Chapter 10 DRAFT **1/18/09**
COMMENTS AND CRITICISMS ARE WELCOME
PLEASE DO NOT QUOTE FROM THIS DRAFT

BEYOND THE CONVENTIONAL THEORY OF COLLECTIVE ACTION AND THE COMMONS

Draft Chapter 10

Amy R. Poteete(a), Marco A. Janssen(b), and Elinor Ostrom(b.c),

Multiple Methods in Practice: Collective Action and the Commons

(a) Department of Political Science, Concordia University, Montreal, Quebec
(b) Center for the Study of Institutional Diversity, School of Human Evolution and Social Change, Arizona University, Tempe, Arizona
(c) Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, Indiana

Workshop in Political Theory and Policy Analysis
Indiana University
513 N. Park Avenue
Bloomington, IN 47408-3895
812-855-0441 • http://www.indiana.edu/~workshop • workshop@indiana.edu

Beyond the Conventional Theory of Collective Action and the Commons

In this chapter, we synthesize how the theory of collective action and the commons has evolved through the use of multiple research methods to go beyond the conventional theory laid out in chapter 2. Research based on field studies, laboratory experiments, and agent-based models has conclusively demonstrated that it is *possible* for individuals to act collectively to manage shared natural resources on a sustainable basis. Numerous field studies have illustrated the possibility of robust collective action that endures over generations. In response to these findings, theory related to collective action and the commons has evolved considerably. For example, field research informed conceptual clarifications related to types of goods and property rights and other institutions. Experiments established the importance of communication and trust in initiating and sustaining collective action. Agent-based models provide alternative formalizations that can explain observed levels of self-organization for specific assumptions.

If earlier puzzles have been addressed, new puzzles have also emerged and pose significant analytical challenges. Research based on field research, laboratory experiments, and agent-based models suggests that collective action related to common-pool resources is far more complicated that the conventional theory had assumed. The evidence simply does not support conventional assumptions that individuals make decisions on an automated basis, reflecting simple self-interested goals, in isolation from other actors. A large number of conditions influence the prospects for collective action (see also Agrawal 2001; Ostrom 2007). Further, findings from research involving a variety of methods suggest that many of these relationships are context-specific (Poteete and Ostrom 2004).

To move beyond the conventional theory of collective action and the commons without getting mired in complexity, we need to build on theoretical developments related to three levels

of analysis: (1) human behavior, (2) the micro-situational features of the immediate collective-action dilemma, and (3) the broader context. The need for three interrelated theoretical efforts is a tad overwhelming, but we do need to move on all three. Reliance on the conventional theory of human behavior is a core reason for the earlier failure to explain why some resource users self-organize and others do not, as well as why some government policies to solve overharvesting work and others do not. The theory of human behavior used to explain and predict likely outcomes in social dilemmas must reflect the strong, accumulated evidence about human behavior in the field and in experimental settings.

Focusing on a richer theory of human behavior, however, is not sufficient by itself. A better theory of human behavior alone cannot explain why individuals tend to behave more cooperatively in some contexts and not in others. We know from extensive empirical research that the specific variables structuring the immediate micro-environment facing individuals have a strong impact on levels of cooperation. We need to integrate these findings into our theoretical understanding of the commons. Further, we also need to understand how the broader context, including the immense complexity of natural resource settings in which commons dilemmas occur, affect specific human interactions and outcomes.

The big challenge in updating the conventional theory is how to avoid the extremes of overly simple or overly complex theories. The multi-tier, ontological framework described later in the chapter (and in Ostrom, 2007) begins to identify the many variables that *may* be involved in some types of collective action dilemmas at one level, but are not involved in all collective action dilemmas at all relevant levels. We need to build a diagnostic theory of social-ecological systems to learn which attributes of a system – and potentially sub-types and even sub-types of subtypes of these attributes – are important when analyzing one type of problem in a particular

context. These attributes are likely to change as the problem changes and/or the context changes. We cannot present a finished product for these efforts in this chapter. These theoretical tasks will require further work by many scholars over many years. We can, however, build on the extensive research reported in parts II and III of this book to provide a better theoretical understanding and a more coherent framework for future work than was available several decades ago.

The rest of this chapter first provides a synopsis of the developments reviewed in parts II and III of the book. Then, we summarize current thinking about a behavioral theory of individual choice. Next, we examine how micro-situational variables affect information, incentives, and the likelihood that trust and reciprocity will sustain cooperation. In the fourth part of this chapter, we examine the most relevant aspects of a micro-setting that affect the likelihood of cooperation in social dilemmas. In the fifth section, we discuss an ontological framework for examining relevant contextual variables at a broader level that then affects outcomes in diverse micro-situations. We then propose that a diagnostic approach that identifies the large *sets* and *subsets* of variables that potentially affect patterns of interactions and outcomes, strikes a good balance between theoretical oversimplification and the complexity represented in context-specific explanations. We conclude with a brief overview of the challenges for future research.

Synopsis of Research Developments Reviewed in Parts II and III

Hardin's (1968) dramatic pronouncement that local users were inexorably trapped in overusing a commons appeared four decades ago. The conventional theory was pristine in its simplicity. Individuals who faced a one-shot or finitely repeated social dilemma situation with a payoff structure that brought more immediate returns if they did not cooperate while others did would

not cooperate. Regardless of the micro-situational structure or broader context, all individuals in a dilemma situation would maximize short-term returns to self. No one would cooperate.[1]

Given the consistency of Hardin's prediction with the work of Gordon (1954) and Scott (1955) before him, with predictions from the theory of collective action (Olson 1965), and with non-cooperative game theory of that era, few saw reasons to challenge it. A sufficient number of well-known examples existed where common-pool resources were severely overharvested that the theory was considered credible by many scholars and policy makers. The theory presumed that external analysts could develop models showing how a preferred rule would change incentives leading to changes in actions so as to produce optimal outcomes. As discussed in chapter 2, it was presumed that these optimal rules could be imposed on participants who then would change their behavior, but not their inner decision-making processes. Thus, based on the conventional theory, many analysts thought that the *only* way to solve the commons problem was to impose a "solution" from the outside.

Fortunately, scholars who conducted case studies of diverse resource systems all over the world were not blinded by the conventional theory. They simply wrote about what they have found in their field sites. In many instances, their findings contradicted the presumption that it was impossible for local users to self-organize. As discussed in chapter 2, the early case study findings were so widely scattered among different disciplines and types of resource systems, that the challenge they represented to the validity of the conventional theory was not well recognized until the mid-1980s. The scholarly and policy world owes a considerable debt of gratitude to the National Research Council for organizing a Panel on Common Property Resource Management. The Panel brought attention to the existence of not just one, but hundreds of counter-examples to the predictions derived from the conventional theory of the commons. The possibility of

collective action has now been confirmed in many cross-national field-based research, experiments, and agent-based models. Because of the strong findings generated using a diversity of approaches, scholars, policy analysts, citizens, and officials now understand that collective action is *possible* and can address problems related to overuse of natural resources effectively.

Successful collective action is not, however, the *only* possibility. Case studies have documented numerous examples of once successful collective arrangements that failed to survive market pressures, government interventions, technological changes, demographic changes, or ecological changes. In other cases, collective action never emerged. Overharvesting tends to occur when resource users do not know who all is involved, do not have a foundation of trust and reciprocity, cannot communicate, have no established rules, and lack effective monitoring and sanctioning mechanisms. Massive overfishing of ocean fisheries and deforestation in many countries illustrate the destruction of resources that can occur in such settings. As discussed in chapter 7, subjects in an experiment presented with a common-pool resource problem substantially overharvest when they do not know who is in their group, receive no feedback on individual actions, and cannot communicate.

What accounts for varied success in collective action to manage common-pool natural resources? The studies reviewed in parts II and III of this book provide numerous suggestions. These studies have highlighted the importance of (1) cognitive limitations and risk aversion, (2) social interaction and norms, and (3) interactions among a variety of contextual conditions.

The conventional theory is based on a very simple model of human behavior. Individuals are assumed to have complete information about the structure of the situation, including the preferences of the other actors, the full range of possible actions, and the probability associated with each outcome that could result from a combination of actions. According to the

conventional model, each individual selects the set of actions that are expected to result in the best outcome for self. Neither risk nor communication, if it occurs, is expected to influence decision-making. The studies reviewed in parts II and III of this book challange these assumptions.

Shared resources include irrigation systems, inshore fisheries and highly mobile multispecies deep sea fisheries, plantations and ranches and multipurpose forests and rangelands. Field studies and meta-analysis have shown that, in fact, these resources and resource systems present management challenges that vary considerably. The conventional theory assumed that management of any shared natural resource could be modeled as a single-shot Prisoners' Dilemma. If resource users value risk-spreading over single-shot yields, however, as has been shown to be the case in some field studies, rewards for cooperative behavior may be considerable. Further, because of the variability and complexity of biological and physical dynamics affecting natural resources, the cognitive challenges presented by natural resource management also vary across settings. How can theory address the influence of *cognitive limitations and risk* on individual decision-making and collective action?

In the lab, once the subjects are enabled to talk about their puzzle in a face-to-face group, most develop joint strategies as well as the trust and reciprocity needed to carry out these strategies, contrary to the conventional theory. Within a few rounds, they reduce overharvesting substantially and improve their individual and joint outcomes. These findings echo behavior in the field where, as discussed in part II, many groups that use inshore fisheries, forests, irrigation systems, and pastures have used communication to develop a diversity of norms and rules to enable them to reduce overharvesting. As we discuss in the next section, although social interaction certainly conveys information about the planned behavior of other actors, its role in

establishing and enforcing norms seems to be at least as important for encouraging collective action. An improved theory must be able to account for *normative influences on human behavior*.

Field-based studies, experiments, and agent-based models have identified a very large number of contextual variables that influence collective action, including micro-situational conditions such as group size and heterogeneity and macro conditions such as market pressures, property rights, and government policies. It seems that few if any of these variables influence collective action in a uniform manner. Evidence has mounted that the simple policy prescriptions that are so often recommended as panaceas—privatize, turn over to the government, or create communal rights—can also fail (see Meinzen-Dick 2007; Berkes 2007; Wilson et al. 2007; Carpenter and Brock 2007). Simple solutions for complex problems are not likely to work. Considerable evidence has been gathered from both the field and the laboratory, that outcomes are influenced by *combinations* of factors.

