

CE7371 REMOTE SENSING IN HYDROLOGY (FALL 2025)

5:00 PM - 7:50 PM Tuesday

Location: RFM 5216

This course focuses on the basics of remote sensing, data collection, processing, and analysis for a wide range of applications for hydrology and water resources at different scales. Topics include the hydrologic cycle, relevant sensor types, the electromagnetic spectrum, active/passive microwave remote sensing (precipitation, soil moisture, snow, vegetation water content, etc.), thermal sensing of evapotranspiration, and the gravity method of groundwater. This course also covers an introduction to data assimilation and practical approaches with remote sensing data for water resources management including floods and drought monitoring.

Instructor

Dr. Eunsang Cho, Assistant Professor of Civil Engineering Ingram
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Communication

Office hours are available by appointment, but you are welcome to stop by my office on any weekday, preferably before 2:00 p.m. Please email me if you have any questions. I respond to emails within 24 hours during the work week. Course announcements will be on Canvas.

Objectives

This course prepares students to:

1. Explain the core principles of remote sensing and relevant applications in hydrology (fundamental knowledge)
2. Analyze state-of-the-art remote sensing data from satellite, airborne, and drone platforms (computational analysis)
3. Summarize and criticize recent literature (critical thinking/evaluation)
4. Design research project related to hydrology/water resources issues and identify suitable remote sensing techniques to solve the project (applications in real world problems)

Instructional Methodologies

- 1) Lectures of the fundamental concepts of remote sensing techniques of water and the natural environment
- 2) Guest lectures to provide a better understanding of real-world applications in hydrological and environmental research
- 3) Computational analysis of remote sensing data during class and regular homework assignments mainly using Google Earth Engine along with R, Python, MATLAB, or a suitable equivalent.
- 4) A literature-based survey of historical and state-of-the-art remote sensing techniques of hydrology and environmental monitoring
- 5) Student-led presentations and scientific report enabling students to synergistically use the above methodologies to analyze and solve identified hydrologic issues (e.g., heatwave, floods, drought, and wildfires)

*It is critical to attend, mentally engage, actively participate, and take notes (research has shown that taking notes increases retention)

*Each class is associated with a module on Canvas. Modules provide materials from the class

Prerequisites

NA

Readings

Readings are critical parts and supplement the materials presented in class

There are no required textbooks for this course. All of the required and supplemental reading is available for free on Canvas

The recommended (not required) textbooks:

1. Remote Sensing in Hydrology and Water Management, Publisher: Springer, Editors: Gert A. Schultz, Edwin T. Engman, 2012, <https://doi.org/10.1007/978-3-642-59583-7>
2. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd edition, Publisher: Pearson, Editor: John Jensen, 2006, ISBN-13: 9780131889507
3. Earth Engine Fundamentals and Applications - EEFA - Live Document - 2021+
<https://docs.google.com/document/d/1PtVEOm5s-2V5Ouv8cEftJR9tIwCI4SVUkmHjr61nHJM/edit?tab=t.0#heading=h.mm0ckpr9chy2>

Relevant Research Articles:

4. Adams, K. H., Reager, J. T., Rosen, P., Wiese, D. N., Farr, T. G., Rao, S., ... & Rodell, M. (2022). Remote sensing of groundwater: current capabilities and future directions. *Water Resources Research*, 58(10), e2022WR032219.
5. Gao, L., Wang, X., Johnson, B. A., Tian, Q., Wang, Y., Verrelst, J., ... & Gu, X. (2020). Remote sensing algorithms for estimation of fractional vegetation cover using pure vegetation index values: A review. *ISPRS Journal of Photogrammetry and Remote Sensing*, 159, 364-377.
6. Mohanty, B. P., Cosh, M. H., Lakshmi, V., & Montzka, C. (2017). Soil moisture remote sensing: State-of-the-science. *Vadose Zone Journal*, 16(1), 1-9.
7. Lakshmi, V. (Ed.). (2016). *Remote sensing of hydrological extremes*. Springer.
8. Lettenmaier, D. P., Alsdorf, D., Dozier, J., Huffman, G. J., Pan, M., & Wood, E. F. (2015). Inroads of remote sensing into hydrologic science during the WRR era. *Water Resources Research*, 51(9), 7309-7342.
9. Hall, D. (2012). *Remote sensing of ice and snow*. Springer Science & Business Media.
10. Schmugge, T. J., Kustas, W. P., Ritchie, J. C., Jackson, T. J., & Rango, A. (2002). Remote sensing in hydrology. *Advances in water resources*, 25(8-12), 1367-1385.

Homework/Reading Assignments

- Course concepts and procedures are applied in the homework
- Reading Assignments: Article Summary or Critical review by providing your own evaluation
- Each assignment is posted on Canvas
- Upload your submission to Canvas as a PDF file
- Feel free to include handwritten work by taking photos or scanning
- Late submissions are generally NOT accepted. Exceptions may be made only if you obtain the instructor's permission in advance.
- Submissions must be entirely your own individual work, but discussion with others is recommended

Term-Project (Subject to schedule change)

- You will work in a team of approximately 2 students (we may have 4-5 groups)
- **Topics:** Specific topics connected to hydrology/water resources and or environmental research such as floods, drought, wildfires, heatwaves etc. using remote sensing data.
- Example topics will be provided in class.
- A unique opportunity to develop your skills in data acquisition, analytics, interpretation, and visualization using remote sensing data.
- Benchmark Article Summary (Three most relevant publications) (Wk 3)
- Concept/Topic Presentations (Wk 5)
- One-Page Plan Submission (Wk 5)
- There are mid- and final presentations (Wk 8 and Wk 15). The presentations will be evaluated by Dr. Cho as well as peers.
- Upload your final report to Canvas as a PDF file (Due date: 5 pm, Dec 9th)

Grading

The following weighting is used to determine course grades:

25% - Attendance/In-class Discussions/Quizzes

25% - Homework/Reading Assignments

50% - Project

- Report Submissions 25% (One-page, Proposal, final report etc.)

