Principles of Remote Sensing

Introduction to EO course
This course is meant to be an introductory course in elements of Remote Sensing with a 5 days duration and a load of 40 hours. All materials are structured in 5 folders, one for each day.

Objective
Participants learn the basics of a free Remote Sensing software, the spatial handling of imagery and image arithmetic, image classification and data manipulation and a glance on qualitative remote sensing.

Generic Syllabus

Electromagnetic radiation (EMR) and Sensors	· RS have an **unavoidable** side on strict physics. Maybe the most important aspect of RS.
	· Understanding of energy sources of EMR, Planck's, Stefan Boltzman's, Wien's and Kirchoff's laws.
	· EMR spectrum and the EMR regions in relation to RS.
	  o Main: Visible, near infrared, and thermal infrared regions.
	  o Other regions.
	· Radiances, reflectance, transmission, emission and the interaction with media (atmosphere) and surface.
	· Reflectance curves

Remote Sensing system Platforms and sensors.	· Glossary: Sensors on board on platforms.
	· Main classification of sensors: Active and passive sensors
	· Classification of imagery capability:
	  o Spatial resolution: ground sample resolution, ground spatial resolution. Scale is meaningless in RS.
	  o Radiometric resolution.
	  o Revisiting time or temporal resolution.
	  o Overpass time.
	  o Expected lifetime.
	· Criteria for image selection: cloudiness and angular distortions
	· Summary of available platforms and imagery (selection to specializations)

GIS input !
Geometric aspects of imagery
	· Basics on Coordinate Systems
	  o Ellipsoids and Horizontal Datum: many to one and one to many.
	    § Country coordinate systems
	  o Projections
	  o Coordinate conversions
	· Image distortions and displacements.
	· Georeferencing: (2D approaches)
	  o Manual georeferencing:
	    § Planar interpolations
	    § Map or GPS to image and image to image methods
	    § Transformations selection as related to imagery: conformal, affine and polynomial.
	· How to correct a distorted imagery: From georeferencing to geocoding.
	  o Matching images with maps.
	  o Process of resampling.

Image visualization and enhancement (Practical requires this information all the time. No specific practical on this topic)	· Histogram operations
	  o Interval and cumulative representations.
	  o Interval classification in terms of clustered reflectance.
	· Contrast enhancement
	  o Linear stretching: bounded, percentage, piecewise.
	  o Non-linear: histogram equalization
	  o Single band color scales
	    § Interval construction
	    § The pseudo color scale
	· Density slicing
	  o Single band classifications by bounding.
	· Filter operations
	  o Low and high frequency images.
	  o Definition of filters and types:
	    § Linear: lowpass (smoothing) and highpass (enhancing)

	· Non-linear: Median, speckle and morphological.

Visual interpretation of Remote Sensing Images	· Definition and objectives
	· Common sources: aerial photographs and Remote Sensors on satellites
	· The interpretation process: reasoning and object identification
	· Object description:
	  o tone/hue, texture, shape, size, pattern, size and association
	· The mapping process
	  o Science oriented
	  o Fieldwork verification
	  o Scales
	  o Legend

Image and tables arithmetic (in combination with practical)	· The Map calculator: Interface and command line languages
	  o Logical and conditional operators
	  o Advance issues: undefined
	· Concept of domains
	· Image dependency
	· Image attributes
	  o Map operation with attributes

Vegetation indexes (reading and calculation in combination with practical)	· Definition and calculation of the following vegetation indexes · Basic indexes: RVI, NDVI, IPVI, DVI, PVI, WDVI, · Minimize soil interference: SAVI, TSAVI, MSAVI, MSAVI2 · Minimize atmospheric noise: GEMI, ARVI · Other indices: GVI

Digital image classification (in combination with practical)	· Introduction: what is it and what can we use it for?
	· Image space versus feature space: arrays, single band, multiband
	· Feature space scatterplots
	  o Distances in feature space
	  o Decision boundaries in feature space
	· Unsupervised versus supervised classification
	· Training
	· Classification algorithms:
	  o Box classification
	  o Minimum distance to the mean
	  o Maximum likelihood
	· Accuracy assessment (classification validation):
	  o Confusion matrix
	  o Ground truth data set
	· Problems in Image classification

Radiometric and atmospheric corrections (in combination with practical)	· Radiometric correction:
	  o Sensor scaling: gain and offsets. Dual scaling. Top of the atmosphere radiance.
	  o Top of the atmosphere reflectance for visible bands.
	  o Brightness temperature for Thermal bands.
	· Atmospheric interaction: scattering and absorption processes of EMR.
	· Quantitative and qualitative atmospheric correction.

Main Book for the RS course
This course is based on a number of publications and bibliography. The selected head book is "Principles of Remote Sensing: An introductory textbook", 1999, Editors: Klaus Tempfli, Norman Kerle, Gerrit C. Huurneman and Lucas L. F. Janssen"

Additional sources
A number of sources are offered in the material of the course.
- Paper: "Fundamentals of Remote Sensing" by George Joseph, 443 pages, Universities Press (10 Jan 2004). ISBN-10: 8173714576. ISBN-13: 978-8173714573. Dimensions 23.8 x 18.2 x 2.4 cm Books (See Top 100 in Books)
- "Essential Image Processing and GIS for Remote Sensing" by Jian Guo Lui and Philippa J. Mason. (2009). ISBN: 978-0-470-51032-2. Ed: Wiley-Blackwell. Printed in Singapore.

Supported study material
The course consists on a total of 14 lectures. Out of them, 1 lecture is optional. All lectures are supported with PDF material and refer to some chapter or section of the main book.

The free ILWIS software version 3.3.1 is offered for the practicals. There are a total of 5 practicals. Out of them, one relates to two different specializations. It is suggested that the participant choose the specialization that best suits him/her or do both. All single practical folders contain one PDF file with instructions to solve the exercises. This should be opened first. All the files are also in the same directory.

Name

- D1
- D2
- D3
- D4
- D5
- e-books
- SOFTWARE