CHAPTER 9

Mobilizing Knowledge for Integrated Ecosystem Assessments

Christo Fabricius, Robert Scholes, and Georgina Cundill

The "truth" is elusive when dealing with complex, dynamic systems (Kay et al. 1999). Researchers, natural resource managers, and environmental practitioners face a number of challenges, including how to deal with information "fuzziness," how to reconcile seemingly contradictory data, how to smooth over geographic and spatial variability or "lumpiness," and how to consolidate information gathered at different spatial scales. One proposed solution has been to amalgamate different types of knowledge, such as by working across disciplines, combining qualitative and quantitative information, and linking formal and local knowledge in a complementary manner. But this approach is no panacea for ecosystem assessments involving complex systems, and new challenges arise when attempts are made to combine knowledge in this way. The techniques to combine different forms of knowledge and data from disparate sources, different spatial scales, and indeed different worldviews are neither well developed nor validated.

The Southern African Millennium Ecosystem Assessment (SAfMA, http://www.maweb.org) was undertaken at a variety of spatial scales, from the regional (with sub-Saharan Africa as the assessment area) to the local (at the scale of a village, single protected area, or microwatershed). Each of these scales had its own stakeholders and thus its own key topics of concern. These in turn defined the information needs for the assessment at that scale. We found that as the scale of assessment moved from regional to local, so the balance of information availability shifted from formal, documented data, typically

Table 9.1

Characteristics of knowledge along a formal–informal and a tacit–explicit gradient

	Formal	Informal
Explicit	Most but not all "scientific" knowledge is in this quadrant. The typical outputs of a conventional assessment are also here.	This knowledge is codified but neither collected nor tested in accordance with conventional scientific rules.
Tacit	Scientifically trained people have formal knowledge that is uncodified.	This knowledge is embedded in local customs, traditions, and memory and is transferred through oral history.

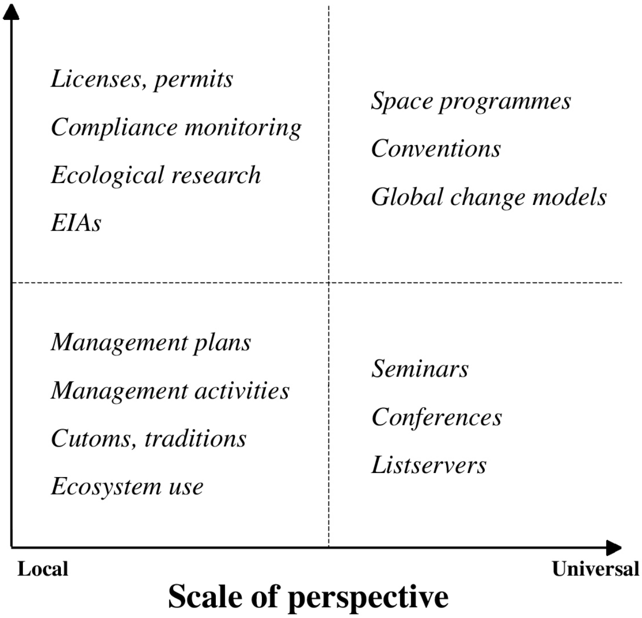
regarded as being in the "scientific domain," toward informal, tacit information contained in the life experience of local residents and in folklore transmitted by oral tradition, or perhaps documented but not in accordance with conventional scientific standards. We contend that the distinction between "formal" and "informal" knowledge is not as absolute as is often thought and that, at the level of broad principles, similar rules of use and validation apply, although the procedures may differ. Elements of both sorts of knowledge exist at all scales, although informal knowledge is generally more site specific and restricted by design and circumstances than scientific knowledge is.

Knowledge can be classified and defined in a variety of ways. Here we use "explicit" to mean knowledge that exists in a written (i.e., codified, including numeric or graphical) and categorical form. "Tacit" knowledge, on the other hand, is held in people's memories and is not documented. "Formal" knowledge has passed through a strict and universally accepted set of rules qualifying it for a particular use, whereas "informal" knowledge has been subject to local rules of validity (table 9.1). "Local" knowledge has a fine-grained perspective and is highly context specific as opposed to "universal" knowledge, which is more coarse grained and incorporates a variety of contexts.

The application of different types of knowledge can be depicted in two dimensions, with the "informal–formal" and "local–universal" gradients on the respective axes (figure 9.1). Local, informal knowledge is mostly reserved for customs, traditions, and local systems of resource utilization, whereas universal, formal knowledge often characterizes large-scale initiatives, such as international conventions, global change models, and space aviation programs. A particular set of rules pertains to the scientific method, and knowledge that satisfies these rules is "scientific" and usually also explicit.

