CHAPTER 15

Integrating Epistemologies through Scenarios

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As Folke et al. (2002, 437) write: "The goal of sustainable development is to create and maintain prosperous social, economic, and ecological systems." These systems are intimately linked; however, our study of them is often discrete. We might study the ecology of a region with a model that largely ignores human impact on the ecosystem. We might study the people of the same system without recognizing the impact that the ecosystem can have on their interactions. When interlinked systems are studied in a discrete way, important dynamics, driving forces, and interactions that help explain the system may be overlooked. Understanding these complex systems requires combining the knowledge and perspectives from many different ways of knowing (Lubchenco 1998).

Recently, many scientists, policy makers, and others concerned about the state of the world have pointed to the increasing urgency of environmental problems (Ehrlich 1997; Millennium Ecosystem Assessment 2005a) and the poor state of our ability to overcome these challenges with disciplinary research (Kinzig et al. 2000; Lubchenco 1998).

Interdisciplinary research, and research that involves perspectives from inside and outside the academic sciences, can mobilize a wider range of understanding and sources of information (Berkes and Folke 1998; Olsson and Folke 2001). Such broader approaches are less likely to be brittle and therefore are more likely to succeed in the long term (Holling, Gunderson, and Ludwig 2002).

These types of approaches are expected to be a key source of feasible solutions to today's critically intertwined environmental problems.

Conventional science has therefore recently turned its attention to working across disciplinary boundaries to solve tough environmental problems (Kinzig 2001). It has also begun to look at ways of knowing that come from outside the academy to add new vision to resource management. The benefits of using this apparent synergy between traditional knowledge and a knowledge gap in Western understanding may result in better ecosystem management. For example, in western Ecuador, interactions between indigenous and scientific knowledge yielded collective action to preserve ecosystem services and biodiversity in a communally owned watershed (Becker and Ghimire 2003).

Although it is widely recognized that integration of many perspectives is needed to understand social-ecological systems, few practical methods for doing so exist. In this chapter, we consider not only various disciplines within the academy of conventional Western science but also the incorporation of local and traditional knowledge and information gained outside the academy. There are often critical disconnects in language, approach, bounding of the problem, and even paradigm among different epistemologies that make communication across this divide extremely difficult.

Each way of knowing basically amounts to a paradigm through which members understand the world (Mingers 2001). This paradigm includes notions of truth, rules of evidence, and standards of rigor. Knowledge is gathered and stored based on a particular collection of assumptions, theories, and methods for understanding the world. These assumptions, and even the conceptual structure of each paradigm, often remain hidden or unspoken, rarely surfacing to a conscious level. Integrative scenarios compel participants to discuss and challenge their assumptions with others who hold different beliefs, an important first step toward better integration.

Here, we present scenario development as a method for improving decision making about social-ecological systems and for building an understanding of these systems that is open to knowledge from many different ways of knowing. In other words, a set of scenarios can be, and often is, a single product that is the result of several worldviews and information from many different perspectives. We begin by briefly discussing different ways of knowing and by exploring the difficulties of integrating information from different epistemologies. We propose and explain the use of scenario development as a tool for

integrating and synthesizing across epistemologies. The bulk of the chapter revolves around four examples of scenario exercises carried out as part of the Millennium Ecosystem Assessment (MA), each of which serves as an illustration of integrating across a different set of epistemologies.

In the first case study, the MA global scenarios provide an example of incorporating qualitative and quantitative information into scenarios. The second case study shows multiple academic disciplines coming together to build a set of scenarios for the Caribbean region. In the third example, academic scientists and local stakeholders work together to build scenarios. Finally, in the last case study, we highlight an example of traditional knowledge and academic science coming together to build scenarios.

The Difficulties of Integrating Epistemologies

Although many experts are talking about the importance of using multiple types of information and incorporating different paradigms in resource management, we struggle for methods to do so. Integrating knowledge from different sources can be hampered by differing methodologies, vocabularies, ways of assigning merit, and even worldviews.

