**ESS 520 – Applications in Geographic Information Systems for the Earth Sciences**
**Winter Quarter 2019**
**4 Credits**
**Lecture/Discussion Sessions: Monday, 1:30-3:20, JHN 021**
**Lab Sessions: Wednesday, 1:30-3:20 and Thursday, 2:30-4:20, JHN 021**

**Pre-requisites: ESS 420 or equivalent, or with instructor's approval; ESS 211 and 326 recommended**

**Instructor:**
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**Course Overview:**
This course provides a survey of applied uses of GIS in the earth sciences. It builds upon skills and topics covered in ESS 420 ("Introduction to Geographic Information Systems for the Earth Sciences"). Though basic GIS skills and topics will be briefly reviewed, it is assumed that students are familiar with data types, essential GIS analytic techniques, and the suite of ArcGIS software packages.

The course will explore a wide range of earth science topics, including some covered in ESS 420, at a more advanced level of analysis. Having covered more of the basic analytic approaches in the introductory GIS course, we will examine and experiment with more detailed, complex analytic techniques using examples from the peer-reviewed literature. This will provide greater insight into how GIS analysis is put into practice in earth science research. Topics include the following: digitizing from DEM's, imagery and/or scanned maps and creating geodatabases; geologic/geomorphic mapping using production-level standards; interpreting terrain characteristics using hypsometric, curvature and morphometric analysis; using hydrologic flow patterns for river bank modeling; floodplain mapping and analysis; measuring and understanding implications of rainfall patterns; landslide forecasting and analysis; and analyzing other geomorphologic phenomena. Geospatial statistics, including interpolation methods and detection of scale dependence in geospatial phenomena, will also be covered.

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 much of the instruction. However, lectures and in-class discussions of course readings, primarily facilitated by the students themselves, will also be a significant aspect of the course content. Course assignments will consist of lab exercises related to a number of the weeks' topics, coordination with facilitation partners for leading in-class reading discussions, and an independent project to be written and presented at the end of the quarter. Collectively these activities will help students to become familiar with and engage in some of the more advanced geospatial analyses used in a wide range of earth science problems and questions.

**Who Takes this Course:**
The course is intended for graduate and professional students in Earth and Space Sciences. However, undergraduates, as well as students from other disciplines in the Colleges of the Environment, Engineering and Arts and Sciences, may also be interested and are welcome to enroll.

**Learning Goals/Objectives:**
By the end of the course, students should:

1. Have a moderately advanced understanding of some key sources for obtaining and producing geologic data sets, including importing field-collected data and creating geospatial databases;
2. Be familiar with some of the more advanced uses of GIS in the earth sciences, including alternative analytic approaches found in the peer-reviewed literature;
3. Understand the basics of geospatial statistical analysis;
4. Know the essentials of creating effective geologic maps and graphics, including prominent mapping standards;
5. Have a moderately advanced understanding of some of the fundamental uses of GIS in the earth sciences, including the relevance of spatial dependence/pattern and issues of scale in geologic and general environmental phenomena;
6. Have the ability to adapt the knowledge, tools and techniques acquired in the course for their own research questions and work applications.

**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 ArcGIS software. 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.
- Access to email and course web pages.

**Recommended Reading (no required course text; readings from the peer-reviewed literature and technical reports will be assigned for course topics):**
- Paul Bolstad. 2016. GIS Fundamentals: A First Text on Geographic Information Systems, 5th Edition. Eider Press.
- Maribeth Price. 2019. Mastering ArcGIS, 8th Edition. McGraw-Hill.
- Michael de Smith, Mike Goodchild, David J. Maguire, and Paul A. Longley. 2018. Geospatial Analysis, 6th Edition. Online e-book/web resource, accessible at http://www.spatialanalysisonline.com/HTML/index.html.

**Course Grading:**
Grading will be based on lab exercises, class participation, and an independent class project and presentation. Students should potentially be able to complete lab exercises within the in-class lab sessions, but may at times require work outside of class; labs will be due by the following week's lab session (unless told otherwise). Late assignments will not be accepted without prior approval from the instructor. Class projects will consist of topics of your own choice in the earth sciences; the subcomponents of the projects will include a brief outline statement of your selected topic (due ~1/3 into the quarter), the report itself, and an in-class presentation. In-class participation, through general contributions during and facilitation of discussion sessions on weekly topics, will also be a part of the overall grade.

The grading breakdown is as follows:
- 40% lab exercises;
- 40% class project;
- 20% in-class participation (in discussion sessions, etc.).

