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Research, part of a Special Feature on Navigating Trade-offs: Working for Conservation and Development Outcomes

A Review of Tools for Incorporating Community Knowledge, Preferences, and Values into Decision Making in Natural Resources Management

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ABSTRACT. We survey and evaluate selected participatory tools that have been proven effective in natural resources management and research during our extensive experience with forest communities. We first establish a framework for our analysis by identifying a set of criteria for evaluating each tool. Next we provide a brief description of each tool, followed by an evaluation and comparison of the strengths and weaknesses of all the tools examined and how well they can be adapted to diverse contexts. We also provide suggestions for avoiding common pitfalls. Our findings suggest that most tools are flexible enough to be adapted to a range of applications, and that results are more robust when tools are used in concert. Practitioners should not be disturbed when results are contradictory or unexpected; initial surprises can lead to unexpected discoveries. Given the complexity of natural resources and their management, picking the right tool does not guarantee that the data desired will be produced, but selecting the wrong tool does make success less likely. The tools assessed are Bayesian belief networks and system dynamic modeling tools, discourse-based valuation, the 4Rs framework, participatory mapping, scoring or the Pebble Distribution Method, future scenarios, spidergrams, Venn diagrams, and Who Counts Matrices.

Key Words: *participatory tools; review; natural resources management; co-management: co-learning*

INTRODUCTION

The importance and necessity of including community perspectives in natural resource management has encouraged the development of a range of approaches and methodologies (Arrow 1951, Campbell and Luckert 2002, Chambers 1992, Nazarea et al. 1999, Nemarundwe and Richards 2002, Pavlikakis and Tsihrintzi 2003). The development of participatory tools is an important contribution to this trend. This paper provides a review of a selection of participatory tools in the analysis, synthesis, and decision making related to natural resource management and policy. Drawing from our experience working with participatory tools to improve local involvement, we identify the positive and negative aspects of these tools, i.e., methods and approaches, and their effectiveness in different contexts.

A number of such tools are now available to elicit the knowledge, values, and preferences of communities. The word "value" has a number of possible meanings. The *Oxford English Dictionary* notes four definitions of relevance to us (Hawkins 1990): (1) the amount of money, goods, or services, etc., considered being equivalent to a thing or for which it can be exchanged; (2) desirability, usefulness, importance; (3) the ability of a thing to serve a purpose or cause an effect; and, in the plural, (4) one's principles or standards; one's judgment of what is valuable or important in life. These four definitions can be associated with (1) economic, (2) social, (3) ecological, and (4) ethical/philosophical concerns, respectively. In general, we use the term to in the sense of (2), i.e., desirability, usefulness, and importance, in this review. The approaches used by these tools have passed through recognizable stages, from awareness-raising of the marginalized in the late 1960s to the incorporation of local perspectives into alternative data collection and planning methods in the 1970s (Pretty et al. 1995), through the recognition of local knowledge and improved knowledge and information systems in the 1980s to the use of participation as a norm of "good" or "sustainable" development in the 1990s.

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There are various competing requirements that practitioners demand of participatory tools, such as standardization vs. flexibility or the often conflicting goals of knowledge or data extraction vs. empowerment (Guijt and Kaul Shah 1998, Cooke and Kothari 2001, Sarin et al. 2003). As a result, practitioners often struggle to find the most appropriate methods to suit their objectives. There has been no synthesis of experience to guide potential users as to the strengths, weaknesses, and capabilities of these tools despite their widespread use. This absence is important in the context of natural resource management and governance, in which practitioners have seldom had experience with more than one or two approaches. Such guidance can, we believe, simplify and improve the selection and application of the available approaches leading to improved natural resource management.

The Center for International Forestry Research (CIFOR) and its partners have been involved in a range of activities that have sought to improve natural resource management through a more effective involvement of, and responsiveness to, local stakeholders. The necessity and difficulty of incorporating local perspectives is greatest in tropical forest-dependent communities in which poverty, literacy, language, culture, and access can all pose obstacles to effective engagement. CIFOR has focused on developing and testing methods in these contexts, in which they must often be creatively adapted to local conditions. Our primary focus has been engaging local communities; we are less concerned with, for example, business enterprises, governments, or NGOs, which are normally quite capable of communicating and articulating their views. Our review draws lessons from these experiences. We offer a simple and relatively nontechnical overview of our reflections in the hope that the benefits of these approaches can be more widely realized and their pitfalls avoided. Our primary goal is to provide guidance for field practitioners as to which methods suit which tasks and contexts. We focus on several tools that we know from our own experience and which we consider relevant and useful.

