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3 **Integrating epistemologies through scenarios**
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14 **Abstract**
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16 There are many ways of knowing or gathering knowledge about social-ecological systems, including
17 both traditional and scientific techniques. Even within these broad categories of “traditional” and
18 “scientific”, there are diverse epistemologies. Many have argued that the guiding of social-ecological
19 systems can be improved by the integrated use of these bodies of knowledge. However, integrating
20 epistemologies can be extremely difficult. Integration is hampered by differing methodologies,
21 vocabularies, ways of assigning merit, and even worldviews. Indeed, we currently lack a conceptual
22 framework for cross-epistemological integration.
23

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

1 that allow for full integration of the knowledge gained through different techniques. In this paper,
2 we consider not only various disciplines within the academy of conventional western science, but
3 also incorporation of traditional knowledge and wisdom gained outside the academy. There are
4 often critical disconnects in language, approach, bounding of the problem, and even paradigm
5 among different epistemologies that make communication across the divide extremely difficult.
6 Here, we present scenario development as a method for making better decisions about social-
7 ecological systems and for building an understanding of these systems that is open to including the
8 knowledge from many different ways of knowing.

9 10 **Different ‘ways of knowing’**

11
12 There are many ways of knowing or gathering knowledge about social-ecological systems, including
13 both traditional and scientific techniques. Even within these broad categories of “traditional” and
14 “scientific”, there are diverse epistemologies. For example, information can be collected and stored
15 qualitatively or quantitatively. Within conventional science, there are also differences among
16 academic disciplines, which can view the world through different paradigms. Each way of knowing
17 has strengths and weaknesses that are particular to its paradigm.

18
19 One of the benefits of the academic style of science is that it allows for rigorous testing of highly
20 specific questions. However, conventional scientific approaches to resource management do not
21 always work (Ludwig et al. 1993, Gunderson et al. 1995). In fact, successful management through
22 western scientific techniques may result in reduced system resilience (Berkes and Folke 1998).
23 Holling (1986) suggests that successes in western-style management in may lead to attempts to keep
24 an ecosystem at “a certain stage of dynamic change, making it more fragile and inviting
25 unpredictable feedbacks from the environment”.

26
27 Within the academic setting, research can be done qualitatively or quantitatively. Quantitative
28 research involves numerical results, mathematical models, and experimentation. It produces
29 quantifiable, reliable data that are usually generalizable. However, this approach can take human
30 behavior out of the context of a real world setting and often ignores the effects of variables that
31 have not been included in the model. Qualitative research generally involves surveys and interviews
32 and observations. The advantage of qualitative methods is that they generate rich, detailed data that

1 leave the participants' perspectives intact and provide a context. A disadvantage is that data
2 collection and analysis may be labor intensive and time-consuming and may not be generalizable to a
3 larger population.

4
5 Another way of knowing that has been the subject of study recently is traditional ecological
6 knowledge, or TEK. TEK is "a cumulative body of knowledge and beliefs, evolving through
7 adaptive processes and handed down through generations by cultural transmission, about the
8 relationship of living beings with one another and the environment" (Berkes 1999; Olsson and Folke
9 2001). It includes natural history, knowledge about local wildlife, and cultural norms for
10 management (Becker and Ghimire 2003). TEK is developed through accumulation of experiences
11 and informal experiments. In general, it is transferred orally and thus, has not often been
12 documented. Recently, western scientists have recognized TEK as a potential source of information
13 and knowledge that could improve management of social-ecological systems (Berkes, Colding, and
14 Folke 2003). An oft-noticed benefit of TEK is that it is often based on very long-term informal
15 study of ecological systems and thus can have a much longer time series of information to work with
16 than most academic studies. It may also have more context than conventionally-collected
17 quantitative information. However, it is important to remember that TEK is necessarily more
18 environmentally-conscious than western management techniques and can even be ecologically
19 maladaptive (Gadgil and Berkes 1991). A potential weakness of TEK is that, because it is often not
20 written down, it can be more easily misinterpreted.

21
22 Each of these ways of knowing basically amounts to a paradigm through which members
23 understand the world (Mingers 2001). The knowledge is gathered and stored based on a particular
24 collection of assumptions, theories, and methods for understanding the world. These assumptions
25 can often remain hidden or unspoken.

26

27 **Integrating epistemologies**

28

29 *The case for integrating epistemologies*

30 While these ways of knowing about social-ecological systems are useful individually, guiding social-
31 ecological systems can be improved by integrated use of these bodies knowledge. Using multiple
32 techniques for gathering information for resource management and decision-making about the

1 environment, “expands the sources of information for ecosystem management” (Olsson and Folke
2 2001).

