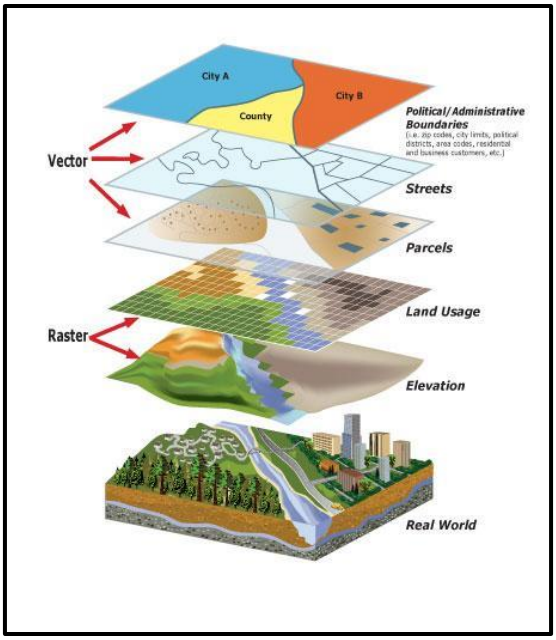
COLUMBIA UNIVERSITY
School of Professional Studies

Master of Science in Sustainability Management

GIS For Sustainability Management SUMA 5205
Wednesday 6.10pm – 8pm
Engineer Terrace 252
3 credits

Instructor:	**Dr. Fabien Cottier** fcottier@cieisin.columbia.edu
Office Hours:	Friday 9am-11am (by appointment over zoom)
Response Policy:	Contact instructor per email. Will respond within 24 hours.
Teaching Assistant	**Yue Yu**. yy3397@columbia.edu
Office Hours:	By appointment over zoom
Response Policy:	Contact TA per email. Will respond within 24 hours.



Course Overview

The use of maps to display, convey and examine spatial information has been a recurrent feature since the dawn of history and is ubiquitous for scientific research from natural sciences to the human and social sciences. Maps provides a way to summarize spatial information and identify trends and patterns in the data. Similarly, most of our data (from google maps entries to tabular data to texts and speeches) are explicitly or implicitly geo- referenced. The ability to leverage these spatial references allows us to identify and study patterns in the data.

Geographic Information Systems (GIS) are a set of modern tools to collect, store, analyze and display spatial information. As part of the class, students will receive a comprehensive introduction to GIS. Through a mixture of lectures, readings, focused discussions, and hands-on exercises, students will acquire an understanding of the variety and structure of spatial data and databases, gain knowledge of the principles behind raster- and vector-based spatial analysis and learn basic cartographic principles for producing maps that effectively communicate a message.

In addition, students will learn to use the software ArcGIS Pro and leverage web-based GIS tools such as ArcGIS Online and similar tools to develop online interactive maps and graphics. Case studies examined in class will draw examples from a wide range of GIS applications developed to assist in the design, implementation and evaluation of sustainable development projects and programs.

While the course will be taught using ArcGIS, students already possessing knowledge of GIS tools may freely use alternative GIS softwares, such as QGIS, PostGresSQL/PostGIS or GIS packages for R or Python. However, students should be aware that no support will be provided for these tools as part of this class.

Students are encouraged to contact Fabien, if they have particular topics or questions they would like to address during class. Likewise, in view of increasing the utility of the short-course, participants are welcome to bring their own data to the short-course to discuss how GIS tools may be useful for describing their own data and research results, as well as conducting analyses.

Learning Objectives

As the end of the class students are expected to be able to:

- Have a basic understanding of geodesy and map projection and be able to select an appropriate projection for the problem that they are examining.
- Efficiently summarize spatial information and produce thematic maps on ArcGIS.
- Distinguish between various forms of spatial data (e.g. vectors, rasters) and understand their respective advantages and limitations.
- Perform overlay analysis with both vector data and raster data.
- Perform spatial queries on vector-based spatial data, as well as use spatial join to combine information from different sources of spatial data (layers).
- Understand the basic map algebra and resampling of raster datasets.
- Perform zonal and focal statistics operations.
- Have a basic understanding of spatial statistics.

Recommended readings

Burrough, P. A., McDonnell R. A. and Lloyd, C. D. 2015. Principles of geographical information systems. Oxford university press.

