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Editorial

Rethinking integrated assessments and management projects in the Americas

Keywords:
Integrated assessment
Climate
Vulnerability.

1. The challenge

Society is transforming the Earth in unprecedented ways. At the same time, increasing trends in temperature, changes in atmospheric and oceanic circulation and their variations on timescales from seasons to decades influence society through direct and indirect impacts. Direct influences on daily life include impacts to health, transportation, drinking water supply, livelihoods, and well-being. Indirect influences affect ecosystems and the resources and services that they provide. In addition, society continues to substantially and rapidly transform other aspects of the Earth system, through changes to land cover, changes to the courses of rivers and streams, air and water pollution, and in many other ways. In sum, these pervasive external influences on societies compound issues of population growth, demographic and land use change, and present formidable challenges to decision-makers in their attempts to plan for socio-economic sustainability.

Science and management agencies have invested substantially in interdisciplinary integrated assessment and management projects to address climate and other threats to water supplies, populations' health and environments in the Americas. These kinds of interdisciplinary efforts, that often bring together scientists and decision-makers, are touted as important approaches for enhancing environmental sustainability and adapting to climate change. However, since many are drawn from traditional approaches to science and its integration with decision making, they face many challenges. First, integrated assessments, often do not account for the unique challenges associated with bringing together decision makers and scholars from different disciplinary domains. Second, little agreement exists on what integrated science or integrated assessments mean in practice.

Within the sometimes differing definitions of this term, integrated research spans a range of efforts such as global environmental assessments, such as those produced by the Intergovernmental Panel on Climate Change (e.g., IPCC, 2007), and the United Nations Environment Program GEO Outlook (e.g., UNEP, 1999; Brasseur et al., 2007; Rothman et al., 2009). They also include integrated assessment models (IAM) (e.g., Rosenberg and Crosson, 1991), assessments that are explicitly participatory (e.g., Hare and Pahl-Wostl, 2002), and local integrated assessments (Lemos and Morehouse, 2005). For instance, global change assessments (GCAs) are collective, deliberative processes by which experts review the state of scientific knowledge, and synthesize it with a view to providing information of relevance to policy or decision makers at many levels. They seek to fulfill several attributes, including *salience* or ability to communicate with the users whose decisions they seek to inform, and *legitimacy* related to their fairness and impartiality, as perceived by all its users. To achieve legitimacy they need to involve participants representing a variety of key stakeholder groups, run a transparent process, provide avenues for input and consultation, and submit the assessment to an open review process. They seek to achieve *credibility*, given by the technical quality of a GCA, as perceived by the relevant scientific or expert communities. Finally, GCAs strive to yield meaningful results that can be applied to achieve, at best, better policies and, at least, better-informed policies.

For this special issue, we define *integrated assessment* (IA) as evaluative research that integrates knowledge from multiple disciplines, perspectives, and approaches to provide information of use to decision makers, as they confront complex environmental resource management and planning problems (*sensu* Parson, 1995). The aforementioned *perspectives* could be sectoral, or experiential, or political, or economic (in the ideological rather than the disciplinary sense; e.g., neoliberal vs. statist, or hegemonic vs. ethical and equitable). (For a discussion of this last point on ethics, see Gerlak et al., 2011.) *Approaches* refer to the application of paradigms, such as integrated water resources management (IWRM). Moreover, the integrated assessment issues about which we are most

interested are those that engage stakeholders and scientists in knowledge exchange and, in the most advanced cases, those that co-produce science and/or policy (e.g., Ostrom and Ostrom, 2004; Lemos and Morehouse, 2005; Robinson, 2008; Wilder et al., 2010). The assessments in this special issue focus on regional and local-scale environmental and resource management problems.

With integrated assessment research and outreach, the devil is often in the details of implementing the work. For IA to succeed, project teams must meet a series of requirements, which include: overcoming the parochial concerns of individual disciplines, perspectives, and approaches, including specialized methods and jargon; adequate definition of the assessment project's audience and goals; definition of the scope of the project, and needs for sustained iterative engagement; communication across the research team and with decision-makers and other stakeholders, and the development of metrics and evaluation of the value added through an integrated process.

