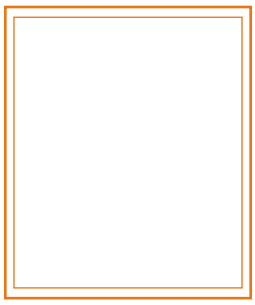
Course Report

Remote Sensing & Geographic Information System Course Report (2016 - 2017)



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The twenty first Post-Graduate Course on Remote Sensing and Geographic Information System (RS&GIS) of CSSTEAP commenced on July 1, 2016 at Indian Institute of Remote Sensing (IIRS),ISRO, Dehradun, one of the host institutions of CSSTEAP. Total 20 participants from 11 countries of Asia-Pacific Region viz. three participants from Mongolia, two each from Bangladesh, DPR Korea, India, Kazakhstan, Kyrgyzstan, Nepal, Sri Lanka and one participant each from Fiji, Indonesia, Myanmar, Tajikistan, Thailand, Uzbekistan and Viet Nam have joined the course.

The course was designed and aimed at learning and skill development in geospatial technologies, and their applications in monitoring and conservation of the natural resources and tackling the challenges such as climate change, sustainable land use and natural disaster mitigation with the help of geospatial technologies. The participants are mainly from Hydrology, watershed management, Environment, Meteorology, urban and regional planning, Geoinformatics, Surveying, cartography and agriculture, Forestry, Geology and Marine sciences background.

The RS&GIS course has two phases. The Phase-I involved 9 months teaching at the IIRS and Phase-II study will be carried out in their home country. The course structure which is based on UN Curricula of UN-OOSA, was taught with minor modifications as suggested by the International Advisory Committee and internal Board of Studies (BOS) committee. The entire period of 9 months was divided into two semesters. Semester-I was further divided into two modules. The Module-1A and 1B were of three and one month duration, respectively. Similarly Semester-II also has two modules Module-II and Module-III of two and three months, respectively. Due to personal reasons one of the participant from Nepal had to leave the course in between after completing six months of the course.

The course started with an 'Induction week' (Module-0) during first week after joining the course where the participants are exposed to geographic perspective of India, social systems, customs and festivals of India, overview of space science, technology and applications, etc. Module-1A covered basically the fundamentals of RS&GIS: Principles of RS, Photogrammetry (Analytical as well as Digital), Image Analysis (included both visual

and digital techniques), basics concepts of GIS and GPS. The module also covered theory, practical and tutorials on principal of Remote Sensing, photogrammetry, image analysis, GPS, GPS & GIS. Several field excursions were taken up during this module for ground truth collection and for interpretation and analysis of satellite data. In GIS the broad topics covered were concepts of GIS, databases, data entry and editing, principles of cartography, map projections, vector and raster geodatabases, network, DEM, concepts of GPS, types of GPS, constellation, GPS application in surveys, mapping and navigation.Module-1B Semester-I, was of one month on recent trends in RS & GIS and environmental analysis & management and the topics covered were, introduction to hyperspectral satellite data, microwave data, interferrometry, etc and in topics on environmental significance like satellite meteorology, Earth processes, natural disaster analysis, biodiversity conservation, monitoring & management. Guest lectures were organized on 'Metrological satellite and sensors', 'weather analysis, forecasting and modelling', 'Earth observation system for climate and climate change','Forest fire & forest information system' on 'Climate change dynamics' and 'EO satellite for climate change'.

In semester-II, the course participants choose one of the eight optical electives. Optional electives are Agriculture & soils, Forest & Ecology, Geosciences & geo-hazards, Marine & Atmospheric Science, Water Resources, Urban & regional planning, Satellite image analysis & photogrammetry and Geo-informaticsweretaken by the participants. Out of 19 participants, 5 participants each have opted Geoinformatics and Satellite image analysis & photogrammetry; 3 each for Urban & Regional Planning and Water Resources; 1 for Forestry & Ecology, two for Marine & Atmospheric Science.They opted the disciplines by considering his/her academic qualification, professional experience, and technical requirement of their parent organization. Again considering their interest they were assisted to choose specific topics in Module III- Pilot project.

The major components of course syllabus were covered by the faculty of IIRS and additional guest lectures by guest faculty on specialized topics was also arranged for the academic benefit of the course participants. The subject experts were invited from various Indian Organizations/Institutes/Universities such as India Meteorological Department (IMD); Indian Institute of Technology (IIT), Roorkee, National Remote Sensing Centre (NRSC), Hyderabad; Aryabhatta Research Institute of Observational Research (ARIES), Nainital; Space Applications Centre (SAC), Ahmedabad, Andhra University, Visakhapatnam etc to deliver specialized lectures.

