University of Florida
Agronomy Department
Fall 2025

Geospatial AI for Sustainability Science
AGR 6932

Instructor:

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Office hours: Monday 1:00 pm – 2:00 pm or by appt at McCarty Hall D, Rm G052A or on Zoom: https://ufl.zoom.us/my/chang.zhao.meeting.room

Course credits: 3

Teaching Format and Course Communications:

- 80-99% or 100% online.
- This course combines asynchronous and synchronous learning through pre-recorded lectures, interactive Perusall readings, live class discussions, and guest speaker sessions. Students will engage in student-led journal article presentations, group discussions, and peer feedback activities. The course emphasizes critical thinking and collaborative learning.
- Canvas eLearning Login: http://elearning.ufl.edu/
- Contact instructor through Canvas messaging system or email.
    - Allow 24 hours for a response during the week.
    - Questions posted over the weekend may not receive a response until Monday.

Pre-Requisites:

Entry-level knowledge of both statistics (STA2023, GEO3162C/6160, or equivalent) and GIS (GIS3043/5107C or equivalent), or the consent of the instructor.

Required Textbook: None

There is no required text for this course. However, you might find the following resources useful as free ebooks from UF Library:

- Potschin, M., Haines-Young, R., Fish, R., & Turner, R. K. (Eds.). (2016). Routledge handbook of ecosystem services. Routledge.
- Gao, Song, and Yingjie Hu, eds. Handbook of Geospatial Artificial Intelligence. Boca Raton, FL: CRC Press, 2024. Print.
- Hastie, T., Tibshirani, R., & Friedman, J. (2009). The elements of statistical learning: Data mining, inference, and prediction. Berlin, Germany: Springer Science & Business Media. https://link.springer.com/book/10.1007/978-0-387-84858-7

For UF students, full text of the book is available with unlimited user access through https://guides.uflib.ufl.edu/ebooks/

Furthermore, throughout the semester Perusall readings will be distributed and discussed. All of these readings will be free, online books or articles and will be posted on Canvas.

Required Technology & How to Obtain the Technology

Technology requirements include:

- Speakers, microphone or a headset for participating in live chat sessions.
- ArcGIS Pro is the premier desktop geographic information system (GIS) application that allows users to explore, analyze, and visualize data, create 2D maps and 3D scenes, and share their work. Students can install and use ArcGIS Pro free of charge on UF-owned or personally owned computers if it is for class purposes only. For more information about download and installation instruction, check the link from UF GeoPlan Center: https://www.geoplan.ufl.edu/software/arcgis-pro/
- Google Colab is a free, cloud-based service allows users to write and execute Python code in a browser-based Jupyter Notebook environment https://colab.research.google.com/
- Shiny is a package that makes it easy to build interactive web apps straight from R & Python: https://mastering-shiny.org/index.html
- RStudio is a free integrated development environment (IDE) for R, Python and Shiny programming http://www.rstudio.com/
- Zoom is an easy-to-use video conferencing service available to all UF students, faculty, and staff that allows for meetings of up to 300 participants. For more information: https://ufl.zoom.us/

Required Technology & Digital Information Literacy Skills

Technical skills required:

- Using the Canvas learning management system
- Using UFL email with attachments
- Creating and submitting files in commonly used word processing program formats, including Microsoft Word and PowerPoint
- Downloading and installing software, including ArcGIS Pro, RStudio, and R.
- Register for a Google account and sign up to Google Colab.
- Using Zoom for live chat sessions

Digital information literacy skills include:

- Using online libraries and databases to locate and gather appropriate information
- Using computer networks to locate and store files or data
- Using online search tools for specific academic purposes, including the ability to use search criteria, keywords, and filters
- Analyzing digital information for credibility, currency, and bias (e.g., disinformation, misinformation)
- Properly citing information sources
- Preparing a presentation of research findings

Course Description:

This course introduces the foundations and applications of Geospatial Artificial Intelligence (GeoAI) in the context of sustainability science. Students will explore how GIS, AI, and spatial data science intersect with environmental and social systems to support sustainable decision-making. Emphasis is placed on the ecosystem services framework and the UN Sustainable Development Goals (SDGs) to examine the connections between ecological processes and human well-being. Through weekly discussions, guest lectures, and student-led presentations, students will critically engage with real-world applications of GeoAI across domains such as biodiversity, climate resilience, food and water security, and cultural ecosystem services. Students will synthesize course concepts by designing a research proposal that tackles a real-world sustainability issue using GeoAI techniques.

Course Learning Objectives:

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

1. Explain core concepts and interdisciplinary linkages in GeoAI and sustainability science, with emphasis on the role of ecosystem services in human–environment systems.