3
4 Conventional science has recently turned its attention to working across disciplinary boundaries to
5 solve tough environmental problems (Kinzig 2001, more refs). It has also begun to look at ways of
6 knowing that come from outside the academy to add some important vision to resource
7 management. For example, Becker and Ghimire (2003) suggest that indigenous communities
8 regularly address one of the key challenges in resource management – meeting the needs of
9 individuals while at the same time sustaining public goods for the community. They suggest that the
10 benefits of utilizing this synergy between traditional knowledge and a knowledge gap in western
11 knowledge can result in better ecosystem management.

12
13 Integrating these different types of information is likely to be essential to solving today’s critically
14 interlinked environmental problems. Ludwig (2001) suggests that there are some ecosystem
15 management problems that are so complex that they are exceedingly difficult to manage using
16 today’s management techniques. These “wicked problems” have no definitive formulation, no
17 stopping rule, and no test for a solution. In fact, they are unlikely to ever be fully resolved. In
18 addressing these types of “unsolvable” problems, we must acknowledge that deciding on a course of
19 action will involve issues of values, power, equity, risk, and justice, in addition to many types of
20 information. It is in addressing these issues that having many different viewpoints will be critical to
21 developing a broadly-acceptable, flexible solution.

22
23 *The difficulties of integrating epistemologies*

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

29
30 Western scientific traditions have generally dealt with the mind-boggling complexity of systems by
31 reducing the complexities to a manageable number of elements interactions. Doing so necessarily
32 means setting system boundaries so that the variables considered to be important are inside and the

1 unimportant ones are outside. Different disciplines may choose different variables to be inside or
2 outside the system. These different ways to bound the problem, combined with different
3 terminology, and even different paradigms can make it extremely difficult for scientists in different
4 disciplines to communicate with one another, even when they are working on the same problem.
5 Different time horizons of research, organizational structures, and institutional traditions such as the
6 means of giving credit for research all complicate interdisciplinary collaboration. TEK faces further
7 difficulties because it may not be written at all and the practitioners of TEK often do not interact
8 with those gathering conventional scientific information about ecosystem management.

9
10 People who share a given epistemology often share a language or set of terminologies or jargon,
11 which may not be easy to understand by others from outside that way of knowing. This gap among
12 disciplines in the conventional scientific academy is well-recognized. It is even wider between
13 scientists and non-scientists. It may be complicated by different cultures, languages, or worldviews
14 and may be yet wider between those who use traditional knowledge and those who use more
15 conventional ways of knowing.

16

17 **Integrating epistemologies through scenario development**

18

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

27

28 *What are scenarios?*

29 The Millennium Ecosystem Assessment (MA) describes scenarios as “plausible alternative futures,
30 each an example of what might happen under particular assumptions” (MA 2002). This definition
31 highlights the MA’s belief in using scenarios to challenging one’s beliefs about the future. They are,

1 simply, stories about the future, told in a set, which are used by making comparisons across the set.
2 Scenarios can be told in the language of both words and numbers (Raskin et al, In review).

3
4 Scenarios are not predictions, forecasts nor projections (though projections and forecasts might be
5 used in the scenarios development process). In contrast to predictions, forecasts, and projections,
6 scenarios do not necessarily assume that the world will remain within today's boundary conditions in
7 the future. They are, in fact, often based on the assumption that the boundary conditions will
8 change, and each scenario in a set follows the path of a different set of boundary conditions. They
9 allow the scenario builders to explicitly think about which boundary conditions might change and
10 how that will impact the future success of decisions made now. One of the most useful ways to
11 imagine different boundary conditions is to gather the perspective of people who come from very
12 different backgrounds. Scenarios are also useful for thinking about dynamic processes and causal
13 chains that affect the future (Rotmans et al. 2000). In this way, the process of developing them
14 challenges our beliefs and assumptions about how social-ecological systems work.

15
16 Scenarios can serve many different purposes. They can be used to explore the level of knowledge
17 about a system by exploring the interactions and linkages between key variables as the scenario plays
18 out. They can also be used as a part of a decision-making or planning process. They can highlight
19 upcoming choices to be made and potential outcomes of those choices (Rotmans et al. 2000). They
20 can lead to challenging assumptions on the functioning of certain processes (Davis 2002) and
21 illustrate different views on their outcomes held by participants of the scenario building exercise.
22 As "a tool for ordering one's perceptions about alternative future environments in which one's
23 decision might be played out" (Schwartz 1996), they are also useful for decision-making.
24 Management options can be tested by exploring how well a given policy works across multiple
25 scenarios.

26
27 Scenarios can consist of qualitative information, quantitative information, or both. Qualitative
28 scenarios, which use a narrative text to convey the main scenario messages, can be very helpful when
29 presenting information to a non-scientific audience. Quantitative scenarios usually employ modeling
30 tools to incorporate quantified information to calculate future developments (Alcamo 2001).

