Integrating epistemologies through scenarios

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Abstract

There are many ways of knowing or gathering knowledge about social-ecological systems, including both traditional and scientific techniques. Even within these broad categories of "traditional" and "scientific", there are diverse epistemologies. Many have argued that the guiding of social-ecological systems can be improved by the integrated use of these bodies of knowledge. However, integrating epistemologies can be extremely difficult. Integration is hampered by differing methodologies, vocabularies, ways of assigning merit, and even worldviews. Indeed, we currently lack a conceptual framework for cross-epistemological integration.

We propose scenario development as one process for thinking about ecosystem management that can integrate different ways of knowing into a useful conceptualization. Scenarios, sets of stories about the future, can be used to integrate multiple epistemologies, including combining traditional or indigenous knowledge with scientific information, as well as integrating social and natural sciences, economics and ecology, quantitative and qualitative results. We present several examples of how scenarios have been used to incorporate different ways of knowing to think more broadly about ecosystem management. By going through the process of using several epistemologies in a single product, scenario development can be used to identify key impediments to the integration process, which can then used to ease the integration process in the future. Because scenarios are able to incorporate many ways of knowing, their development is also useful for engaging local stakeholders and addressing local concerns in a larger context.

Why integrate epistemologies?

As Folke et al. (2002) 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 mathematical model that ignores or minimizes 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. Unfortunately, a complete picture of a social-ecological system from any single perspective is impossible. When we study interlinked systems in a discrete way, we may miss important dynamics, drivers, and other phenomena that explain the system. Understanding these complex systems requires combining the knowledge gained 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) and the poor state of our ability to overcome these challenges with disciplinary research (Kinzig et al. 2000; Lubchenco 1998). The dynamics of social-ecological systems are complex, and single-discipline studies do not seem to be able to fully grasp them well enough for solving environmental issues (Berkes and Folke 1998). In addition, our most pressing environmental problems are characterized by dynamics and interactions that do not allow a clean separation between phenomena that western science describes as being in different disciplines.

Interdisciplinary research, and research that involves perspectives from in- and out-side the academic sciences, can mobilize a wider range of understanding and sources of information (Berkes and Folke 1998). We believe that inter- and multi-disciplinary research will be a key source of feasible solutions to environmental problems. Broader, more balanced approaches that are based on a wide understanding of social-ecological systems are less likely to be brittle than single perspective approaches and therefore more likely to succeed in the long term (Holling, Gunderson, and Ludwig 2002).

Although there is widespread recognition that integration of many perspectives is necessary for understanding social-ecological systems, there are few practical methods for studying these systems that allow for full integration of the knowledge gained through different techniques. In this paper, we consider not only various disciplines within the academy of conventional western science, but also incorporation of traditional knowledge and wisdom 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 the divide extremely difficult. Here, we present scenario development as a method for making better decisions about social-ecological systems and for building an understanding of these systems that is open to including the knowledge from many different ways of knowing.

Different 'ways of knowing'

There are many ways of knowing or gathering knowledge about social-ecological systems, including both traditional and scientific techniques. Even within these broad categories of "traditional" and "scientific", there are diverse epistemologies. For example, information can be collected and stored qualitatively or quantitatively. Within conventional science, there are also differences among academic disciplines, which can view the world through different paradigms. Each way of knowing has strengths and weaknesses that are particular to its paradigm.

One of the benefits of the academic style of science is that it allows for rigorous testing of highly specific questions. However, conventional scientific approaches to resource management do not always work (Ludwig et al. 1993, Gunderson et al. 1995). In fact, successful management through western scientific techniques may result in reduced system resilience (Berkes and Folke 1998). Holling (1986) suggests that successes in western-style management in may lead to attempts to keep an ecosystem at "a certain stage of dynamic change, making it more fragile and inviting unpredictable feedbacks from the environment".

Within the academic setting, research can be done qualitatively or quantitatively. Quantitative research involves numerical results, mathematical models, and experimentation. It produces quantifiable, reliable data that are usually generalizable. However, this approach can take human behavior out of the context of a real world setting and often ignores the effects of variables that have not been included in the model. Qualitative research generally involves surveys and interviews and observations. The advantage of qualitative methods is that they generate rich, detailed data that leave the participants' perspectives intact and provide a context. A disadvantage is that data collection and analysis may be labor intensive and time-consuming and may not be generalizable to a larger population.