Previous literature points to several common concerns and lessons, such as in the design and implementation of IA, IWRM, and multi-stakeholder climate service or knowledge-to-action collaborative initiatives. For example, initiatives that integrate the perspectives of disciplines and/or sectors to address environmental issues, still rarely involve stakeholders in the development of the structure and foundational questions that the assessment will address (Parson, 1995; Pahl-Wostl et al., 2005; McKenzie Hedger et al., 2006). This is reflected in the variety of assessment types in this special issue, which range from simply use-inspired work that speculates about the value of the research to decision-makers, to collaborative and sustained multi-disciplinary assessments, in which stakeholders are co-investigators.

In order to ensure that stakeholders have a central place at the table, many authors make the case that assessment must be relevant to local contexts (e.g., Moser and Eckstrom, 2010; Parson, 1995). This point relates closely to the need for a good fit between scientific knowledge and user or policy-maker needs (e.g., Lemos and Morehouse, 2005; Timmerman and Langaas, 2005; Sarewitz and Pielke, 2007). Such concerns have been embodied in regional integrated assessments (Pulwarty et al., 2009), where both context specificity and information fit are considered essential to adding value for information users.

Boundary organization theory provides a model for describing the roles and structures of the scientist-stakeholder relationships at the core of integrated assessments (Guston, 2001; Cash, 2001). The theory refers to organizations that can link science and policy, intentionally spanning a boundary between policy-makers or professional practitioners (e.g., in resource management) on the one hand and scientific researchers on the other hand. Some functions that boundary organizations provide include: knowledge broker, facilitator, convener of dialogues, translator, integrator, arbiter of equity (Buizer et al., 2010). These functions serve to build capacity that helps move co-produced knowledge to action. However, much work has been done to make the case that capacity building is necessary, but not sufficient, in integrated assessment, to generate information adoption in policy and operations (e.g., McKenzie Hedger et al., 2006; Rotmans, 2006; Pulwarty et al., 2009; Moser and Eckstrom, 2010). Several of the papers in this special issue address these concerns and illustrate the challenges in making the knowledge-to-action link via integrated assessment.

One option for facilitating such linkages is through undervalued, but effective means, such as shared learning, shared visioning, and negotiation (vanKerkhoff and Lebel, 2006; Pahl-Wostl, 2009; Moser and Eckstrom, 2010). Yet, even in such interactions, equity may not be served (Pfaff et al., this issue); or poor timing, in the decision-making cycle, or insertion of information garnered through shared learning, may render useless the information gained through integrated assessment (Castellanos et al., this issue).

In summary, the road to successful implementation of integrated assessment requires an evaluation of which techniques and approaches are most effective for a given setting. This collection of essays attempts to demonstrate that the requisite toolkit is likely to include such practices as capacity building, shared learning, co-production of knowledge, and timely monitoring. Under favorable conditions and done equitably, such approaches better inform policy and lead to good governance.

2. The contributions

The papers included in this issue are diverse and explore complementary approaches to region-specific interdisciplinary integrated assessment. They continue earlier inquiries on efficacy in the co-production of science and policy, as explored by Agrawala et al. (2001) and Lemos and Morehouse (2005), and work on challenges in developing and implementing initiatives, institutions, and organizations that facilitate knowledge exchange across the science-policy boundary, as in Cash (2001) and Guston (2001). In particular, the present collection examines the value added through the process of interdisciplinary integration, challenges in communicating and coordinating across disciplines, and the relevance of these experiments for instituting policy and operational decisions.

Four papers in this special issue explore the experience of integrated assessment teams, and evaluate success through the lenses of integration of disciplinary domains, specific contexts, process, value added through integration, communication (among scientists and with stakeholders), and implications for policy.