Natural resource management is a context-specific exercise. We first provide a summary of decision-making processes within the context of natural resource management. Subsequently, we discuss the tools themselves, our evaluation criteria, and the review method. We finish by distilling the key lessons learned from the field, to provide guidelines for better tool selection.

A DECISION-MAKING CONTEXT

"Conventional" thinking on natural resource management often encourages a technical approach to problem solving (Uphoff 1986, Ramirez 1999, Groot and Maarleveld 2000). The process is usually linear with clearly defined steps: (1) creating a goal statement, (2) assessing constraints or problems and opportunities for achieving the goal, (3) identifying ways to solve problems, (4) selecting the "best" way, and (5) finally implementing the solution. However, practitioners who approach resource management in this top-down manner often exclude the knowledge, preferences, and values of the people affected or concerned by the outcome (Groot and Maarleveld 2002, Long and Long 1992).

There is increasing recognition that positive changes are more likely to be initiated when the attitudes, beliefs, or preferences of the people managing or depending on resources are considered in the identification of problems and the development of solutions (Ramirez 1999). Greater community involvement can achieve the desired understanding or sense of trust that practitioners require to be effective. Stakeholder engagement has evolved from a marginal concern to a driving force. However, there is a caveat: we acknowledge that it is almost impossible for researchers to be objective when they become active agents with vested interests in outcomes, often the necessary consequence of using participatory methodologies. Although this is neither a new revelation nor the inevitable outcome of stakeholder participation, it does need to be mentioned. It is also important to note that not all the research involved in making decisions about local resources demands the same level of local engagement.

Our assessment strives to distinguish the inherent aspects of the tools from the various processes in which they have been applied, although success depends on both. We discuss a number of different approaches that require varying levels of stakeholder involvement (Sheil et al. 2003, Lynam et al. 2004, cf. Diaw and Kusumanto 2005; I. Guijt, *unpublished manuscript*). Most of the methods recognize the need to develop a common

understanding or vision of the domain of the investigation, and some can help search for solutions.

Different stakeholders often have competing demands and obligations. Natural resource decision making requires a process to reconcile multiple actors (Anderson et al. 1999). However, these interventions are seldom value-neutral because normative trade-offs are inevitable (Gass et al. 1997). Conventional management approaches may fail to recognize and balance the multiple interests, interactions, and variables involved in this wider context. A potential pitfall when researchers themselves become actors involved in projects in which the boundaries between research and action are blurred (Sayer and Campbell 2004) is their loss of scientific objectivity and hence scientific credibility.

There are various approaches for involving local views and perspectives. These can be understood as a continuum that we divide into three classes: (1) diagnostic and informing methods that extract knowledge, values, or preferences from a target group to understand local issues more effectively and include them in a decision-making process (Fig. 1A); (2) co-learning methods in which the perspectives of all groups change as a result of the process, but the information generated is then supplied to a decision-making process (Fig. 1B); and (3) co-management methods in which all the actors involved are learning and are included in the decision-making process (Fig. 1C). We discuss the tools in the context of these three approaches.

Deciding which participatory approach is appropriate requires the articulation of a clear question or objective. As with any analysis, well-formulated questions are more likely to generate robust answers. The investigative process must define the degree of detail necessary for each component of the analysis or process: too much information and complexity is overwhelming. A clear objective, an appropriate research design, and careful selection of methods/tools will help to distill the essential and helpful elements from the distractions. This is as true in extractive information gathering as it is in co-management decision making. In this sense, the project design and the research questions and objectives should dictate the degree of participation necessary. However, who makes the decision as to which type of participation will be required is an important issue, especially when the type and level of participation reflects ethical and/or normative choices.

