The *Problematique* of Community-Based Conservation in a Multi-Level World

Fikret Berkes
University of Manitoba
Natural Resources Institute
Winnipeg, Manitoba R3T 2N2
Canada
berkes@cc.umanitoba.ca

Abstract. *Community-based resource management or community-based conservation is not just about communities. It is about governance that starts from the ground up and involves multi-level interactions. Complexities of this multi-level world create problems but also provide opportunities to combine conservation with development. I unpack the problematique of community-based conservation and deal with four aspects of it. The first is the inability and discomfort of our conventional science and resource management to deal with multiple objectives. Many projects are either primarily about conservation or primarily about development, but rarely both. Second, community-based approaches to conservation have rarely employed strong deliberative processes. "Conservation", as conceived at the local level, tends to be different from "conservation" as conceived by international conservation organizations. A multi-lens approach is needed whereby communities become partners (and not the objects) of conservation projects. Third, the field of conservation has not made good use of the lessons from commons theory. Much of so-called community-based conservation of the last 10-15 years has been half-hearted, misdirected, and theory-ignorant. Finally, we can do a better job conceiving, researching and analyzing community-based conservation in terms of scale, organization, uncertainties and dynamics. Community-based conservation in a multi-level world is a complex systems problem and should use the tools and approaches appropriate for dealing with complexity.*

Introduction

Communities are connected to global processes perhaps more than ever before, making them vulnerable to pressures and incentives that may originate at other levels of social, political and economic organization (Armitage and Johnson 2006; Berkes et al. 2006). Communities respond to various outside pressures; these influences (drivers of change) and the linkages between communities and other levels of political organization need to be studied and understood. There is a developing literature about scale and interplay of institutions across scale (Cash & Moser 2000; Young 2002; Lebel et al. 2005; Adger et al. 2006) indicating that institutional linkages and multi-level governance systems are important for a variety of reasons (Berkes et al. 2006; Reid et al., in press).

Understanding the conservation-development issue requires attention to scale. For example, regarding the political economy of conservation in four African countries, Gibson (1999) showed that forces operating at the level of the nation state (many of them related to peculiarities of postcolonial governments) are quite different from those at the levels of regions and communities. In the context of tropical biodiversity conservation,

Barrett et al. (2001) argued that community-based conservation overemphasizes the role of local communities, given that local institutions are only one level in a multi-level system with a paucity of strong institutions. More robust designs may "involve distributing authority across multiple institutions, rather than concentrating it in just one" (Barrett et al. 2001: 497).

Hence, community-based conservation cannot be conservation that is conceived and implemented only at the local level -- because community institutions are only one layer in a multi-level world. More usefully, community-based conservation can be used as a shorthand label for conservation from the bottom up, or decentralized governance that starts from the ground up but involves a network of interactions at various levels. An increasingly globalized world requires institutions that link the local level to the various higher levels of social and political organization. Such linkages can provide ways to deal with governance (Kooiman 2003); multiple objectives (Brown et al. 2005); multiple knowledge systems (Reid et al., in press); and may result in the creation of networks for learning and joint problem-solving (Carlsson and Berkes 2005). They help address various aspects of complexity, such as self-organization, uncertainty, and resilience, as well as dealing with the challenges of scale.

The study of community-based conservation in a multi-level world, with focus on horizontal and vertical linkages, can serve to extend and elaborate commons theory. As Edwards and Steins (1999) pointed out, there is a need to look beyond the community level and deal with contextual issues. More recent treatments of commons theory have been addressing the issue of scale with increasing sophistication, and has a major role to play regarding multi-level governance involving state, private and civil society actors on resource and environment issues (Ostrom et al. 2002; Dietz et al. 2003). Commons theory can inform conservation science and help with the understanding of issues of scale and institutional linkages. This is the gist of our current work with UNDP Equator Initiative (2006) cases.

The objective of this paper is to reconcile local and global objectives of conservation through community-based conservation. Following some definitions, I explore the evolving thinking on the relationship between communities and conservation before I try to unpack the *problematique* of community-based conservation under four headings: developing the capacity to deal with multiple objectives; the importance of deliberative processes; using lessons learned from commons research; and developing a complexity approach for commons governance.

