ESS 420 – Introduction to Geographic Information Systems for the Earth Sciences
Autumn Quarter 2018
Lectures: Mondays and Wednesdays, 2:30-3:50, JHN 175
Labs: Section A – Tuesdays and Thursdays, 10:30-12:20, JHN 021
Section B – Tuesdays and Thursdays, 2:30-4:20, JHN 021
5 Credits

Instructor:
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Canvas website: https://canvas.uw.edu/courses/1220941 (or via list of courses on http://canvas.uw.edu/)

Course Overview:
Earth systems phenomena generally do not occur in uniform patterns, but are instead heterogeneously distributed across space. Hence, the ability to examine and analyze these spatial patterns is an incredibly useful tool for earth scientists – and one such analytic tool at our disposal is the use of geographic information systems (GIS). This course provides an introduction to the use of GIS in the geologic and other earth sciences. We begin by covering the basics of GIS, including the way spatial data are represented and stored, the software tools available, and some of the fundamental methods of analysis. This introduction will also include some of the theoretical aspects of GIS. The bulk of the course will then explore various earth science applications of GIS. Topics include discussion of imported data for GIS analysis, introductions to analyses of topography and hydrologic flow, mapping and general cartography, and a brief overview of other geomorphic phenomena for which GIS analyses can serve as a useful if not essential tool.

The practical nature of GIS usage means that this course will be very hands-on in structure, with in- and outside-class computer lab activities comprising the bulk of the instruction. Lectures and in-class discussions will also cover significant aspects of the course content. Course activities will consist of a number of lab exercises related to each week's topics, a midterm and final exam, and an independent class project. Collectively these activities will help students to become comfortable in the skills necessary to perform spatial analyses for a wide range of earth science problems and questions.

Who Takes this Course:
The course is intended for upper-level undergraduates and graduate students in Earth and Space Sciences, as well as in other disciplines in the College of the Environment.

However, much of the material is also relevant to and useful in other scientific disciplines. Regardless of one's area of expertise/interest, GIS skills are all but essential, and thus it is anticipated that most students in the Department will want to take this and potentially a more advanced course at some point.

What You Will Study in the Course:

1. Fundamentals of spatial relationships in earth systems phenomena;
2. Importance of spatial context, and principles of geospatial analysis in addressing such context;
3. Issues of scale;
4. Some basic theory of GIS, including data types, their underlying coordinate systems, their strengths and limitations for specific applications, and ways in which they are analyzed;
5. Sources and types of earth science data amenable to/used in GIS analysis;
6. Geologic surface analyses;
7. Hydrologic modeling and mapping;
8. Basic mapping and cartographic principles.

Learning Goals/Objectives:

By the end of the course, students should:

1. Gain a fundamental understanding of geospatial analysis principles and techniques;
2. Have a basic understanding or better of spatial and tabular data used in GIS;
3. Know the basics of using ArcGIS software (ArcMap, ArcCatalog, ArcToolbox);
4. Be able to perform essential data manipulations, analyses and graphical presentation skills, particularly with respect to earth science data;
5. Learn of some key sources for earth and environmental science spatial data sets – including how they are collected as well as where some data repositories can be found – and sources and types of uncertainties therein;
6. Have a basic understanding of some of the fundamental uses of GIS in the earth sciences.

Additionally, the intent is to encourage students to begin to think about how GIS mapping and analysis techniques may be applied in their own work – hence the inclusion of an additional independent class project. The project goes beyond the step-by-step instruction that generally characterizes the lab exercises, and requires the students to apply what they have learned to expanded problems in the earth sciences (with suggestions and input from the instructor and other faculty as necessary).

Required Tools:

- A removable storage drive (either a USB flash-/thumb-drive or external hard drive) with at least 4GB of space; **AND/OR** access to the UW campus U drive (see http://itconnect.uw.edu/wares/online-storage/u-drive-central-file-storage-for-

users/ for details on setup and access; 50 GB total storage space) or the UW-sponsored Google Drive (see http://itconnect.uw.edu/connect/email/google-apps/google-drive/ for setup and access instructions; allows virtually unlimited storage space).

- Access to computing resources that include and can run the ArcGIS software suite. A number of computing labs in Johnson Hall, in the libraries (see http://guides.lib.uw.edu/research/gis/lab) and across campus provide access to the software. Students can also connect to the ESS remote desktop protocol (RDP) computing cluster, through which ArcGIS is also available; see https://wiki.ess.washington.edu/dokuwiki/doku.php?id=comphelp:remote_access:rdp_cluster for details and connection instructions. Lastly, students will receive a 1-year student license code to install and run ArcGIS on their own computers, should they wish to do so.
- Reliable access to email and course web pages.

