EAS 541 / ENVIRON 441 WINTER 2022
REMOTE SENSING OF ENVIRONMENT
SYLLABUS: PROCEDURES AND GRADING

COURSE STAFF

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T 10-11:30, Th 12-1:30

GENERAL

Materials other than your L&K textbook (required) or software will be made available over Canvas. In CANVAS make sure you are signed up to receive automatic email announcements for the course, including notifications as to when Files/Resources are uploaded by your instructors to CANVAS and ready for download. You can also always check past announcements there. There are two Canvas sites for this course: one for the Lecture section and one for your Lab section.

LECTURE PERIODS

EAS 541 has two 1.5-hour Lecture periods on **Monday and Wednesday, 1-2:30 p.m**. Lectures will be held synchronous remote (Zoom). The *Schedule and Assignments* part of the syllabus lists the Lecture period topic for each day and reading assignments. Lecture periods start promptly at 1 pm EST. It is important to be prepared to start on time.

Lecture Outlines

Lecture Outlines (pdfs) will be posted on the Lecture section CANVAS site. These do not contain all material covered in Lecture periods, but contain main points, and graphics, and are provided by Dr. Bergen to assist you in efficient note-taking. You should have these available during class. Many Lecture slides have visuals and having either a printout or computer setup on which to take your own notes on the pdf is advised.

Textbook and Readings

The textbook is Lillesand, Kiefer, and Chipman 7th ed. The textbook readings for the course are required: the course is designed with the expectation that students will keep up with the readings. Readings have been parsed (i.e., specific pages listed) for efficiency and to best correspond to Lecture and Lab topics. You may decide whether it is most useful for you to read the assigned Lecture material prior to or after the Lecture on the Lecture topic. But always read material assigned for Lab before Lab.

Class Group Presentation

In the Lecture part of the course, there is one assignment for a structured class presentation by ~5 person teams (by Lab section) on a remote sensing application of the team's choice. This does not involve original research but rather synthesis of other scientists or groups existing work on a focused remote sensing applied topic. Final presentations are team PowerPoint presentations given the last two weeks of the semester. There will be some required preparation milestones and meetings beginning mid-semester.

Exams

There are two examinations: 1) a midterm exam (Mon. Feb. 21) and 2) a final exam (Mon. April 25). See the *Schedule and Assignments* portion of the Syllabus. The midterm will cover approximately the first half of the course. The final will be somewhat longer as it will be cumulative although somewhat emphasizing the second half of the course. Both exams will also cover Lab material if it has also been introduced in Lecture. Exams likely will have shorter questions plus longer written questions.

Exams will be open-book and untimed on the scheduled exam day. Exams will be available on Canvas in the Quiz tab. Students will be required to complete and submit the exam within 24 hours between 12:01 a.m. EST and 11:59 pm EST on the scheduled exam day (If you are in a different time zone you will need to convert this time window to your time zone).

Remote Instruction Software

All students should have Zoom software/app loaded on their personal computers before the first day of Lecture session and know how to connect. You can find all Lecture session Zoom links on Canvas Lecture site Zoom tab.

LABORATORY PROCEDURES

There is one required usually GSI-led 2-hour hands-on Lab per week. Your Lab will be Wednesday starting at 4 pm promptly or Thursdays starting at 10 am promptly or Fridays starting at 12 pm promptly. You must attend your Lab section only. All Labs require that you have completed the Lecture and Lab readings on the topic BEFORE coming to Lab.

Most of the 10 Labs will be held in-person in the Dana Computer Classroom 3325; several Labs will be synchronous remote at their regular time by Zoom. Typically, the GSI gives a short presentation at the beginning of each Lab. The remainder of the Lab time is for you to work through the Lab assignment at your computers. Your GSI will be available throughout the Lab time for consultation and problem-solving. Some Labs have some in-class exercises (part of grade) and three Lab periods are at least partially devoted to your group presentations. Attendance is expected.

Labs and Health Considerations

This semester for students who are not able to or are not comfortable attending Lab in-person for health reasons we will do our best to make a Lab synchronous remote option available to you. Please do not attend Lab in-person if you think you might be contagious (whether it be cold, flu, or covid). Also, give your GSI a heads up if you are ill.