The academic activities like theory, guest lectures, practical, etc. were organized in smart-class rooms. Multi-media self-learning packages, field excursion, seminars, etc. were also organized. All the participants learnt operationalization of software for digital satellite image processing for mapping natural resources for management and planning during computer-based practical exercises. Local field-tours were very effective in understand different ecosystems, phenomenon, and earth surface features using RS data. They were also taught GIS using latest software, concept of datum, projections, database creation, analysis and modeling for understanding earth processes and natural resources management. They applied this knowledge in analyzing and solving problems during pilot project in Module-III. Lecture notes in the form of printed books and supplementary reading materials were distributed well in advance to all the course participants to help easy assimilation of the subject in the class and also for future reading. Soft-copy of the lecture notes were also distributed. Access to audio-visual recording of all the lectures by IIRS faculty and guest lecturers was provided

all the time to them to listen again and again to understand the subject. Academic performance of the course participants was evaluated in each semester through periodic internal and external examinations in the form of written and practical examinations; class test, tutorials, seminar etc.The Semester-I external examinations were held from October..... , 2016 and Semester-II external examination were held from December, 2016.

For interested participants English language class after office hours was organized during the first three months during Module-IA for improving communication, understanding and writing skills in English. English coaching was imparted to all students to improve spoken and written English proficiency with more emphasis on pronunciation/accent, grammar and vocabulary. Significant progress has been observed in proficiency of the students.

Technical and educational visits to Andhra University, Visakhapatnamand National Remote Sensing Centre, Hyderabad were undertaken during October 2016. Field visits for urban and rural landscape of East coast, Eastern Ghats and seascape were also organized. The participants has opportunity to visit the Integrated Multi-mission Ground Segment for Earth Observation Satellites (IMGEOS) which is a state-of-art multi-mission ground segment processing enterprise for earth observation satellites and watched the real time acquisition of EO data at Shadnagar, Hyderabad. IMGEOS provides emergency data products in hours, most of standard products in less than a day, significantly ramp up product throughput per day. The participants has opportunity to visit the technical facilities at NRSC, Hyderabad. At Andhra University, the educational records of all participants were scrutinized for fixing their M.Tech. eligibility. At Andhra University the participants attended 8 lectures on specialized topics on environmental analysis & management, marine, weather forecasting, watershed etc. A field visit in and around Visakhapatnam was also organized for the benefit of the participants. During technical visit, the course participants explored Indian rich heritage and cultural diversity. On the social front, the participants had glimpses of Indian festivities by their active participation in various festivals such as Dussehra, Diwali, Id-ul-Fitr, Christmas, New Year, Holi, etc.

The participants of the course also participated in the IIRS user Interaction Meet 2017 held during February 2017 at IIRS Dehradun. The meet had 200 delegates from all over India from ISRO, various Govt. Departments, Universities, NGO & other scientific organizations. The meet consisted of 3 plenary sessions.

The course participants learnt a great deal with respect to practical and technical aspects of RS & GIS technologies and their applications during the three months of pilot project carried out in Module-III. This module is basically designed to carry out pilot project work by the course participants. Course participants developed and finalized pilot project in consultation with organization in their home country and supervisors of IIRS.

The broad topics of the pilot projects under taken by the course participants during Module-III were:

- Forest Ecosystem Services Assessment Using Geospatial Approach in Pali-Gad Watershed, TehriGarhwal District, Uttarakhand, India
- Forest Fire Detection, burnt area assessment, analysis of the relationship between Land surface temperature (LST) & burn severity