Required Textbooks for Course:

- Paul Bolstad. 2016. GIS Fundamentals: A First Text on Geographic Information Systems, 5th Edition. Eider Press.
- Selected e-book chapters from Mastering ArcGIS (see below for full citation). These chapters provide the material for a number of the course's lab exercises. To purchase (about $17) and download the e-book, go to https://create.mheducation.com/shop/; in the box labeled "Looking for new materials?", type in the ISBN number 9781307284324 (**make sure to search for it using this method rather than by my name, etc. – otherwise you may find an old version of the text**). Follow the instructions provided at the website to obtain the materials (you'll receive the necessary accompanying data sets from the course's Canvas website when we're ready to begin those labs). *Note: although it's not required, it is highly recommended that you print this e-book at some point – access to it is limited to approximately one year, and you may wish to refer to the chapters at a later date (for future GIS courses/work, etc.).*

Recommended Supplemental Reading:

- Maribeth Price. 2019. Mastering ArcGIS, 8th Edition. McGraw-Hill.
  As a text on GIS tools and techniques in general as well as the fundamentals of ArcGIS, Mastering ArcGIS is a handy reference book. This book includes step-by-step tutorials as well as narrative video guides to exercises (on the accompanying DVD-ROM). As noted above, a number of in-class lab exercises will come from this text. Copies of this text should soon be available for use in the Suzzallo GIS Lab.
- Peter A. Burrough, Rachael A. McDonnell, and Christopher D. Lloyd. 2015. Principles of Geographic Information Systems, 3rd Edition. Oxford University Press.

Burrough et al. is a classic (but recently updated) introductory text on GIS. It includes extensive illustrations and graphics that make key concepts particularly accessible.

- Michael J. de Smith, Michael F. Goodchild, and Paul A. Longley. 2018. Geospatial Analysis: A Comprehensive Guide to Principles, Techniques and Software Tools, 6th Edition. Web resource: http://www.spatialanalysisonline.com/HTML/index.html.
  Extending well beyond (the basics of) GIS, this freely accessible web version of the eponymous text provides a wealth of information and reference material on all things geospatial.
- Paul A. Longley, Mike Goodchild, David J. Maguire, and David W. Rhind. 2010. Geographic Information Systems and Science, 3rd Edition. Wiley.
  Longley et al.'s book provides a clear introduction to those students interested in further exploring the science of GIS, and is a useful complement to the Bolstad course text. It also describes analytical principles and other applied uses of GIS.

Course Grading:

Grading will be based on lab exercises, midterm and final exams, and a class project. Students should potentially be able to complete lab exercises within the in-class lab sessions, but the materials for each will be due by the following week's Tuesday lab session (unless told otherwise). Late lab assignments will be accepted only if you contact the instructor prior to the time it is due (and you definitely should turn in your assignments no matter what); late projects and take-home exams will not be accepted. Though I encourage discussion and interaction on completing the labs, the completed exercises must be your own work. Class projects will consist of applied earth/environmental science analysis problems of your own choice; the subcomponents of the projects will include a brief outline statement of your selected topic (due ~1/3 into the quarter) and the final report itself. Undergraduate students will work in groups of 2 or 3; graduate students will undertake individual projects.

The grading breakdown is as follows:

- 35% lab exercises;
- 20% midterm exam;
- 25% class project;
- 20% final exam.

Students are expected to attend lectures and at least one lab session (ideally the first) in each week, although most labs will extend over one session and into at least part of the next. Although class participation and attendance are not part of your grade (except as a possible bonus), you will likely do much better in the course if you **do** attend, since it will be easier to get assistance and answers to questions in-class rather than outside of class. Additionally, you will be provided with a set of topical questions for some if not most weeks, which will form the basis of in-class discussions (and hence give you the opportunity to participate in class). All students are encouraged to email me with questions, and to take advantage of office hours.