Acknowledging and understanding power relations is often important when working with communities, especially within a broader multistakeholder context (Colfer 1995, Diaw and Kusumanto 2004, Sithole 2002). Tools that effectively achieve this include Colfer's (1995) Who Counts Matrix and Venn diagrams (Pretty et al. 1995). The three approaches presented in Fig. 1 reflect different power relations, from a continuum of unbalanced power structures as represented in Fig. 1A, to evenly distributed power relations as shown in Fig. 1C. Whenever group situations are used for sharing information or knowledge, relationships come into play and careful facilitation is essential. Facilitators should be sensitive to power relations. We stress that the researcher or facilitator must address these issues; the tools alone cannot.

It is often difficult to understand linkages of cause and effect in the complexity of dynamic socio-ecological environments in which controlled replicated studies are unfeasible. In these circumstances, our understanding of appropriate outcomes and how to achieve them depends not only on belief and evidence but also on (1) our expectations of costs and normative views about who should bear them, (2) our ethical view of the choices, and (3) how we choose to regard the beliefs of scientists and technical experts relative to the views and knowledge of other stakeholders.

Community-level decision making is a political process, and researchers must be sensitive to the local reality when engaging stakeholders. Whose views and knowledge need to be heard, or whose attitudes and beliefs should be enhanced? These are difficult questions that the tools cannot answer. Careful planning and sensitive implementation will, however, help the conscientious researcher clarify critical aspects and judge their implications.

OVERVIEW OF THE TOOLS

The aim of this overview is to provide potential users with a brief description of what each tool does, what it does not do, and how it is applied. These relationships are summarized in Table 1.

Fig. 1. Modes of knowledge capture and use when making decisions about natural resources. The different-sized stakeholder objects represent the role of stakeholder knowledge and power. The solid arrows represent the contribution of these stakeholders to the process of synthesizing knowledge or understanding, which is represented as the outer cylinder. The final synthesized knowledge is represented as the inner cylinder. The dotted lines represent the uptake of this newly synthesized knowledge by the stakeholders. (A) Extractive use, in which knowledge, values, or preferences are synthesized by the extracting group and passed on as a diagnosis to a decision-making process. (B) Co-learning, in which syntheses are developed jointly and the implications are passed to a decision-making process. (C) Co-management, in which the participants perform the syntheses and include them in a joint decision-making process.

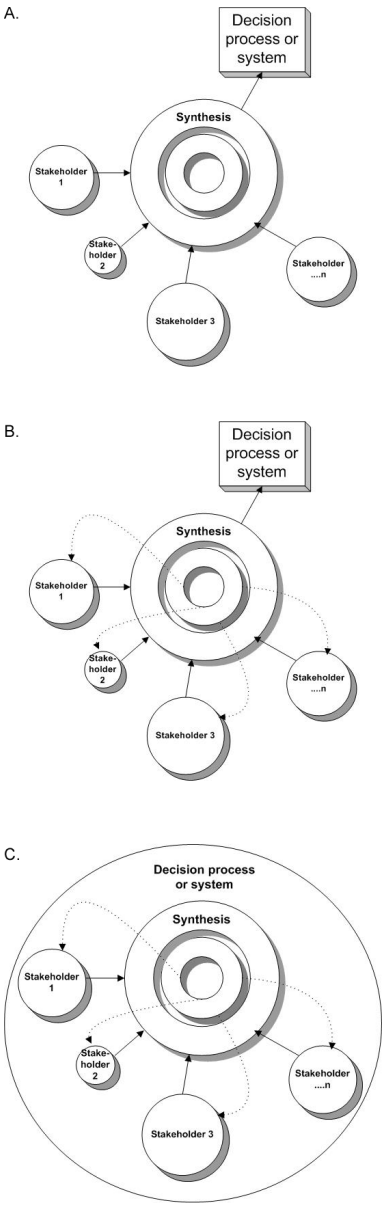

Table 1. Evaluation criteria applied to each of the tools reviewed: capabilities.

