

GIS FOR ENVIRONMENTAL ANALYSIS AND MODELING

(GIS5305 || Fall 2021)

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Class Hours: Tuesdays: 9:45 a.m. – 12:15 p.m.; Bellamy 0320A

Office Hours: Fridays: 12:00 – 2:00 p.m.; largely through Zoom but in-person meetings possible upon request

Teaching Assistant: N/A

Lab Manager (any problems or questions related to the computing system): Shawn Lewers (slewers@fsu.edu)

Course Objective and Description

The purpose of this course is to train students with environmental problem-solving skills using geographic information systems and related spatial analytical and modeling techniques. It focuses on the GIS principles, methods, and techniques that are relevant to and useful for problem solving in environmental science and management. Specifically, this course consists of several major components: an overview on selected GIS principles including data models, scale and spatial sampling, ecological fallacy and modifiable unit problem, time representation, distance, and spatial autocorrelation; a review on some major techniques or issues for environmental data acquisition and integration; an introduction to environmental analysis and modeling techniques including cell-based modeling, statistical modeling, cartographical modeling, cellular automata, and agent-based modeling; and a discussion on several applied areas of environmental analytical and modeling techniques concerning landscape ecology (landscape pattern analysis), hydrology (surface analysis, hydrological feature extraction, soil erosion, and non-point source pollution), natural hazards (floods and wildfires), natural resources management (land cover modeling), and environmental planning (land suitability analysis and urban growth modeling).

This course will be taught at the intermediate-advanced level, with instructor-led lectures, unsupervised lab assignments, reading and discussions, and an independent research project. The lecture focuses on selected topics concerning GIS principles, techniques, and applications. An important component of this course is the computer-based lab assignments that involve the use of a leading commercial GIS software package. A literature review on a technical or applied topic is required for each participant. Finally, each student will need to complete an independent research project and present the result to the class.

Prerequisites

An introductory GIS course or equivalent. In addition to this formal prerequisite, students are expected to have a reasonable background in several relevant areas such as physical geography or environmental science, college algebra, univariate and multivariate statistics, among others.

Computing Environment, Software and GIS Lab Policies

Windows-based ArcGIS (and some extensions) will be used for class assignments. *However, you must be aware that this is not a software training course.* If you are looking for a specific software training course, you should visit the homepage for that software package. The vendor may provide short training courses or some software-specific training materials.

You should read and observe the following policies when using our GIS lab facilities.

You will be given a temporary account in order to log on a computer in COSS GIS Lab. This account may expire by the end of the semester. When you are at the computer lab, you must observe the COSS GIS lab and FSU's related policies. The GIS lab rules include:

- No food or drink in the lab.
- Lab computers are for GIS work only. Your other class work is to be done in other labs.
- Lab printers (if any) are for GIS work only.
- DO NOT install software without permission from your instructor or the lab manager. If you need software, ask!
- DO NOT save your work on the local machines. Use your Z:\ drive. If you use the local machine or temp directory, others will be able to see your work and it may not be there later.
- DO NOT waste color prints (if any), as they are expensive. Use the black and white printer whenever possible.
- Be courteous of others in the lab and stay quiet.
- Clean up after yourself. Lab attendants will throw out things that are left behind.
- DO NOT remove equipment that belongs in the lab from the lab. You will be criminally prosecuted if you are caught.
- DO NOT download MP3 or movie files. Most of these websites are compromised by viruses.
- Always log-off the computers when you are done, but DO Not shut them down.
- No instant messaging is allowed.
- Follow the FSU Honor Code and Code of Conduct rules and behave in an adult-like manner.

It is your responsibility to check and observe these rules. Any violation of these rules can result in the loss of privileges to use this facility. If that happens, it is your responsibility to find an alternative so that you could work on your lab assignments. If you are unsure about a rule or rules, ask a lab employee or Shawn Lewers (slewers@fsu.edu).