Lab Assignments

Lab assignments (Lab exercises and WriteUps) are ***to be completed individually*** to give you maximum hands-on exposure to the computer software and image processing methods. However, you may talk with each other about Labs and problem-solving while working on the exercises. You will need time outside of the Lab period to finish the Labs and WriteUps. **Complete your Lab assignments early in the week to ensure any needed time to problem-solve with GSI and for software access.**

Software for Lab may be accessed via Virtual Sites Apps Anywhere. The ArcGIS Pro and Desktop, and IMAGINE software are also available to be loaded on Windows OS. There are a limited set of IMAGINE floating licenses to use on Virtual sites. Therefore, as a courtesy to your fellow classmates unless you are sitting in Lab, do not use IMAGINE during our scheduled Lab times as the licenses are needed for Lab. Complete the IMAGINE part of your Lab assignments any other (i.e., most) times during the week and always logout when done. Plan ahead with this in mind. If you load your student IMAGINE software on your computer (must have

Windows OS) you may use it anytime as it is not a floating license. If you do have the software installed on your computer, use that instead of virtual sites. You may also bring your own Windows OS laptop (with its locally installed software) to Lab and use it during Lab time; in that case we may make the ESALab tables and monitors available to you during Lab time (right next door to the Computer Classroom) after the initial GSI presentation.

Lab WriteUps

Your Lab WriteUps will be due before or by the beginning of the following week's Lab period unless otherwise noted. ***Lab WriteUps are to be completed individually.*** Grades are scaled 0-100 for each Lab. Late assignments will lose 10 pts/day off down to 50 points out of 100 in addition to any points lost for quality/correctness (see Course Policies below). WriteUps are graded for completeness and accuracy of results, maps, discussions, and interpretation (with evidence of familiarity with reading assignments), meeting requirements, and clarity of image and written presentation. ***You must always 'write in your own' words to receive credit for written answers, and if you refer to any sources printed or online you must also cite them to receive credit.***

Labs must be submitted via the assignment tool on CANVAS as a single PDF file. (Convert Word documents and map files to PDFs and merge them so contact your GSI if you're unsure how to do this). Always use the appropriate Portrait or Landscape orientation for a given page or map in your Lab WriteUp (i.e., do not insert Landscape orientation maps into Portrait orientation pages and always remember to put map compositions/layouts on a separate page, or you will receive a score deduction).

COMPUTING RESOURCES

You are responsible for your computer and an up-to-date operating system, plus accessing and/or installing the needed course software and all of its systems administration. For Macs, we are told that to access UM computing in general you need macOS Sierra 10.12.1 or newer (newer is better for this course, upgrade to macOS Catalina 10.15.6 or newer and test in advance).

Summary: You will use ERDAS IMAGINE 2020, ESRI ArcMap Desktop (version 10.8.1) and ESRI ArcGIS Pro (version 2.8.3) either through installing the software on your computer (Windows OS), or through network access to the software on UM ITS *Virtual Sites* or both. IMAGINE and ESRI ArcGIS software is written only for Windows OS. UM provides Macs access to the software 'virtually' through *Virtual Sites* (or you may want to investigate software such as Bootcamp that installs a Windows OS partition on a Mac, however you would need to figure this out on your own).

Internet and Peripherals: Required is that you will also need to have a good Internet connection to work from home or your workplace of preference (access software via *Virtual Sites*, transfer datasets, etc.). Optional are that some students with laptops like to have a laptop docking station with a larger external monitor and external keyboard/mouse. And a small printer may be helpful for printing out lab slides on which to take notes if you prefer to note-take on paper instead of on the pdf (students have done both successfully).

IMAGINE: You can access ERDAS IMAGINE (and ArcGIS Pro and ArcMap Desktop) virtually by logging into virtualsites.umich.edu and by using Apps Anywhere. See caveat above re: not using IMAGINE on *virtual sites* during scheduled Lab times (unless you are in that Lab section). If you have a PC or other Windows OS computer, you may get a student version of IMAGINE in Lab0 and install the software on your own computer and use it anytime. If working on your personal Windows OS computer please always use your locally installed software and personal student license (rather than virtual sites).

GEE: For Google Earth Engine (GEE) Labs you must request a login/account at the beginning of the semester (info in Lab0).

