The Earth from Above

Introduction to Environmental Remote Sensing

Lectures: Tuesday, Thursday 2:30-3:45 pm,
Russell Labs, 1610 Linden Drive,
room 104

Labs: Wednesday 12:15-1:45 pm, Science Hall, room 380,
Thursday 12:30-2:00 pm, Russell Labs, room A120,
Friday 12:15-1:45 pm, Science Hall, room 380

Professor: Annemarie Schneider

Office: SAGE, Enzyme Institute,
1710 University Avenue, room 206
Office hours: Tuesday 4:00-5:00 pm, or
Thursday by appointment
Email: aschneider4@wisc.edu

Teaching Assistant: Yang Yang

Office: SAGE, Enzyme Institute,
1710 University Avenue, room 144
Office hours:
Email: yyang72@wisc.edu

Class website:
http://sage.wisc.edu/people/schneider/classes/introremotesensing.html

Course objective and overview

The objective of this course is to provide an overall introduction to the Earth as viewed from above, focusing primarily on the use of aerial photography and satellite imagery to study the environment. The intent is to learn how to use these types of data to study issues related to environmental science, geography, earth sciences, forestry and resource management. The synoptic perspective of aerial and satellite remote sensing proves ideal for studying the spatial patterns of surface phenomena and for making maps of surface features. Currently, one of the most exciting uses of remote sensing is to monitor environmental change.

The course covers a wide range of related topics which can be divided primarily into four categories. First, we will pursue a basic understanding of the **physical processes** involved in remote sensing. The key topics here are the nature and properties of electromagnetic radiation and how it is affected by interactions with the atmosphere and the Earth's surface. Second, we will learn about the many **data types** used in remote sensing. There is now a wide variety of sensing capabilities in the optical, thermal, and microwave portions of the electromagnetic spectrum from a range of airborne and satellite platforms. The recent launch of several high resolution satellite systems and the advent of readily available data sources such as Google Earth make this a very dynamic and exciting period for remote sensing.

The motivation for remote sensing is **applications**, or how we can use remote measurements for purposes such as forest inventory, water resource management, agricultural assessment, and global environmental science.

Applications will be discussed nearly every day in some context, and some lectures will be devoted to specific examples discussed in detail. Each weekly lab is designed to introduce the skills needed for a specific environmental application.

Finally, the fourth topic area is **methods**, or how to analyze images to derive the desired information. More than ever, persons wishing to utilize remotely sensed data require a solid foundation in both qualitative and quantitative photo-interpretation methods, photogrammetric techniques, as well as technical savvy. The intersection of remote sensing with geographic information systems (GIS) means that interpretation, analysis, and measurement are now routinely conducted on the computer, often in conjunction with other data sources. While these methodologies will be presented in lectures, much of this information will be taught and discussed in the lab section of this class.

Students who successfully complete this course may wish to build on this skill set by taking Intermediate Environmental Remote Sensing, the second course of the two-semester sequence, or by taking the advanced, graduate-level courses Digital Image Processing for Environmental Sensing (offered every spring), and Remote Sensing of Ecosystems.

Required text

Remote Sensing of the Environment: An Earth Resource Perspective, John Jensen, 2006, Prentice Hall (required)

Introductory Digital Image Processing: A Remote Sensing Perspective, John Jensen, 2004, Prentice Hall (extra)

Copies of the required text are on reserve at the Geography Library and the Steenbock Library. Supplemental readings from *Introductory Digital Image Processing* will be provided in digital format via the class website.

Additional resources

Google Earth available for download at http://earth.google.com (strongly recommended).

ArcGIS 10 student licenses are available upon request, and *ENVI student licenses* can be purchased for $195: http://www.exelisvis.com/Industries/Academic/Students/StudentLicenses.aspx.

Code of conduct

Please be on time to both lecture and lab. Turn off all cell phones, ipads, pdas, etc. during lecture, lab, and when you attend office hours. If using a laptop, no email, instant messaging, or social media during class. No cheating or plagiarism will be tolerated, and will be treated according to the UW academic misconduct guidelines.