Course CANVAS Site

CANVAS will be used to host the course lecture and lab materials. You may find my lecture slides there, *but there is no guarantee that these lecture materials will be available on time.* You will still need to take notes during a lecture session. You are expected to check that site from time to time because some important announcements may be posted there. The CANVAS address is: <https://canvas.fsu.edu>. You will need to use your FSU account username and password to access this site.

I plan to post the information concerning the Zoom meetings for my office hours on the CANVAS site. *Please do not share the Zoom meeting information with a third person. For copyright reason please do not distribute anything posted on the CANVAS site to a third person.*

Grading Polices

System:

A	93-100	B-	80-82	D+	67-69
A-	90-92	C+	77-79	D	63-66
B+	87-89	C	73-76	D-	60-62
B	83-86	C-	70-72	F	59-0

*In qualitative terms, the grade standards are **A**, Outstanding, few errors or omissions (if any); **B**, Good, only minor errors/omissions; **C**, Satisfactory, at least one major error/omission; **D**, Poor, several major errors/omissions; and **F**, Fail: many major errors/omissions.*

Components:

Components	Description	Weights
Lab assignments	There are seven labs to be completed within a fixed time period*	28%
Writing assignment	One writing assignment: a set of questions to be answered within a fixed time period	28%
Literature review	Select and read two articles relevant to a theme or topic, discuss the articles in the class, and write a report; roles as a discussant.	16%
Research project	Identify a research topic, write a short proposal, conduct research, present the findings to the entire class, and write a final report.	28%

**Those who have not taken an intro-level GIS class formally but have some practical experiences in using GIS will need to work on additional lab assignments.*

Course Attendance

Students are required to attend all classes and be punctual. Missing even one lecture can affect your grade substantially. Announcements regarding the course structure and the change of schedule for lectures, labs, and writing assignments may be made in class. All organizational/administrative announcements made during the class period are assumed to be known by all students.

Attendance will be regularly checked. If you are not able to attend a class meeting, you will need to contact the instructor with an excuse provided. Usually, a substantial excuse should be provided for the second time when you miss a class meeting. A 10% of the total grade reduction will be applied for each unexcused absence. Being late or leaving earlier twice will be counted as ONE unexcused absence.

If you have to miss the class meeting during a writing assignment day or during the date you are scheduled to review your articles, you will have to provide an acceptable excuse (before I can reschedule a date for you to work on a set of writing assignments or review the articles).

The list of acceptable excuses includes documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. Consideration will also be given to students whose dependent children experience serious illness. Most other excuses for missing an exam may not be acceptable.

Cell phones, pagers, alarms, laptops, calculators, and other electronic devices must always be turned off in class.

Writing Assignments

The writing assignment can involve any material covered in lectures, reading or discussion assignments, and labs. There is no provision for extra credit work. A make-up writing assignment could be arranged only when you present an acceptable excuse (check the course attendance section for a list). Most other excuses for missing this assignment are NOT acceptable. This policy will be strictly enforced.

Lab Grading Policies

Grades of your lab exercises are based on the quality of your answers. Any answer should be concise and be well organized. The grade for each lab assignment is reported as *points_scored /total_points_of_exercise*. For example, if an assignment is worth 20 points and your answers score 16 points then you should see 16/20 on your marked assignment.

Each assignment will have a due day clearly written on the first page of your lab assignment. The due time is 11:59 p.m. on the due day. Any assignment that is turned in after the due day is considered late, which will receive penalty strictly.

The penalty for a late assignment is based on the number of days late (including weekends). If an assignment is late less than 24 hours, it is considered 1 day late. If an assignment is late less than 48 hours but more than 24 hours, it is considered 2 days late, and so on. Late assignments are penalized 20% per day. Here is the formula for calculating the points of a late assignment:

$$\text{Points}_{\text{get}} = \text{Points}_{\text{scored}} - 0.20 * \text{Num}_{\text{days}_{\text{late}}} * \text{Total}_{\text{points}}$$

The minimum value of $\text{Points}_{\text{get}}$ is 0. Assignments handed in after I have returned the graded assignment to class (usually one week after the due date) will receive no points. Again, you must provide acceptable excuse (see the course attendance section) in order to receive more time for you to complete lab exercises without penalty. You should discuss with the course instructor about your situation no later than the due day. This policy will be strictly applied.

