

DEPARTMENT OF GEOGRAPHY

GEOG 601 Advanced Environmental Systems Modelling 2020

Class Time: Thursdays 14:30 – 17:30 Virtually through BH 511

Instructor: Professor Nigel T. Roulet

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Office Hours: will be arranged before the first course meeting.

* Note: I am attempting to not read my McGill e-mails in evening or on weekends.

Teaching Assistant: TBA

Course Description: This course introduces you to the modelling of environmental systems. The learning objective of this course is to help you develop a systems intuition. This intuition is gained by conceptualizing and constructing simple models of environmental systems. However, even though the models are often very simple they display complex behaviours.

Environmental systems are inherently difficult to deal with. They tend to be complex, poorly defined with fuzzy boundaries, and have weakly constrained relationships between variables. They often contain one or more feedback loops. This course deals with the conceptualization and construction of simple models to examine environmental problems through first a clear question and a well-defined objective, and then you can then begin to map out the critical components of the system-of-interest, defining the reservoirs or stocks (state variables), the flows among reservoirs (fluxes), and/or connecting inputs and outputs across the system's boundary (structure). It will become apparent that very few environmental systems are linear. Once a model runs how do we know it is a "good" representation of an actual system? This can be approached by doing stability tests and evaluating the model's performance with some objective criteria. Sensitivity analysis can give insight to critical relationships and parameters in the model. At this stage we should feel comfortable to use the model to address the original research question. In reality model development is a much more heuristic process than just presented: failure at any step requires reformulation of earlier steps (a negative heuristic process).

This course is taught interactively. Even though GEOG 601 autumn 2020 will be delivered remotely I want to maintain as much interaction as possible. I have eliminated all formal lectures. The learning in 2020 takes place in structured workshops. I still have to work out the structure of the workshops but I am anticipating they will comprise multiple short sessions to provide enough content to get you started interspersed with periods where you will work building models. A number of the workshops will be followed by an assignment to further your understanding. The questions for the assignments will come from the end of the chapters of the textbook. It is very important you come prepared to work through the models we develop in the workshops – so please do the relevant readings before we meet each week. In the last three weeks of the course you will build your own model, or a module to add another component to an existing model.

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For this course we will use STELLA® Archetect Version 2.0 for the workshops, assignments and the project. We have made arrangements for this autumn with ISEE Sytems to have available on virtual machins from the GIC in Burnside Hall. If you want you can also purchase a student version one semester (\$59 USD) or perpetual license (\$159 USD) of Stella (<https://www.iseesystems.com/store/education.aspx>), but this is not necessary to complete the course.

Components of This Course: For 2020 there will be two main activities in this course:

Workshops: There will be a 3 hour workshops each week. Each workshop will contain one or more mini-lectures where I provide content and instructions, and you will then begin to work through model structures. The model examples, for the most part, come directly from the text book, or web material that supports the textbook. It is important that you have the course textbook with you for every clas . In November, there are three workshops dedicated for you to build your own model for the model project. In these workshops I, and possibly a TA, will be available to provide assistance and advice.

Modelling Project: The modelling project requires you to conceptualize, develop, build and test a model, or module for an existing model, of an environmental system that interests you. Many pick an aspect of the system they are studying in their graduate research. You need to submit by 17:00 December 01, 2020, a manuscript in the form of an original research paper, describing your model in a format that would be suitable for Ecological Modelling (http://www.elsevier.com/wps/find/journaldescription.cws_home/503306/authorinstructions). You also need to submit a working version to Professor Roulet your STELLA model code. By classtime Octoboer 15, 2020 you are asked a five page maximum description of the environmental problem your model plans to address. Use the following sub-headings to structure your model outline: background to the modelling problem; the research question your model will address; a one sentence statement of your modelling objective; a graphical outline of your model’s preliminary structure (this can be hand drawn); a description of what you think the main state variables and inputs and outputs will be; and a graph (again hand drawn is fine) of your anticipated model outcome.

We will also hold in the last class, November 26, 2020, a model symposium. You will present your models as poster presentations. This consist of a five minutes presentation of your poster to the entire class.