ArcGIS: Instructions to install on your Windows OS computer:
ArcGIS Pro:
https://experience.arcgis.com/experience/f97dfe30cc504cfb8ca2c915bab784e6/page/page_8/
ArcMap Desktop:
https://experience.arcgis.com/experience/f97dfe30cc504cfb8ca2c915bab784e6/page/page_10/

Computing Storage Space: **AFS:** One storage option to save your Lab work is UM AFS space (your personal UM networked drive space). This space is backed up. Most students use this for 541/441. If you have not used AFS space before, you must 'request' your AFS space: **REQUEST YOUR AFS SPACE SIGNIFICANTLY PRIOR TO LAB 1** using the AFS Self-Provisioning Tool at http://mfile.umich.edu/ For an AFS overview see: http://documentation.its.umich.edu/node/234/

Hard drive: You may save GIS output to your **personal computer's** hard drive, however also *always back it up elsewhere*. Do NOT save to the Dana Computer Classroom or other UM sites computer hard drives – they will be erased. Lost data will not be considered an approved excuse for late Lab assignments. As students in this course and as GIS professionals, it is your responsibility to make sure your work is backed up and retrievable at all stages. We recommend that you keep your AFS space and course materials well-organized. Later 541 Labs rely on performing tasks that are described in detail in earlier Labs materials. ***As you are working – 'save' work often***.

RECORDINGS

Course lectures and/or labs may be audio/video recorded and posted on Canvas for all students in the course. As part of your participation, you may be recorded. If you do not wish to be recorded, you may keep your video/audio off.

Students are prohibited from recording/distributing course lectures or labs. Students are prohibited from posting or sharing any curricular materials made available through this UM course to persons or locations outside of this course and Canvas site.

COURSE POLICIES

General attendance

We encourage you not to be absent during the academic semester. However, if you have any unavoidable formal absences (i.e., a required conference presentation etc.) that might interact with Lab or other graded deadlines you must let us know about this at the beginning of the semester and the nature of the absence. If absences conflict significantly with this course and its graded material, they may not be approved.

Labs

If a Lab WriteUp is turned in late, it will lose 10 pts (of 100) for each day off your otherwise score to a maximum of 50 pts out of 100 for late submission. If during the semester a verified very serious circumstance beyond your control results in missing a Lab (e.g., extended illness or hospitalization), and these circumstances prevent you from completing the Lab by its due date, you will be asked to provide *formal documentation/verification* of such circumstances and, if approved, may be extended. If not turned in by the agreed upon period after your return to class, the assignment will again be subject to the late policy.

Exams

Generally missed Examinations will not qualify for make-up procedures. Should very serious circumstances as per above beyond your control result in missing an Examination, further *formally documented verifiable evidence* needs to be presented in

advance. The final exam will take place on the official University final exam day for this class. It will be open-book with 24-hour window to complete the exam.

GRADING

Term Average

Scores on all EAS 541 graded materials will be used to calculate a Term Average, computed as the average of the following scores. The Term Average is the basis for the final letter grade.

Exam 1	150 points
Labs (term average x 4)	400 points
In-Class Presentation	100 points
Final Examination	200 points

Letter Grades

Letter grades will be based on the Term Average. Letter grades will be assigned in accord with the following scale:

Course Score	Grade	Course Score	Grade
97.0 or above	A+	75.5 to 79.4	C+
91.0 to 96.9	A	71.0 to 75.4	C
89.5 to 90.9	A-	69.5 to 70.9	C-
85.5 to 89.4	B+	65.5 to 69.5	D+
81.0 to 85.4	B	61.0 to 65.4	D
79.5 to 80.9	B-	59.5 to 60.9	D-

Disabilities or Religious Holidays

We will make every effort to accommodate the needs of students with hearing, visual, or other disabilities in coordination with Rackham policy: https://rackham.umich.edu/rackham-life/students-with-disabilities/accommodations-for-graduate-students-with-disabilities/ .

Likewise, we will try to accommodate for major religious holidays. If you are a SEAS international student located in a significantly different time zone let us know at beginning of the course and also contact SEAS OAP staff so that they have a record of this situation. *Be sure to let us know your needs **well in advance**.*

Student Well-Being

Students may experience stressors that can impact both their academic experience and their personal well-being. These may include academic pressure and challenges associated with health, relationships, mental health, alcohol or other drugs, identities, finances, etc. If you are experiencing concerns, seeking help is a courageous thing to do for yourself and those who care about you. If the source of your stressors is academic, please contact me so that we can find solutions together. For personal concerns, U-M offers many resources, some of which are listed at Resources for Student Well-being on the Well-being for U-M Students website. You can also search for additional resources on that website.

