CHAPTER 1

Introduction

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Local communities, national governments, and international institutions all face difficult choices concerning goals, priorities, investments, policies, and institutions needed to effectively address interlinked challenges concerning development and the environment (Millennium Ecosystem Assessment 2005a). They must make these choices in the face of substantial uncertainty about current conditions and the potential future consequences of actions taken, or not taken, today. One way to improve those decisions is to ensure that the best knowledge concerning the problem and potential solutions is available to decision makers and the public. Better knowledge does not guarantee that better choices will be made, but it does provide a sound basis for making better decisions and for holding decision makers accountable.

But how can knowledge concerning environment and development be best mobilized in support of decision making? Over the past thirty to forty years, many different mechanisms have been developed to assemble, assess, and synthesize information for use in decision processes, including environmental impact assessments, technology assessments, scientific advisory boards, national environmental reports, global environmental (or development or economic) reports, and global environmental assessments. Both the processes and scientific methods used for these types of "knowledge assessments" have evolved considerably during this time. Modern global assessments, for example, commonly make use of such tools as scenarios and integrated assessment models used infrequently in earlier assessments. And while the "product" (that is, the assessment report) was all that mattered in earlier assessments, more recent assessments increasingly generate a range of products to better respond to specific needs of diverse stakeholders and are often as heavily focused on the process of stakeholder engagement as they are on the product itself.

This book explores two issues at the cutting edge of the further development and evolution of knowledge assessments: how to address issues of scale and how to embrace different knowledge systems in assessments. More specifically, in the case of scale, there are many reasons to think that both the findings of an assessment and the use of those findings could be enhanced if the assessment incorporates information from multiple spatial and temporal scales and if "cross-scale" effects are examined. But what are the real costs and benefits of such multiscale assessments and, from a pragmatic standpoint, just how can they be implemented? In the case of knowledge systems, assessments traditionally have relied almost exclusively on scientific information, yet considerable knowledge relevant to decisions concerning the environment and development can be found outside of formal scientific disciplines. This includes knowledge held within businesses, knowledge held by local resource managers, and traditional knowledge passed down from one generation to the next. But how can a *science assessment* be transformed into a *knowledge assessment*? Scientific disciplines have well-developed means of validating information through peer review that would rule out incorporating many other forms of knowledge. How can multiple types of knowledge be incorporated in an assessment when each type of knowledge has its own mechanisms for determining validity and utility?

Although these issues of scale and knowledge systems could be dealt with separately and although the literature on the two issues tends to be distinct, in this book we expressly seek to examine the intersection of these issues for both pragmatic and heuristic reasons. From a pragmatic standpoint, while scientific knowledge dominates the considerations of global and long-term processes (such as climate change), local, traditional, and practitioner's knowledge often dominates the considerations of site-specific resource management issues, where detailed scientific studies may not exist. Thus, in order to deal with "multiple scales," an assessment cannot help but confront the need to deal with multiple types of knowledge, reflecting not only different paradigms but also, in some cases, different processes and phenomena. From a heuristic standpoint, the intersection of the issues of scale, knowledge systems, and assessment provides a rich opportunity for obtaining insights into not just how best to assess knowledge for the purposes of decision making but also how to further our understanding of basic socioecological processes.

The Millennium Ecosystem Assessment

This book was catalyzed by the Millennium Ecosystem Assessment (MA), a multiscale assessment of the consequences of ecosystem change for human well-being that was carried out between 2001 and 2005 (MA 2003, MA 2005a). The MA was one of the first global assessments to attempt to incorporate multiple scales and multiple knowledge systems. Recognizing that the base of experience on which to develop these dimensions of the assessment was quite limited, the MA organized an international conference—Bridging Scales and Epistemologies: Linking Local Knowledge and Global Science in Multi-scale Assessments—at the Bibliotheca Alexandrina in Alexandria, Egypt, in March 2004. The conference provided an opportunity for assessment practitioners, academic researchers, indigenous peoples, and individuals directly involved in the MA process to discuss theory, learn from case studies and practical experiences, and debate the strengths and weaknesses of various approaches. The following chapters are drawn from papers presented at that conference. We briefly describe the MA here to provide context and to help introduce the themes of the book, but most of the chapters address the issues of scale and knowledge systems more broadly.

