

Network Governance of the Commons

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Abstract

The survival of the commons is closely associated with the potential to find ways to strengthen contemporary management systems, making them more responsive to a number of complexities, like the dynamics of ecosystems and related, but often fragmented, institutions. A discussion on the desirability of finding ways to establish so-called *cross-scale linkages*, i.e. connections among different actors from different levels of organisation and geographical settings, recently has been vitalised in the literature. The establishment of such linkages is believed to have many advantages for the sustainable management of the commons. In the same vein, concepts like adaptive management, co-management and adaptive co-management have been discussed. In essence, these ways of organizing management to generate alternative governance systems are more closely related to network governance and social network theory, than to political administrative hierarchy. However, so far, attempts to incorporate social network analysis (SNA) in this literature have been rather few, and not particularly elaborate. In this paper, a framework for such an approach will be presented. The framework provides an analytical skeleton for the understanding of joint management and the establishment of cross-scale linkages. The relationships between structural network properties - like density, centrality and heterogeneity, and innovation in adaptive co-management systems - are highlighted as major features of high functioning management systems. The paper makes a theoretical and methodological contribution to the understanding of co-management, and thereby to the survival of the commons.

1. Introduction

To achieve sustainability in environmental, economic, and social development, finding appropriate institutions and management systems is vital. Consequently, for contemporary policy makers, making social and ecological systems work in harmony should be considered a desirable undertaking. However, institutional variety is immense, not only in terms of property rights and mixtures thereof, but also in the ways different societies have chosen to organize human affairs.

Building institutions is a matter of trial and error, as no blueprint exists for the endeavour. However, research has progressed. We know more about how to ‘cope’ with the tragedy of the commons (Feeny, et al., 1990; Ostrom, 1999). Thus, there is no such thing as ‘the best’ institution that once and for all would secure a sustainable utilization of common resources (Ostrom, 2005). Nonetheless, even if we know more, it has been emphasized that few societies possess all the institutional conditions that have been proven to be associated with sustainable management of the commons. Hence, the task has been described as “the struggle to govern the commons” (Dietz, Ostrom and Stern, 2003:1907). Overwhelming evidence suggests that top-down centralized systems are less suitable for this challenging task. Most societal problems are too complex to fit into the formal problem-solving structures of government. While administrative borders, both between different levels of policymaking and different policy sectors, are delineated, societal problems are characterized by their cross-scale nature. They span time, geographic space and, certainly, administrative jurisdictions. While this applies to most policy areas, these features are more apparent within the area of natural resource management (Berkes, 2002).

In order to meet these challenges, the search for appropriate institutional arrangements has resulted in the formulation of a variety of related concepts, such as *adaptive management*, *local adaptive management*, and *co-management* (Walters, 1986, 1997; Plummer, 2004; Olsson, Folke and Berkes, 2004; Carlsson and Berkes, 2005,). The idea is that, in order to cope with the complexity of natural resource systems, institutional arrangements and related management systems should incorporate different actors from different areas of society. Thus, an emphasis on the establishment of multi-actor structures, consisting of both public and private actors, is a common denominator. Due to a general need for exchange of resources, both horizontally and vertically, the actors are believed to have incentives to invest in building such systems (cf. Hanf and Scharpf, 1978; Ostrom, 2001). Another feature of this line of research is the perception of the state, a reorientation that is indicated by a focus on governance, rather than government. While the latter is associated with political-administrative hierarchy, governance is understood as a process by which policy is produced within multi-actor structures beyond a formal hierarchy. Thus, the state is considered one possible, but not necessarily the most important, actor.

Viewed from a state-centred perspective, the challenge for the state is how to adapt to this new role of being a partner that tries to find ways of influencing the existing governance structures or fostering the creation of new ones. The concepts of co-management and governance incorporate an implicit assumption about the establishment of social networks, based upon different logic than political-administrative hierarchy. Briefly, these networks can be described as social structures made up by nodes (actors), which are connected via a multitude of links (e.g. in the form of information flows, exchanges of goods, legal relations, etc). There has been substantial research done in the area of social networks, mainly within the fields of sociology and organizational studies. Issues like how and why networks are formed and in what ways they affect the policy-making process and its outcomes have been discussed (Flap, Bulder and Volker, 1988). In this vein, their possible structural effect on performance has been addressed, often in association with the concept and role of social capital. However, except for some shining exceptions (e.g. Lansing, 1991; Schneider, et al.,

2003; Baker, 2005; Bodin, 2006), there have been few and not particularly elaborate attempts to incorporate social network analysis in the fields of political science and, in particular, resource management. Thus, we do not know well how performance might be associated with particular network features - like density, centrality, and heterogeneity. A reasonable hypothesis is that good performance is associated not only with the establishment of particular management networks, but also with how these are structured.

This paper is based on the assumption that the network theory of social capital will contribute to the search for proper institutional arrangements in the area of natural resource management. In this paper, we set out to bring previous research about the network structure of social capital and the concept of co-management together. Drawing upon contemporary research on co-management and findings from the field of social network analysis, the underlying question to be answered is: What qualities should high functioning networks preferably possess to achieve sustainable governance of the commons?