Another way of knowing that has been the subject of study recently is traditional ecological knowledge, or TEK. TEK is "a cumulative body of knowledge and beliefs, evolving through adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings with one another and the environment" (Berkes 1999; Olsson and Folke 2001). It includes natural history, knowledge about local wildlife, and cultural norms for management (Becker and Ghimire 2003). TEK is developed through accumulation of experiences and informal experiments. In general, it is transferred orally and thus, has not often been documented. Recently, western scientists have recognized TEK as a potential source of information and knowledge that could improve management of social-ecological systems (Berkes, Colding, and Folke 2003). An oft-noticed benefit of TEK is that it is often based on very long-term informal study of ecological systems and thus can have a much longer time series of information to work with than most academic studies. It may also have more context than conventionally-collected quantitative information. However, it is important to remember that TEK is necessarily more environmentally-conscious than western management techniques and can even be ecologically maladaptive (Gadgil and Berkes 1991). A potential weakness of TEK is that, because it is often not written down, it can be more easily misinterpreted.

Each of these ways of knowing basically amounts to a paradigm through which members understand the world (Mingers 2001). The knowledge is gathered and stored based on a particular collection of assumptions, theories, and methods for understanding the world. These assumptions can often remain hidden or unspoken.

Integrating epistemologies

The case for integrating epistemologies

While these ways of knowing about social-ecological systems are useful individually, guiding social-ecological systems can be improved by integrated use of these bodies knowledge. Using multiple techniques for gathering information for resource management and decision-making about the environment, “expands the sources of information for ecosystem management” (Olsson and Folke 2001).

Conventional science has recently turned its attention to working across disciplinary boundaries to solve tough environmental problems (Kinzig 2001, more refs). It has also begun to look at ways of knowing that come from outside the academy to add some important vision to resource management. For example, Becker and Ghimire (2003) suggest that indigenous communities regularly address one of the key challenges in resource management – meeting the needs of individuals while at the same time sustaining public goods for the community. They suggest that the benefits of utilizing this synergy between traditional knowledge and a knowledge gap in western knowledge can result in better ecosystem management.

Integrating these different types of information is likely to be essential to solving today’s critically interlinked environmental problems. Ludwig (2001) suggests that there are some ecosystem management problems that are so complex that they are exceedingly difficult to manage using today’s management techniques. These “wicked problems” have no definitive formulation, no stopping rule, and no test for a solution. In fact, they are unlikely to ever be fully resolved. In addressing these types of “unsolvable” problems, we must acknowledge that deciding on a course of action will involve issues of values, power, equity, risk, and justice, in addition to many types of information. It is in addressing these issues that having many different viewpoints will be critical to developing a broadly-acceptable, flexible solution.

The difficulties of integrating epistemologies

While many experts are talking about how important it is to integrate different ways of knowing, we struggle for methods to do so. Integrating knowledge from different sources can be extremely difficult. Integration is hampered by differing methodologies, vocabularies, ways of assigning merit, and even worldviews. Indeed, we currently lack a conceptual framework for cross-epistemological integration.

Western scientific traditions have generally dealt with the mind-boggling complexity of systems by reducing the complexities to a manageable number of elements interactions. Doing so necessarily means setting system boundaries so that the variables considered to be important are inside and the unimportant ones are outside. Different disciplines may choose different variables to be inside or outside the system. These different ways to bound the problem, combined with different terminology, and even different paradigms can make it extremely difficult for scientists in different disciplines to communicate with one another, even when they are working on the same problem. Different time horizons of research, organizational structures, and institutional traditions such as the means of giving credit for research all complicate interdisciplinary collaboration. TEK faces further difficulties because it may not be written at all and the practitioners of TEK often do not interact with those gathering conventional scientific information about ecosystem management.

People who share a given epistemology often share a language or set of terminologies or jargon, which may not be easy to understand by others from outside that way of knowing. This gap among disciplines in the conventional scientific academy is well-recognized. It is even wider between scientists and non-scientists. It may be complicated by different cultures, languages, or worldviews and may be yet wider between those who use traditional knowledge and those who use more conventional ways of knowing.