Tool	What does it do?	What does it not do?	Methods
Bayesian belief network (BBN), system dynamic model (Cain 2001, Lynam et al. 2002, Lynam 2003)	Simplifies complex systems through key variables and their relationships	Capture all details and nuances	Individual or group setting; usually (but not with BBNs) requires quantitative estimation of relationships
Discourse-based valuation (Wilson and Howarth 2002)	Develops a common (group) representation of importance	Develop causal relationships among variables or entities	Facilitated group interactions
4Rs framework (Dubois 1998)	Assesses stakeholder roles and resilience in forest management	Reveal causal relationships	Carefully facilitated individual or group setting
Participatory mapping (Lynam 1999, 2001, Sheil et al. 2002)	Represents spatial relationships	Represent spatial interactions	Individual or group setting
Pebble Distribution Method (e.g., Colfer et al. 1999*a*, Sheil et al. 2002, 2003)	Rates alternatives (items) and encourages examination of the underlying reasons for these ratings	Represent, clarify, or reveal relationships or processes	Individual or group setting supervised by a facilitator who must carefully introduce and guide the process
Vision/pathway scenario (Wollenberg et al. 2000)	Envisions and articulates an ideal future as a basis for planning and decision making or developing a shared vision	Quantify relationships or identify the causal relationships among process or variables	Entire community
Alternative scenario (Wollenberg et al 2000, Nemarundwe et al. 2003)	Imagines and describes several possible future outcomes (negative or positive) based on current trends and uncertainties	Quantify relationships	Entire community
Spidergram (Lynam 1999, 2001)	Represents causal or categorical relationships among variables related to a central question	Represent feedback or dynamic relationships	Individual or group setting; useful in discourse-based valuation to develop consensus
Venn diagram (Pretty et al. 1995)	Represents social relationships and power differences between stakeholders	Represent causal relationships	Individual or group setting
Who Counts Matrix (Colfer et al. 1999*b*)	Gives priority to stakeholders whose well-being is closely linked to forest management, using seven dimensions to assess these links	Provide specific definitions of terms and indicators to assess dimensions	Individual or group setting

Bayesian belief networks and system dynamic modeling tools

Bayesian belief networks (BBNs) and system dynamic modeling tools (Cain 2001, Sayer and Campbell 2004) are modeling tools, generally computer software packages, that facilitate the development of formal representations of a problem or question. Most often these are cast in numerical terms, but BBNs may also deal with qualitative variables (Cain 2001). The great advantage of modeling is that it compels users to clearly articulate variables and the relationships among variables. Models can be used in group situations that build on the participants' perceptions, or a modeler can construct them from other representations. Modeling tools are not generally good at capturing all the nuances and subtleties in a set of relationships; their usefulness is in representing the essential elements of a problem or issue.

Discourse-based valuation

Discourse-based valuation (Wilson and Howarth 2002) is a method for groups to develop agreed-upon values or orderings for multiple entities. The participants create an agreed-upon preference ordering of entities or concepts. Depending on the metric being used, this ordering can use continuous, discrete, or nominal scales. The process does not develop relationships among variables or value entities. The tool must be applied in a group situation in which the participants perform the valuation. These methods require careful facilitation to prevent the domination of the final values by specific interest groups or individuals.

The 4Rs framework

The 4Rs framework (Dubois 1998) assesses stakeholders' roles and resilience in forest management. This method analyzes the balance/imbalance of the stakeholders' four "Rs": respective rights, responsibilities, returns, and relationships. The tool can be used either by outsiders to organize systematically the 4Rs information or in group settings in which stakeholders identify their roles in forest management and then analyze any imbalance between the four Rs. When used in group settings, the four Rs serve as a facilitation tool to help different stakeholders negotiate their respective roles in forest management. The tool does not reveal causal relationships among entities.

Participatory mapping

Participatory mapping (Lynam 1999, 2001, Mascarenhas 1991, Sheil et al. 2002, 2007) is an individual or group method for developing representations of spatial relationships among real-world structures or objects. Participants use pen and paper to develop sketches or drawings or develop three-dimensional representations to capture the perceptions of the spatial relationships of a group or an individual. Unless scaled maps are first used as a preliminary base, it can be a challenge to generate scaled maps in which the scale relates to true distances on the ground. It is also sometimes difficult to identify which factors, e.g., size, distance, or some other attribute, are contributing to the scaling or weighting that occurs. However, this exercise can be a useful introduction to exploring the processes underpinning the emergent maps. In some situations, using existing geo-referenced information as a starting point can be very useful but also requires careful checking to establish the degree of accuracy.

