Spring 2019

CE597/POL693

Introduction to Modeling Social-Ecological, Socio-Technical, and Socio-Hydrological Systems

(Dynamics of Social-Ecological and Technological Systems)

Credit Hours: 3.00

Tues, Thurs: 9:00-10:15 am (1/7/2019-4/27/2019) @ Armstrong Hall 1103

Sustainability problems are by nature transdisciplinary, calling for a wide range of topics. Many of these can, and should, be addressed mathematically. This course will equip you with some of the **mathematical concepts and tools (and systems thinking)** necessary for understanding and tackling sustainability problems. Therefore, in this course, we will explore mathematical analysis and models from both social, natural, and engineering sciences. These concepts and tools will be introduced in a problem-based context.

Initially, we will explore models on how human and natural systems interact (or **social-ecological systems**), e.g., resource-harvest models. These will introduce the important concepts of **stability**, **resilience**, **regime shift** (an important phenomenon related to sustainability, in which apparently slow changes can lead to large, rapid consequences), and **early warning signals** of such regime shifts. **Dynamical systems theory** will be introduced to gain a mathematical understanding of these concepts. We will also cover **game theory**—an analysis of human conflicts—at the basic level. The **evolutionary dynamics** of some of the classical games will be explored through the replicator equations that mimic social learning. Along the way, we will learn about different types of **social dilemmas**, **behavior of individuals and collectives**, and how various contextual conditions affect the likelihood of human **cooperation** in such situations. Building on this foundation, we will also cover a few simple models of other types of 'coupled' systems, e.g., **socio-technical systems** and **socio-hydrological systems**, in which the role of **engineered** or **technical components** is more clearly present.

Some problems call for analyses and models that are more sophisticated, and sometimes analytically intractable, models. Such circumstances require numerical simulation, which in this course will be done in **MATLAB.** Topics in this section include the effects of stochastic noise on the behavior of the systems and **complex adaptive system approaches** to selected problems. MATLAB codes will be provided in some cases.

Preferred prerequisite: Background in basic calculus.

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