The Millennium Ecosystem Assessment was called for by United Nations (UN) secretary-general Kofi Annan in 2000 in his report to the UN General Assembly *We the Peoples: The Role of the United Nations in the 21st Century* (Annan 2000). Governments subsequently supported establishing the assessment through decisions taken by three international conventions, and the MA was initiated in 2001. The MA was conducted under the auspices of the United Nations, with the secretariat coordinated by the United Nations Environment Programme. It was governed by a multistakeholder board that included representatives of international institutions, governments, business, nongovernmental organizations (NGOs), and indigenous peoples.

The MA was established in response to demands from both policy makers and scientists for an authoritative assessment of the state of the world's ecosystems and of the consequences of ecosystem change for human well-being. By the mid-1990s, many individuals involved in the work of international conventions, such as the Convention on Biological Diversity (CBD) and the Convention to Combat Desertification (CCD), had come to realize that the extensive needs for scientific assessments within the conventions were not being met through the mechanisms then in place. In contrast, such other international environmental conventions as the Framework Convention on Climate Change and the Vienna Convention for the Protection of the Ozone Layer did have effective assessment mechanisms—the Intergovernmental Panel on Climate Change (IPCC) and the Ozone Assessment, respectively—that were proving valuable to these treaties.

The scientific community was also encouraging the establishment of an IPCC-like process to establish scientific consensus on issues related to biodiversity and ecosystems in the belief that the urgency of the problem of ecosystem degradation demanded such an assessment. The major advances that had been made in ecological sciences, resource economics, and other fields during the 1980s and 1990s were poorly reflected in policy discussions concerning ecosystems (Reid 2000; Ayensu et al. 2000; J. C. Clark et al. 2002). Moreover, the scientific community was concerned that existing sectoral assessments (focused on climate, ozone, forests, agriculture, and so forth) were insufficient to address the interlinkages among different environmental problems and among their solutions (Watson et al. 1998).

The design of the MA sought to meet three criteria identified by the Harvard Global Environmental Assessment Project that generally underlie successful global scientific assessments (Clark and Dickson 1999):

- *First, they are scientifically credible.* To meet this criterion, the MA followed the basic procedures used in the IPCC. A team of highly regarded social and natural scientists cochaired the four MA working groups, and prominent scientists from around the world served as coordinating lead authors and lead authors. An independent Peer Review Board oversaw the review process. In the end, more than two thousand authors and expert reviewers were involved in preparing and reviewing the MA.
- *Second, they are politically legitimate.* An assessment is far more likely to be used by its intended audience if that audience has fully "bought in" to the process. In other words, if the intended users request the assessment, have a role in governing the assessment, are involved in its design, and are able to review and comment on draft findings, then they will be far more likely

to use the results. To ensure the legitimacy of the process, the decision to establish the MA was not taken until formal requests for the assessment had been made by international conventions. And, like the IPCC, all of the MA working groups were cochaired by developed and developing country experts and involved a geographically balanced group of authors.

- *Finally, successful assessments respond to decision makers' needs.* This is not to say that scientists do not have an opportunity to introduce new issues and findings that decision makers need to be aware of—they do. But the priority for the assessment is to inform decisions that are being faced or soon will be faced by decision makers. To meet the standard of utility, extensive consultations were made with intended MA users in governments, the private sector, and civil society.

When the idea for the MA first arose in early 1988, it could have been accurately described to be an "IPCC for ecosystems and human well-being." The assessment that was finally launched in 2001, however, differed in several important ways from the IPCC, in particular in relation to scale and knowledge systems. First, the MA was a multiscale assessment—that is, it included analyses at various levels of organization from local to national to international. By contrast, the IPCC was a global assessment, although it increasingly included regional analyses. In addition to the global component, the MA included thirty-three subglobal assessments carried out at the scale of individual communities, watersheds, countries, and regions. The subglobal assessments were not intended to serve as representative samples of all ecosystems; rather, they were designed to meet the needs of decision makers at the scales at which they were undertaken. At the same time, it was anticipated that the global assessment could be informed by findings of the subglobal assessments and vice versa.