Grading

homework and labs	35%
midterm exam 1	15%
midterm exam 2	15%
final exam	30%
attendance, participation, quizzes	5%

There will be approximately nine lab assignments during the semester. Most of the work for these assignments needs to be done in the remote sensing lab. Discussing your assignments with classmates and even helping each other in the lab is fine and to be encouraged. However, all materials submitted for completion of the assignments must be your own work and must be based on your own analysis.

Grading scale

91-100	A
81-90	B
71-80	C
61-70	D
<60	F

Daily schedule and readings

week	day	class	jensen 2006	jensen 2004	lab	
week 1	sept 3	introduction, course logistics, overview of remote sensing and aerial photography	ch 1 p 1-20, ch 4 p 91-99, ch 6 p 149-160		no lab	
	sept 5	elements of aerial photographs, scale, resolution, stereoscopy, ground-camera relationship, air photo interpretation skills	ch 5 p 127-148, ch 6 p 160-174, 189-192			
week 2	sept 10	scale, displacement, distortion; application: remote sensing of urban areas	ch 13 p 443-446, 456-502		lab 1 – introduction to air photo interpretation: urban and industrial structures	
	sept 12	electromagnetic radiation, multispectral remote sensing of vegetation, infrared photos	ch 2 p 37-53			
week 3	sept 17	electromagnetic radiation (continued), remote sensing of vegetation and agriculture	ch 11 p 355-382		lab 2 – interpretation of vegetation and agriculture in visible to near-infrared wavelengths	lab 1 due
	sept 19	introduction to digital imagery, air photos vs. satellite images, resolution types, image enhancement		ch 1 p 12-25		
week 4	sept 24	enhancement techniques for digital imagery; medium resolution sensors and data	ch 7 p 193-232		lab 3 – introduction to ENVI and digital image enhancement	lab 2 due
	sept 26	enhancement techniques (continued); remote sensing of vegetation		ch 4 p 127-141; ch 8 p 255-275		

week 5	oct 1	band arithmetic, image ratios, vegetation indices		ch 8 p 274-275, 301-322	lab 4 – spectral transforms	lab 3 due
	oct 3	vegetation indices and kauth-thomas transforms		ch 8 p 310-322		
week 6	oct 8	FIRST MIDTERM EXAM			no lab	
	oct 10	making maps from satellite imagery: overview of classification and pattern recognition		ch 9 p 337-373, 379-389		
week 7	oct 15	classification continued: unsupervised and supervised algorithms		ch 9 p 374-379	lab 5 – unsupervised classification	lab 4 due
	oct 17	supervised classification, satellite data sources, high resolution	ch 7 p 197-245			
week 8	oct 22	classification error, accuracy assessment, accuracy measures		ch 13 p 495-511	lab 6 – supervised classification	lab 5 due
	oct 24	guest lecture: geological applications of remote sensing (mutlu ozdogan)	ch 14			
week 9	oct 29	accuracy assessment, sample design		ch 13 p 502-505	lab 7 – sample design and accuracy assessment	lab 6 due
	oct 31	coarse resolution data sources, review data and applications	ch 7 p 197-245			
week 10	nov 5	introduction to radar, sonar, lidar, interpretation of radar imagery	ch 9 p 291-334		lab 8 – radar data interpretation	lab 7 due

	nov 7	radar data sources, application: finding water in the desert				
week 11	nov 12	introduction to change detection - methods and applications		ch 12 p 467-492	lab 9 – change detection	lab 8 due
	nov 14	change detection methods (continued) application: agriculture in turkey				
week 12	nov 19	SECOND MIDTERM EXAM			no lab	
	nov 21	guest lecture: land cover change in vietnam's mekong delta (caitlin kontgis)				
week 13	nov 27	change detection and advanced data mining algorithms			no lab	
	nov 29	THANKSGIVING HOLIDAY				
week 14	dec 3	incorporating spatial information: spatial filters, adaptive filters, texture		ch 8 p 276-286; 322-329	no lab	lab 9 due
	dec 5	spatial information (continued): contextual classification and object-oriented classification		ch 9 p 393-401		
week 15	dec 10	application: avian species richness from image texture measures				
	dec 12	FINAL EXAM – in class, 2:30-3:45 pm	class wrap-up and final review			