1.1 Aim, questions and disposition

The primary aim of this paper is to suggest an analytical framework for network studies of co-management of natural resources. How is network structure related to the function of resource management? Based upon previous knowledge about the qualities of co-management and network theory of social capital, a relationship between structure and performance will be hypothesised. What kind of structural features are likely to facilitate high-functioning co-management systems? In other words, what should the qualities of a co-management system governing the commons be? The paper will yield a theoretical and methodological contribution to the understanding of joint management and, thereby, the survival of the commons.

The article is organized into three main sections. In the first section, the concept of co-management will be discussed. What is co-management and what is its purpose? In a subsequent section, social network theory will be addressed. How and in what ways does network structure matter for organizing functions and, thereby, for performance? In the third and final section of this article, the two lines of research will be brought together. The intriguing issue linking co-management to network theory of social capital will be discussed.

2. Co-management as a network governance system

There are many different views as to how co-management should be conceptualized. Published studies show that, in spite of their different interpretations, these views tend to converge. While the concept is broad and unspecified, for the purpose of this paper, suffice it to say that co-management normally is understood as a process by which private and public actors cooperate and share power, in order to solve problems related to natural resource management (Jentoft, McCay, Bonny and Wilson, 1998; Carlsson and Berkes 2005). In the literature, co-management often has been described as a bipolar system of collaboration, typically comprised of an agreement between a community of resource users and the State. Questioning this image, Carlsson and Berkes (ibid), sketched out different ways to perceive such relationships. Their message was that relationships might vary, due to the extent of resource dependencies and the actual condition of exchange, which, in turn, is dependent upon formal legal jurisdictions, informal rules, and norms.

At the lowest level, co-management might be understood to be an exchange of information; i.e., an *exchange system*. Under other conditions, co-management could better be described as *joint organization*; i.e., that the State and users create particular organisations

that make central decisions related to a natural resource. Co-management also can be understood as either a *State-nested or community-nested system*. These two instances of co-management are characterized by power sharing arrangements, in which each actor (i.e., the community and the State) is entrusted to perform management activities within the framework of the other party. For example, a community of fishermen might be allowed to govern their own fishery in State-owned waters. Finally, the fifth image is called *co-management as a network* and is characterized by the circumstance that a variety of actors normally participate in the management system, and the State does not necessarily have any central position. It is this image of collaborative management that is discussed in this paper.

The essence of regarding co-management systems as networks is that the complexity of the interaction is acknowledged. Instead of considering the State as one coherent actor, the multifaceted character of the government is fully recognized. While State authority ranges vertically (from the central governmental level to the local level) and horizontally (through different policy sectors), it has many faces. The relative interests promoted by the actors at these levels and in various public sectors do not need to be compatible. In fact, sometimes they even are contradictory. Governmental actors who are involved in real-life co-management are likely to endorse different tasks and goals. Therefore, speaking of the State as if it was one coherent actor, characterized by unity of power and “unity of command” (Ostrom, V, 1991:36) would be seriously misleading. The same goes for communities, which typically consist of many different individual positions, groups, casts, gender, etc., each of which has its own goals and interests. In more ‘modern’ contexts, communities are even more heterogeneous and can be divided into private actors, companies, environmental groups and other non-governmental organizations. Given this dual complexity, co-management essentially entails creating coherent networks for problem solving. We regard this as a process by which actors meet to pool their resources, and coordinate their actions, in order to address specific management issues. Within these network structures, specific governance arrangements evolve, structuring the actions among its members. To govern is to make rules that are binding for a set of actors. Accordingly, governance can be understood as a process, which “includes the setting of rules, the application of rules, and the enforcement and adjudication of rules,” (Feeny, 1988:172). In this sense, well established co-management systems (i.e., arrangements having some degree of durability) should be acknowledged to be systems of governance. In the next section, the positive functions associated with these structures are sketched.

2.2 The characteristics of a successful co-management system

Drawing upon Pinkerton’s influential work (Pinkerton, 1989), Carlsson and Berkes (2005) discuss six features that are associated with highly functioning co-management systems. First, co-management systems refine the *allocation of tasks*. The great variety in skills and competence among those involved is assumed to enable division of labour and specialization. The second and third factors brought up for discussion are that these systems improve the *exchange of resources*, and that they *link different levels of organizations* that are not necessarily formally connected. Co-management can, from this perspective, be perceived as a web of resource dependencies spanning a diversity of different organizations and hierarchical levels. This also is the essence of the call for cross-scale linkages, as a means of making management more resilient and responsive to ecological systems (Berkes, 2002).

The remaining three factors, assumed to be the positive results of co-management, are the *reduction of transaction costs*, the possibility of *risk sharing* and, finally, the establishment of functioning *conflict resolution mechanisms*. Transaction costs are costs born by individuals for the exchange situation itself. “Transaction costs are the costs of measuring

what is being changed and enforcing of agreements” (North, 1997:149). Even if transaction costs might increase at the initiation of a co-management process (e.g. due to pending conflicts), they are likely to decrease over time. Repeated network exchange is supposed to facilitate the performance of these tasks. The fifth factor has to do with risk sharing. The authors claim that systems that are solely dependent upon one administrative unit are more vulnerable to disturbances than systems of co-management. This quality can be compared to the discussion of resilience and robustness, which refers to a system’s ability to resist external disturbances, and/or its ability to adapt to these without changing the essential functions of the system (Holling, 1986).

