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Synthesis

A Classification of Collaborative Management Methods

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ABSTRACT

Collaboration among multiple stakeholders can be crucial to the success of natural resource management. In recent years, a wide variety of methods have been developed to facilitate such collaboration. Because these methods are relatively new and come from different disciplines, little attention has been paid to drawing comparisons among them. Thus, it is very difficult for potential users to sort through the increasingly large literature regarding such methods. We suggest the use of a consistent framework for comparing collaborative management methods, and develop such a framework based on five criteria: participation, institutional analysis, simplification of the natural resource, spatial scale, and stages in the process of natural resource management. We then apply this framework to six of the more commonly cited methods: soft systems analysis, adaptive management, ecosystem management, agroecosystem analysis, rapid rural appraisal and participatory rural appraisal. Important differences among methods were found in prescriptions for stakeholder participation, institutional analysis, and simplification of complex natural resources. Despite such differences, the methods are surprisingly similar overall. All methods are applicable at the scale of a watershed. Most of the methods include techniques for understanding complex natural resources, but not complex social institutions, and most include monitoring and assessment as well as planning. Our comparisons suggest that, although much work has been done to improve collaborative management of natural resources, both in the development of collaborative methods and in related social science disciplines, the results have not been shared among disciplines. Further organization and classification of this work is therefore necessary to make it more accessible to both practitioners and students of collaborative management.

KEY WORDS: adaptive management, agriculture, agroecosystem analysis, collaboration, ecosystem management, natural resource management, participatory rural appraisal, rapid rural appraisal, soft systems analysis.

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INTRODUCTION

Managing natural resources, whether fish or farmland, involves understanding and manipulating complex systems containing both human and natural components. To manage these systems, groups with divergent interests and expertise are called upon to work together. In recent years, a multitude of methods to guide such collaborations has been described. Many of these methods have arisen simultaneously, and without reference to each other. The resulting abundance and redundancy of literature on collaborative methods present challenges to their potential users. First, because the methods have arisen in relative isolation from one another, they have not been placed in theoretical or practical relation to each other. This task falls to the potential user who seeks to choose among them. Second, the methods are often presented as complete packages that have been developed for specific applications. Such a presentation fails to highlight the aspects of a method that might be most important for a new application or user.

Previously, collaborative methods have been compared with respect to their use of participation, their incorporation of systems methods, and their overall strengths and weaknesses (Cornwall et al. 1994, Rocheleau 1994, Thrupp et al. 1994, Ison et al. 1995). Although these approaches are useful for understanding particular aspects of collaborative management of natural resources, or the usefulness of a particular method in a particular situation, they do not allow for extensive cross-referencing of different methods. Furthermore, because of the large number of methods and the even larger number of possible applications, describing which methods work in which situations is not feasible. A more useful approach would be to identify a set of criteria (e.g., Gardner 1989) that together describe the characteristics a method should have in order to successfully guide collaborative management. Such an approach has several advantages. The use of criteria allows potential users to compare multiple methods in terms of the criteria that are most important to their application. In as much as the criteria describe the components necessary for successful collaborative management, they can also be used to evaluate methods in absolute terms. Finally, criteria based in theory provide an introduction to the theoretical literature, enabling users to acquire more detailed information about specific aspects of collaborative management.

In this paper, we suggest five such criteria and apply them to six commonly cited collaborative management methods. We derive the criteria from aspects of collaborative management suggested to be important by common property resources theory, and from more general theories of collaboration and cooperation (Axelrod 1984, Gray 1989, Ostrom 1999). Together, the criteria are designed to evaluate the way in which methods grapple with the complexity of natural resources and social relationships, and the spatial and temporal scales at which they do so.

In the interest of describing the use of these criteria in greater depth, we have limited the number of methods we examine to six. We have applied the following standards (in order of priority) in choosing our methods. First, we have limited ourselves to methods designed to guide collaborative natural resource management. Second, because little attention has been given to comparing methods across disciplines (but see Rocheleau 1994), we have included methods from both the agricultural and natural resource management literature. Within those broad areas, we have tried to choose the most frequently cited methods. Finally, although we have aimed for breadth in our overall choice of methods, we have also included a set of closely related methods to assess the worth of the criteria in differentiating among similar methods. From the agricultural literature, we have chosen “soft systems analysis” and a set of interrelated methods: “agroecosystem analysis,” “rapid rural appraisal,” and “participatory rural appraisal.” From the natural resource management literature, we have chosen “adaptive ecosystem assessment and management” and “ecosystem management.” For each method, we begin by presenting its history: who developed it, from what, and to what end. We then evaluate the method according to each of the five criteria. Finally, in order to make the description of the method more concrete, we summarize a case study of each method.

Our goals are to illustrate the utility of a consistent framework for comparing methods, to provide an introduction to both the theoretical and the practical literature on collaborative management, and to stimulate dialouge among the various disciplines involved in collaborative management.

DESCRIPTIONS OF CRITERIA

Criterion 1: Participation

Each group involved in a collaborative effort will have its own interests and expertise. The creation of knowledge and the standards that determine its validity will also be unique to each group. The extent to which a collaborative method fosters discourse between such divergent groups, allowing for the productive interaction of different types of knowledge, constitutes our first criterion.

Historically, methods to manage complex human and natural systems have adopted a positivist framework: they have favored knowledge claiming universal validity, often labeled scientific knowledge (Irwin 1995, Lele and Norgaard 1996). Dissent from this framework has arisen from two sides. Social theorists have increasingly described science as a social process that generates results contingent upon the values and structures of the scientific community. Theorists have thus cast doubt on the universality of scientific knowledge (Norgaard 1994). At the same time, researchers have placed more value on the technical and cultural knowledge of citizens in their search for solutions or improvements to local problems (Chambers 1989, Gray 1989, Scoones and Thompson 1994, Thrupp et al. 1994). Collaborative methods have arisen as part of this historical trend toward greater valuation of local knowledge.