31 Qualitative and quantitative scenarios development techniques are often combined to produce a set
32 of comprehensive narratives backed-up by a quantitative modeling exercise. The qualitative part of

1 the storylines, whose development precedes the modeling, is used to stimulate creative, out-of-the-
2 box-thinking about a wide range of plausible futures. The quantification of driving forces provides a
3 consistency check of the narratives and can show upcoming trends and dynamics not anticipated
4 before.

5
6 *Using scenarios as a method to integrate epistemologies*

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

15
16 To build plausible, realistic pictures of the future, we need to think about the large number of
17 factors that will influence the unfolding of the future. Because we must think about so many
18 different factors, it is imperative to involve multiple disciplines and many perspectives in the process
19 of scenario development. Building scenarios with stakeholders who have different knowledge bases
20 brings together many different assumptions about how the world works. The process of building
21 scenarios explicitly requires creation of a set of stories with the broadest realistic set of futures
22 possible. For this reason, it will necessarily include discussions of different assumptions about how
23 the world works and may also include discussion of our assumptions can shape decision-making
24 preferences. This discussion will help begin to bridge the gap between different knowledge systems
25 by forcing scenario developers to talk about their assumptions, including the basis of those
26 assumptions and how they impact our beliefs about the future. Scenario development enables
27 participants first to unearth their own assumptions about the future and how human decisions, will
28 change its course.

29
30 Because scenarios are a set of stories, each of which begins with an assumption about how the
31 system works that will impact the way the future unfolds, they are almost made for integrating
32 different ways of knowing and thinking about the future. Additionally, because they can be told in

1 qualitative narrative or in quantitative fashion, there is room for expressing the same thing many
2 different ways. By talking systematically through important uncertainties and ‘stories’ about how
3 they might play out, each participant can add their perspective and their piece of knowledge to the
4 scenarios process.

5
6 The scenarios development process allows bridging the gap between different types of knowledge at
7 various points. These include the discussion of main uncertainties about the future of the
8 investigated system, the discussion of the main driving forces of change, the qualitative storyline
9 development and the analysis of scenario implications for different stakeholder groups or the
10 investigated system. In each of these discussions different viewpoints can be voiced and different
11 pieces of knowledge presented. These ‘parts of the puzzle’ then allow portraying different plausible
12 future worlds whose descriptions become even richer the more diverse the backgrounds of the
13 scenario builders. After the scenarios are developed, it is the comparison of stories that helps to
14 highlight how our assumptions affect our beliefs. This leads to greater insight about how the ‘way
15 we know’ influences our vision and offers deeper insight into the importance of epistemologies.
16 The process of scenario development can also identify what makes integration so difficult for future
17 study and attention. Here, we present several examples of integration – across qualitative and
18 quantitative storytelling, across disciplines, across TEK and western science, and among
19 stakeholders and academic scientists – and explore what we learned from integrating. For each
20 example, we introduce the example, explain how the scenarios were developed, discuss the
21 difficulties with integration, and conclude with a brief description of what we learned from the
22 process. We submit this information as a first step towards using scenarios for integrated study of
23 the future of social-ecological systems.

24

25 **Examples from the Millennium Ecosystem Assessment**

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

1
2 Part of the MA assessment process is a global scenarios exercise to describe plausible changes in
3 ecosystem services and their consequences for human well-being at a global scale. The MA also
4 supports a number of sub-global assessment exercises. Some of these local, regional or national
5 exercises are also building scenarios. In the following section, four different MA-related scenario
6 exercises are described to illustrate how the scenario development process can be used to integrate
7 different 'ways of knowing'.

8

9 *Integrating the qualitative and the quantitative – the MA global scenarios*

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

21

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

27

28 The MA Global Scenarios will contain qualitative and quantitative information and are an example
29 of how both types of knowledge can be integrated into a single set of scenarios. To achieve this
30 integration a 'storyline-and-simulation' approach was used (Alcamo 2001). In the method, the entire
31 group works together to develop a set of qualitative narratives, or 'storylines'. These storylines are
32 then translated into model variables, which are used to quantify the results of the stories using a

1 number of different models. Harmonizing the storylines and the models is an iterative process in
2 which both the storylines and the models are compared with each other for consistency.

3

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

17

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

24

25 *Talking across the disciplines – the CARSEA scenarios*

26 The Caribbean Sea Ecosystem Assessment (CARSEA) is one of the MA sub-global assessments.
27 The CARSEA group has developed four scenarios which describe plausible developments in the
28 Caribbean region and their outcomes for ecosystem services and human well-being over a 50 year
29 time horizon. The scenarios for example portrayed different ways of managing ecosystem in the
30 region for tourism. In addition one scenario describes a rather bleak view of the proposed free trade
31 agreement with the US. The scenarios were developed qualitatively by a group of scientists and
32 experts from the Caribbean region, and do not include a quantitative modeling exercise. These

1 scenarios are an example of how the scenario development process can help to bridge the different
2 scientific knowledge systems and languages used by each scientific discipline: the CARSEA scenario
3 exercise involved marine biologists, ecologists, social scientists, economists, and many other experts
4 from other disciplines, working together.

