Reports from the Field: Assessing the Art and Science of Participatory Environmental Modeling

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ABSTRACT

Since the work of Tansley (1935) and others, many have embraced the concept that an ecosystem is a synergy of its parts. Numerous science-centric approaches have been developed to address ecosystem management, while also taking into account the needs of the public. Participatory environmental modeling using system dynamics is an effective process for facilitating the integration of ecosystem science and social concerns. This integration helps break barriers between disciplines while also identifying important feedbacks between traditionally segregated types of data. Using the art of facilitation and the science of model building, the methodology creates a common language that integrates various types of information into simulation models. This paper describes a diversity of case studies, that have used system dynamics to create platforms through which stakeholders can simultaneously explore their system, stressors to that system, potential tipping points, resilience, and prospective policies that address the environment, social concerns, and long-term sustainability.

Keywords: Ecosystem Science, Environmental Modeling, Participatory Environmental Modeling, Collaborative Modeling, Participatory Modeling, System Dynamics

INTRODUCTION

As the natural world has become dominated by human influences, environmental problems have become increasingly complex. In the United States, many laws (NEPA, CWA, CWA, ESA) endeavor to protect the environment while at the same time consider the economic and social needs of the nation’s human population. Yet the diversity of local situations often leaves both agency personnel and the public frustrated with laws and regulations that do not effectively address long term sustainability or the specificities of locale. In addition, since the early work of Tansley (1935) and others we have embraced the concept that an ecosystem is a synergy of its parts and the relationship between those parts. In an effort to support the ecosystem concept and improve or sustain environmental and social quality a number of problem-solving processes have been developed and implemented with varying degrees of success. These include the NEPA assessment process, adaptive management, shared vision planning and state and local planning processes. One critical element that has emerged from these science-centric approaches is that public

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involvement in the problem-solving process is essential. Furthermore eliminating barriers between science and society is essential if we are to confront the multitude of real world problems that we face (Wang, 2008). Public participation invites a variety of information, knowledge, opinions and worldviews into the decision-making process. Creating a nexus of science and local knowledge through which problems and solutions may be discussed is essential for finding consensus-based solutions to environmental problems.

Participatory environmental modeling that uses system dynamics (SD) is effective for facilitating the integration of natural resource science and social concerns. Using the art of facilitation and the science of model building the methodology creates a common language that integrates various types of information into simulation models. For example information that has been created through Geographic Information Systems (GIS) modeling, hydrologic system modeling (e.g., MODFLOW), population modeling (e.g., Population Viability Analysis, PVA), or economics can be integrated with experiential knowledge and the values of stakeholders into computer models that may be used for exploring potential futures of dynamic systems. Using SD theory for creating this integration adds a powerful means to feedback discovery and analysis between data types. SD allows us to integrate data from various information systems into easy to use, transparent platforms that allow users to investigate potential future scenarios.

Collaboratively built models assist stakeholders with problem definition and evaluation of potential management or policy alternatives. The process of building a model helps stakeholders clarify their own mental models, better understand those of others, and gain a better understanding of important scientific relationships. The process of evaluating simulation results allows participants to explore “what if” scenarios that depict potential futures. The combination of problem definition, mental model clarification and futures exploration helps participants better understand the scope of a system, potential tipping points and how the system behaves over time. In doing so the barriers between social sciences and natural sciences, between theoretical and applied science and between science and experiential knowledge may be reduced. Furthermore the process requires scientists to interact with decision makers and the lay public. The groups must learn to develop a shared language and understanding of the system in order to create a model. Decision makers and the public become better versed in science; scientists become better versed at the challenges faced by decision makers and the public. And though the results of such processes may be very difficult to measure few would argue “when one part of society offers its services to another, most likely both parties will benefit” (Wang, 2008, p. 2).

This paper recognizes that processes designed for community-based interventions will vary according to the idiosyncrasies of the problem. The availability of quantitative data, types of participation, the timing and length of the intervention, and other variables create challenges for both process design and the comparison of processes. Due to this large degree of variation, the goal of the analysis that follows is to learn about the variety of techniques and a broad range of interventions through an examination of case studies. The diversity of these case studies and the inventiveness of the practitioners to adjust their efforts to the needs of the stakeholders and the environmental problems they are facing illustrates the flexibility of participatory modeling. The art of participatory modeling requires practitioners to develop an understanding of stakeholder values, translate scientific information, and relationships, and well as building model interfaces that are illuminating and educational. The scientific requirements of participatory modeling practitioner include both having an understanding of the scientific issues surrounding the resource of concern and being able to design mathematically correct yet simple and easy to follow parameters and relationships into a transparent and defensible model. Participatory modelers who use SD create customized,
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