- Application of 3D Database in Estimation of Flood Inundation Area using Trivim
- Exploring Cloud Based, Geospatial Processing Infrastructure, to Study Water Spread in Uttar Pradesh
- Web GIS based Solving for Advertisement of Real Estate
- Geospatial Data Processing in Python
- A Case Study: Impact of Classification Techniques on Land Use and Land Cover Mapping and Land Use and Land Cover Change Prediction in Haridwar, Uttarakhand State, India
- Assessment of Rainfall Products for the extreme rainfall events over the North-West Himalayan Region
- Study the Seasonal Variation of Chlorophyll-a with Suspended Sediments ConcentrationinDondra Bay, Sri Lanka using LANDSAT-8
- Analysis and Comparison of DEMs and Orhophotos from UAV Data, Generated by various Specialized Software
- Information extraction usingGroundbased Hyperspectral Data for Land Cover Feature Extraction
- Application of 3D Close Range Photogrammetry for Mapping Flood Inundation in an Urban Scenario
- Potential of SpaceborneBistaticPolarimetric Interferometric Modelling For Vegetation Height Estimation
- Evaluation of Open Spatial Data for Topographic Mapping
- Analysis of Open Green Spaces in Dehradun and surrounding Areas using Remote Sensing and GIS
- Investigating Impervious Surface Area, NDBI and NDVI as Indicators for Urban Heat Island Effect using LANDSAT Imagery Case: Delhi
- Study of Peri-Urban dynamics using High Resolution data and Geographic Information System
- A Case Study: Impact of Climate Change on Runoff Response of Asan Watershed in Dehradun, Uttarakhand State, India
- Sediment Yield And Reservoir Sedimentation Assessment using Geospatial Techniques
- Estimation of Daily Evapotranspiration (ET) using Geo-stationary Satellites Data

Course Participants

Sl.No.	Name	Country
1.	Mr. Nicholas Ting	Fiji
2.	Ms. Allaka Lalitha	India
3.	Mr. Midatana Sarath	India
4.	Ms. Lunara Mukanayeva	Kazakhstan
5.	Ms. Nadiya Yagfarova	Kazakhstan
6.	Mr. Yerzhan Aidarkhanov	Kazakhstan
7.	Ms. Asanakunova Gulzat Kereshbekovna	Kyrgyzstan
8.	Mr. Bat-Erdene Amartur	Mongolia
9.	Ms. Gantig Unenbuyan	Mongolia
10.	Ms. Aye Aye Naing	Myanmar
11.	Ms. Thinzar Nwe	Myanmar
12.	Mr. Prashid Kandel	Nepal
13.	Ms. Weraniya G.N.N. Jayawardhana	Sri Lanka
14.	Mr. Vidanage Maheshindika Chathurange	Sri Lanka
15.	Ms. Ranasinghe A. Chathuri Nisansala	Sri Lanka
16.	Mr. Shahriyor Mavlonzoda	Tajikistan
17.	Mr. Nattapong Puangkaew	Thailand
18.	Mr. Farkhod G. Abdullaev	Uzbekistan
19.	Mr. Rakhmatulla A. Ermanov	Uzbekistan

Brief outline of Course Curriculum - RS & GIS (2016-2017)

SEMESTER - I

Module-1A: Fundamentals of RS & GIS

Duration: Three months

- Remote Sensing Principles
- Image Analysis
- Photogrammetry
- Geoinformatics

Module-1B: Recent Trends in RS & GIS and Environmental Analysis & Management

Duration: One month

- Advanced Aspects of Remote Sensing & GIS
- Satellite Meteorology
- Earth Processes
- Natural Disaster Monitoring and Management
- Environmental Analysis, Monitoring and Management

SEMESTER - II

Module II- Optional Electives
(Duration: Two months)

Agriculture and Soils

- Land use & Soil Resource Management
- Agri-Informatics
- Environmental Soil Science
- Satellite Agrometeorology

Geosciences and Geohazards

- RS for Earth & Planetary Sciences
- Data processing & analysis
- Applied & Tectonic Geomorphology
- Engineering Geology & Ground water

Marine and Atmospheric Science

- Coastal process and Marine Ecology
- Atmosphere & Ocean Dynamics
- Satellite Oceanography
- Satellite meteorology

Satellite Image Analysis & Photogrammetry

- Remote Sensing -II
- Image Processing -II
- Digital Photogrammetry $ mapping
- Surface generation techniques

Forest Ecosystem Assessment & Management

- Forest mapping of & monitoring
- Forest Inventory
- Forest Informatics
- Forest Ecosystem Analysis

Water Resources

- Water Resources Assessment
- Watershed analysis & planning
- Water Resources development
- Water Resources Management

Urban and Regional Studies

- Urban and Regional Planning
- Geo-Spatial technologies in urban area analysis
- Urban Resources services & Facilities analysis
- Geo-spatial technologies for urban Environmental Studies

Geoinformatics

- Spatial database Architechure & modeling
- Programming in Geodata modeling
- Web GIS and Geovisualization
- Spatial data Quality & Geostatistics

