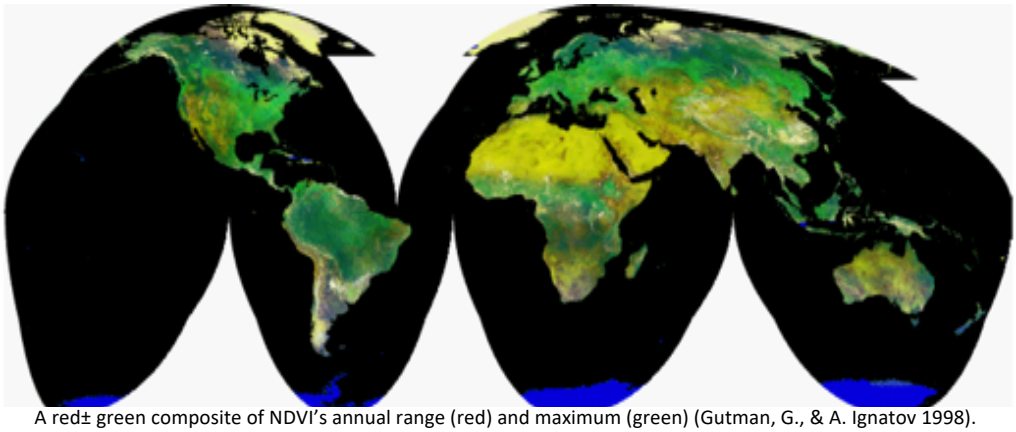
GEOG 362: INTRODUCTION TO REMOTE SENSING



A red± green composite of NDVI's annual range (red) and maximum (green) (Gutman, G., & A. Ignatov 1998).

Term: Fall 2021
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COURSE DESCRIPTION AND OBJECTIVES

This course provides an introduction to the use of remotely sensed data for research. Remote sensing is the science of acquiring information about Earth's surface without actual contact with the object or area being analyzed. Remote sensing is increasingly utilized and relied upon to solve complex physical, biological and social issues affecting our interconnected world. Most biophysical applications of remote sensing use instruments carried on satellites. In this course, we will focus on the interpretation and application of data from space-borne imaging systems (e.g.: Landsat OLI, Landsat ETM, Quickbird, MODIS, AVHRR and SPOT) with a brief introduction to unmanned aerial vehicles (UAVs). Focus will be given to the application of remote sensing data to environmental applications, but other topics will be covered when students work on their projects. By the end of this course, students will:

- Understand the basic concepts, analytical methods and software of satellite remote sensing.
- Apply basic remote sensing and image processing techniques to enhance, analyze and extract information from imagery.
- Analyze environmental systems using satellite remote sensing data and the software Erdas Imagine.
- Implement methods presented in peer-reviewed and technical literature and generally be independent researchers and technicians with beginning expertise in remote sensing analysis.

PREREQUISITES

Introduction to GIS (Geog 225 or similar) or consent of instructor.

MEETING TIMES AND OFFICE HOURS

Time	Monday	Tuesday	Wednesday	Thursday	Friday
09:40-11:10					
10:40-12:00					
1:00 – 3:00					

	Lecture time.
	Lab time.
	Office hours.

TEXTBOOK

Jensen, J. 2015. Introductory Digital Image Processing: A Remote Sensing Perspective. 4th Edition. Pearson Publishing. 656 pp

The above book will be used as a main support textbook. It is available as an eTextBook (for rent or purchase) for a lower price than the hardcopy edition. We have two physical copies, one at the Department of Geography and one in the library.

These are other texts that I recommend. I have copies available. Particularly, if you feel like Jensen sometimes is too technical, I recommend Lillesand, which has a clearer language.

Jensen, J. 2006. Remote Sensing of the Environment: An Earth Resource Perspective. 2nd Edition. Pearson Publishing. 592 pp.

Lillesan, T.M. 2015. Remote Sensing and Image Interpretation. 7th Edition. Wiley Publishing. 720 pp.

In addition to these books, research papers and websites of specific topics are listed in the detailed weekly schedule at the end of this syllabus.