Finally, the sixth quality of a co-management system is its capacity to develop good conflict resolution mechanisms between the different stakeholders involved. Getting together within the framework of an institutional arrangement, communicating and negotiating all increase the likelihood of reaching common agreements that lead to collective action. This way of finding common rules can be referred to as the *covenanting capacities of the system* (Ostrom, 1992). Without explicitly discussing co-management, Lansing demonstrated how high-functioning networks of Balinese irrigation systems coordinate their activities and, thus, contribute to the sustainability of local rice farming and related livelihoods. Although lacking formal coordination, a number of so-called *water temples* fulfil the role of facilitating coordination between the different branches of this extensive system (Lansing, 1991). Because irrigation systems are huge and composed of many “subaks” (i.e. farmer associations), different activities are coordinated through temple meetings. In a recent paper, Lansing and Miller (2006) discussed a puzzle that has been noticed among scholars, specifically why upstream farmers occasionally are willing to contribute extra water to those down stream as the latter, in principle, are unable to pay them back (due to the laws of gravity). Using the Balinese irrigation system as an example, the authors argue that environmental conditions, such as the perceived threat of pests, play an important role in how the farmers decide to synchronize their cropping. “Thus, upstream farmers [...] have an incentive to cooperate by sharing water with down stream farmers so as to minimize pest damage” (Ibid: 3). This sophisticated web of actions reflects an equally complicated social structure.¹

In an extensive study of the Kuhls (i.e., irrigation systems in the North Indian Kangra Valley), Baker (2005) analyzed how and with what means the network quality of the system contributes to sustainability, a phenomenon which is especially pronounced during difficult times. “In the Kuhls of Kangra, we see the potential of networks in enhancing the resilience of common property regimes and thereby facilitating their ability to endure, especially under conditions of environmental risk and uncertainty. [...] Networks composed by interlinked Kuhls provide opportunities for pooling labour, sharing water, and coordinating management tasks among the Kuhls” (Ibid: 208). In contrast to Lansing, Baker offers another explanation of the up-stream, down-stream problem. With reference to local customs, he refers to a sense of ‘brotherhood’, a quality that obviously encompasses the whole system. Thus, the network is sustained both by the physical construction that enables such acts as water sharing, but also by a sense of community that is established.

Yet other examples are provided in a recent dissertation by Bodin (2006). The study is comprised of case studies from Kenya and Madagascar, in conjunction with a set of computerized studies, all of which tell a similar story. Networks matter and their configurations are intimately associated with the performance of social-ecological systems. Furthermore, the network structure, in terms of density, homogeneity etc., seems to account for different levels of performance. This will be discussed later in this paper.

¹ See <http://www.ic.arizona.edu/~lansing/home.htm> for an extensive overview of this research,

Thus, not only the existence of networks, but also how they are configured may matter. What do we mean by structure in this respect, and how are these qualities related to social relationships?

3. The network structure of social capital

Within policy analysis, the actors and their relationships in forming policy networks have long been considered relevant. The ‘network approach’ is known as one way of viewing policy processes and conducting policy analysis. Despite differences, the frameworks and the concepts that underlie this general notion share a bottom-up perspective; i.e., focusing on problem-solving structures that are constituted by the involved actors and their relationships. These structures can be referred to as policy networks, and are understood as “problem-specific entities, organizing a policy area by different forms of collective action” (Carlsson, 2000:508). Actual policy-making is presumed to take place within these structures. This approach is compatible with perceptions of co-management as networks and governance structures, which are demonstrated by the examples provided in the previous section. However, the objective of this article is not merely to emphasize the importance of networks, but to outline in what respect they are important. In order to do this, and to fulfil the purpose of presenting an analytical framework for network studies of co-management systems, there is a need to outline why, and how, network structure can be assumed to matter in organizing and network performance? For this purpose, concepts about purposive action, bargaining, collective action and social capital need to be addressed and related to social network theory.

The evolution of a policy network, and presumably also of co-management networks, can be regarded to be an outcome of purposive action taken by self-interested individuals. The actions emanate from the urge to maintain or procure valuable resources. Lin (2001) wrote about expressive and instrumental action, and claims that it is the latter form that is the driving force behind networking. Thus, networking is a matter of resource exchange; i.e. “a series of interactions between two (or more) actors in which a transaction of resources takes place” (Lin, 2001:143).

Thatcher (1998) discussed networking activities in terms of bargaining games. Due to the state of resource dependency, the actors need to negotiate and adapt to the strategies of others. Similar ideas are conveyed by Hanf and Scharpf (1978). This view is highly compatible with that of Coleman (1990:134ff), who described social action as a negotiating process in which actors, who are constrained by their existing resources and driven to maximize their interests, interact. Thus, interactions may be understood as exchange processes characterized by bargaining and negotiations. These are the activities that, over generations, have been conducted; for example, in the Balinese water temples, among the Kuhls of Kangra, or in fishing communities in Kenya.