The Pebble Distribution Method

The Pebble Distribution Method or PDM (Colfer et al. 1999*a*, Sheil et al. 2002, 2003) is a flexible, simple diagnostic scoring procedure that clarifies both the understandings and the priorities of the participants. A preliminary discussion with the target group defines which aspects will be scored and the criteria for scoring to ensure a clear understanding among the participants. The facilitator then introduces a series of cards with a label and usually a picture symbolizing the aspects to be scored. The facilitator demonstrates how the counters should be distributed on the cards according to the quantitative relationships or values of the group. The participants then distribute counters onto the cards. The scoring is not the end point: the respondents are always asked to explain the final scores. There are innumerable possible applications of this tool. Evaluations applied in the Multidisciplinary Landscape Assessment of the Center for International Forestry Research (see Sheil et al. 2002, 2003) included examining the relative importance of different types of landscape

elements vs. types of use, e.g., food, medicinal products, etc. A hierarchical adaptation of the procedure was successfully used to identify and weigh the relative importance of the most important wild species. Some forms of quantitative analyses of the scoring results are also possible (Sheil and Liswanti 2007).

Future scenarios

Future scenarios methods help people learn about the future and anticipate the unexpected, particularly in conditions of uncertainty and complexity. The key steps of scenarios involve developing likely trajectories of how important aspects of life may evolve over time or interact in the future. Future scenarios methods can also develop desired futures and the pathways needed to reach them, or the method can be adapted to indicate predicted pathways and identify key points at which these pathways can or should be influenced. Wollenberg et al. (2000) used four different scenarios methods in community work, each for a different purpose: vision scenarios serve to elicit people's hopes and aspirations, projection scenarios identify the consequences of the current situation projected into the future, pathway scenarios illustrate routes of evolving scenarios and design for strategies for change, and alternative scenarios show a range of possible alternatives of the future and help to deal with uncertainty.

Spidergrams

Spidergrams (Lynam 1999, 2001) provide a representation of the components, attributes, or dimensions of the answer to a clearly articulated question. The tool explores these factors in increasing detail based on the relative contribution of each component to the answer. Spidergrams can be generated in either group or individual settings and yield results as weighted figures or tables. They are typically used as part of a discourse-based valuation process so that the weights associated with each component are group-defined values. Spidergrams are not good at representing dynamic relationships or feedbacks.

Venn diagrams

Venn diagrams represent social relationships among stakeholders and, where desired, power differences between them. They are an easy-to-use visual tool that helps participants explore social relationships between stakeholders. The tool itself does not reveal causal relationships among entities, but it can be used to encourage participants to explore and analyze causal links. Venn diagrams can be combined with a focused discussion among group participants.

Who Counts Matrices

Who Counts Matrices (Colfer 1995) identify stakeholders whose well-being is closely linked to forest management and could be adapted for other contexts. The tool suggests seven dimensions for assessing this link and provides a simple scoring technique for determining which stakeholders should be given priority in forest management in a particular locale. These seven dimensions are: (1) proximity to the forest, (2) pre-existing rights, (3) dependency on the forest, (4) poverty, (5) local knowledge, (6) forest/culture integration, and (7) power deficits. The matrix is often less useful for academic purposes, which would require a more specific definition of terms, including indicators for assessing dimensions.

RATIONALE AND EVALUATION CRITERIA

Any form of participation, whether in the context of research or natural resource management practice, involves far more than the mechanical application of participatory tools for capturing local stakeholder perspectives and knowledge. Nevertheless, tool selection matters: success is not guaranteed by selecting the right tool, but it is excluded by selecting the wrong one. In addition, an awareness of methodological strengths and weaknesses can help in the application and interpretation of results. A suitable participatory tool, when correctly executed, can change the very attitudes of the people involved, bringing about "reversals" or major insights into the mental how-it-works constructs of both local actors, who are often referred to as "insiders," and field practitioners or researchers, often called "outsiders" (Chambers 1992, 1997). Such experiences provide a powerful means of

generating changes in the relationships between insiders and outsiders and can facilitate greater understanding between all stakeholders.

How did we evaluate the tools? We discussed the merits and failures of each method among ourselves and with colleagues, and when possible examined the literature, in an attempt to clarify which appraisals were justified and appropriate. Published literature is poor at describing failed studies, so our evaluative process draws on our own experiences, suggestions from colleagues, and common sense.