Figure 9.1

The most common uses of different types of knowledge (local to universal), depending on perspective and formality.



The SAfMA team faced a number of challenges when attempting to amalgamate these different types of knowledge across spatial scales. We confronted these potential challenges from the outset by proactively and, sometimes, reactively devising strategies for dealing with them. In the process we learned several lessons about knowledge amalgamation and sense making in complex assessments. This chapter shares the experience in SAfMA of soliciting (making explicit) and assessing (formalizing) traditional knowledge at the local scale and of making explicit the tacit knowledge from "scientific expert" sources at the regional scale. It then discusses the processes by which the assessment adds value to this input data, from whatever source it is derived.

Incorporating Informal, Local Knowledge Systems

Local ecological knowledge, also sometimes called "local knowledge," "informal knowledge," or "traditional ecological knowledge," is embedded in local customs, belief systems, and learning. Local knowledge is particularly relevant in ecosystem management, and its integrity is acknowledged in the Convention on Biological Diversity (Article 8j). The characteristics of local knowledge include the following:

- As with all types of knowledge, it constantly evolves through generations of hands-on experimentation and is carried over from one generation to the next in folklore, societal norms, management systems, and social memory (Berkes and Folke 1998). This adaptive process more often than not acts as a filter on the quality and validity of knowledge that is transferred.
- Local knowledge is very seldom documented (except through intermediaries, such as researchers, writers, and journalists) and is mostly tacit.
- Local knowledge is used in everyday situations. Its main value lies in helping local people cope with day-to day-challenges, detecting early warning signals of change, and knowing how to respond to challenges. It is extensively used by local practitioners to develop natural resource management strategies, to set rules that govern the use of ecosystem services, and to make day-to-day decisions, such as knowing which medicines to use, where to find food and water in times of crisis, and which plants and animals are best avoided or best to use.
- Knowledge is the backbone of local social institutions, which act as knowledge banks and mechanisms for knowledge transfer between individuals and over time. Social institutions convert knowledge into sets of rules, norms, and social behaviors, which then become local management systems (Folke, Berkes, and Colding 1998). Institutions are therefore the conduit that converts knowledge into management systems, strategies, and policies.

Local knowledge, and especially traditional knowledge, is seldom documented or "refereed." Traditional knowledge is often jealously guarded. Many scientists are skeptical of the validity of informal knowledge because of the lack of rigor, while traditional people may be skeptical about science, either because they do not understand it or because science has on some occasions been used to mask realities or manipulate the truth. Concerns about data integrity can mar the confidence in results based on knowledge amalgamation.

Drawbacks of Purely Formal, Scientific Knowledge

The principles and processes of scientific assessments are rooted in the "formal, explicit" quadrant of our knowledge classification. It helps to recognize the shortcomings of science as a knowledge system in order to work around them. Three are particularly salient here.

1. The scientific method tends to be highly compartmentalized and reductionist. It is evolving methods, such as systems modeling, to balance this tendency, but it remains generally discrete rather than integrated.
2. Scientific knowledge remains the domain of a small elite, even in developed countries. It is often either inaccessible or incomprehensible to the general public and even to highly educated policy makers. A consequence is that scientific knowledge is often patchy, with large spatial or subject gaps.
3. It struggles to engage usefully in problems that do not lend themselves to quantification and mathematical representation.

Why Include Local Knowledge in an Ecosystem Assessment?

Local and tacit knowledge can help address some of the shortcomings in formal, explicit knowledge in ecosystem assessments—if the knowledge can be moved into the explicit domain where such assessments reside. There is, however, a fear, especially among indigenous groups, that this could lead to the manipulation and co-option of local and traditional knowledge. Scientists must be perceptive to such sensitivities. Calls have intensified from various disciplines and institutions for broader approaches and solutions to environmental and societal problems as a whole (Berkes, Colding, and Folke 2003), emphasizing, among other things, decentralization and integrated conservation and planning that is sensitive to local cultural values and institutions (Mauro and Hardison 2000). In southern Africa, this has lead to policies that emphasize community participation and cross-sectoral integration—for example, the South African National Water Act (1998), which requires the devolution of authority to local catchment management forums; the community-based natural resource management program in Botswana (Madzwamuse and Fabricius 2004), which enables local communities to contribute to decisions about wildlife harvesting; and the National Forests Act (1998) in South Africa, which stipulates that local communities should participate in forest management.