The outcome, or network performance, is highly dependent upon how such bargaining interactions proceed. Granovetter (1985, 1992) convincingly has supported this stance. In his argument about embeddedness, the relational aspects of social behaviour are stressed. He offers an approach to social phenomena, avoiding both the under and over-socialized views represented by neo-classical economics and sociology, respectively.² These two views have been criticized, partly because of their one-sided emphasis on either action or culture, and partly because they share a “conception of action as uninfluenced by peoples existing social relations” (Granovetter, 1992:6). This ignorance of the ongoing web of interactions restricts the possible explanations that can be deduced. Therefore, an analytic frame must be used that combines elements of methodological individualism, assuming the bounded rationality of

² The terms over and under-socialized are adopted from Granovetter (1985, 1992).

self-interest actors, by means of a structural approach, and acknowledging that all actions are socially situated.³ A network perspective responds to this requirement.

Another argument that underlies the benefit of treating networks as explanatory variables is their institutional capacities. Policy networks might, in fact, be perceived as “organized entities that reflect specific types of institutional arrangements” (Carlsson, 2000:58). With reference to the examples provided in earlier sections of this paper, it can be noted that networks evolve differently in different contexts, because they are the result of purposeful action among actors who try to deal with circumstances that are embedded in a local context. These networks possess potential capacities to form institutional norms and rules, all of which structure the behaviour of the participating individuals.

Within the interdisciplinary field of social network analysis (SNA), the structural properties of the social world have long been recognized (Scott, 2000; Wasserman and Faust, 1994). SNA essentially is based upon the methodological perception that social life should be addressed in relational terms. It also offers valuable tools for mapping and analysing these social structures. Proponents for social network theory state that information about the network structure (i.e. “how the direct relations are combined or arranged in a network”; Friedkin, 1981:41) will elucidate the underlying structure of more stable interactions. As expressed by Mizuchi (1994:330) “the primary tenet of network analysis is that the structure of social relations determines the content of those relations”. So, by studying network structure, important information about network interactions will be revealed. Accordingly, the structural properties of networks can be treated as important independent variables that explain performance and outcomes.

3.1 Heterogenic and centrally integrated networks

Although the concept of social capital was not explicitly discussed in the preceding sections, the fundamental principles behind the concept were all-pervasive. The stance that relational aspects affect resource allocation actually is the basic implication of the concepts of social capital. *Social capital theory* has many faces. The concept has been ascribed many meanings and has been applied to a wide range of social phenomena, on different levels. Within the branch of political science, social capital is associated foremost with Putnam’s seminal work. Through *Making Democracy Work* (1992) and *Bowling Alone: The Collapse and Revival of American Community* (2000), the ideas related to social capital reached a wider audience.

In spite of the wide range of applications, there basically are two elements that unite all lines of research addressing social capital. First, social capital is perceived “as a metaphor about advantage” (Burt, 2000:346f). Using the words of Coleman, “social capital is productive, making possible the achievement of certain ends that would not be attainable in its absence” (Coleman, 1990:302). Second, this advantage is assumed to spring out of the social structure; “the social capital metaphor is that people who do better are somehow better connected” (Burt, 2000:347). Thus, the definitions of social capital encompass two main aspects, relationships (or networks) and resources. Different researchers have handled the two ingredients of social capital differently. For some researchers (Lin, Fu and Hsung, in Lin et al, 2001) the embedded resources are emphasized as the very basic element of social capital. Others, for example Burt (2000, 1997), have focused on the networking aspects of social capital, indicating that network structure is the key element when identifying social capital. It is assumed that certain network configurations provide better resources; and, in accordance

³ Originally launched by Herbert Simon, the concept of *bounded rationality* means that action, constrained by, for example, existing knowledge, also should be regarded rational.

with this, networks thus are perceived as indicators of social capital. This latter standpoint, focusing on the relational aspects of social capital, is compatible with the central objective of this paper.

In an effort to trace the roots of social capital, Krishna (2002) tested three alternative hypotheses about the relationships between social capital and economic development, ethnic peace, and democratic governance. While investigating 69 Indian villages, he compared outcomes with reference to three images of social capital. The first hypothesis stated that observed differences can be explained by social capital alone; i.e., in essence, Putnam's view of the casual links. The second conjectures that social capital is a by-product and, thus, dependent upon the formal institutional structure existing within a society. For example, trust and norms of cooperation, which often are associated with social capital, are proven stronger in societies with institutions that are able to protect property rights, etc. The third and final hypothesis states that "the effects of social capital are translated into performance by mediating agencies, which vary by issue area. The effectiveness of the mediating agency is as important as the level of social capital in understanding variations in institutional performance" (Krishna, 2002:27).

