Building a Program for Institutional Analysis of Social-Ecological Systems: A Review of Revisions to the SES Framework

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Author's Notes: This paper is a much revised version of "IAD and SES Dynamic Flows: Introducing the Program in Institutional Analysis of Social-Ecological Systems (PIASES) Framework," a paper co-authored with Elinor Ostrom and originally presented at Wednesday, March 24, 2010, Workshop in Political Theory and Policy Analysis, Indiana University, Bloomington, and discussed at the meeting of the SES Club held in Delft, Netherlands, Saturday, May 29, 2010.

Readers are cautioned that this is very much a work-in-process, and that the terminology introduced in this paper is likely to undergo significant revisions. Much of it has already been changed in response to comments from several colleagues involved in a collaborative project to integrate institutional analysis and social-ecological systems. Our specific point of departure is the SES framework originally formulated by Elinor Ostrom in her 2007 *PNAS* and 2009 *Science* articles, but the final version of this framework has not yet been determined. This paper summarizes my personal take on some of the difficult conceptual issues that have arisen during our discussions, and I reserve the right to change my mind on particular details.

I would like to thank many colleagues for their extremely helpful comments and suggestions. At some point I will provide a detailed listing, but for now I must single out Lin Ostrom as a leading influence on my work. For this particular paper, however, I must take sole responsibility for any mistakes or misrepresentations.

Readers are encouraged to send comments and suggestions to the author regarding any aspect of this paper. This is very much a work-in-progress, and many revisions still lie ahead.

Abstract

This paper summarizes the current status of the SES framework that lies at the heart of the **Program in Institutional Analysis of Social-Ecological Systems (PIASES)** that is in the process of being established at the Workshop in Political Theory and Policy Analysis at Indiana University. This paper explicitly builds upon and extends previous efforts to revise the long-standing **IAD** (Institutional Analysis and Development) framework to facilitate its application to complex coupled social-ecological systems (**SES**), specifically by modifying the SES framework originally introduced in an influential *PNAS* article by Ostrom (2007a). The action situation concept, which plays a pivotal role in the IAD framework, serves as the primary mechanism for understanding the flows of information and resources within both the social and ecological sides of a SES. The SES framework, as modified here, is intended to provide the foundation for a common language for potential application to diverse forms of governance in many different policy areas. But building a common language takes time, and lots of collaboration, so much of this paper remains tentative, and the whole is very much a work-in-progress.

**Building a Program for Institutional Analysis of Social-Ecological Systems:
A Review of Revisions to the SES Framework**

As more and more scholars are interested in sustainability of social-ecological systems (SESs), the problem of how to provide a coherent analysis of complex, nested systems operating at multiple scales becomes ever more challenging. Disciplines have evolved over time so that each discipline has its own technical language. If one is addressing how diverse forms of governance influence sets of resource users of multiple scales and background and how they impact on resource systems that have diverse characteristics, one needs to draw on diverse scientific disciplines to address such questions. One cannot just pick up an entire disciplinary language system, however, and apply it to a new problem. In many instances, the definition of terms in one discipline's language differs from another such as the meaning of community in ecology versus sociology.

For a number of years, colleagues associated with the Workshop in Political Theory and Policy Analysis attempted to cope with this complexity by the development of the Institutional Analysis and Development (IAD) framework. In the past three decades since the first publication of that framework (Kiser and E. Ostrom, 1982), substantial progress has been made particularly related to the governance of diverse systems and concepts of strategies, rules, norms, and other key institutional terms (see McGinnis, 1999a,b; 2000; Ostrom, 2005; Poteete, Janssen, and Ostrom, 2010).

As many of us began to work more intensively with ecologists, we have repeatedly heard the criticism of the IAD framework as not taking concepts of relevance to ecologists as seriously as we were taking diverse levels of concepts related to institutions. One has to admit that this criticism is telling. Consequently, we began several years ago to slowly expand the original IAD framework to encompass a broader set of variables that are needed for the analysis of a social-ecological system. Since the publication of the first version of the SES framework (Ostrom, 2007a), there has been considerable interest by scholars across a wide diversity of disciplines in that approach. In 2009, a slight revision was published in *Science* and still more interest has accumulated (Ostrom, 2009).

A group of scholars in Europe and colleagues associated with the Workshop have been trying to take the next step of filling out the framework and expanding its relationship to the IAD framework itself. One of the key problems that one faces in undertaking a further exposition is representing key processes as well as the important variables that affect and are affected by these processes. Further, if one is interested in the sustainability of social-ecological systems, understanding dynamic processes over time is essential but even more difficult. If one does not initiate an effort to develop such analyses, however, scholars' interest in sustainability science will continue to cope with gross misunderstandings and poorly specify theories and models. Thus, as a result of a number of meetings at diverse locations and a greater effort to discuss this challenge, we are beginning to try to unpack the dynamic aspects of the SES framework as well as making the internal aspects of the action situation much more obvious than we did in earlier versions.

This paper introduces a framework of analysis for the **Program in Institutional Analysis of Social-Ecological Systems (PIASES)** that has been established at the Workshop in Political Theory and Policy Analysis at Indiana University. This program builds on and extends previous efforts to relate the long-standing IAD (Institutional Analysis and Development) framework to facilitate its application to complex coupled social-ecological systems (SES), specifically by modifying a SES framework originally introduced in an influential *PNAS* article by Ostrom (2007a). The key innovation is that PIASES is explicitly built upon a dynamic understanding of the flows of information and resources within the social and ecological sides of a SES. This framework is intended to provide the foundation for a common language for potential application to diverse forms of resource governance.

