Modelling Human-Environment Systems  FA ENVS-6100-001 / 4950-002

Instructor: Dr. Jacopo Baggio, Contact: jacopo.baggio@usu.edu
Office Hours: Wednesday from 10.00 am to 12.00 pm, and by appointment. Appointments should be schedule via e-mail.
Office Location: NR 336

Course Schedule:
Wednesday: General Lecture 8.30 am to 9.45 am - BNR 360
Friday: Technical Lecture 8.30 am to 9.45 am - QLIB 303

This course is an introduction to modelling human-environment systems (HES). The course will focus on understanding the importance of complexity, system thinking, interdependencies and feedbacks in HES.

To disentangle such complexities and minimize the problem of unintended consequences of decision making, this course will familiarize students with specific topics that will be covered during this course divided into general (readings will refer mainly to these topics) technical, (exercises will refer mainly to these topics) and optional (depending on interest and ability of the class and individual/group final project).

- **Technical skills**: How to model human-environment systems. Simple models that include feedbacks, connectivity and diversity. Assessing models and their applicability to the real world.
- **Optional skills (to be discussed with the instructor)**: Integrating Networks and GIS, Integrating GIS and Computational Modelling, Integrating Networks and Computational Modelling.

To facilitate learning, the course is divided into three main blocks:
1. The first block of the course will introduce different modelling approaches, complex systems and frameworks that are useful to model social-ecological systems.
2. The second block of the course will focus on computational models and feedbacks between humans and the environment. During this part of the course we will explore and learn how to model three main system properties: diversity, connectivity and feedbacks. We will also learn how to assess a model limitations and strengths and its applicability to the real world.
3. The final block of the course will be centered on group and individual final projects. We will work in class on defining hypothesis, variables of interest and rules relating to such variables. In this third part of the course we will also focus on specific optional skills needed to finalize successfully your final project.

**Course Objectives**
1. To provide students with an understanding of the importance of feedbacks and interdependencies when dealing with human-environment systems.
2. To provide students with the technical ability to assess model validity and applicability to the real world.
3. To provide students the ability to design models dealing with specific aspects of human-environment systems.

To facilitate achieving these broad objectives, students will be assigned a variety of tasks to secure this knowledge. Students are expected to read the assigned materials before class and to participate in class discussions. This will not be a standard lecture class. We will all need to engage in discussion.
Requirements
To successfully complete this class you need access to a pc or laptop and the following software:
• Microsoft Office Excel or equivalent
• Microsoft Office Word or equivalent
• Microsoft Office Power Point or equivalent
• PDF Reader
• Netlogo (version 5.0.5 or 5.2) freeware modeling software, which you can download from http://ccl.northwestern.edu/netlogo/.

Not required but recommended is a statistical software of your choice (as it will make some analysis easier than using excel).
For Students interested in optional topics, software targeted to student interest is recommended (i.e. GIS software and Network analysis software).

Prior-Knowledge
It is strongly suggested that students have the following abilities/capabilities
1. Ability to understand and develop figures and graphs in Excel or other software.
2. Knowledge of basic
3. mean, median and standard deviation
4. correlation, pearson and spearman
5. parametric and non-parametric tests
6. Familiarity with concepts of dependent and independent variables

Own research topics are welcome, but not required. If you have a specific research topic you want to work on, final and mid-term projects will be centered on your own research topic.

Expectations
It is expected that students come prepared to lectures. This means that students are expected to have, at least, read the paper that will be discussed in class. Other readings are optional but highly recommended. The course is designed as follows (but subject to modification depending on class educational needs):
• General lecture: will be based on basic concepts for the week topic and discussion of the readings assigned
• Technical lecture: will be centered upon increasing skills and ability in modelling and analysis and will be mainly focused on exercises in class.

Typical Class Format
Although class may follow the format described below, the format is not fixed and will depend on the educational needs of the class and the number of students.

General lecture:
• Discussion Leads for the assigned reading – 10 minutes
• Discussion on the assigned reading – 10 minutes
• Discussion of the readings and summary of the discussion – 25 or more minutes
• Point raised that needs clarification, q&a, "traditional lecture" – remaining time
• The more you are engaged, the more you will learn and the more fun the class can be!

Technical Lecture:
• Revising and discuss previous exercises and concepts
• Exercises in class (this will be varied, from conceptually defining a problem, to modelling)
SYLLABUS DISCLAIMER:
This syllabus is NOT a contract. All parts of this syllabus can be amended by the instructor given students’ educational needs and assessment.