Based upon numerous interviews and the collection of a huge amount of statistical data Krishna found support for the third hypothesis. In short, it was revealed that strong social networks alone do not explain performance, nor does the existence of formal institutions. What is needed are actors who have such positions in the local context as to bridge between formal institutions and local networks. Thus, a dense and homogenous network alone (strong social capital) is not accountable for performance, while bridging is a way of realizing its "propensity for collective action" (Ibid: 70). With reference to the earlier discussion about co-management networks, Krishna's study supports the idea that highly functional management systems likely benefit from heterogeneity, in the sense that the involvement of different types of actors makes it more possible for the system to access resources outside the local context.

As Krishna (2002, 2003) indicated, the literature about social capital is highly variable. This applies to the structural aspects as well. The interdisciplinary aspect of the network approach certainly is an advantage; though, at the same time, it evidently contributes to making the field disconnected and the theoretical work done so far, to some extent, incoherent. Different scientific fields and different researchers have adopted divergent theoretical terminology and significantly different measures to study the structural properties of social networks. However, Burt (2000) has published extensive work compiling empirical studies on social capital, which explicitly adopt a network approach. He identified tremendous variety, but he also noted that there primarily are two divergent ideas about the assumed relationship between network structure and social capital, namely the concepts of *network closure* and *structural holes*.

The *first*, dealing with network closure, is associated with Coleman's notion that well-connected networks foster social capital. Thus, it is assumed that densely-connected networks enhance communication, because of the free flow of information. This interconnectedness also favours collaboration, since it allows the use of sanctions to prevent and restrain opportunistic behaviour (Coleman, 1990:306ff; Burt, 2000:351f; Lin, 2001:27). Accordingly, this kind of network structure, with many and strong connections, is considered rich in social capital.

Whereas the 'closure argument' draws attention to the significance of accurate information channels within a group, the 'structural hole argument' is more concerned with the importance of information diffusion between actors and between different sets of actors. These ideas can be ascribed to Burt, but truly draw on previous work; for example, Granovetter's (1973) often-quoted paper *The Strengths of Weak Ties*. A structural hole is defined as the absence of a connection within a network, or the presence of a weaker

connection. An individual who is able to bridge these holes in the social structure is assumed to have strategic advantages (like the ‘new’ village leaders in Krishna’s study). Such persons gain access to new and a more diversified set of information. Contrary to the information within networks characterised by closure, such information is non-redundant. From this perspective, networks that are comprised of individuals who span many structural holes are considered rich in social capital, and therefore, better performing (cf. Granovetter, 1973).

The ideas underpinning the two perspectives are, in a way, contradictory. However, Burt suggests a synthesis of the two. “While brokerage across structural holes seems to be the source of added value, closure can be critical to realizing the value buried in the structural hole” (Burt, 2000:398). This argument can be better understood by separating the local structure (i.e., the in-group relations) from the global structure (which describes how the network is connected to other network constellations). In short, a network rich in social capital span many global structural holes, thereby reaching out to many diversified network constellations. At the same time, it has a local structure that is closely interconnected, facilitating the achievement of collective action. Thus, the two mechanisms enforce one another in the process of resource allocation. This phenomenon was illustrated nicely in studies by Lansing, Baker, Bodin, and especially Krishna.

These conclusions about the network structure of social capital have been verified by other researchers as well. Lin (2001:47ff), for example, states that heterophilous interactions (i.e., exchange among actors with dissimilar resources) require greater effort, but also yield higher returns for the investors.⁴ This hypothesized relationship has been verified in other empirical studies. Provan and Milward’s (1995) study on implementation structures in community health systems in the US showed that centrally-integrated networks (in-group closure) were more efficient than others. Reagan and Zuckerman’s (2001) study of the performance of R & D teams, on the other hand, confirmed the importance of network diversity; i.e. constellations that span holes in the global structure.

The assumed relationship between structure and performance was subjected to testing in a comparative case study of network performance within the academic sector (Sandström, 2004). Five different networks were compared, relative to their structure and performance. In-group closure was indicated by the level of density and centrality; and the extent to which the networks spanned global structural holes was measured according to the level of network heterogeneity and cross-boundary exchange. Network performance was addressed in terms of effectiveness and innovativeness. It was found that, while network heterogeneity is a necessity for innovative networks to form, their level of effectiveness is positively related to the degree of centralized integration. What is the essence of the indicated mechanisms? What does density and centrality enable, and why does bridging matter?

For the sake of developing a theory of network performance, it is fruitful to draw upon previous implementation research (for example, Carlsson, 1996; Hjern and Porter, 1997; Hull and Hjern, 1987). As elucidated in this research, organization success is found to be dependent upon on the performance of different so-called ‘organizing functions’, namely, problem definition, resource mobilization, prioritizing and evaluation, and the coordination of these. The basic idea is that all types of organization, and the management of natural resources, require that the involved actors agree as to what the ‘problem’ to be addressed is. Given that numerous alternative ways of solving a specific problem exist, prioritizing is essential. Only if actors are endowed with an infinite amount of resources can prioritizing be neglected. In order to devise solutions to identified problems or challenges, resources are needed and must be mobilized. These might consist of information, financial means, or more tangible goods. Also, the mobilization of resources is an intricate activity that must be

⁴ Recall the earlier comment that transaction costs might be high at the initiation of a co-management arrangement, but are found to decrease over time.

organized, and part of this organization is dependent upon some internal perceptions of performance; i.e., evaluation or follow-up. How do the actors in a particular action arena know that their activities advance their joint effort and whether they reach, or come closer to their desired goals? This also must be addressed when organizing a solution to a problem.

