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Analysis

Governing complex commons — The role of communication for experimental learning and coordinated management

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ABSTRACT

In this paper, we build on common-pool research and adaptive management to increase our understanding on if and how communication between resource users affects their joint ability to learn about and manage complex ecological resources. More specifically we study the role of user communication in relation to learning through continual experimentation when managing a complex resource system involving resource interdependencies. For this purpose we designed a laboratory experiment where we tested the effect of user communication over time in a setup with two interdependent resources, and where resource access is asymmetrical: one resource is shared and the other is private. Our results indicate that communication, through its interaction with experimental learning is more multifaceted than what previous experimental studies on commons dilemmas suggest. We show for example that in communicating groups the likelihood of successful resource management increases, but this effect is mostly dominant in earlier periods, when resource dynamics are unknown. We hypothesize however, that communication stimulates continual improvements by fine-tuning of management through experimental learning and coordinated resource extraction. Furthermore, we hypothesize that in communicating groups, the need to quickly gain a basic understanding of the dynamics overshadows not only the devotion to improve management of the private resource but also the potential tensions brought by the asymmetry in resource access.

1. Introduction

Accomplishing effective and sustainable governance of ecosystems and natural resources where a multitude of actors have different stakes poses a tremendous challenge, both for policy makers, resource managers, and researchers. It is increasingly recognized that the complexity of this challenge arises from the dynamics of the ecosystems themselves (Holling, 1973; Levin, 1998), from the dynamics of human interactions and activities framed by socioeconomic structures and institutions (Ostrom, 2005), as well as from the interactions of these dynamics (Folke, 2006; Liu et al., 2007). Thus, we need to understand how the broader social–ecological situation with all its complexities (in which human interactions occur), affect human decisions and how human activities affect the social–ecological system. As pointed out by Poteete et al. (2010) and Young et al. (2006) this requires new and novel research approaches and collaboration between researchers from different disciplines and fields; each bringing specific knowledge about the case of interest and about different methods.

Common pool resource (CPR) research addresses the challenges that arise when multiple resource users are involved and aim to uncover factors that are crucial for overcoming the rivalry between resource users so that they can collectively agree on joint management and thereby avoid unsustainable practices or resource use, for example overharvesting (Ostrom et al., 2002; Bromley et al., 1992; Baland and Platteau, 1996). This literature, builds mostly on case studies, theoretical modeling, and experiments. Whereas, the case studies have been instrumental in providing direct evidence that small groups are able to self-organize and collectively solve natural resource dilemmas (Ostrom, 1990), experiments have been crucial at isolating and illustrating the influence of specific factors that are important for sustaining co-operation, like for example trust, costly sanctioning and perhaps foremost communication (Pretty, 2003; Sally, 1995; Ostrom, 2006). The main contribution of game theory has been to provide a transparent overview of the strategic elements associated with the dilemma and highlight some of necessary conditions that need to be fulfilled to ensure that long-term cooperative outcomes prevail (consider for example the Folk theorem) (Fudenberg and Tirole, 1998). Most of the studies in this research field stem from a social science perspective and do not explicitly take complex ecosystem dynamics into account but instead assume resource dynamics that is static or relatively simple (there are exceptions which we will get back to).

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From an ecologist perspective it is easier to focus on the changes and implications of the natural systems. The implications of ecosystem dynamics have for example been brought forward by the adaptive management literature (Holling, 1978; Walters, 1986) that emphasizes experimentation and learning to deal with complexity. Adaptive management is based on deliberately designing management in such ways as to increase scientific understanding. This approach to management implies that managers will need to adaptively and continually change management in accordance with gained knowledge and feedback from the managed ecosystem.

CPR research and adaptive management research have been fruitfully cross-fertilizing each other within for example adaptive co-management (Armitage et al., 2009) and social–ecological systems research (Berkes and Folke, 1998; Berkes et al., 2003). In this paper, we further explore an integrated approach, drawing from the adaptive management and the common pool resource literature, to increase our understanding of interlinked social–ecological system dynamics. Drawing from the results of the CPR and adaptive management literature we want to focus on the interactions between communication and experimental learning and the implications for dealing with interacting complexity in social and ecological systems.

Ecosystem complexity can entail a number of factors such as spatial dynamics, potential abrupt changes (so called threshold effects or tipping points), resource interdependencies, and uncertainties (e.g. Levin, 1998). Here we focus on resource interdependencies which can be associated with a particular management difficulty; if one of the resources is not managed optimally, there will be negative spill-over effects on the other resource(s). Consider for example coastal and off-shore fisheries. They may be connected through migrating fish, through providing habitat for different life-stages of harvested species, or through food web linkages (for example, nutrient rich coastal ecosystem generating spawning larvae that is consumed by larger fish at sea). Management practices that degrade coastal system lead to undesirable effects also for the off-shore fisheries, whereas sustainable harvesting can have a positive effect across systems (Berkström et al., 2012).

