Course Synopsis
This course is offered through a joint effort of the Dept. of Atmospheric and Oceanic Science and the Earth System Science Interdisciplinary Center (AOSC and ESSIC, part of UMD’s College of Mathematical and Natural Sciences) and the Joint Global Change Research Institute (part of US Dept of Energy’s Pacific Northwest National Laboratory). The course focuses on exploring the relationships between water, climate, land and energy (the so called “nexus”) through an interwoven understanding of the physical, economic and institutional constraints of water resources issues and consideration of climate-related impacts on management and decision-making process in water supply, energy generation and food production. A general modeling framework is developed using integrated assessment models (IAM). Lectures will be complemented with online discussion sessions and real-world based modeling exercises to get hands-on knowledge of practical solutions to nexus challenges. Open to students of all backgrounds (see pre-requisites below).

Course Learning Objectives
• Explore the fundamentals of the interaction between water, climate, land and energy processes at the local, regional and global scales;
• Apply quantitative approaches to provide estimates of water, climate, land and energy stocks and fluxes under the influence of changing forcings (e.g., population, economics);
• Understand the role of water-climate-land-energy interactions in the context of adaptation processes, policy-making and development;
• Conceptualize, design, implement and monitor the effectiveness of adaptation policies and measures in water, energy and food sectors.

Communications Component
This course will explore strategies for analyzing and interpreting sustainability issues, and methods for conveying findings to a broader, non-technical audience. It also provides the opportunity to informally discuss the breadth of sustainability, and to sharpen critical thinking skills in evaluating complex systems. Because of this, the class will include a communications component, in which we will use social media to provide vantage points on sustainability issues, and to generate discussions.

Lecture Topics and Schedule
(1) Intro to IAMs: what are the “big issues” for the class, why IAMs are useful tools, what they do (and what they don’t).
August 31

(2) Introduction to the Global Change Assessment Model (GCAM): history, evolution of the tool and overall structure, types of applications and examples.
September 2

(3) Deep dive into GCAM: model structure, assumptions, basic equations, output results
September 9 (note: lecture will be held on Wednesday of this week, due to Labor Day falling on September 7)

(4) GCAM Tutorial: setting up and using the software, run basic GCAM simulation(s)
September 14 (additional session on September 16 if needed)

(5) The energy system: production/transformation/carriers/end use/demand
September 21

(6) The agricultural system: land use/food system, regions/supply/demand
September 28

(7) The water system: hydrology/basins/water availability/budgeting/scarcity
October 5

(8) The climate system: carbon cycle/atmosphere/oceans/land/forcings
October 12

(9) The economics system: market partial equilibrium approach
October 19

(10) GCAM computations: solution process/algorithms/processing and interpretation of results
October 26

(9) Applications and simulations: types of problems, case studies, analysis of results, policy implications
November 2

(10) Student Projects: in-class sessions, hands-on work on modeling projects
November 9-December 7

References
IAM and applications are a flourishing scientific discipline. As such, there are new developments in the field being published rapidly. This class will therefore be reading-intensive, with regular lectures complemented with several guest lecturers and class discussions. Participation of all students in the discussion is encouraged and will be graded. We will likely read and discuss over 20 journal articles and other readings during this course, covering the variety of lecture topics presented in this syllabus. All class notes and reference materials (journal papers, readings, handouts) will be distributed electronically. Your term project will make use of GCAM. Class reading materials will be distributed in advance. We will also consult the GCAM Model Wiki.

Pre-requisite Coursework
Undergraduate level algebra, knowledge of calculus and introductory differential equations (strongly preferred), and computer proficiency. Please consult with instructor for details.

Grading
This course will be graded through the following exercises (more details to follow):
• Midterm Exam (25%): this will consist of a written project proposal for the class; instructions for its preparation will be provided.
• Term paper (50%): this paper will document the development and application of a system dynamics model to a problem of your choice (in agreement with the instructor).
• Class discussion participation and minor assignments (forum discussion group): 25%

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