2. Examine spatial data science workflows by identifying appropriate data sources and describing the key steps involved in preprocessing, exploring, and visualizing environmental and socioeconomic data.
3. Evaluate the distinctive properties of spatial data and analyze methodological challenges in spatially explicit machine learning, using appropriate diagnostic and evaluation techniques.
4. Synthesize and present key insights from contemporary GeoAI publications, emphasizing methodological innovations and their relevance to sustainability science.
5. Design and justify a research project proposal that integrates GeoAI techniques and interdisciplinary approaches to address a sustainability challenge.

Topic Outline:

Week	Module	Topics	Activities	Assignment and Evaluation
Week 0 (Aug 21-27)	Course Orientation	Course structure, learning outcomes, technology platforms, academic expectations.	Course introduction and vetting online sources	Syllabus quiz + Discussion board introduction + Live discussion
Week 1 (Aug 28-Sept 3)	Foundations of Sustainability Science and Ecosystem Services	Concepts of sustainability science, SDGs, ecosystem services, ecological and socioeconomic indicators.	Lecture + Live zoom session	Perusall reading + Live discussion
Week 2 (Sept 4-10)	Introduction to Spatial Data Science for Sustainability	Spatial data types and formats; sources (field data, remote sensing, citizen science, IoT, social media and others); preprocessing and visualization basics.	Lecture + Live zoom session	Perusall reading + Live discussion
Week 3 (Sept 11-17)	Geo-visualization and Interactive Mapping	Tools and techniques for 2D/3D mapping; interactive dashboards; story maps; digital twins for sustainability applications.	**Guest lecture by Dr. Hao-Yu Liao, University of Florida**	Live discussion with guest speakers
Week 4 (Sept 18-24)	Spatial Data Properties and Modeling Foundations	Spatial autocorrelation (Moran's I, LISA), spatial heterogeneity, and scale issues; MAUP, UGCoP; spatial interpolation; spatial regression.	Lecture + Live zoom session	Perusall reading + Live discussion
Week 5 (Sept 25-Oct 1)	Fundamentals of Machine Learning and	Overview of ML/DL tasks; Regression, Classification, Object Detection and	**Guest lecture by Dr. Wei Shao, University of**	Perusall reading + Live discussion with guest

	Deep Learning in GeoAI	Segmentation; feature engineering; model evaluation.	**Florida**	speakers
Week 6 (Oct 2-8)	Spatially Explicit Machine Learning	Spatial ML concepts and examples; spatial sampling designs; diagnostics and evaluation: spatial cross-validation, uncertainty quantification, residual analysis, local/global interpretation.	Lecture + Live zoom session	Perusall reading + Live discussion
Week 7 (Oct 9-15)	Case Studies on SDGs and Ecosystem Services	Empirical studies and real-world applications related to the SDGs and ecosystem services.	**Guest lecture by Dr. Jiangxiao Qiu, University of Florida**	Live discussion with guest speakers; **Final Project Proposal Outline due Oct 15**
Week 8 (Oct 16-22)	Industry Perspective on Digital Twins and Sustainability	Applications of digital twins, smart infrastructure, and geospatial tech in sustainability.	**Guest lecture by Bentley Systems, Inc. Oct 21**	Live discussion with guest speakers
Week 9 (Oct 23-29)	GeoAI for Biodiversity and Conservation	Habitat and species distribution modeling; biodiversity mapping; pollination modeling.	Student oral presentation + Group discussions	Perusall reading + Live discussion
Week 10 (Oct 30-Nov 5)	GeoAI for Provisioning Services: Food & Water Security	Crop yield prediction, water supply modeling.	Student oral presentation + Group discussions	Perusall reading + Live discussion
Week 11 (Nov 6-12)	GeoAI for Regulating Services: Climate & Environmental Health	Modeling carbon storage, air quality, urban cooling, pollution regulation.	Student oral presentation + Group discussions	Perusall reading + Live discussion
Week 12 (Nov 13-19)	GeoAI for Cultural Services: Nature and Human Well-Being	Modeling access to green space, aesthetics, recreation, cultural heritage.	Student oral presentation + Group discussions	Perusall reading + Live discussion
Week 13 (Nov 20-22, Dec 1-3)	Final Project Proposal Presentations		Student-led presentations of research proposals	Peer review + Instructor feedback; **Final Proposal due during exam week (Dec 6-12)**

Note:

Guest lectures and topics may be adjusted, added, or rescheduled based on speaker availability. However, the grading structure will remain consistent with what is outlined below.

Grading Structure:

Assessment Type	Percent of Final Grade	Description
Final Project Proposal (Written)	30%	A research proposal applying GeoAI methods to a real-world sustainability challenge, incorporating feedback from classmates and instructor.
Perusall Reading Engagement	25%	Active participation in annotated readings and engagement with peers on Perusall.
Student-led Journal Article Presentation	15%	Oral presentation analyzing a contemporary GeoAI publication and its relevance to sustainability science.
Final Project Presentation	15%	Presentation of the proposed research.
Class Participation and Peer Review	15%	Active contributions to live Zoom sessions, guest lectures, and class discussions, as well as thoughtful and constructive feedback on peers' final project proposals and presentations.

