Jul 1st, 12:00 AM

Future Solutions: Integrated Models for SEA and other Land-Use Decision-Making.

Ruth Waldick

David Brunckhorst

Ian Campbelld

Jeff Carmichael

Integrated modeling for landscape and watershed management: building multi-jurisdictional capabilities

Ruth Waldick[a], David Brunckhorst[b], Ian Campbell[c], Jeff Carmichael[d]
[a]Environment Canada (ruth.waldick@ec.gc.ca), [b]University of New England (Australia)/UNESCO, [c]Policy Research Initiative, Government of Canada, [d]University of British Columbia

Abstract: Since policies should reflect societal values and aspirations, decision-making would benefit from tools that allow consideration of all entities that contribute to, or are affected by decisions. At a minimum, policy should include those key economic, social, and environmental activities taking place within a geophysically relevant area. The barriers that impede the development of integrated modeling programs that try to include many of the processes and outcomes of interest in studying a problem represent a series of common challenges associated with most integrative and cross-jurisdictional projects. Although computer-based modeling and scenario tools can inform the decision-making process, the scope of their use will continue to be limited by the existence of administrative, jurisdictional, and epistemological barriers, along with current (and evolving) principles for decision-making (e.g., precautionary principle, adaptive management, robustness, etc). The development of science-based approaches to support decision-making requires the provision of, and access to data and information that enables supports long-term basic and applied research, and the development of new multidisciplinary technologies and tools for forecasting and integrated prediction. What are needed are institutional structures, or forums, to facilitate the necessary exchanges. However, to be effective, any approach used must specifically deal with boundaries between knowledge and action, while also initiating and supporting communication, coordination and mediation across these same boundaries.

***Keywords**:* Start keywords one space below the abstract and provide 3 to 5 keywords separated by semicolons.

1. INTRODUCTION

Sustainable development objectives, which aims to ensure viable ecosystems for use by future generations, have been the focus of much discussion in the international community over the past 20 or more years. The extent to which current behaviours and decisions are undermining future options has been made more tangible through the five-year Millenium Ecosystem Assessment. The implications of failing to address sustainability targets are not just of economic concern, but also of human health concerns associated with the ever broadening pressures on ecosystems, ranging from direct impacts, such as depletion or degradation of freshwater resources, to less obvious impacts associated with bioaccumulation. Particularly strong feedback loops between human health and ecosystem degradation have emerged, most notably that the dependency of societies on ecosystem services will increase as they become increasingly scarce.

Substantial challenges in addressing these major issues of sustainability are in integrating information across existing boundaries, coordinating multiparty assessments, analyzing cause and effect relationships between proposed actions and impacts, managing associated multiple (large) datasets, and quantifying uncertainty.

One potentially valuable approach for dealing with problems of implementation and integration is that of integrated modeling, which strives to address complex interactions across multiple land, water, or resource use through the use of computer-based simulation models. Systems have been developed for a variety of purposes, ranging from visioning and forecasting exercises to identify future desired conditions, cumulative effects and risk analysis, environmental assessments/strategic environmental assessments, policy analysis, and monitoring.

In this paper, we review some of the applications of, and impediments to, the development of multi-jurisdictional integrated management models. We focus on discussions of institutions and governance, but also acknowledge the important complementary issues of communication and engagement, and technical development. To stimulate thinking about instutionalization issues we present five possible frameworks that could be used to implement multi-scale modeling programs.

The benefits and limitations of each institutional framework and their potential application for the development, coordination and implementation of integrated landscape management modeling programs for multiple levels of jurisdiction are discussed.

2. CHALLENGES

Integrated modeling tools first emerged in the 1970s, in response to a growing understanding that many issues require understanding of complex systems that go beyond individual disciplines, and that changes in one discipline may in fact have consequent impacts in other disciplines. The desire for research-based policy is compelling researchers into increasingly interdisciplinary and integrated research.

Two of the most important requirements for increasing interdisciplinary and integrated research are to develop methods for improved communication on technical and engagement issues. While much progress has been made in the technical realm, progress on communication and engagement have had mixed results.