Note: *This year optional electives-Agriculture & Soils; Water Resources; Urban & Regional Studies; Geo informatics; Satellite Image Analysis & Photogrammetry were taken by the participants.*

Module-III: Pilot Project Work

(Duration: Three months)

- Project Planning
- Pre-field Interpretation and analysis
- Field Data Collection and Data Analysis
- Post field analysis and Report
- Project Seminar

Course Content

Subject	Major Topics (Theory)	Major Topics (Practical Exercise /Demonstration)
Module-IA		
1.1 Remote Sensing	Interaction between EM Radiation and matter; RS Systems Active & Passive, Imaging & Non Imaging Systems; Concept of Resolutions - Spatial, Spectral, Radiometric and Temporal; Orbits and Platforms for Earth Observation; Physical basis of spectral signatures of the objects; data reception & processing; image quality & structure, Thermal and Microwave remote sensing.	Study on spectral and image characteristics of optical, thermal & microwave aero-space RS data for characterization major earth features; Study on spectral signatures of objects using ground truth instruments - Radiometers, Spectrometers
1.2 Image Interpretation & Analysis	Principles of visual Interpretation of aerial photos and satellite imagery; Mathematical concepts mathematics & statistics used in digital image processing (DIP); Principles of DIP techniques rectification, enhancement, classification, feature selection & separability, image transformation, spectral indices, accuracy assessment, etc.	Visual interpretation of land cover details from aerial photograph and satellite images; DIP exercises - Image registration, Image enhancement & spectral indices; Image classification (supervised and unsupervised) & classification accuracy assessment
1.3 Photogrammetry	Basics of aerial Photography; stereoscopy & binocular vision; stereoscopic parallax; stereophotogrammetry; Analytical Photogrammetry- Collinearity and Co-planarity conditions, Concept of Rotation Matrix; Introductory concepts in Digital Photogrammetry; Satellite based Digital Photogrammetry; Concept of DEM, DSM and DTM, DEM extraction and Orthoimage generation	Stereoscopic interpretation of aerial photographs; Determination of heights using parallax bar; Familiarization with Digital Photogrammetry; feature extraction; Generation of DEM and orthoimage
1.4 Geoinformatics	Spatial Information System-overview; Hardware and Software requirements of GIS; Conceptual Model of Spatial & Non-Spatial Information; Spatial data Analysis (Vector & Raster based); network analysis; data quality & errors; Fundamental Concepts of GPS; Map projections, resource surveys, mapping & navigation, DEm, interpolation & DEM derivates; overview of spatial data infrastructure	Working with GIS software; Preparation and organization of spatial and non-spatial data in GIS; digitization & editing; Query & analysis; Spatial data analysis (Vector & Raster based); DEM; network analysis; Familiarization with different types of GPS receivers; area survey
Module-IB		
1.5 Recent Trends in RS and GIS & Environmental Assessment and Monitoring	Principles & applications of Hyperspectral & Laser RS, and SAR Interferrometry; Advances in DIP; Concept and approaches of Multi-criteria decision making; GIS customization concepts; Concepts & applications of Geostatistics; Satellite Meteorology; Concept of sustainable development & Integrated resource management for sustainable development; Global climatic change and its impact; Natural disasters- geological, environmental & hydro-meteorological; Biodiversity characterization & management; Urban and coastal zones monitoring and management; Watershed management	Advance DIP techniques e.g. Fuzzy, ANN, Expert system, Image Segmentation etc; SAR Interferrometry and its applications; Analysis of hyperspectral satellite data; GIS customization concepts; Concept and approaches of Multi-criteria decision making; Geostatistics.
Module-II (optional electives, one to be chosen)		
2.1 Agriculture & Soils		
2.1.1 Land Use & Soil Resource Management	Concept & issues of sustainable agriculture; land use/land cover analysis; impact on biogeochemical & hydrological cycle; soil characteristics & pedogenesis; soil resource mapping; RS in soil survey & mapping; digital soil mapping; soil classification; soil morphology; soil taxonomy; land evaluation; land capability classification; soil & land irrigability; FAO framework of land evaluation; soil & land productivity indices	Agriculture land use mapping following visual and digital analysis; soil characteristics & analysis; soil classification; morphology characteristics; soil taxonomy; soil resource mapping; physiographic analysis; land evaluation
2.1.2 Agri-Informatics	Crop inventory & assessment; crop discrimination, acreage estimation, crop system analysis; crop management; precision agriculture; canopy reflectance modeling; microwave RS in crop inventory; ICT applications in agriculture; relational agri-database, retrieval of biophysical and socio-economic aspects; productivity contrast analysis; decision support systems	Crop identification, area estimation and condition assessment using digital techniques; crop condition & stress; Demonstration on use of Hyderspectral data in crop inventory; SAR data analysis; SDSS for crop input optimization.