In the study referred to above (Sandström, 2004), an attempt to relate these functions to different network characteristics was made. On the basis of these empirical findings, it was suggested that the function of prioritizing, so vital for the process of organizing to proceed, is facilitated within centrally-integrated networks. On the other hand, the function of resource mobilization is facilitated within heterogenic networks. Therefore, the main conclusion is that network heterogeneity is positively related to the functions of resource mobilization and innovativeness, while the level of centralized integration is likely to affect the prioritizing function and, thereby, effectiveness.

As previously emphasised, attempts to apply the ideas and tools of SNA to study natural resource management systems have been rare.⁵ However, without explicitly discussing the logic of organizing or the structure of co-management, Bodin's (2006) findings support most of the arguments above. Bodin and his colleagues have conducted a set of studies that, together, aimed to apply "a network perspective on ecosystems, societies, and natural resources management." The conclusions regarding network structure are summarized as follows:

- (1) High density may be beneficial since it enhances the exchange of various desirability's, such as good ideas, information, genetic material, etc., which can increase the system's ability to respond to change and disturbance (adaptive capacity)
- (2) High density may enhance a system's resilience in terms of reducing its vulnerability to the removal of individual components.
- (3) Too high density may, however, contribute to a homogenization of the system. It may reduce inherited variability and diversity (such as knowledge-, and genetic variations), which would reduce the systems ability to cope with changes, disturbances and surprises (i.e. reduces adaptive capacity)

(Bodin, 2006:26)

Given this as a broad background, how would these observations apply to the phenomenon of co-management? This is the topic of the next section.

3.2 The structural features of co-management systems

Co-management is assumed to facilitate the function of task allocation and resource exchange, to reduce transaction costs and risk, and finally to promote the evolvement of mechanisms for handling conflicts. These, indeed, might be related to the different network characteristics – heterogeneity and integration. What would a co-management network look like? Figure 1 depicts how a community of resource users (for example a communal forest) might be connected to a multitude of actors outside the organizational boundary of the community itself. The State and its various units (discussed earlier) are illustrated at right in the figure. In the centre, one finds the community and management tasks (A–F) that presumably must be conducted. As can be seen, the web of relationships is fairly rich and spans over organisational boundaries, even to other geographical areas. It also should be apparent that the traditional divide between what is regarded as private and public is blurred

⁵ However, within disciplines, like biology and ecology, network analysis is rather common.

(cf. Giesler and Daneker, 2000). Obviously, the indicated network spans a number of structural holes, thus indicating a certain degree of heterogeneity. Whether the network is regarded dense, whether some actors have a more central position, or whether some relationships are stronger than others cannot be determined from Figure 1.

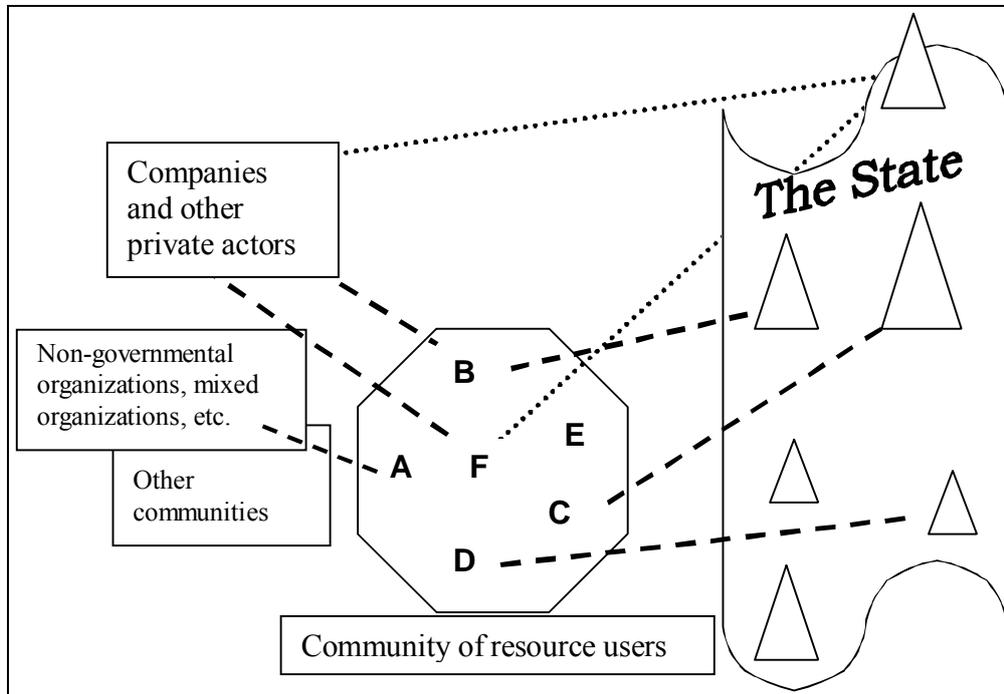


Figure 1: Example of a co-management network. (Source: Carlsson and Berkes, 2005:69)⁶

