ENV 4386 Remote Sensing

Baylor University
Department of Environmental Science
Semester: Fall 2026

Meeting Times: Thursdays, 2:00pm-4:45pm
Location: BSB E414 and BSB D405 for labs
Instructor: Dr. Erich Seamon
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Office: C423
Office Hours: 10am-noon TTh or by appointment
Credits: 3

Course Description

This course provides a rigorous introduction to satellite and aerial remote sensing with an emphasis on environmental monitoring, climate change applications, and hands-on geospatial analysis. The course integrates the physical foundations of remote sensing - electromagnetic radiation, absorption, reflection, transmission, atmospheric effects, surface reflectance, and thermal emission - with applied workflows using ArcGIS Pro, R/RStudio, and remote sensing data products.

The first portion of the course develops the scientific principles underlying remote sensing, including electromagnetic energy interactions with the Earth's surface and atmosphere, radiative transfer, spectral behavior of common surface materials, atmospheric correction, sensor and platform tradeoffs, and quantitative interpretation of reflectance and temperature products. Students will learn how remote sensing systems gather environmental data from a distance and how those data are converted into meaningful measurements of land, water, vegetation, climate, and atmospheric features.

The second portion of the course focuses on applied environmental and climate applications. Topics include vegetation dynamics and drought monitoring, urban heat islands and land surface temperature, land cover classification and change detection, wildfire and disturbance mapping, water resources and cryosphere monitoring, radar/SAR applications, and the use of remote sensing products in environmental assessment and decision-making.

Emphasis is placed on physically meaningful interpretation, reproducible workflows, hands-on projects, clear visualization, and professional communication of results through maps, figures, short technical reports, and a final remote sensing project.

Learning Outcomes

By the end of this course, students should be able to:

- Explain and apply core remote sensing principles, including electromagnetic radiation, absorption, reflection, transmission, radiative transfer, and atmospheric effects.
- Interpret spectral signatures and explain the physical meaning of reflectance, emissivity, and brightness temperature for common Earth surface materials.

- Distinguish among major satellite and aerial sensor platforms, including differences in spatial, spectral, radiometric, and temporal resolution.
- Convert digital numbers to radiance, reflectance, vegetation indices, water indices, and surface temperature products where applicable, and describe key sources of uncertainty.
- Compute and interpret vegetation and water indices such as NDVI, EVI, SAVI, NDWI, and NBR in relation to environmental conditions and climate variability.
- Derive and interpret land surface temperature products and analyze urban heat island patterns in relation to land cover, surface materials, and climate risk.
- Perform supervised image classification, conduct basic accuracy assessment, and evaluate land cover change using climate-relevant interpretation.
- Use ArcGIS Pro and R/RStudio to process, visualize, classify, and analyze raster remote sensing data in a reproducible manner.
- Connect remote sensing outputs to applied environmental science questions involving vegetation, drought, wildfire, water resources, urban climate, and land cover change.
- Design and complete a remote sensing analysis project and communicate results through professional-quality maps, figures, a written report, and a short presentation.

Course Level and Expectations

This is a medium-advanced remote sensing course intended for:

- Advanced undergraduates who have completed at least one introductory GIS course and a basic statistics course.
- Graduate students who have completed at least one GIS course and have some prior experience in a scripting language.
- Students interested in environmental monitoring, climate change, spatial data science, geospatial modeling, or applied environmental analysis.

The course is designed to be challenging but manageable with appropriate effort. Because the class meets once weekly for a 2 hour and 45 minute block, each meeting will combine lecture, guided demonstration, discussion, and project-oriented work time. Students are expected to stay current with readings, complete short preparation tasks, and make steady progress on course projects between class meetings.

Projects are organized as three major applied projects spread across the semester, along with one midterm exam. Each project will be introduced during class with a guided walkthrough and then completed over subsequent weeks. Most projects will be scaffolded: students will receive starter data, example workflows, and structured instructions, with an emphasis on selecting appropriate imagery, interpreting remote sensing products, running guided analyses, and documenting decisions rather than building every step from scratch.

Undergraduate students are expected to: (1) stay current with readings and project milestones, (2) develop working competence in core tools such as ArcGIS Pro and R/RStudio, and (3) demonstrate that they can interpret and communicate results from

remote sensing analyses. Graduate students will be expected to engage more deeply with uncertainty, methodological justification, and interpretation, with optional extensions available in each project.