The importance of cognitive limitations and risk, social interactions and norms, and interactions among contextual variables has been confirmed in numerous studies based on case studies, cross-national comparisons, experiments, and agent-based models. Current theories of collective action do not fully address interactions among these conditions. The theoretical challenge has several aspects. An improved theory should offer the tools for simplification that are inherent in theoretical analysis while allowing for complexity. It should allow for complexity and contingency without losing sight of patterns that apply to multiple cases. And it should account for cases that were well-explained by the conventional theory as well as the many cases that deviate from the older theory. The research reviewed in parts II and III of this book present a challenge to theory, but also provide building blocks for an improved theory. The next several

sections draw out those building blocks, beginning with movements toward a more general behavioral theory of human action.

Toward a More General Behavioral Theory of Human Action

The clear and unambiguous predictions derived from the conventional theory described in chapter 2 have been replaced with a range of possible actions, including some that are far more optimistic. The theoretical and empirical enterprise has, however, become more uncertain and complex. Explanations can no longer rest entirely on the model of the individual facing a particular type of payoff function. Instead, as shown in figure 10.1, an adequate explanation must account for the role of learning and norm-adoption, and the influence of micro-situational and broader contextual variables, in generating variable levels of cooperation.

{Figure 10.1 about here}

This is frustrating for scholars who yearn to have one simple theory that explains human behavior in all settings. It is particularly upsetting to have one theory—rational choice theory—that explains how individuals achieve close to optimal outcomes in competitive market settings, but fails to explain how individuals will or will not cope with social dilemmas.[2] Simply assuming that individuals are socialized into seeking better group outcomes does not explain the obvious fact that groups struggle with this problem and often fail to obtain jointly beneficial outcomes (Dietz et al. 2003). Holding onto a theory because it has done so well in one type of situation, is no longer an acceptable scientific strategy when it does not predict behavior well in many other types of situations.

We need to recognize that what has come to be called rational choice *theory* is instead one *model* in a family of models that is useful to conducting formal analyses of human decisions in highly structured settings as we discuss in chapter 7. It should be thought of as a model of

human behavior when individuals face highly competitive settings and would not remain in the game unless they focus narrowly on benefits to self. As Alchian (1950) demonstrated long ago, competitive markets eliminate players that do not maximize profits. Further, markets generate limited, but sufficient, statistics needed to maximize profits. The institutional structure of a market rewards individuals who make economically rational decisions and who can then be modeled as if they were determinate, calculating machines. Predictions of the conventional model are well-supported empirically for behavior in competitive markets and other highly structured and competitive environments (Holt 2007; Lian and Plott 1998; Smith 1962; Smith and Walker 1993). When it is used successfully, the rational choice model is largely dependent for its predictive power on the structure of the situation involved (Satz and Ferejohn 1994). In other words, the attributes of the situation within which individuals interact is more important in predicting outcomes than relying primarily on the model of rational behavior (Orbell et al. 2004).

In their effort to understand the extensive research that has challenged the validity of the model of rational behavior used so successfully in predicting behavior in highly competitive situations, scholars have attempted to modify this model at the margins to retain simplicity while accounting for deviations from the assumptions that individuals maximize their own utility.[3] These modifications posit other goals that humans appear to seek beyond immediate material benefits, or acknowledge cognitive limitations and varied attitudes toward risk. The fact that many participants cooperate even in one-shot social dilemma situations indicates that their preferences are not entirely dictated by the monetary payoffs they receive in the experiments. Thus, allowing for norms and social preferences is *necessary* in explaining the dynamics of these action arenas, but not *sufficient* as discussed below for predicting cooperation.

Contestation over the relative influence of attributes of individual personality and of the specific situation that individuals face has existed for long time within psychology (see Lewin 1936; Mechelen and Raad 1999). Given this puzzle, Waichmann and Requate (2008) recently undertook a careful test of the personality traits of subjects in Cournot duopoly experiments[4] and assessed whether personality traits affect subjects' behavior. They found in the first few rounds of an experiment that personality traits did help predict individual behavior. On the other hand, they found that "after subjects have gained experience, their behavior is largely independent of their personality traits (Waichmann and Requate 2008, 11). In concluding their analysis, they state that: "Our findings support the hypothesis that it is the situation rather than the personality characteristics of the subjects that mainly determines their behavior" (Waichmann and Requate 2008, 11).

All of the detailed models of human behavior that have been developed to explain deviations from the conventional model predict behavior well in some nonmarket situations but do not make accurate predictions across a full diversity of social dilemmas (see Janssen and Ahn 2006). Thus, it is unwise to settle on a single new *model* of individual behavior to replace the model of fully self-interested behaviour. Rather we wish to posit three broad theoretical attributes of human behaviour that help understand why individuals act in particular ways in one situation versus another. The weight of an explanation for cooperation in social dilemmas must lie both in the general theory of human behaviour *and* the characteristics of the situations they are in.

Assumptions of the Behavioral Theory

A broader theory of human behavior views humans as adaptive creatures who attempt to do well given the constraints and opportunities of the situations in which they find themselves

(or the ones that they seek out) (Simon 1955, 1957, 1999; Jones 2001). Humans learn norms, heuristics, and full analytical strategies from one another, from feedback from the world, and from their own capacity to engage in self-reflection and imagine a differently structured world. They are capable of designing new tools—including institutions—that can change the structure of the worlds they face for good or evil purposes. Multiple models are consistent with a behavioral theory of human actions, including a model of complete rationality when paired with specific models of repetitive, highly competitive situations.

Basically a behavioral theory of human decision-making is based on three core assumptions:

1. Actors possess incomplete information about the structure of the situation in which they are interacting with others, but they learn more complete and reliable information over time especially in situations that are frequently repeated and generate reliable feedback to those involved.
2. Actors do have preferences related to achieving net benefits for self but these are combined to some extent with other-regarding preferences and norms about appropriate action and outcomes that affect their decision.
3. Actors use a variety of heuristics in making daily decisions that may approximate maximization of net benefits (for self and others) in some competitive settings.

If, as we assume, decision-making relies on learning and adaptation, other-regarding preferences and norms, and heuristics, then trust can play a central role in influencing the prospects for collective action We discuss each of these basic assumptions and then draw out the implications for the centrality of trust.

Incomplete Information with Learning

In most of the common-pool resource settings, it would be unrealistic to assume that all individuals make decisions in light of having complete information about all of the structural aspects of the situation they face. Instead of assuming that complete and perfect information is a universal property of the individual decision maker, in a behavioral theory one assumes that structural elements of a relevant situation affect the accuracy and completeness of the information that an individual possesses.

In a relatively simple situation that is repeated without major structure changes, one can assume that individuals learn more accurate information over time about other participants, the individual actions that are allowed and how these are linked to outcomes, and their individual and joint payoffs. When predicting behavior in laboratory experiments, for example, it is less problematic to assume full information about the structure of the situation. Most researchers expend substantial effort to increase the probability that all participants share the same and accurate information about the number of other participants, the actions they can and cannot take, the payoffs of different combination of actions and whether the experiment will be repeated with (or without) the same linkage among participants.

Norms and Other-Regarding Preferences

In addition to learning more reliable information, individuals also learn norms. By norms, we mean that the individual attaches an internal valuation—positive or negative—to taking particular types of action in specific situations. Crawford and Ostrom (2005) refer to this internal valuation as a delta parameter that is added to or subtracted from the objective costs of an action or an outcome. Knack (1992) refers to negative internal valuations as "duty." The strength of the commitment (Sen 1977) made by an individual to take particular types of future

actions (telling the truth, keeping promises), is reflected in the size of the internal positive or negative weight (delta parameter) that they add to their preference function.

Analytically, individuals can be thought of as learning norms of behavior that are relatively general and fit a wide diversity of particular situations. Cox and colleagues posit that individual behavior in a particular setting is affected by an individual's initial emotional or normative state and then by direct experience with others in a specific setting (Cox 2004; Cox and Deck 2006; Cox, Friedman, and Gjerstad 2007;Cox, Sadiraj, and Sadiraj 2008). The underlying norms and direct experience in a particular setting combine to affect orientations toward reciprocity. There are multiple ways of representing these social preferences (Frohlich 1974; Andreoni 1989; Rabin 1993; Ledyard 1995; Fehr and Schmidt 1999; Bolton and Ockenfels 2000; Charness and Rabin 2002; Cox and Friedman 2002, for example).

Fairness and justice are among the norms used by many individuals in dealing with collective action settings (Frohlich and Oppenheimer 1992). The maximal net return to a group may be obtained in a manner that is perceived to be fair or unfair by those involved—using the general concept that "equals should be treated equally and unequals unequally" (see Isaac, Mathieu, and Zajac 1991). Fehr and Schmidt (1999) propose another explanation for experimental observations, namely *inequity aversion*, which is a dislike of unequal outcomes per se, independent whether it has been the result of kind or hostile intensions. When participants are symmetric in regard to all strategically relevant variables, the only real fairness issue relates to the potential capability of some to free ride on others (Dawes, Orbell, and van de Kragt 1986). When participants differ, however, finding an allocation formula perceived by most participants as fair is far more challenging (Rawls 1971; Eckel and Grossman 1996). In most cases, however,

theorists have argued that when participants think that a proposal for sharing costs and benefits is fair, they are more willing to contribute.

Assuming that individuals adopt norms is not sufficient to generate a prediction of when individuals will cooperate in a dilemma situation or when they will not. As de Oliveira et al. (2008, 19) point out, "individuals may have a stable preference to 'do the right thing,'" but even with this stable preference, "observed behavior may vary by context because the perception of the 'right thing' would change." Multiple aspects of particular situations combine to enhance the importance of following norms and valuing returns to others or of ignoring these. Factors, such as not knowing who else is involved or learning that others are not cooperating, have a strong negative impact on the willingness of an individual—who may have strong norms or other-regarding preferences—from giving any weight to these in this situation. Who wants to be a sucker or to help those who are free-riders?