Kirchhoff et al. examine the roles of institutions, perceived risk, and the character of organizations attempting to broker knowledge exchange. They compare case studies of integrated assessment and integrated water resource management projects in the United States and Brazil, and use the contrast in governance and institutional frameworks as givens in an examination of ancillary factors that facilitate the use of climate information in water resources decision-making and policy. The authors point to two critical factors in the uptake of information: (1) individual water manager risk tolerance and risk perception, which can enable or preclude information uptake, regardless of the potential provided by the institutional framework, and (2) the strength and character of partnerships formed by boundary organizations, which, they note, are conditioned by iterative engagement (engendering trust and strength of relationship) and sufficient human and

technical capacity in water management agencies (engendering a secure foundation for knowledge exchange). Their findings are relevant to organizations brokering multistakeholder processes to build adaptive capacity.

Castellanos et al. evaluate difficulties in achieving knowledge co-production, in the context of agricultural livelihoods in Mexico and Central America. They note that successful communication is essential, but insufficient, in the co-production of knowledge and policy. Their work highlights the important role of policy dynamics, for example between affected parties such as farmers and rural communities, and decision-makers with influence over structural conditions to address vulnerabilities. Key aspects of policy dynamics include the level at which management decisions are made, and the timing of decisions in the policy cycle. The latter, they maintain, is critical for the framing of information, to ensure successful infusion and adoption of information in policy-making. The authors note that the interdisciplinarity and cross-national strategies used in their approach broadened the scope of knowledge production and improved the usability of information; however, interdisciplinary integration was difficult, particularly with regard to the comparability of data collection. Their work also highlights the critical role of researchers' relationships with local boundary organizations (Cash et al., 2002), who can sustain efforts to translate science to the policy community and maintain ongoing assessment.

Romero Lankao and colleagues reflect on the experience of the ADAPTE initiative (Adaptation to the Health Impacts of Air Pollution and Climate Extremes in Latin American Cities), an issue-driven integrated assessment of climate-related public health risks in large urban areas – ''megacities'' – in the Americas. ADAPTE's work, across four multi-disciplinary teams in four countries, focuses on the challenges of initiating new researchers into working in a collaborative integrated assessment paradigm. The paper, sponsored by the Inter-American Institute for Global Change Research, illustrates the constraints to in implementing key facets of IA research, which include reconciling theoretical perspectives, sustaining iterative interactions between researchers and stakeholders, and developing communication infrastructure that facilitates the involvement of multiple stakeholder communities in assessment of health vulnerabilities and risks. The authors note, in particular, the role of societal transformations, such as democratization and governance decentralization in both enhancing public participation in inclusive participatory processes and, ironically, reducing the capacities of local governments to respond to environmental challenges.

Podesta et al. seek insights about collaborative interdisciplinary use-inspired research, through a process of active and systematic self-reflection by the integrated assessment team. They observe that interdisciplinary efforts are not without ''coordination costs.'' However, their outlook on such activities is sanguine, provided that the science and stakeholder partners engage in integrated activities throughout the course of a project – from project definition to validation of outcomes. The authors further state that shared problem definition, development of common language, and the use of adaptive budgeting foster successful integration. They conclude that cooperative production of knowledge hinges on a common definitions of success, and firm consensus on criteria for the assessment of results. Moreover, Podesta et al. articulate the benefits of stakeholder engagement, a buzzword in integrated assessments, including improved credibility and acceptance of models developed by the research team, access to insights from a sufficient variety of actors, access to data, and greater success in developing and sustaining ongoing outreach to relevant communities.

Wilhelmi and Morss broaden the scope of typical flood hazards research, which has primarily addressed exposure to hazard, through the integration of multi-disciplinary knowledge regarding demographic sensitivities and coping capacities. Their approach offers a more comprehensive view of risk and vulnerability, and highlights the need for inclusion of a broader spectrum of indicators to prepare for a possible increased risk of flash floods, due to climate change-related increases in the chances of extreme precipitation. Such indicators include not only exposure and sensitivity, but also adaptive capacity and long-term preparedness. They note that the scale of information used in hazard assessment is important, because local data on social and behavioral characteristics of individuals and communities can provide a more nuanced interpretation of indicators. Combinations of quantitative and qualitative local-scale social and behavioral data, garnered through participatory mapping, also add value for placing scientific information into contexts that can be readily applied to policy.