The heterogeneity of the network, or using Burt's terminology, the existence of global structural holes in various network studies has been related to the function of resource mobilization and performance, in terms of innovation (Reagan and Zuckerman, 2001; Sandström, 2004). The *structural hole hypothesis* is, in its original form, a matter of access to a diversified information base. As already indicated, however, it should be emphasised that it could as well be a matter of other kinds of resources. The literature on the importance of cross-scale linkages can be perceived as elaborate support of the benefits of heterogenic networks, and arrangements that integrate actors from different sectors and different levels of society. Applied to the discussion about co-management, the hypothesis would be that heterogenic networks facilitate a system's ability to access and exchange resources. Therefore, it could be proposed that high functioning co-management systems are heterogenic networks that have a tendency to cross organizational boundaries.

Figure 2 illustrates how input data for social networks normally are represented, in particular as a matrix of relationships. For the purpose of the discussion, Figure 2 is a so-called un-weighted matrix, only indicating the existence of a particular relationship, not, for instance, indicating if these are frequent or represent large amounts of money or flows of information.

⁶ The figure is based on the pattern of collaboration that has been elucidated within the community-managed forests in Sweden (Carlsson, 2003)

	Actor 1	Actor 2	Actor 3	Actor 4	Actor 5
Community 1	●		●	●	
Community 2		●			
Community 3					●
Community 4		●			
Community 5	●	●			

Figure 2. Example of a matrix of relationships among five communities and six external actors

As illustrated in Figure 2, five different communities have some kind of relationship with five external actors. These actors might be NGOs, state authorities, public foundations, scientific organisations, companies, etc. For example, Community #1 has relationships with Actors #1, 3 and 4; while Community #3 has a relationship with Actor #5 only. If Figure 2 would have been filled with “dots”, and if the relationships would have exhibited significant strength (e.g. strong, repeated interactions), we would conclude that the network is dense. Here, however, our mission is to discuss the logic of heterogeneity and, for this purpose, it can be assumed that the relationships represent management agreements; for example, that Actor #5 performs monitoring tasks on behalf of Community #3, while Actor #2 serves three different communities, and so forth. Given that the external actors, as already indicated, represent different groups, levels of competence, skills, and interests, this network definitely spans a number of structural holes. And, in the best of all worlds, these differences will increase the quality of management. This type of heterogeneity can be understood as *first-order heterogeneity*, but there also is something that we can call *second-order heterogeneity*, which is traceable in Figure 2.

Following the methods of SNA, it is possible to generate two more matrices from the information provided in Figure 2. Thus, it can be concluded that Actors #1, 3 and 4 are connected, because they serve the same community. Consequently, it is possible to conclude that Community #1 has “created” a network among external actors that are not elsewhere connected. The same logic can be applied to the communities; for example, Communities #2, 4 and 5 can be said to be connected, because they share the benefits of having access to the same competence (actor).

The empirical reality behind these stylized relationships is easy to comprehend. For example, it is likely that NGOs or academic units that serve the same village have reasons to meet, discuss, and compare their experiences. The same goes for communities that utilize services from the same external actors. This type of indirect coordination has not been elaborated in co-management research, something that SNA enables. However, it should be noted that Lindblom (1965) already has emphasized the importance of indirect coordination in policymaking. Here, we call this phenomenon *second-order heterogeneity*, because it is to be regarded as a by-product of management systems that have a multi-actor character.

How are these observations related to the other salient feature of networks, viz. density? It is known that the integration of networks is related to the ability to achieve collective action (Coleman, 1990). Integration also is connected to the earlier-mentioned organizing functions of prioritizing and effectiveness (Provan and Milward, 1995; Sandström, 2004). When it comes to co-management, the hypothesis would be that this network feature affects the internal activity within the network, in a way that reduces transaction costs and fosters a system’s ability to make decisions and solve conflicts between different stakeholders. Thus,

the hypothesis would be that high functioning co-management systems are comprised of networks characterized by a heterogeneous set of actors and that they, at same time, are centrally and densely integrated.

Resilience is a key concept in the discussion about sustainable natural resources management. Paradoxically, a management system needs both to resist losing its structure and to react and adapt to disturbances in the external environment. This implies that, if co-management systems are too dense, they are more vulnerable to external stress and less innovative; but if they are too heterogeneous, it is more difficult to prioritize and make joint decisions. Based upon a study using computerized agents, Bodin and Norberg (2005) concluded that “too much connectivity and too little autonomy among management units reduces variation in knowledge, which is crucial in managing complex systems” (p. 188). Cross-scale networks, with a heterogeneous set of actors, thus are less vulnerable to negative disturbances. At the same time, they are more likely to possess the proper resources, like ecological knowledge, to know when to react and adapt. The level of network integration also can be connected to the discussion of resilience. The more closely connected a group of actors is the more stable the network will be. Additionally, in order to react and to achieve institutional change, a high level of integration is necessary. Thus, resilience obviously is highly affected by both structural properties.