Subject	Major Topics (Theory)	Major Topics (Practical Exercise /Demonstration)
2.1.3 Environmental Soil Science	Land degradation; factors, processes & RS use; Watershed characterization, delineation codification & management; soil erosion, conservation, monitoring and impact; soil quality indicators, measurement & assessment; soil carbon sequestration, soil biogeochemical cycle, soil pollution, soil nutrient management and impact of climate change on soil processes; Optimal land use planning; agro ecological characterization; land evaluation methods; FAO-AEZ based land use planning	Digital analysis of degraded land mapping; GIS applications for soil erosion inventory & modeling; Land evaluation and suitability analysis; Watershed analysis-prioritization and soil conservation planning; soil erosion modeling; MCA approach for agricultural land use planning; soil quality indicator, variability analysis.
2.1.4 Satellite Agrometeorology	Agro-meteorology for sustainable agriculture; agrometeorological factors & considerable for sustainable agriculture; Agrometeorologcal parameters retrieval from satellite; crop yield modeling & production forecasting; integrating RS & crop growth models; regional crop production assessment & forecasting; global energy balance & early warning system; Land surface climatology; impact of climate change and variability on agriculture; climate change mitigation and adaption strategies	Drought & rainfall climatology analysis; surface temperature, rainfall, biophysical parameter estimation from satellite; regional evapotranspiration; crop water requirement; crop yield estimation from satellite; climate change impact on crop productivity; eddy covariance measurements & simulation of energy water & CO2 exchange
2.2 Forest Ecosystem Assessment & Management		
2.2.1 Forest Mapping & Monitoring	Forest mapping, distribution, types, status & classification; Spectral properties of vegetation & spectral indices; Visual and digital analysis of satellite image for forest cover type mapping; Forest change, growth, green wave & Insect pest damaged forest detection; hyperspectral and Microwave RS in forestry, LiDAR RS for tree height determination; biophysical spectral response based forest canopy density mapping	Forest mapping & density assessment using RS data using visual & digital techniques; Forest cover change detection; hyperspectral, Microwave and LiDAR interpretation techniques
2.2.2 Forest Inventory	Principle of forest inventory; Sampling theory & design; Forest mapping & density assessment using RS data; Stock mapping for preparation of forest management plan; Forest cover change detection; growing stock, biomass & carbon estimation; statistical data analysis; Fuel wood and fodder resource assessment; Use of optical, radar & Lidar in growing & biomass assessment	Measurement of tree height and crown density; Forest sampling techniques; Growing stock estimation; statistical data processing and geostatistical analysis & modelling
2.2.3 Forest Informatics	Modelling approaches in forestry; Geoinformatics for Forest working plan; Fire ecology, detection, risk assessment & modeling; Geo-spatial technology for wild life habitat; protected areas, habitat suitability models & modeling; Forest degradation assessment and monitoring	Site suitability analysis for forestry; Revision and updating of stock maps; GIS database creation for forest management; Forest fire risk modeling; Wild life habitat analysis; forest degradation assessment
2.2.4 Forest Ecosystem Analysis	Forest ecosystem principles & concept; Landscape & ecosystem analysis; Biodiversity characterization at landscape level; Forest, environment & climate change impacts on forest & biodiversity, habitats; environmental policy & strategy; Environmental impact assessment (EIA); Wetland monitoring & conservation planning; biodiversity conservation planning	Landscape analysis; phtosociological analysis; biomass, productivity assessment; vegetation cover prediction modeling; biodiversity characterization; EIA case study
2.3 Geosciences & Geo-hazards		
2.3.1 Remote Sensing for Earth & Planetary Sciences	Satellite image interpretation in Lithological and structural analysis; Geological Interpretation of Thermal & Microwave Remote Sensing Data; Hyperspectral Remote Sensing for lithological mapping & mineral exploration; RS and GIS in Oil & Mineral Exploration; RS for hydrocarbon exploration- hydrocarbon resources, model of occurrence & indicators; mapping geological & geomorphological anomalies related to petroleum occurrences; overview, RS of planetary missions	Geological Mapping, spectral analysis using Satellite Imagery; Geological applications of RS data in mineral and oil explorations; Geological Interpretation of Microwave RS data, planetary missions
2.3.2 Data processing & Analysis for Geosciences	DIP for geological applications; Landform analysis based on satellite data Interpretation; hyperspectral & microwave data processing for mineral, alteration zone, terrain mapping, crustal deformation & land subsidence; Geodatabase, creation, geospatial analysis, output generation, DTM and 3D data handling for geological applications & watershed analysis; Applied statistics & geostatistics	Geomorphological Mapping; hyperspectal and MW image analysis for mineral, DEM, crustal deformation and land subsidence studies; data fusion & change detection for surface change analysis; geological database organization, spatial analysis, terrain analysis & terrain parameter extraction; multivariate statistics