Readers are warned that the framework developed here is *complicated*, as an early commenter put it politely. The SES framework is designed for application to policy settings in which (1) a set of actors, at least some of whom are (2) organized into larger collective decision entities, and who (3) make use of available information, infrastructure, and other relevant technology to (4) extract resource units from (5) an existing pool of common resources (CPR system) which is (6) replenished or maintained via dynamic processes only partially under of the control of these actors, and that these extracted units are used to (7) create something of economic (or other) value that may (8) be directly consumed or exchanged or used as an input to some other production process and that these actions may (9) have detrimental effects on the long-term viability of that resource pool and potentially (10) on related resources or ecosystems as well as having (11) positive or negative externalities on other actors who may (12) draw upon existing governance processes to redress their grievances or implement changes in process of extraction, transformation, distribution, and consumption.

We admit that we may have aimed at too general an initial formulation. However, we are convinced that it is essential to first establish a common conceptual language if we are to ever glean general lessons from a growing number of empirical investigations of particular examples of the specific institutional arrangements used by community user groups (and other entities) in the management of common-pool resources of diverse kinds in all regions of the world.

This paper is organized into several sections. The first section provides a brief overview of the origins of the IAD and SES frameworks. The bulk of this paper discusses some changes that have been made or proposed after the initial formulation of the SES framework. The second section covers changes that have emerged as a consensus choice from discussions thus far, specifically related to basic terminology (components, entities, attributes, interactions, and levels of aggregation). The third section introduces the concept of a "network of adjacent action situations" that may not be relevant for scholars outside of the Ostrom Workshop community. Section 4 suggests how the SES framework, with or without the adjacency network addition, might be applied to policy settings outside of the normal purview of resource management, including technological infrastructure, economic policy, and local public goods.

I must also clarify that this paper covers only the conceptual side of what is a much larger project. In a separate paper I suggest more specialized revisions meant to focus attention on how the flow of information affects the prospects for sustainable management of a social-ecological resource (McGinnis 2010a). Other participants in this research program have begun to prepare documents in which the current version of the SES framework is used to organize factors relevant to situations in specific resource sectors. The PIASES research agenda will make progress only through iterated communication between these applications and consideration of broader conceptual issues. So readers of this paper are advised to stay tuned for future developments on the application side.

1. From IAD to SES

The IAD framework (Figure 1) applies to a broad range of social situations (Ostrom 2007b, 2010). It highlights interactions among individuals (or other actors) who jointly affect outcomes that are differentially valued by those actors. This framework highlights the social-cultural, institutional, and biophysical context within which all such decisions are made. It explicitly distinguishes three levels of choice: (1) operational level choices (of actors as individuals or as representatives of specific collective entities); (2) collective level choices involving the determination of which strategies, norms and rules are, should be, or are not available to actors fulfilling the specific roles defined by that group (as well as specifying who is assigned to fill these roles); and (3) constitutional level choices relating to who is or should be empowered to participate in the making of collective and operational level decisions.

The actors in an action situation are presumed to be boundedly rational. They seek to achieve goals for themselves and for the communities to which they identify but do so within the context of ubiquitous social dilemmas and biophysical constraints, as well as cognitive limitations and cultural predispositions. Within this broad framework a range of theoretical perspectives may be employed to develop and analyze models of specific situations.

The IAD framework has been used as a tool to categorize many of the factors deemed to be relevant to understanding the patterns of behavior and outcomes observed in a vast array of diverse policy areas (Ostrom 2010). Not all of these authors may realize that the IAD framework was originally an extended elaboration on a basic systems model of policy processes. Social, institutional, and biophysical factors were seen as inputs to a process of decisions made by individuals (with those decisions presumed to be influenced by their pre-existing cognitive capabilities and cultural presuppositions), and these decisions were somehow aggregated to constitute policy outputs that would then interact with exogenous factors to produce some observable outcomes, and evaluations of these outcomes by these actors (or by other observers) would then feedback into all of the previous components of this never-ending process.

By highlighting the pivotal position of the action situation within that framework, we can re-emphasize this dynamic aspect. Contextual factors shape the conditions under which an action situation operates, and its outputs generate outcomes that are later evaluated, all of which feeds back into the background contextual conditions and into the action situation itself.

The **action situation** lies at the heart of both the IAD and SES frameworks. In previous descriptions of the IAD framework an action situation was subdivided into a set of actors and the action arena confronting those actors, but we now prefer to explicitly embed the actors within the context of their ongoing interactions. In Lin's initial formulation of the SES framework she did not explicitly include the phrase "action situation" hoping that the label "Interactions arrow Outcomes" would connote the appropriate level of dynamic complexity. In later discussions several scholars asked what happened to the action situation that lies at the heart of the IAD framework, and so in more recent versions of the core SES figure that term has been added.

When the IAD framework has been applied in research on closely coupled social-ecological systems (or SESs), it may appear that insufficient attention is given to the biophysical dynamics within which resource users make operational, collective, and constitutional level decisions. In a series of recent papers Ostrom (2007a, 2009) has offered an alternative (but closely related) SES framework that more explicitly recognizes the co-equal contributions of the social and ecological sides of an SES. This PNAS framework highlights the following fundamental components at its top (or first) tier (or level):

1. Resource system
2. Resource units
3. Governance system
4. Users (later replaced by Actors, see below)
5. Interactions and Outcomes (Action Situation)

As shown in Figure 2, these five key components affect and are affected by the larger social-political and ecological systems within which this focal SES is located.