4. Conclusions and questions

This paper provides an analytical framework for network study of co-management of natural resources. It is assumed that the qualities of a high functioning system will be facilitated by certain network properties, particularly network heterogeneity and centralized integration. Accordingly, co-management networks that are heterogenic, involving a diversity of actors, and that are centrally and densely-connected, are assumed to perform better than those not having these qualities. While there are other related issues to consider, in developing theory, the hypothesised relationship needs to be a concern for further empirical investigations. This challenge is conceptualized in Figure 3.

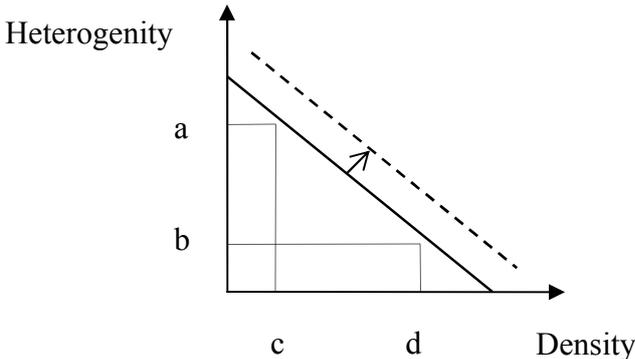


Figure 3. Trade-off between density and heterogeneity in co-management systems.

Presumably, all co-management networks can be described in terms of a mixture, and a trade-off, between heterogeneity and density. Thus, system a-c, in Figure 3, is characterized by a high level of heterogeneity and a low level of density, whereas system b-d has the opposite qualities. Whether there is any “best” mixture in this regard really is unknown. Intuitively,

one might think that increasing one of the features automatically would reduce the other; but, to our knowledge, this has not yet been demonstrated empirically. It may be that we must accept the indicated “seesaw principle”; the only remaining alternative is to shift the line to the right in Figure 3. How might this be done in real-world settings?

To conclude, if the assumed relationship between structure and performance is taken seriously, obvious questions would be: How should such networks be established? And, conversely, do they just evolve? From a state-centred perspective on governance, the role of the state in establishing such networks is especially interesting to acknowledge. Is it possible for the state to affect the establishment of these successful networks; and, if so, how? How public actors may apply a network perspective, as a means to improve policy making, has been discussed thoroughly by Kickert, Klijn and Koppenjan (1999). Due to their unique possession of resources (such as legislation power, budgets, personnel, access to mass media, and democratic legitimacy), governmental actors have considerable power to affect governance processes. An empirical analysis by Schneider et. al. (2003) showed that federal policy programs can have a direct affect on the establishment of policy networks. The authors compared the qualities of policy networks in relation to the National Estuary Program, with networks in estuaries that were not taking part in this program. Their conclusion was that networks within areas subject to the federal program were more boundary-spanning than others. These findings indicate that government might, in fact, facilitate the establishment of certain network constellations.

Thus, adopting a network perspective on governance does not necessary eliminate involvement of the state. As a matter of fact, the state, or the different ‘faces’ of the state, might be important actors in the policy process. This is discussed in the previously-mentioned work by Baker (2005) and, following his approach, one can conclude that the actual relevance of particular actors, such as the State, needs to be subjected to empirical investigation and not taken for granted. The adoption of a network perspective on co-management does not mean that the power within the governance structures is believed to be equally distributed. A common misconception about networks is that they always have a non-hierarchical structure. However, policy networks often are hierarchical; due to the asymmetric state of resource dependency, but this power distribution does not necessary reflect the formal hierarchy.⁷

Actors, resources, and power distribution are subjected to constant change within social networks. Therefore, it is important to regard co-management networks as evolving institutional arrangements, and not as fixed entities that can be inherited, like State hierarchies. Thus, in order to better understand contemporary systems for natural resources management, the dynamic of network evolvement and the relationship between structure and performance during different time phases (fulfilling different functions) must be addressed.

We believe that applying a network perspective to co-management opens up a wide range of new questions that need to be answered. By treating these structures as systems of governance, valuable knowledge about how to govern the commons might be achieved. The structural affect of co-management networks governing the commons must be a concern for further empirical investigations, however. Studies examining the structural properties of successful and less-successful management systems would provide valuable knowledge regarding how structure affects performance. Case studies on natural resource management, comparing systems with divergent outcomes, potentially could be invaluable in developing theories regarding network structure of social capital and its implication for co-management. It also should be noted that there are other issues that need to be illuminated. For example,

⁷ In many publications, the non-hierarchical quality of policy networks has been emphasized. However, in most of these publications, the objective has been to contrast the entities with formal political-administrative hierarchy, not to discuss their structural features.

what kinds of boundaries are important to bridge? How densely connected should an effective network be? Is there a trade-off between heterogeneity and integration? And so forth.

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