Heuristics

When theorists use a model of complete rationality, they assume that individual have access to complete information – information about all potential actions that one could take, all outcomes that could be obtained, and all strategies that others could take. The conventional model also assumes that individuals will consider all available information when making decisions. In fact, many situations in life do not generate accurate information about all potential actions that one could take, all outcomes that could be obtained, and all strategies that others could take. Even when information can be acquired, it may be costly to do so. In other situations, the volume and complexity of information is overwhelming. In most everyday situations individuals use heuristics—rules of thumb—that they have learned over time regarding responses that tend to give them good (but, not necessarily optimal) outcomes in particular kinds of situations. In

frequently encountered, repetitive situations, such as those faced by pastoralists roving with their animals, individuals learn better and better heuristics that are tailored to the particular situation. In other words, over time, individuals develop rough approximations of the benefits and costs of actions they can take in a particular setting. With repetition and sufficiently large stakes, individuals may learn heuristic that approach best-response strategies and thus approach local optima (Gigerenzer and Selten 2001).[5]

Theorists interested in collective action have examined the potentially positive effects of participants adopting simple heuristics when they are in a social dilemma situation. Morikawa, Orbell, and Runde (1995), for example, examine the efficacy of using the simple heuristic of "expect others to have the same dispositions as yourself." They conduct a simulation where each actor in a population of 10,000 actors is matched to another actor. Those simulated agents whose payoff is above the mean are multiplied by two, while those whose payoff is below the mean are eliminated from the simulation. Their simulations generate the prediction that the heuristic will be most valuable when social dilemmas occur among those in close proximity. Other heuristics, such as always take your share, may lead to negative outcomes in some situations.

Using a behavioral theory of individuals who learn from past history and current interactions in a situation, who are other-regarding (to some extent), and who hold internal norms related to their behavior, is still consistent with assuming that individuals do a *rough* benefit-cost calculation to evaluate which actions they should take or heuristics to use in a particular situation. When the situation of concern is primarily commercial and framed by a competitive market, a researcher can gain a relatively reliable estimate of the expected financial benefits and costs of an action. If it is an over-time situation characterized by risk, the researcher has to make a rough estimate of the discount rate and how participants would estimate the risks involved.

The Centrality of Trust

In situations where individuals can acquire a reputation for being trustworthy and for using positive and negative reciprocity, others can learn to trust those with such a reputation and begin to cooperate so as to sustain higher returns for all (Fukuyama 1995; Rothstein 2005; Ostrom 1998). Levels of trust can act as a heuristic guiding the choice among alternative norms. Thus, at the core of an evolving theoretical explanation of successful or unsuccessful collective action is the internal link between the trust among participants in a common-pool setting - or a more general collective-action situation - and the increased probability of all participants using reciprocity norms (see figure 10.2).

{Figure 10.2 about here}

The conventional theory of collective action does not include *any* reference to the concepts of trust and reciprocity even though the distinguished economist, Kenneth Arrow (1974), had long ago pointed to the essential role of trust between partners as the most efficient mechanism for governing transactions. The prediction of an outcome was based entirely on the payoff function, so little theoretical attention was given to examine how contextual variables at multiple levels affect cooperation.

When some individuals initiate cooperation in a repeated situation, others may learn to trust them and be more willing to adopt reciprocity themselves leading to higher levels of cooperation, even though cooperation may not reach 100 percent (Milinski, Semmann, and Krambeck 2002). And, when more individuals use reciprocity, gaining a reputation for being trustworthy is a good investment as well as having an intrinsic value. Thus, levels of trust and reciprocity are mutually reinforcing. This also means that a decrease in either can generate a

downward cascade leading to little or no cooperation—unless there are appropriate ways of sanctioning non-contributors that reverse a trend downward.

Whether participants in a social dilemma trust others and/or have adopted a norm of reciprocity is hard to measure reliably and accurately by researchers or by other participants. The existence of trust and reciprocity has been inferred by researchers from two sources: (1) asking participants about their sense of trust and reciprocity through interviews in the field or surveys conducted after experiments, and (2) observed changes in behavior when changes occur in the context of a collective action problem. Participants have to infer these inner values of other participants from a variety of contextual variables and past behavior that help to increase their confidence that it is relatively safe to trust others.

The Importance of Context

Extensive research on collective action has shown that individual behavior in similar situations is relatively diverse.[6] More people cooperate than predicted by the conventional theory, but substantial variation in behavior exists across and within situations. Thus, we are less able to predict precise outcomes in collective action situations as we are in highly structured competitive situations. With the extensive research reported in parts II and III of this book, however, we are able to make rough predictions about how combinations of situational and broader contextual variables affect decisions made by individuals who learn the benefits and costs of cooperation, who value norms and returns to others to some extent, and who initially use heuristics rather than a full plan of action. Thus, our next theoretical task is to begin to develop analytical tools to help unpack the concept of context.

As mentioned in the introduction to this chapter, to move beyond the conventional theory of collective action will require theoretical development at two more levels beyond a better

understanding of human behavior: the micro-situation in which individuals directly act and the broader context related to the social-ecological system in which individuals make decisions in the field. Analysis of the broader context requires a multi-tier ontological framework for unpacking the huge number of potential variables relevant to the diverse resource dilemmas that occur in field settings. We will defer that discussion until the next section of this chapter and focus now on context at the micro level.

The Micro-Situational Context

In evaluating whether to trust that it is safe to cooperate (and that the chances of being a sucker are relatively low), individuals have to use information about the structure of the situation they are in—and the behavior of others that they may be able to observe over time. A social dilemma situation in which an individual has *no* information about who else is involved and makes an *anonymous* decision relieves many individual participants of the need to follow norms or value outcomes for others. It also enables a researcher to make a relatively clear prediction that a substantial proportion of individuals in such situations will *not* cooperate. One-shot experiments using double-blind designs where the participants know that their decisions are kept anonymous and that even the experimenter will not know what they do, tend to generate the most self-regarding behavior. In a recent synthesis of dilemma experiments, Ebenhöh and Pahl-Wostl (2008) found that the level of cooperation was lowest in those experiments where the identity of others was not known, anonymity was fully protected, and there was no chance to build a reputation.

The Impact of Micro-Situational Variables on Cooperation

Given the extensive results of experiments that use micro-situational variables in their design and a behavioral theory of human action, we are slowly gaining confidence that we can explain and

predict when participants in many social dilemmas related to the use of natural resources will achieve higher joint and individual payoffs. We are now able to move beyond resting all explanatory weight on models of human behavior or simply asserting that "context" makes a difference.[7] The core problem that needs to be solved in order to increase cooperation is creating trust among participants that others are reciprocators and that cooperating will not make an individual a sucker.

Thus, we start with the prediction that participants in a repeated social dilemma are more likely to cooperate when: they trust that other participants will cooperate, they expect higher benefits than costs, and they do not think that non-contributors will take advantage of contributors (Frohlich and Oppenheimer, 2001). The following six micro-situational variables have been found to increase trust and positive outcomes in multiple experimental social dilemmas.

S1 *High marginal per capita return.* If MPCR is high, each individual can recognize that their own contributions make more of a difference than with low marginal per capita returns and that others are more likely to recognize this and contribute.

S2 *Security* that contributions will be returned if not sufficient. If an individual's contribution will be returned if not enough others contribute, each individual is safeguarded against being a sucker and is more willing to contribute.

S3 *The reputations of participants are known.* While individuals may not know specifically with whom they are clustered, knowing enough about their past history of being a contributor is likely to increase cooperation levels when the reputation is positive.

S4 *Longer time horizon*. Participants can reason with themselves that showing a willingness to contribute early may lead others to contribute and the longer the time horizon involved the better the return on individual investment.

S5 Capability to *exit* from some groups and *enter* others. This enables participants to leave micro-settings where they are dissatisfied with outcomes and enter situations where others are cooperating at a higher level.[8]

S6 C*ommunication* is feasible with the full set of participants. Even sending structured messages to each other can increase trust. When discussion is organized in a face-to-face manner, the way words are expressed, facial expressions, and physical actions help individuals assess the trustworthiness of others and the willingness to contribute. Even when participants have unequal assets for investing in a public good or common-pool resource, being able to communicate about alternative formulas that could be used to achieve a fair distribution of costs and benefits can help increase trust and joint payoffs.[9]

While the above six structural variables have been shown in multiple micro situations to have a positive impact on levels of cooperation, other structural variables have generated a diversity of outcomes.

S7 *Size of group.* When individuals face a public good problem, they are more likely to contribute in larger groups than in smaller groups. In a public good situation, cooperation by any individual increases the non-subtractive benefits to all while holding individual costs constant and lowering the fear of being a sucker. Contrariwise, in a common-pool resource, each unit harvested by one individual is subtracted from those available to others. As the group gets larger, the fear of

being a sucker (by not harvesting while others harvest) also increases. In both types of situations, increases in group size make it more difficult to establish trust, but related to public goods increasing a group's potential for resource mobilization may have a stronger impact.

S8 *Information about the average contributions is made available*. In public good settings, cooperation levels tend to shift downward over time and where individuals see that downward trend, they also tend to stop contributing. In a common-pool resource, information about past overuse may lead some individuals to pull back and harvest less out of fear of losing all future opportunities.

S9 *Sanctioning capabilities.* Depending on how a sanctioning capability is established, the ratio of the cost of sanctioning, and the cost of being sanctioned, whether rewards can also be issued, and whether there is communication, some situations with sanction capabilities allocated to individuals increase joint returns and joint returns are decreased in others. One has to examine the effect of sanctioning capabilities on the levels of trust or distrust it engenders.

A tenth structural variable that differs across micro-situational variables and usually is associated with low levels of cooperation is:

S10 *Heterogeneity in benefits and costs*. When it appears to some participants that others will receive more benefits without paying more costs, those with fewer assets may be unwilling to contribute—especially if there is no way to communicate about how to share costs and benefits.[10]

The substantial number of carefully designed experiments that have been conducted by researchers in many laboratories (as well as in related field experiments) provides a solid empirical foundation for developing this initial list of micro-situational variables that affect levels of cooperation as illustrated in figure 10.3. The list of variables, and identification of sub-categories of variables is likely to grow over time as more experimental research is undertaken related to collective action. Currently, these variables have been used primarily to structure micro-situations in order to test theory. They can also be used diagnostically in efforts to understand, and potentially modify, micro situations, such as small work-teams, where cooperation is low.

(Figure 10.3 about here)

Understanding the link between situational variables and the capacity of participants to gain trust and cooperate in micro-situations, such as those found in laboratory experiments or small groups who harvest together from a resource, is easier to explain than the link from broader contextual variables to level of cooperation in field settings. In micro settings studied in the lab or agent-based models, the attributes of the situation are specified very clearly by the researcher. With repetition of the experimental conditions and replication of them by other scholars, one can assess whether: (1) a particular situational variable has a consistent, predicted impact on behavior in a diversity of settings, (2) its impact depends on the combination of structural variables present, or (3) it had an impact in one setting only and should not play a role in future theoretical development. That is the process that led to the identification of 10 variables listed above and shown in figure 10.3. This process will slowly add more micro-situational variables to this set as more experiments are conducted that introduce new variables or break previously studied variables into subtypes.

