ESCI 4XXX: Landscape Evolution Modeling

Course Information

Institution: University of Minnesota-Twin Cities
Department: Earth and Environmental Sciences
Location: Tate Hall XXX
Semester: Spring 2023
Time: TTh 10:00am - 11:15am
Instructor: Jeffrey Kwang
Credit Hours: 4
Prerequisites: ESCI 4701: Geomorphology and familiarity with computer programming

Office Hours

Please reach out if you have concerns or questions about the course material or if you just want to chat about landscapes, research, cats, or anything else.

Location: Tate Hall XXX
Time: TTh 12:00pm - 2:00pm or by appointment
Email: kwang004@umn.edu
website: https://jeffskwang.github.io/

Course Description and Goals

This course will explore the geomorphic processes and numerical methods required to build models that simulate how the surface of Earth (and other planets) evolve over human and geologic timescales. Numerical models named landscape evolution models are an emerging tool for understanding the interactions of different geomorphic processes. In this course, we will use landscape evolution models, to understand how complex patterns emerge and change on the Earth's surface. The goals of this course are to:

- Develop a modeling skill set in the Landlab, a Python-based modeling environment for creating landscape evolution models.
- Understand the interaction and feedbacks between geomorphic processes using numerical models.

By the end of the course, students will be able to:

- Interpret geomorphic processes as sets of differential equations and solving them using the Python.
- Create landscape evolution models in Landlab and test different hypotheses and scenarios.

Course Schedule

Course Schedule. Topics covered, student learning outcomes, and assignments due:

Week	Topics	Student Learning Outcomes (Students will be able to...)	Assignments Due
1: 1/16 - 1/20	Python Basics	1a. use Python to solve simple arithmetic problems 1b. prepare data visualizations in matplotlib	
2: 1/23 - 1/27	Numerical Methods in Python	2a. identify different numerical methods used to solve equations 2b. apply Python to code numerical methods	PS1: Python Basics (due 1/26)
3: 1/30 - 2/3	Hillslope Processes	3a. define hillslope diffusion processes 3b. recognize a diffusion equation and its properties	DP1: Find a slope in Google Earth (due 2/2)
4: 2/6 - 2/10	Bedrock Incision	4a. define the stream power incision model 4b. recognize an advection equation and its properties	PS2: Hillslope Diffusion Model (due 2/9)
5: 2/13 - 2/17	Sediment Transport	5a. identify sand and gravel sediment transport equations 5b. discuss effects of sediment transport of bedrock incision	PS3: Bedrock River Model (due 2/16)
6: 2/20 - 2/24	Flow Routing Algorithms	6a. define and list different flow routing algorithms 6b. develop flow routing algorithm in python	
7: 2/27 - 3/3	Introduction to Landlab	7a. apply Landlab to create a grid structure 7b. illustrate data using Python and Landlab plotting scripts	DP2: Map Rivers in your Hometown (due 3/2)
8: 3/6 - 3/10	Spring Recess	no class	

9: 3/13 - 3/17	Building Numerical Models	9a. distinguish difference between analytical/numerical models 9b. outline the framework of a landscape evolution model (LEM) 9c. develop hypotheses that can be tested in LEMs	DP3: Landlab map of your Hometown (due 3/16)
10: 3/20 - 3/24	Coupling Geomorphic Processes	10a. combine different processes in Landlab 10b. design first landscape evolution model	Project Plan (due 3/23)
11: 3/27 - 3/31	Landscape Equilibrium	11a. recognize methods for determining landscape equilibrium 11b. compare different definitions of landscape equilibrium	PS4: Vanilla Landscape Evolution Model (due 3/30)
12: 4/3 - 4/7	Allogenic Processes	12a. modify LEM to include allogenic dynamics 12b. determine role of allogenic processes in LEMs	
13: 4/10 - 4/14	Autogenic Processes	13a. modify LEM to include autogenic dynamics 13b. determine role of autogenic processes in LEMs	PS5: Allogenic vs. Autogenic Model (due 4/13)
14: 4/17 - 4/21	Engineering Applications of LEMs	14a. research applications of numerical LEMs 14b. evaluate utility of LEM in engineering applications	DP4: LEM Case Study (due 4/20)
15: 4/24 - 4/28	Final Project Presentations	15a. test individual hypothesis in landscape evolution model 15b. evaluate landscape evolution hypothesis	Final Project (due 4/27)

Assignments and Projects

Discussion Preparation (DP#) (**80 total points**: 4 assignments, 20 points each)
These activities will prepare you for in-class discussions. You will bring in your findings to class for both small group and class discussion. For DP1-3, your goal will be to create landscape figures to share with your group. For DP4, you will write a critique of a report/article that uses LEMs in an engineering application. Your deliverable will be graded for 10 points, and you will receive 10 points for completing peer assessment forms (see Canvas/Google Drive) for each of your other group members.