Second, the MA included a mechanism allowing use of both published scientific information and traditional, indigenous, and practitioner's knowledge, while the IPCC uses only published scientific information. Much local and traditional knowledge was incorporated into many of the local MA subglobal assessments using this mechanism. While the mechanism allowed, in principle, for local, traditional, and practitioner's knowledge to also be incorporated into the global assessment products, this was quite rare in practice and only occurred to any significant extent in the global report prepared by the MA Sub-Global Working Group.

The primary reasons the MA adopted this multiscale approach and sought to incorporate multiple types of knowledge relate to the nature of ecological process and to the locus of authority for decisions affecting ecosystems. Compare the issues addressed in the MA, for example, with those addressed by the IPCC. Climate change is the classic example of a global environmental change. Although considerable local specificity exists as to the causes of emissions of greenhouse gases, once those gases are emitted they quickly mix in the atmosphere. The increased greenhouse gas concentrations in the atmosphere will have a global impact in that all countries are affected by this change (although, again, the local impacts differ from region to region). Also, decisions taken to address the problem must have a strong global component, although many decisions for emission reduction and—in particular—adaptation will be local (Kates and Wilbanks 2003; Wilbanks et al. 2003).

While ecosystem change and biodiversity loss are of global environmental concern, and although the problem and its solutions have global dimensions, the subglobal dimensions are often much more significant. Factors affecting ecosystems include drivers with global impacts such as climate change and species introductions, regional impacts such as regional trade or agricultural policies, and local impacts such as land use practices and the construction of irrigation systems. Changes to ecosystems can have global consequences, such as the contribution of deforestation to climate change; regional consequences, such as the impact of nutrient loading in agricultural ecosystems on coastal fisheries production; and local consequences, such as the impact of overharvesting or land degradation on local food security. Policy, institutional, technological, and behavioral responses to ecosystem-related issues can involve global actions, such as the creation of global financial mechanisms; regional actions, such as regional agreements for wetlands conservation for migratory bird protection; and local responses, such as a decision by a farmer to alter land management practices to conserve topsoil.

In light of this multiscale nature of both the issues involved and the decisions being made, it was clear that a strictly global assessment would be insufficient. Assessments at subglobal scales are needed because ecosystems are highly differentiated in space and time and because sound management requires careful local planning and action. Local assessments alone are insufficient, however, because some processes are global and because local goods, services, matter, and energy are often transferred across regions (Ayensu et al. 2000). These same considerations also caused the MA organizers to rethink the question of what type of knowledge should "count" in an ecosystem assessment.

For example, at the scale of an individual village, much of the knowledge concerning trends in ecosystems, impacts of ecosystem change on people, and potential responses to ecosystem change will often be held by the members of that community. Such information is unlikely to have been published in a scientific journal. The IPCC relies primarily on peer-reviewed information in order to ensure its credibility. But if a local assessment is to have any credibility at all for local decision makers, then clearly it would make little sense to use only the limited published information bearing on the conditions in a particular village when much better knowledge existed within the community itself.

Moreover, considerations of the legitimacy of the process also forced the reconsideration of policies for what sources of knowledge should be included in the assessment. Legitimacy can be conferred on a process in part through formal mechanisms (e.g., the involvement of particular stakeholders in governance roles), but many other less tangible elements are also involved in any particular stakeholder's decision about whether a process is legitimate and sufficiently trusted to be of use in the person's own decision making. The IPCC arrangements, as well as its reliance on scientific knowledge, were appropriate to ensure that the process was seen as legitimate by governments. But it was unlikely that the MA would be viewed as legitimate by other decision makers such as the business community and indigenous people if it expressly excluded their knowledge from the process.