Assignments
For Essay type assignments you are asked to use word processing that your instructor can access. Therefore, preferably use Word, pdf, or plain text files. If you use software that is different and you may not sure whether it will be accessible by your instructor, contact Dr. Baggio. Files that cannot be opened will not be graded. The total available is 110%.

Assignments deadline:
General Assessment: Friday after leading the Tuesday in-class discussion.
Technical Assessment: Friday at 11.59 pm (week 2 technical assignment is due Friday of week 3).

Late Assignments:
Continuous Evaluation: Late assignments are penalized 1 point each 12 hours late. (after 36hrs, 0 points are awarded).
Final Project: Late assignment will be evaluated with 0 points.

Exception to late assignments: only medical (WITH doctor's note) late assignments can be accepted, unless otherwise stated by the university policies.

Continuous Evaluation
General Assessment: Discussion Leads (20 points)

Each week (depending on enrollment) one course participant will need to read and discuss a peer-reviewed article. Each discussion lead will have 3 main tasks – (all have to participate in the discussion as all receive points for participation)
1. Critically assess the validity of the paper assigned. You can use a power point or not. You are encouraged to search for critiques/validation of the paper assigned. If you have doubts or do not know how to proceed you can organize a meeting with me and I will provide guidelines for critiquing the paper assigned.
2. If the class does not discuss the paper, randomly someone will be chosen to lead the discussion on limitations strengths of the paper assigned.
3. Each participation is evaluated each week. If you do not participate you will get 0 points for a specific week.

Technical Assessment: Exercises take-home assignments (25 points)

Each week all students will be expected to complete the assignments given. Assignments vary. There will be paper and pencil exercises, finding error in models, simple model analysis and simple model building.

The maximum amount of points you will receive for each assignment is 3.2

Mid-Term Assessment (15 points)
Mid-Term assessment is not set, it can be a take home exam, a conference presentation, participating in a workshop and so on. If it will be in the form of a take home exam, the Mid-Term exam will include topics and technical material discussed in class.
Final Project

Project Presentation (15 points)

- The project presentations can be done individually or in groups. Presentation cannot be longer than 15 minutes (and they will be timed, going over time will result in a penalization in points).
- If in groups, all the names of all the group members have to be reported by each individual.
- Each individual will have to present part of the project to receive a grade.
- If an individual part of a group does not actually presents, s/he will receive 0 points for this assignment.
- A group can be of no more than 3 people.

Final Project Paper (35 points)

The final project is due 1 week after class has ended

- The final project can be discussed with me at any time during the course. If you have your own topic, we will work on that, if not, you can choose any topic covered during the course or you will be assigned one.
- The final project has to showcase your technical skills. It has to involve an in-depth analysis of a topic of your choices centered upon networks, and/or computational modelling.
- The final project can be done individually or in groups. If in groups, all the names of all the group member have to be reported by each individual.
- Contribution of each member should be stated, if not all members will be assumed to have participated equally.
- Groups can be of no more than 3 people.
- Your final project will consist of a thoughtful analysis of a model on a topic of your choice:
  - You can choose to analyze and critique a model, to replicate one or to build one.
  - The final essay should contain a brief literature review on the topic you are working on, description of the model (yours or the one you choose to discuss in depth), an analysis of the problems, limitations and your own conclusions.
  - You need to cite at least five peer review articles that deal with the topic of your choice.
- APA style is required as well as proper citation.

The essay must be at least 2000 words, not to exceed 3500 words.

Summary of impact of the different assignment on your final grade:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Learning</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td>20</td>
</tr>
<tr>
<td>Take-Home Assignments</td>
<td>25</td>
</tr>
<tr>
<td>Mid Term</td>
<td></td>
</tr>
<tr>
<td>Mid-Term Assessment</td>
<td>15</td>
</tr>
<tr>
<td>Final Evaluation</td>
<td></td>
</tr>
<tr>
<td>Project Presentation</td>
<td>15</td>
</tr>
<tr>
<td>Final Project Paper</td>
<td>35</td>
</tr>
</tbody>
</table>

Course Schedule

This course schedule as well as the syllabus can change depending on class educational needs. Some topics / skills may require more time than envisioned and in such cases the course schedule will be adjusted. All readings will be uploaded into Canvas. The course is divided in three main blocks
BLOCK 1: Modelling approaches and Frameworks to model Social-Ecological Systems

Week 1:

- **Introduction to the course.** What we will do, what is expected, what are the aims and objectives and the philosophy behind the teaching.