Required Texts and Resources

- *Chuvieco, E. Fundamentals of Satellite Remote Sensing: An Environmental Approach.* (4th edition). CRC Press.
- Additional articles, tutorials, technical documentation, and example workflows will be assigned and provided through Canvas.
- Software: ArcGIS Pro; R and RStudio.
- Optional tools may include QGIS, Google Earth Engine, NASA Earthdata resources, USGS EarthExplorer, and Sentinel Hub resources.
- Course materials, project instructions, starter code, and datasets will be provided through Canvas. Students may use lab computers or their own laptops.

Course Format

Each Thursday meeting will typically combine conceptual lecture, remote sensing data demonstrations, guided hands-on work in ArcGIS Pro and/or R, and discussion of interpretation, uncertainty, and environmental decision-making.

Because the course meets only once per week, attendance and active engagement are especially important. Missing a class may mean missing both the conceptual foundation and the technical walkthrough for a multi-week project.

Assessment and Grading

Assessment	Focus	Points
Project 1	Remote sensing image selection, project design, and visual interpretation	25 pts
Midterm	Chapters 1-6: remote sensing foundations, sensors/platforms, project design, visual interpretation, and preprocessing	20 pts
Project 2	Applied digital interpretation: spectral indices, introductory classification, and change detection	25 pts
Final Project	Climate Monitoring Final Project: written report, professional figures/maps, and presentation	25 pts
Participation and Engagement	Attendance, discussion, in-class work, project progress, and peer feedback	5 pts
Total		**100 pts**

Major Project Overview
Project 1: Remote Sensing Image Selection and Visual Interpretation

Students will develop a professional remote sensing feasibility and interpretation memo. The project focuses on defining an environmental monitoring question, comparing candidate sensors or image products, justifying image selection using spatial/spectral/temporal/radiometric resolution, and visually interpreting true-color and false-color imagery. Because this project is due before the Chapter 6 lecture is completed, it does not require quantitative preprocessing, classification, NDVI calculation, or change detection.

Project 2: Applied Digital Interpretation, Spectral Indices, and Change Detection

Students will complete a guided applied analysis using prepared imagery and structured workflows. The project introduces spectral indices such as NDVI, NDWI, and NBR; basic digital image interpretation; introductory classification concepts; and change detection. The emphasis is on interpreting environmental meaning, documenting workflow decisions, and connecting image products to vegetation, water, disturbance, urban heat, or land-cover change. Because Project 2 is due before the full validation lecture can be incorporated into the assignment, formal accuracy assessment will be treated as a conceptual extension rather than a major graded component.

Final Project: Climate Monitoring Remote Sensing Application

Students will design and complete an applied remote sensing project focused on an environmental or climate-monitoring question. Projects may address vegetation change, drought, wildfire disturbance, water resources, urban heat, land cover change, coastal or wetland dynamics, hazards, or another approved topic. Final deliverables include a short written report, professional-quality figures/maps, and a short presentation.