Figure 3 lists the second-tier (or second-level) components as of Ostrom (2009). These terms are used to organize the many factors or characteristics that might be relevant to understanding social and/or ecological conditions in play in any particular setting. This list of factors is meant to be exhaustive, in the sense that any factor deemed relevant to a particular case should be able to be classified somewhere in this classification scheme. This presumption has been tested by several researchers who have used this scheme to develop structured lists of those factors deemed most important in those areas of applications with which they are most familiar.

In the initial applications of this framework, relevant factors have been assigned to categories defined at the first, second, third, or even lower levels or tiers. For two early examples of applications to different resource systems, see Brock and Carpenter (2007), Nagendra (2007), plus supplemental on-line resources for each of these articles.

Later discussions demonstrated the importance of putting this collection of second-tier components on more secure dynamic foundation. In this paper we offer a revised formulation of this framework in order to highlight, and make analytical use of, this dynamic foundation. Specifically, the action situation lying at the heart of the IAD framework becomes the center stage upon which these dynamic processes take place, alongside the dynamics inherent in both the social/institutional and bio/physical sides of a coupled social-ecological system.

The remainder of this paper presents revisions to this basic framework. Some of these revisions have emerged as consensus solutions to difficulties that emerged in later discussions, and others remain more tentative suggestions on my own part. It is important to note, however, that the initial SES framework has already been used as a point of departure for many scholars investigating different types of resources, and so the revisions should be kept as limited as possible. In particular, it will be important to make sure that any revisions make it possible to easily translate the details of previous applications of the initial SES framework to particular resource settings into the revised terminology. Indeed, some of these revisions have been introduced as a means of recognizing the way in which researchers have applied the initial framework in particular settings. Clearly, this is an iterative process, involving both conceptual and practical investigations.

2. Consensus Changes

In this section I summarize a few changes in the top tier components that have emerged as consensus changes from discussions since publication of the initial versions of the SES framework.

2.1. Changes in Labels for Top Tier Components

Action Situation: Figure 2 already includes one key revision in the original 2007 figure, by incorporating the label Action Situation into what was originally the Interactions and Outcomes component. As noted above, this was done to highlight the central importance of action situation as the pivot between the social and ecological sides of an SES.

Actors: Figure 2 also includes another change. Several colleagues expressed concern that term "Users" is unnecessarily limiting, and that "Actors" would be a more inclusive term. Users may make sense for applications to natural resources, but this framework is meant to have more general applications. For example, in social-technical systems much of that technical infrastructure may have been created by human actions. Any application to economic dynamics would require inclusion of a wide array of actors, and so this more generic term is much preferred.

2.2. Mistaken Interpretations

User Groups: The term Actor also helps avoid confusion that arose when some interpreted the User category as consisting of a single formally organized User Group. Discussions soon made it clear that many resource settings are characterized by multiple types of users, who may or may not be organized into coherent groups. Even if they are organized, there may be multiple user groups, each pursing purposes that may not be compatible with the goals of other user groups. At this point we remain agnostic about the category of Actors, which may or may not include corporate actors as well as individuals. The composition of the set of relevant actors remains to be determined in specific applications.

Nested Aggregation. When I first encountered the SES framework, I misinterpreted it as being based on a neatly hierarchical arrangement of levels of aggregation, in both the social and ecological sides. I initially presumed that the users and resource units that were involved in the focal level of interactions (and outcomes) were each encompassed within broader aggregates, with users inhabiting a governance system and resource units being part of a broader resource system. I presumed that these systems were themselves components of broader social, economic and political settings or related ecosystems, respectively. In this way I presumed that the focal level was embedded within a nested series of levels of aggregation, and that factors relevant to progressively higher levels of aggregation could be incorporated into the analysis using this hierarchical structure.

Figure 4 illustrates the nested hierarchy that I had in mind at that time, but which I now think is not the appropriate way to proceed. One advantage of this formulation is that it potentially highlights the dynamic complexity inherent in this framework. Dynamic changes occur at all levels of aggregation, and dynamic changes in adjacent levels are intimately tied together. Dynamic processes occurring within each of the core rectangles are presumed to be of indefinite duration, with direct effects moving from left to right on the page and indirect feedback cycles from right to left and back again. It may be useful to think of Figure 4 as representing the constellation of actions occurring within a given "season," which suggests that similar figures for subsequent seasons should be imagined in an endlessly repeating array extending into the indefinite future.

However, I soon found it impossible to maintain this interpretation of the SES framework as I examined lower-level components of this framework. With this kind of nested hierarchical ordering, there would have to be neat relationships between characteristics of resource units, for example, and their aggregate value at the level of the resource system as a whole. But that is not the way the second-level categories are organized, and so I got more and more confused.

Given my extensive previous experience with the ideas behind the Ostrom Workshop, I should have known better, and I now realize that Lin had something rather more subtle in mind.

2.3. Multiple Components in the First-Tier

One important clarification that emerged in these discussions is that any one application or realization of this framework may require specification of a set of inter-related action situations as well as multiple instances of each of the entity classes. This discussion leads naturally to a major revision of the framework, in which each of these first-tier components are allowed to exist in multiple versions in any given application.

Initially the SES framework was presented as if the focal action situation involved only one set of actors, inhabiting one overarching governance system, who were dependent on a particular type of resource unit, which were in turn encompassed by a particular resource system. The possibility of multiple governance settings or ecosystems was incorporated in the S and ECO categories located outside of the focal box. However, the initial figures made it appear as if there were only one of the first tier components.

Figure 5 shows a representation that explicitly allows for the co-existence of multiple manifestations of each of the top-tier components. In practical examples, some researchers identified more than one resource system, or more than one relevant resource unit, as well as multiple users. For example, in their analysis of the *acequias* example, Lin Ostrom and Michael Cox treat land, forests, groundwater and surface water as four separate subcomponents of the overall resource system.