Western scientific traditions have typically dealt with the mind-boggling complexity of systems by reducing the complexities to a manageable number of elements. Doing so necessarily means setting system boundaries. Disciplinary understanding affects how system boundaries are chosen. Differing time horizons of research, organizational structures, and institutional traditions (such as the means of giving credit for research) also complicate interdisciplinary collaboration. Traditional ecological knowledge (TEK) faces further difficulties because it may not be written and because the practitioners of TEK often do not interact with those gathering conventional scientific information about ecosystem management.

Additionally, issues of power may be problematic. In multidisciplinary or transdisciplinary projects, one paradigm may remain dominant and simply absorb bits of information from other paradigms. Using information without understanding the paradigm in which it originated may lead to overlooking important boundary conditions about how that information can be used. Finally, disregarding some paradigms may cause stakeholders to walk away from the table if they are not allowed to participate in defining the question.

Integrating Epistemologies through Scenario Development

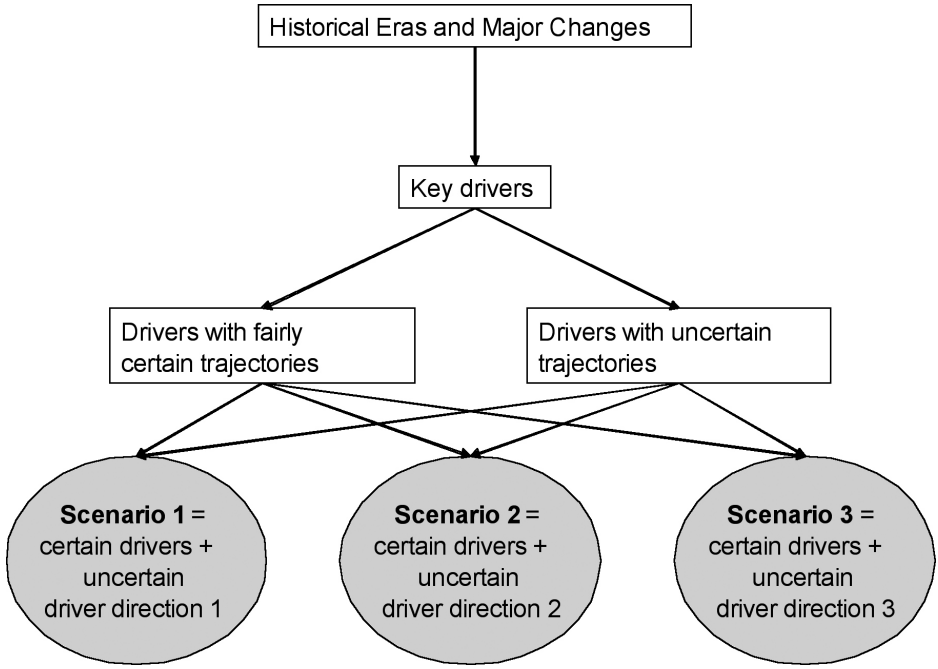
Scenario planning was developed as a creative, systematic way to think about the future (Peterson, Cumming, and Carpenter 2003). Scenario planning has been used in the business community for decades (Schwartz 1996) and has recently become an important part of integrated assessment exercises (e.g., the Intergovernmental Panel on Climate Change and the MA). Scenarios are now increasingly explored by natural resource managers for exploring new management approaches (Bennett et al. 2003). The appeal of scenario building lies in the possibility of bringing many stakeholders and different viewpoints into the process. In fact, multiple perspectives are almost a necessity for a compelling scenario-building exercise. Stakeholder groups might include scientists of many disciplines, TEK practitioners, ecosystem managers, local stakeholders, policy makers at various geographical scales, and others. Needing to get all of these groups to agree on a set of scenarios makes the scenario-building process a useful tool for exploring differences in knowledge systems, learning how these differences might influence decision making, and considering ways to bridge them in the decision-making process.

What Are Scenarios?