The Challenge of Linking Broader Context to Cooperation

The vastly more numerous contextual variables observed in the field, and the challenge of measuring them precisely, make theoretical predictions related to field studies far more difficult. Measuring the size of a group in a lab experiment is a trivial task. Measuring the size of a group in the field so as to gain a better prediction about cooperation is frequently quite a challenge. The number of fishers, who regularly fish from a particular in-shore fishery, may be easier to ascertain especially where all boats leave and return to the same port. It is much more difficult to assess for ocean fisheries, or when some of the harvesters from an inshore fishery are illegal and try to conceal their participation. Further, it is not always apparent to the researcher whether sub-groupings among participants exist within a larger group in the field.

Several recent efforts to conduct the same experiments in a variety of field settings illustrates that behavior is affected both by the micro-situational variables used in conducting an experiment and by the broader contextual variables that affect the field settings where experiments were run. Henrich et al. (2004, 2005) conducted a series of ultimatum and public good games in fifteen small communities located in Africa, Asia, and Latin American to assess the whether the findings from lab experiments with undergraduate students enrolled in Universities located in developed countries would stand up at all when conducted in multiple developing countries. Two major findings from this study help to understand why micro situational and broader context variables are both important in understanding cooperation. First, Henrich and colleagues found that behavior and outcomes were broadly similar in most of the same experimental games conducted across the societies included in their study. Second, they found that the culture and environment in which an experiment was conducted also affected the behavior of participants and the outcomes. As discussed in chapter 7, colleagues in Colombia

have also found both similarities in experimental results across diverse field settings in the same country, but also some variations due to different ecological and historical factors of a field site (Cardenas 2001, 2003; Cardenas et al. forthcoming; Lopez forthcoming).

Coping with Complexity

A crucial challenge at the current stage of development is the need to move toward theories of collective action and common-pool resources that acknowledge complexity and multiple levels of analysis, but yet offer meaningful analytical leverage, can be tested, and improved over time. To accomplish this difficult task, we need to recognize the importance of developing ontological frameworks and diagnostic theories and using both in future research. Ontological frameworks and diagnostic theories are used in medicine, biology, and information sciences to enable scholars to identify relevant causal processes within complex, nested systems. Answers to initial research questions identify further questions that need to be addressed in a repeated process until one has found answers to understand the causal processes that are leading to some set of outcomes of interest. Since there are many potential dependant variables to explain, one needs to develop a set of related theories rather than just a single theory.

Ontological frameworks complement the development of powerful diagnostic theories. Ontology refers to the essence of reality. In previous chapters, we referred to the ontological assumptions of various methods of analysis and highlighted ontological differences. These earlier references to ontology concerned assumptions about the essential nature of reality in terms of causality, such as the relative influence of structure and agency, and the degree to which universal patterns exist. A linguistic construction such as a concept is composed of sub-concepts, which are in turn composed of sub-concepts, and further sub-concepts. An ontological framework enables one to bring some order to the infinite regress problem so that one recognizes

nested systems without being overwhelmed by them. Ontological frameworks are widely used in biology, medicine, and informatics, to lay out of the nested nature of the elements of a complex system (Madin et al. 2007; Salafsky et al. 2008).

When we have a medical problem, for example, a doctor will ask us a number of initial questions and take regular measurements. In light of that information, the doctor proceeds down a medical ontology to ask further and more specific questions (or prescribes tests) until a reasonable hypothesis regarding the source of the problem can be found and supported. An ecologist studies a diversity of plants and animals as they interact on a geographical plan and assesses which factors affect the resilience of the system. A biologist, on the other hand, may be interested in the growth patterns of one particular mammal living in that ecology. The research questions asked about the life patterns of a particular animal (including humans) differ substantially than those asked about other animals, or about an ecology composed of the interaction of many animals and plants. Further, a biologist would expect that the processes related to a specific animal will differ somewhat when that animal is studied in one ecological zone versus another.

Doctors, biologists and ecologists are more comfortable than social scientists with the notion of analytic systems within systems within systems, where the researcher has to determine the appropriate system—and variables within—to address a particular set of questions. Within the social sciences, Herbert Simon (1985, 196) introduced a similar concept that he called a hierarchic system, by which he meant: "a system that is composed of interrelated subsystems, each of the latter being in turn hierarchic in structure until we reach some lowest level of elementary subsystem. In most systems in nature it is somewhat arbitrary as to where we leave off the partitioning and what subsystems we take as elementary."[11]

When we think about a particular collective action problem, we need to think about which of the attributes of a particular system are likely to have a major impact on the patterns of interactions and outcomes to be explained. The researcher picks the focal system to address a particular set of questions and the relevant variables operating at that level for addressing this question. To address an interesting question one usually also examines processes occurring at one or two levels above and below that focal system. No focal system is correct for all questions. Nor is there a set of variables at any particular level that are always involved for any of the important questions a researcher may want to address.

An Ontological Framework of Social-Ecological Systems

As a point of departure, we draw on a multitier framework presented in a recent article on "A Diagnostic Approach for Going beyond Panaceas" (Ostrom 2007). The broad first tier of this framework relates resource systems and their units with governance systems and users that together generate interactions and outcomes (see figure 10.4). An initial unpacking of the first tier leads to a very large set of variables that may characterize any of the basic systems identified at the first tier (see table 10.1 below). The second tier variables may be further unpacked into third, fourth, or fifth tier variables – depending on the question being asked and whether different sub-types of a variable tend to generate different outcomes in particular types of processes.

{Figure 10.4 about here}

The framework can be used to study a wide variety of questions related to any particular resource system, ranging in scale from a small inshore fishery to the global commons. A scholar interested in explaining a particular puzzle would first identify which type and size of a resource system, its resource units, the governance system related to it, and the users that are relevant for answering that question. The question might be why fishers in Kafue Flats fisheries of Zambia

do not engage in collective action (see Haller and Merten 2008), or why two fishery communities on the coast of Mexico were able to self-organize while a neighboring community was not (Basurto and Ostrom 2008).

Scientists trying to understand multiple cases that vary in regard to the first tier identified in figure 10.4, need to design research so that cases are broadly similar in regard to either the left or the right side of the figure. Thus, a social scientist may want to hold the resource system and its units constant for a particular study, so these are not different while the scholar is trying to understand the impact of diverse rules on user behavior leading to outcomes. An ecologist, on the other hand, might want to hold the governance systems and attributes of users relatively constant in choosing cases to study so that differences in the resource system can be examined without substantial simultaneous interaction with social structure. As we stated above, which particular variables, subtypes of variables, and subtypes of subtypes are most relevant vary substantially across research questions.

The broad SES framework presented in figure 10.4 provides a "frame" for our earlier focus on how micro-situational variables impact on the core relationships in a social dilemma. In figure 10.5 we illustrate the nesting of micro-situations examined in figure 10.3 within the broader context of figure 10.4. By doing this we illustrate the complexity of relationships between the broader context of a situation as it impacts the structure of the situation of the actors at the micro-level.

{Figure 10.5 about here}

To begin to diagnose the causal patterns that affect outcomes such as successful formation of self-organization or its sustainability in field settings, one needs to incorporate a subset of "second-tier" contextual variables that are contained within the first tier identified in

figure 10.4 and impact on outcomes. The list of second-tier variables (and two third tier variables) in table 10.1 constitutes an initial effort to help group and classify important variables in an ontology of potential importance to the analysis of multiple theoretical puzzles related to SES outcomes. Table 10.1 is not the "final" list of relevant second-tier variables of a social ecological system – as more research is undertaken the framework will be improved over time.

{Table 10.1 about here}

It is essential to understand that an analyst should *not* include fifty or more variables when studying a well-defined theoretical question. No scholar can develop a theory that includes *all* of the second-tier variables (or the many third and fourth tier variables) that do affect some of the important processes occurring with social-ecological systems. A list of variables is not a theory. The ontological framework should not be substituted for careful theoretical work, but it can help in the identification of relevant variables. The intention is to help scholars, officials, and citizens to understand the *potential* set of variables and their sub-variables that can be important in analyzing diverse theoretical questions related to the governance of resources.

Explaining Self-Organization

When will users invest in making new rules related to their use of a common-pool resource? This is a very general question to which a very general theoretical answer can be given. Users of a resource system will continue to harvest resource units, without trying to change the rules of their system, unless they perceive that the benefits they would receive from a change in their rules will be greater than the costs involved. Trust affects expectations related to transaction costs involved in changing rules, as well as the monitoring costs of new rules. Appendix 10.1 contains a short, formal theory of the type of benefit-cost analysis that would be involved. The conclusion of the theory is that when the perceived benefits of a change of rules exceeds the

perceived costs of this effort for a winning coalition of users, the users will choose a new set of rules. Otherwise, they will continue with the old.

The prediction is very clear. The challenge is doing field work, however, is that measuring the perceived benefits and costs of those involved is almost impossible, and the specific contextual variables that affect perceived benefits and costs differ substantially across settings. To diagnose when users will or will not invest in new rules in field settings, one needs to relate broad contextual variables to the benefits and costs perceived by individuals in specific contexts.

Fortunately, given the extensive work of CPR scholars focused on explaining collective-action outcomes related to natural resources as summarized in parts II and III, considerable consensus exists about a subset of second and third-tier variables that tend to affect whether users self-organize to avoid the continuance of open-access, or at least that users will develop rules and norms to limit their harvesting or protect their resource in some manner (see Baland and Platteau 1996; McKean 1998; Wade 1994; Schlager 1990; Tang 1992; Ostrom 1992; 2001; Ostrom, Gardner, and Walker 1994). We list these variables below and have placed a star next to them in table 10.1.

We do not assert that any of the variables listed below is *always* associated with success or failure in avoiding the tragedy of the commons. Rather, it is the overall combination of these variables in many cases that affects how participants judge the benefits and costs of new operational rules.[12] The potential set of variables related to resource systems include:

> Size of resource system (RS3): The CPR is sufficiently small, given communication and transportation technologies in use, that the users can acquire accurate knowledge about the boundaries and dynamics of the system.
>
> Productivity of system (RS5): The productivity of the CPR has not been exhausted nor is it so abundant that there is no need to organize.