Participation serves several practical purposes in collaborative management. Multiple stakeholders provide multiple perspectives, leading to the development of a comprehensive understanding of the problem (Gray 1989). Furthermore, broad participation greatly reduces the possibility that one or more stakeholders will prevent the results of a collaborative effort from being enacted (Gray 1989). Over time, participation also increases the knowledge that each stakeholder has about the actions of the others. This knowledge, together with the interaction itself, can lead to the development of trust among stakeholders (Axelrod 1984, Ostrom 1992). Trust, in turn, greatly facilitates collaboration by increasing the ease of planning and decreasing the costs associated with monitoring stakeholder behavior (Gray 1989, Baland and Plateau 1996, Ostrom 1999).

Criterion 2: Institutional analysis

Our second criterion describes how participants organize their interactions with one another. Most natural resource management decisions are made by some form of social institution, whether an extended family or a large regulatory agency. Collaboration has been described as a process of “deinstitutionalization and reinstitutionalization” (Gray 1989: 236). As participants step out of their customary roles and interact with new people and groups, old social institutions are changed and new ones are formed. Because the long-term success of collaborative management depends on the success of these new institutions, it is important for collaborative methods to consider those aspects of institutional structure that lead to institutional success (Ostrom 1990). Factors leading to effective resource management institutions include, (1) a well-defined group of stakeholders, with legitimate stakes in management of the natural resource and sufficient autonomy to act on their decisions; (2) a balance of power among those stakeholders; (3) financial resources to sustain the institution; (4) sanctions to encourage cooperation once decisions have been made; and (5) mechanisms for resolving conflict (Gray 1989, Baland and Plateau 1996, Ostrom 1999). Criterion 2 is a measure of the degree to which a method considers such institutional attributes in guiding collaborative natural resource management.

Criterion 3: Simplification of natural resource

Developing a common understanding of a resource is an important step in managing that resource collaboratively (Gray 1989, Ostrom 1990, 1999). Stakeholders must come not only to see the resource from multiple perspectives, but also to understand the improvements that might be made through management (Gray 1989, Ostrom 1999). Particular attributes of the resource may facilitate such understanding, such as clear boundaries, predictability, and the presence of indicators of resource quality (Ostrom 1999). Where natural resources are less easily understood, ways of simplifying those resources are necessary if collaborators are to reach a common understanding of the resource and options for its management. Our third criterion describes the attention that a method gives to natural resource complexity and the techniques that it provides for making that complexity easier to understand.

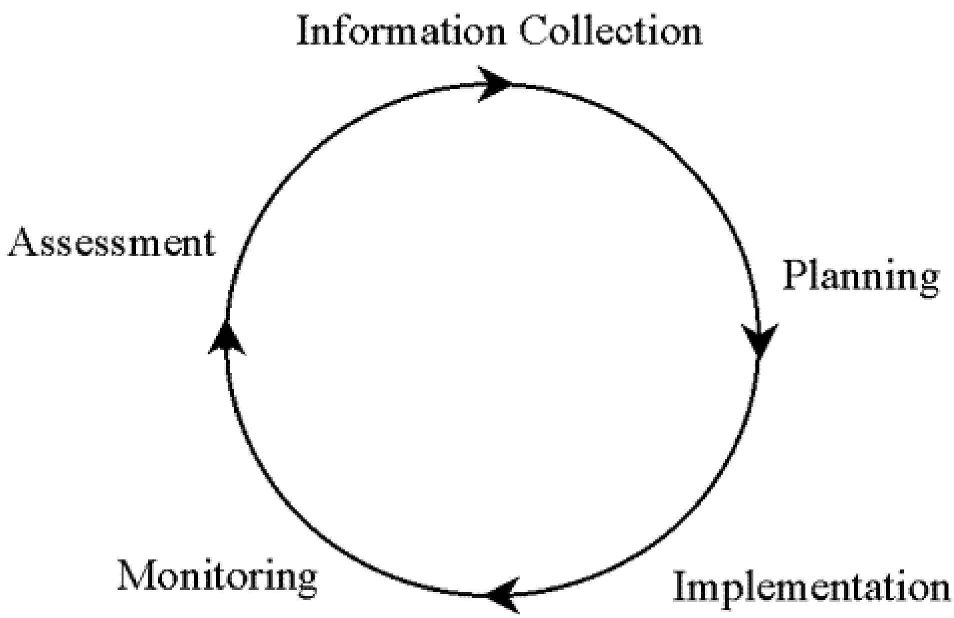
Criterion 4: Scale of application

The spatial scale on which the methods were designed to operate varies considerably, from single farms to very large ecosystems. Spatial scale has been found to influence both the social and natural aspects of resource management. More stakeholders are involved at larger scales, making the *collaboration* part of collaborative management both more essential and more difficult. As the number of stakeholders increases, the number of interactions among stakeholders and the stakeholders’ knowledge of each other’s actions decrease, lowering the likelihood of collaboration (Axelrod 1984, Ostrom 1992). Larger scales also encompass more variation in the ecosystems being managed, making generalizations about the system and its management more problematic. Conversely, at very small scales, important stakeholders may be left out of the process (Gray 1989) and collaborators may not have the resources necessary to organize and maintain the social institutions of collaborative management (Ostrom 1999).

Criterion 5: Stage of application

The fifth criterion describes at what point in the process of management a particular method is designed to be used. For example, a method may be most useful in decision making; alternatively, a method may be designed for assessing the impacts of decisions made through other processes. To visualize differences among methods, we have divided the process into five stages at which they can be applied (Fig. 1). The importance of stage of application to collaborative management is suggested by the frequency with which authors call for either monitoring (the assessment stage has often been ignored), or adaptive management (which includes iteration among all of these stages). Inclusion of multiple stages and/or iterations among stages serves to increase the frequency and duration of interactions among collaborators, thereby increasing the likelihood of successful collaboration (Axelrod 1984, Ostrom 1999). Individual stages may also be particularly important. For example, much stronger forms of collaboration are thought to occur in methods that guide, rather than simply respond to, decision making (Rocheleau 1994, Irwin 1995).

Fig. 1. An iterative view of management.



