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 11:00-12:30 pm or 12:45-2:15 pm
Russell Labs, room A120

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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 Digital Image Processing, the advanced, graduate-level course.

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.ittvis.com/Academic/Students/ENVIStudentEdition.aspx (optional – e.g. if you cannot work in the lab).

Grading

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

Undergraduate and graduate students will be graded on separate scales.

There will be approximately eight 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.

Code of conduct

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

Daily schedule and readings

week	day	class	jensen 2006	jensen 2004	lab	
week 1	sept 6	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 8	elements of aerial photographs, scale, resolution, stereoscopy, air photo interpretation skills	ch 5 p 127-148, ch 6 p 155-174, 189-192			
week 2	sept 13	air photo interpretation (continued); remote sensing of urban areas	ch 13 p 443-446, 456-502		lab 1 – introduction to air photo interpretation: urban and industrial structures	
	sept 15	electromagnetic radiation and multispectral remote sensing	ch 2 p 37-53			
week 3	sept 20	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 22	remote sensing of vegetation (continued); introduction to digital imagery, air photos vs. satellite images		ch 1 p 12-25		
week 4	sept 27	resolution types, enhancement techniques for digital imagery		ch 1 p 1-28	lab 3 – introduction to ENVI and digital image enhancement	lab 2 due
	sept 29	enhancement techniques, continued; medium resolution sensors and data	ch 7 p 189-232	ch 4 p 127-141; ch 8 p 255-275		

week 5	oct 4	band arithmetic, image ratios, vegetation indices		ch 8 p 274-275, 301-322	lab 4 – spectral transforms	lab 3 due
	oct 6	medium resolution sensors and data	ch 7 p 189-232			
week 6	oct 11	FIRST MIDTERM EXAM			no lab	
	oct 13	making maps from satellite imagery: overview of classification and pattern recognition		ch 9 p 337-373, 379-389		
week 7	oct 18	classification continued; remote sensing of archaeology		ch 9 p 337-379	lab 5 – unsupervised classification	lab 4 due
	oct 20	writing a scientific report, satellite data sources, high resolution				
week 8	oct 25	supervised classification algorithms		ch 9 p 370-379	lab 6 – supervised classification	lab 5 due
	oct 27	classification error, accuracy assessment, accuracy measures		ch 13 p 495-511		
week 9	nov 1	class canceled			lab 7 – sample design and accuracy assessment	lab 6 due
	nov 3	accuracy assessment, continued; coarse resolution data sources, review data and applications	ch 7 p 197-245			
week 10	nov 8	introduction to radar, lidar, sonar, interpretation of radar imagery	ch 9 p 291-334		lab 7 continued	

	nov 10	guest lecture: lidar data and applications (jordan muss)	ch 10 p 335-348			
week 11	nov 15	introduction to change detection - methods and applications		ch 12 p 467-492	lab 8 - radar data interpretation	lab 7 due
	nov 17	guest lecture: change detection methods (mutlu ozdogan)				
week 12	nov 22	SECOND MIDTERM EXAM				
	nov 24	THANKSGIVING HOLIDAY				
week 13	nov 29	guest lecture: land cover change in southwest china's himalayan mountains (jodi brandt)				lab 8 due
	dec 1	guest lecture: agricultural abandonment in the former soviet union (matthias baumann)				
week 14	dec 6	change detection and advanced data mining algorithms				
	dec 8	guest lecture: avian species richness from image texture measures (patrick culbert)		ch 8 p 322-329		
week 15	dec 13	tentative guest lecture: monitoring forest defoliation (bernie isaacson)				
	dec 15	guest lecture: geological applications of remote sensing (mutlu ozdogan); class wrap-up and final review	ch 14			

week 16	dec 21	FINAL EXAM – 10:05-12:05 pm				