Traditional knowledge, in particular, is increasingly being recognized as holding lessons for adaptive managers. Berkes, Colding, and Folke (2000), for example, suggest that traditional knowledge can be described as adaptive because it acknowledges that environmental conditions will always change, assumes in many instances that nature cannot be controlled, and assumes that yields cannot be predicted. Adaptive management is designed to improve on a trial-and-error basis, an attribute inherent in the social learning process, where learning occurs at the level of the group rather than that of the individual.

Local knowledge is an invaluable source of fine-grained, detailed information about local ecosystem services, especially (but not exclusively) in areas where little formal knowledge exists. At Mt. Coke in South Africa, local geographic knowledge was, for example, converted to formal maps with the aid of a geographic information system (GIS) (Bohensky et al. 2004). This provided new insights into such fine-grained information as the positive correlation between tree density and distance from the village, due to fuel wood depletion near villages. Knowledge about patterns of ecosystem change can be used to inductively develop and test models of ecosystem dynamics, as was done in the Gorongosa area in Mozambique (Lynam et al. 2004). Resource users possess detailed knowledge of fine-grained resource patches, such as fountains, sacred pools, caves, patches rich in soil nutrients, and fuel wood (Hendricks 2003; Fabricius and Cundill, forthcoming).

Local knowledge is often the only source of information about past patterns of ecosystem use, past land use, traditional customs, and the history of local politics, especially in communal areas where this information is mostly undocumented. In the Mt. Coke area, for example, local information about land boundaries and political events could be triangulated with historical records to produce a rich body of information about the drivers of the social-ecological system that would not otherwise have been available (Shackleton et al. 2003). Local people routinely adopt an integrated approach when assessing and managing ecosystems. Culture, natural resources, livelihoods, and management practices are viewed as part of the same system. Economic, political, and climatic drivers of change are assimilated in local knowledge systems, and the links between these causal factors are more obvious to local resource users than to scientific investigators. In the Macubeni catchment near Queenstown in South Africa, local groups were able to construct complex "problem trees" of the underlying causes of land degradation in a matter of hours. The causes included chronic poverty, past politics, national economic change, and human population density (Fabricius, Matsiliza, and Buckle 2003).

Local knowledge has, in many instances, coevolved with ecosystems. The feedbacks between ecosystem change and knowledge is evident in local customs, belief systems, and day-to-day adaptive management practices. In South Africa's Richtersveld National Park, for example, Nama pastoralists move their livestock in response to short-term and seasonal fluctuations in rangeland productivity and condition, and fuel wood collectors in the Great Fish River basin adapt their wood collection patterns in response to resource availability (Bohensky et al. 2004). Many of the flexible livelihood strategies observed in local societies are intended to reduce people's vulnerability to sudden change. The flexible social systems—such as the mobility, flexible leadership structures, and variable group sizes of the Basarwa people in the Okavango Delta—have evolved with highly dynamic ecosystems (Madzwamuse and Fabricius 2004).

Shortcomings of Local Knowledge

Local knowledge falls short where the rate of change in social-ecological systems is faster than the rate of knowledge evolution. Consistently high livestock densities in the Great Fish River basin, for example, are a recent phenomenon precipitated by elevated human population densities resulting from social engineering during a previous political dispensation (Ainslie 2002). This has resulted in an ecological "flip" due to the invasion of unpalatable shrubs (notably *Euryops* spp. and *Pteronia incana,* or blue bush), which outcompete other plants for moisture and thereby reduce forage production. The appropriate response is to rest invaded areas from grazing, thereby enabling more frequent fire regimes, and to reseed the area with shrubs and grass. But local people have never experienced these invasions until recently and have not evolved local knowledge to cope with them. The same applies to alien invaders, although in that case the coping strategy is to "switch" to invasive aliens as sources of fuel and building materials.

Local knowledge sometimes evolves inappropriately as a result of powerful external influences that override sensible local adaptations. In Richtersveld National Park, for example, Nama pastoralists believe that donkeys may not be harmed because of their biblical significance and that killing a feral donkey will lead to prolonged drought (Hendricks 2003). Local people have no use for feral donkeys, which compete with their goats and sheep as well as harm biodiversity and productivity, but the custom is religiously applied.

Local knowledge is often too fine grained and context specific to detect larger scale and slow change, and it does not respond to events and processes that do not have direct local repercussions. For example, local collectors of rare succulents in Lesotho and Richtersveld are unaware of the global conservation significance of the plants they illegally trade (H. Hendricks, personal communication).