Classification of methods according to specific criteria helps to organize one's understanding of these techniques and allows for cross-referencing among individual methods. In order see relationships among all of the methods at once, we present the criteria graphically (Fig. 2 and Fig. 3).

Fig. 2. Spatial scales at which methods have been applied.

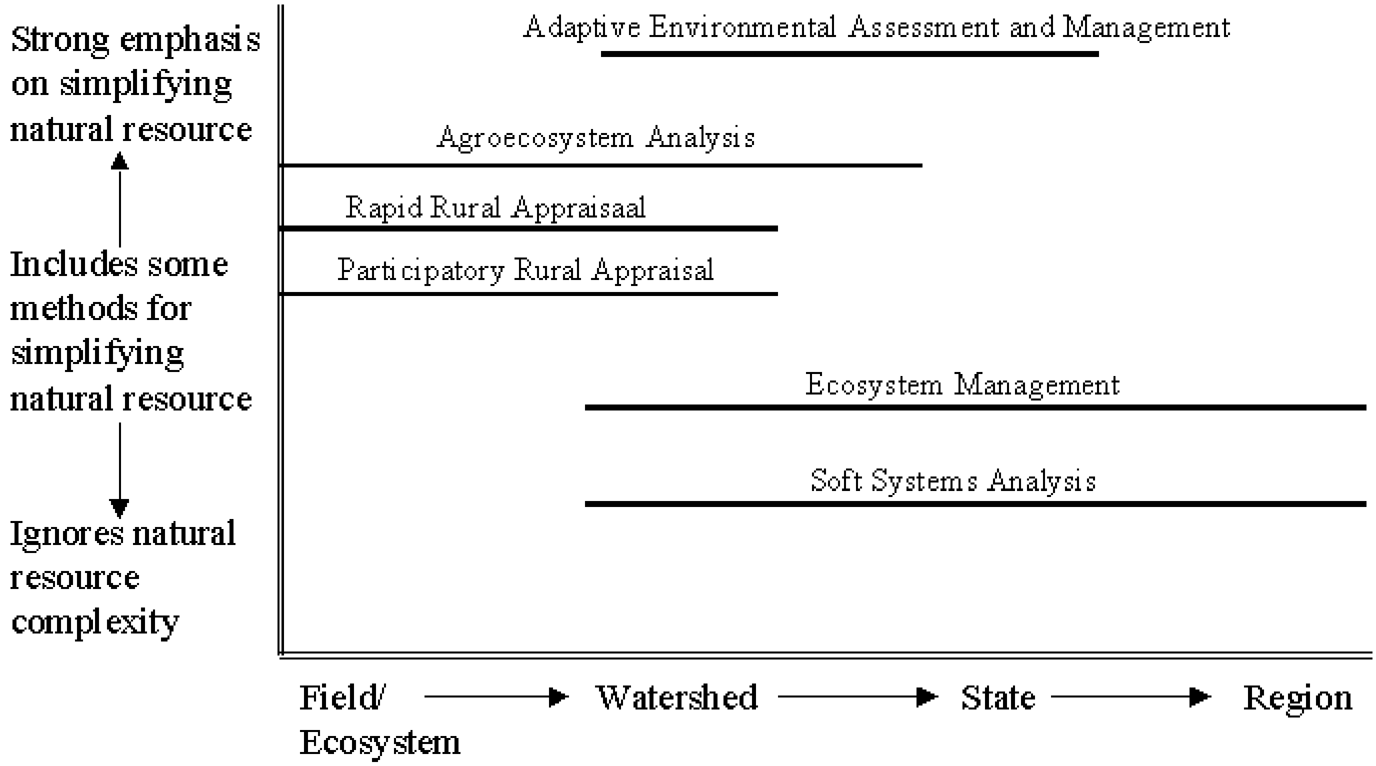
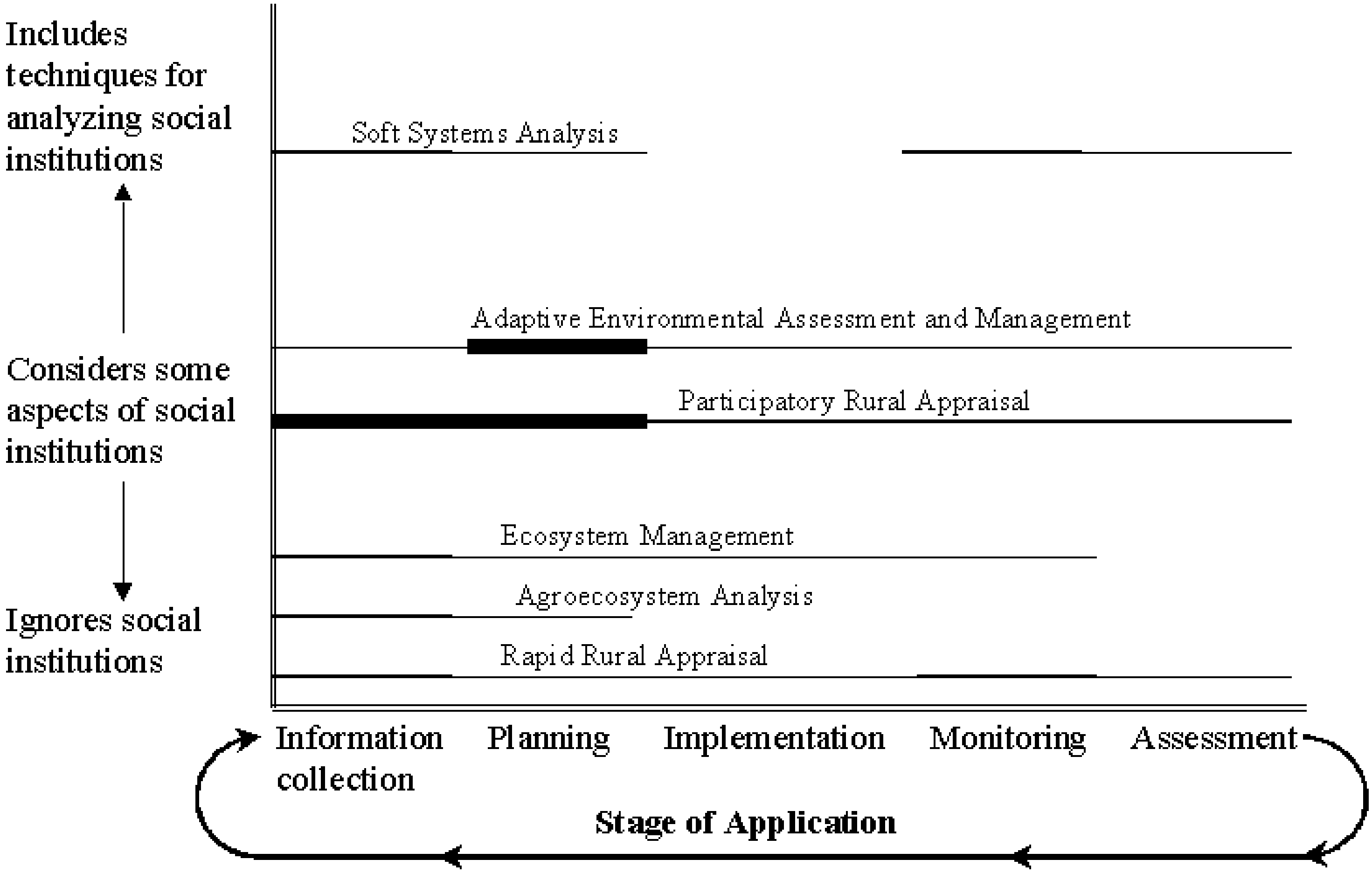