Problem Sets (PS#) (**100 total points**: 5 assignments, 20 points each)
Problem sets will cover the application of the course material. Students are required to submit copies of their commented code and their results in written format. You will be graded based on a provided rubric (see Canvas/Google Drive). In your deliverable, equations and parameters need to be defined, figures are required to be captioned and explained, and written answers should be well-reasoned and logical.

Final Project (**120 total points**: plan, 20 points and presentation, 100 points)
In this course, groups of 2-3 students will develop a testable hypothesis that they will investigate using a landscape evolution model. During Week 9 & 10 of the course, student groups will choose from a list of possible final project ideas that I will provide. For 20 points, your group will write a 1-page document that states which project idea you will pursue and how you will test it in your model. An example of this project plan will be provided. Student groups will present their findings as oral presentations during Week 15. Your presentation will be assessed with a grading rubric (see Canvas/Google Drive) and will be worth 100 points.

Course Expectations

To be successful in this course, I expect students to arrive on time and give their full attention during class and to your peers. To prepare for class, students need to have their deliverables completed before class to discuss. During discussions, students must be respectful to one another and work to bridge or understand their differences. Students are encouraged to work together on problem sets and discussion preparation outside of class; however, students are still are required to turn in your own individual write-up.

To help students be successful in this course, it is my role to foster an inclusive environment where students are comfortable to explore and discuss landscape evolution. For students to assess their learning, I will give students feedback on their assignments in a timely manner (within 2 weeks). For questions, comments, and concerns, I will be fully present at office hours and available to talk through email appointments. Last, for the final group project, I will work with groups to keep projects feasible within our time constraints.

Grading

Grades
Your final grade will be determined out of 300 total points. Letter grades will be assigned based on your cumulative course points percentage (**X**) as follows:

A+	$97 \leq X$
A	$93 \leq X < 97$
A-	$90 \leq X < 93$
B+	$87 \leq X < 90$
B	$83 \leq X < 87$
B-	$80 \leq X < 83$
C+	$77 \leq X < 80$
C	$73 \leq X < 77$
C-	$70 \leq X < 73$
D	$60 \leq X < 70$
F	$X < 60$

Expected Student Academic Work
In order to complete the work of the course to achieve an average grade of **C**, students must show the ability to write and run a landscape evolution model, but their answers to the problem sets may be incorrect or not well-reasoned. To achieve a higher grade, students must fully understand their model results to find the correct answers. A **C**-level final project, will present model results using different parameters, but will not explicitly test a scientific hypothesis. In the final projects, students who are able to demonstrate an ability to run a variety scenarios and discuss why the model is sensitive to certain parameters will receive a higher grade.

Required Materials

Required Textbook

- Pelletier, J. (2008). **Quantitative Modeling of Earth Surface Processes**. Cambridge: Cambridge University Press. doi:10.1017/CBO9780511813849
- A copy will be held at Walter Library; Sci/Eng Books (Level F); GB400.42.M33 P45 2008

Access to a computer with Python-coding language

- Landlab and Python will install on Windows, Macintosh, and Linux-based operating systems.
- If you do not have a personal computer, please reach out to me, I will help make arrangements for you to participate.
- Access to various computer labs are available: https://cse.umn.edu/cseit/classrooms-labs

Course Policies

Attendance Policy
To do well in this course and in your assignments, you will need to attend the scheduled lectures. However, things happens, and I completely understand if you need to miss lecture. For planned absences, please let me and you group know. You will not be penalized for absences, but please reach out if you start to fall behind.