Note that every person must hand in his or her own lab assignments. Working together is permitted and encouraged. BUT each person will be graded separately, must answer "creative response" questions independently, and must create his or her OWN maps (if any). Turning in identical or substantially similar assignments will result in a significant grade reduction.

Literature Review and Discussion

Each participant is required to review at least TWO articles being related to a *single* research theme. These articles will be selected by the course participants. They need to be a major research article published by a peer-reviewed journal; if you are not sure about this please contact the course instructor. Note that the articles must **NOT** be reviewed by the course participants in a different course. Please do NOT use any web materials to replace a journal article. Each participant will need to discuss the papers in the class and lead the discussion. The leader is expected to prepare several questions for each article at least one week before the actual discussion. These questions should be posted on the CANVAS site momentarily with the help of the instructor. Along with a leader (who actually reviews the articles), at least one "discussant" will be assigned to each review. Every student will need to address the review questions when reading through the articles, and the assigned "discussant" should play a critical role in the discussion. The leader should prepare a few slides to initiate the discussion and summarize the major findings resulting from the classroom discussion. The summary report is due one week after the discussion. Each discussion session can last up to 30 minutes depending upon the topic. All students are expected to actively participate in the discussion.

Research Project

To be discussed in a separate document.

Course Materials

Recommended books:

- **Zhu, X., 2016. *GIS for Environmental Applications: A Practical Approach*. Routledge, 490p.**
- **Wainwright, J. and Mulligan, M. (eds) 2013. *Environmental Modeling: Finding Simplicity in Complexity (2nd)*. Wiley, 628p. (A newer edition to be released in the near future).**

Recommended books on environmental or physical geography:

- Marsh, W. M. and Grossa, J. M., 2004. *Environmental Geography: Science, Land Use, and Earth Systems (3rd)*. New York: Wiley and Sons, 528p.
- Strahler, A., 2013. *Introducing Physical Geography (6th edition)*. New York: Wiley and Sons, 644p.

Recommended books on GIS fundamentals:

- **Bolstad, P., 2019. *GIS Fundamentals: A First Text on Geographic Information Systems (6th)*. XanEdu Publishing Inc, 764p.**

- Burrough, P.A. and McDonnell, R.A. 1998. *Principles of Geographic Information Systems*. New York: Oxford University Press, 333 p.
- Chang, K. S., 2018. *Introduction to Geographic Information Systems* (9th). McGraw-Hill Education, 464p.
- De Smith, M. J., Goodchild, M. F., and Longley, P. A. 2021. *Geospatial analysis: A Comprehensive Guide to Principles, Techniques and Software Tools*. The Winchelsea Press. Web version: <https://www.spatialanalysisonline.com/HTML/index.html>
- Heywood, I., Cornelius, S., and Carver, S. 2012. *An Introduction to Geographical Information Systems* (4th). Prentice Hall, 480p.
- Lo, C. P. and Yeung, A. K.W. 2007. *Concepts and Techniques of Geographic Information Systems* (2nd). Prentice Hall, New Jersey, 492p.
- Longley, P. A., Goodchild, M. F., Maguire, D. J. and Rhind, D. 2005. *Geographical Information Systems (Abridged; 2nd)*. New York: Wiley and Sons, 358p (with CD).
- Longley, P. A., Goodchild, M. F., Maguire, D. J. and Rhind, D. 2015. *Geographical Information Systems and Science* (4th). New York: Wiley and Sons, 496p.
- Madden, M. (ed). 2009. *Manual of Geographic Information Systems*. ASPRS, 1330p.
- McMaster, R. B. and Uery, E. L. (eds) 2004. *A Research Agenda for Geographic Information Science*. CRC Press, 404p. (note that most of the materials included in this book can be accessed from UCGIS website-www.ucgis.org; go to priorities/research)
- Zeiler, M. 2010. *Modeling Our World: The ESRI Guide to Geodatabase Design* (2nd). Redlands: ESRI Press, 308p.