Integrating epistemologies through scenario development

Scenario building has been developed as a creative, systematic way to think about the future and the uncertainties it involves (Peterson et al. 2003). Scenario building has been used in the business community for decades (Schwartz 1996) and has recently come to the attention of the scientific and management communities (Bennett et al. 2003). Unlike other methods for considering the future, scenario building requires bringing many stakeholders and different viewpoints into the process. This makes them useful tool for bridging epistemologies between stakeholder groups involved in the decision-making process. These stakeholder groups can include scientists of many disciplines, TEK practitioners, and others.

What are scenarios?

The Millennium Ecosystem Assessment (MA) describes scenarios as "plausible alternative futures, each an example of what might happen under particular assumptions" (MA 2002). This definition highlights the MA's belief in using scenarios to challenging one's beliefs about the future. They are, simply, stories about the future, told in a set, which are used by making comparisons across the set. Scenarios can be told in the language of both words and numbers (Raskin et al, In review).

Scenarios are not predictions, forecasts nor projections (though projections and forecasts might be used in the scenarios development process). In contrast to predictions, forecasts, and projections, scenarios do not necessarily assume that the world will remain within today's boundary conditions in the future. They 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. They allow the scenario builders to explicitly think about which boundary conditions might change and how that will impact the future success of decisions made now. One of the most useful ways to imagine different boundary conditions is to gather the perspective of people who come from very different backgrounds. Scenarios are also useful for thinking about dynamic processes and causal chains that affect the future (Rotmans et al. 2000). In this way, the process of developing them challenges our beliefs and assumptions about how social-ecological systems work.

Scenarios can serve many different purposes. They can be used to explore the level of knowledge about a system by exploring the interactions and linkages between key variables as the scenario plays out. They can also be used as a 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). They can lead to challenging assumptions on the functioning of certain processes (Davis 2002) and illustrate different views on their outcomes held by participants of the scenario building exercise. As "a tool for ordering one's perceptions about alternative future environments in which one's decision might be played out" (Schwartz 1996), they are also useful for decision-making. Management options can be tested by exploring how well a given policy works across multiple scenarios.

Scenarios can consist of qualitative information, quantitative information, or both. Qualitative scenarios, which use a narrative text to convey the main scenario messages, can be very helpful when presenting information to a non-scientific audience. Quantitative scenarios usually employ modeling tools to incorporate quantified information to calculate future developments (Alcamo 2001). Qualitative and quantitative scenarios development techniques are often combined to produce a set of comprehensive narratives backed-up by a quantitative modeling exercise. The qualitative part of the storylines, whose development precedes the modeling, is used to stimulate creative, out-of-the-box-thinking about a wide range of plausible futures. The quantification of driving forces provides a consistency check of the narratives and can show upcoming trends and dynamics not anticipated before.

Using scenarios as a method to integrate epistemologies

We all make decisions based on what we think the future will be like. To do this, we rely, often unconsciously, on our beliefs about how the future will develop. These beliefs are based on our knowledge and understanding of how the system works. In other words, the kind of knowledge that we have, and often the way we have acquired this knowledge, plays a decisive role in shaping our beliefs about the future. As we have described above, one goal of the scenario development process is to make these assumptions explicit and explore their impact on decision-making. In fact, in a set of scenarios, each scenario often represents a different worldview about what the boundary conditions might be like in the future.

To build plausible, realistic pictures of the future, we need to think about the large number of factors that will influence the unfolding of the future. Because we must think about so many different factors, it is imperative to involve multiple disciplines and many perspectives in the process of scenario development. Building scenarios with stakeholders who have different knowledge bases brings together many different assumptions about how the world works. The process of building scenarios explicitly requires creation of a set of stories with the broadest realistic set of futures possible. For this reason, it will necessarily include discussions of different assumptions about how the world works and may also include discussion of our assumptions can shape decision-making preferences. This discussion will help begin to bridge the gap between different knowledge systems by forcing scenario developers to talk about their assumptions, including the basis of those assumptions and how they impact our beliefs about the future. Scenario development enables participants first to unearth their own assumptions about the future and how human decisions, will change its course.