2.4. Entities and Attributes

When the PIASES working group was initially formed, we spent a lot of time discussing the logical nature of the categorization scheme implicit in Ostrom's initial formulation of the SES framework. We investigated the potential of representing that multi-tiered conceptual hierarchy in the form of a formal ontology, but that did not seem appropriate until we had a better shared understanding of how all the pieces of this framework fit together. As noted above, the nature of the aggregation process confused matters, but eventually we came to realize that something else was going on here.

In a 2010 meeting in Delft, Netherlands, Pieter Bots came up with a simple scheme which cut through this conceptual confusion. After stressing the importance of arriving at an agreed upon set of crisp procedures and rules for clarification, he offered the following critical clarifications:

1. The four first tier components (Resource Systems, Resource Units, Actors, Governance System) should be conceptualized as **entities** (or classes of entities).
2. Each of these entities has **attributes** (as designated in the SES framework), and specific variable values can be assigned for each of the relevant attributes.

In subsequent discussion the topic of **emergent properties** came up, and the following resolution seems reasonable. Whenever emergent properties are important to consider, they can be treated as attributes of the higher-order entity, without requiring specification of the micro-level origins of that property. In more detailed applications or models, however, the researcher may need to add that level of specificity. But it is not necessary for us to slavishly follow the nested hierarchical subsystems structure assumed in traditional versions of systems theory.

This formulation also provides a means of dealing with the simultaneous presence of **multiple first-tier components** (as discussed above). Rather than defining all attributes in terms of systems defined at a single level of aggregation, it makes more sense to assign attributes to each entity within a class, that is, to any instance of any of the top-tier components of the SES framework. This would also be the case for an entity that encompasses within itself one or more of the other elements of that class.

For example, the productivity of an in-shore fishery may be considered separately from the productivity of neighboring forested areas, and still another measure of productivity might be appropriate for application to the ecosystem as a whole. In a case like southwestern U.S. *acequias* (Cox and Ostrom 2010) the river valley as a whole could constitute one governance system and local communities or tribes would constitute other examples of governance systems. In other words, among the multiple components (Figure 5) there may be entities located at different levels of aggregation.

One minor presentational detail: the double-headed arrows entering the dashed box from above and below are shown as crossing the boundaries of that box to allow exogenous influences to intervene at any point in the process.

2.5.Re-Visiting the Tiers/Levels in the SES Framework

Before moving to interactions between entities, allow me to summarize my current state of understanding about how the tiers (or levels) in the categorization scheme in Figure 3 can best be interpreted. Sometimes the same term (variables, factors, etc.) has been used to refer to the entries listed at different tiers or levels, but I think it will be important to carefully distinguish among the meanings attached to entries at different tiers.

- Tier 1 Components: the basic classes of entities that in conjunction constitute the focal SES. Each instance of a given class (Resource System, Resource Unit, Governance System, Actor) constitutes an entity.
- Tier 2 Attributes: characteristics assigned to specific first-tier entities.
- Tier 3, 4, 5, etc. Sub-dimensions of attributes: terms used to denote more specialized or detailed manifestations or representations of tier 2 attributes as realized or observed in particular settings. However many tiers are used, the lowest tier should consist of operational indicators.

The depth to which an analyst goes through the assignment process depends on particular applications. We expect that in many cases only a few aspects will need to be examined at more than 3 tiers. An essential part of the process of analysis will be determining how detailed it is necessary to go in order to understand the critical properties of that particular application. I should also point out that this interpretation of the tiers is the last change made in this (the July 23) version of this draft, so details remain very much in flux.

2.6 Classifying Interactions Between Entities

If there are multiple entities in each of the first-tier components, then we will need to consider relationships among these entities. Also, there will be relationships between entities of different classes (such as between resource units and resource systems, or resource units and actors). It was not immediately apparent how to fit these relationships into a framework organized along the lines of Figures 2 or 5.

At Delft Pieter Bots introduced a 4x4 matrix defining 10 different types of interactions involving each pair of the four first tier components (**Resource Systems, Resource Units, Actors, Governance System**). Figure 6 illustrates this matrix, with the cells filled in with examples, mostly of my own devising. Those cells denoted NA (for Not Applicable) duplicate the combinations in other cells arranged symmetrically in that matrix. Bots insisted that it would not be necessary, at this abstract conceptual level, to treat these interactions as directed. That detail may need to be added for particular applications, but for present purposes it is only important to know what kind of entities are being connected.

Interactions may also have attributes, but these need not be drawn from the same overarching set of attributes assigned to either of the entities that are interacting.

In some cases, a given form of interaction may have related effects on different levels of aggregation. To use Bots' example, angling can be seen as an interaction between actors and a resource system, or between actors and resource units, depending on whether or not those particular interactions have systematic effects.

In other cases, the relationship may be one of aggregation, as is the case when multiple kinds of resource units are aggregated up to create a resource system.

Cells on the diagonal of this matrix designate situations in which one entity interacts with other entities within its same class, that is, between different instances of the same first-tier component. For example, how resource system interacts with other resource systems, or how two different types of actors interact with each other.

In some cases, a group of actors may interact so regularly with each other that they have effectively created a user group. Any such group would have to have rules that guide how its members should behave, and so the collection of actors would be more than just an actor. For now it remains unclear exactly where in this framework such a user group should reside. From one perspective it is a collective actor, from another perspective it might be seen as an instance of a governance system, and thus an entity in the GS class. Under this latter interpretation, variables related to operational, collective, or constitutional choice rules definitely do fall under the Governance System category, and are not properties of the users themselves. But it remains clear that in Lin's original formulation a user group was seen as an example of the User class (since renamed Actors).