The MA describes scenarios as "plausible alternative futures, each an example of what might happen under particular assumptions" (Millennium Ecosystem Assessment 2003). This definition highlights the MA's belief in using scenarios to challenge beliefs about the future. Scenarios are stories about the future, told in a set. Scenarios can be developed in many different ways. Based on previous scenario experiences, the MA has developed a process for building scenarios with participants who had little to no previous knowledge of scenario development (figure 15.1). These steps include considering long-term change in the study site, listing key drivers of current change, distinguishing those drivers with known trajectories from those whose future is uncertain, and finally, telling stories that allow uncertain drivers to unfold differently across the scenarios to examine the results.

Scenarios can be qualitative, quantitative, or both (Raskin 2005). Qualitative and quantitative scenario development techniques are often combined to produce a set of comprehensive narratives supported by a quantitative modeling exercise (e.g., the Intergovernmental Panel on Climate Change's Special

Figure 15.1
Steps used in the Millennium Ecosystem Assessment scenario-building process.



Report on Emissions Scenarios; the MA; and the Global Scenario Group). The qualitative story lines are used to stimulate creative, outside-the-box-thinking. The quantification of driving forces provides a consistency check and can illuminate unanticipated dynamics.

Scenarios are not predictions, forecasts, or projections. In contrast to these methods for describing the future, scenarios do not necessarily assume that the world will remain within today's boundary conditions. Scenarios are, in fact, often based on the assumption that the boundary conditions will change, and each scenario in a set follows the path of a different set of boundary conditions. One of the most useful ways to imagine different boundary conditions is to gather the perspectives of people who come from very different backgrounds and have different concerns about the future.

Scenarios are often part of a decision-making or planning process. They can highlight upcoming choices to be made and potential outcomes of those choices (Rotmans et al. 2000). Scenarios are also useful for thinking about dynamic

processes and causal chains that affect the future. In this way, the process of developing scenarios challenges our beliefs and assumptions about how social-ecological systems work. Thus, scenarios are used as "a tool for ordering one's perceptions about alternative future environments in which one's decision might be played out" (Schwartz 1996). Management options can, for example, be tested by exploring how well a given policy works across multiple possible futures.

Using Scenarios as a Method to Integrate Epistemologies

The knowledge that we have, and often the way we have acquired this knowledge, plays a decisive role in shaping our beliefs about the future. Scientists from the same discipline or people representing a particular interest group are likely to use similar concepts and share a common understanding of how the system of interest should be defined; they may find it difficult to communicate with others from different backgrounds. Bridging the unspoken assumptions that come with any given paradigm is a common difficulty of multidisciplinary or transdisciplinary work.

For the scenario development process to succeed, these underlying assumptions must be made explicit so the team can explore their impact on decision making. The process of scenario building often leads to conversations in which individuals from different backgrounds challenge one another about the focal questions of the process, key drivers, and assumptions about how the world works. This type of discussion can lead to a critical examination of assumptions, which helps to assess and deepen the understanding of the system components and their interactions.

The first step in MA scenario building—discussing key uncertainties—is often the scenario development team's first discussions about what is known and unknown from the perspective of their discipline or source of knowledge (table 15.1). Something that one team member believes to be an uncertainty may be clarified by knowledge from another team member. Likewise, something that a team member believes to be certain may be questioned by another team member. These discussions help the scenario-building team explore the knowledge, and the gaps in knowledge, of each member of the team, including themselves.

The second step in scenario building is agreeing on the key drivers of change in the system. Splitting these drivers into those with a fairly certain trajectory versus those for which the trajectory is uncertain helps to make the transition from talking about the social-ecological system in the abstract to deciding which

Table 15.1

How bridging epistemologies occurs at different stages of scenario development

Scenario Development Stage	How Bridging Is Achieved
Discussion of main uncertainties about the future, focal questions	• Voicing different viewpoints about the focal questions • Presenting different pieces of knowledge about the main uncertainties • Discussing assumptions about how uncertainties will play out in the future
Discussion of main driving forces of change	• Voicing viewpoints on the importance of specific drivers • Providing information about how drivers are changing
Putting the scenarios' story lines together	• Developing elements of the story lines • Enriching the story lines by adding particular pieces of knowledge • If models are used, using model results to ground-truth assumptions
Analysis of implications for main stakeholders across the scenarios set	• Analyzing from different viewpoints • Questioning beliefs and assumptions of all knowledge • Understanding the influence of the paradigm in which information is collected and how this affects the way we use information