5
6 In two workshops, the key driving forces and critical uncertainties that would determine the future
7 of the region were discussed. Each discipline brought their specific expertise to the table in
8 suggesting driving forces and uncertainties. Although it was sometimes difficult, broad discussion
9 helped to form a common language between all participants. Difficulties also arose when the main
10 uncertainties for the region and the trade-offs for ecosystem services as the result of various
11 plausible trajectories were discussed. These difficulties came as much from differing views among
12 participants from the same discipline as from differences among the disciplines and had to do with
13 attaching varying levels of importance to particular uncertainties. Some economists for example
14 thought that the proposed free-trade agreement of the region with the US will be one of the most
15 important determinants for the future of the region, while some natural scientists stressed the
16 negative impacts of certain new diseases in marine species and of sea level rise on the tourism
17 industry. Prioritizing uncertainties helped to select the set of scenario storylines to be developed.
18 The next step was the actual development of the storylines, which was undertaken in small, multi-
19 disciplinary teams of 2 to 3 people. These teams did their best to incorporate viewpoints from all the
20 disciplines involved. Each storyline was then presented and critiqued by the whole group. The
21 discussion was a consistency check for the proposed storylines in which each discipline could
22 question the assumptions made by other group members. Input from across disciplines enriched the
23 scenarios by adding additional detail to the storylines.

24
25 Bringing a multi-disciplinary team of experts together to talk about the future of the Caribbean
26 helped to thoroughly discuss the challenges the region is facing, seen from different view points.
27 Each discipline could enrich the discussion and with this the storylines by providing their expertise
28 on the one side and questioning some of the propositions of other disciplines on the other side. In
29 this way the storylines did not just gain in details but also their plausibility constantly checked and
30 improved. The scenarios methodology provided a platform to develop a common language between
31 the disciplines, though this was not an easy process. In addition, the stepwise process of talking
32 through main driving forces and key uncertainties allowed to develop a consistent set of scenarios

1 that are able to address the most important decisions that need to be taken in the future and their
2 consequences.

3

4 *Combining scientific and local knowledge – The Northern Wisconsin scenarios*

5

6 In Northern Wisconsin, a workshop was held in September 2002 to develop scenarios for the near
7 future of the Northern Highland Lake District (NHLD, 2002-2027). The goal of the scenarios was
8 to explore the ability of the NHLD to maintain its present desirable social and ecological features
9 despite changes driven from outside the region. Viewpoints of those at the workshop included those
10 from federal and state resource management agencies, lake associations, out-of-state owners of
11 lakeshore property, realtors, and Native Americans. In addition, academic experts were present from
12 around the world, bringing expertise in fields such as ecology, human demography, economics, and
13 mathematical models of social-ecological systems.

14

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

22

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

30

31 In addition to stakeholders’ preferences, we also used the best scientific information about the
32 current state of the social-ecological system and recent trends. For some scenarios, this was easily

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

6

7 The integrated results were more believable than stories with no scientific information. It was also
8 easier to convince non-participants of the validity of the scenarios. Yet, because the scenarios were
9 still based in the interests and concerns of local stakeholders, they were more interesting to other
10 local residents than purely scientifically-determined futures would be.

11

12 We learned that it is possible, and even relatively easy, to make stories that are based on scientific
13 information about the social-ecological system and also have the scenarios address the issues that
14 people are really interested in. The difficulties we faced occurred when people's understanding of the
15 system is different from the scientific understanding. For example, it can be difficult to tell a story
16 about the ecological quality of a system if people believe water quality is getting worse, but the
17 scientifically-collected data indicate that it is not. Usually, these misunderstandings can be worked
18 out through discussion.

19

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

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

29

30 As in the CARSEA scenario development process, the discussion on key driving forces that are
31 changing the communities, these drivers' roots in the present, and their implications for the future
32 allowed the participants to bring their different knowledge and experiences to the table. After

1 identifying the most important sources of uncertainty for the future of the Cabécar territory and
2 their culture, narrowing the focus of the stories to a rather desirable and a rather negative future
3 forced participants to systematically think through the interactions between forces outside the
4 territory and the ones controllable from inside the territory. This identification process was not easy
5 though and participants often had differing view points on the importance drivers and how they
6 interact with each other. Also finding a similar definition of driving forces required some initial
7 discussions.

8

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

19

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

28

29

30 **Conclusions**

31

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

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