

GEOG*6550 Environmental Modelling

PROVISIONAL DRAFT

The University of Guelph, Department of Geography

Winter 2026, 0.5 Credits

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Office Hours: Fridays 12:00PM-01:00PM

Course Description

This course aims to provide students with an understanding of the processes and techniques involved in environmental modelling practice and will focus on the power and limitations of existing models.

Objectives

Most computer models of environmental process are exceedingly complex and require a substantial amount of experience and familiarity to operate. Furthermore, these models tend to focus on specific problem domains, e.g. hydrological, ecological, climate, or geomorphological models. Geography is a very broad discipline and I assume that each of you have your own areas of interest in which you hope to become more knowledgeable and adept as modellers. As such, it would be futile for me to teach this class with an emphasis on learning how to operate one or two existing computer models, such as the SWAT model. Instead, I intend to focus more on the broad issues in environmental modelling. By the end of the course, students should be familiar with the various model types and modelling approaches, and the major issues involved in modelling practice.

Although it is not necessary to learn a programming language to operate many existing environmental models, if you advance as a modeller far enough, you will certainly find that programming is a prerequisite and indispensable skill. Programming can aid not only with the development of new computer models, but also with more common tasks encountered by model-users, such as data preparation and visualization. Programming often provides the language by which modellers communicate with their models. It would be nice if you had previous experience with a programming language, although I assume that many (perhaps most) have very limited experience programming. If you have none, don't worry because we will work through it together in class. **You will learn basic programming skills in this course through the lecture, practical, and research-based class components.** The aim is to enable students to programmatically handle the input and output data used in environmental models. Your willingness to learn is what counts.

Readings

There is no required course text. Instead, I will draw upon selected journal articles and book chapters.

Course Website

This course does have a CourseLink site. This site will be used to distribute information about the course, lecture notes, and learning resources. You are advised to check this site weekly.

Content

In addition to lecturing, there will be a practical component to some classes. As such, students are advised to ***bring a laptop computer to class***. If you do not own or have access to a laptop, please speak with me after the first lecture.

Week	Date	Topic ¹	Notes ²
1	Jan 5	Introduction	
2	Jan 12	Modelling types and approaches	
3	Jan 19	Developing a computer model	
4	Jan 26	Model data	- Model proposal is due
5	Feb 2	Model parameterization	
6	Feb 9	No class (conflicting senate meeting)	
	Feb 16	Winter Break – No class	
7	Feb 23	Model calibration and validation	
8	March 2	Error and uncertainty in models	
9	March 9	Error and uncertainty in models	- Milestone is due
10	March 16	Modelling and scale	
11	March 23	Data visualization	
12	March 30	Student project help session (Ending at 4:00PM)	
	April 14	Final project is due by 5:00PM	

Notes: 1. Topics and dates are subject to change as I inevitably fall behind. 2. The schedule of the student research project presentations is yet to be determined.

Evaluation

Paper Presentation (15%)

Each student will give a short presentation (**no more than 10 minutes max**) on an original published research paper (i.e., a journal article published in a scholarly journal, e.g. *Ecological Modelling, Hydrological Processes, Earth Surface Processes and Landforms, Environmental Modelling & Software*, etc.) describing a topic of their choosing. Students will need to **provide me with a copy of their selected paper**. The paper should describe and apply a model to the study of some environmental phenomenon. The focus of the presentation will be on the modelling workflow described in the paper, including input data, output predictions, and implicit and explicit assumptions underlying the models used and any limitations. I will post a schedule of paper presentations during the first few weeks of the course.

Coding Assignments (15%)

Throughout the semester, we will engage in a number of practical sessions, where we will learn to use programming to complete common modelling tasks (e.g. data manipulation, visualization), and even to code our own model as a group. This is always a lot of fun! There will be a number of small coding tasks that I will assign for students to work on outside of the in-class practical sessions (usually about three), and collectively these will be worth 10% of your final grade.