Late Work
Many of the concepts build on one another, so it is important to complete the previous assignments before moving to the next one. One assignments can be turned in late without any point deduction. Missed discussion participation credits (peer assessment forms) can be made up by submitting written answers to discussion questions (see Canvas/Google Drive). Late problem sets will be accepted and graded, but they will be deducted 2 points per week (maximum deduction 10 points). Late assignments can be submitted until the last day of exams (5/10/23).

Incomplete Work
I highly recommend you submit any assignment even if they are late. If you have concerns about completing your work, please reach out! Under extraordinary circumstances that would prevent you from completing the course-work, an incomplete ,"I", can be assigned. More information can be found here: https://onestop.umn.edu/academics/transcripts-and-grades/grading-policies

Extra Credit
An extra credit assignment can be completed for an additional 20 points. In addition to the LEM Case Study (Week 14), students will find another case study (paper or report) to critique and discuss.

Personal Safety

Your personal safety comes first before this course. If you do not feel safe attending class (icy or dangerous driving conditions; other matters of safety), please prioritize your safety first and contact me as soon as is reasonable about safety concerns. Absences due to personal safety will not be counted against you.

University of Minnesota Policies

Student Code of Conduct

The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. Similarly, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

As a student at the University you are expected to adhere to Board of Regents Policy: Student Conduct Code. To review the Student Conduct Code, please see: https://regents.umn.edu/sites/regents.umn.edu/files/2022-07/policy_student_conduct_code.pdf

Note that the conduct code specifically addresses disruptive classroom conduct, which means "engaging in behavior that substantially or repeatedly interrupts either the instructor's ability to teach and/or a student's ability to learn." The classroom extends to any setting where a student is engaged in work toward academic credit or satisfaction of program-based requirements or related activities.

Use of Personal Electronic Devices in the Classroom

Using personal electronic devices in the classroom setting can hinder instruction and learning, not only for the student using the device but also for other students in the class. To this end, the University establishes the right of each instructor to determine if and how personal electronic devices are allowed to be used in the classroom. For complete information, please reference: https://policy.umn.edu/education/studentresp

Scholastic Dishonesty

You are expected to do your own academic work and cite sources as necessary. Failing to do so is scholastic dishonesty. Scholastic dishonesty means plagiarizing; cheating on assignments or examinations; engaging in unauthorized collaboration on academic work; taking, acquiring, or using test materials without faculty permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain dishonestly grades, honors, awards, or professional endorsement; altering, forging, or misusing a University academic record; or fabricating or falsifying data, research procedures, or data analysis. (Student Conduct Code) If it is determined that a student has cheated, the student may be given an "F" or an "N" for the course, and may face additional sanctions from the University. For additional information, please see: https://policy.umn.edu/education/instructorresp

The Office for Community Standards has compiled a useful list of Frequently Asked Questions pertaining to scholastic dishonesty: https://communitystandards.umn.edu/avoid-violations/avoiding-scholastic-dishonesty

If you have additional questions, please clarify with your instructor for the course. Your instructor can respond to your specific questions regarding what would constitute scholastic dishonesty in the context of a particular class, e.g., whether collaboration on assignments is permitted, requirements and methods for citing sources, if electronic aids are permitted or prohibited during an exam.

Makeup Work for Legitimate Absences

Students will not be penalized for absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include verified illness, participation in intercollegiate athletic events, subpoenas, jury duty, military service, bereavement, and religious observances. Such circumstances do not include voting in local, state, or national elections. For complete information, please see: https://policy.umn.edu/education/makeupwork

Appropriate Student Use of Class Notes and Course Materials

Taking notes is a means of recording information but more importantly of personally absorbing and integrating the educational experience. However, broadly disseminating class notes beyond the classroom community or accepting compensation for taking and distributing classroom notes undermines instructor interests in their intellectual work product while not substantially furthering instructor and student interests in effective learning. Such actions violate shared norms and standards of the academic community. For additional information, please see: https://policy.umn.edu/education/studentresp

University Grading Scales

The University has two distinct grading scales: A-F and S-N.