Indicators of the productivity of the system (RS5a): Reliable and valid indicators of CPR conditions are available at a low cost.

Predictability of system dynamics (RS7): The system dynamics are sufficiently predictable that users can estimate what would happen if they continued old rules or changed the rules and strategies in use.

The variables related to users that are potentially important include:

Leadership (U5): Some users of a resource have skills of organizing and local leadership as a result of prior organization for other purposes or learning from neighboring groups.

Norms/social capital (U6): Users have generally developed trust in one another so as to keep promises and return reciprocity with reciprocity.

Knowledge of the social-ecological system (U7): Users share knowledge of relevant CPR attributes and how their own actions affect each other.

Dependence on resource (U8): Users are dependent on the CPR for a major portion of their livelihood.

Many of the variables related to the governance system will also be important but empirical studies show that having collective choice autonomy to make one's own rules has repeatedly been shown to be important (see, for example, Haller and Merten 2008).

Autonomy to make own operational rules (GS6a): Local users have some degree of autonomy at the collective choice level to make some or all of their operational rules.

Diagnosing Institutional Change

A list of variables is not, however, a sufficient explanation for processes and outcomes. In analyzing empirical cases, the researcher or policy analyst must try to diagnose how the above factors affect the expected potential benefits and costs that users, in a particular setting, face if they continue old rules or attempt to change them. One would start with the listed variables and ask how they are roughly likely to affect the benefits and costs of users.

The starred attributes of a resource system are likely to affect the perceived benefits and costs of institutional change in the following ways. If the resource system is highly productive

(R5), there are few reasons for users to invest costly time and effort in organizing as there is no apparent need. On the other hand, if the resource is already substantially degraded, the high costs of organizing may not generate sufficient benefits. Thus, self-organization is likely to occur only after users observe some scarcity, but not too much (Wade 1994). The danger they face is that rapid, exogenous shocks might occur that leads to a change in relative abundance of the resource units, and users may not adapt quickly enough to new circumstances (Libecap & Wiggins 1985). That is why having frequently available, reliable indicators about the conditions of a resource (RS5a) is also important. It affects the capacity of users to adapt relatively soon to changes that could adversely impact their long-term benefit stream (Moxnes 1998).

A resource flow that is highly predictable (RS7) is much easier to understand and manage than one that is erratic. This is true for both the users themselves and for public officials who may have acquired management responsibilities for a resource of a particular type in a region (Brock & Carpenter 2007). In the latter case, it is always difficult for users (or, for scientists and government officials) to judge whether changes in the resource stock or flow are due to overharvesting or to random exogenous variables. Unpredictability of resource units in micro-settings, such as private pastures, may lead users to create a larger common-property unit to increase the predictability of resource availability somewhere in the larger unit (Netting 1972; Wilson & Thompson 1993). The spatial extent of a resource (RS3) affects the costs of defining reasonable boundaries and monitoring them over time.

The attributes of the users themselves also affect their expected benefits and costs. If users do not obtain a major part of their income from a resource (U8), the high costs of organizing and maintaining a self-governing system may not be worth their effort. If users do not share a common understanding of how complex resource systems operate (U7), they will find it

extremely difficult to agree on future joint strategies. As Libecap and Wiggins (1985) argue, asymmetric private information about heterogeneous assets may adversely affect the willingness of participants to agree to a reduction in their use patterns before considerable damage is done to a resource.

Given the complexity of many common-pool resources—especially multispecies or multiproduct resources—understanding how these systems work may be challenging even for those who make daily contacts with the resource. In resources that are highly variable (RS7), it may be particularly difficult to understand and to sort out those outcomes stemming from exogenous factors and those resulting from the actions of users. And as Brander and Taylor (1998) have argued, when the resource base itself grows very slowly, population growth may exceed the carrying capacity before participants have achieved a common understanding of the problem they face. Of course, this is also a problem facing officials as well as users. Users with many other viable and attractive options, who thus discount the importance of future income from a particular resource, may prefer to "mine" one resource without spending resources to regulate it (Berkes et al. 2006). They simply move on to other resources and become "roving bandits," since they assume that other resources will be available to them.

Users who share norms and trust one another (U6) to keep agreements and use reciprocity in their relationships with one another, face lower expected costs in efforts to achieve better outcomes as well lower costs of monitoring and sanctioning one another over time. Users who lack trust at the beginning of a process of organizing may be able to gain trust over time if they initially adopt small changes that most users follow before trying to make major institutional changes. Autonomy (GS6a) tends to lower the costs of organizing. A group that has little autonomy may find that those who disagree with locally developed rules seek contacts with

higher-level officials to undo the efforts of users to achieve their own new rules. With the legal autonomy to make their own rules, users face substantially lower costs in defending their own rules against other authorities.

Prior experience with other forms of local organization and development of local leadership (U5) greatly enhances the repertoire of rules and strategies known by local participants as potentially useful to achieve various forms of regulation. Further, users are more likely to agree upon rules whose operation they understand from prior experience, than upon rules that are introduced by external actors and are new to their experience. Given the complexity of many field settings, users face a difficult task in evaluating how diverse variables affect expected benefits and costs over a long time horizon. In many cases, it is just as difficult, if not more so, for scientists to make a valid and reliable estimate of total benefits and costs and their distribution (Wilson et al. 2007).

Linking these contextual variables to a theory of institutional change does *not* lead to a conclusion that most users using common-pool resources will undertake self-governed regulation.[13] Many settings exist where the expectation should be the opposite: Users will overuse the resource unless efforts are made to change one or more of the variables affecting perceived costs or benefits (Berkes 2007; Meinzen-Dick 2007). Given the number of variables that affect these costs and benefits, many points of external intervention can enhance or reduce the probability of users' agreeing upon and following rules that generate higher social returns (Nagendra 2007). Both social scientists and policymakers have a lot to learn about how these variables operate interactively in field settings.

Aspects of the macro-institutional structure surrounding a particular setting may also affect the perceived costs and benefits. Thus, external authorities can do a lot to enhance or

impede the likelihood and performance of self-governing institutions. Further, when the activities of one set of users have "spillover effects" on others, external authorities can either facilitate processes that allow multiple groups to solve conflicts arising from negative spillovers or take a more active role in governing particular resources themselves.

Researchers and public officials need to recognize the multiple manifestations of these theoretical variables in the field. Users may be highly dependent on a resource (U8), for example, because they are in a remote location and few roads exist to enable them to leave. Or, they may be located in a central location, but other opportunities are not open to them due to lack of training or a discriminatory labor market. Users' discount rates in relation to a particular resource may be low because they have lived for a long time in a particular location and expect that they and their grandchildren will remain in that location, or because they possess a secure and well-defined bundle of property rights to this resource. Reliable indicators of the condition of a resource (RS5a) may result from activities that the users themselves do –such as regularly shearing the wool from sheep (see Gilles and Jamtgaard 1981)-- or because of efforts to gather reliable information by researchers or by external authorities (Blomquist 1992; Blomquist and Ostrom 2007; Basurto 2008). Predictability of resource units (RS7) may result from a clear regularity in the natural environment of the resource or because storage has been constructed in order to even out the flow of resource units over both good and bad years (Schlager et al. 1994). They may have autonomy to make their own rules (GS6a) because national law formally legitimates local self-governance or because national government is weak and unable to exert authority over resources that it formally owns.

When the benefits of organizing are commonly understood by participants to be relatively high, users lacking many of the attributes identified above as conducive to the development of

self-governing institutions may still overcome their liabilities and establish effective agreements. The crucial factor is *not* whether all contextual attributes are favorable. Most important is the relative size of the expected benefits and costs they generate as perceived by the participants who comprise a winning coalition given the collective-choice rules in use. All of these variables potentially affect the expected benefits and costs of users, but there may be other contextual variables that are highly relevant in a particular case. It is difficult, however, particularly for outsiders, to estimate their impact on expected benefits and costs given the difficulty of making precise measures of these variables and weighing them on a cumulative scale.[14]

Even in a group that differs on many variables, if at least a minimally winning subset of users harvesting from an overused but valuable resource are dependent on it (U8), share a common understanding of their situations (U7), trust one another (U6), and have autonomy to make their own rules (GS6a), it is more likely that they will estimate the expected benefits of governing their resource greater than the expected costs. Whether the rules agreed upon distribute benefits and costs fairly depends both on the collective-choice rule used, the history of this group, and the type and degree of heterogeneity existing in the community.

Challenges for Future Research

In addition to the growing consensus concerning the contextual variables most likely to enhance self-organization, many unresolved issues still exist about collective action and the commons. The research findings in parts II and III of this book have led to cumulative understanding in many regards, but have also generated debate about the effect of scale, heterogeneity, and dynamics on collective action. Understanding the multiple effects of scale, heterogeneity, and dynamics are among the major challenges of future research on the commons. A diagnostic

theory based on an ontological framework offers a promising initial strategy for making sense of these complex, multi-tiered relationships.

In regard to the effect of the scale and heterogeneity of a user group and/or of the resource units produced by a resource system, research findings from field studies are quite diverse. One of the problems with a focus on size of group as a key determining factor is that many other variables change as group size increases. If the costs of providing a public good related to the use of a common-pool resource, say a sanctioning system, remain relatively constant as group size increases, then increasing the number of participants brings additional resources that could be drawn upon to provide the benefit enjoyed by all. On the other hand, if one is analyzing the transaction costs of arriving at acceptable allocation formulas, group size may exacerbate the problems of self-governing systems. Future work will need to focus on the combinations of variables that impact on incentives and outcomes rather than presuming that one variable—such as size of group—determines results.

Scale is also important regarding a full social-ecological system. A social-ecological system can be considered to function as a nested, hierarchical structure, with processes clustered within subsystems at several scales (e.g., the farm, region and state) (Ostrom and Janssen 2004). The subsystems are semi-autonomous, but cross-scale interactions do occur. For effective governance the different spatial and temporal scales of social and ecological processes need to be taken into account, leading to a "multilevel" governance approach (Duit and Galaz forthcoming; Young 2006; Young et al. 2006).[15] A multilevel approach will experience challenges due to asymmetries in leadership, relevant knowledge of social and ecological processes at different levels of scale, and differences in dependence of resources. The scale of ecological processes affects the cost of monitoring. To measure effectiveness of climate change policies, for example,

many different processes at the global and regional scale need to be monitored over long periods of time.