Students taking the course are expected to attend lecture/discussion sessions and at least one lab session per week (most labs extend over one session and into at least part of the next). Because lecture/discussion sessions are primarily driven by you, the students (and hence are a significant percentage of the grade), missing these sessions will deter from your experience in the class. Though attendance in both weekly lab sessions is not required per se, it will be much easier to get assistance and answers to questions in-class rather than outside of class. Students are strongly encouraged to be actively engaged in the course, to email me with questions, and to take advantage of office hours.

**Course Policies (some of this reiterated from above):**
- You are expected to do the weekly reading assignments and peruse/think about points for discussion prior to class; this will provide food for thought for weekly discussion sessions and allow them to run more smoothly.

- If extenuating circumstances arise that will necessitate turning something in late, contact the instructor as far in advance as possible. Again, however, late projects will not be accepted.
- The same applies for missing class sessions, especially on Mondays. These sessions require the most “in-person” time, and thus you shouldn’t miss these unless absolutely necessary.
- 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 the 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 (e.g., using data sets or processing output from others). You may obtain information from online sources, but you should be sure to phrase such information in your own words (again, no copying nor paraphrasing) and references are required. You may discuss with your classmates any materials that you like, and are more than welcome to confer with one another as you work on labs. However, the actual work that you complete and turn in must be completely your own. Violations of this will result in disciplinary actions. Please contact me if you ever have questions about what is and isn’t permissible.

**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 (current as of 1/7/2019; subject to change):**
Labs are due by 1:30PM on Wednesday on the week in question, unless specified otherwise in class/on Canvas. Numbers for reading assignments correspond to readings in the bibliography list on the following pages. Those readings in parentheses are optional. A signup sheet for facilitating weekly discussion sessions will be passed around during the first week of class and will subsequently be posted on Canvas.

| **Meeting Dates** | **Lecture Topic** | **Lab Assignment** | **Reading Assign-ments** | **Due Dates** |
|---|---|---|---|---|
| January 7-10 | Course intro; Introduction to digitizing | Lab 1: Digitizing (Basic Editing of GIS Data) | None | |
| January 9-17 | USGS geologic mapping standards (Dr. Ralph Haugerud, USGS) | Lab 2: Cartographic Techniques – Creating Digital Geomorphic Maps Using USGS Standards | 19, (14), (23) | Lab 1 due **<u>Monday, 1/14</u>** |
| January 23-24 | Geospatial statistics | Lab 2 continued | 4, 11, (9) | Project topic outline due 1/25 |
| January 28-31 | Terrain analyses: morphometric applications of curvature and hypsometry | Lab 3: Using & Applying Geostatistical Analyst | 1, 16 | Lab 2 due |
| February 4-7 | Hydrologic analysis: river channel morphology and dynamics | Lab 4: Intermediate Terrain Analysis – Comparisons Between the WA Cascade & Olympic Mountain Ranges | 3, 20, (13) | Lab 3 due |
| February 11-14 | Landslide forecasting | Lab 4 continued | 8, 17, (7) | |
| February 20-21 | Floodplain mapping and analysis | Lab 5: Landslide Forecasting | 21, 24, (5), (18) | Lab 4 due |
| February 25-28 | Analyzing rainfall patterns | Lab 6: Geomorphology Using Google Earth | 15, 25, (6), (9), (22) | Lab 5 due |
| March 4-7 | 3D Structure in Google Earth; Project presentations | Open lab W for project work & assistance | 2, 10, (12) | Lab 6 due |
| March 11-14 | Project presentations | | | Final projects due 3/15 by 11:59PM |

**Reading List (materials obtainable through the UW Libraries or via listed web links, except where noted):**


1) Amerson, B. E., D. R. Montgomery and G. Meyer. 2008. Relative size of fluvial and glaciated valleys in central Idaho. Geomorphology 93(3-4):537-47.

2) Atha, J. B. 2014. Identification of fluvial wood using Google Earth. River Research and Applications 30:857-864.

3) Bizzi, S. and D. N. Lerner. 2012. Characterizing physical habitats in rivers using map-derived drivers of fluvial geomorphic processes. Geomorphology 169:64-73.

4) Burrough P. A. 2001. GIS and geostatistics: Essential partners for spatial analysis. Environmental and Ecological Statistics 8(4):361-377.