Because scenarios are a set of stories, each of which begins with an assumption about how the system works that will impact the way the future unfolds, they are almost made for integrating different ways of knowing and thinking about the future. Additionally, because they can be told in qualitative narrative or in quantitative fashion, there is room for expressing the same thing many different ways. By talking systematically through important uncertainties and 'stories' about how they might play out, each participant can add their perspective and their piece of knowledge to the scenarios process.

The scenarios development process allows bridging the gap between different types of knowledge at various points. These include the discussion of main uncertainties about the future of the investigated system, the discussion of the main driving forces of change, the qualitative storyline development and the analysis of scenario implications for different stakeholder groups or the investigated system. In each of these discussions different viewpoints can be voiced and different pieces of knowledge presented. These 'parts of the puzzle' then allow portraying different plausible future worlds whose descriptions become even richer the more diverse the backgrounds of the scenario builders. After the scenarios are developed, it is the comparison of stories that helps to highlight how our assumptions affect our beliefs. This leads to greater insight about how the 'way we know' influences our vision and offers deeper insight into the importance of epistemologies. The process of scenario development can also identify what makes integration so difficult for future study and attention. Here, we present several examples of integration – across qualitative and quantitative storytelling, across disciplines, across TEK and western science, and among stakeholders and academic scientists – and explore what we learned from integrating. For each example, we introduce the example, explain how the scenarios were developed, discuss the difficulties with integration, and conclude with a brief description of what we learned from the process. We submit this information as a first step towards using scenarios for integrated study of the future of social-ecological systems.

Examples from the Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) is an international effort to assess the consequences of ecosystem change on human well-being and elicit options for responding to those changes. The MA aims to provide scientifically sound information to decision-makers and the public to improve ecosystem management at different scales and thereby contribute to human well-being. The assessment focuses on the interactions of driving forces of ecosystem change, their impact on ecosystem services (the benefits people obtain form ecosystems) and how these changes have and will affect humans.

Part of the MA assessment process is a global scenarios exercise to describe plausible changes in ecosystem services and their consequences for human well-being at a global scale. The MA also supports a number of sub-global assessment exercises. Some of these local, regional or national exercises are also building scenarios. In the following section, four different MA-related scenario exercises are described to illustrate how the scenario development process can be used to integrate different ‘ways of knowing’.

Integrating the qualitative and the quantitative – the MA global scenarios

Often in conventional western science, scientific information is presented qualitatively or quantitatively, but not both. Qualitative and quantitative research can be difficult to integrate because the paradigms behind them are so different (Streubert and Carpenter 1995). For example, qualitative research is often done to develop theory, while quantitative research is primarily designed to test existing theory. The quantitative paradigm generally assumes one reality, and the goal of the research is to understand that reality as precisely and accurately as possible. As discussed earlier, the goal is precise but generalizable results. On the other hand, qualitative research often assumes multiple realities, and the goal is to interpret, share, and describe those realities. The goal is to provide a context for understanding the system, and not necessarily to provide generalizable results. Because of this, it is often difficult to integrate quantitative and qualitative results into a single, more comprehensive understanding of a system.

The MA is developing a set of four global scenarios about the future of ecosystem services and human well-being. Each of the four MA scenarios describes how social-ecological systems might develop between 2000 and 2050. The scenarios are developed by a working group of about 50 experts from around the world and from many different academic disciplines, including ecologists, economists, sociologists, and a team of global modelers.

The MA Global Scenarios will contain qualitative and quantitative information and are an example of how both types of knowledge can be integrated into a single set of scenarios. To achieve this integration a ‘storyline-and-simulation’ approach was used (Alcamo 2001). In the method, the entire group works together to develop a set of qualitative narratives, or ‘storylines’. These storylines are then translated into model variables, which are used to quantify the results of the stories using a number of different models. Harmonizing the storylines and the models is an iterative process in which both the storylines and the models are compared with each other for consistency.

