Department of Geography and Geoinformation Science
College of Science
George Mason University

GGS 553: Geographic Information Systems

Spring 2026

About the Course

Time and Location	Wed 4:30 – 7:10 PM Exploratory Hall 2103
Credits	3 Credit Hours
Website	https://canvas.gmu.edu
Textbook	Bolstad, P. and S. Manson. 2022. *GIS fundamentals: A first text on geographic information systems*. 7th ed. White Bear Lake, MN: Eider Press.

About Instructor

Instructor	Armita Kar (she/her)
Office Hours	By Appointment
Office Location	Exploratory Hall 2215 (Zoom)
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Teaching Assistant	Meng Yuan (myuan5@gmu.edu)

1 Course Overview

Geographic Information Systems (GIS) are computerized systems used to create, manage, analyze, and map geographically referenced data. They provide a powerful scientific platform for visualizing, exploring, and modeling human–environment interactions in a digital environment. By integrating location data (where things are) with descriptive attributes (what things are like at those locations), GIS enables the analysis of spatial relationships, patterns, and processes across cultural, biological, demographic, economic, and physical phenomena. Because of its ability to translate complex spatiotemporal processes into actionable digital representations, GIS is widely used across industries to support real-world problem-solving and decision-making. By the end of this course, students will have a solid foundation for identifying the spatial dimensions of diverse application areas and for integrating spatial thinking and GIS analysis into their academic research and professional careers.

This course is required for those pursuing the Geographic and Cartographic Sciences MS, the Geoinformatics and Geospatial Intelligence MS, the Accelerated MS degrees offered by GGS, and both the Geospatial Intelligence and the Geographic Information Science graduate certificates. It is an optional core class for those pursuing the Earth Systems and Geoinformation Sciences PhD, the Earth Systems Science MS, or the Environmental GIS and Biodiversity Conservation graduate certificate. Beyond those programs, this course is also targeted for students within other graduate programs who want to learn the fundamentals of GIS and develop geoinformation analysis techniques.

Prerequisites: It is recommended that students take GGS 550 or an equivalent, or receive the instructor's permission.

1.1 Learning Outcomes

In this graduate-level course, students will learn GIS history, theory, and methods through readings and lectures. Through lab assignments, in-class activities, and a group project, students will apply these principles in ‘hands-on’ experience with real-world datasets, using the software package ArcGIS Pro and Python Programming (as appropriate). Upon successful completion of this course, students will be able to:

1. Describe the fundamental concepts, theories, and techniques related to GIS.
2. Demonstrate skills of data creation, management, and analysis using commercial GIS software and Python programming (as appropriate).
3. Conduct graduate-level independent research by defining and investigating real-world spatial problems using appropriate spatial data and methods.
4. Design, model, and produce effective visualizations, such as maps, charts, and graphics that communicate spatial problems and solutions in accordance with professional cartographic standards and aesthetic principles.
5. Synthesize and communicate spatial analyses and results through clear scientific writing and formal oral presentations for both academic and broader audiences.

1.2 Course format

The class will meet every Wednesday at Exploratory Hall 2103. The first half of the class will be a lecture covering the theories and methods, and the second half will involve lab and hands-on activities using geospatial data and software on the same topic. There may be a few exceptions; please review the course outline provided with this syllabus.

2 Course Materials

This course will use the following textbooks:

- Bolstad, P. and S. Manson. 2022. *GIS fundamentals: A first text on geographic information systems*. 7th ed. White Bear Lake, MN: Eider Press.
    - Can be purchased through the GMU bookstore or any other sources. You may buy an older version of the book – the texts might be slightly different, but they cover the same content.
- GIS&T Body of Knowledge by University Consortium of Geographic Information Science
    - Available online: UCGIS Bok Visualizer and Search

Additional content-specific lectures and lab materials will be distributed through Canvas. A few example resources for lab materials include:

- Guide to the Geographic Approach GIScience Education for the Modern Era UCSB
- Tutorial Gallery | Documentation
- GGS366_Spatial_Computing/Lectures at main · armitakar/GGS366_Spatial_Computing

You will need the following technical resources to complete the course assignments and project.

- **GMU Email account and NetID**: You must use your GMU email account and NetID to access Canvas, OneDrive, and lab computers.

