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DEPARTMENT OF GEOGRAPHY

GEOG 501 Modelling Environmental Systems 2014

Instructors

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Office Hours: Tuesday 12:00 – 13:30 (except Sept. 09)

* Note: I do not read my McGill University e-mails in the evening or on weekends. I use e-mail for course administrative purposes only. I do not provide advice or directions on the assignments or the project by e-mail. I have found it a very inefficient tool for this purpose. If you need assistance on assignments please see the TA during their office hours, or come and see me during my office hours. If you cannot make it to my office hours for legitimate reason – e.g. scheduling conflicts with classes, contact me by e-mail to make an appointment. On weekdays I will make every attempt to respond to your e-mail within 24 hours.

Teaching Assistant: Drew Pinsonneault – E-mail Andrew.pinsonneault@mail.mcgill.ca
Office Hours: Monday 11:00 – 12:00 (deliberately set the day before assignments are due)

Course Description: This course introduces you to the modelling of environmental systems. It is designed to help you develop your 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. This process begins with a clear question and a well-defined objective. 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 few environmental systems are a linear. Once a model that 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 the critical relationships and parameters in the modeled. Finally, at this stage we may feel comfortable to use the model to address the original research question.

In reality model development is a much more iterative process than presented above - i.e. failure at various steps (the negative heuristic) requires reformulation of earlier steps.

With recent developments in computer aided modelling packages (e.g. STELLA®, POWERISM®, VENISM®, SIMILIE®, etc.) a modelling intuition can be gained without much mathematics beyond algebra and basic calculus. The focus of this course is on the intuitive part of

modelling and not on skills of model development or computer programming. This course is on systems thinking not the mathematics of system modelling.

This course is taught interactively. There are very few formal lectures – most of the learning takes place in structured workshops followed by assignments based on questions related to the material developed in the workshops. Towards the end of the course you build your own model, or add another component to an existing model, to help you gain a greater understanding of some problem in the environment that interests you. We use STELLA® Version 10 for assignments and the project. It has been installed on the computers in BH 511and the library area of the 5th floor. In addition Stella can be found on any computer in the library system. If you want a copy of STELLA for your own computer you can purchase a student's version of STELLA: Perpetual License is ~ $129 USD or a 6 Month limited license ~ $59.00 USD -http://www.iseesystems.com/store/university.aspx. To be eligible for the student versions I have to send to ISEE a list of names and student numbers to confirm you are registered in this course and they will then send you a link to allow you to purchase the software.

BH 511 Active Learning Classroom: In 2009 the BH 511 classroom was built and GEOG 501 was the first course taught in the new classroom. GEOG 501 has now been taught in BH511 five times. This classroom has many features to enhance your learning experience and it is ideal for a course like GEOG 501. There are three sets of a pair wall screens and projectors so every student can see the material being projected from two different tools. I can also switch the main screens to any work station in the room so when appropriate, we can collectively find solutions to common problems you are having. The tables have 6 work stations and they are shaped like a banana-slip bowl so 3 students on one side can see each other's screens. The screens can be lowered so you can easily interact with the 3 students across from you. This arrangement should allow for much more and broader interactions, and collaborative and collective learning.

Warning – this classroom and this course involves teaching and learning that relies on interaction. This course and classroom requires you to commit to learning differently – to actively learn. During each session we will spend a lot of time developing model examples and we will communally solve problems you generate. Hence to succeed you need to be engaged and to participate.

Components of This Course: There are four different activities in this course:

Lectures: There are 3 formal lectures in this course.

Workshops: There will be either a 1 ½ hour or a 3 hour workshop in this course each week depending on whether there is a lecture or not. In the workshops you will be shown and asked to work with examples of model structures. These examples come from the text book so it is important you bring your textbook to every class. In November the workshop time is for to build your own model for the model project. In these workshops the TA and I will be available to provide assistance and advice. I strongly recommend that you take advantage of these structured workshops – I do not have much sympathy for students seeking help outside of class time who have not attended these in-class workshops.

Modelling Project: The modelling project requires you to conceptualize, develop, build and test a model, or module for an existing model, for an environmental system that interests you. Many pick an aspect of the system they are studying in their graduate or undergraduate research. You need to submit by 17:00 Dec. 05, 2014 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 to the Professor your STELLA model code. To prepare your thinking about your model you are required to submit a maximum four page description of the environmental problem you plan to address, the research question you will address with you model, a statement of the objective of your model, a graphical outline of the model preliminary model structure, what you think we be the main state variables and inputs and outputs, and a graph of your anticipated outcome. This is due the beginning of class October 21, 2014.

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 (8 @ 6% each) ..	48%
Individual modelling Project	
Research problem and model objectives (due October 21)	7%
Research paper and code (due December 5)	45%

Policy on Late Assignments: All submitted material will be considered late after the due time and date. Late laboratory assignments and modelling projects will have 25% deducted for the first 24 hours they are late and 10% for each additional day thereafter.

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 following course text is available at Paragraphe Books (2220 McGill College Avenue – across Sherbrooke from the Roddick Gates).

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.

In addition to the text book there are 8 papers from scholarly journals that have been assigned for reading. This 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.

Blanco, J.A. (2010) Seven steps to create ecological models for natural resource management. SciTopics (http://www.scitopics.com/Seven_steps_to_create_ecological_models_for_natural_resource_management.html)

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

Oreskes, N., K. Shrader_Frechette, and K. Belitz (1994). "Verification, validation, and confirmation of numerical models in the earth sciences." Science **263**: 641-646.

Rastetter, E.B. Validating models of ecosystem response to global change. Bioscience 46:190-198, 1996.

Rykiel, E.J. Testing ecological models: the meaning of validation. Ecological Modeling 90:229-244, 1996.

Scheffer, M. & J. Beets. Ecological models and the pitfalls of causality. Hydrobiologia 275/276:115-124, 1994.

Van Nes, E. H. and M. Scheffer (2005). "A strategy to improve the contribution of complex simulation models to ecological theory." Ecological Modeling **185**(2-4): 153-164.

These readings are to help you gain a better understanding of the modelling process. They provide a discussion of some of the more philosophical questions.

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. I have placed several of these on course reserves.

Case, Ted. *An illustrated guide to theoretical ecology*. Oxford, 2000. QH541.15 M3 C36 2000 Life Science

Meadows, Donella H. *Thinking in Systems*, earthscan, 2008. QA402 M425 2008 Schulich & Macdonald

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

Senge, Peter. *The fifth discipline: the art and practice of the learning organization*. Doubleday, 2006. HD58.9 S46 2006 McLennan Reserve Room (not under this course number)

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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McGill University values academic integrity. Therefore, all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).*(approved by Senate on 29 January 2003)*

L'université McGill attache une haute importance à l'honnêteté académique. Il incombe par conséquent à tous les étudiants de comprendre ce que l'on entend par tricherie, plagiat et autres infractions académiques, ainsi que les conséquences que peuvent avoir de telles actions, selon le Code de conduite de l'étudiant et des procédures disciplinaires (pour de plus amples renseignements, veuillez consulter le site www.mcgill.ca/students/srr/honest/).

Other general University Rules, regulations and guidelines
(copied from http://www.mcgill.ca/tls/teaching/course-design/outline)

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- *"As the instructor of this course I endeavor to provide an inclusive learning environment. However, if you experience barriers to learning in this course, do not hesitate to discuss them with me and the Office for Students with Disabilities, 514-398-6009."*

- *"End-of-course evaluations are one of the ways that McGill works towards maintaining and improving the quality of courses and the student's learning experience. You will be notified by e-mail when the evaluations are available on Mercury, the online course evaluation system. Please note that a minimum number of responses must be received for results to be available to students."*

- *"McGill has policies on sustainability, paper use and other initiatives to promote a culture of sustainability at McGill." (See the Office of Sustainability.)*

- *"Additional policies governing academic issues which affect students can be found in the McGill Charter of Students' Rights" (The Handbook on Student Rights and Reponsibilities is available here).*