Subject	Major Topics (Theory)	Major Topics (Practical Exercise /Demonstration)
2.3.3 Applied & Tectonic Geomorphology	Geomorphic processes & landform evolution; tectonic geomorphology, ative tectonics, neotectonics, earthquake geology, land system analysis; applied geomorphologic mapping; geomorphic classification systems; climate tectonic relationship and landform dynamics	Geologic and Geomorphic Interpretation; Fluvial landform mapping & analysis; Glacier & snow cover mapping, snout position identification, glacier landform mapping; tectonic landform mapping and analysis; applied geomorphological mapping
2.3.4 Engineering Geology & Ground Water	Engineering geology & mass movement types, classifications of landslides & modeling; Engineering geological site investigations and environmental impact assessment of dams & reservoir; Principles of RS in hydrogeological mapping and groundwater exploration; RS & GIS in ground water exploration and management in hard rock/unconsolidated material; Groundwater Management, Artificial Recharge and Rain Water Harvesting; Groundwater quality	Engineering geological mapping using RS data; landslide hazard zonation & risk analysis; route alignment, suitable site selection for dam/reservoir, catchment & rim area analysis; RS for Construction material investigations and estimation of rock mass strength; Erosion and Mass Movement Processes; Highway Alignment Studies & geologic hazards; RS & GIS for groundwater exploration; Interpretation of hydrochemical data & ground water quality zonation
2.4 Urban & Regional Studies		
2.4.1 Fundamentals of Urban & Regional Planning	Concept of settlement planning; town planning practices; urban & regional planning models; preparation of development/master/ zonal plans; image interpretation of urban areas; urban land use planning; urban land use classification system; accuracy assessment; base map and cadastral maps for urban areas; photo-maps; ortho-maps; foot print map; RS & GIS for property tax assessment	Identification of urban objects using satellite images on different scales; interpretation & delineation of urban areas; Population estimation; Urban growth monitoring; urban LU/LC classification system;
2.4.2 Geo-Spatial technologies in Urban Area Analysis	Urban sprawl; slum & squatter analysis; census operation & population studies; population estimation through RS; concept of space use; techniques of space use mapping; quantitative techniques for urban analysis; techniques in human geography; analysis of spatial data; structuring spatial relationships	Urban sprawl mapping; census updating & population estimation techniques; space use mapping; supervised & un-supervised classification of urban areas, various statistical techniques of data analysis
2.4.3 Urban Resources, Services and Facilities Analysis	Geo-spatial technologies for urban utility mapping; solid waste management; urban hydrology, water supply etc; urban hazard & risk assessment; urban geomorphology for hazard identification; multi-risk assessment; damage assessment due to earthquake, fire & explosion; traffic & transportation studies; geo-spatial technologies in route alignment studies; urban resources studies; spatial distribution of resources; urban energy consumption & sustainability	Facility mapping & buffer analysis; network analysis; urban hazard mapping, analysis & risk assessment; traffic & parking survey & inventory
2.4.4 Geo-Spatial Technologies for Urban Environmental Studies	Object based image analysis for urban areas; virtualizing of 3D real world for urban designs; ANN for modeling urban growth; mobile mapping, ALTM, LiDAR for urban surface modeling; concept of CA in urban growth studies; Climate change, diseases & human health; urban heat island; urban microclimate, urban pollution, urban forestry, multi-criteria techniques in land evaluation & suitability analysis; urban & village information system	DEM generation, mobile mapping & updating maps; urban plan monitoring & change detection; urban noise survey, mapping & analysis; U.I.S & web GIS design & implementation, village resource centre programme
2.5 Marine & Atmospheric Science		
2.5.1 Coastal Processes & Marine Ecology	Elements of coastal geomorphology & visual interpretation of satellite image; RS application of coastal land form sedimentation, erosional & depositional processes; retrieval of coastal bathymetry from optical & SAR data; coastal & esturine dynamics, near shore circulation pattern, coastal hazards predictions, tsunami, sea level rise; elements of oceanic eco-system, bio-pyramids pelagic, non-pelagic, benthos, beach & sub-tidal ecology, coastal wetland, mangroves , corals & marine ecology; biogeochemical cycles	Visual and Digital analysis of satellite data in mapping costal landforms; Coastal landform analysis and mapping shoreline changes; Coastal zone density measurement; circulation pattern, bathymetry, suspended sediment analysis etc; biogeochemical cycle model
2.5.2 Atmosphere & Ocean Dynamics	Atmosphere structure & composition, atmospheric circulation & climate, ocean structure & composition, radiation & heat budget; governing equations, atmosphere & ocean; tropical dynamics, large scale tropical circulations, equatorial wave theory etc, ENSO & Indian monsoon	Rainfall data analysis; atmospheric dynamics, ocean dynamics