Course Policies (some of this reiterated from above):

- With the exception of the first day, you are expected to do the weekly reading assignments and peruse/think about discussion questions prior to class; this practice will help you better grasp the material presented in lectures, and will provide food for thought for weekly discussion sessions.
- If extenuating circumstances arise that will necessitate turning something in late, contact the instructor as far in advance as possible. Again, however, late projects and exams will not be accepted.
- Be communicative! If you have difficulties that arise, of any type (e.g., with the material, attendance, etc.), for any reason, do not hesitate to contact the instructor. The sooner it's communicated, the sooner it can be addressed.
- Don't be shy about raising questions in class (though you are most welcome to email questions at any time as well). This is a very technically-oriented course (obviously), so if you have a question about something, somebody else is probably wondering the same thing.
- Be sure to frequently monitor your email and the class website for announcements. This is the primary way in which I communicate outside of class (even if I've also made the announcement in-class, and sometimes the announcement changes).
- Except for note-taking, please refrain from using computers during lectures. Additionally, please refrain from using all handheld devices during lectures; if you absolutely must return a phone call or text message, please excuse yourself from the classroom first. (These policies can be relaxed during lab sessions.)
- No "collaboration" of any kind on the work you turn in is allowed: this includes not only copying (or even paraphrasing) answers from past or current students, but also receiving assistance of any kind from other students. You may obtain information from online sources, but you should be sure to phrase such writing in your own words (again, no copying nor paraphrasing) and references are required. With the exception of work on exams, you may discuss with your classmates any materials that you like. However, the work you turn in must be completely your own. Violations of this policy must be reported to the College of the Environment and will result in disciplinary actions. Please contact me if you ever have questions about what is and isn't permissible; see below for more specific details with respect to University policies.

Policies on Access and Accommodation:

Your experience in this class is important to me. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course.

If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or

health impacts), you are welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or https://depts.washington.edu/uwdrs/. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between you, your instructor(s) and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

Official University Policies

Student Conduct

All UW students agree to abide by, and familiarize themselves with, the Student Conduct Code when enrolling at the University of Washington. All students in ESS courses are expected to abide by the Student Conduct Code (also known as WAC 478-121).

The possession, use, or distribution of controlled substances, firearms, and dangerous weapons will not be tolerated. Physical abuse, sexual harassment, or harassment of any kind, for any reason, will not be tolerated.

Violations will be immediately reported to the Community Standards and Student Conduct, and possibly the UW Police Department. The Student Conduct Code can be viewed at: http://apps.leg.wa.gov/WAC/default.aspx?cite=478-121

If you have questions or concerns regarding an alleged violation of the Student Conduct Code please contact your instructor, ESS Student Services (206-616-8511 or essadv@uw.edu), or Community Standards and Student Conduct (206-685-6194 or cssc@uw.edu).

Misconduct

At the University level, passing anyone else's scholarly work (which can include written material, exam answers, graphics or other images, and even ideas) as your own, without proper attribution is considered academic misconduct.

Plagiarism, cheating, and other misconduct are serious violations of the University of Washington Student Conduct Code (WAC 478-121). We expect that you will know and follow the UW's policies on cheating and plagiarism. Any suspected cases of academic misconduct will be handled according to UW regulations. For more information, see the College of the Environment Academic Misconduct Policy and the UW Community Standards and Student Conduct website: https://environment.uw.edu/intranet/academics/academic-integrity/academic-misconduct/.

Course Schedule (revised 10/29/2018):

Meeting Dates	Lecture and Associated Lab Topics	Readings	Due Dates
September 26-27	Fundamentals of geospatial analysis – spatial relationships & context; issues of scale	Bolstad Chs. 1 & 2	
October 1-4	Intro to ArcGIS; data types; sources of earth science data & their uncertainties	Bolstad Chs. 6 (249-251), 7 (pp. 297-310, 312-315, 318-327) & 14	Lab "0" due 10/2
October 8-11	Data queries; coordinate systems	Bolstad Chs. 8 & 3	Lab 1 due 10/9; Class project topic outline due 10/12
October 15-18	Basic GIS analyses 1	Bolstad Ch. 9	Lab 2 due 10/16
October 22-25	Midterm review		Lab 3 due 10/23; Midterm exam 10/24 (due 10/26 by 11:59PM)
October 29-November 1	Basic GIS analyses 2; Importing geospatial data	Bolstad Ch. 10	
November 5-8	Introduction to topographic analysis	Bolstad Ch. 11	Lab 4 due 11/6
November 13-15	Guest lecture (Wed): Dr. Ralph Haugerud, USGS		Lab 5 due 11/13
November 19-21	Introduction to hydrologic modeling	Bolstad Ch. 11	Lab 6 due 11/20
November 26-29	Mapping geospatial data	Bolstad Ch. 4 (pp. 183-189)	Lab 7 due 11/27
December 3-6	Other topics of earth science interest; course summary	Bolstad Ch. 13	Final projects due 12/7 by 11:59PM
December 10-14	Final exam (distributed 12/7)		Due date TBD