variables should play a major role in the scenarios. Drivers for which the trajectory is fairly certain are played out similarly across the scenarios. On the other hand, drivers with uncertain trajectories are the ones around which the important stories are told. Involving people with different knowledge bases in the process of scenario development can broaden the perspective of which drivers are important as well as what trajectories those drivers may take in the future. Similar to step one, these discussions bridge the gap between different knowledge systems by helping the scenario team talk through their assumptions, including where these assumptions come from and how they affect beliefs about the future.

In the third step—the development of each story—the opportunities shift from understanding the assumptions and worldviews behind different epistemologies to actually bridging the gaps that have been uncovered. Because scenarios can be qualitative or quantitative, room exists for expressing the same thing many different ways. Because each scenario can follow a different logic,

there is room for expressing many different ideas as well. By systematically talking through important uncertainties and "stories" about how they might play out, individual participants can add their perspective and their piece of knowledge to the scenarios process.

Finally, after the scenarios have been developed, they can be interpreted and their implications for different stakeholder groups analyzed. Analyzing the plausible long-term consequences of various decisions through the lenses of many groups or disciplines helps to reinforce the many different visions that people have for the future. It also allows for the combined use of several paradigms by compelling participants to discuss why they believe what they believe. Shedding light on the differences in interpretation helps to understand which information is really used by which people, how it is processed, and how conclusions are drawn. This analysis reveals the influence of the structure and paradigm used by each different epistemological group and how these backgrounds influence people's decisions.

Examples from the Millennium Ecosystem Assessment

The MA aimed to provide scientifically sound information to decision makers and the public to improve ecosystem management and thereby contribute to human well-being. Part of the MA assessment process was a scenarios exercise to describe plausible changes in ecosystem services and their consequences for human well-being at a global scale. The MA also supported a number of subglobal assessment exercises, some of which also built scenarios.

In this section, four different MA-related scenario exercises are described to illustrate how scenario building can be used to integrate information from across epistemologies into a single coherent message. In the first example, the global scenario exercise incorporated qualitative and quantitative information. The second case shows multiple academic disciplines coming together to build a set of scenarios for the Caribbean region. In the third example, academic science and local stakeholders work together to build scenarios. And finally, in the last case study, we highlight an example of traditional knowledge and academic science building scenarios together. In each of the following sections, we describe the process of each scenario-building exercise, including the problems faced, how these problems were solved, and what insight was gained from the process.

Integrating the Qualitative and the Quantitative: The MA Global Scenarios

The MA developed a set of four global scenarios about the future of ecosystem services and human well-being, combining quantitative modeling tools with qualitative approaches. Quantitative results were desired for their scientific credibility, and qualitative results were needed because they could easily incorporate nonlinearities that the models could not address.

Each of the four MA scenarios describes how social-ecological systems might develop between 2000 and 2050 based on different assumptions about how demographic, economic, sociopolitical, cultural, technological, and biophysical factors might develop in the future. The scenarios were developed in a series of eight workshops over three years by a group of about seventy experts from around the world and from many different academic disciplines. The team included ecologists, economists, sociologists, scenarios experts, and global modelers. The process required bringing together knowledge from several different academic disciplines and harmonizing qualitative story lines with quantitative model results. The group was led by two ecologists and two economists. Facilitation and conflict resolution methods were used whenever necessary by involving a professional facilitator in the process.

To achieve integration between quantitative and qualitative information, a "storyline-and-simulation" approach was used (Alcamo 2001). According to this method, a set of qualitative narratives, or story lines, are developed first and are then translated into model variables. The models are used to quantify the results of the stories. Harmonizing the story lines and the models is an iterative process in which both the story lines and the models are compared with each other and adjusted for consistency.

