GEOG 676: Modeling Land-Cover Change – Fall 2007

Instructor: Amy C Burnicki; burnicki@wisc.edu
Meets: Tuesday/Thursday 8:00-9:15am, 350 Science Hall
Labs: Tuesday 2:25-3:15pm, 380 Science Hall
Office Hours: Monday & Wednesday 2:00-3:00pm, 375 Science Hall

Course Overview:
Mapping land-cover change and creating models that successfully predict future land-cover changes have become key research priorities for national and international programs examining global environmental change. Land-Cover and Land-Use Change (LCLUC) represents a vibrant and dynamic area of research, since land cover changes continually due to human political, economic, and cultural activities. Among the many themes addressed by NASA's LCLUC program are topics focused on improving the detection and monitoring of land-cover/-use change and building models that predict future changes in land-cover/-use. A key objective of the program is to "model and forecast land-use and land-cover change", and more specifically "identify the current distribution of land-cover types and track their conversion to other types".

This course investigates the dynamics of land-cover change by examining a series of modeling approaches that describe observed land-cover changes and predict future changes in land-cover. Specifically, this course examines the theories and methods used to map, model and explain land-cover change, and the tools available to validate models of land-cover change and accuracy assess model predictions. It will integrate theories and techniques from the fields of GIS, remote sensing, and spatial analysis and modeling. As such, this course is designed to introduce students to the ways in which GIS and spatial analysis can be applied to explore and model changing human-environmental systems as evidenced by changes in land-cover.

Course Organization. This course is divided into two sections. The first section, covering the first five weeks of the semester (~1/3 of course), will introduce students to the field of land change science and address several fundamental topics in researching land-cover change: measuring land-cover change, describing change patterns and understanding the driving forces of change. Specifically, the following research questions will be addressed:

- How do we measure and map land-cover and land-cover change?
- What typical spatial patterns and characteristics are observed for land-cover changes?
- What drives changes in land-cover, and how are these driving forces represented in models of land-cover change?
- What challenges face researchers attempting to quantify and model land-cover transitions?

The second section, covering the remaining 10 weeks of the semester (~2/3 of course), will examine a series of modeling approaches that describe and predict changes in land-cover. We will examine a series of models that represent statistical/analytic, optimization, and Markov-based approaches to modeling observed land-cover change patterns. More dynamic modeling approaches, such as multi-agent system models, and models that incorporate multiple approaches will also be discussed. Finally, we will consider the impact of uncertainty in modeling land-cover change – from assessing error inputs when measuring land-cover change to evaluating predictions of land-cover change models. Specifically, the following research questions will be addressed:

- Why do we model & how are models characterized?

- ? What types of models are used to analyze past land-cover changes and describe relationships between observed changes and potential driving factors?
- ? What types of models are used to quantify the potential for experiencing land-cover change and create maps that predict future land-cover changes?
- ? How do we validate the output of land-cover change models, and how can we evaluate land-cover change maps in the presence of uncertainty?

Prior Experience. Students should be knowledgeable in GIS, basic mathematics, and standard statistical methodology including descriptive statistics and bivariate regression. This translates to at least one statistics course and an introductory GIS course or its equivalent.

Structure. This is a hands-on course that builds around a series of laboratory exercises designed to provide students with first-hand knowledge of the methods and tools available to model land-cover change. A series of focused readings and discussions will provide the necessary groundwork for understanding: 1. How land-cover change is measured and what drives changes in land-cover; 2. Methods available to analyze past land-cover changes, model the potential for change and predict future land-cover changes; and, 3. How to evaluate the accuracy of land-cover change maps and the predictive ability of change models. This translates into 40% lecture, 20% discussion, and 40% laboratory.

Course Objectives:

This course is designed to provide students with a comprehensive overview of land-cover change modeling research. After completing this course, students will be able to apply GIS and spatial analysis techniques to explore and model the pattern and dynamics of land-cover change. Specifically, students will be able to:

- ? Create a map of land-cover change and characterize observed change patterns and rates
- ? Identify and create a series of explanatory variables that describe the potential for experiencing a land-cover change
- ? Produce models that describe observed patterns of land-cover and create maps that illustrate future land-cover transitions
- ? Evaluate the accuracy of maps of land-cover and validate model predictions

Students will be able to critically-assess land-cover change models found in land change science research, both in terms of the appropriateness of the chosen model and chosen explanatory variables, and assess the accuracy of model predictions. More importantly, students will be able to apply the modeling techniques examined in this course to their own research questions.

This course will provide an environment in which students can pursue and discuss their individual research interests in the field of LCLUC with an interdisciplinary group of upper-level undergraduate and graduate-level students. This requires active student participation. To foster student participation and provide an interactive learning environment, several classes will be composed of both lecture and discussion. This will provide students with the opportunity to critically examine the presented topic and direct discussion to their individual interests and views.

