GEOG/IB 476, Applied GIS to Environmental Studies (Spring 2020)

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, rates of environmental degradation have increased directly (via land use change) and indirectly (via climate), which 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, QGIS, and Google Earth Engine (GEE). We will capitalize on the growing "data revolution", as data are getting bigger, faster, and more detailed than ever before, enabling better, faster, and more sophisticated solutions to local 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 the exponentially growing geospatial data products for applications in fields of Earth Sciences (i.e. geography, ecology, hydrology, geology, glaciology, etc.). We will use publicly available datasets and platforms for learning to address local, 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 and readings. Importantly, students will engage with all environmental applications from 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:

Dr. Mark J. Lara
Office: 155 Morrill Hall, 505 S. Goodwin Ave.
Department of Plant Biology
Department of Geography and GIS
Phone: 217.244.2082
Office hours: TR 2-3pm

Overarching Learning Outcome

Knowledge of how to obtain, integrate, analyze, and interpret GIS and Remote Sensing data for addressing environmental and/or ecological applications using open source platforms (R, QGIS, 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.

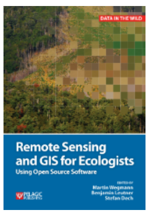
- Formulate a GIS and RS approach for addressing/resolving an environmental and/or ecological problem(s).
- Learn to work as a team!

Course Logistics:

GEOG/IB 476 will meet TR 12:30 to 1:50pm (room TBA). *Please bring laptop computers to class.* Contact Dr. Lara for approval of excused absences from lecture and exams. Take advantage of office hours for questions and comments, as appointments will be limited. *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: GIS and Remote Sensing courses will be beneficial, but not essential prerequisites for this course.

Grading

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, QGIS, or Google Earth Engine to demonstrate your understanding of the material, which will be posted to Moodle. Students that are engaged with lecture, readings, and assignments will likely perform well in projects. 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.

	Points
Project 1	30
Project 2	30
Participation	10
Weekly Assignments	20
Quizzes	10
Total	100

Weekly Schedule (warning: subject to change)

Date	Day	Assignment	Quiz	Project	Topic	Readings
					Unit 1: Introduction to Environmental Geospatial Analysis	
21-Jan	T		1		Course Introduction and Motivation	
23-Jan	TH				Introduction to GIS and Remote Sensing of the	Wegmann: ch 2
28-Jan	T				Environment	Wegmann: ch 2
30-Jan	TH	1	2		Spatial Data and Software	Wegmann: ch 1
4-Feb	T				Geospatial Environmental Applications	
6-Feb	TH				Where to obtain spatial data?	Wegmann: ch 3
11-Feb	T	2	3		Inquiry-driven spatial analysis	Wegmann: ch 4
13-Feb	TH					
					Unit 2: Local-scale Geospatial Analysis	
18-Feb	T	3	4		**Introduction to Project 1**	
20-Feb	TH				Pre-processing Remote Sensing Data	Wegmann: ch 5; Young et al., 2017
25-Feb	T	4			Field Data for Remote Sensing Data Analysis	Wegmann: ch 6
27-Feb	TH	5			From Spectral to Ecological Information	Wegmann: ch 7; Kumar: Robinson et al., 2017
3-Mar	T	6			Land Cover or Image Classification Approaches	Wegmann: ch 8
5-Mar	TH	7	5		Land Cover Change or Change Detection	Wegmann: ch 9
10-Mar	T	8			Continuous Land Cover Information	Wegmann: ch 10
12-Mar	TH	9	6		Time Series Analysis	Wegmann: ch 11
17-Mar	T	10		1	Spatial Land Cover Pattern Analysis	Wegmann: ch 12
					Unit 3: Regional-scale Geospatial Analytics	
19-Mar	TH	11	7		**Introduction to Project 2**	
24-Mar	T				Javascript in Google Earth Engine	Kumar & Mutanga, 2018
26-Mar	TH					
31-Mar	T	12			Importing and Exporting vector, raster, and attribute data in Earth Engine	
2-Apr	TH		8		Global Forest Change	Hansen et al., 2013
7-Apr	T					Kumar: TBD
9-Apr	TH					Kumar: TBD
14-Apr	T	13			Big Data: Environmental Applications	Kumar: TBD
16-Apr	TH		9			Lara et al., 2019
21-Apr	T				Group Presentations	
23-Apr	TH	14	10	2		
28-Apr	T				Advances and future challenges for Earth Observing Systems	
30-Apr	TH				Synthesize, Interpret, Articulate	
5-May	T				Discussion	

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 in either R or QGIS. 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 regional-specific environmental challenges in three different biomes in 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 the 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 contribute only briefly at the beginning of the project as he was "busy" committing untold crimes… His group gave 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 clear overall game plan (lead by a graduate student or group leader) and 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 complete, 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.