2.1 Technical Progress

Despite the notable progress in the development of modeling tools, their adoption and use continues to be limited by: (a) difficulties in managing information at different scales (time and space), (b) open and efficient access to necessary data or information, including their sources, (c) the need for information on uncertainty among variables, Rotmans and van Asselt [2001], (d) the need to address value-laden assumptions associated with models, van der Sluijs [2002], (e) the need for compatibility among models, data, and the methods used to address data and model gaps and output incompatibilities, (f) the need for professional sanction of models (i.e., certification by professional societies, etc), and (g) the absence of mechanisms to build on existing programs, knowledge, and methodologies, such as modeling networks/forums. These challenges are further amplified by uncertainties regarding the use of models to examine risk over geophysical or evolutionary time scales. Moreover, many current planners have limited experience in the use of complex technical models, and may not be fully aware of their potential values and applications.

The combination of data and modeling concerns, with a perception that such tools are unable to help local agencies achieve their mandates, can lead to significant reluctance to take part in such modeling efforts and applications. Incentives for involvement are a particular barrier. Examples given later suggest approaches that may reduce such barriers.

2.2 Communication and Engagement

The adoption of integrated models depends on the willingness of planners and decision-makers to use them. The most successful examples of the adoption of integrated modeling programs are those designed to include strategies for communicating to, and engaging with a wide range of actors at different levels, and those with flexible data requirements. This requires that the general lack of awareness regarding these approaches be addressed by: (a) establishing training for users, particularly policy makers and land-use planners, in the use of modeling tools, (b) appropriate forums to engage and inform community stakeholders in planning and decision-making through the use of modeling approaches, and (c) a means of communicating and transferring knowledge across disciplines and sectors.

Clearly, collaboration and communication are a critical requirement for progress toward integrated decision-making. Analyses of inter-organizational collaborations over the past few decades provide some indication that there may be characteristic features associated with successful environmental and sustainable development initiatives, including having: a ‘vision’, a broad societal network (‘*network amplification*’), entrepreneurial leadership, and technological competency, Westley & Vredenburg, [1997].

In order to successfully develop a cross-jurisdictional capacity for the use of strategic planning tools, a process must be established to: identify a community of expert modelers and stakeholders for the issues at hand; develop and provide training for a series of modular, peer reviewed toolkits; provide a forum for expert and stakeholder engagement; support the transfer of data, knowledge, and models for social, economic, ecological, and geophysical analyses. However, many of the existing forums for public and private stakeholder participation in local planning and decision-making processes tend to be limited to interest groups as many citizens and stakeholders do not feel their concerns will be adequately considered.

While scenario-based modeling tools provide a means for engaging stakeholders in complex land- and resource-use decision-making, in the absence of formalized mechanisms for public and private participation, forums for public discourse are frequently limited to simplified and dichotomous alternatives (eg.,), making complex issues such as

environmental planning and sustainable development difficult to manage.

3. INSTITUTIONALIZATION AND GOVERNANCE

A number of major challenges exist to the implementing of an integrated modeling capability for land use planning, and environmental planning, management and assessment. In particular, it is clear that a form of governance structure will be required to address implementation gaps, particularly those associated with (a) a lack of authority or leadership in intergovernmental integration, (b) policy and mandate conflicts, (c) the often absence of any formal modeling or quantitative analysis requirement in policy development and land use planning, and (d) funding and other resource disparities.

Accordingly, centralized vs. multi-level governance approaches are currently the topic of much discussion in the literature. However, such discussions tend not to consider these in the context of knowledge transfer and use in policy and land-use decisions, focusing rather on promoting innovation, which is a very different objective. We postulate that there are a number of possible components of an integrated modeling capability that could be fostered for multi-jurisdictional applications. We present several possible 'centralized approaches', below.

Although we may agree on the functional components required within a modeling program, such as communication, knowledge transfer, and technical development, it is also clear that a formalized mechanism would be essential if such a program were to be successfully implemented. One of the principle gaps is in the transfer and implementation of modeling efforts into policy and land management planning agencies. We suggest several pathways to a program to deal with this implementation gap, ranging from independent, theme-based centres of excellence to a centralized national facility that could either facilitate or actually undertake the development and delivery of models and data at national or (sub?) supra-national scales. These pathways represent a range of different possible approaches that could be used for a variety of objectives: to assist in goal identification, to promote integration of research activities, and to inform land- and resource-managers through an inclusive consultation and knowledge transfer process involving experts in policy, members of the public, government, industry and scientific research communities.

We discuss these frameworks below bearing in mind that each has advantages and disadvantages in how leadership might develop, how technical developments might occur, how priorities could be set, how community engagement could take place, and how funding might be mobilized.