Subject	Major Topics (Theory)	Major Topics (Practical Exercise /Demonstration)
2.5.3 Satellite Oceanography	Principles of ocean RS; visible RS of ocean; retrieval of phytoplankton, suspended sediment conc. yellow substance, coastal bathymetry; thermal, MW RS of ocean; retrieval of various parameters from thermal and MW data; active MW RS and understanding retrieval of parameters; satellite scatterometery of sea surface winds; satellite altimetry of sea-surface topography; principle & return wave form analysis	Computation of in situ underwater optical data; retrieval & analysis of sea surface temperature from thermal and MW data; altimeter wave form analysis; retrieval of wind field from scatterometer observation
2.5.4 Satellite Meteorology	Principles of atmospheric RS; Meteorological satellite instrumentation & image interpretation; earth radiation budget etc; interferometer, limb scanner, MW imager etc; Retrieval of temperature, trace gases, ozone and winds; retrieval of aerosols and precipitation; measurement of earth radiation budget	Satellite imagery interpretation for meteorological phenomena; retrieval of ozone, rainfall, aerosol optical depth etc
2.6 Water Resources		
2.6.1 Water Resources Assessment	Hydrological cycle & its components, concept of watershed, RS & GIS applications in hydrology, quantification of hydrological elements; surface water & quality, spectral signature, RS in water quality analysis; Spectral Characteristics of Water, Snow and Surface Water Inventory; Hydrologic Elements and Quantification through RS; Snow Hydrology- Snowmelt Runoff Modelling and glacier Inventory; water Balance components & computation	Watershed delineation; stasticial & spatial analysis of precipitation using RS; rainfall, soil moisture, ET retrieval; surface water body mapping & water quality analysis; snow cover area mapping, snow melt runoff modeling; climatic water balance components
2.6.2 Watershed Analysis & Planning	Watershed hydrology; Terrain indices for water resources applications; DEM derivatives; soil erosion processes & modeling, sediment yield modeling using empirical & process based models; watershed prioritization & conservation planning; urban hydrology, water distribution system & modeling, RS & GIS in urban hydrological process	Watershed characterization, morphometric analysis & GIUH derivation; DEM generation from optical and InSAR techniques; soil erosion modeling; watershed conservation planning using RS & GIS; urban hydrological modelling
2.6.3 Water Resources Development	Site suitability for water resource projects; water harvesting structures, database required and decision rules; EIA of river valley projects; Irrigation infrastructure development, performance evaluation & conjunctive water use planning; water logging & salinity in irrigation command; ground water targeting & modelling	Database creation & identifying suitable sites for WHS, hydro power projects using RS & GIS; EIA of river valley projects; irrigation command area mapping; crop water requirement calculation; mapping and monitoring of waterlogged & saline areas; ground water targeting & modelling
2.6.4 Water Resources Management	Reservoir sedimentation, suspended sediments, sedimentation rate through RS; flood hydrology damage assessment & risk zone mapping; flood inundation mapping & modeling; drought monitoring & assessment; climate change scenarios- dynamic & statistical & water resources; glacier retreat & glacial lake mapping; modeling of climate change scenarios & scaling issues; integrated water resources management	Monitoring of reservoir sedimentation; flood peak flow estimation; hydrologic modeling & flood flow estimation; flood inundation, flow mapping & modeling; drought assessment; analysis of hydro-meteorological parameters; glacier retreat mapping & hydrological modeling for climate change scenarios
2.7 Satellite Image Analysis & Photogrammetry		
2.7.1 Remote Sensing-II	Hyperspectral RS; noise & data dimensionality reduction; data quality; Radiometric & Atmospheric corrections for multispectral & hyperspectral sensors; concepts of radiative transfer theory; retrieval of biophysical parameters; space based thermal imaging system; retrieval of geo-physical parameters using thermal sensors; meteorological sensors in atmospheric sounding, meteorological parameters	Retrieval of geo-physical parameters using thermal data; radiative transfer modeling; atmospheric correction of hyper-spectral & MSS data; spectral library creation; end member selection & classification; ground data collection
2.7.2 Image Processing-II	Advanced classifier- fuzzy classification, ANN & classification methods; image segmentation & objected oriented classification; automatic feature extraction; automatic extraction of deterministic objects	Fuzzy & ANN Classifications ; Multi resolution segmentation of Image objects; Texture Analysis and Texture based segmentation; automatic linear feature extraction
2.7.3 Digital Photogrammetry and Mapping	Conventional survey techniques, Geodesy, integration from different sources for large scale mapping; GNSS, mobile mapping; Aerial & satellite Photogrammetry; data processing for stereo generation, ortho-rectification; Digital cartography, 3D simulation, visualization & terrain analysis	Ground survey; GCP collection, processing & data integration; stereo restitution of satellite images, feature extraction in 2D & 3D mode; digital cartography, digital earth model