Note: *“In accord with McGill University’s Charter of Students’ Rights, students in this course have the right to submit in English or in French any written work that is to be graded.” (approved by Senate on 21 January 2009)”*

“Conformément à la Charte des droits de l’étudiant de l’Université McGill, chaque étudiant a le droit de soumettre en français ou en anglais tout travail écrit devant être noté (sauf dans le cas des cours dont l’un des objets est la maîtrise d’une langue).”

Evaluation

Assignments (5 @ 8% each) ..	40%
Individual modelling Project	
Research problem and model objectives (due October 18, 2018)	5%
Research paper and code (due December 5, 2018)	50%

Modelling symposium presentation (November 29, 2018)

5%

Policy on Late Assignments: All submitted material will be considered late after the due time and date. Late assignments and modelling projects will have 25% deducted for the first 24 hours they are late and 10% for each additional day thereafter. If there are reasons you cannot meet a deadline be sure to inform Professor Roulet well ahead of time but there a few legitimate reasons for late assignments or projects. I have been a university professor for over 30 years so I have heard most excuses.

NOTE: There will be no supplemental examination and no additional work will be accepted to upgrade marks of D, F, or J.

Course Text and Websites: The course text is:

Ford, Andrew (2009). Modeling Environment: An Introduction to Systems Dynamic Modeling of Environmental Systems – 2nd edition, Island Press, Washington DC, 380 pp. There is a good website supporting this textbook <http://public.wsu.edu/~forda/AA2nd.html>. Bring the text each class as we use it regularly during class. Because this book has been used in past years there may be used texts available. I have contacted Island Press and they have sent me an electronic version of the text and say it will be available for purchase sometime early July. In a normal autumn term the text can be purchased at Paragraphe Books (2220 McGill College Avenue – across Sherbrooke from the Roddick Gates). I will ask them if they can get a number of copies for those of you who will be in Montreal and want a physical text.

In addition to the text book there are three papers from scholarly journals or on the web that have been assigned for reading. These are:

[Aber, J.D. Why don't we believe the models? Bulletin of the Ecological Society of America 78 \(3\): 232-233, 1997.](#)

[Aumann, C. A. \(2007\). "A methodology for developing simulation models of complex systems." Ecological Modelling 202\(3-4\): 385-396.](#)

[Jackson, L.J., A.S. Trebitz & K.L. Cottingham. An introduction to the practice of ecological modeling. Bioscience 50:694-706, 2000.](#)

There are several websites that contain a good introduction and/or discussion of systems modelling. A few good ones you may wish to refer from time-to-time during the course to are: <http://www.systems-thinking.org/>, <http://www.donellameadows.org/systems-thinking-resources/>, and two interesting short videos: one by Peter Senge <http://www.mutualresponsibility.org/science/what-is-systems-thinking-peter-senge-explains-systems-thinking-approach-and-principles> and an interesting TED talk http://www.youtube.com/watch?v=jS0zj_dYeBE

There are also a number of books on environmental modelling and systems thinking that can help you out over the term. These are normally available through the library, but I am not sure if they will be this autumn.

Meadows, Donella H. *Thinking in Systems*, earthscan, 2008. [QA402 M425 2008 Schulich & Macdonald](#)

Morecroft, John. *Strategic 4 modeling and business dynamics: a feedback systems approach*, John Wiley & Sons, 2007. [HD30.23 M663 2007 Schulich](#)

Smith, Jo. *Introduction to Environmental Modelling*, Oxford, 2007. [GE45 M37 S65 2007 Schulich](#)

Wainwright, John. *Environmental modeling: finding simplicity in complexity*, Wiley, 2004. [Access through McGill libraries to http://onlinelibrary.wiley.com/book/10.1002/9781118351475](#)

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Other relevant general University Rules, regulations and guidelines

(copied from <http://www.mcgill.ca/tls/teaching/course-design/outline>)

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- "McGill has policies on sustainability, paper use and other initiatives to promote a culture of sustainability at McGill." (See the [Office of Sustainability](#).)
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Charter of Students' Rights" (The Handbook on Student Rights and Responsibilities is available at <https://www.mcgill.ca/deanofstudents/rights>)

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