COURSE DETAILS

Structure

While the Covid-19 emergency forced us to have more than a year of on-line instruction, it also offered an opportunity to explore different approaches to engage more with class content and to facilitate the student learning experience. Building on this experience, I will adopt various teaching approaches during this semester. Some classes will follow a “flip-classroom model”, where students will prepare the material prior to class and come prepare to explore topics in greater depth and to analyze examples, e.g. analyses of remote sensing images. Other classes will follow a “blending learning model”, where some material will be prepared in advanced and will be partially accompanied by lectures. A limited number of classes will follow a more traditional lecture-based form of content delivery.

In addition to daily participation, students should expect to have to do short presentations on various topics, such as remote sensing sensors, project proposal., etc.

Resources

All course material, including lecture slides, readings and lab manuals, will be made available on Moodle. Your assignments will have to be turned in using the Moodle platform too. Please note that submission times are defined by Moodle's timestamps, it is your responsibility to ensure that your assignments are correctly submitted. Once an assignment is closed in Moodle, you will no longer be able to submit it. Depending on the circumstances, late assignments will be accepted with a 20% drop on the final grade for each 24-hour period that it is late.

I will hold regular office hours to discuss questions, issues or concerns about the class in detail. If your schedule conflicts with posted office hours, we can schedule a different meeting time. Outside of class and office hours, email is the best way to contact me. I respond to email as soon as possible, but I mostly respond during work hours (8:00 am to 4:00 pm on weekdays).

Labs

Lab time will be used to demonstrate remote sensing analysis and applications using ERDAS IMAGINE and other geography software. Lab manuals will be available on each lab class and lab reports are expected the week following a lab session. Most labs will require additional time beyond class.

At least one of the labs will include short field visits to collect data in the areas around Saint Paul and Minneapolis. The precise locations will be determined during the first weeks of the semester, but students should expect to have to stay after hours during one or more class periods or have a weekend day available for field work. More details will be available as I define field work locations.

For field work, students will also need approximately 50 MB of data in their smartphones to download and operate a data collecting app. GPS and printer copies of data collecting sheets will be made available for students that do not have smartphones. More details about a field lab will be available as regulations around Covid-19 become available.

All lab material will be already available to you in the GIS drive. It is STRONGLY RECOMMENDED that you save the original data and intermediate steps in a shared drive of your preference such as the H drive. You might use this drive also to save the material you will have to download for your personal research projects.

Research Project

During the semester, students will work on a research project of their choice. The idea of this project is to utilize learned techniques to address a research question that reflects students' personal interests. We will work during the first half of the semester to define a good and feasible research question for a class project, select and acquire the best data (i.e. imagery) to address this question and the best methodological approach. Final results will be presented orally at the end of the semester. Past student projects are available in the Remote Sensing Webpage of the Department of Geography. I encourage you to check them, ask questions about them starting the first day of class, contact former students, etc.

Activities and Participation

In-class discussions, presentations, short assignments, on-line discussion forums, responses to brief writing assignments, etc. will be factored into your activities and participation grade.

Exams

Exams (a mid-term and a final) will consist of short answers, essay, image interpretation and applied problem-solving questions. The mid-term will be close notes in-class. The final exam will be open-

notes (his includes everything as long as you work independently) in-class. Make-up exams will be given in the event of illness or emergencies.

GRADING

Assignment	Points
Laboratory Exercises	45%
Midterm Exam	13%
Student Project	20%
Class Activities and Class Participation	10%
Final Exam	12%

Scale Letter	Range
A	93.0% to 100 %
A-	90.0% to < 93.0 %
B+	87.0% to < 90.0 %
B	83.0% to < 87.0 %
B-	80.0% to < 83.0 %
C+	77.0% to < 80.0 %
C	73.0% to < 77.0 %
C-	70.0% to < 73.0 %
D+	67.0% to < 70.0 %
D	63.0% to < 67.0 %
D-	60.0% to < 63.0 %
F	0.0% to < 60.0 %

COURSE POLICIES AND SUPPORST

Attendance

Attendance plays an essential role in learning; you are warmly invited, encouraged, and expected to attend all class/lab meetings. Attendance will be important not only for your learning, but also for our ability to build a community together and maintain a sense of connection and commitment to one another.