I refer to community-based conservation as a *problematique* in the sense of Rose (1974: 148-149): a constellation of issues that need to be considered at higher as well as lower scales; have a large social content; interact and intersect with one another; tend to be inherently in conflict; and require long time horizons. "Wicked problems" (Rittel and Webber 1973; Ludwig 2001) are similar, but I chose the term *problematique* because of its explicit reference to scale. Following the terminology of Young (2002), institutional *interplay* involves institutions that may interact *horizontally* (across the same level) and/or *vertically* (across levels of organization).

According to Western and Wright (1994: 7) "community-based conservation includes natural resources or biodiversity protection by, for, and with the local community." They note that defining it more precisely would be futile since community-based conservation includes a range of activities practiced in various part of the world,

but that the central idea in the concept is "the coexistence of people and nature, as distinct from protectionism and the segregation of people and nature" (Western and Wright 1994: 8). I am suggesting an extension of the definition, so that community-based conservation includes natural resources or biodiversity protection by, for, and with the local community, taking into account drivers, institutional linkages at the local level, and multiple levels of organization that impact and shape institutions at the local level.

The terms conservation-development and Integrated Conservation and Development Projects (ICDPs) are sometimes used interchangeably in this paper; conservation-development is the more general term and ICDPs are those projects that attempt an integration of the two activities. The concept of *livelihood* is about individuals, households or groups making a living, attempting to meet their various consumption and economic necessities, coping with uncertainties and responding to new opportunities (De Haan and Zoomers 2003). Livelihood is subsumed in the MA concept of *well-being*, a context and situation-dependent state, comprising basic material for a good life, freedom and choice, health, good social relations and security (MA 2003: 216). A *driver* is any natural or human-induced factor that directly or indirectly causes a change in an ecosystem (MA 2003: 210). Complexity may be defined as an interconnected network of components that cannot be described by a few rules; generally manifest in structure, order and function emerging from the interactions among diverse parts (Levin 1999: 231).

Relationships between communities and conservation

A key question that some commons scholars have been examining is the conflict between conservation policies set by the state and the rights of local or indigenous peoples (e.g., Moeliono 2006). The issue has a long history (e.g., Western and Wright 1994; Borgerhoff Mulder and Coppolillo 2005). Biodiversity is a global commons, and its conservation is beneficial for the world. But is it also good for the local people? If biodiversity conservation is pursued through the creation of protected areas (PAs) and if these PAs exclude resource use for livelihoods, then local people are bearing the costs of a process that is providing global benefits. Further, given the inability of the state to enforce PAs in many parts of the world, the usual experience is that when a local commons is turned into a PA, it effectively becomes open-access, benefiting neither the conservation cause nor local livelihoods. The relationships between communities and conservation are being contested in several arenas. Here I refer to two debates: the one over the human use of PAs and the one on the question of integrating conservation and development.

The debate over the human use of PAs is not new. There has been a growing realization at least since the 1980 *World Conservation Strategy* of the importance of understanding the needs and perspectives of local people (IUCN 1980). The 1992 *Convention on Biological Diversity* was developed to emphasize the sustainable use of resources and to stop the practice of excluding people, including indigenous people, from new PAs. "Conceived as a practical tool for translating the principles of *Agenda 21* into reality, the *Convention* recognizes that biological diversity is about more than plants, animals and micro organisms and their ecosystems – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy

environment" (CBD 2006). Among other things, the *Convention on Biological Diversity* has resulted in the creation of new PA categories V and VI to allow for greater human use (IUCN 1994).

Some conservationists have opposed this development as giving social considerations higher priority over biological ones, and the increased human use of resources in PAs, as taking the PA agenda toward a "tragic failure" (Locke and Dearden 2005). In turn, some social scientists have claimed that large international conservation organizations have become increasingly influential in setting the agenda for global conservation to the detriment of local interests, rolling back the *Convention on Biological Diversity* commitment to social considerations such as livelihoods and equity (Brosius and Russell 2003; Chapin 2004). The issue is of intensive debate both within and outside of the conservation community (Brechin et al. 2003; Borgerhoff Mulder and Coppolillo 2005; Steiner 2005).

The question of integrating conservation and development is a second arena of controversy. The Word Bank and Asian Development Bank started funding development projects, known as Integrated Conservation and Development Projects (ICDPs) in the 1980s. Assuming that poverty drives people to encroach on protected areas, the object was to target poor people in and around parks and protected areas. Over the years, these efforts have resulted in the establishment of some kind of participatory management in national parks in most parts of the world, but ICDPs themselves have often floundered (e.g., Brown 2002; Borgerhoff Mulder and Coppolillo 2005).