EAS 541 / ENVIRON 441 **SYLLABUS: SCHEDULE & ASSIGNMENTS** **Winter 2022**

Instructors:
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Dr. Silvia-Cordero-Sancho, SEAS, corderos@umich.edu
GSIs:
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Lyndsay Zemanek, SEAS, lzemanek@umich.edu

Course Materials: Canvas
Lecture: Synchronous Remote / Zoom
Labs: In-Person 3325 Dana Bldg*
(*selected labs in synchronous remote)
Software: ERDAS IMAGINE, Google Earth Engine, ArcGIS Desktop, ArcGIS Pro

Lecture number & date	***Lecture Subject***	***Lecture & Lab Readings, the Weeks Lab topic, Exams, Presentations*** *L&K = textbook; PL = color plates in L&K; CP = coursepack material on Canvas*
1.Wed Jan 5	Introduction to the Course Introduction Syllabus/Requirements	Lecture: Acquire Textbook; Read Syllabus; Complete Student Questionnaire (on Lecture section Canvas site Assignments tab)
2. Mon Jan 10	The E-M Spectrum Energy Flow Profile Energy Sources	**Lecture:** L&K: Chap 1 pp 1-9; Read Syllabus
3. Wed Jan 12	Energy Flow Profile Interactions with the Atmosphere Reflectance Characteristics of Land Cover I	**Lecture:** L&K Chap 1 pp 9-25, 57-58 *(Lab 0: Introduction to 541 Labs) *synchronous remote*
Mon Jan 17	**MLK Day No Classes**	
4. Wed Jan 19	Energy Flow Profile Reflectance Characteristics of Land Cover II	**Lecture:** L & K Chap 1 pp 25-30; Chap 8 pp 609-610, 619-628, 639-640, 646-649; PL #2 **Lab:** Lecture plus L&K Chap 1 pp 30-42, 49-58 *(Lab 1: Intro to ERDAS IMAGINE/ArcGIS)*
5. Mon Jan 24	Remote Sensing with Film Camera Systems Black & White Color and Color-IR Elements of Image Interpretation (EIIs)	**Lecture:** L&K Chap 1 pp 59-84; Chap 2 pp 85-92, 95-100, 105-117, 119-121, 142-143 ("detection section"); Chap 8 pp 658-662, 665-668; PL #3,4,5,6
6. Wed Jan 26	Basic Principles of Photogrammetry Geometric Correction Intro	**Lecture:** Chap 1 pp 49-58; Chap 3 pp 146-175; Chap. 7 pp 495-499; Chap 8 682-686 *(Lab 2: Spectral Reflectance/Spectral Curves)*
7. Mon Jan 31	Geometric Correction Cont'd Digital Imagery Introduction Sensors Through Time	**Lecture:** Chap 1 pp 30-35; Chap 7 pp 485-490

8. Wed Feb 2	Resolutions in Remote Sensing Radiometric Image Enhancements	**Lecture:** L&K Chap 1 pp 72-76; Chap 7 pp 499-506, 604-608; PL #36,37,38, 40 **Lab:** Read CP_Maps_Images_Projections pp 6-18, 22-26, 28-33; CP_FilmsFilters& Spectral Bands 1-16, 21-23, 25-27; USGSTopoSymbols *(Lab 3: Image Interpretation)*
9. Mon Feb 7	Multi-Spectral Optical Line-Scanner Systems Moderate spatial resolution satellite sensors including Landsat, SPOT, Sentinel	**Lecture:** L&K Chap 4 pp 218-242; Chap 5 pp 283-349, 375-378; PL #12,13
10. Wed Feb 9	Coarse spatial resolution satellite sensors including AVHRR, MODIS and others Vegetation Indices	***Lecture:*** *L&K Chap 5 pp 359-375; Chap 7 pp 517-530;* 587-591 ; *PL #18,19* *(Lab 4: Landsat Data Import and Spectral Image Enhancement) *synchronous remote*
11. Mon Feb 14	Introduction to Image Classification Classification Schemes Manual Classification	**Lecture:** L&K Chap 8 pp 611-618, 654-657; Read/Skim MI_LCLU_Classif_2012; Anderson_USGS
12. Wed Feb 16	**Presentation:** Lost City of Ubar & Intro to Radar Remote Sensing Intro to Google Earth Engine	**Lecture:** L&K Chap 6 pp 385-389; 409-413, 425-435; Chap 8 pp 662-665 *(Lab 5 Intro GEE/ NDVI / Presentation Groups)*
Mon Feb 21	**EXAM 1 (midterm)**	Covers material through Lecture 12
13. Wed Feb 23	Digital Land-Cover Classification I Unsupervised Classification	**Lecture:** L&K Chap 7 pp 537-563, 568-569, 591-597; **Lab:** Read CP_ Interpretation of Land/Cover Use – all pp; Read/Skim MI_LCLU_Classif_2012; Anderson_USGS *(Lab 6: Land-Cover Classification – Manual) *synchronous remote*
	SPRING BREAK	
14. Mon Mar 7	Digital Land-Cover Classification II Supervised Classifications Accuracy Assessment	**Lecture:** L&K Chap 1 pp 39-45; Chap 7 pp 575-582; PL #30
15. Wed Mar 9	Change Detection **Case Study**: *Land-Cover Change in Siberia 1975-2010 - Bergen*	**Lecture:** L&K Chap 7 pp 582-591, Chap 8 pp 640-645, 649-652 *(Lab 7: Land-Cover Classification – Digital)*
16. Mon Mar 14	Thermal Remote Sensing **Case Studies:** *Boreal Forest Fires, Urban Heat Islands - Bergen*	***Lecture****: L&K Chap 4 pp 243-270; Chap 8 668-677; PL #9,20 ;* Imhoff et al 2010