The experience of the MA in using multiple scale and multiple knowledge systems was somewhat mixed (MA 2005b). Overall, it appears that both the assessment findings and the use of those findings were strengthened by incorporating these two dimensions. However, the mechanisms used by the assessment to address these issues fell short of the initial goals. Lessons from the MA experience are summarized in MA 2005b, and in particular in MA chapters by Ericksen et al. (2005) and Zermoglio et al. (2005).

Scale

We define the term *scale* to be the physical dimensions, in either space or time, of phenomena or observations (MA 2003). *Level*, in contrast, is a characterization of perceived influence; not a physical measure, it is what people accept it to be. A network of cooperating irrigation farmers can contain dozens or thousands of farmers, operating at different scales but on the same level, while state-run irrigation systems at both scales of dozens or thousands of farmers may be perceived to be operating at a "higher" level (Zermoglio et al. 2005). The term *cross-scale interactions* refers to situations where events or phenomena at one scale influence phenomena at another scale. The process of wetlands drainage, for example, takes place at local scales but can in turn influence regional hydrology (by lessening water storage capacity and thereby exacerbating floods) and global climate (by affecting rates of carbon emissions).

The meaning of scale in the context of an assessment is somewhat ambiguous. Environmental assessments are typically characterized by their geographic scale, such as a global, national, river basin, or local community assessment. That characterization means not that the assessment ignores factors operating at other scales but, rather, that the scale defines the primary area of interest (in terms of impacts, potential actions by decision makers, and so forth). Thus a "national"-scale assessment might include both considerations of global climate change and subnational problems of water pollution, but its focus would be on the national implications and the potential decisions that might be taken nationally.

The choice of scale for an assessment is not politically neutral, because that selection may intentionally or unintentionally privilege certain groups (MA 2003). Adopting a particular scale of assessment limits the types of problems that can be addressed, the modes of explanation, and the generalizations that are likely to be used in analysis. For example, users of a global assessment of ecosystem services would be interested in some issues, such as carbon sequestration, that may be of relatively little interest to users of a local assessment. In contrast, the users of a local assessment might be more interested in questions related to, for example, sanitation or local commodity prices that would not necessarily be the focus of a global assessment. Similarly, a global assessment is likely to implicitly devalue local knowledge (and the interests and concerns of the holders of that knowledge) since it is not in a form that can be readily aggregated to provide useful global information, while a local assessment would reinforce the importance of local knowledge and the perspectives of holders of that knowledge.

A large body of literature emphasizes the importance of considering temporal and spatial scale for understanding and assessing processes of social and ecological change (Clark 1985; Wilbanks and Kates 1999; Gunderson and Holling 2002; Giampietro 2003; Rotmans and Rothman 2003; Wilbanks 2003; MA 2003; Zermoglio et al. 2005). There are several ways in which an assessment can be conducted to better consider multiple scales. First, the assessment could simply include analyses undertaken at other space and time scales. Thus a national assessment could include a set of case studies undertaken at the scale of individual river basins within the country. Alternatively, the assessment could be composed of multiple semi-independent subassessments, each with its own user audience and own scale of analysis. The MA defines the former category to be "single scale assessments with multi-scale analyses" and the latter to be a "multi-scale assessment." (The MA, for example, is a multiscale assessment since each of the subglobal assessments included in the process was a semi-independent process with its own user group and assessment team.)

The potential benefits of a process that includes multiple scales differ somewhat depending on which of these two arrangements is used, but they fall into two basic categories: *information benefits* that might improve the accuracy, validity, or applicability of the assessment findings, and *impact benefits* that would improve the relevance, utility, ownership, and legitimacy of the assessment with decision makers.

Potential information benefits gained through considering multiple scales include the following (see Zermoglio et al. 2005).

- *Better problem definition.* A single-scale assessment tends to focus narrowly on the issues, theories, and information most relevant to that scale. Perspectives gained from other scales would contribute to a fuller understanding of the issues.
- *Improved analysis of scale-dependent processes.* Many ecological and social processes exhibit a characteristic scale. If a process is observed at a scale significantly smaller or larger than its characteristic scale, drawing the wrong conclusions would be likely (MA 2003).
- *Improved analysis of cross-scale effects.* For example, the direct cause of a change in an ecosystem is often intrinsically localized (a farmer cutting a patch of forest), while the indirect drivers of that change (for example, a subsidy to farmers for forest clearing) may operate at a regional or national scale.