Local knowledge also rarely responds to slow processes, such as gradual soil erosion, changes in the composition of palatable rangelands, siltation of water bodies, invasive plants, encroachments of mines on rangelands, and slow changes in groundwater quality due to salinization and cattle dips. Often local people's explanations for the causes of these slow changes are flawed, especially when they make spurious links between cause and effect. People at Machibi village in the Eastern Cape, for example, observed an increase in spider webs on unpalatable invasive shrubs. This was mainly because the webs, which were always there, became more visible in the structurally altered shrubland. People started believing that a linked drop in livestock fecundity was caused by spiders, rather than by the reduced productivity and palatability of the vegetation (C. Fabricius, personal observation).

Concerns and Challenges When Collecting Local Knowledge

Analysts have warned that local knowledge may not be relevant outside of the local context (du Toit, Walker, and Campbell 2004), and concern exists about the ability and impact of scaling local knowledge up to broader spatial scales (Lovell, Mandondo, and Moriarty 2002). Other analysts warn of a downplaying of environmental problems when local knowledge is overemphasized in line with "political correctness," and they are concerned about politicians using flawed local knowledge as a reason for ignoring environmental challenges (Burningham and Cooper 1999).

Some analysts also argue that integration with more dominant formal knowledge systems can marginalize local knowledge systems. By enabling the extension of the social and conceptual networks of scientific assessment (Latour 1987; Nadasdy 1999), integration can lead to the concentration of power in the hands of Western science, rather than the intended outcome of empowering local people. However, efforts to integrate or bridge different knowledge systems can help translate local knowledge into a form understandable and usable by scientists and formally trained resource managers (Nadasdy 1999).

Techniques Used to Collect and Integrate Local Knowledge

A wide range of participatory research techniques was used to collect and integrate local knowledge into the SAfMA process (Babbie et al. 2001). Among the techniques used to collect local knowledge were focus group workshops and interviews (Borrini-Feyerabend 1997), semistructured interviews with key informants (Pretty et al. 1995), a range of participatory rural appraisal (PRA) techniques (Chambers 1994; Borrini-Feyerabend 1997; Campbell 2002), participatory mapping (Alcorn 2000), and forum theatre. The range of PRA (also called participatory learning and action) techniques included matrixes, freehand and GIS mapping, pie charts, trend lines, timelines, ranking, Venn diagrams, problem trees, pyramids, role-playing, and seasonal calendars (Borrini-Feyerabend 1997; Jordan and Shrestha 1998; Jordan 1998; Department for International Development 1999; Motteux 2001).

Problem trees were particularly useful for identifying proximate and ultimate causes of ecosystem and social change. Mapping was an essential tool to define spatial change, while trend lines proved invaluable for recording local perceptions of change in key goods and services during predefined eras. Most valuably, these participatory techniques broke down barriers between scientists and villagers and enabled illiterate people to confidently participate in the process without being overwhelmed by grammatical and linguistic barriers.

However, these techniques proved useful only in collecting information. A larger challenge was posed by the need to integrate this information into the assessment findings. This integration was achieved in a number of ways. For example, data thus collected was converted into digitally enhanced charts, graphs, and reports by the specific researchers involved, thereby making tacit knowledge accessible to other scientists. However, to prevent an extractive process with a one-way transfer of knowledge (i.e., solely from local people to scientists), scientific knowledge was equally translated into a form that local participants could relate to. Story lines and drama, for example, were used to translate to local participants such complex issues as future scenarios developed at the national level. Reactions were then recorded and delivered to scientists working at coarser spatial scales. Forum theatre was particularly useful for converting complicated scientific scenarios of the future into dramatic presentations, to which local communities could relate (Burt and Copteros 2004).

Approaches to Validating Knowledge

Combining formal and local knowledge can produce a great deal of uncertainty. Thus it is essential to validate both formal and informal knowledge. Validation can be achieved through the cross-validation of both formal and informal knowledge. In other words, local experts validate scientific knowledge, and scientists validate informal knowledge. For example, to improve confidence in the data generated using the techniques outlined earlier, qualitative findings were validated through social and biophysical surveys, historical sources, and GIS and time-series mapping. Validation of scientists' interpretation of local knowledge took place through formal feedback meetings, where community members could challenge the validity of information. These feedback meetings were especially useful where local working group members, rather than scientists, provided the feedback. The most useful feedback meetings were those where scientists provided feedback by using modern technology—such as video, printed posters, and digital slideshows—followed by local people responding in their own language, using charts, hand-drawn maps, and verbal presentations.

