Photograph |
|------|---|-----------|---|
| 9. | Dr. (Er.) Puneet Swaroop Scientist/Engr-'SE' Indian Institute of Remote Sensing 4 Kalidas Road, Dehradun Email:puneet@iirs.gov.in | India |  |
| 10. | Mr. Ranjan Kumar Research Assistant SAARC Disaster Management Centre NFDN Building, IIPA Campus, MG Road, New Delhi 110 002 Email: ranjan.sdene@gmail.com | India |  |
| 11. | Mr. Vikas Baliyan Intern SAARC Disaster Management Centre NFDN Building, IIPA Campus, MG Road, New Delhi 110 002 Email: vikasbaliyan2002@gmail.com | India |  |
| 12. | Mr. Shakeel Moosa Disaster Management Officer Maldives National Defence Force National Disaster Management Center, Male, Maldives Email: shakeel.moosa@ndmc.gov.mv | Maldives |  |
| 13. | Mr. Mukesh Kumar Keshari Computer Engineer Ministry of Home Affairs, Singh Durbar, Kathmandu, Nepal Email: mukesh525@gmail.com | Nepal |  |
| 14. | Mr. Maqsoodullah Khan Assistant Director (DRR-III) National Disaster Management Authority (NDMA) Room#207-A, NDMA Prime Minister Secretariat, Islamabad, Pakistan Email: ad_drr3@ndma.gov.pk | Pakistan |  |
| 15. | Ms. Amarasingha A.A. Kumudu Kumari Seneviratne Assistant Director (Mitigation) SADKN Focal Point, Disaster Management Centre VidyaMawatha, Colombo-07, Sri Lanka Email: seneviratne.anoja@gmail.com | Sri Lanka |  |
| 16. | Ms. Kumari Mala Weerasinghe Senior Scientist National Building Research Organisation 99/1 Jawatta Rd, Colombo 05, Sri Lanka Email: kmweera@yahoo.com | Sri Lanka |  |

Topics and Details of Faculty

| S.No. | Topics | Faculty | Photograph |
|-------|---|--|--|
| 1. | Improving Disaster Risk Management through Geo-referenced Information System in the ESCAP region. Email: kimt@un.org | Mr. Tae Hyung Kim ICTDRRD, Economic and Social Commission for Asia and the Pacific/UNESCAP, Bangkok |  |
| 2. | Overview of Geo-referenced Disaster Risk Management (Geo-DRM) Information System SAARC region <ul style="list-style-type: none"> • Introduction of CSSTEAP and IIRS (programs and courses) Email: samam@iirs.gov.in • Use of GIS/RS for disaster risk reduction, good practices/lessons learnt in the region • Introduction toGIC/AIT activities on the use of space based technologies on DRR in Asia | Dr. Samam Singh Indian Institute of Remote Sensing (ISRO), Dehradun), India Dr. P.K. Champati Ray Indian Institute of Remote Sensing (ISRO), Dehradun), India Email: champati_ray@iirs.gov.in Dr. Lal Samarakoon Geoinformatics Centre Asian Institute of Technology Bangkok, Thailand Email: lalsamarakoon@gmail.com |   |
| 3. | Overview of Geo-referenced Disaster Risk Management (Geo-DRM) Information System in SAARC Sub Region (continue) | Dr. Lal Samarakoon Geoinformatics Centre Asian Institute of Technology, Bangkok, Thailand Email: lalsamarakoon@gmail.com |  |
| 4. | Early warning Systems <ul style="list-style-type: none"> • Effectiveness of early Warning Systems and it practical applications in the region (meteorology, forest fires, Tsunami, landslides, flood) | Dr. S.K. Srivastav Indian Institute of Remote Sensing (ISRO), Dehradun), India Email: sksrivastav@iirs.gov.in |  |
| 5. | <ul style="list-style-type: none"> • Real time data collection and Mobile GIS applications for disaster management. | Dr. Harish Karnatak Indian Institute of Remote Sensing (ISRO), Dehradun), India Email: harish_k@nrsc.gov.in |  |
| 6. | Networking and Community of Practices(COP): motivation, sustaining interest and willingness to share information | Mr Rajindra Ariyabandu, Economic Affairs Officer, Information and Communication Technology and Disaster Risk Reduction Division, United Nations ESCAP, United Nations Building, Bangkok Email: ariyabandun@un.org |  |

| S.No. | Topics | Faculty | Photograph |
|-------|--|---|--|
| 7. | Sub-regional Geo-DRM Information Systems | Dr. Lal Samarakoon Geoinformatics Centre Asian Institute of Technology Bangkok, Thailand Email: lalsamarakoon@gmail.com & Mr. C. Wickramasinghe Email: chathura.hasanka@gmail.com |  |
| 8. | SAARC Secretariat Regional Activities • Role of the SAARC secretariat on sub-regional DRR information sharing through SADKN Country Presentations- Issues and requirements | Mr. Ranjan Kumar SAARC Disaster Management Centre NFDN Building, IIPA Campus, New Delhi Email: ranjan.sdene@gmail.com Member country presentations |  |
| 9. | Introduction to Geo Portal via Training Institutional, Policy Issues and networking | Mr Rajindra Ariyabandu, Economic Affairs Officer, Information and Communication Technology and Disaster Risk Reduction Division, United Nations ESCAP, United Nations Building, Bangkok Email: ariyabandur@un.org ISDR an UN-ESCAP |  |
| 10. | Introduction to Geo -DRM portal through Training (continue) | Mr Rajindra Ariyabandu, Economic Affairs Officer, Information and Communication Technology and Disaster Risk Reduction Division, United Nations ESCAP, United Nations Building, Bangkok Email: ariyabandur@un.org |  |
| 11. | Geo-DRM portal-Self-running the process using data provided Disaster map download and integration | Mr Rajindra Ariyabandu, Economic Affairs Officer, Information and Communication Technology and Disaster Risk Reduction Division, United Nations ESCAP, United Nations Building, Bangkok Email: ariyabandur@un.org |  |
| 12. | Feedback and Way forward (Moderated by IIRS and ESCAP) | Mr Rajindra Ariyabandu, Economic Affairs Officer, Information and Communication Technology and Disaster Risk Reduction Division, United Nations ESCAP, United Nations Building, Bangkok Email: ariyabandur@un.org Dr. Harish Kamatak Indian Institute of Remote Sensing (ISRO), Dehradun, India Email: harish_k@nrs.gov.in |   |