A-F grading scale. The A-F grading scale allows the following grades and corresponding GPA points:

Grade	GPA Points	Definitions for undergraduate credit
A	4.000	Represents achievement that significantly exceeds expectations in the course
A-	3.667	
B+	3.333	
B	3.000	Represents achievement that is above the minimum expectations in the course
B-	2.667	
C+	2.333	
C	2.000	Represents achievement that meets the minimum expectations in the course
C-	1.667	
D+	1.333	
D	1.000	Represents achievement that partially meets the minimum expectations in the course. Credit is earned but it may not fulfill major or program requirements
F	0.000	Represents failure in the course and no credit is earned

S-N grading scale. The S-N grading scale allows for the following grades and corresponding GPA points:

Grade	GPA Points	Definitions for undergraduate credit
S	0.000	Satisfactory (equivalent to a C- or better)
N	0.000	Not Satisfactory

For additional information, please refer to: https://policy.umn.edu/education/gradingtranscripts

Sexual harassment, sexual assault, stalking and relationship violence

The University prohibits sexual misconduct, and encourages anyone experiencing sexual misconduct to access resources for personal support and reporting. If you want to speak confidentially with someone about an experience of sexual misconduct, please contact your campus resources including the Aurora Center, Boynton Mental Health or Student Counseling Services (https://eoaa.umn.edu/report-misconduct). If you want to report sexual misconduct, or have questions about the University's policies and procedures related to sexual misconduct, please contact your campus Title IX office or relevant policy contacts.

Instructors are required to share information they learn about possible sexual misconduct with the campus Title IX office that addresses these concerns. This allows a Title IX staff member to reach out to those who have experienced sexual misconduct to provide information about personal support resources and options for investigation. You may talk to instructors about concerns related to sexual misconduct, and they will provide support and keep the information you share private to the extent possible given their University role.

https://regents.umn.edu/sites/regents.umn.edu/files/2019-09/policy_sexual_harassment_sexual_assault_stalking_and_relationship_violence.pdf

Equity, Diversity, Equal Opportunity, and Affirmative Action

The University provides equal access to and opportunity in its programs and facilities, without regard to race, color, creed, religion, national origin, gender, age, marital status, disability, public assistance status, membership or activity in a local commission created for the purpose of dealing with discrimination, veteran status, sexual orientation, gender identity, or gender expression. For more information, please consult Board of Regents Policy: https://regents.umn.edu/sites/regents.umn.edu/files/2019-09/policy_equity_diversity_equal_opportunity_and_affirmative_action.pdf.

Disability Accommodations

The University views disability as an important aspect of diversity, and is committed to providing equitable access to learning opportunities for all students. The Disability Resource Center (DRC) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.

- If you have, or think you have, a disability in any area such as, mental health, attention, learning, chronic health, sensory, or physical, please contact the DRC office on your campus (UM Twin Cities - 626.1333) to arrange a confidential discussion regarding equitable access and reasonable accommodations.
- Students with short-term disabilities, such as a broken arm, can often work with instructors to minimize classroom barriers. In situations where additional assistance is needed, students should contact the DRC as noted above.
- If you are registered with the DRC and have a disability accommodation letter dated for this semester or this year, please contact your instructor early in the semester to review how the accommodations will be applied in the course.
- If you are registered with the DRC and have questions or concerns about your accommodations please contact your (access consultant/disability specialist).

Additional Information: https://diversity.umn.edu/disability/
Contact Information: drc@umn.edu

Mental Health and Stress Management

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance and may reduce your ability to participate in daily activities. University services are available to assist you. You can learn more about the broad range of confidential mental health services available on campus via the Student Mental Health Website: http://www.mentalhealth.umn.edu

Academic Freedom and Responsibility *for courses that involve students in research*

Academic freedom is a cornerstone of the University. Within the scope and content of the course as defined by the instructor, it includes the freedom to discuss relevant matters in the classroom and conduct relevant research. Along with this freedom comes responsibility. Students are encouraged to develop the capacity for critical judgment and to engage in a sustained and independent search for truth. Students are free to take reasoned exception to the views offered in any course of study and to reserve judgment about matters of opinion, but they are responsible for learning the content of any course of study for which they are enrolled.* When conducting research, pertinent institutional approvals must be obtained and the research must be consistent with University policies.

Reports of concerns about academic freedom are taken seriously, and there are individuals and offices available for help. Contact the instructor, the Department Chair, your adviser, the associate dean of the college, or the Vice Provost for Faculty and Academic Affairs in the Office of the Provost.

**Language adapted from the American Association of University Professors "Joint Statement on Rights and Freedoms of Students".*