3.1 Centres of excellence

One possible component of a model development and implementation program capacity is through the creation of so-called centres of excellence. Using this approach, a number of themes, such as 'governance and implementation' and 'knowledge integration', could be identified. Research lines and focuses would be suggested by the centres' boards of directors or advisers. Proposals for specific projects would be requested and subjected to a competitive evaluation process in order to identify the most appropriate idea for each. Centres could be distributed by sub-national jurisdiction, by theme (e.g., by geographic, sectoral, media-land/water/air), or by some mix of the jurisdictional responsibilities and geographic boundaries.

An example of a centre of excellence system is the existing granting programs between the Private sector, the National Sciences and Engineering Research Centre and the Social Sciences and Humanities Research Centre in Canada, which offers industrial-oriented research awards. A similar program in the United States is that of the National Science Foundation, which supports a variety of multi-disciplinary centers of excellence. In the US, the centres of excellence use thematic centers of expertise (e.g, hydrology) and are currently expanding the concept to Communities of Practice (CoPs), which would involve virtual teams of scientists and engineers with common interests/expertise e.g., ecosystem restoration, planning, etc. The major lesson learned – these approaches can be effective for knowledge transfer but some funding is required and user groups must also be made aware of the existence of this resource.

An alternative structure for national or international centres of excellence would be to facilitate knowledge transfer and implementation between the network of centres of excellence through a central policy hub. As in the previous approach, the centres could be housed at academic or other research sites. However, the policy hub would provide a single site comprised of a collection of policy people from across government. In this structure, the steering group would be comprised of centrally located policy people from different orders and agencies of government and would offer an opportunity to establish a more formalized transfer or integration of information between institutions and agencies.

Examples of this type of approach are currently evolving within the European Union, to centralize and coordinate among the various national policies within the Union.

3.2 Central modeling facility

Facilitation and integration could also be managed through a more centralized facility. This could take the form of an institute that either supports, or brings modelers and policy analysts from a variety of organizations together (governmental and non-governmental) to address specific stakeholder needs and requests. Integration of modeling approaches, policy needs, and implementation would be achieved through the collective experience of a variety of professionals working on a focused, common problem (over finite time periods). A likely role for a national or supra-national government would be in identifying and formalizing partnerships among stakeholders and researchers, helping to establish funding and communication services and the dissemination of information. The key feature of this structure is that it provides a physical location that is identified as a source of expert support for addressing complex problems. The knowledge gained by members of such working teams, and the network it creates, is then redistributed nationally, or internationally, where the expertise becomes available regionally.

An excellent example of this framework is that of the European Union's support of the International Institute for Applied Systems Analysis (IIASA), a non-governmental research body that focuses on expert study of inter-disciplinary scientific studies that integrate environmental, economic, technological and social issues within the context of human dimensions of global change. Integrated modeling is a particularly important component of IIASAs work, involving interdisciplinary teams collaborating closely with specialists in modeling methods and tools. By bringing together the appropriate mixes of experts, IIASA intends to address gaps in integrated modeling methodologies, better integrate the use of these methods into policy (at different spatial and temporal levels), and identify ways to deal with uncertainty and risk.

3.3 A Centralized Facilitation Facility

Given that a critical component of all integrated work is in identifying and accessing available information, any such initiative must always contend with searches for data, data sharing agreements (or purchases), and standardization issues. A variant on the above centralized theme is to focus on this universal requirement. A central facility could benefit all integrated and sustainable development initiatives by facilitating data and knowledge development and transfer. Although such a facility would not be actively involved in model development, it would play a critical role in data identification, conversion, delivery, establishing data sharing agreements and overcoming data gaps, and appropriate model identification. These roles could be facilitated through specially constructed, problem-based decision trees designed to address individual user needs (eg., model types, data sources, stakeholder resources, etc). However other roles could also include facilitating and directing expert workshops, formalizing of client relationships, developing client products and communication mechanisms.

Examples of this type of 'data coordination centre' include the existing US National Biological Information Infrastructure, which provides links to resources through support from a variety of US and international governments, and the National Center for Biotechnology Information, which provides access to data and information resources both directly and indirectly (eg., Genbank). A slightly different example is that of the National Center for Ecological Analysis and Synthesis at the University of California at Santa Barbara, which provides a forum for interaction/collaboration, facilities and equipment, and staff support to promote the analysis and synthesis of environmental/ecological data and information.