This has led to a debate regarding the merits of community-based conservation and to critical evaluations of these efforts. Two positions have been emerging. One holds that the failure of community conservation is not due to any weakness of the concept itself but rather its improper implementation, especially with regard to the devolution of authority and responsibility (Murphree 2002) and to participation, empowerment and institution-building (Brown 2002). The second position holds that the conservation and development objectives, both important in their own right, should be delinked because the mixed objective does not serve either objective well (Redford and Sanderson 2000).

To address the two debates, the big question is whether local people are willing and able to participate in protected area management and in the conservation of biodiversity in general. I have argued elsewhere that "Does community-based conservation work?" is the wrong question. Sometimes it does, sometimes it does not. More important is to learn about the conditions under which it does or does not work (Berkes 2004). No doubt there are many ways to approach this debate. One promising approach is to focus on the livelihood needs of the local people, as done by the IIED (Roe et al. 2000), CIFOR, and IDRC among others. A focus on livelihoods as a point of entry into the conservation-development *problematique* is consistent with the field experience in many areas (e.g., Western and Wright 1994; Zerner 2000; Marschke and Berkes 2005).

Based on the results of IIED's international project on community-based wildlife conservation, Roe et al. (2000) start by observing that the late 19th century notion that people and wildlife are in conflict, and that wild areas should be set aside purely for non-consumptive purposes, is a historic anomaly. And so is the assumption of ownership of wildlife resources by the state, and idea that has come to dominate conservation policy worldwide. Roe et al. (2000) argue that PAs based on human exclusion merely sets up a vicious circle: exclusion and lack of attention to livelihoods leads to encroachment and

poaching and this, in turn, reinforces the view that people do not have the will or capacity to conserve biodiversity. The solution is to break the vicious circle by linking conservation to improved livelihoods, thereby providing incentives for people to conserve (Roe et al. 2000).

Linking conservation to livelihoods, as a broad strategy, requires a search for implementation models. Salafsky and Wollenberg (2000) provide models of three conservation strategies. In the "protected area" model based on human exclusion, local livelihood activities merely appear as one of the internal threats to biodiversity. The PA implementation is designed to counter these threats ("fences and fines"). In the "economic substitution" model as used by some ICDPs, the project implements alternative livelihood activities as substitutes for those that adversely affect biodiversity. The goal here is to increase benefits from these other livelihoods, as a way to reduce the threat to conservation from local people. Finally, in the "linked incentives" model, a link is constructed between biodiversity and livelihood. This link closes the loop and becomes the driving force leading to conservation because it establishes a direct incentive to protect biodiversity in the long-term (Salafsky and Wollenberg 2000).

Such an analysis brings out the necessity to deal with multiple objectives; to engage in deliberation to reconcile the local and global menings of conservation; to make full use of lessons from commons research; and to develop a complexity approach for governing the commons. I deal with each in turn.

Developing the capacity to deal with multiple objectives

If conservation and development can be simultaneously achieved, then the interests of both can be served. However, many ICDPs are either primarily about conservation or primarily about development -- but rarely both. More common are situations in which one objective or the other dominates (Brown 2002). For example, involving local communities in conservation is often used as a means of making conservation measures less likely to meet local resistance, but the ultimate objective remains one of conservation. Conversely, protecting the productivity of a resource may be used as a means to enhance local livelihoods and development options, but the main objective remains development. Management approaches that explicitly have more than one objective are far less common than those that have only one.

The Millennium Ecosystem Assessment terms this multiple objectives approach, "integrated responses". They are those responses that explicitly and purposely state that their objectives address more than one ecosystem service(s) and human well-being simultaneously (Brown et al. 2005). The Millennium Ecosystem Assessment report deals with four areas in which integrated responses are explored: sustainable forest management, integrated coastal zone management, watershed and river basin management, and ICDPs (Brown et al. 2005). Note that all four of these areas satisfy the criteria that define a *problematique.*

Integrated responses may be seen as a way of moving from problem-solving in simple systems to problem-solving in complex adaptive systems. Consistent with the needs of managing complexity, integrated responses tend to involve networks and partnerships of various levels of government, private sector and civil society (Kooiman 2003). Recent approaches such as the Millennium Ecosystem Assessment and *World*

Resources 2005 (WRI 2005) promote the integration of ecosystem management with human well-being. They recognize that biodiversity conservation and livelihood needs are complementary goals.