Fig. 3. Stage of application, participation, and institutional analysis. The *x*-axis describes the stages of management addressed by each method. The thickness of the line represents the degree of participation at that stage, with thicker lines representing more participation. The *y*-axis shows the attention given by each method to social institutions.



DESCRIPTIONS OF INDIVIDUAL METHODOLOGIES

Soft systems analysis

Soft systems analysis (SSA) is a technique for understanding complex human activity systems (i.e., systems that include people) from multiple perspectives (Checkland and Scholes 1990). "Soft" refers to the flexible nature of human activity systems, the fact that they change depending on the observer. Soft systems analysis allows people to set objectives and means by which to accomplish objectives with respect to a particular system *despite* the soft nature of a system. It works by compartmentalizing a system, whittling it down to its essential components, those that drive, allow, or constrain the workings of the system. Using SSA involves a methodical examination of the roles and values of the people involved in a collaborative effort, the outcomes desired by those people, and the constraints on change exerted from outside the system. These factors are used to create visual and verbal models of the system that enable the user to understand the system from the perspectives of multiple stakeholders (Appendix 1). The main strength of SSA is its ability to include, and limit the analysis to, those factors relevant to enacting change.

History. – Soft systems analysis was developed by Peter Checkland (1981) and later expanded by Checkland and Scholes (1990). Its origins lie in a combination of systems engineering (a hard systems approach) and action research (a mode of inquiry that includes the place of the researcher relative to the object of study; Checkland and Scholes 1990). Although SSA was developed with an eye toward managing large corporations, its usefulness in understanding the human activity systems that interact with natural ecosystems was quickly recognized, and the original form of SSA (Checkland 1981) has been elaborated in relation to such systems (Wilson 1988, Wilson and Morren 1990).

Participation. – Soft systems analysis does not explicitly include participation. However, its primary focus is the inclusion of multiple perspectives. Although the qualitative modeling that forms the base of the method might be done by a single person, that person must somehow come to understand the system through the eyes of all people with power to affect the system. Participation per se may be difficult to achieve with SSA, given the complexity of the method and the amount of time necessary to become versed in it. It can, however, be used by group facilitators as part of a process in which collaboration is desired

(Appendix 1).

Institutional analysis. – Soft systems analysis includes explicit consideration of two important aspects of institutions. It begins with a careful description of the people and groups involved in the collaborative process, and attempts to model the system from the perspective of each (Checkland and Scholes1990). This analysis is complemented by ongoing analyses of the roles and values of individual stakeholders and the power dynamics among stakeholders (Checkland and Scholes 1990). Although SSA does not suggest institutional configurations that work for natural resource management institutions, its practical methods for examining institutional components would complement the institutional structure approach taken in the common property resources literature.

Simplification of natural resource. – Within SSA, the natural ecosystem is a subsystem that can be modeled as a hard system, i.e., a system for which objectives may be set (Wilson and Morren 1990). Therefore, SSA defers to hard systems approaches for reducing complexity. In this respect, SSA resembles the hard systems modeling approaches of adaptive management and agroecosystem analysis.

Scale. – At very small scales, for example, a few farms or a local park, stakeholders may be few enough for the system to be treated as a hard system. At larger scales, with more people involved, the soft nature of systems will tend to become more important (Appendix 1). The limitation at very large scales is the analyst’s ability to acquire information about the various important components of the system.

Stage of application. – SSA is a technique aimed at organizing information to enable objective setting and planning (Appendix 1). Although it does not include techniques to guide implementation, it is explicitly iterative; the model of the soft system changes as work with the model yields additional information.

Adaptive Environmental Assessment and Management/Adaptive Management

These two terms cover very closely related methods. Adaptive Environmental Assessment and Management (AEAM) is a process of organizing people and their decisions around systems modeling and iterative hypothesis testing (Appendix 2). Strictly speaking, Adaptive Management (AM) refers only to the systems-modeling/hypothesis-testing portion of AEAM, although it is often used more broadly (McLain and Lee 1996). Adaptive Management aims to base management decisions on site-specific information gained through experimentation with management. Experimentation with management serves to combine information collection and policy design into a single process, in which policy is both informed by, and designed to yield, information. AEAM places Adaptive Management within a context of regional modeling workshops, aiming to ensure that all stakeholders take part in the learning process (Walters 1986).