- Concept/Mid/Final Presentations 25%

** There will be no exams. The instructor may give quizzes, which could be counted toward attendance grade.*

Improvement and growth are the keys. The instructor will conduct his/her expert assessment on student performance and will assign grades consistent with the following:

- **A (excellent)** exceptional performance; exceeding the requirements of the course, showing strong academic initiative and independent resourcefulness.
- **B (good)** performance above the norm; accurate and complete; beyond the minimum requirements of the course; work demonstrates marked progress and initiative.
- **C (average)** satisfactory work that adequately meets minimum requirements and demonstrates satisfactory comprehension, communication skills, and effort; demonstrates little initiative to investigate the problem without substantial prodding of the instructor and/or work shows little improvement.
- **D (inferior)** unsatisfactorily meets minimum requirements; demonstrates minimum comprehension, communication skills, and effort at an inferior level; initiative lacking and/or improvement not noticeable.
- **F (failing)** does not meet minimum requirements; fails to adequately demonstrate comprehension, communication skills, and effort

Course Outline (Subject to Change)

Week 1 [8/26]– Introduction & Hydrologic Cycle & Remote Sensing Fundamentals

Week 2 [9/2] – Hydrologic Variables & Electromagnetic Spectrum

Week 3 [9/9] – Microwave Remote Sensing: Soil Moisture

(Invited Speaker: Dr. Hyunglok Kim; GIST, South Korea)

Week 4 [9/16] – UAV LiDAR Remote Sensing (Field Session at Meadow Center)

Week 5 [9/23] – Concept/Topic Presentations

Week 6 [9/30] – Thermal Infrared Remote Sensing (Note: Dr. Cho will be away this week)
(Invited Speaker: Dr. Yuanhui Zhu; Geography, Texas State Univ)

Week 7 [10/7] – Active Microwave Remote Sensing

Week 8 [10/14] – Mid Presentations/Proposal

~~Week 9 [10/21] – Snow Hydrology Remote Sensing~~

Week 10 [10/28] – Surface Water Remote Sensing

Week 11 [11/4] – Groundwater Remote Sensing

(Invited Speaker: Dr. Eunsuem Cho; NASA GSFC)

Week 12 [11/11] – Evapotranspiration and Vegetation Water Use

Week 13 [11/18] – Data Integration & Machine Learning Applications

(Invited Speaker: TBD; Geo & Environ Studies, TXST)

Week 14 [11/25] – Climate Extremes & Applications (Floods, Droughts, Wildfires)

Week 15 [12/2] – Final Project Presentations & Wrap-Up

Week 16 [12/9] - Final Report Submission

Guidance on Using AI Tools (e.g., ChatGPT) in this Course

Artificial Intelligence (AI) tools, such as ChatGPT, can be useful resources for enhancing your understanding of concepts and/or assisting with projects and coding. However, their use must adhere to ethical guidelines and support your learning rather than replace critical thinking or original work.

Appropriate Uses of AI Tools:

- Concept Clarification: Use AI tools to clarify concepts and/or methodologies.
- Draft Refinement: Obtain suggestions for improving the structure, clarity, or grammar of your written work.
- Coding Assistance: Seek help with basic programming tasks or troubleshooting scripts, while ensuring you understand the methodology.

Inappropriate Uses of AI Tools:

- Academic Misconduct: Do not use AI tools to generate complete answers for assignments, exams, or projects that require original thought and effort.
- Plagiarism: Submitting AI-generated content as your own is a violation of academic integrity policies.
- Uncritical Reliance: Avoid using AI-generated outputs without verifying accuracy and relevance, as these tools may occasionally provide incorrect or incomplete information.

Best Practices:

- Cite Appropriately: If you use AI-generated content as a reference, acknowledge it in your work (e.g., "This explanation was assisted by ChatGPT.").
- Engage Critically: Treat AI outputs as starting points and cross-check them against reputable sources.
- Collaborate with Integrity: If you think unclear, discuss the use of AI tools with me to ensure alignment with course policies.

Notifications

This course adheres to the TXST academic integrity policy as stated in the General Catalog and the Student Conduct Code

Instructors are required by law to notify university officials about any disclosures of interpersonal violence
It is a violation of academic integrity and/or copyright laws to share, post, republish, or repurpose any course materials. All materials are provided only for your personal use.

Resources (see Canvas syllabus for hyperlinks)

Any student who self-identifies with the Student Disability Center (SDC) as having a disability is eligible for support from the SDC

Any student seeking an exemption from attending class or meeting a deadline for a religious observance should submit the Religious Accommodation Request Form to the Division of Student Affairs