Why then is there such a resistance to dealing with livelihood and biodiversity conservation objectives simultaneously? This may be so in part because of the inability and discomfort of our conventional science and resource management to deal with multiple objectives. We have seen this in the area of fisheries management, for example, in moving from the management for a single biological objective (e.g., the MSY) to multiple objectives including biological, economic and social. In the area of water resources engineering, dealing with multiple objectives is common and the problem is approached for example with optimization models. In conservation-development, optimization models would probably not work, and there is no common language (common concepts) between the two kinds of practitioners that would enable the two sides to look for common goals and deal with the issue of tradeoffs. The issue is perhaps one of capacity-building among the practitioners, developing a new interdisciplinary science of integrated conservation-development. Developing a set of common concepts and tools may take some time, and may require the education of a whole new generation of integrated conservation-development practitioners.

Importance of deliberative processes

There has been a dearth of successful cases of community-based conservation. This is often because biodiversity conservation, as conceived by international conservation agencies, is not usually a high priority for local communities (Steiner 2005). In turn, conservation based on livelihood needs, as conceived by local communities, does not fit the preservationist thinking of some conservation agencies. The disconnect may have been exaggerated (Chapin 2004) because there are, after all, some cases such as UNDP Equator Initiative projects (Timmer and Juma 2005; WRI 2005) that seem to be achieving the integration. The Conservation International Kayapo project shows that local indigenous people and international conservation agencies can forge alliances that work for both parties (Zimmerman et al. 2001).

Following the letter and spirit of the *Convention on Biological Diversity*, a key consideration is to design ICDPs that involve communities as partners. Taking local priorities and objectives into account in conservation planning requires real participation of the communities and not merely consultation. Achieving this would require a major shift in approach, as many authors have documented that participation is often employed as part of a top-down process of cooption and consultation, rather than participation that can lead to collaboration. Brown (2002) considers this as one of the reasons for the failure of many ICDPs.

Such collaboration in turn requires systematic discussion that Brown (2002), Stern (2005) and others refer to as deliberation: “any process for communication and for raising and collectively considering issues… In deliberation, people discuss, ponder, exchange observation and views, reflect upon information and judgements concerning matters of mutual interest, and attempt to persuade each other” (NRC 1996: 215). As Stern (2005) points out, deliberation is especially important when understanding requires interdisciplinary input, as in the case of Millennium Ecosystem Assessment. Note that

the MA used deliberation in several ways to produce a consensus document: by consulting the views of different disciplines, views of government policy-makers (as opposed to natural and social scientists), and in the case of 33 sub-global assessments, the views of community and regional (as opposed to national and international) bodies.

The basic idea behind deliberation, argues Stern (2005), is that democracies have multiple centers of power. This is also to some extent true in developing counties without long traditions of democracy; many of them do have traditions of local-level deliberation through village councils, elders' groups, panchayats and the like. In any case, deliberation provides correctives for error and bias. It "makes it easier to detect and sanction violations, and it therefore gives citizens incentives, as well as moral justifications, for upholding the norms" (Stern 2005: 980). All of these roles of deliberation are clearly important for ICDPs, especially in the "linked incentives" model of Salafsky and Wollenberg (2000).

Using lessons learned from commons research

Could the dual objectives of conservation and development be reconciled by making better use of relevant findings in the area of community-based research? With very few exceptions (e.g., Momberg et al. 2000; Zimmerman et al. 2001), conservation science has not made good use of the lessons from commons theory and a number of other relatively recent sub-fields that combine natural science and social science thinking, such as ecological economics, environmental history and political ecology (Berkes 2004). Much of so-called community-based conservation of the last two decades or so has been half-hearted, misdirected, and theory-ignorant. Therefore, there is a responsibility for commons researchers to rectify this by generating guidelines that can be put into use by conservation-development practitioners.

Such a project can start by going back to commons basics. Commons share two characteristics: (a) exclusion or the control of access of potential users is difficult, and (b) each user is capable of subtracting from the welfare of all others, or the *exclusion problem* and the *subtractability problem*, respectively (Ostrom 1990; Berkes 1996; Ostrom et al. 1999). Hence, a checklist for the conservation-development practitioner can start by asking if there is an exclusion problem and if there is a substractability problem in the project area (Table 1). The exclusion issue is important because community-based conservation is more likely to work if the users enjoy exclusive rights to the resource and have a stake in conserving the resource.