History. – Adaptive Environmental Assessment and Management emerged from the work of researchers at the International Institute of Applied Systems Analysis, and has been defined largely by two key books (Holling 1978, Walters 1986). Although AEAM represents a new concept for natural resource management, its basic ideas are borrowed from control process theory (whence the concept of iteration) and operations research and management science (which provided theory on the use of systems modeling and hypothesis testing to solve complex problems; McLain and Lee 1996).

Participation. – Participation is built into AEAM through regional modeling workshops in which participants set goals and seek a common understanding of a system through modeling. Participation may be limited by the workshop composition and/or the inaccessibility of the systems modeling techniques (Gardner 1989, McLain and Lee 1996). The explicit reliance on systems modeling and hypothesis testing also limits the type of knowledge included in the AEAM process. Where differences in values and/or objectives are central to management issues, this limitation may lead to the failure of AEAM as a strategy (Appendix 2; McLain and Lee 1996).

Institutional analysis. – Adaptive environmental assessment and management has focused on resource management by existing institutions; perhaps for that reason, it does not emphasize the role of social institutions. Subsequent work, however, has focused on both institutional resilience (Gunderson et al. 1995) and social learning (Lee 1993). Because of its focus on change as a constant feature of resource management, much attention has been given to the means by which existing institutions can adapt to new social and ecological environments. In the process, institutional characteristics such as the inclusion of important stakeholders (Gunderson et al. 1995), a balance of power among stakeholders (Westley 1995), and the process of conflict resolution (Lee 1993) have been addressed. Although this body of theory has not been integrated into a method, as in the case of Adaptive Management per se, it has the potential to increase the range of applicability of AEAM, enhancing its success as a method for complex social situations.

Simplification of natural resource. – By rejecting the notion that all of the components of the natural system must be understood in order to effectively manage the system, AEAM automatically reduces amount of natural resource complexity that must be understood. Systems modeling, an integral part of AEAM, further reduces complexity by identifying the important components of a complex natural resource and using them to limit the number of possible management options (Walters 1986). Modeling is an effective approach for dealing with large and/or complex natural systems, but requires expertise, technology, and a commitment to learning on the part of stakeholders. Thus, it may be difficult to apply in many situations (McLain and Lee

1996).

Scale. – Adaptive Environmental Assessment and Management typically focuses on a particular problem at the scale of a particular ecosystem (Appendix 2). The scale at which the ecosystem is defined appears to be a compromise between the scale at which important ecological interactions occur (Walters 1986) and the ability of the various stakeholders encompassed by this scale to interact effectively.

Stage of application. – Adaptive Environmental Assessment and Management is explicitly iterative (thus the word "adaptive"), and includes descriptions of techniques for information gathering, planning, management, and assessment. This is both one of its foci and one of its strengths (McLain and Lee 1996).

Ecosystem management

Ecosystem management is a broad concept. In the words of one commentator, "Ecosystem management is a concept in search of a practice" (Alpert 1995). There is disagreement about whether the concept is a more or less coherent body of ideas (Grumbine 1994) or a battleground for conflicting ideologies (Stanley 1994). The most common approach in the literature is to present EM as a wish list (Borman et al. 1994, Grumbine 1994, Irland 1994, Jensen and Everett 1994). In some cases, the items on the wish list may be in direct opposition to one another (Brunner and Clark 1997). Common themes in the EM literature include systems thinking, maintenance of ecological structure and function, the need for scientific data in both planning and monitoring, and the need to consider human values and institutions (Grumbine 1994, 1997).

History. – Although ecosystems have been a subject of interest in natural resource management for some time, it is only recently that the term “ecosystem management ” has become popular (Agee and Johnson 1988), and even more recently that EM has started to be developed as a method (Grumbine 1994, Alpert 1995). In 1992, it took on political significance when the U. S. Forest Service adopted EM as its official policy for managing national forests (Borman et al. 1994). Other federal agencies followed suit (Grumbine 1997). Once an officially sanctioned buzzword, the definition of Ecosystem Management became the subject of much debate.

Participation. – Ecosystem management has developed within agencies with complete jurisdiction over large tracts of land and, therefore, little overt need for participation. Calls for participation have increased in recent years (Borman et al. 1994, Daniels et al. 1994, Grumbine 1994, 1997), largely in response to increased spatial scales of management, which require cooperation from, and hence collaboration with, private landowners and/or other agencies (Appendix 3; Irland 1994, Sample 1994). Some calls for participation, however, recognize the need for public support even where jurisdiction over the managed area is held by a single agency (Borman et al. 1994, Daniels et al. 1994, Grumbine 1997). Despite much interest in participation, prescriptions for achieving participation are largely absent from the literature. Such prescriptions may, in time, be gleaned from surveys of case studies (Daniels et al. 1994, Brunner and Clark 1997).

Institutional analysis. – Although institutional change has been included in many discussions of EM (Grumbine 1994), the literature has focused almost exclusively on natural, rather than social, systems (Gerlach and Bengston 1994). More recent work, however, describes how and why institutional analysis should be conducted within the context of EM (Imperial 1999).

Simplification of natural resources. – A primary goal of EM has been to draw attention to the complexity of natural resources (Borman 1994, Grumbine 1994). Efforts have also been made to identify those aspects of ecosystems that require attention in order to manage them effectively (Grumbine 1994). Nevertheless, specific techniques for understanding complexity are not included within EM.

Scale. – Many authors suggest that EM should be applied over large spatial and temporal scales (e.g., Gerlach and Bengston 1994, Borman et al. 1994). This focus on large scales appears to stem from the importance, in the development of EM, of both species with large ranges and institutions with large jurisdictions. Most of the literature considers ecosystem management to be applicable at or above the scale of a watershed (Borman et al. 1994, Irland 1994, Jensen and Everett 1994).

Stage of application. – By virtue of its breadth and flexibility, ecosystem management tends to be defined to include all stages of the management cycle. Primary emphasis is placed on planning, but many authors also stress the importance of monitoring, often with explicit reference to adaptive management (Agee and Johnson 1988, Borman et al. 1994, Grumbine 1994, 1997, Jensen and Everett 1994, Brunner and Clark 1997). Some authors also stress the need for increased information collection (Borman et al. 1994, Grumbine 1994).