Useful GIS books relating environmental applications:

- Bartlett, D. 2004. *GIS for Coastal Zone Management*. Taylor & Francis, 328p.
- Bourgeron, P. S., Jensen, M, and Lessard, G., 2001. *A Guidebook for Integrated Ecological Assessments*. Springer, 552p.
- Clarke, K. C., Parks, B. O. and Crane, M. P. (eds) 2002. *Geographic Information Systems and Environmental Modeling*. New Jersey: Prentice Hall, 306p.
- Convis, C. (ed) 2001. *Conservation Geography: Case Studies in GIS, Computer Mapping, and Activism*. Redlands: ESRI Press.
- Costanza, R., Constanza, Voinov, A. 2003. *Landscape Simulation Modeling*. Springer, 330p.
- DeMers, M. N. 2002. *GIS Modeling in Raster*. New York: John Wiley & Sons, 203p.
- Goodchild, M. F. et al. (eds). 1993. *Environmental modeling with GIS*. New York: Oxford University Press, 520p.
- Goodchild, M. F., Steyaert, L. T., Parks, B. O, Johnston, C., Maidment, D., Crane, M., and Glendinning, S. (eds), 1996. *GIS and Environmental Modeling: Progress and Research Issues*. Wiley and Sons, 504p.
- Gurnell, A. M. and Montgomery, D.R. (eds), 2000. *Hydrological Applications of GIS*. New York: John Wiley, 176 p.
- Halls, P. J. 2001. *Spatial Information and the Environment*. Taylor & Francis, 328p.
- Heuvelink, G. and Goodchild, M. F. 1998. *Error Propagation in Environmental Modelling With GIS*. Taylor & Francis, 127p.
- Johnston, C. A. 1998. *Geographic Information Systems in Ecology*. Blackwell Publishing, 239p.
- Lang, L. 1998. *Managing Natural Resources with GIS*. ESRI Press.
- Long, E. T. 2003. *Coastal and Marine Geo Information Systems*. Springer, 620p.
- Lyon, J. G. 1995. *Wetlands and Environmental Applications of GIS*. CRC Press, 400p.
- Maidment, D. and Morehouse, S. 2002. *ArcHydro: GIS for Water Resources*. ESRI Press, 220p.
- Malczewski, J. 1999. *GIS and Multicriteria Decision Analysis*. John Wiley, 392 p.
- Millington, A., Walsh, S. J., and Osborne, P.E. 2001. *GIS and Remote Sensing Applications in Biogeography and Ecology*. Springer, 344p.
- Mladenoff, M. G. and Baker, W.L. 1999. *Spatial Modeling of Forest Landscapes*. Cambridge

University Press, 364p.

- Shamsi, U.M. 2002. *GIS Tools for Water, Wastewater, and Stormwater Systems*. ASCE Publications, 375p.
- Skidmore, A. (ed) 2002. *Environmental Modelling with GIS and Remote Sensing*. Taylor and Francis.
- Wilson, J. P. And Gallant, J.C. (eds) 2000. *Terrain Analysis: Principles and Applications*. John Wiley, 479p.
- Wright, D. J. (ed) 2001. *Undersea with GIS*. ESRI Press. 253p.

GIScience and Relevant Journals

In this course, journal articles will be recommended to students to read. Students should constantly check the following journals for useful articles on GIS theories and applications:

- International Journal of Geographic Information Science
- Transaction in GIS
- Journal of Geographical Systems
- Computer, Environment and Urban Systems

Because students in this course often come from different disciplines, they can check a variety of scholarly journals in their own fields to find relevant GIS application papers. For example, for landscape architects, a journal such as *Environmental Planning and Landscape and Urban Planning* can be helpful. Three other geography journals also publish some GIS-related applications, *Annals of AAG*, *Applied Geography*, and *Professional Geographer*. Papers concerning GIS applications for environmental management and natural resources can be found from journals such as *Environmental Management and Journal of Environmental Management*.