The subtractability question is important because community-based conservation needs to build on existing local rules-in-use. Here the practitioner would need to know that common-property systems have two-way feedbacks that enable institutions (rules-in-use) to regulate resource use. By contrast, in open-access systems, there are no institutions to respond to signals from the resource and no negative or stabilizing feedbacks to regulate resource use. This has the consequence that open-access use is characterized by positive feedback loops (vicious circles) whereby resource depletion leads to more intensified use, which leads to even more depletion (Figure 1).

At the next level of inquiry, the conservation-development practitioner can turn to Ostrom (1990) principles, and/or the more detailed set of "critical enabling conditions for commons sustainability" that Agrawal (2002: 62-63) has generated from Ostrom (1990)

and other sources. Especially important here for the multi-level world are questions with regard to linking, and the effectiveness of NGOs and other groups that have a role in bridging scales (Cash and Moser 2000). Linkages seem to be crucial for conservation-development project success. Our preliminary results from the UNDP Equator Initiative cases indicate that award-winning projects tend to have links across four or five layers of organization, plus a large number of horizontal linkages providing rich networks of support. Finally, underlying all, are questions of political economy and power relations regarding linkages and networks (Zerner 2000; Lebel et al. 2005; Adger et al. 2006).

Up to this point in Table 1, we are basically taking stock of the status of the commons and commons institutions in the area of the conservation-development project. For effective community-based conservation, the project needs to do something more: find strategies to strengthen existing commons institutions; build new linkages horizontally and vertically; engage in capacity-building, trust-building and mutual learning; and invest sufficient time and resources to achieve these objectives. Some of these strategies, liberally borrowed from Berkes et al. (in press), are itemized in Table 1. This table is offered here as a modest starting point for a checklist and is no doubt incomplete. As well, it is important to recognize that no one checklist could be applicable across the board, and no one set of strategies could work in all regions.

Developing a complexity approach for commons governance

Community-based conservation is a complex systems problem and should employ the tools and approaches appropriate for dealing with complexity. If community-based conservation in a multi-level world is about governance that starts from the ground up but involves multi-level interactions, then it needs to be analyzed with attention to the ways in which such conservation originates and gets organized, the partnerships involved, and the linkages that connect the local-level to a multiplicity of other levels. All of these are considerations are in the realm of complex adaptive systems which includes a consideration of scale but it also includes much more.

Pursuing this theme further, using complex adaptive systems terminology, the aspects to be considered include: self-organization, path-dependency, scale, multiple perspectives, multiple stability domains, non-linearity, uncertainty, and emergence. Each of these features, as described in Table 2, is a characteristic of complex adaptive systems, that is, attributes not observed in simple systems (Levin 1999; Berkes et al. 2003).

According to the ecologist Levin, self-organization provides a unifying principle for complex adaptive systems. “The specifics are in the often simple rules that govern how the system changes in response to past and present conditions, rather than in some goal-seeking behaviour” (Levin 1999: 12). Most social scientists would favour a less mechanistic view that takes into account human agency. Analyses of conservation-development projects clearly indicate the overwhelming importance of factors such as feedback learning, trust-building and leadership – these are not mechanistic processes (Borgerhoff Mulder and Coppolillo 2005; Timmer and Juma 2005).

The idea of scale, as for example used in geography, predates the development of complex adaptive systems thinking but is now a major element of the latter. Both social systems and ecological systems are hierarchically organized, with each subsystem nested in a larger subsystem. A social-ecological example might be the Balinese water temple

system (Lansing 1991) or Ostrom's (1990) classic example of the Spanish *huerta* irrigation system, with its nested irrigation canals (small canals, larger canals, … river basin) and the commons institutions that go with it.

Complex systems theory holds that the levels are linked but that each level requires new concepts and principles. Thus, processes at the community, regional, and international levels require different but overlapping set of concepts and principles; this is beginning to be reflected in the commons literature (Dietz et al. 2003). An important implication of multi-scale thinking is multiple perspective thinking. Each level of a scale is different, and the perspective from each level is different. The global lens of biodiversity conservation (global commons) is therefore likely to be different from the local lens on biodiversity (local commons for livelihoods).

Conclusions

Community-based conservation is not only about communities; it is also about institutional linkages and multiple levels of organization that impact and shape institutions at the local level. Complexities of this multi-level world create problems in reconciling local and global objectives of conservation. I have made the argument that conservation-development is a *problematique* that requires (a) the use of multiple objectives and the ability to deal with them; (b) deliberative processes; (c) the proper use of the lessons of commons research and allied disciplines; and (d) complex systems thinking in the broader sense, rather than merely addressing the scale issue.