I recognize that there are unavoidable circumstances that sometimes make it impossible for you to attend class. If you will not be in class for any reason, it is your responsibility to inform me in advance via email at xharocar@macalester.edu It is also your responsibility to make up work you missed in your absence. Students with disabilities should discuss their accommodations with me early in the course to work out a plan that aligns with maintaining course expectations and learning goals.

Students may wish to take part in religious observances that occur during this semester. If you have a religious observance/practice that conflicts with your participation in the course, please contact me before the end of the first week of the module to discuss appropriate accommodations.

Diversity
In an ideal world, biophysical sciences (including remote sensing) would be objective. However, much of the scientific content has been historically built on a small subset of privileged voices. I acknowledge that the readings for this course reflect that history. Therefore there may be both overt and covert biases in the material due to the lens with which it was written, even though the material is primarily of a scientific nature. Integrating a diverse set of experiences is important for a more comprehensive understanding of science and I am working continuously to enhance the diversity of bibliographic sources used in this class. In addition to course content, I am also committed to create a learning environment that supports a diversity of thoughts, perspectives and experiences, and to honor your identities including race, gender, class, nationality, religion, etc. Please contact me (in person or electronically) or submit anonymous feedback if you have any suggestions to improve the quality of the course materials and enhance diversity and inclusion.

Disabilities
I am committed to ensuring access to course content for all students, including those with disabilities. If you are encountering barriers to your learning that we can mitigate, please bring them to my attention. I will be happy to work with you to ensure your success in the class.
Reasonable accommodations are available for students with documented disabilities. Contact the Disability Services office by emailing disabilityservices@macalester.edu or calling 651-696-6874 to schedule an appointment to discuss your individual needs.
Personalized tutoring, academic support and study skills are available at the Macalester Academic Excellence (MAX) at: https://www.macalester.edu/max/#/0. These resources are there to help you and I encourage you to make good use of them.

Well-Being
Here at Macalester, you are encouraged to make your well-being a priority throughout this semester and your career here. Investing time into taking care of yourself will help you engage more fully in your academic experience. Remember that beyond being a student, you are a human being carrying your own experiences, thoughts, emotions, and identities with you. It is important to acknowledge any stressors you may be facing, which can be mental, emotional, physical, financial, etc., and how they can have an academic impact. I encourage you to remember that you have a body with needs. In the classroom, eat when you are hungry, drink water, use the restroom, and step out if you are upset and need a break. Please do what is necessary so long as it does not impede your or others' ability to be mentally and emotionally present in the course. Outside of the classroom, sleep, moving your body, and connecting with others can be strategies to help you be resilient at Macalester. If you are having difficulties maintaining your well-being, please don't hesitate to contact me and/or find support from other resources on the following page.

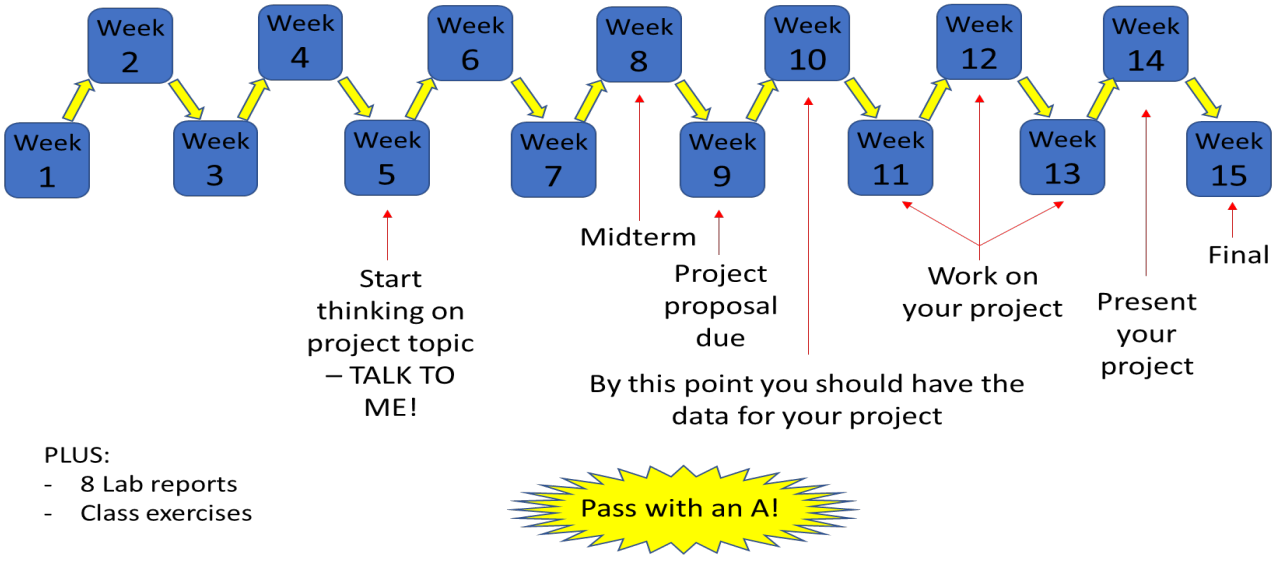
Title IX
Macalester is committed to providing a safe and open learning and living environment for all students, staff, and faculty. Any community member experiencing sexual harassment, sexual violence, relationship violence, or stalking, is encouraged to seek help and support. Please be aware that as a faculty member, I need to report disclosure about sexual harassment, sexual misconduct, relationship violence, and stalking to the Title IX Office. The purpose of this report is to ensure that anyone experiencing harm receives the resources and support they need. I will keep this information private and it will not be shared beyond this required report. You can contact Macalester's Title IX Coordinator directly at titleixcordinator@macalester.edu.