Incorporating Formal but Tacit Knowledge

Formal knowledge can also be tacit, and formally trained scientists and managers have accumulated a large body of knowledge that is undocumented. "Expert opinion"–based processes are common enough in scientific assessments. For instance, uncertainty statements, a key feature of the Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report, are virtually impossible to derive given current information sources and technology by formal statistical procedures. Almost all the IPCC uncertainty ranges are based on expert opinions but are nevertheless extremely valuable. An attempt is made to calibrate them and make them internally consistent by defining a shared vocabulary (Moss and Schneider 2000). Some formal processes, such as the "Delphi Method," exist for formalizing and making explicit such tacit knowledge in a transparent way. These processes are not without critics, because they may give a veneer of quantification and precision to what remains a value-ridden process.

SAfMA, at the regional scale, faced a problem in synthesizing the vast amount of data relating to biodiversity. Biggs, Scholes, and Reyers (2004) defined a "biodiversity intactness index" as a synthesizing framework for the information and then conducted sixteen independent (three- to five-hour) interviews with technical experts to solicit the information. The process was greatly aided by first carefully defining the purpose, the metric, a reference point (large protected areas), and the nature of the land use activities. The broad taxa were further subdivided into functional groups (i.e., groups of organisms that respond in similar ways to particular land transformations, such as "seed-eating birds" or "large mammal herbivores") in collaboration with the experts, and the total study region was divided into ecosystem types. The expert opinions were tested against the small body of independently gathered field data that exists (Scholes and Biggs 2005). The mean and range of the expert estimates of the effect of different land use practices on biotic populations in each ecosystem type were then used in calculating an aggregate impact, which can be thought of as the abundance of wild populations relative to their abundance in an untransformed state. The convergence in estimates between experts was remarkable, allowing the uncertainty range on the aggregate index to be estimated as ±7 percent around a mean of 84 percent.

Adding Value through the Assessment Process

If assessments work on existing data, as they claim to do, where does the added value come from that could justify the expense of undertaking the assessment? Feedback from end users—that is, local communities and government decision makers—suggests that well-conducted assessments are valuable to existing and future resource managers. The source of this value is the assessment process itself. Assessment moves data up the value chain, to information, then to knowledge, and in some cases, perhaps even to wisdom. Assessment achieves this movement through six basic processes: collation, evaluation, summarization, synthesis, dialectic, and communication.

Collation

Collation consists of making relevant information easily available. It is the most basic function of an assessment. The information is typically obtained from diverse, and often hard-to-access, sources, such as unpublished reports or "gray literature." For many policy makers in Africa, even the technically "open" literature, such as international scientific journals and books, is either inaccessible or incomprehensible. Policy makers everywhere are typically overworked and overwhelmed by information, so collated, well-organized, source-attributed information on a particular topic that is available all in one place is a significant benefit.

SAfMA contains many examples of this kind of activity. For example, the Zambezi Basin study brought together rainfall, evapotranspiration, and river flow data for all the subcatchments by combining climate databases with model outputs and GIS analysis (Desanker and Kwesha 2004). Another example is the use of GIS to capture fine-scaled local interpretations of land use change and changes in forest quality in the SAfMA local studies. This local knowledge about spatial changes was captured and made available to the assessment team working at coarser spatial resolutions.

Evaluation

Evalutation involves comparing, checking, and applying informed judgment to information. In this respect, an assessment differs fundamentally from a review. Scientific reviewers are expected to be "neutral," simply presenting all the sources of information while hesitating to provide an opinion. Members of their target audience are assumed to be in a position to draw their own opinions. Assessments, on the other hand, *are* expected to express an opinion on the validity and meaning of data, especially if competing or conflicting data sources are involved. If they fail to do so, the decision makers who are the assessment audience are forced to reach their own conclusions but often are not equipped to do so. This does not, however, violate the assessment stricture "to be policy relevant, but not policy prescriptive," and it stops short of making a normative statement about what *should* happen as a result. It should also include a statement of uncertainty, which can be formal (e.g., "the protein supply is 45 ± 5 g/person/day") or informal ("it can be concluded with high certainty that . . . ").