Agroecosystem Analysis (AA), Rapid Rural Appraisal (RRA), and Participatory Rural Appraisal (PRA)

These three methods are presented together because of their common origins in development work within what Chambers (1989) calls complex, risk-prone, and diverse (CRD) agricultural systems. The primary codifiers of AA, RRA, and PRA have been Gordon Conway and co-workers (Conway 1985, 1986, McCracken et al. 1988) and Robert Chambers (Chambers 1994*a, b, c*), although others have been involved in parallel developments (the Sondeo method: Hildebrand [1986], Brophy et al. [1991]; informal agricultural survey: Rhoades [1986]; participatory farmer design: Ashby [1990]).

History. – Agroecosystem Analysis originated in the late 1970s at the University of Chang Mai in northern Thailand (Conway and Barbier 1990). At the time, interest in Farming Systems Research was increasing, motivated by the realization that production per unit area was not the only constraint facing farmers in their pursuit of improved livelihood. To be adopted, new technologies needed to heed other constraints and, therefore, to emerge out of an analysis of the farm system as a whole. Agroecosystem analysis is a codification of the kinds of information that need to be gathered in order to generate technologies appropriate to different farming systems. It entails a broad and often visual systems analysis (Conway 1986) used to understand opportunities and constraints in an agroecosystem.

Thai agricultural researchers found the formal interviews and surveys of AA too slow for obtaining data from rural areas. More rapid methods were needed (McCracken et al. 1988), and the series of techniques developed in response to this need came to be grouped under the umbrella term of RRA. Rapid rural appraisal adopts a systems framework that owes much to AA. To this framework, RRA adds a specific philosophy on information gathering: the process is rapid but seeks information from several sources to improve its reliability; the process is iterative, allowing knowledge gaps to be filled successively; the process avoids formality; and learning takes place with community participants (McCracken et al. 1988: Chapter3). Indeed, much of the impetus behind the development of RRA techniques came from the desire to bring local knowledge to bear on analyses such as AA. A number of techniques have evolved in conjunction with this philosophy, including semi-structured interviews, reliance on key informants within the community, and group interviews.

One subset of RRA, the participatory RRA (PRA), was later much expanded and given its own philosophical foundation, primarily by Chambers (1994*a, b, c*). Other intellectual progenitors of PRA include activist participatory research and applied anthropology (Chambers 1994*a*). According to Chambers (1994*a*), PRA encompasses a family of methods to enable local people to share, enhance, and analyze their knowledge of life and its conditions, to plan, and to act. Many of the techniques used in PRA are similar to those used in RRA, with an added emphasis on visual sharing of information (Chambers 1994*a*). The distinction between RRA and PRA comes from PRA's insistence that local groups themselves analyze the data collected, and that they plan and manage accordingly. The role of outside groups is one of convening and facilitating (Appendix 4).

Participation. – Agroecosystem analysis was designed to facilitate collaboration among teams of researchers. Although the diagrams of systems components that are the primary tools of AA are designed to be accessible to researchers, farmers, and policy makers, AA does not require participation of local groups.

Overwhelmingly, RRA values local knowledge. The techniques that it encompasses capitalize upon the information that becomes available when local groups are asked for their expertise. Nevertheless, the goal of RRA is not necessarily to enable local analysis of information or to facilitate local action. Like AA, RRA uses an analytical framework that may have little to do with local modes of thought. Rapid rural appraisal bills itself, above all, as an effective method for generating cost-effective and adoptable development projects (McCracken et al. 1988).

If there is any theme central to the philosophy of PRA, it is that the people living within a given area have the best information to manage that area. Coupled with this theme is the theme of empowerment: local inhabitants not only have the best information, but also need to be given the power to act to make changes in accord with the information at their disposal. Thus, PRA seeks to include not only local knowledge, but also local analysis and decision making. Some PRA practitioners also advocate activism and politicization of the PRA teams in working with local people (Holland and Blackburn 1998). The attention given by PRA to local participation, however, may come at the expense of outsider participation. For example, no place is provided within PRA for the application of scientific knowledge.

Institutional analysis. – Agroecosystem analysis does not seek to change social institutions, but to develop technologies that will fit within given agroecosystem constraints. Agroecosystem analysis is therefore concerned with social institutions only insofar as they give rise to such constraints. That said, AA's approach to the relationship between a new technology and social structure is not simplistic: AA entails discussion of a technology in terms not only of system productivity, but also of distributional equity, stability, and sustainability (Conway 1986). Tools of analysis at this level are few, however. Rapid rural appraisal is designed for collecting information and, consequently, does not address the structure of the institution that might use that information. By contrast, inclusion and empowerment, two prerequisites for sustainable institutions, are central themes of PRA. Evidence for PRA's effectiveness at empowering at the grassroots level comes from the way in which its techniques have spread. Chambers (1994*c*) gives the example of villagers who had previous experience with PRA demonstrating the techniques in another village in Gujarat. Despite such examples, it is unclear how consistently PRA delivers local empowerment and effective development (Webber and Ison 1995, Holland and Blackburn 1998). Where PRA does not succeed, it may be due to a lack of in-depth institutional analysis. Critics of PRA have recognized this possibility, and have begun to describe how detailed institutional analyses can be used in conjunction with PRA (Scoones and Thompson 1994).

Simplification of natural resource. – The systems analyses used by AA include characterization of the context within which the system is embedded, and then of several aspects of the system itself: a history; maps/transects; seasonal calendars; flows of energy, materials, and information; and decision trees affecting actor choices (Conway 1986). Diagrams of the system components are used in formulating key management questions that can be addressed through research. Many of these same techniques are used in RRA, which also emphasizes semi-structured interviews, the collection of only relevant information, and iteration. Although PRA uses many of the same techniques as AA and RRA, PRA shifts the job of simplifying the resource from the outsiders to the local community, and focuses on visual rather than verbal techniques (Chambers 1994*a*).