A pair of papers from the Pacific Climate Impacts Consortium (Flower et al.; Murdock et al.) examines the projected ecological and economic impacts of climate change on forests and the timber industry in British Columbia, Canada. Their project integrates the disciplines of climatology, forest ecology, entomology, economics and forest management, through a series of engagements involving researchers and resource managers in the provincial and federal governments. The investigators used bio-climatic and bio-economic models to examine the confluence of potential changes in tree species distribution, insect pest outbreaks, and timber supply. Modeling decisions were grounded in dialogues between scientists and managers; thus, outputs included analyses of uncertainty that could allow managers to focus operational decisions on regions with relatively higher certainty in projections of the future. Among the many challenges in moving from knowledge creation to action, are appropriate matching of scales, particularly in the bio-economic modeling, and follow up on assumptions that prohibited the research team from a robust examination of worst-case scenarios. As with other IA initiatives, these authors point to ongoing, iterative interaction as a means of homing in on science that is sufficiently ''actionable'' for adaptation decision-making.

Pfaff and his co-authors, who are economists, conducted bargaining and gaming experiments, as a way of evaluating the effects of inequalities in information dissemination in support of adaptation. Their integrated multi-disciplinary research looks at nuances in the flows of climate forecast information, and note that even when all stakeholders are aware of the forecasts and use forecast information in bargaining for resources, such as water allocations, institutional factors can increase the vulnerability of the least empowered members of participatory groups. Their research illustrates the critical roles of capacity building and technical

intermediaries to ensure correct forecast interpretation (notably, with regard to forecast certainty), and access to information. They suggest that experiments, using bargaining exercises, can help reveal information asymmetries and inequities and can allow integrated assessment teams to test a variety of institutional arrangements, to ensure that the good that comes from making use of seasonal forecast skill does not undermine the goals of reducing vulnerability and enhancing adaptation potential.

The paper by Varady et al. reports on an ongoing research effort by a binational, University of Arizona-based team supported by the Inter-American Institute for Global Change Research. The piece describes an integrated, interdisciplinary approach to incorporating climate diagnostics within adaptive water-resources management in northwestern Mexico and the southwestern United States. This initiative attempts to evaluate risks and vulnerabilities of climate threats to water supplies, populations and ecosystems, so as to help identify and strengthen regional adaptation. One key element of this approach is an information and policy product designed to improve the flow of climate diagnostics on drought- and monsoon-affected areas straddling the U.S.–Mexico border. The paper assesses both urban and rural vulnerabilities, particularly for groundwater use, climatic variability, and onset and strength of the North American monsoon. Finally, the authors report on a transborder *community of practice* led by scientists and resource managers, that has helped disseminate relevant vulnerability information to policy-makers. The paper offers lessons on opportunities and limitations of integrated assessments for enhancing regional adaptation to climate and water variability.

In summary, the papers in this special issue explore the efficacy of the core scientist-practitioner research partnerships of integrated assessments and their effectiveness in targeting solutions and enhancing information exchange. They also shed light on the challenges and opportunities offered by integrated assessments, including the obstacles to genuine stakeholder involvement, the goodness of fit between knowledge and user needs, the importance, but insufficiency, of capacity building, and the relevance of governance.

Acknowledgments

The guest editors would like to acknowledge several sources of inspiration and support in the process of bringing together this special issue. Christiane Barranguet, of Elsevier, encouraged us to pursue this effort, through spirited conversations following science-policy talks that we presented at the 2009 meeting of the Association for the Sciences of Limnology and Oceanography. Editors Jim Briden and Martin Beniston have carried the torch lit by Ms. Barranguet's initial spark of enthusiasm. Further impetus was given by the Inter-American Institute for Global Change Research (IAI); through IAI's Collaborative Research Network program, and its forward-thinking director, Holm Tiessen, we homed in on assessment projects in the Americas, and were able to connect with many of the authors represented in this special issue. The guest editors acknowledge the further boost that we received through the 2010 American Geophysical Union's Meeting of the Americas, from which we were able to garner additional ideas and momentum. Finally, we thank the National Oceanic and Atmospheric Administration and the National Science Foundation for their strong support of the kinds of regional assessment studies highlighted herein.

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1462-9011/$ – see front matter
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doi:10.1016/j.envsci.2011.12.010