COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainability Science

GIS for Sustainable Science (SUSCPS5050)

Scheduled Meeting Times: Tu 4:10-6pm
Location: TBD

Instructor:	Frank O. Nitsche, Research Scientist in the Lamont-Doherty Earth Observatory of Columbia University, fnitsche@ldeo.columbia.edu, (845) 365-8746
Office Hours:	after class or by appointment
Response Policy:	Instructor is available for short discussions before or after class or on e-mail and for scheduled Zoom meetings by appointment.

Facilitator/Teaching Assistant: TBD

Course Overview

Many environmental and sustainable science issues have a spatial, location-based component. Increasingly available spatial data allow location-specific analysis and solutions to problems and understanding issues. As result, analyzing and identifying successful and sustainable solutions for these issues often requires the use of spatial analysis and tools. This course introduces common spatial data types and fundamental methods to organize, visualize and analyze those data using Geographic Information Systems (GIS). Through a combination of lectures and practical computer activities the students will learn and practice fundamental GIS and spatial analysis methods using typical sustainable science case studies and scenarios.

A key objective of this course is to provide students with essential GIS skills that will aid them in their professional career and to offer an overview of current GIS applications. In the first part, the course will cover basic spatial data types and GIS concepts. The students will apply those techniques by analyzing potential impacts of storms on New York City as part of a guided case study. A mid-term report describing this case study and the results is required. In the second part, building on the basic concepts introduced in the first part, students will be asked to identify a sustainable science question of their choice that they would like to address as a final project. Together with the instructor they will be developing a strategy of analyzing and presenting related spatial data. While the students are working on their projects additional GIS methods and spatial analysis concepts will be covered in class. At the end of the course Students will briefly present their final project and submit a paper describing their project.

This course is aimed at students with no or only basic GIS experience and will cover:

- introduction and use of GIS software (ArcGIS, QGIS as alternative)
- basic spatial data types (vector, raster, databases)
- creating maps and cartographic representation
- working with data from different source and create and edit new data
- basic spatial analysis, including data query, selection, overlay and proximity
- working with raster data
- basic data interpolation techniques
- identifying and answering spatial questions using typical sustainable science case studies/scenarios
- outlook of advanced GIS techniques, including web GIS, modelling, 3D applications

This course would contribute to the curriculum areas 1 (Integrative Courses in Sustainability Science) and 3 (Analyzing and Modeling Environmental Conditions and Impacts).

Master of Science in Sustainability Science

Learning Objectives

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

L1: Define and distinguish different types of spatial data
L2: Generate and manipulate spatial data from various sources
L3: Create effective maps and visualization of different data types using GIS software
L4: Perform GIS analysis including combining and extracting spatial data
L5: Identify spatial questions from a given problem and design a workflow for spatial analysis
L6: Access strengths and weaknesses of maps and spatial data from other sources

Readings

Recommend core reading (either one):

- Bolstad (2019). GIS Fundamentals: A First Text on Geographic Information Systems (6th Edition). XanEdu Publishing. 764 pp.
- Heywood, Cornelius and Carver (2012). An Introduction to Geographical Information Systems (4th Edition). Prentice Hall. 480 pages.

Additional readings and paper will be provided as pdf through CourseWorks.

Resources

Columbia University Library
Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: http://library.columbia.edu/.

SPS Academic Resources
The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources.

GIS specific resources
The Digital Social Science Center of the Columbia Libraries located in the basement of Lehman Library is an excellent resource for GIS data and technical assistance: http://library.columbia.edu/indiv/dssc/data.

Through the Columbia University license agreement, ArcGIS software licenses will be available for the participants of the course as well as access to ESRI online self-guided tutorials.

This course is best taught in a computer lab and as a result there might be a limit on participants depending the number of computers available in the class room.

Course Requirements (Assignments)

Class Participation (10%) (L1, L2, L3, L4, L5, L6)

Class participation, including oral communication, exercises important job skills. Weekly readings and practical exercises from the previous class should be completed before class. This will prepare students for class discussions and hands-on exercises. Parts of the course and the lab exercises will build onto each other.

Homework Assignment (20%) (L2, L3, L4)

Learning the practical skills of using GIS tools is a key objective of this course. The students will be given weekly assignments, which will guide them to practice the material presented in class. In many cases this might just consist of finishing or continuing practical exercises from a class.

Midterm Paper (30%) (L1, L2, L3, L4, L6)

Students will write a short midterm paper based on the first case study. The midterm paper will be in the form of a report including introduction/background, a description of the data and applied methods, results including maps, and a brief discussion of the findings. This report will demonstrate how familiar the students are with the course material at that point, allow them to practice communication of the results in a professional way, and provide a way for students to critically reflect on limitations of data used in the case study. Feedback on this report will prepare the students for the final paper.