We sought to make it easier to compare tools by developing general themes such as categories of evaluation criteria and by devising standard criteria to accompany these. Considering the observations we have made so far, we believe that participatory tools must: (1) support communication and learning between the insiders and outsiders who are using the tools; (2) be adaptable for implementation in various decision-making contexts and for use by diverse users, including those at the local level; and (3) produce data and information that are useful and valid as a basis for decision-making or can be used for further analyses.

Based on these characteristics, we defined three different categories of evaluation criteria: (1) capabilities, in which the potential applications of the tool are evaluated; (2) use, in which the conditions or context of use are evaluated; and (3) products, in which the nature of the results or outputs of the tool are evaluated. Although the diversity of contexts and variables makes it a challenge to choose the most appropriate evaluation criteria, these three principal types of criteria can provide guidance in the selection of tools for participatory decision making.

In terms of capabilities, we were seeking tools that could identify the stakeholders or their relative importance, elicit knowledge and values, make it easier to deal with culturally sensitive issues, be either flexible or narrow in use, produce data in a specific format, and be either analytic or creative. With regard to use, tools had to encourage communication and/or learning among different local stakeholders and between local stakeholders and the researchers using the tool; promote co-learning or single group learning; be simple to use; be readily translatable across socioeconomic groups and cultures; be dynamic, iterative, or recursive; easily provide specialized knowledge; require specific skills from the user; be suitable for use by members of the community; and be capable of rapid implementation. The products generated by these tools had to enable the expression or understanding of uncertainty; provide results that are readily communicated to target groups, easily aggregated and summarized, and clear and appealing to distant or centralized policy/decision makers; and be reasonably accurate and precise.

APPLYING EVALUATION CRITERIA TO A SELECTION OF TOOLS

We applied the evaluation criteria listed above to the tools in Table 1 and present the results in Tables 2, 3, and 4. Our judgments are based primarily on forest management in poor and marginalized communities. We do not expect that a single tool will be appropriate for all purposes. The reader should be able to select the tools that are the most appropriate for the defined needs or question by comparing the tools' performance based on these criteria. Before implementing a tool, we strongly advise the reader to refer to the literature that describes the tools and seek guidance from practitioners experienced in their application.

KEY LESSONS FROM THE FIELD

We have learned a great deal about what works, under what conditions and why from our experience applying these tools across various problem domains and contexts. We do not illustrate our account with field examples, because the amount of text needed to provide adequate context for each was felt to outweigh the benefits. In this section we summarize some of the key lessons that are reflected in Tables 2–4.

Most importantly, the nature of the process in which the tools are embedded plays a critical role in success and failure. This is probably more significant in the context of natural resource decision making with local communities than in many other fields of enquiry. Most of the tools presented in this paper can be used either to extract information as in Fig. 1A or for participatory co-management as in Fig. 1C. Although some tools may be more suitable for one application than another, the reality is that each tool could be used anywhere across the continuum. The investigator

Table 2. Evaluation criteria applied to each of the tools reviewed: use.

Tools	Does it identify stakeholders or their relative importance?	Does it elicit knowledge?	Does it elicit values?	Is it flexible or narrow in use?	Does it help deal with culturally sensitive issues?	What formats does it produce?	Is it analytic or creative?
Bayesian belief network and system dynamic model	Yes	Yes	Not usually	Narrow	No	Highly varied from maps to text	Both
Discourse-based valuation	No	Not usually	Yes	Narrow	Yes	Tables	Analytic
4Rs framework	Yes	Yes	Yes	Narrow	Yes	Tables	Analytic
Participatory mapping	No	Yes	No	Flexible[†]	No	Maps drawn on paper or the ground	Analytic
Pebble Distribution Method	Not usually	No	Yes	Flexible	Possible	Tables; numbers; explanatory statements	Analytic
Future scenario	Not usually	Yes	No	Narrow	No	Stories and drawings	Both
Spidergram	Yes, but not their relationships	Yes	Yes	Flexible	Yes	Figures; tables	Analytic
Venn diagram	Yes	Depends on use	Yes	Flexible	Depends on use	Drawings	Both
Who Counts Matrixes	Yes	Yes	Yes	Narrow	Depends on use	Tables	Analytic

[†]In the context of spatial representations.

must identify which level of engagement is required to achieve his or her given objectives. The tools can then be adapted to achieve specific goals.