Chang, K., 2014. Introduction to Geographic Information Systems. McGraw-Hill: New York, NY, USA. Chapter 3, Vector Data Model & Chapter 4, Raster Data Model.

Course policies and assignments

1. Attendance and Participation

   Attendance and participation in this course are mandatory and will comprise 5% of the final grade. Students are expected to attend classes synchronously each week unless they have received permission from the instructor to make other arrangements in advance.

   Students will be assigned weekly readings or videos to be completed/viewed in advance of each class session.

2. Lab Exercises

   Students are required to submit weekly hands-on GIS exercises using the ESRI E-Learning online learning system. The topics will cover many applications of GIS technology. The cumulative lab tutorials grade equals 20% of the final grade. Labs are due on Wednesday 6 pm before class.

3. Mid-term exam

   There will be one midterm exam. It will comprise 35% of the final grade. The exams will require students to draw on the knowledge gained from lectures, labs, reading/videos, and class discussions to successfully answer a variety of multiple choice, short answer, essay, etc. questions and independently complete a spatial analysis/mapping exercise.

4. Term project

Students will be required to complete a GIS project on a research question of their choice and present the results to the class using an ArcGIS Story Map. This project offers an opportunity for students to apply GIS techniques learned during the class and apply it to a problem examined in other classes or of interest to them. This term project involves the following tasks:

Review of the literature: at least 5 articles on theme chosen by the students. 2 pages. 5% of final project grade.

Data Review: Identification and acquisition of data relevant to the proposed research question. 2 page memo with citations and bullet list of steps taken to obtain relevant data and preprocessing requirements. 5% of final grade.

Project Proposal: A 2-4 page memo outlining the proposed research question and study area, with a detailed workflow proposal/diagram. 10% of the final grade

An ESRI Story Map: will be used to make a presentation of research results during the last week of class. This will comprise 20% of the final grade

5. Late submission
   Assignments that are not submitted on the due date and time noted in the course syllabus without advance notice and permission from the instructor will receive a 20% penalty to the grade per day late. For the mid-term exam and final project, the penalty is 20% per hour late. Emergency and other exceptional circumstances are reserved, the student must, however, contact the instructor at the earliest opportunity.

6. Citation & Submission

   All written assignments must use standard citation format (e.g., MLA, APA, Chicago), cite sources, and be submitted to the course website (not via email).

Grading

In order to succeed the class, the students will have to meet the following requirements:

(1) Active participation in-class (5%)

(2) Submission of labs tutorial (20%)

(3) Mid-term exam (35%)

(4) Group-based project (40%)

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

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.

Class Help and Other Resources:

A discussion board is available for this class on our CourseWorks site to foster conversations, knowledge growth, and information-sharing. Use this site to post questions, answers questions, make comments, or share items of interest. Additionally, there are many extremely helpful online communities, listservs, and help desks dedicated to assisting GIS user that will be discussed in class.

Electronic Data Services (EDS): Electronic Data Service (www.columbia.edu/acis/eds) is located in the basement of Lehman Library and is a great resource for GIS data. EDS also has technical consultants available during regularly scheduled hours for questions regarding the acquisition of data, as well as the technical questions related to performing specific GIS tasks. The lab has computers available where you can use GIS software

Equipment
Computers are necessary for this course. Students will connect to Online GIS and remotely access computers with the ArcGIS software installed to complete assignments and lab exercises.

Course Schedule/Course Calendar

	Session	Class	Lab	Reading
1	Sep 6	Introduction to GIS ***Discussion board***	Esri E-Learnings: *ArcGIS Pro Basics*	Chang, ch.2 Foresman, ch.5 (pp.63-79)
2	Sep 13	Introduction to ArcGIS Pro and file format: creation & edition	Esri E-Learnings: *ArcGIS Pro Basics* *Editing Basics in ArcGIS Pro*	Chang, ch.3 Longley, ch. 9 Kurland ArcGISPro Video (see coursework file)
3	Sep 20	Visualizing GIS data	Esri E-Learnings: *Symbolizing Map Layers* *Creating a Map Layout*	Peters 2004 Brewer, ch.1 and ch.4 (especially pages 67-78)
4	Sep 27	Projection & coordinates systems *Guest Lecturer: Kytt McManus*	Esri E-Learning: *Introduction to Coordinate Systems*	Kurland Map Projections Video Hayword & Parent 2009 Chang, ch.2 (review)
5	Oct 4	Vector data analysis I ***Literature Review due***	Esri E-Learning: *Getting Started with Spatial Analysis* *Understanding Spatial Relationship*	Mitchell, ch.1 Foresman, pp.80-94 Chang ch 3, pp.50- 57 (review) YouTube Videos (see Reading List)
6	Oct 11	Vector data analysis II	*Custom lab assignment*	Longley et al. 2015, Ch 13 (especially 291-307)
7	Oct 18	Vector data analysis III & Model builder ***Data Review due***	*Custom lab assignment*	—
8	Oct 25	**Mid-term review**	No assignment	
9	Nov 1	Raster data analysis I	Custom lab assignment:	Chang, ch.4 Artigas 2016