Academic Honor Policy

The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to ". . . be honest and truthful and . . . [to] strive for personal and institutional integrity at Florida State University." (Florida State University Academic Honor Policy, found at

<http://fda.fsu.edu/academic-resources/academic-integrity-and-grievances/academic-honor-policy>)

PLAGIARISM: All submitted assignments must be your own original, independent work. All sources must be properly cited (especially in the graduate student paper). Ask the instructor if you are unsure what to do. Plagiarism will result in significant grade reduction.

Academic Success

Your academic success is a top priority for Florida State University. University resources to help you succeed include tutoring centers, computer labs, counseling and health services, and services for designated groups, such as veterans and students with disabilities. The following information is not exhaustive, so please check with your advisor or the Dean of Students office to learn more.

Americans With Disabilities Act

Florida State University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. Our goal is to create learning environments that are usable, equitable, inclusive, and welcoming. FSU is committed to providing reasonable accommodations for all persons with disabilities in a manner that is consistent with academic standards of the course while empowering the student to meet integral requirements of the course.

To receive academic accommodations, a student: (1) must register with and provide documentation to the

Office of Accessibility Services (OAS); (2) must provide a letter from OAS to the instructor indicating the need for accommodation and what type; and (3) should communicate with the instructor, as needed, to discuss recommended accommodations. A request for a meeting may be initiated by the student or the instructor. This should be done during the first week of class.

Please note that instructors are not allowed to provide classroom accommodations to a student until appropriate verification from the Office of Accessibility Services has been provided.

This syllabus and other class materials are available in alternative format upon request. For more information about services available to FSU students with disabilities, contact the

Office of Accessibility Services
874 Traditions Way
108 Student Services Building
Florida State University
Tallahassee, FL 32306-4167
850- 644-9566 (voice)
850-644-8504 (TDD)
oas@fsu.edu
<https://dsst.fsu.edu/oas>

Confidential campus resources

Various centers and programs are available to assist students with navigating stressors that might impact academic success. These include the following:

Victim Advocate Program
University Center A, Rm. 4100
(850) 644-7161
Available 24/7/365
Office Hours: M-F 8-5
<https://dsst.fsu.edu/vap>

Counseling and Psychological
Services
Askew Student Life Center, 2nd
floor
942 Learning Way
(850) 644-8255
<https://counseling.fsu.edu/>

University Health Services
Health and Wellness Center
(850) 644-6230
<https://uhs.fsu.edu/>

Free Tutoring from FSU

On-campus tutoring and writing assistance is available for many courses at Florida State University. For more information, visit the Academic Center for Excellence (ACE) Tutoring Services' comprehensive list of on-campus tutoring options - see <http://ace.fsu.edu/tutoring> or contact tutor@fsu.edu. High-quality tutoring is available by appointment and on a walk-in basis. These services are offered by tutors trained to encourage the highest level of individual academic success while upholding personal academic integrity.

Syllabus Change Policy

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice. The instructor reserves the

right to change the content of the syllabus or course material during the course of the semester. Any changes will be posted in the announcement section on Canvas or be notified through emails. Students should check announcements and your FSU email account timely.

Statement On Public Health Protocols (Approved by FSU Faculty Senate in Fall 2021)

In our classroom, I will expect everyone to wear a proper, well-fitting mask. As our President has informed the university community, FSU expects everyone on campus to use face-coverings. In regions where virus rates are high, the CDC recommends that even vaccinated individuals wear masks in public indoor spaces, like classrooms, especially where social distancing is not possible. Florida infection and hospitalization rates are greater now than they were at the height of the 2020 surge due to the Delta variant, a more infectious and easily transmissible version of the COVID-19 virus. The best way to protect against serious illness is to be fully vaccinated, but not everyone among us can be. Because the Delta variant can infect even vaccinated individuals and can be spread by them to others, it poses a special threat to members of the community with underlying health conditions and children at home who are too young for vaccination.