The researcher must recognize that the relationships among the participants of an informant group, including the researcher, will influence the results. Any observed outcomes reflect the dynamics among the stakeholders, as well as societal and cultural norms. This presents challenges to the practitioner, who must identify underlying power relations and then either adjust for them or take them into account.

Unlike conventional social research, in which a method can be pretested by, e.g., piloting a questionnaire or trying out a semi-structured interview process, many of the tools described here are applied in contexts in which pretesting is not

Table 3. Evaluation criteria applied to each of the tools reviewed: products.

Tools	Does it encourage communication and learning among different stakeholders?	Does it encourage co-learning or single group learning?	Does it encourage communication and learning between local stakeholders and users?	Is it simple to use?	Is it readily translatable across socioeconomic groups?	Is it readily translatable across cultures?	Does it allow for dynamic, iterative, or recursive use?	Does it easily provide specialized knowledge?	What specific skills are required from the user?	Can community members use it themselves?	Is it capable of rapid implementation?
Bayesian belief network and system dynamic model	Yes	Can be co-learning, but this is difficult	Yes, if developed jointly	No	No	Unknown	Yes	No	Numeracy; abstract reasoning	No	No
Discourse-based valuation	Yes	Co-learning	Yes	Variable	Dependent on power structures	Unknown	Yes	Yes	Numeracy	Yes, with training	Yes
4Rs framework	Yes	Both	Depends on use	Variable	Yes	Unknown	Yes	No	Able to mediate/facilitate divergent views	Yes, with training, but needs neutral facilitator, may be difficult	No
Participatory mapping	Yes	Co-learning	Yes	Yes	No	Unknown	Yes	Yes	Drawing; two-dimensional abstract thinking and representation	Yes	Yes
Pebble Distribution Method	Yes	Both possible	Yes	Yes	Yes	Yes	Can be	Yes	Numeracy and shared definitions	Yes	Yes
Future scenario	Yes	Co-learning	Yes	No	Yes	Yes	Yes	Yes	Abstract reasoning	Yes	No
Spidergram	Yes	Co-learning	Yes	Yes	Yes	Yes	Yes	Yes	Numeracy	Yes	Yes
Venn diagram	Yes	Both	Depends on use	Yes	Yes	Yes	Yes	Yes	Abstract visualizing and inferring	Yes	Yes
Who Counts Matrix	Yes	Can be both	Depends on use	Yes	Yes	Yes	No	No	Shared definitions and numeracy	Yes	No

Table 4. Evaluation criteria for tools grouped into their general capabilities, their use in practice, and the products they generate.

Tools	Does it enable expression or understanding of uncertainty?	Are the results readily communicable to target groups?	Are the results easily aggregated and summarized?	Are the results clear and appealing to distant/central policy/decision makers?	Does it provide reasonable levels of accuracy?	Does it provide reasonable levels of precision?
Bayesian belief network and system dynamic model	Yes	No	Yes	Probably, yes	Yes	Yes
Discourse-based valuation	Yes	Variable	Yes	Unknown	Yes	Yes
4Rs framework	Yes	Variable	No	Yes	Depends on use	Depends on use
Participatory mapping	No	Yes	No	No	Possible, depends on use	Depends on use
Pebble Distribution Method	Yes (replication and explanation)	Yes	Yes	Yes	Possible, depends on use	Yes
Future scenarios	Yes	No, difficult with illiterate stakeholders	No	Unclear	Variable	Depends on use
Spidergram	Partial	Yes	Sometimes	Unclear	Depends on use	Depends on use
Venn diagram	Depends on use	Yes	Unknown	Depends on presentation	Depends on use	Depends on use
Who Counts Matrix	Depends on use	Depends on use and the way in which results are communicated	Unknown	Depends on presentation	Depends on use	Depends on use

feasible. Therefore, the researcher must develop suitably flexible guidelines and quality controls for research of this type. Cross-checking procedures are important. Clarifying surprising or contradictory results is important; such clarifications can highlight significant failures of assumptions or indeed provide valuable new insights (Sheil and Liswanti 2007). One cross-checking method involves implementing different approaches to elicit the same information, a process called triangulation. Another cross-checking solution would be to make sure that the membership of a focus group reflects the distribution of people or classes within the community. Yet another possibility is to start with coarse-level information and then iterate to finer and more precise information. The purpose and context will define the degree to which cross-checking is necessary. For example, a practitioner who has not yet developed trust with a community will have to implement a careful triangulation strategy, consulting widely with the community to determine if everything is as it seems, whereas a practitioner

with long-standing relationships with co-management partners and a significant level of trust will have more reliable results, is more likely to spot a problem when it arises, and may find additional methods unnecessary.