Scale. – Agroecosystem Analysis claims to be applicable to many scales of systems analysis, from the farm field to a region containing multiple agroecosystem zones (Conway 1986). In practice, the method has focused on two scales. At or above the watershed scale, AA helps to delineate "recommendation domains" within which agroecosystems are sufficiently similar to benefit from the same recommendations. At a local scale, AA functions to improve understanding of farming system opportunities and constraints. Rapid and participatory rural appraisal have been adopted primarily at the level of individual communities (Webber and Ison 1995). Unlike AA, RRA and PRA do not emphasize system hierarchies, and their historical restriction to the community level may limit their use at other scales.

Stage of application. – The primary stages of application of AA are the initial information-gathering and planning stages. Agroecosystem analysis does not purport to provide techniques to be used during management of a new technology or for assessing its effects. In contrast, RRA has been explicitly divided into four classes, each representing a different stage of application: exploratory (to obtain initial information), topical (to explore a chosen issue in more detail), participatory (to elicit more participation in regard to possible plans), and monitoring (to asses management impacts). These classes of RRA should adapt it for use at multiple stages (McCracken et al. 1988). Participatory rural appraisal has similarly been used for planning, implementation, monitoring and assessment of programs (Chambers 1994*a*). A variety of examples, however, support the contention that RRA and PRA most often address the initial stages in the management cycle (Appendix 4, White and Tacket 1997). Given PRA's emphasis on local decision making, it may operate under an assumption that monitoring can happen automatically at the local level.

DISCUSSION

Methods for managing complex human and natural systems have been constructed in response to the inherent difficulty of the task. As the need for collaboration among stakeholders has become increasingly evident, this added level of complexity has led to both changes in existing methods and the development of new methods. The criteria presented in this paper are meant to facilitate learning about collaborative management by providing a framework for comparisons among multiple methods. Here, we discuss what we learned through the application of these criteria, and suggest how we, as students and practitioners of collaborative management, can improve our collective ability to learn from experience.

The application of the five criteria pointed to several important differences among the methods that we examined. For example, although almost all of the methods recognize the importance of stakeholder participation, the methods differ in the degree and timing of that participation (Fig. 3). With respect to the analysis of social institutions, SSA includes practical techniques for analyzing institutions; AEAM and PRA emphasize particular aspects of institutions; and the remaining methods have largely ignored institutions (Fig. 3). Similarly, AEAM contains sophisticated techniques for making sense of complex natural resources; AA, RRA, and PRA rely on simpler visual models; and SSA and EM do not contain any such techniques (Fig. 2).

Notwithstanding important differences among methods, the most important lesson learned from our application of these criteria is that there is a great deal of similarity among methods. Given the diverse origins and purposes of these methods, the degree of similarity among them is surprising. For example, most of the methods are applicable at the watershed scale, although those originating in agricultural management seem to be aimed toward somewhat smaller scales (Fig. 2). Most of the methods are also explicitly iterative, but provide little help in implementing strategies developed during planning stages (Fig. 3). Finally, with the lack of attention to implementation comes a neglect, by all of the methods, of the institutional structures necessary for implementation (Fig. 3).

Similar charateristics among methods appear to have arisen from similar needs in collaborative management. The iterative nature of these methods serves the same purpose in each of them: to allow for adaptation of management strategies over time. Similarly, participation is usually desired to create management practices that enjoy ongoing support from stakeholders. Furthermore, because collaboration is unimportant at very small scales and intractable at very large scales, it makes sense to design methods for use at the watershed scale. That different schools of thought have developed similar methods is encouraging, because it suggests that the methods address important aspects of collaborative management. Such parallel developments also suggest, however, that we have thus far been ineffective at learning across disciplines. Although it is understandable that we would invent the wheel several times in such a new area of study, the importance and difficulty of managing our natural resources suggest that we should not to continue to do so.

There are several things that can be done to facilitate learning about collaborative management. First, we must stop to examine wheels that have already been designed. This will be difficult, not only because the literature is diverse and comes from a number of different disciplines, but also because many of the experts in this field are specifically charged with *doing,* rather than teaching or learning. Nevertheless, comparative analyses, like that presented here, reveal many ways in which practitioners of one method can learn from another. For example, recent discussions of EM have adopted an emphasis on monitoring and assessment from AEAM (Grumbine 1994), whereas the same would be very useful for, but is notably absent from, SSA (Mills-Packo et al. 1991). Conversely, many of the methods might benefit from the practical approach to institutional analysis that is included within SSA.

The second thing that we must do, now that we have a passable understanding of the idea of the wheel, is to pay more attention to pieces of our wheel, which, luckily, have already been well studied. Much relevant theory can be found within the social sciences. Theories of common property resources and collaboration provide not only the rationale for, but also more detailed exploration of, the criteria used in this paper (e.g., Axelrod 1984, Gray 1989, Baland and Plateau 1996, Ostrom 1999). In addition, certain aspects of social institutions that are important to collaborative management have been particularly well studied by social scientists, including, power dynamics among stakeholders (Peet and Watts 1996), public involvement processes, and conflict negotiation and mediation (Endter-Wada et al. 1998). Grounding collaborative methods in theory will help us to compare and improve upon methods, and also will provide a road map for those wishing to explore particular aspects of collaborative management in more detail.

In sum, in developing these methods for collaborative management, most of which hold experimentation and monitoring as central tenets, we have done a good deal of experimentation. Because our methods for experimenting are also experimental methods, we suggest that we now should make a concerted attempt to monitor our own progress and learn from our experience. The five criteria presented in this paper have proved useful in organizing our understanding of a subset of these experimental methods. Further organization and classification of these methods would greatly facilitate the formidable task of learning collaborative management.

RESPONSES TO THIS ARTICLE

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APPENDICES

Appendix 1. Soft Systems Analysis applied in Hawaii (Mills-Packo et al. 1991).