At this point it also remains uncertain whether or not the consensus version of the SES framework should allow for multiple action situations, as shown in Figure 7. If so, then how might we represent interactions between separate action situations? The following section details one possible way of handling these interactions, but that approach draws heavily upon other aspects of the Ostrom Workshop research tradition that may not be acceptable to all those wishing to make use of the SES framework itself.

My impression is that other researchers may be comfortable allowing for multiple instances of the action situation being relevant for applications of the SES framework. After all, the interactions between entities as illustrated in Figure 6 can be taken to suggest that different types of interactions and outcomes are relevant for consideration. Thus, it seems reasonable to treat Figure 7 as the most general version of the SES framework as yet devised.

3. Adjacent Action Situations and Polycentric Governance Within the SES Framework

In this section I introduce a few changes that seem to me to emerge as natural extensions of the Ostrom Workshop approach to the study of institutions. However, scholars coming from other research traditions may not find these ideas as compelling, so it would not be appropriate to include them as part of the SES framework per se. This framework is intended to be theory-neutral, and some might interpret the specifications made in this section to require adoption of a specific decision-theoretic perspective.

3.1. Networks of Adjacent Action Situations

One of the best known components of the IAD framework is the distinction between different levels of analysis (or arenas of interaction). Figure 8 shows an alternative representation of the IAD framework, one which more explicitly differentiates among the operational, collective, and constitutional levels of choice, as well as adding a more fundamental level of metaconstitutional situations, less directly amenable to change by human agency (but nonetheless part of the overall situation in which any community finds itself). In the **operational choice arena**, concrete actions are undertaken by those individuals most directly affected or by public officials. The rules that define and constrain the operational activities of individual citizens and officials have been established by processes occurring in **arenas of collective choice**, and the rules by which these rules themselves are subject to modification are determined in the **arena of constitutional choice.** Depending on whether he or she is involved in operational, collective, or constitutional choice, an individual might be expected to behave differently. For example, operational choices routinely involve calculations of individual self-interest that might seem inappropriate for those participating in the self-conscious design of new institutions or constitutional frameworks. This is not to say that self-interest is totally absent in any of these settings, but we may still observe variation in the extent to which strategic calculations are expressed, and in the patterns of behavior exhibited in different settings.

Figure x also includes a still deeper (or more rarified?) **arena of meta-constitutional choice** out of which cultural predispositions and tendencies of thought emerge that subtly shape all of these activities. The term choice may be less appropriate for this cultural level, but even deep structures can change over time as a consequence of changing patterns of human behavior.

Within each of these levels of analysis reside action situations, perhaps more than one at any one level. Too often those applying the IAD framework to a particular policy setting stop after identifying only one example per level of these three primary levels of analysis (or arenas of interaction). Doing so results in an incomplete realization of this analytical perspective, for important distinctions can be drawn among different tasks carried out at the same level of analysis.

The operational level, for example, can be applied to many different types of activities. Fishers drawing fish from the water are engaged in the task of appropriation, but at other times their activities may be focused on monitoring the actions of other fishers and perhaps imposing sanctions on those who have violated the rules. At the collective choice level, the tasks of writing and enforcing laws or regulations are typically implemented by distinct sets of agents.

The action situation lies at the heart of the IAD framework, as it is where contextual influences are brought to bear on the key participants whose interactions shape policy outcomes. The "working components of an action situation" are shown as capitalized phrases in the middle of Figure 9, which is taken from Ostrom (2005: 189). These components are determined by the values of seven types of rules (shown immediately outside of the rectangle in Figure 9), as originally specified in Ostrom (1986) and elaborated in later works. Implicitly assumed is that these rules have themselves been established as the outcomes of processes occurring at other levels of analysis, but thus far this relationship has not be formalized.

One way forward is to treat the working components of a given action situation as the outcomes of processes occurring in "**adjacent**" action situations. Figure 10 represents a generic example of a network of adjacent action situations. Each box denotes a separate action situation, or a separate game. The action situation in the center is taken as the core or focal action situation in this network. Figure 10 shows 12 adjacent action situations, each of which generates outcomes that define one or more of the rules which Ostrom (2005) identifies as the immediate sources of the working components of a focal action situation.

In most applications of network analyses in the social sciences, the relevant networks are built by connections between the actors themselves, but in a network of adjacent action situations the connections instead link distinct action situations. Participants in these action situations, or players in the associated games, may themselves be connected to each other through various sorts of interpersonal ties, but the social network connections remain analytically separate from the adjacency relations between action situations.

In some circumstances, basically the same individuals may participate in many of the adjacent games that determine the value of these working components. In some unusual circumstances, the sets of participants in all of the critical action situations may collapse into a single set of actors. This would be the case for a self-organized community of resource users who live in a remote area and only rarely experience interference from outside actors, whether governmental officials, multi-national corporations, or international aid organizations. In such an isolated context, adjacent action situations may effectively collapse into a single action situation defined by the interactions among members of a self-defined and self-organized user group.

In most circumstances, however, it will not be possible to identify any one group responsible for all aspects of governance. It may, however, be possible to assess the relative importance of adjacent action situations, to prioritize which of them most clearly need to be included in the analysis of a particular case. Note that in Figure 10 the labels of half of the adjacent action situations are bolded, highlighting those most likely to be important in many different contexts.

Subsequent iteration of the focal action situation is a logical place to start, given the frequency with which the analysis of repeated games has been used to extend the logic of game models. Repeated games allow players to adopt strategies conditional on the choices of other players, and in the process they can develop patterns of reciprocal cooperation (Axelrod 1984). Such repeated games stand as a special case of the adjacency network proposed here, one in which the adjacency relationship is defined as a temporal one.