		Midterm exam due		Maguiri 2016
10	Nov 8	Raster data analysis II ***Project Proposal due***	Custom lab assignment: *Custom lab assignment*	Burrough et al 2015., ch. 10
11	Nov 15	WebGIS & StoryMap	Esri E-Learning: Sharing Maps & Layers with ArcGIS Pro (Only the section "Sharing Map Content for Generating Apps") Get Started with ArcGIS StoryMaps	Fu, ch.1 and ch.3 Video: Living Atlas of the World: An Introduction
	Nov 22	Academic holiday, No class		
12	Nov 29	Spatial statistics	Esri E-Learning: *Mapping Clusters: Hotspot and Cluster and Outlier Analysis*	Mitchell, ch.4 Rosenshein 2011
13	Dec 6	Open-source GIS & Conclusion		TBD
14	TBD	**Term project due**		

School and University Policies and Resources

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 https://sps.columbia.edu/students/student-support/academic-integrity-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.

Diversity Statement
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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: https://health.columbia.edu/content/disability-services.

Class Recordings
All or portions of the class may be recorded at the discretion of the Instructor to support your learning. At any point, the Instructor has the right to discontinue the recording if it is deemed to be obstructive to the learning process.

If the recording is posted, it is confidential and it is prohibited to share the recording outside of the class.

SPS Academic Resources

The Division of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: https://sps.columbia.edu/students/student-support/student-support-resources.

Columbia University Information Technology
Columbia University Information Technology (CUIT) provides Columbia University students, faculty and staff with central computing and communications services. Students, faculty and staff may access University-provided and discounted software downloads.

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.

The Writing Center
The Writing Center provides writing support to undergraduate and graduate students through one-on-one consultations and workshops. They provide support at every stage of your writing, from brainstorming to final drafts. If you would like writing support, please visit the following site to learn about services offered and steps for scheduling an appointment. This resource is open to Columbia graduate students at no additional charge. Visit http://www.college.columbia.edu/core/uwp/writing-center.

Career Design Lab
The Career Design Lab supports current students and alumni with individualized career coaching including career assessment, resume & cover letter writing, agile internship job search strategy, personal branding, interview skills, career transitions, salary negotiations, and much more. Wherever you are in your career journey, the Career Design Lab team is here to support you. Link to https://careerdesignlab.sps.columbia.edu/

Netiquette
Online sessions in this course will be offered through Zoom, accessible through Canvas. A reliable Internet connection and functioning webcam and microphone are required. It is your responsibility to resolve any known technical issues prior to class. Your webcam should remain turned on for the duration of each class, and you should expect to be present the entire time. Avoid distractions and maintain professional etiquette.

Please note: Instructors may use Canvas or Zoom analytics in evaluating your online participation.

More guidance can be found at: https://jolt.merlot.org/vol6no1/mintu-wimsatt_0310.htm

Netiquette is a way of defining professionalism for collaborations and communication that take place in online environments. Here are some Student Guidelines for this class:

- Avoid using offensive language or language that is not appropriate for a professional setting.
- Do not criticize or mock someone's abilities or skills.
- Communicate in a way that is clear, accurate and easy for others to understand.
- Balance collegiality with academic honesty.
- Keep an open-mind and be willing to express your opinion.
- Reflect on your statements and how they might impact others.
- Do not hesitate to ask for feedback.
- When in doubt, always check with your instructor for clarification

References:

Artigas, F., Bosits, S., Kojak, S., Elefante, D., & Pechmann, I. (2016). Conveying flood hazard risk through spatial modeling: a case study for Hurricane Sandy-affected communities in northern New Jersey. Environmental management, 58(4), 636-644.