Class Schedule

Date	Topic / Notes	Due
Aug 27, 2026	**Chapter 1:** Introduction to remote sensing. Course overview; what remote sensing is; historical development; remote sensing components; environmental and climate applications.	
Sep 03, 2026	**Chapter 2:** Physical basis of remote sensing. Electromagnetic energy; reflection, absorption, transmission, emission; optical, thermal, and microwave sensing; atmospheric effects.	
Sep 10, 2026	**Chapter 3:** Sensors and platforms. Spatial, spectral, temporal, radiometric, angular, and polarimetric resolution; satellite, aerial, and commercial imagery; Landsat, Sentinel, MODIS/VIIRS.	
Sep 17, 2026	**Chapter 4:** Organizing a remote sensing project. Project objectives, scale, accuracy, sensor/image selection, timing, feasibility, resources, and environmental applications. Project 1 introduced.	**Project 1 introduced**
Sep 24, 2026	**Chapter 5:** Visual image interpretation. Color composites, brightness, texture, shape, pattern, context, phenology, spectral signatures, and interpretation criteria.	
Oct 01, 2026	**Chapter 6:** Digital image preprocessing. Raster structure, image enhancement, geometric correction, radiometric correction, reflectance products, temperature products, and preprocessing uncertainty.	**Project 1 due at start of class**
Oct 08, 2026	**Chapter 6 extended:** Applied foundations workshop. Reflectance products, spectral index logic, preprocessing decisions, image quality, uncertainty, and environmental interpretation examples that connect foundational concepts to applied remote sensing projects.	
Oct 15, 2026	**Midterm Exam.** Covers Chapters 1-6 and foundational applied concepts.	**Midterm Exam**
Oct 22, 2026	**Applied digital image interpretation / Project 2 kickoff.** NDVI, NDWI, NBR; vegetation, water, and burn interpretation; introductory LST/urban heat framing; classification and change detection project setup.	**Project 2 introduced**
Oct 29, 2026	**Chapter 7:** Digital image interpretation. Digital classification, spectral indices, supervised/unsupervised methods, training data, machine learning concepts, multitemporal analysis, and change detection.	
Nov 05, 2026	**Chapter 8:** Validation. Reference data, sampling design, accuracy assessment, confusion matrices, regression/RMSE, spatial validation, uncertainty, and error interpretation.	**Project 2 due at start of class**
Nov 12, 2026	**Chapter 9:** GIS and remote sensing integration. Auxiliary GIS layers, DEMs, land cover, impervious surface, environmental context, spatial overlays, and decision-making applications. Final Project introduced.	**Final Project introduced**
Nov 19, 2026	**Final project workshop and applied synthesis.** Climate/environmental monitoring project design, urban heat, land cover change, water resources, hazards, trend/anomaly framing, and project work time.	
Nov 26, 2026	Thanksgiving Break - No Class	
Dec 03, 2026	**Final project presentations and course wrap-up.** Remote sensing in environmental assessment, climate monitoring, uncertainty, and decision-making.	**Final Project due**

Key Course Policies
Detailed Baylor University policies on academic integrity, accommodations, attendance, and other matters will be provided in the official syllabus on Canvas and follow current Baylor guidelines. Highlights include:

- Academic Integrity: All work must adhere to Baylor's policies on academic honesty. Plagiarism or other forms of academic misconduct will not be tolerated.
- Accessibility and Accommodations: Students requiring accommodations should contact the Office of Access and Learning Accommodation (OALA) and inform the instructor early in the semester.
- Attendance and Participation: Because this course meets once weekly and includes multi-week projects, regular attendance and active participation are essential for success.
- Technology and Computing: Students are responsible for maintaining access to required software (ArcGIS Pro and R/RStudio) and for backing up their work.

Announcements in Canvas
The Announcements section of Canvas will be used to post general messages, reminders, and other pertinent course information that is relevant to all students. In addition to receiving notifications of new announcements upon logging on to Canvas, all students are required to enable real-time (i.e. ASAP) notifications for course Announcements to their respective Baylor University email address. Specific instructions for modifying Canvas notification preferences can be found on the Canvas Notification guide.

Academic Integrity
Plagiarism or any form of cheating involves a breach of student-teacher trust. This means that any work submitted under your name is expected to be your own, neither composed by anyone else as a whole or in part, nor handed over to another person for complete or partial revision. Be sure to document all ideas that are not your own. In addition, you must not provide course materials to other students, whether individually or generally (such as online) that would enable them to gain an unfair academic advantage. I expect you, as a Baylor student, to be intimately familiar with the Honor Code. Instances of plagiarism or any other act of academic dishonesty will be reported to Office of Academic Integrity and may result in failure of the course. Such instances may be referred to the Honor Council for action.

Artificial Intelligence Usage
This course recognizes that generative AI tools (e.g., ChatGPT, Copilot, Gemini) are increasingly used in academic and professional settings. You may use AI as a learning aid to brainstorm, outline, debug code, clarify concepts, or improve clarity of writing, but you may not use AI to replace your own thinking or submit AI-generated work as if it were your own.

Allowed uses (with disclosure)

- Brainstorming topics, refining research questions, outlining

- Explaining concepts you already encountered in class/readings
- Debugging code or troubleshooting workflows (you must understand and explain the final solution)
- Editing for clarity/grammar

Not allowed (academic misconduct)

- Submitting AI-generated text, code, analyses, figures, or answers as your original work
- Using AI to complete project reports
- Having AI construct sources, citations, data, quotes, or results
- Uploading restricted course materials (project materials/code, lectures) into AI tools
- Disclosure requirement

For any assignment where AI is used, include a short AI Use Note at the end: Tool(s) used; what you used it for; and what you changed and/or verified yourself.