The tools evaluated here are all flexible and can be applied adaptively to co-learning or co-management approaches (Lynam et al. 2002). However, when a completely open research agenda is initiated in a co-management context, it is hard to predict where the process will lead. In this situation, investigators should encourage stakeholders to agree on a monitoring strategy for the process from the beginning. If the researcher/practitioner is a skilled facilitator and is comfortable adapting the tools, he or she can adapt them to suit the changing situation. Each tool can elicit a range of information or be used to achieve various outcomes. Future scenarios, for example, can identify major drivers of change that might then become the focus of the research. Scenarios can also be used to engage stakeholders in developing a common understanding of the future. The flexibility inherent in several of the tools reviewed here is a double-edged sword; on the one hand it increases the utility of the tool, but, on the other, it means that careless, uncritical, or ambiguous use may yield ambiguous results.

The flexibility of the tools is often an asset in precisely those situations in which the key issues are not yet clear or important questions have not been defined. In these contexts, it is recommended to start with creative and open tools such as future scenarios, Venn diagrams, participatory mapping, or spidergrams and then move steadily to the more focused methods such as discourse-based valuation or modeling. We also suggest shifting between creative and analytical tools to ensure that the results are not constrained by the tools or the issue currently in focus.

Uncertainty about the future is a key problem in decision making and research, and there are several participatory tools that can be used to explore the major sources of uncertainty as well as to quantify uncertainty by placing probability distributions on states or outcomes. Future scenarios explore uncertainty by stimulating creative thinking about the future and possible outcomes. Bayesian belief networks are also effective futuring tools, but require considerable specialist knowledge to use. Lynam (2001) has developed and used another method called "possibility diagrams," not included in this review, that enables local communities to express quantitatively their uncertainty about outcomes or relationships.

Participatory tools are often used to facilitate co-learning with a small group of participants. However, changing the views of a segment of a community can create new problems if the information and experience are not shared more widely. Communicating not only conclusions, but an understanding of where the conclusions come from, is important, but is a challenge. We have used theatre, videos, meetings, pamphlets, and posters to communicate results back to communities and other stakeholders. For instance, future scenarios narratives can be enacted as plays to demonstrate the possible stories about the future that the participants have developed. Where possible, a communication and dissemination strategy should be planned from the outset.

Different forms of engagement are appropriate in different circumstances. We might erroneously assume that more participation is always better and that co-management is preferable to co-learning, which is in turn superior to extractive and diagnostic approaches. However, this is not necessarily true in a project context. We know that it is difficult to involve every stakeholder in every decision, because neither time nor resources will allow it. Even polling views requires a considerable investment of resources. The practitioner needs to judge the strategies that can best enhance recognition of local people's stake in natural resource management.

Many of the tools discussed here, but particularly the computer-based modeling tools have the potential to become ends unto themselves, with the researchers focusing almost exclusively on development of the tool. This is a trap that needs to be avoided. The reason why a tool is being used needs to be clearly articulated in terms of a goal or end point that can be reached. The use of the tool after this end point must be justified, and the revised goal and new end point must be clearly stated.

CONCLUSIONS

Participatory tools are rarely used alone; they are typically part of a series of methods and procedures. Very often it is the combination of methods and the robustness of the research and implementation

design that determines if the tool is useful and ultimately effective. Although the process and context of implementation are critically important, we are able to provide a set of general guidelines to enable potential users to identify which tools may be best suited for their purposes. Most have a range of uses and applications. Some, such as spidergrams or Pebble Distribution Method can be used for many purposes; others such as participatory mapping are relatively narrow in their use. The criteria that we adopt are a first step in simplifying the process of tool selection. For most investigations or collaborations, we recommend general-purpose tools in the early stages of an analysis and then more situation-specific tools applied in a more precise and carefully defined manner to narrow the focus. Unexpected or contradictory results should always be examined further; we often learn most from investigating surprises.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/vol12/iss1/art5/responses/

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