Solutions include the use of multiple perspectives and knowledge systems to capture an appropriately wide range of considerations and information. There is a necessity of doing a better job conceiving, researching and analyzing community-based conservation in terms of organization and scale. Issues of uncertainty and emergence (for example, how to keep social-ecological systems resilient in a world of change) are also important but beyond the scope of this paper (see Berkes et al. 2003).

When the system under consideration is simple (for example, biophysical aspects of protected area planning), expert knowledge may be perfectly adequate. But if there are "people issues" in the park (as there inevitable are) then the era of expert-knows-best management is over, as Ludwig (2001) might say, and the rules of the game become very different. More complex is the system under consideration, greater is the need for deliberation in the process of collective judgement and interpretation (Stern 2005).

In trying to reconcile local and global objectives of conservation through community-based conservation, it is particularly important to transcend unhelpful dualities and simplistic formulations such as: "Does community-based conservation work?" "Are indigenous people conservationists?" As the Director General of IUCN, Achim Steiner (2005: 90), observes: "Society no longer needs to frame conservation solutions as either 'we touch it' or 'we don't touch it'. The latter is a very fundamentalist option to impose on people …" There are legitimate community perspectives on what conservation is or could be, and it is an important task for conservation-development practitioners to understand these perspectives and deal with them. Conservation solutions can be framed as long-term sustainability issues that take into account both global commons and local commons considerations, and biological conservation objectives as well local livelihood needs.

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Table 1.
Building community-based conservation: a checklist for practitioners.

Status of the project area: commons basics

- Is the **exclusion** (or the control of access of potential users) difficult in the project area?
- Do the users have institutions (rules-in-use) to deal with the **substractability** problem in the project area?

Status following Ostrom (1990) principles, as may be augmented by Agarwal (2002)

- Are there clear **boundaries** that define the resource to eliminate open-access conditions?
- Are there clear **context-appropriate rules** and the recognition that no one set of rules will be suitable for all areas?
- Are there **collective choice arrangements** through which participants gain a stake in, and participate in, the creation of the rules and governance structures?
- Is there **monitoring** of resource use by appropriators to address issues of subtractability and status of resource?
- Are there graduated **sanctions** for appropriators who violate agreed upon rules?
- Are there platforms for low cost, effective **conflict resolution** mechanisms to address conflicts among appropriators or between users and officials?
- Is there **political space** for appropriators to devise their own institutions?

Status with regard to institutional linkages

- Are there **nested institutions** to provide a hierarchy of governance structures?
- What **horizontal linkages** (across the same level of organization) and **vertical linkages** (across levels of organization) exist in the study area?
- Are there boundary organizations involved in the project that can play **bridging roles** across levels of organization?

Strategies for strengthening community-based conservation

- Does the project allow for pluralism by recognizing a **diversity of perspectives**?
- Does the project foster the building of **mutual trust** among the parties?
- Does the project recognize a mix of methodological approaches and tools that allow for broad **stakeholder participation**?
- Does the project accommodate **local, traditional or indigenous knowledge**?
- Are there platforms for **deliberation**?
- Does the project use a diversity of modes of **communication** for deliberation?
- Does the project foster the development of **new skills** among stakeholders, particularly for those who have been usually excluded or marginalized?
- Does the project undertake **capacity building** and development of new skills for strengthening horizontal and vertical linkages?
- Does the project **report back** to the community and other parties on its findings?
- Has the project invested enough **time and resources** in capacity-building, trust-building and mutual learning?

Table 2.
Developing a complexity approach for commons governance: characteristics of complex adaptive systems.