Evaluation is central to assessments, since their purpose is to act as a translator between the domains of technical knowledge and decision making. It is also the area where most classically trained scientists feel least comfortable; they like to be near certain before venturing an opinion. An example of this kind of process in SAfMA is the comparison of four different forest cover products at the regional scale, leading to the opinion that there is 4.5 ± 0.5 million square kilometers of forest in southern Africa (Scholes and Biggs 2004). Another example, one involving local knowledge, was the comparison of locally developed land use change maps with historical aerial photographs of the areas in question. This process of evaluation enabled the assessment team to make informed recommendations regarding land use.

Summarization

Summarization includes all approaches that help reduce the complexity and detail of data. This process operates differently, of course, when dealing with formal knowledge and local knowledge. In terms of formal knowledge, even in data-poor areas there are usually more data on hand than a decision maker can usefully assimilate. The volume needs to be reduced until each decision is informed by only one to five variables. Statistical summaries (means, medians, modes, standard deviations, and ranges) all fall into this category. Great care must be taken to perform the statistical summarization appropriately. For instance, there are important scaling considerations when accumulating averages from different-sized populations.

Indices and indicators also fall into this category. Indices are mathematical compilations of different types of data, forming a composite measure. Indicators are typically proxy data that suggest a trend in some other, more fundamental assessment variable. Indicators are a feature of state-of-the-environment reporting but run the risk of becoming so numerous that they fail to achieve the objective of simplification. An example of summarization in SAfMA is the biodiversity intactness index (Biggs, Scholes, and Reyers 2004), which combines thousands of observations at species level, with land cover and ecosystem maps, into a single score for biodiversity performance, with a confidence interval. The index can be progressively "unpacked" at different scales or for different taxa or land cover types.

In terms of informal knowledge, summarization is a more difficult task since it involves processed information rather than empirical data. It is also somewhat challenging to apply the inherently scientific approach of "summarization" to local knowledge since the knowledge systems faced often do not lend themselves to this process and value could be removed by so doing. Nevertheless, being part of an ecosystem assessment requires that information be summarized. This was achieved in the SAfMA in various ways, from using GIS technologies to capture spatial information to creating locally appropriate scenarios to summarize key drivers and trends within villages (see Burt and Copteros 2004). Feedback from local decision makers and resource users indicated that this information was enormously useful.

Synthesis

Synthesis consists of combining primary information in ways that provide novel insights. The simplest syntheses may be ratios. For instance, when yield data are divided by population data, the result is the average food supply per person. If this is then compared with a threshold (e.g., 2,000 cal/person/day), the result is information on food security that is not present in any one of the input variables alone but is a result of their combination through synthesis. Synthesis can also take place through applying much more complex models. An example from SAfMA is the regional-scale analysis of the grazing service—that is, the service provided by the ecosystem of grazing land for livestock. Data from subnational livestock databases were converted, through metabolic models, into forage demand values. Climate, soil, topography, and vegetation databases were the input to grass production models that calculated forage supply. The difference between supply and demand provided a synthesized, spatial assessment of the pressure on the service that could be related to independently derived satellite observations on land degradation (Scholes and Biggs 2004). Synthesis represents perhaps the most intellectually challenging aspect of assessment, but it is also the process that can add the greatest value.

Dialectic

A valuable assessment process is the dialogue and debate that occur when investigators with different analytical models apply themselves to the same problem. One example is the interaction between social scientists and biophysical scientists. Another is between researchers looking at the same issue at different scales. A third is the interaction between "Western" worldviews and "African" worldviews. Finally, even within one discipline (e.g., ecology, economics, or political science), different schools of thought usually exist. The assessment can be greatly enriched if these "conflicts" are not excluded or papered over but, instead, are actively encouraged as a source of constructive dialogue and critique. For example, SAfMA included researchers whose training, disposition, and experience caused them to favor aggregated, large-scale, generalized approaches to assessment, and others who for the same reasons favored disaggregated, place-based, specific approaches. We ended up using both—in some cases, as different lenses through which to view the same problem; in other cases, as approaches appropriate to different questions. If convergence can be achieved, then confidence in the robustness and wide acceptability of the finding is increased. Failure to converge, on the other hand, does not mean a failed process. It clearly establishes the uncertainty range of the issue.

Successful use of dialectic requires a high level of self-confidence and mutual trust among the participants. SAfMA was characterized by much dialectical debate, which quite unnerved new observers. The different approaches to scenario construction applied by the different subprojects are an example (compare Lynam et al. 2004, Scholes and Biggs 2004, Bohensky et al. 2004, and Burt and Copteros 2004). The coherence of the entire enterprise was built on the a priori agreement to use the Millennium Ecosystem Assessment's conceptual framework as the meeting point (MA 2003).