Studying the dynamics of social-ecological systems is a major priority for future work (Levin, 1999). The characteristics of the resource users and the government system evolve over time due to technological development, deriving new knowledge, and changing norms and knowledge. Ecological systems evolve and adapt continuously at different temporal and spatial scales. Change might be triggered by predictable cycles, such as seasonal variability, or unpredictable events, such as fires and disease outbreaks. To craft effective and durable institutional arrangements these temporal and spatial dynamics need to be taken into account (Janssen et al. 2007). It is important to find ways to undertake combined studies of social-ecological systems over time (similar to the International Forestry Resources and Institutions research program discussed in chapter 6) so that future understanding and policies are based on a knowledge of dynamics as well as on static relationships for both the social and the ecological subsystems.

Conclusion

The conventional theory of common-pool resources, which presumed that external authorities were needed to impose new rules on those users trapped into producing excessive negative externalities on themselves and others, should be considered a special case of a more general theoretical structure. Based on a behavioral theory of human action, on micro-institutional analysis, and the analysis of broader social-ecological systems, we now know that the users of some resource systems are trapped into massive overuse, but that this is not the only outcomes. When a winning coalition of users conclude that the expected benefits from creating and following their own rules (as well as modifying them over time) will exceed the immediate and

long-term expected costs, they are likely to reformulate these rules. When users cannot communicate and have no way of gaining trust through their own efforts or with the help of the macro-institutional system within which they are embedded, the prediction of the earlier theory is supported. Ocean fisheries, the stratosphere, and other global commons come closest to the appropriate empirical referents.

If users can engage in face-to-face bargaining and have autonomy to change their rules, they may well attempt to organize themselves. Whether they organize depends on attributes of the resource system and the users themselves that affect their trust in one another and the benefits to be achieved and the costs of achieving them. Whether their self-governed enterprise succeeds over the long-term depends on whether the institutions they design sustain high levels of trust as well as the conditions of the resource itself. Users or policymakers who design systems with well defined boundaries, provide arenas for conflict resolutions and internal policy making over time, arrange methods for monitoring and sanction nonconformance, are more likely to survive long periods of time. The design principles of robust socio-ecological systems discussed in chapter 5 do themselves appear to be robust given a substantial number of scholars have examined their relevance for the sustainability of SESs and found them to characterize a substantial number of cases for which over-time data is available (Ostrom 2009). The theory of common-pool resources has progressed substantially during the past half century. There are, however, many challenging puzzles to be examined in future work.

Notes

[1] The theoretical predictions for an indefinitely repeated social dilemma included all possible actions from full cooperation to no cooperation at all—again regardless of the structure of the immediate micro-situation.

[2] James Buchanan (1984, 5) articulated the earlier view of most economists when he wrote that: "The burden of proof rests with those who suggest wholly different models of man apply in the political and economic realms of behavior.

[3] The journal, *Public Choice,* devoted a Special Issue in December 2008 to the topic of "Homo Economics and Homo Politicus" edited by Geoffrey Brennan and Michael Gillespie with nine articles addressing the question of how to reconcile the basic differences between theories of human behavior in economics and political science. In the introduction, Brennan (2008, 431) reflects that "the ambition to find common ground on which public choice scholars and "political theorists" of a more tradition kind might have profitable exchange is not a trivial one: we start from very different conceptions of what counts as theory—even of what counts as worthwhile scholarship—and from different disciplinary presuppositions as to how differences in approach can most profitably be engaged and resolved."

[4] In a Cournot duopoly experiments the two players in the game represent firms who both produce a virtual good. The production functions are only known by the players themselves. Players have to make choices how much to produce. Profits are affected by the total level of production and the share of each firm of that total. The earnings of the participants depend on the profits made by their firm.

[5] Heuristics perform less well in responding to rapid changes, especially sudden shocks, and highly unpredictable conditions.

[6] See figures 7.1 and 7.2 in chapter 7 as well as similar figures in many research articles.

[7] Thaler and Sunstein (2003, 2008) refer to the importance of micro-situational variables and public policy about choice-architecture. By taking into account regularities in human behavior micro-situations can be designed in such a way that socially desired decisions are made by free choice. For example, having organ donation being the default choice substantially increases the number of organ donations (see also Levitt and List 2007).

[8] When examining the impact of the broader context in field research, however, considerable mobility of resource users may discourage development of trust and cooperation. In some setting, mobility may lead to "roving bandits" (Berkes, et al., 2006).

[9] Messick and Brewer (1983:22) point to four ways that communication facilitates communication: (1) By eliciting information about the choices of others, (2) by enhancing trust in other group members, (3) by activating social values and responsibility, and (4) by creating a group identity.

[10] One of the design principles discussed in Chapter 5 related the robustness of institutional arrangements to the proportional equivalence between benefits and costs of cooperation.

[11] Simon overtly distinguished his concept of hierarchy from one involving human bosses at each level. "We shall want to consider systems in which the relations among subsystems are more complex than in the formal organizational hierarchy. . . . We shall want to include systems in which there is no relation of subordination among sub-systems" (Simon 1985, 197).

[12] We would argue, however, that researchers who are interested in understanding collective action to overcome CPR dilemmas in the field, should try to obtain empirical measures for at least this set of variables in their efforts to understand why some groups organize and others do

not. In some settings, other variables will also be important and some of those listed here will play no role, but given the likely importance of this set of variables in affecting the benefits and costs of collective action, they constitute an important set of variables to help explain collective action successes and failures.

[13] Based on extensive field research by Xavier Basurto, a recent paper (Basurto and Ostrom 2008) draws on this set of broader contextual variables affecting the cost-benefit calculation of local fishers to explain why two small-scale fishing communities on the Gulf of California in Mexico (Puerto Peñasco and the Seri village of Punta Chueca) were able to self-organize while a third, nearby fishing community that differed in only a few of the variables identified above (Kino Bay) was not able to self-organize.

[14] When analyzing the effect of multiple variables, developing simple mathematical models is difficult, while utilizing agent-based models becomes a powerful tool (see chapters 8 and 9).

[15] The extensive work on polycentricity is quite relevant to this question (see McGinnis, 1999a and b; 2000; V. Ostrom, 2008a; 2008b.

References

Acheson, James M., James A. Wilson, and Robert S. Steneck. 1998. "Managing Chaotic Fisheries." In *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience,* ed. Fikret Berkes and Carl Folke, 390–413. Cambridge: Cambridge University Press.

Arrow, Kenneth. 1974. *The Limits of Organization.* New York: Norton.

Basurto, Xavier, 2008, "Biological and ecological mechanisms supporting marine self-governance: The Seri Callo de Hacha fishery", *Ecology and Society* 13, no. 2: 20.

Basurto, Xavier and Elinor Ostrom, 2008. "Beyond the Tragedy of the Commons." Bloomington, Indiana. Workshop in Political Theory and Policy Analysis, Working paper.

Berkes, F., Hughes, T.P., Steneck, R.S., Wilson, J.A., Bellwood, D.R. et al., 2006. Globalization, roving bandits, and marine resources. *Science,* 311(5767), p. 1557-58.

Brennan, Geoffrey. 2008. "Homo Economicus and Homo Politicus: An Introduction," *Public Choice.* 137 (no. 3-4): 429-438.

Buchanan, James. 1984. "Politics without Romance," *Zeitschrift des Instituts fur Hohere Studien.* 3: p. 1-11.

Cardenas, Juan Camilo 2001. "How Do Groups Solve Local Commons Dilemmas? Lessons from Experimental Economics in the Field." *Environment, Development and Sustainability*, 2(3-4): 305-322.

Cardenas, Juan-Camilo, Marco A. Janssen, and Francois Bousquet. Forthcoming. "Dynamics of Rules and Resources: Three New Field Experiments on Water, Forests and Fisheries." In *Handbook on Experimental Economics and the Environment*, ed. John List and Michael Price.

Costa, P. T. and R. R. McCrae. 2006. *Revised NEO Personality Inventory Manuar—UK Edition of the Manual.* Oxford, UK: Hogrefe Ltd.

Deutsch, Morton. 1973. *The Resolution of Conflict*. New Haven: Yale University Press.

Duit**, A**. and V. Galaz. forthcoming. "Governance in a 'Wired World′— Emerging Issues for Governance Theory". *Governance*

Ebenhöh, Eva and Claudia Pahl-Wostl. 2008. "Agent Behavior between Maximization and Cooperation." *Rationality and Society* 20(2): 227–52.

Eckel, Catherine and Philip J. Grossman. 1996. "The Relative Price of Fairness: Gendeter Difference in a Punishment Game." *Journal of Economic Behavior and Organization.* 30: 143-158.

Fehr, Ernst, and Simon Gächter. 2000a. "Cooperation and Punishment in Public Goods Experiments." *American Economic Review* 90(4):980–94.

Fehr, Ernst, and Simon Gächter. 2000b. "Fairness and Retaliation: The Economics of Reciprocity." *Journal of Economic Perspectives* 14(3):159–81.

Fehr, Ernst, and Andreas Leibbrant. 2008. "Cooperativeness and Impatience in the Tragedy of the Commons." Zurich: University of Zurich, Institute for Empirical Research in Economics. Working Paper, ISSN 1424-0459.

Fehr, Ernst, and Bettina Rockenbach. 2003. "Detrimental Effects of Sanctions on Human Altruism." *Nature* 422 (March 13): 137–40.

Fehr, Ernst, and Klaus Schmidt. 1999. "A Theory of Fairness, Competition, and Cooperation." *Quarterly Journal of Economics* 114(3):817–68.

Frohlich, Norman. 1974. "Self Interest or Altruism, What Difference? *Journal of Conflict Resolution.* 18 (1): 55-73.

Frohlich, Norman, and Joe Oppenheimer. 1992. *Choosing Justice: An Experimental Approach to Ethical Theory.* Berkeley: California University Press.

Frohlich, Norman, and Joe Oppenheimer. 2000. "How People Reason about Ethics and the Role of Experiments: Content and Methods of Discovery." In *Elements of Political Reason: Cognition, Choice, and the Bounds of Rationality,* ed. Arthur Lupia, Matthew D. McCubbins, and Samuel L. Popkin, 85–107. New York: Cambridge University Press.

Garcia-Lopez, Gustavo A. 2008. "Factors affecting success of collective action." Bloomington, In: Workshop in Political Theory and Policy Analysis. Working Paper

Gilles, Jere L., and Keith Jamtgaard. 1981. "Overgrazing in Pastoral Areas: the Commons Reconsidered." *Sociologia Ruralis* 21:129–41.