Course Expectations & Evaluation:

Students are expected to read all assigned articles and attend class. Planned absences should be brought to the instructor’s attention prior to the missed class. Missing class is not a valid excuse for a late assignment.

Students are evaluated on their class participation, laboratory assignments and final exam. Each component is assigned a set number of points and contributes towards the final point total. A maximum total of 235 points can be achieved in this class. The component breakdown is as follows: 1. Participation = 20; 2. Labs = 135; and 3. Final = 80.

Class Participation. The key to a successful class experience is participation, which in turn relies on students completing all readings, attending class meetings, and discussing assigned readings and related issues. Grades for participation are therefore based on the following criteria: 1. Demonstration that the student has read and understood class material; 2. Arguments that evidence creativity and logical structure; and 3. Consistent in class participation without monopolizing the discussion. It is expected that all discussions will take place in an environment characterized by civility and mutual respect.

Labs. Each student is required to attend scheduled lab sections. The first scheduled lab is Tuesday, September 11. The purpose of this introductory lab is to familiarize each student with the IDRISI software package and fundamental GIS operations.

The second lab meeting takes place September 18th, and begins a series of seven bi-weekly lab sessions that examine various models that describe and predict land-cover change. Labs are scheduled for the following dates: September 18th, October 2nd, 16th and 30th, November 13th and 27th, and December 11th. Students will have two weeks to complete each lab assignment, and are not required to attend lab on non-scheduled days. However, the lab will be open during the scheduled class time, 2:25-3:15pm, every Tuesday to provide students with an opportunity to continue work on lab assignments not finished during scheduled lab time. Labs are due by 4:30pm on the Monday prior to the next scheduled lab session. The only exception is the last bi-weekly lab scheduled for December 11th. This lab is due by 4:30pm on Friday, December 14th. Labs should be uploaded to the course webpage on the Learn@UW system.

For example, the first bi-weekly laboratory assignment will be distributed and introduced in lab on September 18th. Students will have the remainder of that class period to work on the assignment. Students requiring additional computing time can attend lab on the following Tuesday, September 25th. The lab is due by 4:30pm on Monday, October 1st.

Points are assigned to each individual lab assignment, and contribute to the 135 total points that can be achieved within the laboratory grading component. The IDRISI introduction lab is worth 5 points. The first and last bi-weekly lab assignments are worth 15 points. All other lab assignments are worth 20 points.

Late lab assignments will be accepted, within reason, with a 10% penalty deducted each day the assignment was late beyond the due date.

Final Exam. The final exam for this course is a take-home final designed to evaluate each student's ability to critically assess land-cover change modeling approaches and apply land-cover change modeling techniques to research questions examining land-cover change. The final will be posted on the course webpage on the Learn@UW system by 5pm on Friday, December 14th. The final is due on the following Friday, December 21st, by 5pm.

A note on student work. Group discussion during lab sessions is expected and encouraged. However, all written work including lab assignments and the final exam must be completed individually by each student. It is expected that work submitted by a student reflects his or her original ideas and responses. Submissions that reflect substantially similar work by more than one student will be dealt with as an act of scholarly dishonesty. Please refer to the "Student Academic

Misconduct Policy & Procedures" document produced by Student Advocacy & Judicial Affairs division of the Offices of the Dean of Students for further information.

Course Readings:

All assigned articles and book chapters will be available digitally on the course website on the Learn@UW system. Readings will be added to the course website during the semester as the course develops. A schedule of readings will be distributed periodically in class which will detail readings for the upcoming week(s).

Course Outline:

The tentative course schedule follows. Changes may be made at the discretion of the instructor as the course develops.

Week	***Tuesday***	***Thursday***	***Lab***
1	Course Intro. & Importance of LCChg	Defining LC & LU; Measuring LC	
2	Defining & measuring LCChg	Challenges in observing Chg	Intro to Idrisi
3	Chg patterns & char.	Landscape metrics	Land-Cover/-Use & Mapping Change
4	Examining drivers	Modeling drivers	
5	Challenges in modeling drivers	Modeling LCChg – Res. questions/goals	LCChg Pattern & Predictors
6	Modeling LCChg – Defining & categorizing models	Statistical approaches – Logistic regression	
7	Logistic regression	Logistic regression	Logistic Regression
8	Optimization approaches – MCE	MCE/MOLA	
9	MCE/MOLA	Cellular Automata approaches	MCE
10	CA/Markov	CA/Markov	
11	Dynamic modeling approaches	Dynamic & MAS	CA_Markov
12	MAS	MAS	
13	Synthesizing modeling approaches	Challenges to modeling LCChg	Dynamic modeling – Neural nets
14	Uncertainty in LCChg modeling; Acc. Assess	Validating LCChg maps – null & spatial	
15	Validating LCChg maps – path dependence & comparisons	Future challenges & research goals for LCChg modeling	Accuracy Assessment & Validation