Communication

Communication transfers knowledge from the specialist and technical domain into a policy domain. It involves as much listening as speaking, remembering that communication is the message received, not the message transmitted. Assessment can be thought of as a translation device. It needs to render a signal intelligible and to deliver it where needed. The jargon-ridden, extremely detailed scientific discourse often needs simplifying (think of this as taking out the noise and leaving the main signal), but it should not be distorted in the process. The classical medium is the written report, because of its archival value and ease of use, but this format is increasingly being supplemented by electronic dissemination (Web pages, CD-ROMs), video productions, radio broadcasts, posters, and brochures. However, in the SAfMA, all of these devices proved themselves inadequate at the local level, so other methods were sought, such as visual displays, storytelling, theatre, and PRA (see Burt and Copteros 2004; Cundill 2005).

Face-to-face communication with the chosen target audience is an invaluable complement to the report in all instances. Assessment reports typically include a lot of graphical communication devices, such as maps, graphs, diagrams, photographs, and tables. Assessments often underestimate the time and resources needed for this process, without which the effort put into the preceding processes is fruitless. Ideally, communication should involve stakeholder involvement from the start. Although this is one of the guiding principles of integrated assessments such as the SafMA, full stakeholder involvement is difficult to achieve in practice unless enough time and resources are allocated for it. As a rough guideline, about a fifth of the total resources need to be dedicated to communication.

We suggest that the level of each process above can be used as a yardstick for "assessing assessments." An assessment that applies them all to a high degree is likely to yield a worthwhile outcome.

Acknowledgments

This work resulted from the Southern African Millennium Ecosystem Assessment, which was largely funded from the United Nations Environment Programme, using resources made available by the Government of Norway.

The contribution of the entire SAfMA team, and of a large number of scientific experts and holders of local and indigenous technical knowledge, to the project and to the ideas in this paper are acknowledged.

References

Ainslie, A. 2002. Cattle ownership and production in the communal areas of the Eastern Cape, South Africa. Research report no. 10. Cape Town: Programme for Land and Agrarian Studies, University of the Western Cape.

Alcorn, J. B. 2000. Keys to mapping's good magic. International Institute for Environment and Development. *PLA Notes* 39. http://www.iied.org/sarl/pla_notes/pla_backissues.

Babbie, E., J. Mouton, P. Vorster, and B. Prozesky. 2001. *The practice of social research.* Oxford: Oxford University Press.

Berkes, F., J. Colding, and C. Folke. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10:1251–62.

———, eds. 2003. *Navigating social-ecological systems: Building resilience for complexity and change.* Cambridge: Cambridge University Press.

Berkes, F., and C. Folke, eds. 1998. *Linking social and ecological systems: Management practices and social mechanisms for building resilience.* Cambridge: Cambridge University Press.

Biggs, R., R. J. Scholes, and B. Reyers. 2004. Assessing biodiversity at multiple scales. Online proceedings of the Bridging Scales and Epistemologies Conference, Alexandria, March 17–20, 2004. Penang, Malaysia: Millennium Ecosystem Assessment. http://www.millenniumassessment.org/en/about.meetings.bridging.proceedings.aspx.

Bohensky, E., B. Reyers, A. van Jaarsveld, and C. Fabricius. 2004. *Ecosystem services in the Gariep Basin: Southern African Millennium Assessment Report.* Stellenbosch, South Africa: University of Stellenbosch.

Borrini-Feyerabend, G., comp. 1997. *Beyond fences: Seeking social sustainability in conservation.* Gland, Switzerland: IUCN (World Conservation Union)/Kasparek Verlag.

Burningham, K., and G. Cooper. 1999. Being constructive: Social constructivism and the environment. *Sociology* 33:297–316.

Burt, J., and A. Copteros. 2004. Dramatic futures: A pilot project of theatre for transformation and future scenarios. Unpublished report for the Environmental Education Department, Rhodes University, South Africa.

Campbell, B. 2002. A critical appraisal of participatory methods in development research. *Social Research Methodology* 5:19–29.

Chambers, R. 1994. Participatory rural appraisal (PRA): Analysis and experience. *World Development* 22:1253–68.

Cundill, G. 2005. Institutional change and ecosystem dynamics in the communal areas around Mt. Coke State Forest, Eastern Cape, South Africa. Master's thesis, Rhodes University, Grahamstown, South Africa.

Department for International Development. 1999. Sustainable livelihoods guidance sheets. http://www.livelihoods.org (accessed October 1, 2003).