- **Computer access**: Personal access to a computer with an operating system of Windows 10 or Mac OSX 10.13 or higher and a stable internet connection can be beneficial, but not mandatory. Alternatively, you may use the **GGS Computer lab** to complete assignments. Once registered for a GGS class, you have 24/7 access to the GGS Computer Lab, Exploratory Hall 2102, via your student ID. Please email at ggs@gmu.edu to report issues. You can also use the GMU Virtual Computing Lab (https://www.vcl.gmu.edu/).

- **Data storage:** I encourage you to carry a 32GB USB flash drive or of higher storage capacity to store and access the lab files. After completing each lab, I suggest using OneDrive cloud storage to save your data and lab work as a backup.

- **Canvas**: This course will extensively use Canvas for course materials distribution (if not provided in the textbook), lab submissions, and exams.

3 Course Activities and Grading

The course has four main activities: 7 labs (35%), 3 graded in-class activities (6%), an exam (10%), and a final project (49%).

Category		Total points	Assessment level	Percentage of total grade
Lab		175 (7 labs, 25 points each)	Individual	35%
In-class activities (Best 3 out of 4 will be considered)		30	Individual/group	6%
Exam		50	Individual	10%
Project	Proposal presentation	25	Group	5%
	Project proposal	50	Group	10%
	Final presentation	70	Individual	14%
	Final report	100	Individual	20%
Total		500		100%

3.1 Labs

This course has 7 labs administered via Canvas. Each lab involves hands-on exercises on the topics taught that week and is **due the following Wednesday at 11:59 PM**. Please correspond with Canvas to keep track of course activities and their due dates to ensure on-time submission.

Labs are designed to practice and sharpen your spatial analytical skills and gain firsthand experience exploring, visualizing, and analyzing geospatial data using ArcGIS Pro. Students with prior Python programming experience are welcome to use Python to simplify repeated tasks. That said, knowing or using Python is not mandatory for this class. The lab instruction will provide guidance on solving all labs using both ArcGIS Pro and Python (as appropriate), so students can choose the route they are comfortable with and that matches their learning interests.

Your lab submissions will be assessed on both the correctness of your answers, as well as your logical workflow; in other words, how proficiently you approach a problem is equally important as finding the correct answer. Therefore, please be sure to describe your step-by-step workflow to receive partial credit even if your answers are incorrect.

I will post the lab instructions and supplementary datasets on Canvas. **Please use the Canvas discussion board to post any course or lab-related queries, as well as help your peers resolve the issues**. However, each student is responsible for completing the work independently and submitting their individual assignments. Each lab is worth 25 points, totaling 175 points. The labs will account for 35% of the total grade.

You are encouraged to explore online resources, such as the official ESRI tutorials, GitHub pages, and online lectures from other universities that illustrate example applications for solving their lab assignments. Please be sure to cite the online resources as appropriate.

3.2 Project

The course project will involve applying GIS techniques and models to a research topic of your choice. **Students will complete the project in groups of 3-4 students.** Students are welcome to create their own groups. Otherwise, I will create project groups based on similarities in students' research interests.

Week 4 lectures will cover the detailed instructions regarding the class project. I will introduce you to the publicly available geospatial datasets, example research questions, and methods appropriate for the class project. You are welcome to choose any research questions that interest you. Following the project introduction, four main tasks will be due in the upcoming weeks:

- **Project proposal presentation:** In week 6, each group will present their initial idea (problem statement, objectives, potential data source, and method) to the class to receive feedback from their peers and instructor. The proposal presentation is worth 5% of the total grade. **The proposal presentation will be graded as a group effort.** The presentations will be assessed based on your participation and effort, rather than the quality and feasibility of the initial idea.
- **Project proposal:** This project proposal is due in week 7 and is worth 10% of the total grade. It should not be more than 1000 words and contain a problem statement, objectives, preliminary literature review, data and methods, expected outcomes, and references (excluded from the word count). **The project proposal will be graded as a group effort.** In addition to the project proposal, each group needs to submit a list stating the distribution of tasks among the team members, which will later be used to evaluate your contributions toward the final presentation and report.
- **Final presentation:** In week 14, each group will present their final project, including introduction, objectives, data and methods, results, and implications. Team members responsible for each task will present their corresponding sections. This is worth 14% of your total grade. **Each student will be graded individually based on the section they presented.**
- **Final report:** The final project is due in week 15 and is worth 20% of the total grade. Each group will submit a project report of about 6000-7000 words. This report must follow a standard journal article format, containing sections on Introduction, Literature review, Data and Method, Results, Discussion, and Conclusion. In addition, each group needs to provide a title page stating author names and affiliations, abstract (<250 words), and references (excluded from the word count). The references should follow APA format (7th edition). You are encouraged to use referencing software such as Zotero or Endnote to automate the referencing system. **The final report will be individually graded based on the quality of the sections each student contributed**.

