Modeling Dynamic Systems for Sustainable Development

Noelle Selin¹, Amanda Giang², and William Clark

¹Massachusetts Institute of Technology, Cambridge, United States of America (selin@mit.edu)
²Institute for Resources, Environment and Sustainability, University of British Columbia, Vancouver, BC, Canada

We summarize recent progress in dynamic modeling of nature-society systems to inform efforts towards sustainable development. Drawing on lessons learned from a series of virtual workshops and a journal Special Feature, we identify and highlight examples of novel methods and advances, focusing on four stages of modeling practice -- defining purpose, selecting components, analyzing interactions, and assessing interventions. We highlight insights for researchers interested in assessing the implementation of system-wide sustainability strategies, with a focus on human well-being as an overarching objective, including methods that incorporate nature-society interactions into sectoral decision-support models, simulating cross-sector connections and differing contexts, and implementing computational and statistical approaches that evaluate decision scenarios under uncertainty. We additionally highlight techniques that can serve to foreground issues of power differentials among actors, including methods that can capture diverse societal actions and their agency, and incorporate different perspectives and normative visions. As a concrete example of the utility of a set of methods and advances from this survey of coupled nature-society systems modeling, we show how advances in computational techniques can be used to assess the degree to which national-scale climate policies in the United States can impact air pollution exposure to different racial/ethnic groups.