In the case of the MA, the four storylines were developed by the working group based on the results of interviews with decision-makers around the world about their hopes and fears for the future. The storylines describe different pathways into the future, including the key events and driving forces behind each pathway. The driving forces are variables such as population growth, economic development, and landuse change. Each storyline is then translated into a set of variables that serve as inputs to global models. The outputs of these models are ecosystem services such as crop production, fish harvest or water quality. Each model is run separately for each storyline with different values for input variables based on the assumptions made in that storyline. The results of the model runs are then compared with the narratives to ground-truth the assumptions made in each scenario, check the storylines for internal consistency, and to add quantitative information in form of graphs and figures. The result will be narratives which contain a number of quantitative variables that are consistent with available modeling exercises together with various qualitative variables that can not be modeled.

The MA global scenarios are an example of how one can harmonize qualitative storylines and quantitative model results to strengthen the story told by each. It is also an example of how difficult it is to do this. In our efforts to quantify the storylines, they had to be simplified in a way that was not always comfortable to those most familiar with the storylines. This difficulty was overcome through conversation about what features of the storylines could be simplified and which could not. It was also overcome by allowing the storylines to be told both as narrative and in numbers.

Talking across the disciplines – the CARSEA scenarios

The Caribbean Sea Ecosystem Assessment (CARSEA) is one of the MA sub-global assessments. The CARSEA group has developed four scenarios which describe plausible developments in the Caribbean region and their outcomes for ecosystem services and human well-being over a 50 year time horizon. The scenarios for example portrayed different ways of managing ecosystem in the region for tourism. In addition one scenario describes a rather bleak view of the proposed free trade agreement with the US. The scenarios were developed qualitatively by a group of scientists and experts from the Caribbean region, and do not include a quantitative modeling exercise. These scenarios are an example of how the scenario development process can help to bridge the different scientific knowledge systems and languages used by each scientific discipline: the CARSEA scenario exercise involved marine biologists, ecologists, social scientists, economists, and many other experts from other disciplines, working together.

In two workshops, the key driving forces and critical uncertainties that would determine the future of the region were discussed. Each discipline brought their specific expertise to the table in suggesting driving forces and uncertainties. Although it was sometimes difficult, broad discussion helped to form a common language between all participants. Difficulties also arose when the main uncertainties for the region and the trade-offs for ecosystem services as the result of various plausible trajectories were discussed. These difficulties came as much from differing views among participants from the same discipline as from differences among the disciplines and had to do with attaching varying levels of importance to particular uncertainties. Some economists for example thought that the proposed free-trade agreement of the region with the US will be one of the most important determinants for the future of the region, while some natural scientists stressed the negative impacts of certain new diseases in marine species and of sea level rise on the tourism industry. Prioritizing uncertainties helped to select the set of scenario storylines to be developed. The next step was the actual development of the storylines, which was undertaken in small, multi-disciplinary teams of 2 to 3 people. These teams did their best to incorporate viewpoints from all the disciplines involved. Each storyline was then presented and critiqued by the whole group. The discussion was a consistency check for the proposed storylines in which each discipline could question the assumptions made by other group members. Input from across disciplines enriched the scenarios by adding additional detail to the storylines.

Bringing a multi-disciplinary team of experts together to talk about the future of the Caribbean helped to thoroughly discuss the challenges the region is facing, seen from different view points. Each discipline could enrich the discussion and with this the storylines by providing their expertise on the one side and questioning some of the propositions of other disciplines on the other side. In this way the storylines did not just gain in details but also their plausibility constantly checked and improved. The scenarios methodology provided a platform to develop a common language between the disciplines, though this was not an easy process. In addition, the stepwise process of talking through main driving forces and key uncertainties allowed to develop a consistent set of scenarios that are able to address the most important decisions that need to be taken in the future and their consequences.

Combing scientific and local knowledge – The Northern Wisconsin scenarios

In Northern Wisconsin, a workshop was held in September 2002 to develop scenarios for the near future of the Northern Highland Lake District (NHLD, 2002-2027). 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 outside the region. Viewpoints of those at the workshop included those from federal and state resource management agencies, lake associations, out-of-state owners of lakeshore property, realtors, and Native Americans. In addition, academic experts were present from around the world, bringing expertise in fields such as ecology, human demography, economics, and mathematical models of social-ecological systems.