Please submit all project-related documents online through Canvas.

3.3 Exam

The exam will consist of multiple-choice questions on the lectures taught up to week 7 (module 1 and 2) and will be worth 10% of the total grade. The exam will be closed-book and administered via Canvas. There will be no final exam at the end of the semester for this course.

3.4 Graded In-class Activities

There will be four graded in-class activities. **The dates for these activities will be determined spontaneously and will not be announced in advance.** Each activity will be based on the topic discussed

during that class and may take place in various forms, such as individual minute papers or group-based discussions, to promote active learning. The activities will be graded individually or as a group, and the best three out of four will count toward your final grade. Each activity is worth 10 points, totaling 6% of the final grade.

3.5 Grading Scale

Grades	Percentage Required	Grades	Percentage Required
A+	96 to 100	**C**	70 to 79.9
A	93 to 95.9	**F**	<70
A-	90 to 92.9		
B+	86 to 89.9		
B	83 to 85.9		
B-	80 to 82.9		

3.6 Course Outline and Tentative Schedule

*** The syllabus is subject to change; please review Canvas for the most up-to-date version ***

Week	Date	Topic	Reading/ Assignment due
Week 1	21-Jan	Course overview, GIS history, and Introduction to spatial data	Chapter 1
		Module 1: Spatial Data, Projection, and Cartography	
Week 2	28-Jan	Spatial Data Models and Projection Lab 1: Exploring spatial data and reprojection	Chapter 2-3
Week 3	4-Feb	Cartographic principles, data mapping, and editing Lab 2: Mapping and editing spatial data	Chapter 4 **Lab 1**
		Module 2: Spatial Data Processing and Analysis	
Week 4	11-Feb	Vector data processing: Spatial operations and query Lab 3: Spatial data selection, joining, and overlay **Project Introduction**	Chapter 8-9 **Lab 2**
Week 5	18-Feb	Raster data processing: Map algebra, image reclassification, and terrain analysis Lab 4: Terrain modelling	Chapter 6, 10-11 **Lab 3**
Week 6	25-Feb	**Project proposal presentation**	**Lab 4**
Week 7	4-Mar	Network analysis Lab 5: Geocoding and service area analysis	Chapter 9 **Project proposal**
	11-Mar	**Spring Recess (no lectures)**	
Week 8	18-Mar	**Exam**	**Lab 5**
		Module 3: Advanced modelling (Spatial statistics)	
Week 9	25-Mar	Core area mapping and spatial autocorrelation Lab 6: Hotspot analysis	Chapter 12
Week 10	1-Apr	Spatial interpolation Lab 7: IDW and kriging	Chapter 12 **Lab 6**
Week 11	8-Apr	Spatial regression	Chapter 12-13 **Lab 7**

Week 12	15-Apr	**Emerging geospatial artificial intelligence and ethical considerations**
Week 13	22-Apr	**Project progress meeting**
Week 14	29-Apr	**Project Presentation**
Week 15	6-May	**Project Report Submission**

4 Student Engagement Policies

4.1 Attendance

There is no attendance grade. I encourage you to attend classes regularly to understand the course concepts better and follow the lab instructions. Research shows that a student is significantly more likely to excel in a course if attended regularly. Additionally, I will not make any special accommodations if you miss a class unannounced. You are responsible for contacting me and catching up on missed materials or instructions.

I will provide reasonable accommodations for university-approved excused absences, such as religious observations and university activities. To receive approval, please notify me with documentation within the first two weeks of the semester.

I will also make an exception for personal emergencies, such as illness and family crises. To request an exception, please email me as soon as the situation arises. Please note that you are responsible for following up with me to discuss potential make-up work options (e.g., time extensions for labs with no penalties and make-up exams).

4.2 Make-up assignments

I will provide reasonable accommodations for university-approved excused absences, such as religious observations and university activities. To receive approval, please notify me with documentation within the first two weeks of the semester.