The story lines of the MA global scenarios addressed two main types of uncertainties whose combinations were seen as potentially leading the world into fundamentally different trajectories: the degree of connectedness of countries, markets, and institutions, and the degree to which ecosystem management is reactive or proactive. Each story line was translated into a set of variables that served as inputs to global models that were used to calculate outcomes for various ecosystem services, such as crop production, fish harvest, or water quality. Five different models were used, and each model was run separately for each story line with input values based on the story lines. The results of the model runs were then compared with the narratives to verify the assumptions,

to check the story lines for internal consistency, and to add quantitative information. The final product for each scenario was a qualitative narrative that contained quantitative information. Ultimately, the set of scenarios was analyzed for their implications for different stakeholders and for the provisioning of ecosystem services in the future (MA 2005b).

The MA global scenario exercise is an example of how one can harmonize qualitative story lines and quantitative model results to strengthen the final message. In our efforts to quantify the story lines, they had to be simplified in a way that was not always comfortable to those most familiar with the stories. This difficulty was overcome through conversation about what features of the story lines could be simplified and which could not. It was also overcome by allowing the story lines to be told both as narrative and in numbers. Thus, while the narratives were simplified to be useful to the modelers, they could retain their complexity in the final qualitative telling.

A related difficulty was determining whether the scenarios should be driven primarily by the qualitative story lines or by the quantitative modeling results. Discussions resulted in an assessment of the available modeling tools, which determined that the models alone could not adequately answer the focal questions. The decision was taken to use the models primarily as a consistency check of, and quantitative framework for, the story lines. A professional facilitator and strong, balanced leadership were necessary components of these successful decision-making processes.

The integration process between qualitative and quantitative information resulted in a set of detailed stories about the future of ecosystem services and human well-being that were better than scenarios, which were either solely quantitative or solely qualitative. The qualitative aspects of the scenarios added a richness and ability to deal with nonquantifiable nonlinearities in ecosystem services' changes, while the quantitative aspects of the scenarios served as an important consistency check for the story lines. The discussions among qualitative and quantitative scientists and, in particular, the need to defend assumptions made each group's efforts much clearer and stronger than they would have been alone.

Talking across the Disciplines: The CARSEA Scenarios

The Caribbean Sea Ecosystem Assessment (CARSEA) was an MA subglobal assessment designed to evaluate changes in Caribbean ecosystems and

ecosystem services and to develop options for responding to these changes. The assessment team chose to develop scenarios as part of their assessment because of the flexibility of the method for thinking broadly about the future without losing scientific rigor and because of its ability to incorporate a wide variety of expert knowledge. The team was very knowledgeable about Caribbean ecosystems, including information from diverse disciplines. The process was led by a multidisciplinary team of five natural and social scientists who had previous experience with scenarios.

The CARSEA group developed four scenarios, which described plausible developments in the Caribbean region and their outcomes for ecosystem services and human well-being over a fifty-year time horizon. In two workshops over the course of 2003, a team of approximately forty participants discussed the key driving forces and critical uncertainties that they expected would determine the future of the region. Prioritizing uncertainties helped to select the set of scenario story lines to be developed. The most critical uncertainties—which turned out to be the level of reliance on income from outside the region, the level of reliance on tourism and its management, global environmental change such as climate change, and the level of regional cooperation—were used to determine the major differences among the story lines.

The next step was the development of the story lines, which was undertaken in small teams of two or three people. These teams developed draft scenarios that aimed to incorporate as many different viewpoints from earlier discussions as possible. Each story line was then presented to and critiqued by the whole group. The discussion was a consistency check for the proposed story lines in which each group member could question the assumptions made in developing each scenario. Input from across disciplines enriched the scenarios by adding additional detail to the story lines. After a few iterations, the majority of differences in viewpoint were settled and the story lines were finalized. Analysis of the scenario implications was undertaken by a small writing team during the final write-up of the scenarios and the assessment report.

Broad discussion helped to form a common language among all participants. Difficulties arose primarily when the main uncertainties for the region were discussed. These difficulties came primarily from differences among the disciplines and had to do with attaching different levels of importance to particular uncertainties. In general, people thought that the uncertainties closest to their own discipline were the most important. For example, some economists

thought that the proposed free trade agreement of the region with the United States would be one of the most important determinants for the future of the region, while some natural scientists stressed the negative impacts of new marine diseases and of a rise in sea level on the tourism industry.