Academic Integrity
Students are expected to complete and turn in their own work and to follow established academic practices regarding proper use and citation of materials and ideas that are not their own. Engaging in cheating or plagiarism will result in a failing grade in this class. More information is available about Macalester's academic integrity at:
https://www.macalester.edu/academicprograms/academicpolicies/academicintegrity/

DETAILED WEEKLY SCHEDULE

Disclaimer: This schedule represents my current plan and objectives. These plans may need to change to enhance your learning experience.

At glance, key milestones:



Week 1: Welcome
September 2

Learning outcome: Welcome! This week we will understand what this class is about and get to know each other.

Before Thursday class:

- Read the syllabus.

Thursday:

- Course Introduction.

Week 2: Introduction and Foundations of Remote Sensing I

September 7 & 9

Learning outcome: Learn about remote sensing history and start becoming familiar with the software Erdas Imagine.

Tuesday:

- Lecture: Remote sensing history.

Thursday:

- Lab 1: Introduction to Erdas Image and Map Composition.

Week 3: Introduction and Foundations of Remote Sensing II

September 14 & 16

Learning outcome: Understand basic principles of electromagnetic theory as the foundational principles of remote sensing research. Continue learning about basic function of Erdas Imagine.

Before Tuesday class:

- Listen to pre-recorded lecture about Electromagnetic Theory and come ready to discuss analyzed topics.

Tuesday:

- Electromagnetic Theory and Imagery Discussion.

Thursday:

- Lab 2: Image Interpretation, Analysis and Display

Due at end of the week (Friday before lab's starting time):

- Lab 1: Introduction to Erdas Image and Map Composition Report.

Week 4: Sensor characteristics

September 21 & 23

Learning outcome: Learn about sensors and sensor resolutions. We will also start a field lab that we will finish later in the semester (It is nice and warm now for a field lab 😉).

Before Tuesday class:

- Complete pre-class exercise posted in Moodle.

Tuesday:

- Sensors and Resolutions Lecture and Discussion.
- Brief explanation of Lab 7.

Thursday:

- Lab 7: Training Data Collection Part A (Field lab)

Due at end of the week (Friday before lab's starting time):

- Lab 2: Image Interpretation, Analysis and Display report.

Week 5: Color Composite Theory & Sensors

September 28 & 30

Learning outcome: Understand color composite theory and how it is used in remote sensing to display images. Students will start presentations on different sensors and, instead of lab, we will review examples and application of remote sensing analysis.

Tuesday:

- Lecture: Color Models and Composite Imagery.
- Sensors 1 & 2

Before Thursday class:

- Listen to the Podcasts posted in Moodle.

Thursday:

- Sensors 3, 4, & 5.
- Podcast Discussion.