There is an increasing concern about the problem of fit between complex ecosystem processes and governance structures (e.g. Folke et al., 2007; Galaz et al., 2008) and recently attempts have been made to develop methodologies that can be used to analyze such problems (like the one we mentioned above) empirically (see for example Bodin et al., 2014; Bodin and Tengö, 2012; Ekstrom and Young, 2009; Kininmonth et al., 2015; Bergsten et al., 2014). These studies have mainly focused on identifying patterns of governance structures that align more (or less) with specific resource linkages. So far we have seen no studies that more explicitly look into how resource interdependencies affect resource users' behavior. To further our understanding of these coupled social–ecological systems, and to complement these recent studies, we feel that it is important to address this gap. In this way we also follow the recent calls for applying a multi-method approach to increase understanding of complex social–ecological systems (Poteete et al., 2010; Young et al., 2006).

More specifically we look into the role of user communication in relation to learning through continual experimentation, when managing interlinked ecological resources over time. In particular, we explore if and to what extent communication 1) affects abilities of resource extractors to overcome the dilemma that comes with asymmetrically distributed, common, and interlinked ecological resources, and 2) enhance experimental learning through coordinated resource extraction.

We rely on the experimental method to collect data. For one, collecting field data on human behavior in relation to ecosystem management is challenging and time consuming. Secondly, experiments have been particularly valuable for gathering empirical data on human behavior in common resource systems (Kopelman et al., 2002; Ostrom, 2006) and recently, studies have demonstrated the advantage of using experiments for analyzing the potential impact of specific ecological features or social–ecological interactions in such systems (see for example Cardenas et al., 2013 or Poteete et al., 2010 for comprehensive overviews). For example, Janssen et al. (2010) introduce an experimental environment to test the effects of complex spatial and temporal resource dynamics on user behavior. Their results stress the importance of communication to achieve cooperation, but here they also point to sanctioning among resource users as a specific mechanism where communication in managing complex resources is important. They find that ecological complexity essentially blurs the message, and if not combined with exchange of information, sanctioning loses much of its value as a means for enforcement. Another common pool resource experiment concerned with ecosystem complexity is a study by Lindahl et al. (2014). They show that a group will manage a resource more efficiently when confronted with a latent abrupt change in the renewal rate of the natural resource. Even among cooperative groups there is a significant difference in behavior when users are confronted with such complexity, although the game theoretic prediction is that there should be none (in both cases a cooperative group should reach an optimal harvest level which in their case is independent of treatment). They argue that effectiveness of communication is endogenous to the problem; the threat of reaching a critical tipping point, beyond which the growth rate will drop drastically, triggers more effective communication within the group, enabling stronger commitment for cooperation and more knowledge sharing, which together explain the increase in efficiency in spite of the increased complexity. Janssen et al. (2011) show, by using both laboratory and field experiments, how resource access asymmetries, such as when upstream water users in a drainage basin possess an inbuilt advantage versus downstream users, affect cooperation in common pool resource management. Again, communication is here indicatively found to be beneficial for collaborative outcomes in that it help refrain head-enders from excessive resource extraction, which make downstream users more willing to invest in the common good. So far, we have found no experimental studies on resource interdependencies.

Experiments are generally employed to test hypotheses in a structured manner by using random assignment into treatment and control conditions (List and Price, 2013). By introducing ecological—as well as social complexity in our experimental design, the focus of our experiments inevitably shifts from testing hypotheses to instead allowing for a more exploratory approach, with the aim to hopefully generate new hypotheses about crucial features and linkages in relation to learning and communication in integrated social–ecological systems. We believe that such an approach is necessary if we want to be serious in our attempt to understand these integrated systems. By being explorative we may for example have a higher chance of uncovering micro-situational and contextual variables that influence user decisions and the influence of the broader social–ecological context in which users interact (Poteete et al., 2010; Anderies et al., 2011).

2. Method

2.1. Approach

Our study is based on controlled laboratory experiments where human subjects are confronted with virtual management situations, and are presented with different objectives and incentives. Experiments are randomized evaluations that can measure the impact of a specific variable by randomly assigning individuals to treatment groups. Relative to traditional empirical studies, experiments provide an advantage by creating exogenous variation in the variables of interest, allowing the researcher to establish internally valid causality rather than mere correlation (List, 2006).

There are several types of experiments (see Harrison and List (2004) for a classification of experiments). A conventional laboratory experiment is often performed in a classroom with a standard pool of subjects (often university students), that are isolated and not allowed to communicate with each other, unless of course communication is the