- *Better understanding of causality.* The relationships among environmental, social, and economic processes are often too complex to fully understand when viewed at any single scale. Studies at additional scales are often needed to fully understand the implications of changes at any given scale.
- *Improved accuracy and reliability of findings.* Subglobal assessment activities can help to ground-truth the global findings.

Potential impact benefits gained through multiscale processes, particularly those that include separate user groups at different scales, include the following.

- *Improved relevance of the problem definition and assessment findings for users and decision makers.* An assessment focused on the specific needs of the users at a particular scale will be more relevant than an assessment in which those users have little input.
- *Improved scenarios.* Although commonly used in environmental assessments, scenarios are most useful in decision making if the decision makers play a direct role in their development.
- *Increased ownership by the intended users.* For example, the legitimacy of the global assessment could be enhanced for governments by the presence of subglobal assessments in individual countries. Similarly, the legitimacy of subglobal assessments for the users of those assessments could be enhanced by virtue of the inclusion of the assessment in a globally authorized assessment mechanism.

But as significant as these potential benefits may be, the challenges associated with designing and implementing a multiscale assessment are also significant. How should scales of analysis be selected? Is there an inherent tradeoff between a design based on scientific sampling and a design based on relevance to users at smaller scales? How can the information and findings from nested assessments be incorporated effectively in larger scale assessments (upscaled) and vice versa (downscaled)? Can common indicators or variables be measured at multiple scales? Can a common conceptual framework be used at multiple scales? Does the added cost and time of a multiscale assessment justify the benefits gained? And, as will be explored in the next section, how can the different types of knowledge present at different scales of analysis be incorporated effectively into a single assessment process?

Knowledge Systems

We define a knowledge system as a body of propositions actually adhered to (whether formal or otherwise) that are routinely used to claim truth (Feyerabend 1987). As described by Zermoglio et al. (2005): "Knowledge is a construction of a group's perceived reality, which the group members use to guide behavior toward each other and the world around them." Science is defined as systematized knowledge that can be replicated and that is validated through a process of academic peer review by an established community of recognized experts in formal research institutions (Zermoglio et al. 2005). Traditional ecological knowledge is a "cumulative body of knowledge, practice and beliefs, evolving by adaptive processes and handed down through generations by cultural transmission" about local ecology (Berkes 1999, 8). Traditional ecological knowledge may or may not be indigenous but has roots firmly in the past. Local knowledge refers to place-based experiential knowledge, knowledge that is largely oral and practice based, in contrast to that acquired by formal education or book learning (Gadgil et al. 2003; Zermoglio et al. 2005).

The norms and procedures of scientific research have evolved and persisted because they have provided a successful mechanism to advance understanding of social and natural systems. Given that background, it makes good sense to ground an assessment of the state of knowledge concerning a particular issue on formal scientific procedures of peer review and publication. Yet scientific knowledge is not the only source of knowledge and, in the case of issues concerning the management of ecosystems in particular locales, may not be the most valuable source of knowledge that can be brought to bear on a problem. In that context, how could an assessment of the state of knowledge *not* include local and traditional knowledge?

There are a number of reasons why incorporating multiple knowledge systems into integrated assessments of environmental and development issues should be beneficial (Warren, Slikkerveer, and Brokensha, 1995; MA 2003; Pahl-Wostl 2003). First, the incorporation of multiple systems of knowledge should increase the amount and quality of information available about a particular environmental or development issue. The experiential knowledge of a local farmer or resource manager, for example, may not meet the criteria of formal science, but it certainly could aid in the understanding and assessment of a local environmental issue. Incorporating multiple systems of knowledge can also potentially bring benefits similar to those obtained through interdisciplinary processes. Assessments are usually enhanced when they are informed by a variety of research disciplines and scientific perspectives. Scientists in different disciplines tend to frame issues in different ways, question assumptions that other disciplines may treat as facts, and broaden the nature of the evidence brought to bear on particular problems. The incorporation of different systems of knowledge in an assessment could produce similar benefits. People using different systems of knowledge, for example, will frame questions and define problems in different ways and have different perspectives on issues.

