GEOG/IB 476, Applied GIS to Environmental Studies (Spring 2022)

Motivation: Global human populations have more than doubled since the 1960s, (2019: 7.7 billion) and projected to approach 10 billion by 2050. Due to the demand of natural resources needed to sustain global populations, the rate of environmental degradation has increased (e.g., land use change, climate interactions) and will be magnified in the future. To combat this global crisis, analysts with the knowledge and creativity to develop innovative solutions using the latest technology, tools, and platforms will be better equipped to address pressing environmental and ecological issues. Therefore, this course will begin to develop the skills necessary for students to engage with the wealth of cutting-edge geospatial data and new powerful and transferable open source geospatial platforms such as R and Google Earth Engine (GEE). We will capitalize on the growing "data revolution", as many "big data applications" are enabling better, faster, and more sophisticated solutions from regional to global environmental and ecological problems.

Applied GIS to Environmental Studies is strategically developed to broaden the perspectives of students interested in learning how to exploit geospatial and remote sensing data products to advance knowledge in fields of Earth Sciences (i.e. geography, ecology, hydrology, geology, glaciology, etc.). We will use open source, freely available datasets and image processing platforms to address regional to global-scale environmental problems. This course will challenge students to think creatively and multi-dimensional, with hands on projects and assignments that will be reinforced by lectures, readings, and tutorials. Importantly, students will engage with all environmental applications using an inquiry-based learning perspective. In order to achieve this goal, students will gain experience 1) evaluating the strengths and weakness of geospatial data products, 2) identifying datacenters for data download, 3) pre/post processing of data, 4) initiating spatial analyses, 5) synthesizing and exporting data, and 6) interpreting spatiotemporal patterns and uncertainties to a pseudo-stakeholder(s)/decision maker(s). **The objective of this course is to provide the necessary knowledge, direction, and experience for students to cultivate the necessary analytical skills for addressing environmental and/or ecological problems using powerful geospatial solutions in their future endeavors.**

Instructor:

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Overarching Learning Outcome

Knowledge of how to obtain, integrate, analyze, and interpret Geographic Information System (GIS) and Remote Sensing (RS) data for addressing environmental and/or ecological applications using open source platforms (R and GEE). *This will be achieved with the following learning outcomes:*

- Identify where GIS and RS data exists and their strengths and weaknesses.
- Learn basic R scripts needed to transform R into a GIS.
- Learn basic javascripts needed to interact and analyze big data applications in GEE.
- Formulate a GIS and RS approach for addressing/resolving an environmental and/or ecological problem(s).
- Learn to work as a team!

Course Logistics:

GEOG/IB 476 will meet 12:30 to 1:50pm in room 1020 Natural History Building. *Please bring laptop computers to class.* Due to university recommendations, week 1 of classes will be implemented remotely (via Zoom). Dr. Lara will be in touch with greater details on Monday January 17th. Contact Dr. Lara for approval of excused absences from lecture and/or assignment deadlines. *For emails, please start subject as "GEOG 476" or "IB 476"*.

Textbook(s)

Required textbooks are as follows:

1) "Remote Sensing and GIS for Ecologists: *Using Open Source Software*", eds Martin Wegmann, Benjamin Leutner, and Stefan Dech (2016). Exeter: Pelagic publishing. ISBN 978-1-78427-022-3

2) " Google Earth Engine Applications", eds Lalit Kumar and Onisimo Muanga (2019). Exeter: MDPI. ISBN 978-3-03897-885-5 (freely available online via .pdf).

Prerequisites: GEOG 224 Environmental Data Science is recommended (familiarity with R programming) and any additional GIS and Remote Sensing course will be beneficial.

Grading

	Points
Project 1	30
Project 2	30
Participation	10
Weekly Assignments	20

Quizzes	10
Total	100

Two projects will derive the majority of your grade in this course. You will be given all participation points at the start of the semester, but the accumulation of unexcused absences will linearly depreciate this score. You will be given weekly to bi-weekly assignments in R or Google Earth Engine to demonstrate your understanding of the material, which will be posted to Moodle. Students that are engaged with lecture and assignments (reinforced by readings) will perform well in the projects and in the course. See the calendar for due dates. We will follow the typical letter grading scheme: A = ≥90, B = 89-80, C = 79-70, D = 69-60, F = ≤59.

Schedule subject to change!

