CSS643: Land-Use Modeling Techniques and Applications
/EVPP 741 - 005/GGS 531 - 001

Tuesday 4:30pm–7:10pm, 205 Innovation Hall
Qing Tian, 703-993-1405, qtian2@gmu.edu
Office hours: Tuesday 3:00pm-4:00pm, Room 374, Research Hall

Overview

This course surveys literature on empirical models of Land Use and Land Cover Change. We begin with an introduction to Land Change Science which provides a theoretical background for land-use modeling. The bulk of the course will be spent reviewing techniques for land-use modeling, including statistical models, cellular automata, optimization and planning, agent-based models, and integrated models. Through discussions of case studies, we will learn the strengths and weaknesses and data requirements of each modeling technique as well as potential complementarities of the models to address complex research questions and acquire in-depth understandings of land use systems. Readings consist of peer-reviewed journal articles and some book chapters. Labs are included to enhance students’ hands-on modeling skills.

Objectives

Having completed the course, students should be able to critically review and interpret a land-use model, whether presented in a report or a scholarly article. They should have an understanding of the input data requirements, the ways in which the model output can be used, the spatial, temporal, and human scale over which the model operates, the disciplinary scope of the model, and the strengths, weaknesses, and limitations of the modeling technique used. Students should have an understanding of what empirical modeling techniques can be applied to a given data set. Finally, they should have an understanding of what modeling techniques are appropriate for particular research questions.

Recommended Prerequisites

It is helpful if students have a working understanding of spatial data structures, GIS, and statistical regression analysis, and are comfortable with simple optimization problems and systems of linear equations. However, motivated students without this prior knowledge have done very well in the past.

Course Work

Students are expected to actively participate in class discussions. Students should read all the required material before each class and write a brief note on two or three points from the readings that strike him/her (not a summary of the readings) to share with the class, and a list of questions (at least two) for further discussion in class.

Students are required to do a term project and write a report. You can work on a project individually or as a group (depending on the size of the project) using one land-use modeling
approach covered in class. Other options are possible, such as writing a review paper, but must be approved by the instructor beforehand.

There are three lab sessions with detailed instructions. You are required to submit a brief report for each lab.

**Grading**

1. Class discussion participation: 20%
2. Paper presentation (about 3 papers): 15%
3. Lab reports (4 labs): 40%
4. Term project: 25%

**Disability Statement**

If you have a documented learning disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with the Office of Disability Services (SUB I, Rm. 222; 993-2474; [http://www.gmu.edu/student/drc/](http://www.gmu.edu/student/drc/)) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

**Honor Policy**

The integrity of the University community is affected by the individual choices made by each of us. GMU has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification.

**Useful Resources**

**ArcGIS**


**Raster package in R**

https://cran.r-project.org/web/packages/raster/vignettes/Raster.pdf

**Netlogo**

[https://ccl.northwestern.edu/netlogo/download.shtml](https://ccl.northwestern.edu/netlogo/download.shtml)
Course Context

- Explain, predict, plan, and evaluate consequences
- Rural, urban, suburban areas
- Labs using R, Netlogo, ArcGIS

Diagram:
- Processes & Dynamics
  - Households
  - Local Environments
  - Markets, Broader Development & Institutional Settings

- Statistical models of household surveys
- Spatial statistical modeling
- Agent-based modeling
- Planning
- Cellular Automata
- Integrated models
- Other Models: demographic, macroeconomic, market, ecological...
<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Reading</th>
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<tbody>
<tr>
<td>1</td>
<td>Jan 24</td>
<td><strong>Introduction to Land Change Science and Land Use Modeling</strong></td>
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**Required reading:**


**Further reading:**


| 2    | Jan 31 | **Classic theoretical perspectives and statistical models** |

**Required reading:**


Jan Peter Lesschen, Peter H. Verburg, and Steven J. Staal. Statistical methods for analysing the spatial dimension of changes in land use and farming systems. *LUCC Report Series No. 7 (a good intro to statistical land use models)*

<p>| 3    | Feb 7  | <strong>Spatial statistical modeling lab (LAB1) (due Feb 17 by 8am)</strong> |</p>
<table>
<thead>
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<th>Day</th>
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| 4   | Feb 14 | **Statistical models and mixed methods**  
**Required reading:**  
Jan Peter Lesschen, Peter H. Verburg, and Steven J. Staal. Statistical methods for analysing the spatial dimension of changes in land use and farming systems. LUCC Report Series No. 7 *(a good intro to statistical land use models)*  
**Further reading:**  
| 5   | Feb 21 | **ABM I**  
**Required reading:**  
**Further reading:**  
| 6   | Feb 28 | **ABM lab (LAB2) (due March 3 by 8am)**  
**You may read:**  
March 7

**Cellular Automata (CA)**

**Required reading:**

**Further reading:**

March 14

Spring Break

March 21

**CA lab (LAB3) (due March 24 by 8am)**

March 28

**Optimization and planning**

**Required reading:**

**Further reading:**

April 4

**Multi-criteria/multi-objective land allocation lab (LAB4) (due April 7 by 8am)**
| Date  | April 11 | **No class meeting** (Qing Tian out of town for US-IALE conference)  
**Students work on term projects** |
|-------|----------|---------------------------------------------------------------|
| 12    | April 18 | **Integrated Models**  
**Required reading:**  
**Further reading:**  
Kristina A. Luus, Derek T. Robinson & Peter J. Deadman (2013) Representing ecological processes in agent-based models of land use and cover change, Journal of Land Use Science, 8:2, 175-198 (a review article)  
| 13    | April 25 | **Term project presentation and discussion (first round)** |
| 14    | May 2    | **ABM II**  
**Required reading:**  
| 15    | May 9    | **Term project presentation and discussion**  
**Reports due May 12 by 8am** |