In many cases it may be especially important to incorporate the effects of changing behavior on the part of certain external actors. Public officials from state or national government agencies may impose new rules or restrictions on the actors in a given situation. Even if these new rules are not always enforced, they have effectively given participants a new option that they might choose to pursue, specifically, the legal right to appeal to these officials if they feel other participants in this focal action situation have treated them unfairly. For example, the formation of user groups may be constrained by formal rules assigning official jurisdiction over a resource area to some particular public entities. Similarly, changes in the market value of products may dramatically change the tenor of relationships among the relevant parties.

Two of the highlighted action situations strike me as being especially critical for subsequent development of this mode of analysis. First, the way in which information is generated and made available (or not) to participants is often a critical factor to consider.

Second, the contents of the set of strategies, norms, rules, and organizational roles available for use by the participants in an action situation must have come from somewhere. Any item included in this **decisional repertoire** would be available for use (either directly or indirectly as a justification for proposals made to other players) to any of these participants. As typically defined, game players have a fixed set of options that are made available to them by the analyst defining that game. In practice, game players (and action situation participants) are active participants in the process of generating new options for their possible use. In summary, the choice rules which define the set of feasible actions available to participants in positions in an action situation can be conceptualized as a dynamic repertoire that must be replenished or expanded through the actions of the participants themselves, as well as public entrepreneurs active in adjacent action situations.

<u>*Generic Functional Tasks of Governance*</u>

The IAD framework serves to remind us that each actor's preferences, as well as the choice options available to them, are determined by the institutional arrangements that define their position. Games over collective deliberations are in turn shaped by the positions and interests defined or manifested in the constitutional choice arena. As noted above, there is more going on here than interactions among single action situations at the operational, collective, and constitutional choice level. Figure 10 illustrates how easily it is to come up with at least a dozen tasks that might be said to help define a particular decisions situation, but it would be nice to develop a more systematic methods of building networks of adjacent action situations.

One promising direction for future development would be to return to the classic Ostrom, Tiebout and Warren (1961) article on polycentric political systems. In that article they began the process of identifying a small set of generic tasks that must be completed in any governance setting, that is, any time multiple private, public, toll, or common-pool goods are present. They explicitly distinguished between the act of producing goods and the provision decision regarding which goods would be available for consumption by the members of the relevant collective consumption unit. A key component of the polycentric governance system that they describe is that providers face an array of options after deciding to procure some public good for their constituents (or for themselves, if the provision and consumption units are identical). Specifically, they might produce the good themselves or hire some other unit to produce it.

Other critical tasks include arranging the financing for the production of goods, coordinating the actions of the relevant actors, and setting up some means by which the inevitable disputes that arise among consumers, providers, producers, financers, and coordinators can be resolved. Those Workshoppers who have investigated the operation of local public economies have devoted considerable attention to these tasks, and especially to untangling the complex connections among consuming, providing, and producing units (see Oakerson 1999).

Although the local public economy research program was well under way before the initial articulation of the IAD framework, both traditions emerged from common inspirations. This connection can best be seen by realizing that each of these generic tasks of governance (provision, production, financing, coordination, dispute resolution) constitute separate action situations. There will often be overlapping sets of actors involved in different action situations, but each task can be distinguished for analytical purposes.

To this list I would add two additional tasks, each of which strikes me as truly fundamental. The first is the gathering and dissemination of information regarding the conditions prevalent in a policy setting. Monitoring has been identified as a critical component of any sustainable system of resource management, and monitoring is basically a process of generating information and transmitting that information to those who may choose to act upon it.

A second generic task has not played as prominent a role in Workshop research. Although the boundedly rational individuals who inhabit the IAD framework are allowed to be influenced by the dictates of norms, little attention has been paid to where those norms come from. One especially important role for some position-holders is the transmission of cultural norms and expectations to members of the next generation and to other new members of a community. Socialization processes are especially important for the case of position-holders themselves. Ideally, actors assigned responsibilities for collective decisions or actions should internalize the role expectations of those responsible for selecting agents of that collectivity. Even in the absence of effective internalization, agents must satisfy minimal expectations of those who selected holders of that position, or else they are likely to be replaced.

In short, those actors responsible for generating and dissemination information and for shaping the motivation structure of actors need to be included in the expanded form of the IAD framework being developed here. In particular the revised SES framework should definitely allow analysts to apply it to situations in which public or tool goods were more pressing concerns than a common pool. It would be especially important for SES to apply to local public goods, and making that connection more clearly remains a task for subsequent development.

As soon as an analyst identifies, in any policy setting, the relevant sets of actors involved in processes of production, provision, and consumption, as well as the related tasks of financing, coordinating, dispute resolving, monitoring, and motivating, then that analyst may start to suspect that polycentricity may well be the natural order of things in the social world. Each of these processes constitutes an action situation in its own right, and polycentricity emerges as a property of the network constructed by dynamic interactions among these processes.

3.2. Example of a Network of Adjacent Action Situations (Maine Fisheries)

Elsewhere (McGinnis 2010b) I have devised network representations of three policy sectors, but for this paper we need only consider the most explicitly resource-based example. Figure 11 identifies the key types of actors directly involved in the critical set of governance tasks associated with the case of Maine lobster fisheries. (My analysis draws heavily from the work of Acheson 2003.) Rows correspond to the key types of actors involved in that policy setting; columns designate the set of generic governance tasks that seem most relevant to that setting. Entries in the cells of a matrix summarize the roles that key actors play in different action situations.