Desanker, P. V., and D. Kwesha. 2004. *Ecosystem services in the Zambezi River basin.* Harare: Zimbabwe Forestry Commission.

Du Toit, J., B. Walker, and B. Campbell. 2004. Conserving tropical nature: Current challenges for ecologists. *Trends in Ecology and Evolution* 19:12–17.

Fabricius, C., and G. Cundill. Forthcoming. Restoring natural capital in communal areas. In *Restoring natural capital,* ed. J. Aronson and S. Milton. Washington, DC: Island Press.

Fabricius, C., B. Matsiliza, and J. Buckle. 2003. *Community-based natural resource management in Emalahleni and Mbashe: Eastern Cape Planning Process.* Pretoria: GTZ Transform.

Folke, C., F. Berkes, and J. Colding. 1998. Ecological practices and social mechanisms for building resilience and sustainability. In *Linking social and ecological systems,* ed. F. Berkes and C. Folke, 414–36. Cambridge: Cambridge University Press.

Hendricks, H. 2003. *Southern African Millennium Assessment: Lower Gariep Basin scoping report.* Kimberley: South African National Parks.

Jordan, G. H. 1998. A public participation GIS for community forestry user groups in Nepal. Paper presented at the Public Participation GIS specialist meeting, October 14–18, Santa Barbara, California. http://www.ncgia.ucsb.edu/varenius/ppgis/papers/jordan.pdf.

Jordan, G. H., and B. Shrestha. 1998. *Integrating geomatics and participatory techniques for community forest management: Case studies from the Yarsha Khola watershed, Dolakha District, Nepal.* Kathmandu: International Centre for Integrated Mountain Development.

Kay, J., H. Regier, M. Boyle, and G. Francis. 1999. An ecosystem approach for sustainability: Addressing the challenge of complexity. *Futures* 31:721–42.

Latour, B. 1987. *Science in action.* Cambridge, MA: Harvard University Press.

Lovell, C., A. Mandondo, and P. Moriarty. 2002. The question of scale in integrated natural resource management. *Conservation Ecology* 5 (2): 25. http://www.ecologyandsociety.org/vol5/iss2/art25/.

Lynam, T., A. Sitoe, B. Reichelt, R. Owen, R. Zolho, R. Cunliffe, and I. Bwerinofa. 2004. *Human wellbeing and ecosystem services: An assessment of the linkages in the Gorongosa-Marromeu region of Sofala Province, Mozambique to 2015.* Harare: Institute of Environment Studies, University of Zimbabwe.

Madzwamuse, M., and C. Fabricius. 2004. Local ecological knowledge and the Basarwa in the Okavango Delta: The case of Xaxaba, Ngamiland District. In *Rights, resources and rural development: Community-based natural resource management in southern Africa,* ed. C. Fabricius and E. Koch, 160–73. London: Earthscan.

Mauro, F., and D. Hardison. 2000. Traditional knowledge of indigenous and local communities: International debate and policy initiatives. *Ecological Applications* 10:1263–69.

Millennium Ecosystem Assessment (MA). 2003. *Ecosystems and human well-being: A framework for assessment.* Washington, DC: Island Press.

Moss, R. H., and S. H. Schneider. 2000. Uncertainties in the IPCC TAR: Recommendations to lead authors for more consistent assessment and reporting. In *Guidance papers on the cross-cutting issues of the Third Assessment Report of the IPCC,* ed. R. Pachuari, T. Taniguchi, and K. Tanaka, 31–51. Geneva: World Meteorological Organisation.

Motteux, N. 2001. *The development and co-ordination of catchment fora through the empowerment of rural communities.* Water Research Commission Report No. 1014/1/01. Pretoria: Water Research Commission.

Nadasdy, P. 1999. The politics of TEK: Power and the "integration" of knowledge. *Arctic Anthropology* 36:1–18.

Pretty, J., I. Guijt, I. Scoones, and J. Thompson. 1995. *A trainer's guide for participatory learning and action.* Sustainable Agriculture Programme. London: IIED Participatory Methodology Series, International Institute for Environment and Development.

Scholes, R. J., and R. Biggs. 2004. *Ecosystem services in Southern Africa: A regional assessment.* Pretoria, South Africa: Council for Scientific and Industrial Research.

———. 2005. A biodiversity intactness index. *Nature* 434:45–49.

Shackleton C., G. Guthrie, J. Keirungi, and J. Stewart. 2003. Fuelwood availability and use in the Richtersveld National Park, South Africa. *Koedoe* 46:1–8.