Final Independent Research Project Report (45%)

Each student will develop a computer model to using the Python programming language (other languages are possible if approved). Notice, your model must **simulate some environmental process**. I recommend choosing a model that adopts a **process-based approach**, however, statistical and machine-learning based models may be permissible, if approved. Importantly, you must code a model workflow—simply calling existing code, which does the heavy lifting (e.g., writing a Python script to call an existing model) is not permitted. Your model must be able to process real-world data (meaning that data availability will be a factor in deciding on a model to implement). Please discuss your topic with me early in the semester. Any mathematical model of an environmental phenomenon would be suitable for this project. Some examples of process-based environmental models of a suitable scope for this assignment include:

- The Penman–Monteith equation, a common method for estimating net evapotranspiration
- The D8 steepest descent algorithm for simulating overland flow
- The Revised Universal Soil Loss Equation (RUSLE) for simulating soil erosion
- A radiative equilibrium model for energy balance modelling
- An implementation of Gallant's (2003) multiresolution index of valley bottom flatness for modelling depositional areas

Note the above models are provided here simply to give examples of a suitable scope and level of difficulty; you should choose your own model. Your model must not share any code with an existing code base, i.e. you are expected to create this model yourself. The model must take input spatial/temporal data and create output data that can be used to evaluate the performance of the model (validation). Your model can rely on geospatial data and can use GIS and/or remote

sensing software for visualization, if suited, although this is not a requirement. You will not be assessed on how well the underlying mathematical model works to simulate the process at study, but rather, you will be assessed on how well your model represents the mathematical model.

The project report must be **no longer than 15 pages 1.5-spaced** (this is a firm limit), 12-point font size, including figures and tables but excluding references and appendices (for which there is no limit). The report should include the code for the computer model in Appendix A. Students are expected to complete a 'milestone' report towards this final project (i.e., a project progress report) to ensure adequate progression. **The results of the final report should be presented in the format of an academic journal article** and should include an introduction with the specific objectives of the study, a brief, pertinent literature review, methodology (including a model description and description of the input data), presentation of results, model validation, discussion, and conclusion. The model description should include an explicit description of the model type, a mathematical model description, parameters, data requirements, and limitations. All figures should be of high quality in keeping with a graduate-level course. You may want to examine articles published in *Environmental Modelling & Software* or *Computers & Geosciences* as examples of how to format your project report.

Poster Presentation (15%)

Students will design and present a poster summarizing their research project. They will present their posters during a designated poster session near the end of the session, which may be scheduled outside regular lecture time (e.g. during the common Geography department poster session, which is usually the last day of the semester).

Participation (10%)

Students will be expected to attend class sessions and participate in discussions and activities. The participation grade will be drawn from in-class participation, 1-on-1 meetings and will be informed by self and peer evaluation components.

Disclaimer

Please note that unforeseen circumstances (e.g., a pandemic) may necessitate a revision of the format of course offerings, changes in classroom protocols, and academic schedules. Any such changes will be announced via CourseLink and/or class email.

Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g. final exam or major assignment).

For information on current safety protocols, follow these links: <https://news.uoguelph.ca/return-to-campuses/how-u-of-g-is-preparing-for-your-safe-return/>

<https://news.uoguelph.ca/return-to-campuses/spaces/#ClassroomSpaces>

Please note, these guidelines may be updated as required in response to evolving University,

Public Health or government directives

E-mail Communication

As per university regulations, all students are required to check their <uoguelph.ca> e-mail account regularly: e-mail is the official route of communication between the University and its students.

When You Cannot Meet a Course Requirement

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons, please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. [See the undergraduate calendar for information on regulations and procedures for Academic Consideration.](#)

Drop Date

Courses that are one semester long must be dropped by the end of the last day of classes; two-semester courses must be dropped by the last day of classes in the second semester. The regulations and procedures for [Dropping Courses](#) are available in the Undergraduate Calendar.

Copies of out-of-class assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required, however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 7 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

More information: www.uoguelph.ca/sas

Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community – faculty, staff, and students – to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their

location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

[The Academic Misconduct Policy is detailed in the Undergraduate Calendar.](#)

Recording of Materials

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, a classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

Resources

The [Academic Calendars](#) are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs.