FRSHWTR-650
Topics in Freshwater Sciences:
An Introduction to Modeling Dynamic Systems
(Using R as a Simulation Platform)

Spring 2018

Instructor: Dr. James T. Waples
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Office hours: Any time
Course meeting: Thursday
Location: Rm 1084, Great Lakes WATER Institute

Course Description

Glover et al. (2011) preface their textbook *Modeling Methods for Marine Science* with the statement that “if you are a student of science in the twenty-first century, but are not using computers, then you are probably not doing science.” Few of us still rely on only paper and pencil to do our mathematical calculations – but what does it mean to “use computers” and do our high-school graphing calculators still count?

In this course, we’ll use computers to build and run models that examine how energy and material flows through a system. More specifically, we’ll explore the advantages of using a scripting language program (R) to learn the basics of constructing and running a model and compare these platform advantages to more familiar means of calculation using spreadsheet (Excel) and visual programming (Stella) software.

Learning Outcomes

This course is designed to improve a student’s ability to:

1. Express a dynamic process as a mathematical equation.
2. Couple a series of process equations to form a model.
3. Run a model, with an emphasis on using R as a simulation platform.
Required Readings


Recommended Readings

TBD

Course Requirements and Grading

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<thead>
<tr>
<th></th>
<th>Undergraduate</th>
<th>Graduate</th>
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<tbody>
<tr>
<td>Problem sets</td>
<td>60%</td>
<td>60%</td>
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<tr>
<td>Independent Project</td>
<td>40%</td>
<td>NA</td>
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<tr>
<td>Advanced Independent Project</td>
<td>NA</td>
<td>40%</td>
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</tbody>
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Problem sets may include a writing assignment or oral presentation

Workload

This is a 3 credit-hour course. Students are to devote at least 9 hours per week to this course over the duration of the 16-week semester. Expectations requiring time commitment include:

- Class time (up to 2.5 hours per week)
- Completion of take-home assignments
- Proficiency in course related computer software use

Prerequisites

Students should have completed FRSHWTR 504 (*An Introduction to Quantitative Analysis of the Environment*) with a grade of B+ or better; consent of instructor also required.
Topics Covered

**Week 1**
What is a model and why do we need them?
Our toolbox: a pencil, Excel, Stella, and R

**Week 2**
Model formulation
- The conceptual model
- Math formulations

**Week 3**
PROJECT: Spherical Cow → Stella → R model (1)
Flow of atmospheric ethane between hemispheres

**Week 4**
PROJECT: Spherical Cow → Stella → R model (2)
$^{222}$Rn and $^{218}$Po fluxes in a house

**Week 5**
PROJECT: Spherical Cow → Stella → R model (3)
A coal-fired power plant

**Week 6**
PROJECT: Degradation model
Bacterial degradation of detritus

**Week 7**
PROJECT: Chemostat model
Nutrient-algae Chemostat

**Week 8**
PROJECT: Advection-reaction model
Organic matter settling through a water column

**Week 9**
**SPRING BREAK**

**Week 10**
PROJECT: Diffusion-reaction model
Random dispersal of aphids on plants

**Week 11**
PROJECT: Advection-diffusion-reaction model
Oxygen in sediments

**Week 12**
Student model project (1)

**Week 13**
Student model project (2)

**Week 14**
Student model project (3)

**Week 15**
Student model project (4)

**Week 16**
Student model presentations

*Most meetings will include homework review*
Resources

Class Website. The course will use a Desire 2 Learn (D2L)-based website in order to coordinate the class, communicate information, and also to deliver assignments and feedback. Details are provided at the end of the syllabus. **Please check the website and your email frequently because you are responsible for all announcements and changes to the syllabus posted there.** If you need assistance with D2L, you can:

- send an email to help@uwm.edu
- pick up a phone and call 229-4040 (or 4040 on a campus phone)
- go to Bolton 225 (this lab is not open all day -- check for specific hours)
- if you are calling from outside the 414 or 262 area codes, call 1-877-381-3459

The Library. Library work can be an important part of the course and essential to completing the assignment.

Class Notes: Homework assignments and related material will be available on the D2L site.

Students with Special Needs: Students with special needs should arrange to speak with me during the first week of classes so we can best accommodate your learning style. Note University Policies: *Students with disabilities*. Verification of disability, class standards, the policy on the use of alternate materials and test accommodations can be found at the following: [http://www.uwm.edu/Dept/DSAD/SAC/SACltr.pdf](http://www.uwm.edu/Dept/DSAD/SAC/SACltr.pdf)

The Writing Center welcomes writers at all skill levels, inexperienced through advanced, freshmen through graduate students. FYI--over 1/3 of the students who visited in the past 4 yrs were juniors, seniors or grad students. Whether still exploring a reading, brainstorming, drafting or revising, writers can benefit from talking one with one of our well-qualified and well-trained tutors. Make appointments online 24/7: [http://www.writingcenter.uwm.edu](http://www.writingcenter.uwm.edu). Even if you do not need the Writing Center for this course, you should still make an effort to see what they have to offer.

Course Policies

Attendance: Some of the material for this course will be made accessible through the D2L website. This material is meant to help the student prepare for class, but it does not replace the material presented in class.

Late assignments will be downgraded for each day past the due date.

Academic Misconduct: In this course, you are expected to perform to the best of your ability in an honest manner. Cheating, plagiarism, or other acts of misconduct will result in a severe penalty to you, as per University of Wisconsin System Chapter 1.

Other University Policies: Various policies related to this course can be found on the Secretary of the University’s website at [http://www4.uwm.edu/secu/SyllabusLinks.pdf](http://www4.uwm.edu/secu/SyllabusLinks.pdf)