5) Charrier, R. and Y. Li. 2012. Assessing resolution and source effects of digital elevation models on automated floodplain delineation: A case study from the Camp Creek Watershed, Missouri. Applied Geography 34:38-46. (optional)

6) Clark M.P. and Slater A.G. 2006. Probabilistic quantitative precipitation estimation in complex terrain. Journal of Hydrometeorology 7: 3-22. (optional)

7) Conforti M., Robustelli G., Muto F. and Critelli S. 2012. Application and validation of bivariate GIS-based landslide susceptibility assessment for the Vitravo river catchment (Calabria, south Italy). Natural Hazards 61: 127-141. (optional)

8) Conoscenti C., Di Maggio C. and Rotigliano E. 2008. GIS analysis to assess landslide susceptibility in a fluvial basin of NW Sicily (Italy). Geomorphology 94: 325-339.

9) Diodato N, Ceccarelli M. 2005. Interpolation processes using multivariate geostatistics for mapping of climatological precipitation mean in the Sannio Mountains (southern Italy). Earth Surface Processes and Landforms 30(3):259-268. (optional)

10) Dolliver, H. A. S. 2012. Using Google Earth to teach geomorphology. Pages 419-429 in S. J. Whitmeyer, J. E. Bailey, D. P. D.G., and T. Ornduff, editors. Google Earth and Virtual Visualizations in Geoscience Education and Research. GSA Special Papers 492. The Geological Society of America, Inc. *Available on/ download from course Canvas site.*

11) Erdogan S. 2009. A comparison of interpolation methods for producing digital elevation models at the field scale. Earth Surface Processes and Landforms 34(3):366-376.

12) Goudie, A. 2013. Characterising the distribution and morphology of creeks and pans on salt marshes in England and Wales using Google Earth. Estuarine Coastal and Shelf Science 129:112-123.

13) Gurnell A.M., Bickerton M., Angold P., Bell D., Morrissey I., Petts G.E. and Sadler J. 1998. Morphological and ecological change on a meander bend: the role of hydrological processes and the application of GIS. Hydrological Processes 12: 981-993. (optional)

14) Gustavsson M., Kolstrup E. and Seijmonsbergen A.C. 2006. A new symbol-and-GIS based detailed geomorphological mapping system: Renewal of a scientific discipline for understanding landscape development. Geomorphology 77: 90-111. (optional)

15) Marquinez J., Lastra J. and Garcia P. 2003. Estimation models for precipitation in mountainous regions: the use of GIS and multivariate analysis. Journal of Hydrology 270: 1-11.

16) Montgomery, DR, G Balco, and SD Willett. 2001. Climate, tectonics, and the morphology of the Andes. Geology 29(7):579-82.

17) Montgomery D.R., Schmidt K.M., Greenberg H.M. and Dietrich W.E. 2000. Forest clearing and regional landsliding. Geology 28: 311-314.

18) Nardi, F., E. R. Vivoni, and S. Grimaldi. 2006. Investigating a floodplain scaling relation using a hydrogeomorphic delineation method. Water Resources Research 42. (optional)

19) NCGMP09 geodatabase standards for geologic mapping (you should be fine reading pgs. 93-108: the rest covers more technical specifics and details about what to include in a complete geodatabase package): http://pubs.usgs.gov/of/2010/1335/pdf/usgs_of2010-1335_NCGMP09.pdf

20) Neeson, T. M., A. M. Gorman, P. J. Whiting, and J. F. Koonce. 2008. Factors affecting accuracy of stream channel slope estimates derived from geographical information systems. North American Journal of Fisheries Management 28:722-732.

21) Paz, A. R., J. M. Bravo, D. Allasia, W. Collischonn, and C. E. M. Tucci. 2010. Large-Scale Hydrodynamic Modeling of a Complex River Network and Floodplains. Journal of Hydrologic Engineering 15:152-165.

22) Ramasankaran R.A.A.J., Kothyari U.C., Ghosh S.K., Malcherek A. and Murugesan K. 2012. Geospatially based distributed rainfall-runoff modelling for simulation of internal and outlet responses in a semi-forested lower Himalayan watershed. Hydrological Processes 26: 1405-1426. (optional)

23) Vitek, JD, JR Giardino and JW Fitzgerald. 1996. Mapping geomorphology: A journey from paper maps, through computer mapping to GIS and Virtual Reality. Geomorphology 16(3):233-49. (optional)

24) Yang, J., R. D. Townsend, and B. Daneshfar. 2006. Applying the HEC-RAS model and GIS techniques in river network floodplain delineation. Canadian Journal of Civil Engineering 33:19-28.

25) Zhang X.S. and Srinivasan R. 2009. GIS-Based Spatial Precipitation Estimation: A Comparison of Geostatistical Approaches (1). Journal of the American Water Resources Association 45: 894-906.