Some of these differences were resolved by bringing one key uncertainty to the foreground of each scenario. For example, one scenario focuses on the consequences of a free trade agreement of Caribbean countries with the United States, and another centers on the impact of sea level rise and marine diseases. Knowing that several key uncertainties could be addressed across the set of scenarios meant that we did not have to keep discussing until all participants agreed on a single uncertainty. The flexibility to have several uncertainties eased tension among participants over whose ideas were the most important.

Bringing a multidisciplinary team of experts together to talk about the future of the Caribbean helped to thoroughly discuss the challenges the region is facing as seen from different scientific viewpoints. Each participant enriched the discussion with knowledge from his or her discipline. This helped to improve the story lines by providing their expertise and by questioning some of the propositions of other disciplines and prompting a deeper level of discussion. In this way, not only did the story lines gain in details but their plausibility was also constantly checked and improved. The scenarios methodology provided a platform for two different outcomes: (1) to develop a common language between the disciplines, and (2) to synthesize information and knowledge from different academic disciplines in a consistent, systematic manner.

On the issue of developing a common language, participants were constantly obliged to state concepts used in their discipline in a way that was understandable to people coming from a different discipline. Multidisciplinary experts were a very important factor in the success of these scenarios because they could translate terminology, paradigms, and theories across disciplinary boundaries, leading to better understanding and agreement among participants.

One of the most difficult parts of the process was to make sure that each participant was comfortable with how his or her assumptions about the future were incorporated into the scenarios. In the CARSEA scenario-development process, the experts were familiar with one another from working together on previous projects, which helped them find a common ground for discussion.

In fact, the participants had been carefully selected by the leaders to be people who were known to be good "team players."

The CARSEA scenario-development process provided a platform for weaving together a set of consistent stories about the future that incorporated information and knowledge from across many different academic disciplines. Different disciplinary perspectives, although sometimes controversial, helped the team to develop new insights about important driving forces of change in the Caribbean region. The experience showed how the scenarios process can lead from incorporating different knowledge types to integrating knowledge into pictures of the future that people had not thought of before. The scenarios team believed that these integrated visions of the future brought unforeseen insights that would not have been realized in a single-discipline study.

Combining Scientific and Local Knowledge: The Northern Wisconsin Scenarios

A workshop was held in September 2002 to develop scenarios for the near future of the Northern Highland Lake District (NHLD) in northern Wisconsin, United States. The goal of the scenarios was to explore the ability of the NHLD to maintain its present desirable social and ecological features despite changes driven from within and from outside the region (Carpenter et al. 2003). We chose scenario building in part because we wanted to generate discussion about the future among stakeholders who normally would disagree strongly or not talk at all about managing the NHLD.

The workshop included participants from federal and state resource management agencies, lake associations, out-of-state owners of lakeshore property, realtors, and Native Americans. In addition, academic experts from around the world were present to act as resource people, bringing expertise in such fields as ecology, human demography, economics, and mathematical models of social-ecological systems. In its focus on stakeholders, the exercise differs from the two presented before. Leadership was provided by scientists who had experience with scenario development and facilitation. The goals were integration across many opinions about managing the region and bridging the gap between local stakeholders and academics.

The scenarios were developed following a methodology similar to that of the CARSEA scenarios. Broad discussions of all participants were followed by

small groups developing the actual story lines. In this case, the local participants had a very wide range of different desires for the future of the region. In many other scenario-development exercises, such as those developed for CARSEA, the participants generally agreed easily on what would be a "good" outcome for the future of the social-ecological system in question. In the case of the NHLD scenarios, however, no such agreement existed. Instead, there were obvious differences in the interest groups' hopes for the future. Thus, the potential for conflict among stakeholders was high.