Second, the findings of an assessment for those individuals using different systems of knowledge should be more useful if multiple systems of knowledge are incorporated in the assessment. If an assessment is to be used by a local community, for example, then it should respond to problems and issues identified by those communities; thus the "local problem" definition is more important than a "scientific" definition of the problem. Similarly, if a business or local community is to use the findings of an assessment, then they must perceive the findings to be credible and the process to be legitimate. That perception will not exist if their knowledge and information are excluded from the assessment. They will not see the assessment as a credible source of information because they know that they may have better information, and they will not perceive the process to be legitimate because their holders of knowledge were excluded from the process.

Finally, the use of multiple knowledge systems can help empower groups that hold that knowledge (Agarwal 1995). For example, at one extreme an environmental or development assessment of a local community could be undertaken by external scientists, who gather data from the community, interview local people, categorize and interpret that information through their own knowledge system, and report their findings to local and regional decision makers. Such an assessment not only would tend to muffle that community's voice or influence in its own future but also could miss or misinterpret vital local information and lead to inappropriate decisions. In contrast, an assessment of that same community that involved both external experts and local experts, was guided by the needs of the community, and involved mechanisms to validate both the scientific and local knowledge of the problems and their solutions would both enhance the utility of the findings for the community and strengthen the ability of that community to influence change, in part through the recognition given to the utility and validity of the knowledge and perspectives of the community (Holt 2005).

The challenges to incorporating multiple knowledge systems in an assessment are significant. First, who establishes what appropriate "validation" of information is? The MA adopted a scientific mechanism of validation (triangulation of information, review by other communities, review at other scales, and so forth). Yet different people and different cultures use different systems for validating the "truth" of information. (Indeed, any individual may use his or her own different standards for examining the truth of information; for example, the process an individual uses to validate information about whether or not it is raining outside might use different standards from the process of validating information related to religious beliefs.) Thus, while an assessment like the MA might indeed obtain better information through the incorporation of local or indigenous knowledge (because it in essence transforms that knowledge into formal scientific knowledge through an implicit peer review or validation mechanism), do the findings of that assessment in fact have any greater value for the original holders of that information (Moller et al. 2004)? They may not, if the standards by which those communities are judging the truth or legitimacy of information are very different from the standards used by the assessment process.

Second, can an assessment like the MA, which is grounded in a formal Western scientific tradition, ever hope to be seen as being "legitimate, credible, and useful" to indigenous communities or other individuals who hold very different worldviews and use different standards for evaluating the utility of information? And, conversely, how can it be ensured that a knowledge assessment that utilizes local and traditional knowledge is also seen as credible within the scientific community?

Theory and Experiences in Bridging Scales and Epistemologies

The chapters in this book explore theoretical issues related to bridging scales and knowledge systems as well as practical experiences and case studies involving issues of scale and knowledge in assessments. The volume begins with a set of chapters that focus primarily on issues of scale. Chapter 2, "How Scale Matters: Some Concepts and Findings," by Thomas Wilbanks, provides an overview of concepts related to how geographic scale matters in conducting integrative nature-society assessments and examines in particular how phenomena and processes differ between scales and how phenomena and processes at different scales affect each other. While chapter 2 focuses on the questions of how understanding and knowledge can be enhanced through considerations of scale, chapter 3, "The Politics of Scale in Environmental Assessments," by Louis Lebel, explores the political questions of who gains and who loses from the choice of scales in scientific assessments. This chapter argues that political considerations often define the choice of scales and that this choice, in turn, tends to further privilege the favored or more powerful resource users.

Chapter 4, "Assessing Ecosystem Services at Different Scales in the Portugal Millennium Ecosystem Assessment," by Henrique Pereira, Tiago Domingos and Luís Vicente, and chapter 5, "A Synthesis of Data and Methods across Scales to Connect Local Policy Decisions to Regional Environmental Conditions: The Case of the Cascadia Scorecard," by Chris Davis, then provide case study examples that explore the practical issues involved in bridging scales in knowledge assessments.