I will also make an exception for personal emergencies, such as illness and family crises. To request an exception, please email me as soon as the situation arises. Please note that you are responsible for following up with me to discuss potential make-up work options (e.g., time extensions for labs with no penalties).

4.3 Late Lab Assignment

The due dates and times for each lab are posted on Canvas. A submission will be considered late if marked as late on Canvas. The following penalties apply to late submissions:

- A 10% grade reduction if the assignment is submitted within a week of the due date.
- A 25% grade reduction if the assignment is submitted within two weeks of the due date.
- Submissions over two weeks late will receive 0 points unless a time extension has been granted for exceptional circumstances, as discussed above.

You should be proactive in completing your lab assignments early to avoid last-minute technical issues such as "didn't have internet," "computer system error," or "Canvas was giving me an error." No time

extensions will be granted for such cases. You may choose to submit partial work on time or submit late and receive a grade with late penalties.

4.4 Classroom Conduct and Participation

As the course instructor, I will ensure that the class maintains a welcoming, engaging, and respectful learning environment, and I ask for your cooperation in this regard. Classroom participation is highly appreciated. I encourage you to raise your hand and share your questions, concerns, and thoughts at any time during the class. However, please avoid using inappropriate language or expressing thoughts that might be hurtful to your peers.

4.5 Student Use of Electronic Devices

You may use electronic devices (phones and tablets) for learning purposes, such as note-taking and reading course materials. Please ensure that your use of these devices does not distract others, and keep them in silent mode throughout the entire class. Additionally, **do not use electronic devices for audio or video recording without my consent**.

You must comply with Mason's student code of conduct. Disruptive behavior will result in classroom removal.

4.6 Proper Address and Pronoun Use

I welcome you to share your chosen name and gender pronouns via the Mason-provided website: https://registrar.gmu.edu/updating-chosen-name-pronouns/. These changes will appear in the Canvas class sites and other places, helping me to best address you.

My pronouns are she/her/hers. I appreciate you addressing me by my first name.

4.7 Contacting Me

Please feel free to email me for any queries. I will do my best to respond to emails received on weekdays within 24 hours and weekend emails within 48 hours. You may send a gentle reminder if you do not receive a response within this timeframe. If you need further assistance, you can also schedule an appointment to meet me in person or via Zoom during my office hours. **Please use your GMU email account for any correspondence related to this class.**

That said, **if you have any general questions about lab assignments, please post them on the Canvas discussion board**. This collaborative approach helps everyone by enabling group problem-solving. Peers who have encountered similar issues can respond quickly, and future students facing the same challenges can benefit from the shared discussion.

5 University Policies and Support Services

5.1 Academic Standards

Academic Standards exist to promote authentic scholarship, support the institution's goal of maintaining high standards of academic excellence, and encourage continued ethical behavior of faculty and students to cultivate an educational community which values integrity and produces graduates who carry this commitment forward into professional practice.

As members of the George Mason University community, we are committed to fostering an environment of trust, respect, and scholarly excellence. Our academic standards are the foundation of this commitment, guiding our behavior and interactions within this academic community. The practices for implementing these standards adapt to modern practices, disciplinary contexts, and technological advancements. Our standards are embodied in our courses, policies, and scholarship, and are upheld in the following principles:

- **Honesty:** Providing accurate information in all academic endeavors, including communications, assignments, and examinations.

- **Acknowledgement:** Giving proper credit for all contributions to one's work. This involves the use of accurate citations and references for any ideas, words, or materials created by others in the style appropriate to the discipline. It also includes acknowledging shared authorship in group projects, co-authored pieces, and project reports.

- **Uniqueness of Work:** Ensuring that all submitted work is the result of one's own effort and is original, including free from self-plagiarism. This principle extends to written assignments, code, presentations, exams, and all other forms of academic work.

Violations of these standards—including but not limited to plagiarism, fabrication, and cheating—are taken seriously and will be addressed in accordance with university policies. The process for reporting, investigating, and adjudicating violations is outlined in the university's procedures. Consequences of violations may include academic sanctions, disciplinary actions, and other measures necessary to uphold the integrity of our academic community.

The principles outlined in these academic standards reflect our collective commitment to upholding the highest standards of honesty, acknowledgement, and uniqueness of work. By adhering to these principles, we ensure the continued excellence and integrity of George Mason University's academic community.