The last row in Figure 11 includes the ecosystem as the equivalent of an actor type. I concede that this is not quite the right representation, but analysis of closely-coupled social-ecological system requires that the ecological side be given careful consideration as well (Ostrom 2007a, 2009). Perhaps it would make more sense to treat ecological growth or replenishment processes as a form of production function, independent of any strategic action on the part of relevant human actors.

Also, entries in parentheses in Figure 11 are of second-level importance; although their actions contribute to the corresponding action situation, the contributions do not seem to be as pivotal as other cells in that same column.

This case nicely fits the template of a common-pool resource that has been successfully managed by a community of resource users. The movement of lobsters is quite predicable, as they spend most of the year near shorelines but move into the ocean in the winter months. Lobsters are typically harvested through the use of fixed traps placed on the ocean floor. Fishing is most productive in late summer, at which time trap congestion can become problematic. Maine lobster fishers often live in tightly knit communities, and they have developed an effective set of informal rules and procedures. Specifically, only members of a local “harbor gang” may set traps in certain areas near shore, and the traps set by non-members are subject to being cut or destroyed.

Although the term gang may not suggest the presence of creativity, these communities have proven quite innovative in their approach to resource management. As presented in Acheson (2003), some long-forgotten individual came up with the brilliant idea of cutting a V-notch in the tail of egg-bearing female lobsters and returning that lobster to the sea. Since this notch lasts until that lobster molts, other fishers could realize that here was a fertile female who should be returned to the sea in hopes that she could produce more lobsters to be caught in later years.

Diffusion of this policy innovation throughout the community was helped by social coercion, as local fishers and merchants who violated this rule were subject to boycotts or other forms of social pressure. Soon, no notched female could be sold in local markets. Lobbying efforts succeeded in enshrining these rules into state law, but state authorities never recognized the exclusive rights claimed by harbor gangs.

State and federal governments have, for the most part, left these communities to govern themselves by these rules. Limitations on catch sizes and the V-notch have been enshrined in state law, as a consequence of vigorous lobbying by the industry. However, the practice of cutting traps remains illegal. Acheson and Gardner conclude their analysis of their game models by expressing concern about the potential undermining of this system, now that more fishers are treating the cutting of their traps as a reason for litigation.

For present purposes, this can be seen as a successful example of a “level-shifting” strategy, in the sense that lobster fishers went to the legislature to enshrine into law practices they considered desirable. Acheson concludes that this ability of the lobster industry to lobby legislators to pass laws based on informal rules is key to its success. It also effectively assures that local fishers are key participants in virtually of the critical governance action situations.

Figures 11 and 12 summarize my reading of this policy setting in terms of the generic tasks of governance. Figure 11 lists the most important actor types and the roles each plays in each of the major functional components of this policy process. Figure 12 represents each of these functional categories as a separate action situation, and specifies key types of actors involved in generating the outcomes of each action situation. The figure as a whole denotes the network of adjacent action situations that could be used as the basis for a more detailed model of this policy process.

Production is undertaken by lobster fishers, and they devise, monitor, and implement rules through their interactions within harbor gangs. These rule-making efforts are reinforced by the support of laws or rules enacted by the state legislature or by the recently established co-management zones. The important point to note about Figure 11 is that every column has an entry corresponding to the participation of individual fishers or harbor gangs. Even the tasks of coordination and dispute resolution, which are primarily handled by state regulators or co-management boards, are influenced by community action. In this sense, this case comes very close to the template of a community of resource users with sufficient autonomy to successfully manage resources critical to their own survival.

However, this autonomy may not be sustainable through the foreseeable future. Recent changes in technology and society have lead to increased occurrences of external intrusion onto formerly exclusive areas, thereby putting the current system under new pressure. Meanwhile, the rise of environmental consciousness has brought local practices into question, including those of the Maine lobster industry, even though these fishers were themselves originally inspired by strong self-interest in conservation.

This leads me to conjecture that self-governance may be easiest to achieve and to sustain when actor sets of most of these action situations overlap or coincide, as in the Maine fisheries case. However, this remains an open question (for further discussion of this point, see McGinnis 2010a).

4. Potential Applications beyond Resource Management

In the opening paragraphs of this paper I summarized the basic idea of the SES framework as follows:

> The SES framework is designed for application to policy settings in which
> (1) a set of actors, at least some of whom are
> (2) organized into larger collective decision entities, and who
> (3) make use of available information, infrastructure, and other relevant technology to
> (4) extract resource units from
> (5) an existing pool of common resources (CPR system) which is
> (6) replenished or maintained via dynamic processes only partially under of the control of these actors, and that these extracted units are used to
> (7) create something of economic (or other) value that may
> (8) be directly consumed or exchanged or used as an input to some other production process and that these actions may
> (9) have detrimental effects on the long-term viability of that resource pool and potentially
> (10) on related resources or ecosystems as well as having
> (11) positive or negative externalities on other actors who may
> (12) draw upon existing governance processes to redress their grievances or implement changes in process of extraction, transformation, distribution, and consumption.

This list format makes it easier to consider each of these components separately from the others. There are, of course, a wide diversity of policy settings which satisfy all twelve of these characteristics, and thus the SES framework has great potential for broad application. (This sentence also demonstrates why this framework is necessarily a bit complicated.) But there are still more situations in which one or more of these conditions are not directly satisfied, and yet something like SES might still prove useful.