Chapter 6, "Scales of Governance in Carbon Sinks: Global Priorities and Local Realities," by Emily Boyd, also serves as a case study of the issue of scale in assessments. It focuses in particular on the disconnect that often exists between the framing and findings of global assessments and the on-the-ground realities of the actors who may be called on to take action in response to those assessments. The chapter demonstrates the benefits that assessments conducted at different scales can provide in understanding problems while also underlining the tremendous challenges that exist in developing institutions that can serve to bridge global and local institutions in the context of assessments.

Chapter 7, "What Counts as Local Knowledge in Global Environmental Assessments and Conventions?" (by Peter Brosius) turns more specifically to issues of knowledge systems, examining how local knowledge is constituted in global environmental assessments. Local and traditional knowledge is often seen as inseparable from its social context. While individual "facts" held in local knowledge systems (e.g., the timing of migration of a particular species) might be readily integrated in global scientific assessments, local communities generally hold a much broader set of knowledge that could also be of value in global assessments. But just how that knowledge is used depends on the "politics of translation" and the receptivity of global institutions to the more expansive definition of knowledge held by these communities. In chapter 8, "Bridging the Gap or Crossing a Bridge? Indigenous Knowledge and the Language of Law and Policy," Michael Davis explores the division that exists between indigenous knowledge and Western science, examines the basis on which local, traditional, and indigenous knowledge has been marginalized and assimilated by the dominant discourse of science, and then explores the extent to which legal instruments may be able to help restore the diversity of worldviews.

The next five chapters—chapters 9 through 13—present case studies of different attempts to bridge scales and knowledge systems in assessments and resource management. These chapters provide a rich set of lessons concerning methods that work or fail and the costs and benefits associated with these efforts. A number of themes recur in these chapters: the importance of "boundary organizations" that help to negotiate and facilitate the interactions across scales or knowledge systems; the tension that exists between mutually agreed use of local knowledge and the risk of knowledge being "extracted" for use in ways that do not return local benefits and may even result in local costs; and the challenge of knowledge validation. Yet, given the numerous problems that such bridging efforts face, overall this set of experiences is surprisingly positive. In the right context, with the right institutions, the potential for mechanisms to effectively bridge scales and knowledge systems in ways that benefit all stakeholders clearly exists.

But while positive examples do exist, chapter 14, "Barriers to Local-level Ecosystem Assessment and Participatory Management in Brazil," by Cristiana S. Seixas, uses four case studies of participatory fisheries management in Brazil to highlight some of the very real challenges involved in making such assessments a reality. Given the history of centralized decision making in most countries, the weak capacity of many local communities to engage in assessment or policy processes, and the continuing tendency to dismiss the value of local knowledge, it is clear that many barriers remain.

The last two chapters before the final, synthesis chapter examine how the structures and tools used in global environmental assessments might be modified to better address issues related to scale and knowledge systems. Chapter 15, "Integrating Epistemologies through Scenarios," by Elena Bennett and Monika Zurek, argues that a tool now commonly used in global assessments—scenario development—in fact provides a potentially valuable mechanism for bridging knowledge systems in assessment processes. Scenarios are most effective when they are developed jointly by experts and "users" in part because it is only in this way that they adequately represent the worldview of the potential decision makers and can thereby be relevant to those decision makers. This feature should lend itself to processes involving multiple knowledge systems, and Bennett and Zurek provide several case studies where this has been the case.

Chapter 16, "The Politics of Bridging Scales and Epistemologies: Science and Democracy in Global Environmental Governance," by Clark Miller and Paul Erickson, pulls together many of the threads of the earlier chapters to argue that the regionalization of "global" assessments can act to strengthen global civil society by fostering a deeper engagement of groups in the processes, strengthening regional voices in global governance, and providing a forum that respects the diversity of cultures.

The final chapter provides a short synthesis of lessons and conclusions from the previous chapters in the volume.

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