Student responsibility: Students are responsible for understanding how these general expectations regarding academic standards apply to each course, assignment, or exam they participate in; students should ask their instructor for clarification on any aspect that is not clear to them.

5.2 Accommodations for Students with Disabilities

Disability Services at George Mason University is committed to upholding the letter and spirit of the laws that ensure equal treatment of people with disabilities. Under the administration of University Life, Disability Services implements and coordinates reasonable accommodations and disability-related services that afford equal access to university programs and activities. Students can begin the registration process with Disability Services at any time during their enrollment at George Mason University. If you are seeking

accommodations, please visit https://ds.gmu.edu/ for detailed information about the Disability Services registration process. Disability Services is located in Student Union Building I (SUB I), Suite 2500. Email: ods@gmu.edu. Phone: (703) 993-2474.

Student responsibility: Students are responsible for registering with Disability Services and communicating about their approved accommodations with their instructor in advance of any relevant class meeting, assignment, or exam.

5.3 FERPA and Use of GMU Email Addresses for Course Communication

The Family Educational Rights and Privacy Act (FERPA) governs the disclosure of education records for eligible students and is an essential aspect of any course. **Students must use their GMU email account** to receive important University information, including communications related to this class. Instructors will not respond to messages sent from or send messages regarding course content to a non-GMU email address.

Student responsibility: Students are responsible for checking their GMU email regularly for course-related information, and/or ensuring that GMU email messages are forwarded to an account they do check.

5.4 Title IX Resources and Required Reporting

As a part of George Mason University's commitment to providing a safe and non-discriminatory learning, living, and working environment for all members of the University community, the University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities. Accordingly, **all non-confidential employees, including your faculty member, have a legal requirement to report to the Title IX Coordinator, all relevant details obtained directly or indirectly about any incident of Prohibited Conduct** (such as sexual harassment, sexual assault, gender-based stalking, dating/domestic violence). Upon notifying the Title IX Coordinator of possible Prohibited Conduct, the Title IX Coordinator will assess the report and determine if outreach is required. If outreach is required, the individual the report is about (the "Complainant") will receive a communication, likely in the form of an email, offering that person the option to meet with a representative of the Title IX office.

For more information about non-confidential employees, resources, and Prohibited Conduct, please see University Policy 1202: Sexual and Gender-Based Misconduct and Other Forms of Interpersonal Violence. Questions regarding Title IX can be directed to the Title IX Coordinator via email to TitleIX@gmu.edu, by phone at 703-993-8730, or in person on the Fairfax campus in Aquia 373.

Student opportunity: If you prefer to speak to someone **confidentially**, please contact one of Mason's confidential employees in Student Support and Advocacy (SSAC), Counseling and Psychological Services (CAPS), Student Health Services (SHS), and/or the Office of the University Ombudsperson.

5.5 AI use policy

Students must complete all course labs and assignments independently, without relying on generative AI tools. All data processing, map visualizations, and written responses must be the students' own work. The use of Generative AI tools, such as ChatGPT, Gemini, and Claude, is permissible for brainstorming, idea generation, and grammar and sentence refinement, but all implementations must be their own. Note that, while using Generative AI tools, you should strictly follow the fundamental principles of the academic standards stated in Section 5.1. Directly producing your answers from GenAI (e.g., directly generating your

lab responses, models, and visualizations with GenAI) is strictly prohibited. At the end of each lab, please include a note citing the capacity in which you have used generative AI tools or any other online content.

Students should also recognize both the benefits and limitations of AI in learning and research. While AI can provide useful suggestions, it is not always accurate or reliable. Students are expected to critically evaluate AI-generated knowledge and rely primarily on the course textbook and other assigned materials. Violations of this policy will be considered academic misconduct. If you have any questions about whether a specific use of AI is permitted, please ask for clarification in advance.

5.6 University-wide Closures and Class Cancellations/Delays

There may be times during the semester in which George Mason University announces university-wide closures or delays. Should inclement weather or another emergency force Mason to close, causing our class to cancel meeting times, we will not meet. Check the Mason website and our own Canvas site for updates. Other cancellations or delays to class will be announced via canvas by your professor. In the event that this course has missed meeting times, the course schedule, assignment deadlines, and other course alterations will be decided upon and announced via canvas and email by the professor. You are expected to stay abreast of any changes.