Modeling at the Interface of Human and Natural Systems

Summary of a Workshop at The Commons in Spooner Hall University of Kansas

Shaily Menon

It is my pleasure, this morning, to present a summary of the highlights of a series of presentations and a panel discussion yesterday related to Modeling at the Interface of Human and Natural Systems.

In his welcome, Kris Krishtalka, Director of the Natural History Museum and Biodiversity Institute at KU, reminded us that our topic is of one of the grand challenges for the 21st century. He suggested that the Commons, a truly interdisciplinary place or indeed an idea, was a fitting location for a workshop such as this one, bringing together folks from different disciplines to examine modeling at the interface of human and natural systems. Understanding and forecasting ecological change in the central plains grassland has been a partnership between the University of Kansas, Kansas State University and other participants and the goal of this workshop was to explore the issues involved in integrating natural systems model with human systems models. He exhorted us to ask questions such as What are the reciprocal impacts? How well can we model complexity? And Why is this critical? He cited a local example, involving corn, a Kansas planning board meeting, and a public strongly against building an ethanol plant and asked Is science advising these kinds of decisions? He underscored the importance of decision making informed by science and if we are not successful, he said, we are doomed, and headed to a very hot place in a hand basket.

Johannes Feddema, Professor of Geography, highlighted the big question in the climate change debate – What is the contribution of humans? and pointed out the challenges in answering that question: which human processes are important to simulate, how should they be simulated, how should human decision making be included, how can Earth System Models improve impact assessment, how can we address the lack of information (historical, present and future) driving human systems, and how can we deal with different spatial and temporal scales? He described an Urban Model example, which will help determine the impact of urbanization on climate (heat islands) and to simulate the impact of different mitigation strategies.

He was followed by Town Peterson, Distinguished Professor of Ecology and Evolutionary Biology, and Curator in Charge, Natural History Museum and Biodiversity Institute, who discussed disease geography – where nature and public health meet. He described a recent analysis which showed that contrary to popular belief diseases are emerging not in the tropics but in areas of human presence. For example, the West Nile virus had a disease emergence in NY in 1999 through unknown means. He showed us maps of plague endemic areas and human endemic areas – plague cases happen where the two intersect. The natural-human interface is often the focus of disease emergence and the challenge is to understand where that interface is for each disease system.

Jorge Soberon, Senior Research Scientist, Natural History Museum and Biodiversity Institute, and soon to be Professor, described the complex nature of valuing biodiversity and how we might include non-scientific factors in biodiversity prioritization exercises. Different social groups (scientists, lawyers, ngos, indigenous people) have different points of view, different systems of values, and sometimes even different ways of knowing. Valuing biodiversity often uncovers a clash of values between these different groups and requires negotiation, weighting of values, and agreement between different social sectors about what is important. Valuation exercises should be conducted in tandem with the scientific assessments that provide information or hypotheses about components of biodiversity, or their functioning.

Jeff Peterson, Associate Professor of Agricultural Economics at Kansas State University gave us an economics perspective. He described the decision boomerang – decisions that are made now have environmental effects which in turn affect future opportunities and decisions, (for example soil erosion or aquifer depletion). To change the boomerang effect, either economic incentives or social factors driving the decisions must change. He discussed the Coupled Groundwater-Economic Model, which predicts changes in groundwater applied to Sheridan County, and which analyzed existing policy, and various carrot and stick approaches (regulation vs. incentives). Social processes are likely to dynamically impact economic behavior and more research is needed in this area. In analyses of Economic-Social Interactions – traditional economic models are inhabited by *Homo economicus* (infinitely rational, infinitely self-interested, and infinitely self-disciplined). Fortunately, behavioral economists study the choices and interactions of the "dumber, nicer, and weaker" *Homo sapiens* who will depart from the 'self-interest' assumption to make sound environmental decisions.

Shaily Menon, Associate Professor and Department Chair of Biology at Grand Valley State University, and Research Associate at the University of Kansas, discussed land change modeling in the context of conservation priority-setting with examples from two mega-diversity hotspots in India. Several approaches have been developed for conservation priority-setting including biodiversity hotspots, rarity and complementary sets, and gap analysis. She discussed an example of a modified gap analysis within the Western Ghats, India. While we lack the detailed knowledge of biodiversity distribution over extensive geographic areas required by these approaches, we know that land change is widespread, is driven by a host of socioeconomic and geophysical variables, and is leading to biodiversity loss. And yet, we have not often combined our knowledge of human geography and land-use patterns with our knowledge of biodiversity distribution to predict how and where land-use change may be leading to biodiversity loss and how we might curtail these losses. Her second example, from northeast India, demonstrated an application of predictive land change modeling based on the way humans use land in order to help us prioritize areas for monitoring and conservation of biodiversity.

Roelof Boumans, Associate Research Scientist and Ecosystem Ecologist, Institute of Ecological Economics at the University of Vermont described the Multi-scale Integrated Model of the Earth Systems or MIMES approach to modeling ecosystem services and associated values. MIMES includes models to describe ecosystem services or ecosystem contributions to economic sectors

AND the production of environmental externalities by economic sectors which have impacts on ecosystems. MIMES takes a collaborative model approach and invites contributions to model development and Roelof invited participants to be part of the collaboratory.

Keith Yehle, Director of University Communications at the University of Kansas, talked about the interface of modeling and government and working with government relations. He reminded us that Congress is not the National Academy of Science (11 docs, 6 ministers, 36 mayors, major league baseball player, 5 accountants, astronaut…). How do you communicate modeling to them? Congressional offices are legislative engines and legislative assistants are issue experts, good liberal arts skill sets, learn a little about a lot quickly, continue to learn, when needed become subject matter expert, always looking for science mentor. Keith proposed a model for communicating modeling – teach a semester course on modeling to undergraduates in 30 minutes, think about what do you want to leave behind – not on paper but in the minds/memory of congressman/staff, tie it back to KS, US, water quality, soil conservation, you can't teach/educate/advocate with textbooks on Capitol Hill, you can teach with maps, well-designed computer programs, KARS/Avian Flu examples.

A panel discussion followed the presentations.

Michael Lynch, Assistant Professor of Political Science, University of Kansas started us off with a discussion about modeling in political science, specifically policy making. Is science advising policy decisions? Are elite policy makers more like homo economicus or more like homo sapiens?, In forecasting policy we are not predicting specific policy, but are looking at the micro-motivation of legislators and individual decision-making rules that legislators are likely to use, based on general ideology, past voting records, constituents and so on. He shared some dismal statistics from a recent Gallup Poll for Earth Day – Global Warming Worries are Static Over Time, and fewer % of people think humans are responsible for global warming; and policy makers may have shorter time horizons based on their stay in office rather than stay on the planet.

Based on the questions from the audience related to incorporating nonlinearities, feedback controls, and stochasticity in the modeling process, a couple of ideas were generated for harvesting low hanging fruit to develop a proof of concept:

1. These included an exercise on valuing ecosystem services at the scale at which decisions are made

2. Taking a common problem, say biofuels, which would be addressed by different communities and then integrated

3. Small steps to build the ladder for each the next generation of modeling and providing resources to interdisciplinary teams of graduate students and postdocs, who have the time and creative energy to tackle these problems