Haller, Tobias, and Sonja Merten. 2008. "We are Zambians—Don't Tell Us How to Fish! Institutional Change, Power Relations and Conflicts in the Kafue Flats Fisheries in Zambia." *Human Ecology* 36(5) (October): 699–715.

Henrich, Joseph, Robert Boyd, Samuel Bowles, Colin Camerer, Ernst Fehr, and Herbert Gintis, eds. 2004. *Foundations of Human Sociality: Economic Experiments and Ethnographic Evidence from Fifteen Small-Scale Societies.* Oxford: Oxford University Press.

Henrich, Joseph, et al. 2005. "'Economic Man' in Cross-Cultural Perspective: Behavioral Experiments in 15 Small-Scale Societies," *Behavioral and Brain Sciences.* 28(6): 795–855.

Holt, Charles A. 2007. *Markets, Games, & Strategic Behavior*. Boston: Addison Wesley.

Janssen, M.A., J.M. Anderies and E. Ostrom (2007) Robustness of Social-Ecological Systems to Spatial and Temporal Variability, *Society and Natural Resources* 20(4): 307-322

Levin, Simon A. 1999. *Fragile Dominion: Complexity and the Commons*. Reading, MA: Perseus Books.

Lopez, Maria Claudia, James J. Murphy, John M. Spraggon, John K. Strandlund. Forthcoming. "Does Government Regulation Complement Existing Community Efforts to Support Cooperation? Evidence from Field Experiments in Colombia. In John List and Michael Price. *Handbook on Experimental Economics and the Environment.*

Levitt, Steven D. and John A. List. 2007. "What Do Laborataory Experiments Measuring Social Preferences Reveal About the Real World" *Journal of Economic Perspectives.* 21 (2): 153-174.

Lewin, Kurt. 1936. *Principles of Topological Psychology.* New York: McGraw-Hill.

Lian, Peng, and Charles R. Plott. 1998. "General Equilibrium, Markets, Macroeconomics and Money in a Laboratory Experimental Environment." *Economic Theory* 12(1):21–75.

Madin, Joshua S., Shawn Bowers, Mark P. Schildhauer and Matthew B. Jones. 2007 "Advancing Ecological Research with Ontologies," *Trends in Ecology and Evolution* 23 (3): 159-168.

Mechelen, I. V. and B. D. Raad, 1999. "Introduction to the Special Issue: Personality and Situations." *European Journal of Personality.* 13: 333-336

Messick, David M. and Marilyn Brewer. 1983. "Solving Social Dilemmas. A Review." *Review of Personality and Social Psychology.* 4: 11-44.

Milinski, Manfred, Dirk Semmann, and Hans-Jűrgen Krambeck. 2002. "Reputation Helps Solve the 'Tragedy of the Commons.'" *Nature.* 415 (January 24): 424-426.

Nagendra, Harini. 2008. "Do Parks Work? Impact of Protected Areas on Land Cover Clearing." *Ambio.* 37 (5): 330-337.

de Oliveria, Angela C. M., Rachel T. A. Croson, and Catherine Eckel. 2008. "Are Preferences Stable Across Domains? An Experimental Investigation of Social Preferences in the Field," Dallas: University of Texas at Dallas, CBEES Working Paper #2008-3.

Ostrom, Elinor and Marco A. Janssen (2004) Multi-Level Governance and Resilience of Social-Ecological Systems, M. Spoor (ed.) *Globalisation, Poverty and Conflict: A Critical 'Development' Reader,* Kluwer Academic Publishers, Dordrecht and Boston, 239-259.

Rothstein, Bo. 2005. *Social Traps and the Problem of Trust: Theories of Institutional Design***.** Cambridge: Cambridge University Press.

Salafsky, Nick, et al., 2008. "A Standard Lexicon for Biodiversity Conservation: Unified Classifications of Threats and Actions" *Conservation Biology.* Need to get final vol number – have a copy from the on line prior publ

Sen, Amatrya. 1977. Rational Fools: A Critique of the Behavioral Foundations of Economic Theory. *Philosophy and Public Affairs,* 6(4), p. 317-44.

Simon, Herbert A. 1985. *The Sciences of the Artificial*. Cambridge, MA: MIT Press.

Smith, Vernon L. 1962. An Experimental Study of Competitive Market Behavior," *Journal of Political Economy.* 70: 111-137.

Smith, Vernon L. and James M. Walker. 1993. "Monetary Rewards and Decision Cost in Experimental Economics." *Economic Inquiry.* 31: 245-261.

Sztompka, P. 1999. *Trust: A Sociological Theory.* Cambridge, Mass: Cambridge University Press.

Thaler, Richard H. and Cass R. Sunstein. 2003. "Libertarian Paternalism," *American Economic Review* 93(2): 175-179

Thaler, Richard H. and Cass R. Sunstein. 2008. *Nudge*. Yale University Press

Udéhn, Lars. 1993. "Twenty-five Years with The Logic of Collective Action." Acta Sociologica 36: 239-261.

Waichman, Israel and Till Requate. 2008. "Do Personality Traits Matter in Oligopoly Experiments?" Kiel, Germany: Department of Economics, University of Kiel, Working Paper

Young, Oran. 2006. "Vertical Interplay Among Scale-dependent Environmental and Resource regimes." *Ecology and Society,* 11(1): 27. [online] ttp://www.ecologyandsociety.org/vol11/iss1/art27/

Young, Oran, Frans Berkhout, Gilberto C. Gallopin et. al. 2006. "The Globalization of Socio-Ecological Systems: An Agenda for Scientific Research." *Global Environmental Change*, 16(3):304-316.

Zucker, Lynne G. 1986. "Production of Trust: Institutional Sources of Economic Structure, 1840-1920" in Barry M. Staw and L. L. Cummings, eds. *Research in Organizational Behavior.* JAI Press. 53-111.

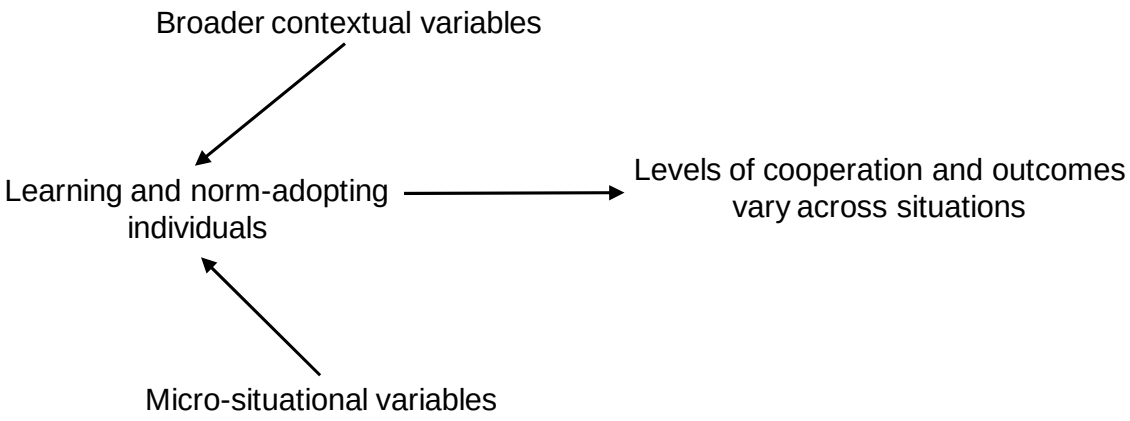

Figure 10.1 In behavioral theory, cooperation in social dilemmas depends on individual differences and context

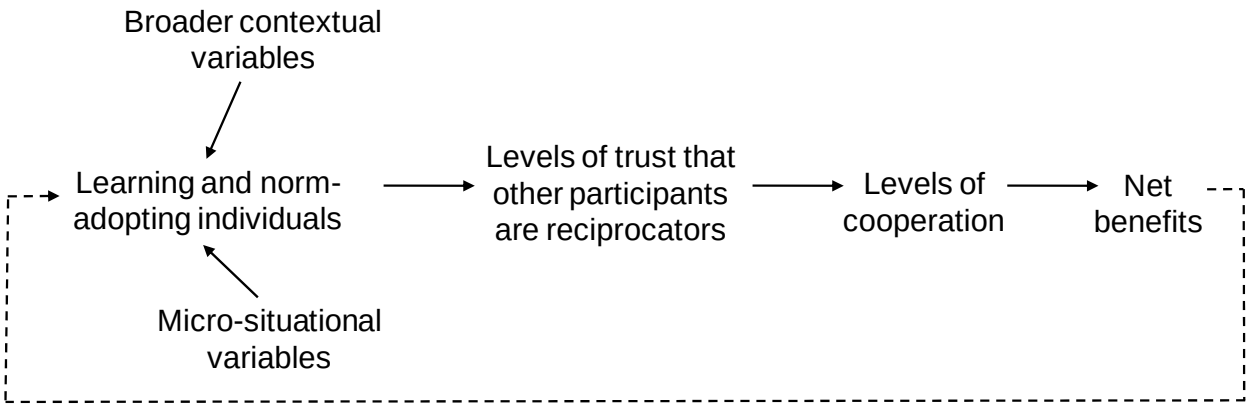

Figure 10.2 Micro-situational and broader context of social dilemmas affects levels of trust and cooperation

