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Integrating Science with Society: Environmental Systems Analysis in a Participatory Context

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Integrating Science with Society:
Environmental Systems Analysis in a Participatory Context

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The conventional approach to environmental systems analysis is based on the concept of forecasting, employing mathematical models for predicting both the impacts of natural stressors and the outcomes of anthropogenic actions on the environment. However, the reliability of such predictions is limited to the behavior domain defined by the historical data employed for conceptualizing and calibrating the model. Often, unforeseen future changes in external stressors and internal structure tend to produce system behavior significantly different from prior predictions. To abate this seeming lack of credibility in model-based forecasting, it is now customary to qualify predictions with uncertainty estimates.

This paper presents the concept of *backcasting* as a complementary inverse approach, that employs future endpoints as a basis for identifying the key attributes of the modeled system. A framework is presented for integrating society (via elicited stakeholder imagination) with scientific theory (via mathematical modeling), with systems analysis providing the integrating factor in the form of a methodology for uncertainty and sensitivity analysis. By comparing the ranking of key sources of uncertainty in the model outputs, the analysis reveals possible structural changes in attaining alternative speculated future endpoints.

Proof of concept is demonstrated in a case study of Lake Lanier, Georgia. Two extreme future endpoints elicited at a foresight workshop describe the fears and desires expressed by a community of stakeholders for the future ecological condition of the reservoir. Results of the analysis of model outputs, compared with the prescribed endpoints, indicate that the desired future is more reachable, but accompanied by more significant structural changes, than the feared future. In addition, the key attributes identified suggest that future research be directed towards understanding sediment-water interactions, microbial production, and secondary production within the reservoir ecosystem.

Such an integrated assessment is potentially beneficial to science, policy, and the society at large. Specifically, it provides a means for: (i) establishing credibility and public trust in the science base, via stakeholder participation; (ii) confirming or refuting stakeholder concerns for the future environment; (iii) identifying critical gaps in current knowledge, in order to prioritize future scientific research in areas that are relevant to society; (iv) informing priorities for future policy and management actions; and (v) promoting communication and adaptive community learning, through the continual mutual feedback between scenario-generation and systematic analysis.

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