Date	Day	Week	Assignment Due	Quiz	Topic	Readings
18-Jan	T	1	1	1	Motivation	
20-Jan	TH	1	2		Introduction to GIS and Remote Sensing I	Wegmann: ch 2
25-Jan	T	2		2	Introduction to GIS and Remote Sensing II	
27-Jan	TH	2			Spatial Data and Software	Wegmann: ch 1
1-Feb	T	3	3		Where to obtain spatial data?	Wegmann: ch 3
3-Feb	TH	3	4		Inquiry-driven spatial analysis	Wegmann: ch 4
8-Feb	T	4		3	Spatial data analysis & Project 1 (local-scale application)	Young et al., 2017, Wegmann ch4
10-Feb	TH	4			Pre-processing Remote Sensing Data & Field Data for Remote Sensing Data Analysis	Wegmann: ch 5 & 6
15-Feb	T	5	5	4	From Spectral to Ecological Information	Wegmann: ch 7; Gamon et al. 2019
17-Feb	TH	5			Land Cover & Image Classification Approaches 1	Wegmann: ch 8, Kumar: Robinson et al., 2017
22-Feb	T	6	6		Land Cover & Image Classification Approaches 2	
24-Feb	TH	6		5	Land Cover Change or Change Detection/ Analysis	Wegmann: ch 9
1-Mar	T	7	7		Continuous Land Cover Information	Wegmann: ch 10

3-Mar	TH	7		6	Spatial Analyses in R finale	
8-Mar	T	8			Project 1 wrap-up	
10-Mar	TH	8	Project 1		Project 2 (regional-scale application)	
15-Mar	T	9			***Spring break!***	
17-Mar	TH	9				
22-Mar	T	10			Javascript in Google Earth Engine	Kumar & Mutanga, 2018
24-Mar	TH	10				
29-Mar	T	11	8		Importing and Exporting vector, raster, and attribute data in Earth Engine	Tutorials will be posted
31-Mar	TH	11				
5-Apr	T	12	9	7	Big Data synthesis and analysis	Tutorials will be posted
7-Apr	TH	12				
12-Apr	T	13	10		Big Data: charting and exporting	Tutorials will be posted
14-Apr	TH	13		8		
19-Apr	T	14			Big Data: Environmental Applications	Hansen et al., 2013
21-Apr	TH	14		9		Lara et al., 2019, TBD
26-Apr	T	15			The future of geospatial analyses	
28-Apr	TH	15			**Video Presentations/Judging**	
3-May	T	16		10		
5-May	TH	16	Project 2		Discussion	

Schedule subject to change!

Projects

Project 1 will be completed individually, while Project 2 as a group. You will be challenged to address pressing environmental and/or ecological problem(s) posed by your instructor. Single or multiple scenario(s) will be described for Project 1, giving the student the discretion to select the scenario most interesting and relevant to address using R. A small proportion of our weekly meeting times will be devoted to Project development. ***Project 1 grading*** will be based on application *novelty* (20%), application transparency (20%) by providing either *code* (organization, readability, commenting if using R) or graphical *conceptual model* (stepwise data processing workflow if using QGIS), *products* (maps, figures, graphs, other; 20%), and *interpretation* of results (40%). *Graduate students will write a 3-4 page paper interpreting and discussing results, while undergraduates will only be responsible for a 2-3 page paper.*

Project 2 will address regionally-specific environmental challenges from three different biomes using Google Earth Engine. This group project will evaluate multiple environmental drivers of landscape change in the urbanized continental United States (U.S.), Arctic tundra, or the Tropical rainforest to address concerns of stakeholders (i.e., U.S. Fish and Wildlife Service, Landscape Conservation Cooperatives, National Interagency Fire Center, Federal Emergency Management Agency, Brazilian Institute of Environmental and Renewable Natural Resources, and the Intergovernmental Panel on Climate Change). *Graduate students will be responsible for organizing, overseeing, and allocating work within group projects and co-leading a class discussion (5-May) over similarities, differences, and implications of spatial patterns of change identified by all groups.* **Project 2 grading** will be similarly based on application *novelty* (10%), *code* (20%), *products* (15%), *interpretation* (25%), *presentation* (20 %), and overall *clarity* of the presentation (interpretations and results) as scored by the class (10%). Due to the collaborative nature of project 2, group members will "grade" their counter parts from 1 to 0, based on their contribution to the overall project. The average score for each group member will be used as a scaling factor to modify the individuals overall score for project 2. For example, if the group "GeoWizards" received an overall score of a 90 on project 2, but group member Charlie Manson decided to only minimally contribute at the start of the project as he was "busy" committing untold crimes… his group may have scored him a 0.3 or 30% participation grade. This would adjust his overall project 2 grade to a 27! Therefore, it is imperative to have a clear overall game plan (led by a graduate student or group leader) and that all group members are aware of their responsibilities and expectations. The group leader will coordinate 1) what tasks need to be accomplished, 2) when tasks need to be completed, 3) who will complete each task, and 4) organize meeting times for all members to integrate, interpret, and articulate results to address the proposed environmental/ecological challenge.

Attendance is not mandatory. However, both your overall participation grade and group participation grade (Project 2) will be impacted by absences.

Academic Integrity

According to the Student Code, `It is the responsibility of each student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.' Please know that it is my responsibility as an instructor to uphold the academic integrity policy of the University, which can be found here: http://studentcode.illinois.edu/article1_part4_1-401.html

Disability Accommodations

To ensure that disability-related concerns are properly addressed from the beginning, students with disabilities who require assistance to participate in this class are asked to see me as soon as possible.