These scenarios were developed following a similar methodology to the CARSEA scenarios. Broad discussions of all participants were followed by small groups developing the actual storylines. Again, numerical models were not used to develop the storylines. In this case, the local participants included a very wide range of different hopes for the future of the region. In many other scenario-development exercises, such as those developed for the Caribbean Sea, the participants generally agree on what would be a 'good' outcome for the future of the social-ecological system in question. In the case of the NHLD scenarios, no such agreement existed.

Because of this, we developed the scenarios such that several of the scenarios fully played out different stakeholder group's hopes for the future of the NHLD. Because some hoped that the area would become a thriving commercial center, we told one scenario of rapid development. Since others hoped that the NHLD would remain sparsely populated, we told one scenario in which development did not happen. Following the consequences of each of these stories helped everyone – both those that preferred that particular outcome and those that did not – understand the benefits and drawbacks of that scenario.

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 some scenarios, this was easily accomplished. Local interest determined the basic thrust of the storyline, and scientific information provided the details, particularly details about the outcomes for provision of ecosystem services. However, where the scientific information diverged from what stakeholders thought would happen, it was more difficult. In these cases, long discussions about stakeholders' and scientists' beliefs about the system were required to come to an agreement about how the story would play out.

The integrated results were more believable than stories with no scientific information. It was also easier to convince non-participants of the validity of the scenarios. 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.

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 also have the scenarios address the issues that people are really interested in. The difficulties we faced occurred when people's understanding of the system is different 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 can be worked out through discussion.

Integrating TEK and western science – Scenarios for Bajo Chirripó, Cost Rica

The Bajo Chirripó assessment is another of the MA sub-global assessments. The assessment is undertaken by a group of Cabécar indigenous people together with a Costa Rican non-governmental organization (NGO) that works on indigenous people's issues in the Bajo Chirripó region of Costa Rica. Part of the assessment is a scenarios exercise in which community members developed two scenarios together with NGO members and a few scientists, portraying plausible changes in the area and their communities over a three to five year horizon. The purpose of the exercise was to discuss possible options for community members to cope with and react to ongoing developments in the area, which threaten the communities' territory and culture.

As in the CARSEA scenario development process, the discussion on key driving forces that are changing the communities, these drivers' roots in the present, and their implications for the future allowed the participants to bring their different knowledge and experiences to the table. After identifying the most important sources of uncertainty for the future of the Cabécar territory and their culture, narrowing the focus of the stories to a rather desirable and a rather negative future forced participants to systematically think through the interactions between forces outside the territory and the ones controllable from inside the territory. This identification process was not easy though and participants often had differing view points on the importance drivers and how they interact with each other. Also finding a similar definition of driving forces required some initial discussions.

Similar to the other exercises, the main storylines were developed through discussions in break out groups and in plenary. Here the knowledge of scientists and NGO members on broader developments in Costa Rica and the world helped to select the ones really relevant for the Cabécar region. The expertise of the Cabécar participants allowed to determine the important drivers that can be controlled by community members and to elicit plausible reactions to the external ones. In addition, the knowledge of the Cabécar of the ecosystems in their territory and their functioning helped to portray likely consequences of different decisions taken today for ecosystem services in the future. The scientific tradition of trying to describe a relatively balanced picture of positive and negative outcomes allowed participants to think through both positive and negative sides of a scenario.

The Bajo Chirripó scenarios are an example of how the scenario development process can bring indigenous people together with others (including scientists) from outside the indigenous community to discuss their perceptions of future developments in a constructive manner. The process allowed to combine two very different kinds of knowledge and develop consistent pictures of the future. The discussion also helped to clarify which processes from outside the indigenous territory can be controlled inside the territory and which not. In addition, possible reactions to internal and external drivers could be discussed. Integrating differing views on drivers and possible response to them enlarged the perspectives and knowledge of both participants groups.

Conclusions

Scenarios help us question how our knowledge influences our vision of the future. Developing scenarios with stakeholders who have different knowledge bases can lead to a broad understanding of how our epistemologies influence our understanding of the world and the future. By understanding how the way that we know influences our vision, we make progress toward integrate epistemologies into a single, consistent set of stories. Because scenarios are so useful for integrating many ways of knowing, their development is also useful for engaging local stakeholders and addressing their concerns in a larger context.

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