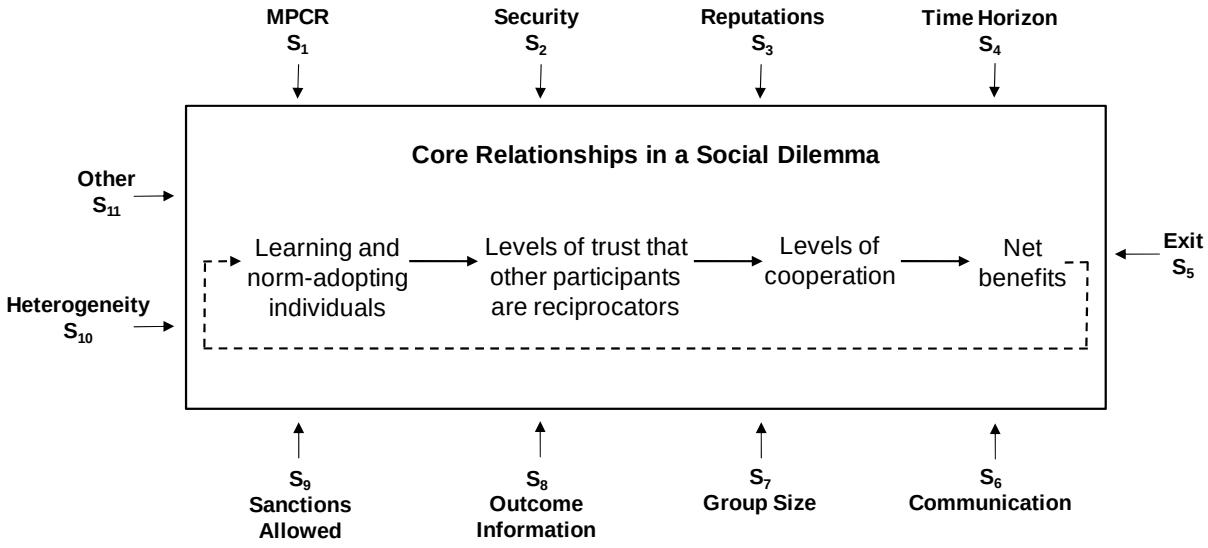

Figure 10.3 Micro-situational variables affecting trust and cooperation in social dilemmas

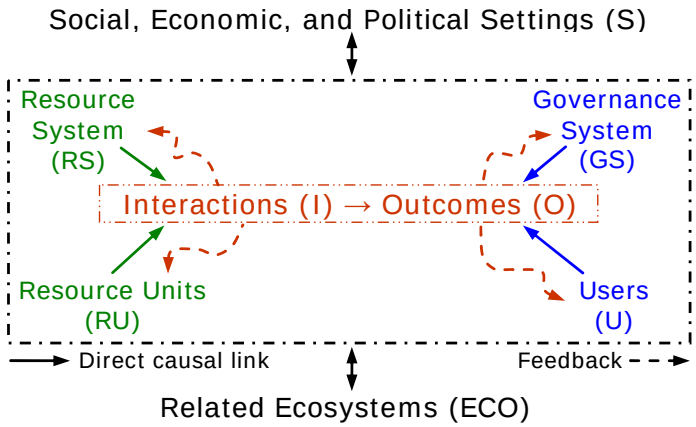

Figure 10.4: A multitier framework for analyzing a social-ecological system

Source: Ostrom (2007b, 15182).

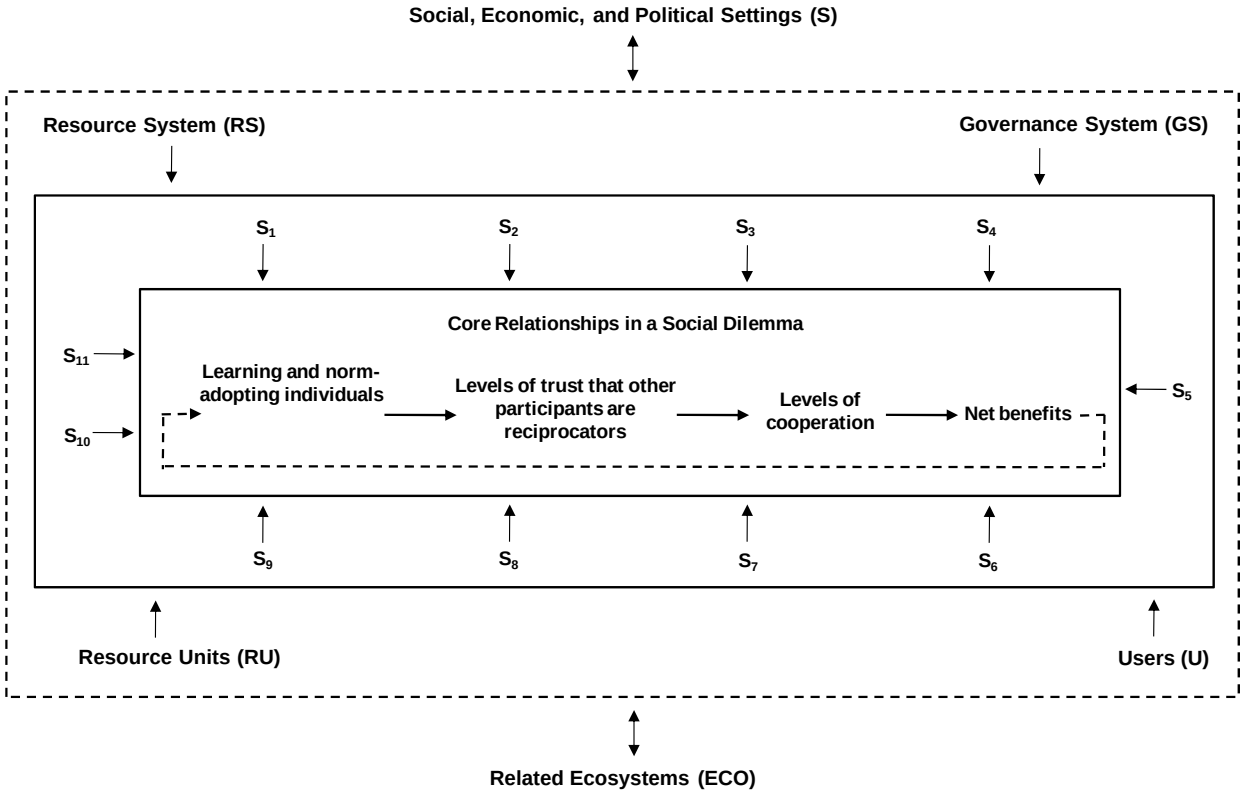

Figure 10.5 SES macro context as affecting micro situations

TABLE 10.1
Second-tier variables in framework for analyzing a social-ecological system

Social, Economic, and Political Settings (S)
S1- Economic development. S2- Demographic trends. S3- Political stability.
S4- Government resource policies. S5- Market incentives. S6- Media organization.

Resource System (RS)	Governance System (GS)
RS1- Sector (e.g., water, forests, pasture, fish) RS2- Clarity of system boundaries RS3- Size of resource system* RS4- Human-constructed facilities RS5- Productivity of system* RS5a. Indicators of the system* RS6- Equilibrium properties RS7- Predictability of system dynamics* RS8- Storage characteristics RS9- Location	GS1- Government organizations GS2- Non-government organizations GS3- Network structure GS4- Property-rights systems GS5- Operational rules GS6- Collective-choice rules GS6a-Local Collective Choice autonomy* GS7- Constitutional rules GS8- Monitoring & sanctioning processes
Resource Units (RU)	**Users (U)**
RU1- Resource unit mobility RU2- Growth or replacement rate RU3- Interaction among resource units RU4- Economic value RU5- Size RU6- Distinctive markings RU7- Spatial & temporal distribution	U1- Number of users U2- Socioeconomic attributes of users U3- History of use U4- Location U5- Leadership/entrepreneurship* U6- Norms/social capital* U7- Knowledge of SES/mental models* U8- Dependence on resource* U9- Technology used
Interactions (I) → Outcomes (O)	
I1- Harvesting levels of diverse users I2- Information sharing among users I3- Deliberation processes I4- Conflicts among users I5- Investment activities I6- Lobbying activities	O1- Social performance measures (e.g., efficiency, equity, accountability) O2- Ecological performance measures (e.g., overharvested, resilience, diversity) O3- Externalities to other SESs

Related Ecosystems (ECO)
ECO1- Climate patterns. ECO2- Pollution patterns. ECO3- Flows into and out of focal SES.

Source: Adapted from Ostrom (2007b, 15183).

Appendix to Chapter 10

A Puzzle: Why Do Some Resource Users Self-Organize and Others Do Not?

Let us posit that each user (i C U) of a resource system compares the expected net benefits of harvesting, using the old operational rules (GS5*O*) in use—which may be open access—with the benefits they expect to achieve using a new set of operational rules (GS5*N*). Each user i must ask whether their incentive to change (D_i) is positive or negative.

$$D_i = B_i\,(GS5N - GS5O) \quad (1)$$

If D_i is negative for all users, no one has an incentive to change and no new rules will be established. If D_i is positive for some users, they then need to estimate three types of costs:

C1: Up-front costs of time and effort spent devising and agreeing upon new rules;

C2: The short-term costs of implementing new rules; and

C3: The long-term costs of monitoring and maintaining a self-governed system over time.

If the sum of these expected costs for each user exceeds the incentive to change, no user will invest the time and resources needed to create new institutions. Thus, if

$$D_i < (C1_i + C2_i + C3_i) \quad (2)$$

for all (i C U), no change occurs. But, if for at least one coalition K C U, there is a "winning coalition" given the rules-in-use such that:

$$D_k > (C1_k + C2_k + C3_k) \quad (3)$$

it is likely that new rules will be chosen.

Some may perceive positive benefits after all costs have been taken into account, while others perceive net losses. Consequently, the local collective-choice rules (GS6a) used to change the day-to-day operational rules related to the resource affect whether an institutional change favored by some and opposed by others will occur. No guarantee exists that any such decisions

taken in the field will be optimal. In field settings, everyone is not likely to expect the same costs and benefits from a proposed change.

If there are substantial differences in the perceived benefits and costs of users, it is possible that a minority of users will impose a new set of rules that strongly favors those in the winning coalition and imposes losses or lower benefits on those in the losing coalition (Thompson et al. 1988). If a local chief or other notable has dictatorial powers at the collective-choice level, then only this single person has to estimate that the costs of changing a rule are less than the benefits of a new rule. In this case, of course, there may not be widespread benefits for other members of the group. If expected benefits from a change in institutional arrangements are not greater than expected costs for many of the relevant participants, however, the costs of enforcing a change in institutions will be much higher than when most participants expect to benefit from a change in rules over time. If the group relies on majority rule or a larger collective-choice rule and if there are several such coalitions, the question of which coalition will form, and thus which rules will result, is a further theoretical issue (see Shepsle 1989; Bianco et al. 2006; and others on coalition building in collective-choice settings).

Obviously, if one could obtain valid and reliable measures of the perceived benefits and costs of collective action for those involved, that data would be the core information needed to predict when collective action to change rules would occur. Gaining information about specific benefits and costs perceived by users at the time of collective-action decisions is, however, next to impossible. Thus, gaining information about the attributes of resource systems and their users (as well as their autonomy to make rules), is an essential step to increase capabilities of diagnosing why some groups do overcome the challenge of collective action and others do not.