Because of these differences, the scenarios were developed such that the scenarios reflected the social-ecological outcomes of different stakeholders' hopes for the future of the NHLD. Because some hoped that the area would become a thriving commercial center, one scenario told the story of rapid development. Since others hoped that the NHLD would remain sparsely populated, another scenario portrayed a plausible path in which increased development did not take place. Following the consequences of each of these stories helped everyone—both those who preferred the particular outcome and those who did not—understand the benefits and drawbacks of each scenario. Other scenarios described the potential for wildlife disease to affect the area or explored the consequences of a massive and rapid influx of residents to this sparsely populated region.

In addition to stakeholders' preferences, we also used the best scientific information about the current state of the social-ecological system and recent trends. For most scenarios, this was fairly easily accomplished. Local interest determined the basic thrust of the story line, and scientific information provided the details, particularly details about the outcomes for provision of ecosystem services. For example, stakeholders told us that one story line should include increased telecommuting leading to a larger population in the NHLD. Scientific literature helped us understand how an increase in the population of young telecommuters would affect ecosystem services in the region. When the best scientific expertise disagreed with stakeholder beliefs or showed a cost of a favored strategy, conflict arose. Some participants were happy to accept the scientific experts' opinions, but others were not.

The integrated results were thought to be more believable than stories developed without scientific expertise. It was also easier to convince nonparticipants of the validity of the scenarios because of the participation of a wide range of stakeholders and scientific experts. Yet, because the scenarios were still based

in the interests and concerns of local stakeholders, they were more interesting to other local residents than purely scientifically determined futures would be. Additionally, local stakeholders who participated in the process showed the scenarios to their friends and family in the region, spreading the discussion beyond the boundaries of the workshop participants.

We learned that it is possible, and even relatively easy, to make stories that are based on scientific information about the social-ecological system and at the same time to have the scenarios address the issues that people are really interested in. The difficulties we faced occurred when people's understanding of the system differed from the scientific understanding. For example, it can be difficult to tell a story about the ecological quality of a system if people believe water quality is getting worse but the scientifically collected data indicate that it is not. Usually, these misunderstandings were worked out through discussion. Where this was not possible, we used this potential disadvantage to our advantage by developing two scenarios that explored the split in beliefs.

Integrating TEK and Western Science: Scenarios for Bajo Chirripó, Costa Rica

The Bajo Chirripó assessment was undertaken by a group of Cabécar indigenous people and a Costa Rican nongovernmental organization (NGO) that works on indigenous peoples' issues. The scenario-building team, including NGO members, representatives of the indigenous communities, and two local scientists, carried out a pilot scenario-building exercise. The goal was to help the Cabécar community derive a common vision of their future and to help them cope with ongoing regional developments, some of which threaten the community's territory and culture. Of particular concern was the loss of traditional knowledge and values. Scenarios were chosen as a method because of their ability to incorporate traditional belief systems along with academic or other "outsider" beliefs and information.

For the pilot study, community members came together in a one-day workshop to develop scenarios. The NGO members and the scientists played a double role of representing the view from outside the community and providing some background information on political and societal developments that might affect indigenous communities. The group developed two pilot story lines, which described plausible changes in the region and in their community over a five-year horizon.

As in the other scenario exercises, the discussion of key forces changing the community allowed the participants to bring their knowledge and experience to the table. After identifying the most important sources of uncertainty for the future of the Cabécar, narrowing the focus of the stories forced participants to determine which forces were affecting the community from outside and which were controllable by the community. This identification process was not easy because the views of the Cabécar community often differed from those of participants from outside the community, including the leaders of the exercise. These differences were not totally resolved in this pilot exercise, but the exercise built understanding of the origin of the discrepancies and how they influenced decision making.

The Bajo Chirripó scenarios are an example of how the scenario-development process can bring indigenous people together with others from outside the community to discuss their perceptions of future developments constructively. The process allowed us to combine two very different kinds of knowledge and still develop consistent pictures of the future. The discussion also helped to clarify which processes the Cabécar community can control and which they cannot. In addition, we discussed possible reactions to both controllable and uncontrollable drivers. Incorporating differing views on drivers and possible responses to them enlarged the perspectives and knowledge of all participants.