Due at end of the week (Friday before lab's starting time):

- Nothing 😊

Week 6: Image Transformation & Sensors

October 5 & 7

Learning outcome: Explore the use of vegetation indices, image transformation and spectral enhancements. Students will continue presentations on different sensors.

Before Tuesday class:

- Complete pre-class exercise posted in Moodle.

Tuesday:

- Spectral Enhancements and Vegetation Indices Lecture and Discussion.
- Sensors 6 & 7

Thursday:

- Lab 3: Spectral Enhancement, Image Indices and Image Transformations.

Due at end of the week (Friday before lab's starting time):

- Nothing 😊

Week 7: Image Transformation & Classification Analysis

October 12 &14

Learning outcome: Understand what is considered probably the "flag" topic of remote sensing, we will learn image classification! We will finish sensor presentations and, in lab, we will explore the use of unmanned aerial vehicles (UAVs) for remote sensing research, a bran new lab for this class! and another field experience!

Before Tuesday class:

- Complete pre-class exercise posted in Moodle.

Tuesday:

- Image transformations and classification analysis.

- Sensors 8 & 9.

Thursday:

- Lab 4: Unmanned aerial vehicles (UAV).

Due at end of the week (Friday before lab's starting time):

- Lab 3: Spectral Enhancement, Image Indices and Image Transformations Report.

Week 8: MIDTERM

October 19

Learning outcome: Test our knowledge of the topics studied in class until this point.

Tuesday:

- MIDTERM EXAM.
- You should have come to talk about your research project during office hours at least once!

Week 9: Classification and Change Detection

October 26 & 28

Learning outcome: Considered also a "flag ship" of remote sensing, we will learn about change detection or land-cover change analysis. In lab, we will explore how to conduct a classification analysis.

Before Tuesday class:

- Come ready to talk about potential project topics.

Tuesday:

- Land-cover change.
- Research Project conversation.

Thursday:

- Lab 5: Image Classification.

Due at end of the week (Friday before lab's starting time):

- Lab 4: Unmanned aerial vehicles (UAV) Report.
- Project Proposal.

Week 10: Classification and Accuracy Assessments

November 2 & 4

Learning outcome: Learn about accuracy assessment and some additional classification approaches.

Tuesday:

- Lecture: Fuzzy Classification.
- Lecture: Accuracy Assessments

Thursday:

- Lab 6. Change detection and Introduction to Spatial Modeler

Due at end of the week (Friday before lab's starting time):

- Lab 5: Image Classification Report.
- Project Proposals Peer-review .

Week 11: Training Data & Student Projects I

November 9 & 11

Learning outcome: Learn about the importance of training data and having good reference information for classification analyses and for any type of remote sensing research. Evaluate each other project proposals with the purpose of making each other research better.

Tuesday:

- Project Proposals Presentations.

Thursday:

- Lecture: Training Data.
- Lab 7: Training Data Collection Part b (Google Earth Pro)

Due at end of the week (Friday before lab's starting time):

- Lab 6. Change detection and Introduction to Spatial Modeler Report.

Week 12: Landscape Ecology and Remote Sensing

November 16 & 18

Learning outcome: Remote sensing has direct applications in many other fields. This week we will study the applications of remote sensing in landscape ecology as an example.

Tuesday:

- Lecture and case-studies: landscape ecology and remote sensing.

Thursday:

- Project work.

Due at end of the week (Friday before lab's starting time):

- Lab 7: Training Data Collection Report.

Week 13: Accuracy Assessment Lab

November 23

Learning outcome: Reinforce the concepts previously learn in lecture about accuracy assessment with a lab.

Tuesday:

- Lab 8. Accuracy Assessments.

Week 14: Student Projects II

November 30 & December 2

Learning outcome: A key milestone in this class! This week we will learn from each other about different case studies of remote sensing research.

Tuesday:

- Project presentations.

Thursday:

- Project presentations.

Due at end of the week (Friday before lab's starting time):
Lab 8. Accuracy Assessments Report.

Week 15: What's Next?

December 7 & 9

Learning outcome: The End! This week we will apply all knowledge acquired during the semester into solving social / environmental problems in the Final. We will also learn about opportunities to continue working in remote sensing research at Macalester.

Tuesday:

- Introduction to Advanced Remote Sensing.

Thursday:

- FINAL EXAM.