Week 2:

- **General: Systems, an introduction:** What is a system? What is the difference between simple, complicated and complex system? Examples of complex systems vs complicated systems.
  - Discussion: Complex Adaptive Systems (Lansing paper)
- **Technical: Introduction to Modelling:** What is a model? How do we build a model? How do we evaluate a model?
  - Assignment: Define a hypothesis and the fundamental variables impacting your hypothesis (why you choose specific variables and not others?)
- **Readings:**

Week 3:

- **General: Understanding Systems:** What can we learn and predict? What are the methods that help us understanding complex systems? What can we not expect to know or predict?
  - Discussion: exploring the known, the unknown and the unknowable (Levin’s paper) and All models are stupid, We need more of them (Smaldino)
- **Technical: Modelling Approaches, an introduction:** System Dynamics, and Agent Based Models
  - Assignment: Differences between system dynamics and agent based models. Reflect on the hypothesis and variables of week 2 and define strengths and weaknesses of system dynamics and agent based modelling.
- **Readings:**
Week 4:

- **General: Frameworks to understand Social-Ecological Systems**: An overview of frameworks useful to model social-ecological systems
  - **Discussion**: Differences and similarities between Ostrom SES and Anderies et al. Robustness Framework
- **Technical: Modelling Approaches**: Analyzing a model in NetLogo: simple predator prey models
  - **Assignment**: analyze the wolf-sheep predation model as a system dynamics model and as an agent based model in Netlogo. Explain differences and similarities.
- **Readings**:

Week 5:

- **General: Frameworks to understand Social-Ecological Systems**: The Institution Analysis and Development framework (IAD)
  - **Discussion**: IAD framework: strengths and limitation of the IAD framework in comparison to the Robustness framework
- **Technical: System properties**: Computational models: logic of programming and simple statements. Using stocks and flows.
  - **Assignment**: Exercises on simple statements needed when modelling human-environment systems.
- **Readings**:

BLOCK 2: Modelling Human Environmental Systems. System Properties and Model Assessment

Week 6:

- **General: System Properties: Diversity**: What is the role of diversity and how does diversity influences human-environment systems?
  - **Discussion**: the role of diversity in modelling human-environmental Systems. (Kotcschy et al. 2015). What is are the pros and cons of diversity in human-environmental systems? How can we overcome issues of a too diverse or too homogeneous world?
- **Technical: Modelling Human-Environment Systems 1**: Introducing diversity of rules to simulate human-environment systems.
o **Assignment:** Exercises on developing rules for interaction

- **Readings:**

**Week 7:**

- **General: System Properties: Connectivity.** Should Social-Ecological System be more or less connected? What is the relationship between connectivity, diversity and resilience?
  - **Discussion:** the role of connectivity in human-environmental systems (based on Dakos et al. 2015). What are problems that we may face when the world is too interconnected?
- **Technical: Modelling Human-Environment Systems 2:** Introducing structured interactions (networks) and modelling landscapes.
  - **Assignment:** Building a simple random networks with a simulation software.
- **Readings:**

**Week 8:**

- **General: System Properties: Slow Variables and Feedbacks.** What is the role of feedbacks in social-ecological systems? What is the difference between slow and fast variables?
  - **Discussion:** importance of feedbacks in governing human-environment systems (based on Biggs et al. 2015).
- **Technical: Modelling Human-Environment Systems 3:** modelling positive and negative feedbacks.
  - **Assignment:** build a simple model representing a positive feedback and a simple model representing a negative feedback
- **Readings:**

**Week 9:**

- **General: Assessing modelling papers:** How can we assess strengths and limitation of a model?
  - **Discussion:** Assessing strengths, limitations and applicability to the real world of the model proposed by Schoon *et al.* 2014.
- **Technical: Modelling Human-Environment Systems:** Bringing it all together: modelling different interacting agents on networks and landscapes

- **Readings:**

**Week 10:**

- **General: Summary: The ODD protocol:** Assessing your knowledge of Modelling approaches, frameworks and system properties. Assessing interests and groups for Part 3 of the course
- **Technical: Doubts and Issues so far. Recap how to model diversity, connectivity and feedbacks (including the possibility of learning) Writing an ODD protocol
- **Readings:**

- **Assignment:** Draft an ODD protocol for the model you intend to build for your final project.

**Week 11:**

- **General: Assessing modelling papers:** ODD protocol, justification of assumption and research question for your final project paper
- **Technical: Modelling Human-Environment Systems:** Bringing it all together: continued from last week. Modelling different agents and their interactions on networks and landscapes.
BLOCK 3: Individual/Group projects and optional skills to be developed

Week 12:
- **Group Project, working in class** – Presenting the Purpose of your model, agent types and scales – First draft of model scheduling

Week 13:
- **Group Project, working in class** – Presenting model scheduling and initialization – drafting submodels

Week 14:
- **Group Project** – Presenting preliminary results of your model

Week 15:
- Presenting your Project