Conclusions

Ecosystem management can be improved by using multiple types of knowledge to formulate management plans (Berkes and Folke 1998). Yet, bridging the gap between paradigms can be difficult. Although many consider it an important task, few known methods exist that can be used to integrate multiple sources of information into a single coherent product.

We have suggested that scenario building may be an effective method for bridging the gap between epistemologies. Scenarios themselves will be more informative and useful if they can incorporate multiple perspectives (Schwartz 1996). As such, the MA process for scenario building consists of conversations about what is known and what is not known, providing an ideal space for questioning assumptions made by different disciplines or within different paradigms. The discussions that are required to build multidisciplinary scenarios help participants understand, and then question, how their knowledge and

Table 15.2

Comparison of key players in the scenario exercises and their contribution

Scenarios Exercise	Key Players in the Exercise	Contribution of Each Player to the Scenario Development Process
Global Millennium Ecosystem Assessment (MA) scenarios (integrating the qualitative and quantitative)	Story line developers (experts from different disciplines—ecologists, economists, social scientists)	Understanding of specific driving forces and their impacts
	Global modelers (experts from different disciplines)	Modeling capabilities to support assumptions
	Core scenarios team	Leadership; experience with scenario development
Caribbean Sea Ecosystem Assessment (integrating across disciplines)	Experts from different disciplines (ecologists, economists, social scientists)	Scientific knowledge of driving forces and their impacts
	Local stakeholders	Understanding of main problems and political processes; creativity; knowledge about local institutions
	Core scenarios team	Scenarios methodology
Northern Highland Lake District (combining scientific and local knowledge)	Local stakeholders	Understanding of main problems; knowledge about local institutions
	External experts	Scientific knowledge of driving forces and their impacts; scenarios methodology
	Core scenarios team	Scenarios methodology and experience
Bajo Chirripó, Costa Rica (integrating traditional ecological knowledge and Western science)	Indigenous local people	Understanding of main problems; institutional knowledge
	Local NGO	Scenarios methodology
	External experts	Scientific knowledge of driving forces and their impacts; scenarios methodology

paradigms influence the vision of the future. The process of scenario development helps identify blind spots that each type of knowledge has because it obliges each discipline to explain its beliefs and expose the certainties and uncertainties in conversation with other participants. By understanding how the

epistemologies influence the vision, we make progress toward integrating epistemologies into a single, consistent set of stories.

Each of the scenario exercises that we highlighted involved many players, each of whom contributed to the process (table 15.2). Core scenario teams contributed scenario expertise. Experts contributed information from their respective disciplines along with information about the boundary conditions of how that information should and should not be used. Local stakeholders contributed creativity, understanding of the key problems, and knowledge of local institutions. Outside experts, when used, added understanding of other systems and could provide information about how the problems faced in the region were similar to problems being faced in other locations. Without multiple perspectives, each of the sets of scenarios, and the scenario-building process itself, would have been less informative. Scenario development also often builds important networks among people who might otherwise not talk about the future together and creates through its process a "safe" discussion forum to express diverging viewpoints.

Scenarios have limitations too. They are not yet well established within the scientific community as a credible method. Although they are useful for synthesizing existing information and for pointing out where further research is needed, they do not generate new information. As with all multidisciplinary projects, power dynamics can play an important role. If not handled carefully, these dynamics may lead some participants to refuse to participate, essentially ending or severely limiting the project. Similarly, because it is easy to simply incorporate each perspective by adding a single scenario that follows that set of beliefs, it may be too easy to gloss over the difficult conversations needed to make the scenarios truly integrative.

Despite its limitations, however, scenario development may be an important step toward bridging the gap between epistemologies and improving ecosystem management. Scenario building is a method for thinking about the future that is made stronger by incorporating multiple perspectives. The discussion required to incorporate these perspectives into a single set of scenarios encourages scenario builders to consider how their assumptions and backgrounds lead to particular beliefs about the way the world works. These discussions not only make better scenarios but enhance our understanding of our epistemological boundaries and, in so doing, improve our ability to work with others from different backgrounds.

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