17. Wed Mar 16	High Spatial Resolution Sensors Satellite Sensors Digital Airborne Sensors	**Lecture:** Chap 5 349-356; Chap 2 124-132; 140-143; Chap 8 628-631, 652-653; PL 17,35,39 **Lab:** L&K Chap 7 pp 582-587; Bergen et al 2008 *(Lab 8: Post Classification Change Detection)*
18. Mon Mar 21	Hyperspectral Sensors **Case Study:** *Congo Basin Mapping with High Resolution WV-1 – Cordero-Sancho*	**Lecture:** L&K Chap 4 pp 271-282; Chap 5 pp 356-359; Chap 7 pp 598-602; PL #10,11,22
19. Wed Mar 23	Radiometric/Atmospheric Correction Sensor Selection	**Lecture:** L&K Chap 7 pp 488-495 *(Lab 9: Radiometric & Geometric Correction)*
20. Mon Mar 28	Lidar Remote Sensing **Case Studies:** *Drone-Based Sensing & Lidar at UMBS – Tallant*	**Lecture:** L&K Chap 1 pp 35-39; Chap 5 371-379; Chap 6 pp 471-484; PL #1,28
21. Wed Mar 30	Radar Remote Sensing	**Lec:** L&K Chap 6 pp 385-434, 441-464 (some reading duplicates Lec 12 – review) *(Lab 10a: MODIS Land Surface Temperature & Urban Heat Effect using Google Earth Engine;* ***OR*** *10b LiDAR & DEM/DSM at La Selva* *(Lab 10 will have extended due time TBD)*
22. Mon Apr 4	Mapping Quantitative Biophysical Properties **Case Studies:** *Mapping Water Chlorophyll Concentrations; Radar-Derived Forest Height & Biomass – Bergen*	**Lecture:** L&K Chap 7 pp 602-608
23. Wed Apr 6	Class Presentations Teams Lecture Breakouts – *Cordero-Sancho*	**Lab:** *Presentations Teams Meeting and Work Time*
24. Mon Apr 11	***Class Presentations***	**Lecture:** ***Class Presentations due (2 teams)***
25. Wed Apr 13	***Class Presentations***	**Lecture:** ***Class Presentations due (2 teams)*** **Lab:** ***Class Presentations due (7 teams)***
26. Mon Apr 18	***Class Presentations***	**Lecture:** ***Class Presentations due (2 teams)***
Mon Apr 25	**EXAM 2 (final)**	**Exam 2 (final exam) held only on scheduled final exam day Monday, April 25, as a take-home exam to be completed between 12:01 a.m. EST until 11:59 pm EST.**

Required Text

- (L&K) Lillesand, Kiefer & Chipman. *Remote Sensing and Image Interpretation*, 7th ed. Campus bookstores have ordered some for purchase or rent, they also recommend checking Amazon.com or Abebooks.com or other resale site; if you order from a resale site, be sure you get the 7th or latest edition and not an earlier edition.

CANVAS (download and print from Canvas as needed):

- (CP) Olson, scanned excerpts from a former print Coursepack for Map and Image Interpretation.
- Additional PDFs of Lab reading materials will be provided on Canvas prior to advance reading date.