Subject	Major Topics (Theory)	Major Topics (Practical Exercise /Demonstration)
2.7.4 Surface Generation Techniques	DSM generation; limitations of photogrammetry extraction using optical data & alternatives; close range photogrammetry, data processing surface generation; SAR & differential interferometry, processing, analysis and accuracies; SAR polarimetry; Laser RS, concepts, extraction from point data & waveform processing	Interferometric processing for DEM generation; polarimetric SAR data processing; LiDAR wave form data processing; filtering & elevation information; close range photogrammetry
2.8 Geoinformatics		
2.8.1 Spatial database Architectures & modeling	Database overview; spatial databases, types & structures; conceptual data modeling, UML, database design & topology relationship; spatial database storage & retrieval; Geospatial modeling & its classification, decision modeling concepts, decision support systems, agent based modeling & its applications	Spatial database creation, design, schema creation; file storage, data type insertion & retrieval, spatial queries, optimization & index creation; multi criteria decision modeling & agent based modeling
2.8.2 Programming in Geodata modeling	Basics programming concepts, expressions, statements, conditionals & iterations; data structure and object oriented programming; open source programming APIs; scientific plotting, database connectivity, imaging library; KML parsing API, geodata abstraction library; customizing open source GIS software	Familirization of programming language, variables & functions; data structure & object oriented programming; Matplotlib & Python imaging library, KML parsing, python library
2.8.3 Web GIS and Geovisualization	Internet technology & Web GIS; internet GIS, networking, protocols & client/server architecture; web programming; distributed GIS; service oriented architecture, interoperability & standards; web GI services, OGC standards, open GIS, map servers, OGC, WMS & WFS,KML, cloud computing; Geo-visualization exploration; 3D topology	Internet GIS; web designing; server side scripting; open source geo- network metadata cataloguing system; creation & dissemination of OGC WMS & WFS services, Google & Bhuvan APIs; visualization of 3D geospatial data & creation of 3D models
2.8.4 Spatial Data Quality and Geostatistics	Concepts of probability & statistics, regression & least squares, quality & fitness of measurement data; uncertainty & its quantification; Atrribute & positional uncertainty, sources, precision; Error & uncertainty propagation, taylor series approprixation, uncertainty cascade, error models, systematic error & model uncertainty; spatial variation models & dependence measures; spatial sampling and modeling; Modeling the variogram, Ordinary Kriging, Universal Kriging; Co-Kriging , Indicator Kriging	Exploratory data analysis, probability & statistics, regression & least squares; image generation at varied spatial resolutions; Taylor series expansion, error & uncertainty modeling & propagation; modeling spatial structure from point samples, assessing quality of spatial predictions; variogram, semi-variogram; geostatisticsl estimation using kriging, universal kriging & block kriging

List of Core Faculty

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Dr. A. Senthil Kumar	• Integrated watershed management-challenges & opportunities	senthil@iirs.gov.in	
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