Rubrics will be provided with graded activities. See Canvas assignments for individual rubrics.

Grades and Grading Scale:

Percentage	Letter Grade
>=91.0	A
90.0 – 90.9	A-
87.0 – 89.9	B+
81.0 – 86.9	B
80.0 – 80.9	B-
77.0 – 79.9	C+
71.0 – 76.9	C
70.0 – 70.9	C-
67.0 – 69.9	D+

64.0 – 66.9	D
60.0 – 63.9	D-
<60.0	E

Current UF grading policy for assigning grade point averages can be found here: https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/

Final Project Proposal

Each student will develop an individual research proposal that applies GeoAI methods to analyze a sustainability challenge of their choice. The proposal should demonstrate thoughtful integration of concepts, data sources, and techniques introduced throughout the course. Students are encouraged to align the project with their graduate thesis, dissertation, or professional interests.

The project includes three components:

- Project Outline **(30% of proposal grade)**: A preliminary outline summarizing the research question, objectives, relevant data sources, and intended GeoAI methods. This is due **Wednesday, October 15**.
- Proposal Presentation: Students will deliver a professional 15-minute presentation of their proposed project to the class during **Week 13 (Nov 20-22, Dec 1-3)**, followed by peer and instructor feedback.
- Written Proposal (6–8 double-spaced pages, approximately 1500-2500 words, excluding references and appendices): The final proposal should include research background, objectives, data sources, methodology, anticipated outcomes, and broader sustainability relevance. It is due during **final exam week (Dec 6–12)**.

Proposals will be evaluated based on the clarity of the research question, the depth and relevance of the literature review, the appropriateness and rigor of the proposed methods, the integration of course concepts, overall feasibility, and the quality of both written and oral communication. Detailed guidelines and evaluation rubrics will be available on Canvas.

Chat Sessions

Weekly chat sessions will be held via Zoom, and all students are expected to participate. These sessions will take place outside the Canvas platform. To participate, students will need access to a computer with audio capabilities; a webcam is recommended but not required.

The schedule for the first and subsequent sessions will be determined after course registration to best accommodate students' availability. Additional sessions may be offered at the instructor's discretion to address scheduling conflicts.

If you are unable to attend a scheduled chat session, you may be required to watch the session recording and complete a make-up assignment on Canvas, subject to the instructor's approval.

Policy on the Use of Generative Artificial Intelligence Tools: You may use generative artificial intelligence (AI) programs, e.g. ChatGPT, to help generate ideas and brainstorm. However, you should note that the material generated by these programs may be inaccurate, incomplete, or otherwise problematic. Beware that use may also stifle your own independent thinking and creativity. You may not submit work generated by an AI program as your own. If you include material generated by an AI program, it should be cited like any other reference material. Submitting work containing any content generated by AI when not explicitly cited or not directed to do so by the instructor will be considered an act of academic dishonesty.

Class Demeanor or Netiquette: All members of the class are expected to follow rules of common courtesy in all email messages, threaded discussions and chats.

Privacy Disclaimer: Our chat sessions are audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance and Late Policy:

Requirements for class attendance (module participation), make-up assignments, and other work in this course are consistent with university policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx

Academic Policies and Resources

Academic policies for this course are consistent with university policies. See https://syllabus.ufl.edu/syllabus-policy/uf-syllabus-policy-links/

Software Use

All faculty, staff and students of the university are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against university policies and rules, disciplinary action will be taken as appropriate.

Campus Health and Wellness Resources

Visit https://one.uf.edu/whole-gator/topics for resources that are designed to help you thrive physically, mentally, and emotionally at UF.

Please contact UMatterWeCare for additional and immediate support.

Privacy and Accessibility Policies

For information about the privacy policies of the tools used in this course, see the links below:

- Instructure (Canvas)
  - Instructure Privacy Policy
  - Instructure Accessibility
- Microsoft
  - Microsoft Privacy Policy
  - Microsoft Accessibility
- Sonic Foundry (Mediasite Streaming Video Player)
  - Sonic Foundry Privacy Policy
  - Mediasite Accessibility (PDF)
- ArcGIS Pro
  - ESRI Privacy Policy
  - ESRI Accessibility
- Shiny
  - Posit Privacy Policy
  - Posit Accessibility
- RStudio
  - RStudio Privacy Policy
  - RStudio Accessibility
- Google Colab
  - Google Privacy Policy
  - Google Accessibility
- Zoom
  - Zoom Privacy Policy
  - Zoom Accessibility