Characteristic	Description
Self-organization	Self-organization characterizes the development of complex adaptive systems in which multiple outcomes are possible depending on accidents of history.
Path-dependency	Context (history, politics, culture) is important in understanding complex adaptive systems. Such a system is irreversible, meaning (among other things) that experiences from one case cannot readily be transferred to another.
Scale	Complex adaptive systems tend to be hierarchically organized, with each subsystem nested in a larger subsystem. Each level of the scale is independent, to some degree, of the levels above and below, and hence have some similarities and some key differences.
Multiple perspectives	"More is different": Processes at different levels require different concepts and principles, and the perspective at each level will be different. There is no one "correct" level: levels can be analyzed separately but also simultaneously across scale.
Multiple stability domains	Complex adaptive systems organize themselves around one of several possible equilibrium states or attractors. A system's feedback loops tend to maintain a given equilibrium up to a point, followed by a "flip" into a different equilibrium state.
Non-linearity	Mathematical solutions to non-linear equations do not give simple answers but a collection of values for the variables that satisfy an equation. That is, complexity implies not one equilibrium but many.
Uncertainty	Complex systems are characterized by inherent uncertainty. No matter how much is known about a system, there is still irreducible uncertainty related to non-linearity and multiple stability domains.
Emergence	An emergent property of a system is one that cannot be predicted or understood simply by examining the parts of a system.

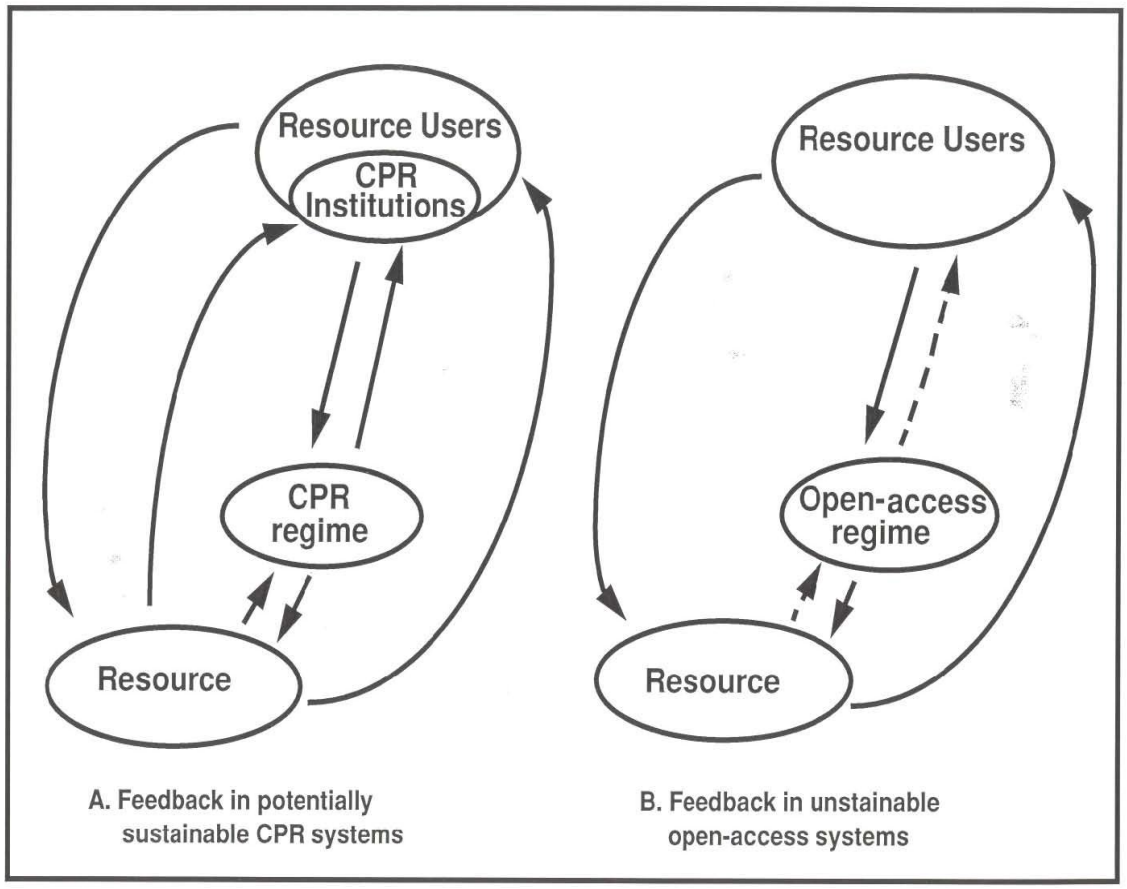

Figure 1.

Common-property systems have two-way feedbacks that enable institutions (rules-in-use) to regulate resource use. By contrast, in open-access systems, there are no institutions to respond to signals from the resource and no negative or stabilizing feedbacks to regulate resource use. This has the consequence that open-access use is characterized by positive feedback loops (vicious circles) whereby resource depletion leads to more intensified use, which leads to even more depletion. Source: Berkes (1996).