For these reasons, FSU expects each member of the community to comply with the public health protocols our President set forth on August 9, 2020, including *(1) wearing masks in public indoor spaces, (2) getting fully vaccinated, (3) being tested for the virus if you have symptoms, and (4) staying home and away from others if you are sick.* Please remember that you should NOT attend class in person if you have tested positive for COVID-19 or are quarantining after exposure. Finally, please bear in mind that the COVID-19 situation is fast moving and that university guidance on the issue may change at any time.

Statement for Classes Subject to HB233 Recording (Approved by FSU Faculty Senate in Fall 2021)

In this class, consistent with state law and university policy, students are permitted to make recordings of class lectures for personal use only. As noted, sharing, posting, or publishing classroom recordings may subject you to honor code violations and legal penalties associated with theft of intellectual property and violations of other state law. Moreover, students and educators have expressed concern that recording classroom activities may negatively impact the learning experience for others, especially in classes that involve questions, discussion, or participation. *To protect a learning environment in which everyone feels free to experiment with ideas, we ask you refrain from recording in ways that could make others feel reluctant to ask questions, explore new ideas, or otherwise participate in class.* Students must monitor their recording so that they do not include participation by other students without permission. Students with disabilities will continue to have appropriate accommodations for recordings as established by the Office of Accessibility Services.

Fall 2021 Tentative Schedule*

Weeks	Dates	Lectures	Labs	Readings	Remarks
1	8/24	Introduction to the course	N/A	N/A	A brief meeting
2	8/31	Introduction to the course and Environmental GIS: GIS overview/Environment and GIS/ ArcGIS overview	Lab 1: Getting started with ArcGIS Pro (ESRI)	Check the Canvas site	N/A
3	9/07				Literature review guidelines
4	9/14	GIS principles I: Data models/Issue of scale/Spatial sampling			Article selection and pdf copy due/ Project guidelines
5	9/21	GIS principles II: Pitfalls of spatial data (Spatial autocorrelation/Ecological fallacy/MAUP & scale)/Time representation	Lab 2: Spatial variability of environmental data		Review question due
6	9/28				Review I
7	10/05	Environmental data acquisition and integration I&II: Big geospatial data/Open geospatial data/GPS/Remote sensing/Social sensing Georeferencing/Error & uncertainties	Lab 3: Field data collection using ArcGIS Field Maps (ESRI)		Research proposal due/Review II
8	10/12				Proposal discussion
9	10/19	Environmental data acquisition and integration III: Spatial interpolation (point and areal based)	Lab 4: Spatial interpolation of environmental data		Review III
10	10/26	Environmental data analysis and modeling I: Overview of GIS-based spatial analysis & modeling techniques	Lab 5: Building geoprocessing models (ESRI)		Review IV
			Lab 6: GIS for natural resource management and planning		
11	11/02	Writing Assignment			
12	11/09	Environmental data analysis and modeling II: Cell-based analysis and modeling & GIS for geo-hazard analysis	Lab 7: GIS-based geohazard analysis	Check the CANVAS Site	Review V
13	11/16	Environmental data analysis and modeling III: Digital elevation models/Surface analysis/Hydrological network modeling	Lab 8: GIS-based hydrological network modeling		Review VI Project progress
14	11/23	Environmental data analysis and modeling IV: Soil erosion modeling/non-point source pollution modeling/ Landscape metrics/Spatial pattern analysis/Land change modeling	Lab 9: GIS-based landscape pattern analysis		Review VII
15	11/30	Research Presentations (10' each including questions)/Teaching Evaluation (online)			
16	12/07	Research Project Report Due Midnight			

*The schedule is subject to change from time to time. Please pay attention on my announcements during class meetings or through the CANVAS system.