3.4 Sub-national or regional centres

A multi-jurisdictional modeling capacity could also aim specifically at regional priorities through the establishment of provincial or regional centres. This could take several forms, either being located at multiple regional centres, or in each of the governmental jurisdictions working within a single location. Activities, such as model development, data collection, identification, and delivery, coordination, and integration would be diverse and would, ideally, aim to coordinate or expand on knowledge and information from other regional groups. A formalized reporting and communications mechanism from the centres to national or supra-national governments would facilitate integration of ongoing and new programs over at the larger scales. The focus and organization of a centre or centres could be based on jurisdictional or thematic research lines, either by sector or media (land/water/air), or some combination of these. Examples of possible regional physical facilities within Canada include the National Research Council and Environment Canada's National Water Research Institute.

Another possible approach is to divide modeling resources among several regional facilities, each of which is distinguished by a regionally-specific problem-driven research agenda. Each regional facility has a research team. The teams are not associated with expertise in one single area of expertise, such as surface water quality modeling. Instead, a problem-driven approach is used to identify typical regional problems for which multi-disciplinary modeling capacity and analysis will be valuable. Such problems typically cross governmental jurisdictions, address environmental, economic, and social issues, and require expertise in several areas, such as climate modeling and habitat assessment. Teams are comprised of members with a variety of modeling expertise from many disciplines, in line with identified regional issues and opportunities that the team chooses to address.

This approach to structuring modeling expertise provides a format that is explicitly multi-disciplinary, because many of the most common and challenging issues (problems and opportunities) facing regions require cross-disciplinary cooperation. At the same time, the approach creates distinct teams, as each centre develops expertise in line with identified regional issues. In this way, the approach is especially well suited to addressing regional challenges. Another significant strength of this approach is that it places modeling expertise in close proximity to local and provincial governing agencies and non-governmental organizations, creating opportunities to map out 'on the ground' policy initiatives in coordination with local agencies that are willing to explore adding new policy dimensions to existing operating procedures.

3.5 Highly distributed

An alternative to a nationally directed approach would be a national, facilitated, peer-to-peer initiative, where dialogue, knowledge transfer, and stakeholder involvement occur independent of active integration strategies. It is unclear whether such an approach would require a 'lead' or, if it could accomplish practical knowledge transfers independently.

Examples of peer-to-peer approaches to knowledge transfer and data sharing include the e-Dialogues for Sustainable Development Project. This project is a partnership between Royal Roads University of Victoria, BC, the Canadian Public Policy Forum, and the Canadian Policy Research Initiative, which runs a series of 'real time' electronic dialogues on specific policy themes pertaining to sustainable development.

Another excellent example of such an approach is that of the Scientific Information for Policy Support in Europe (SINAPSE), which is a web-based forum designed to "promote a more efficient use of scientific information and expertise in support of policy-making." SINAPSE, initiated in 2005, is a communications forum developed to allow the establishment and implementation of new forms of governance through coordination of "actors who are currently hard to consult" for knowledge exchange on issues. One key concern with such informal approaches, however, is that their success is directly dependent on the willingness of individuals from various sectors to make use of it.

4. CONCLUSIONS

This paper has briefly reviewed some of the applications of, and impediments to the development of multi-jurisdictional, integrated modeling capabilities for resource governance and policy applications. We have focused on discussions of institutions and organizational forms for governance but, also acknowledge the important complementary issues of communication and engagement, and technical development. To stimulate thinking about institutional and organizational design issues, we presented five possible frameworks that could be used to implement multi-scale modeling programs. Some of the benefits and limitations of each institutional framework and their potential application for the development, coordination and implementation of integrated landscape management modeling programs for multiple levels of jurisdiction have been discussed.

5. REFERENCES

Rotmans, J., and M.B.A. van Asselt, Uncertainty management in integrated assessment modelling: towards a pluralistic approach, *Environmental Monitoring and Assessment*, 69(2), 101-130, 2001.

van der Sluijs, J.P., A way out of the credibility crisis around model-use in integrated environmental assessment, *Futures*, 34, 133-146, 2002.

Westley, F., and H. Vredenburg, Interorganizational collaboration and the preservation of global biodiversity. *Organization Science* 8(4), 381-404, 1997.