Brewer, Cynthia A., 2015. Designing Better Maps: a Guide for GIS users. ESRI Press: Redlands, CA, USA. Chapters 1 and 4.

Burrough, P. A., McDonnell R. A. and Lloyd, C. D. 2015. Principles of geographical information systems. Oxford university press.

Chang, K., 2014. Introduction to Geographic Information Systems. McGraw-Hill: New York, NY, USA. Chapter 3, Vector Data Model & Chapter 4, Raster Data Model.

Foresman, J. & UNEP. 2002. My Community Our Earth: A Student Project Guide to Sustainable Development and Geography. Chapter 5: GIS for Beginners

Fu, P. & Sun, J. 2011. Web GIS Principles and Applications. Redlands CA, ESRI Press. Chapter 1: GIS in the Web Era.

Longley, P, et al. 2011. Geographic Information Systems & Science. Wiley & Sons Inc. NJ. Chapter 9: GIS Data Collection.

Hayward, P., & Parent, J. (2009). Modeling the influence of the modifiable areal unit problem (MAUP) on poverty in Pennsylvania. The Pennsylvania Geographer, 47(1), 120-135.

Hicken, E. Date Unknown. GIS (Geographical Information Systems) As a Facilitation Tool for Sustainable Development in Africa. Obtained on August 12, 2014 from http://www.aag.org/galleries/gdest/Hickenpaper.pdf

Maguiri, A., Kissi, B., Idrissi, L., & Souabi, S.. 2016. Landfill site selection using GIS, remote sensing and multicriteria decision analysis: case of the city of Mohammedia, Morocco.

Bulletinof Engineering Geology and the Environment. Vol. 75, pp. 1301 - 1309.https://doi.org/10.1007/S10064-016-0889-Z

Mitchell, A. 1999. The ESRI Guide to GIS Analysis Volume 1: Geographic Patterns and Relationships. Redlands CA, ESRI Press. Chapter 1: Introducing GIS Analysis.

Mitchell, A. 2009. The ESRI Guide to GIS Analysis. Volume 2: Spatial Measurements and Statistics Redlands CA, ESRI Press. Chapter 4: Identifying Clusters.

Peters A, & MacDonald H. 2004. Unlocking the Census with GIS. Redlands CA, ESRI Press. Chapter 1: The census: An Introduction.

Rosenshein, L., Scott L., & Pratt, M. 2011. Finding a Meaningful Model. ArcUser Winter 2011. Obtained on January 10, 2020 from https://www.esri.com/news/arcuser/0111/files/findmodel.pdf

Solis, P, McCusker, B., Nwasinachi, M., Cowan, N., & Blevins, C. 2018. Engaging global youth in participatory spatial data creation for the UN sustainable development goals: The case of open mapping for malaria prevention. Applied Geography. Vol. 90, pp. 143-155.https://doi.org/10.1016/j.apgeog.2018.07.013

Steiniger S., Hunter A.J.S. 2012 Free and Open Source GIS Software for Building a Spatial Data Infrastructure. In: Bocher E., Neteler M. (eds) Geospatial Free and Open Source Software in the 21st Century. Lecture Notes in Geoinformation and Cartography. Springer, Berlin,

Heidelberg. Obtained January 10, 2020 from https://doi.org/10.1007/978-3-642-10595-1_15 United Nations. 2016. Activities related to Sustainable Development and the 2030 Agenda for

Sustainable Development. Obtained on August 5, 2016 from http://ggim.un.org/docs/meetings/GGIM6/E-C20-2016-11%20SD%20and%202030%20Development%20Agenda.pdf

YouTube videos:

Week 5: Spatial Analysis: Vector

ArcGIS Pro: Using Dissolve to Aggregate & Summarize Data (~5 minutes) - https://www.youtube.com/watch?v=qdpA2P2WbdY

Vector Geoprocessing in ArcGIS Pro: Buffer & Overlay (~6 minutes) - https://www.youtube.com/watch?v=vdM6hOkL_6U

Optional and recommended: Scale Matters (~22 minutes) - http://youtu.be/blF0fXMCFZU

Weeks 11&12: WebGIS

Living Atlas of the World: An Introduction (45 minutes) https://www.esri.com/training/catalog/617872207f30895ce2dc9275/arcgis-living-atlas-of-the-world%3A-an-introduction/