Final project and presentation (40%) (L1, L2, L3, L4, L5, L6)

Students will be responsible for completing and presenting a final GIS project that demonstrates they have mastered the concepts and skills presented in the class. Ideally, the project will allow the students to apply the GIS and spatial analysis skills they have learned to problems discussed in their other classes or internships. Around mid-term the students will present their ideas to the instructor, who will guide them towards achievable project goals. Students will prepare both a written description of the project results and a brief oral presentation delivered to the class [The form of the later might depend on class size]. It will show that the students are capable of designing a GIS workflow to address a sustainable science problem.

Evaluation/Grading

Participation (10%)

Participation will be graded on a scale of 0-100%. Participation includes class attendance and active discussions in class. The students are expected to show critical thinking, respectful interactions with classmates and a positive attitude towards learning and freely discussing the topics proposed. Students are encouraged to share the critical questions from their assignments with their peers.

Class and homework assignments (20%)

Class and homework assignments will be graded on a scale of 0-100%. The grade will be based on completes and correctness of the results.

Midterm Paper (30%)

The midterm paper will be judged on a scale of 0-100%. The midterm paper should be prepared as a report on the first case study. It should include introduction, data and methods, results and discussion section. The grade will depend on completeness and correctness of the different sections. Approximately one-third of the evaluation will be based on the clarity of the written work. Instructor comments will be returned with the graded work and should be used as guidance for the final project paper.

Final Project Paper and Presentation (40%)

Both the written final project report (two-thirds of the final project grade) and the class presentation (one-third of the final project grade) will be graded on a scale of 0-100%. The written report will be graded based on completeness (i.e., including background and motivation, methods, results, conclusions and references) and correct use of methods and interpretation of the results. The class presentation will be graded based on clarity, quality of the presentation materials, finishing in a timely manner, and responses to audience questions.

The final grade will be calculated as described below:

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

ASSIGNMENT	% Weight
Class participation	10
Homework and lab assignments	20
Mid-term paper	30
Final project and presentation	40

Course Policies

Participation and Attendance
I expect you to come to class on time and thoroughly prepared. I will keep track of attendance and look forward to an interesting, lively and confidential discussion. You are expected to complete all assigned readings, attend all class sessions, and engage with others in discussions. If you miss an experience in class, you miss an important learning moment and the class misses your contribution. If you need to miss a class for any reason, please discuss the absence with me in advance.

Late work
Work that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor will be graded down the equivalent of 1/3 of a grade for every day it is late (e.g., from a B+ to a B).

Citation & Submission
All written assignments must cite sources and be submitted to the course website (not via email).

School Policies

Copyright Policy
Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity
Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It

is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.

Diversity Statement

It is our intent that students from all diverse backgrounds and perspectives be well-served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that the students bring to this class be viewed as a resource, strength and benefit. It is our intent to present materials and activities that are respectful of diversity: gender identity, sexuality, disability, age, socioeconomic status, ethnicity, race, nationality, religion, and culture.

Course Schedule/Course Calendar

Date	Topics and Activities	Readings	Assignments (due on this date)
wk 1 Jan 16	Course introductions Intro GIS and spatial data First steps with software	Notes on Canvas (class 1) (Heywood, chapter 1)	
wk 2 Jan 23	GIS basics spatial data, tables, databases, census data	Notes on Canvas (class 2) (Heywood, chapter 2 & 3)	Assignment from previous class
wk 3 Jan 30	Intro into first case study Projections Map creation Symbolizing data	Notes on Canvas (class 3) (Heywood chapter 2 & 8)	Assignment from previous class
wk 4 Feb 6	Data creation and editing GPS data	Notes on Canvas (Heywood chapter 4 & 5)	Assignment from previous class
wk 5 Feb 13	Spatial analysis: Data selection and info Data overlay, extraction	Notes on Canvas (Heywood, chapter 6)	Assignment from previous class
wk 6 Feb 20	Spatial analysis: Proximity and statistics	Notes on Canvas (Heywood, chapter 6)	Assignment from previous class
wk 7 Feb 27	Intro raster data DEM, Visualizing raster data	Notes on Canvas (Heywood, chapter 3)	Assignment from previous class
wk 8 Mar 5	Raster analysis (zonal statistics)	Notes on Canvas (Heywood, chapter 6)	Report on first case study
Mar 12	Spring break		
wk 9 Mar 19	Raster calculation (work on project)	Notes on Canvas	Assignment from previous class
wk 10 Mar 26	Interpolation (work on project)	Notes on Canvas (Heywood, chapter 6)	Assignment from previous class
wk 11 Apr 2	Spatial models (work on project)	Notes on Canvas (Heywood, chapter 7)	Assignment from previous class
wk 12 Apr 9	web GIS (work on project)	Notes on Canvas (Heywood, chapter 13)	Assignment from previous class

wk 13 Apr 16	Outlook on advanced GIS techniques, 3D visualization (work on project)	Notes on Canvas	
Wk 14 Apr 23	Last class Project presentations		Final project presentation
	(Work on final report)		Final project paper due TBD

* chapters in Heywood et al. are optional reading suggestions