Example: I used ChatGPT to brainstorm an outline and to help debug a R script. I rewrote the final code and verified the outputs by reproducing results and adding comments.

Responsibility

You are responsible for the accuracy, originality, and integrity of everything you submit. If you cannot explain your submission, it will be treated as not your work.

Accommodations

Any student who needs academic accommodations related to a documented disability should inform me immediately at the beginning of the semester. You are required to obtain appropriate documentation and information regarding your accommodations from the Office of Access and Learning Accommodation (OALA). OALA is in the basement level of the east wing of the Sid Richardson building (reachable via elevator or stairs). They can also be reached by phone (254) 710-3605 or email OALA@baylor.edu.

Success Center

We want every student who has been admitted to Baylor to be successful, and I want to partner with you to help you thrive academically. Be sure to take advantage of the many resources available for academic success, including coming to see me during my office hours. Students who regularly utilize the great resources in the Paul L. Foster Success Center such as tutoring, Learning Lab, and Academic Mentoring are among my most successful students. If your academic performance in this class is substandard, I will submit an Academic Progress Report to the Success Center so that the team of coordinated care professionals can ensure that you get the help you need.

Classroom Community
Everyone deserves to be treated with respect and dignity in this classroom space: students, teaching assistants, instructors, and guests. Baylor's Code of Ethics (BU-PP 024) states, Members of the Baylor University community are expected to act in a way that builds a distinctive sense of caring, kindness, mutual respect, collegiality, and fairness. Incivility, unkindness, and aggression have no place in our classroom community.

Crisis and Emergency Numbers:
• Counseling Center Crisis Line: (254) 710-2467 (Business Hours/Non-Business Hours/Weekends)

• Baylor Police Department: (254) 710-2222

• MHMR Crisis Center: (254) 867-6550

• MHMR 24-Hour Emergency/Crisis Number: (254) 752-3451

• National Hope Network Hotline: 1-800-SUICIDE (1-800-784-2433)

• National Suicide Prevention Lifeline: 1-800-273-TALK (1-800-273-8255)

Sexual and Interpersonal Misconduct Policy and Civil Rights Policy
Baylor University does not tolerate unlawful harassment or discrimination on the basis of sex, gender, race, color, disability, national origin, ancestry, age, citizenship, genetic information or the refusal to submit to a genetic test, past, current, or prospective service in the uniformed services, or any other characteristic protected under applicable federal, Texas, or local law. These policies also prohibit discrimination and harassment based on pregnancy or related conditions. If you or someone you know would like help related to prohibited conduct, please visit www.baylor.edu/titleix or www.baylor.edu/civilrights, or contact the Equity, Civil Rights, and Title IX Office at (254) 710-8454.

First-Generation Students
Baylor University defines a first-generation college student as a student whose parents did not complete a four-year college degree. The First in Line program is a support office for first-generation college students to utilize if they have any questions or concerns. Please check out First in Line, visit us in Sid Richardson, or email firstinline@baylor.edu.

Military-Connected Students
Veterans, active-duty military personnel, and dependents are encouraged to connect with the VET program, a space dedicated to supporting our military-connected students. Please communicate, in advance if possible, any special circumstances (e.g., upcoming deployment, drill requirements, disability accommodations).

Mission
The mission of Baylor University is to educate men and women for worldwide leadership and service by integrating academic excellence and Christian commitment within a caring community.

Religious Observances
I am committed to providing a caring environment in which students from diverse religious backgrounds can succeed. Please review all the course requirements for assignments, exams, or attendance expectations that conflict with religious observance and related cultural practices. I ask that you communicate any conflicts to me within the first week of the semester to allow time for us to discuss the conflict and determine any fair and reasonable adjustments to the schedule.

Land Acknowledgement
We respectfully acknowledge that Baylor University in Waco and its original campus in Independence are on the land and territories originally occupied by Indigenous peoples including the Waco and Tawakoni of the Wichita and Affiliated Tribes, the Tonkawa, the Nʉmʉnʉʉ (Comanche), Karankawa, and Lipan Apache. These Indigenous peoples were dispossessed of and removed from their lands over centuries by European colonization and American expansionism. In recognition that these Native Nations are the original stewards of Baylor's campus locations, the University strives to build sustainable relationships with sovereign Native Nations and Indigenous communities through education offerings, partnerships, and community service.