The Extension Service of the land grant colleges in the United States has as its primary purpose helping farmers through the transfer of technology. Because of the speed of change in agriculture and budget limitations, however, the extension service is not always able to fulfil this mandate effectively. On the island of Kona, Hawaii, several researchers attempted to improve the relationship between the university and tree farmers through the use of SSA. The initial process took less than a year and relied heavily on the facilitation provided by Mills-Packo et al. Within that time, several iterations of information gathering, modeling, and planning were carried out:

• Participants (both farmers and extension personnel) were interviewed.

• “Mind maps” were developed to illustrate participant’s view of extension.

• A second set of interviews, centered on the mind maps, was conducted to learn about changes desired by participants.

• More detailed models were drawn of four of the most commonly mentioned changes.

• These models were refined, both by discussion among a subgroup of participants and by a third set of interviews, and were elaborated into 31 “proposals for change.”

• Participants debated these proposals to determine what action to take, and developed an “implementation plan.”

The most important result of this process was increased communication among farmers and between farmers and the university. The process also generated ongoing political involvement of farmers, which, in turn, led to the provision of funding for an additional extension agent.

Despite this progress, the authors noted two limitations to the use of SSA. First, SSA did not include sufficient guidelines to ensure collaboration of all relevant stakeholders. Limited involvement by university personnel in the refinement of the models meant that these models did not necessarily represent their views. The second limitation noted was that SSA was useful only in information gathering and planning. Additional processes may be needed to implement change, especially where controversy exists or where many stakeholders are involved.

Appendix 2. Salmon and Adaptive Management in British Columbia (Walters et al. 1993).

In Rivers Inlet, on the British Colombia coast, the sockeye salmon population relies on naturally spawning salmon to maintain the population. To maintain large salmon populations, it is thus necessary for a certain number (somewhere between 250,000 and 1.5 x 10^6) of fish to escape fishing each year. Because of the economic importance of the fishery, it is important for the number of salmon returning each year to be as large as possible. For this reason, and because very low salmon populations were recorded several times between the late 1950s and mid-1970s, the Department of Fisheries and Oceans (DFO) decided to experiment with management, halting fishing in the inlet in the hopes of rebuilding salmon populations and learning how many spawning salmon were necessary to yield the maximum population size. Unfortunately, the inherently large variability in salmon populations and uncertain methods for counting salmon meant that five years into the project, they still were not able to determine whether more spawning salmon were resulting in higher populations. Thus, a workshop was held by the DFO in which their own scientists worked with fishing industry representatives to design a new plan for managing the salmon harvest. Participants used mathematical models, either hand calculations or simple computer simulations, to examine the effects of different harvest strategies on salmon populations. These models structured the communication about different potential options, and allowed them to reach agreement on a new strategy in which fishing was allowed to resume. This strategy also pursued the original AM experiment by occasionally allowing large numbers of spawners to escape fishing, but over a much longer time frame (60-80 years). The result of collaboration in this case was not ideal from a scientific, and perhaps a long-term economic, standpoint. The authors suggested that the original lack of collaboration and inadequate assurances of meaningful results were largely responsible for the lack of support for the experimental policy. The authors recommended that collaboration be included throughout the various stages of the AM process.

Appendix 3. Ecosystem Management in the Everglades (Harwell 1998).

The Florida Everglades ecosystem is at once diverse, highly valued, and highly disturbed. Because of the size of the ecosystem (originally more than 10,000 km^2) and the importance of water to the various human activities adjacent to the Everglades, its management is both complex and controversial. Attempts to control the hydrology of southern Florida for flood control and the creation of farmland have led to decreases in both the quantity and the quality of the water moving through the Everglades. In turn, these changes in the water regime of the ecosystem have led to large-scale community shifts and dramatic reductions in many bird populations. Although the interconnectedness of the ecosystem and the consequent necessity of large-scale management were recognized early in the 20th century (Light et al. 1995), it is only within the last decade that the term “Ecosystem Management” has been applied to the Everglades. During this same decade, government agencies, scientists, and industry have intensified their efforts to reach both an understanding of the ecosystem and an agreement about its management. Participation in ecosystem management of the Everglades has been scaled up to match the size of the ecosystem. Two separate institutions, the federal Interagency Task Force and the state Governor’s Council have coordinated information collection and planning among government agencies, social and natural scientists, environmental groups and industry.

Preliminary results of the process are promising. Scientists have found that there is plenty of water entering the Everglades, and that satisfying multiple stakeholders may be accomplished, at least in part, simply by altering the hydrology of the system. Collaboration continues to be key, however, in working out the relationship between sugar cane production and the Everglades. Because of the importance of hydrology and the public ownership of most of the Everglades, participation in the *implementation* of ecosystem management will be limited largely to government agencies (particularly the Army Corps of Engineers), and the sugar industry; *information collection and assessment* will be done by scientists, and full participation will recur with subsequent rounds of planning.

Appendix 4. Landcare and Participatory Rural Appraisal in the Kyeamba Valley, New South Wales. (Webber and Ison 1995)

The Kyeamba Valley comprises about 90,000 ha, with 100 landholders involved in agriculture: cropping, dairying, sheep, and beef production. A PRA was initiated in conjunction with Landcare, a government-funded program to stimulate and support local land and water resource management. The team of researchers strove to include participation throughout the PRA process. They first interviewed 30 landholder families, seeking to elicit individual and family perspectives about social, physical, and economic issues affecting their livelihoods. Themes that emerged from these interviews were used to structure problem identification workshop, attended by 72 landholders. Participants in the workshop prioritized issues. The research team then organized these priorities for subsequent discussion. Finally, small groups of participants explored specific issues in greater depth and began to identify opportunities for action. In this case, the PRA stopped at the initial stages of planning. A second PRA, conducted to assess the results of the first, found that the new connections between local landowners, and the exploration of common concerns led to limited amounts of action on several of those concerns. In this PRA, the scale (large enough to allow new relationships to form among participants but small enough to allow a large proportion of the community to participate) interacted effectively with the type of collaboration (an emphasis on problem identification, discussion, and relationship building) to generate new community networks. The restriction of the PRA to the information collection/planning stages, however, appears to have limited its worth as a tool for generating action.

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