Before suggesting potential applications to other policy situations, allow me to direct the reader's attention back to Figures 2 and 3, the canonical representations of the SES framework, or to Figures 5 or 7, the revised versions allowing for multiple manifestations of first-tier components. Perhaps the term "system" is over-used in those figures. The Resource System component might be better labeled a **Resource Pool**, from which units are extracted by the relevant actors. And the Governance System term might be replaced with **Governance Unit**, within which the relevant collective decisions are made. In this way the generic term system could be reserved for application to the broader social or ecological contexts within which this focal policy setting is located. This might also help avoid further confusions drawn from analogies to other interpretations of the terminology associated with multi-level systems.

To return to the 12 defining characteristics of the domain of application for the SES framework, the first two components seem absolutely necessary, since we are interested in understanding situations in which human actions can have significant consequences on observed outcomes, and since in any situation there remains potential that the relevant actors may form themselves into some kinds of collective decision units. In some settings the relevant collective units may remain quite close to the individual level, as, for example, in any study of agricultural systems dominated by family farms the collective decision apparatus in the SES framework would need to be downplayed, unless, of course, farmer cooperatives play important roles in that system.

The SES framework should prove serviceable for application to other policy settings, merely by making a few adjustments necessitated by different configurations of the twelve focal characteristics listed above. There remains some room for adjustment in each of the other characteristics.

Social-technical systems (STS). In some cases points 3 and 5 may converge, when the existing array of infrastructure or other relevant technology itself becomes the pool from which resource units are drawn. In this way this SES framework would be directly applicable to analyses of social-technical systems such as power grids, transportation systems, or communication networks. Infrastructure systems can be very complex, and their systems level dynamics may not be fully understood, even by its designers. Some details of the framework may need to be modified to take account of this conflation of the common pool and the technology used to extract resource units, but the basic framework should remain intact.

Public and toll goods. Although the SES framework requires the presence of some common pool from which resource units are drawn, in many policy settings this pool and/or the resources extracted are closely related to other types of collective goods. Maintaining general access to a common pool, for example, can often be interpreted as a public good, which immediately brings into play all of the dilemmas associated with the provision and production of public goods. For toll goods exclusion of actors outside of a core group can be effected at low costs, and thus formation of clubs may prove to be a viable solution. Such a club becomes, in effect, a governance unit which treats the toll good in question as if it were a pool common to the members of that club.

I would like to suggest **local public goods** as an especially promising area of non-ecological applications for the SES framework. Members of a local community jointly share in the enjoyment of a wide array of goods and services, sometimes whether they want to or not. In addition, collective goods with policy sectors generally considered quite separate may instead be closely interrelated in the context of local communities. Consider the findings of urban ecologists concerning the extent to which the physical layout of a neighborhood can affect patterns of energy consumption as well as the health of community members. For example, even the simple expedient of planting trees and maintaining walking paths with easy access to grocery stores and workplaces can lessen reliance on automobiles and encourage regular physical activity, and perhaps even help nurture a sense of community among people who encounter each other in a variety of settings. Community health, energy, transportation systems, and social capital might serve as analytically separate resource pools that interact with each other and with community members in ways consistent with the SES framework.

Private goods and economic systems. In many analyses of common pool resource settings it is not necessary to consider in any detail what happens after a resource unit has been extracted from the common pool, and thus point 8 is not a major consideration in such studies. However, this step would be critical for any study of markets and other economic systems. Since these systems operate according to their own dynamics, as identified by centuries of economic analyses, it seems reasonable to presume that economic systems can never be completely under the control of any set of actors, as required by point 6. After all, once a resource unit has been extracted from a common pool, it can become in effect a private good that can be consumed or exchanged for other goods. In this way the SES framework might enable analysts to come to grips with the cultural foundations required for an economic system to operate with high efficiency. For example, a widespread sense of general trust is required to prevent excessive levels of transaction costs, and the continued prevalence of trust can itself be seen as a common pool from which private actors can draw when they contemplate market exchanges.

Sustainability. Characteristic 9 explicitly identifies sustainability as a potential topic of analysis using the SES framework. However, there are many other topics that could serve as the focus of analysis within PIASES.

Religion and other cultural dynamics. It may be too much of a stretch to replace the ecological side of an SES with cultural systems, but I think this idea may be worth pursuing. Elsewhere I have investigated the extent to which religious communities operate according to their own internally directed dynamics, and as a natural consequence of those dynamics generate welfare service programs that may affect other members of a political community. These externalities may be positive or negative, thus giving political authorities reasons to engage in efforts (albeit often subtle in nature) to encourage some activities by religious believers and their leaders while discouraging other activities.

This final suggestion raises a series of sensitive issues that I consider in more detail elsewhere (McGinnis 2008). In a recent paper (McGinnis 2010b) I use the network of adjacent action situations to organize discussion of controversies associated with the faith-based initiative, as well as more traditional resource based examples. In subsequent research I intend to explore further connections between the SES framework and the study of religion and politics, and I suspect that other aspects of cultural production might be treated in an analogous fashion. However, I also realize that many readers may see this as a crazy idea, so I leave it for there for now.

Even without this extension to cultural dynamics, the SES framework shows an impressive potential for application to a wide array of policy settings. I fully expect that later versions of this paper will include considerably more citations to examples of its use in diverse empirical settings.

As a final indication of the tentative nature of this paper, I include two versions of a figure meant to incorporate the changes suggested in this paper. Figure 13 suggests alternative designations for the first-tier components RS (resource systems or resource pools) and GS (governance systems or governance units). My impression is that the second option in both cases is more general, but I realize that these terms are not totally consistent with the original formulation of the SES framework. Thus, Figure 14 show an alternative version of the multiple first-tier component SES framework that uses the same terms as in earlier figures (as well as the colors used in an early version of the core figure). For present purposes Figure 14 should be interpreted (provisionally) as the current representation of the SES framework.

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Figure 1: IAD Framework

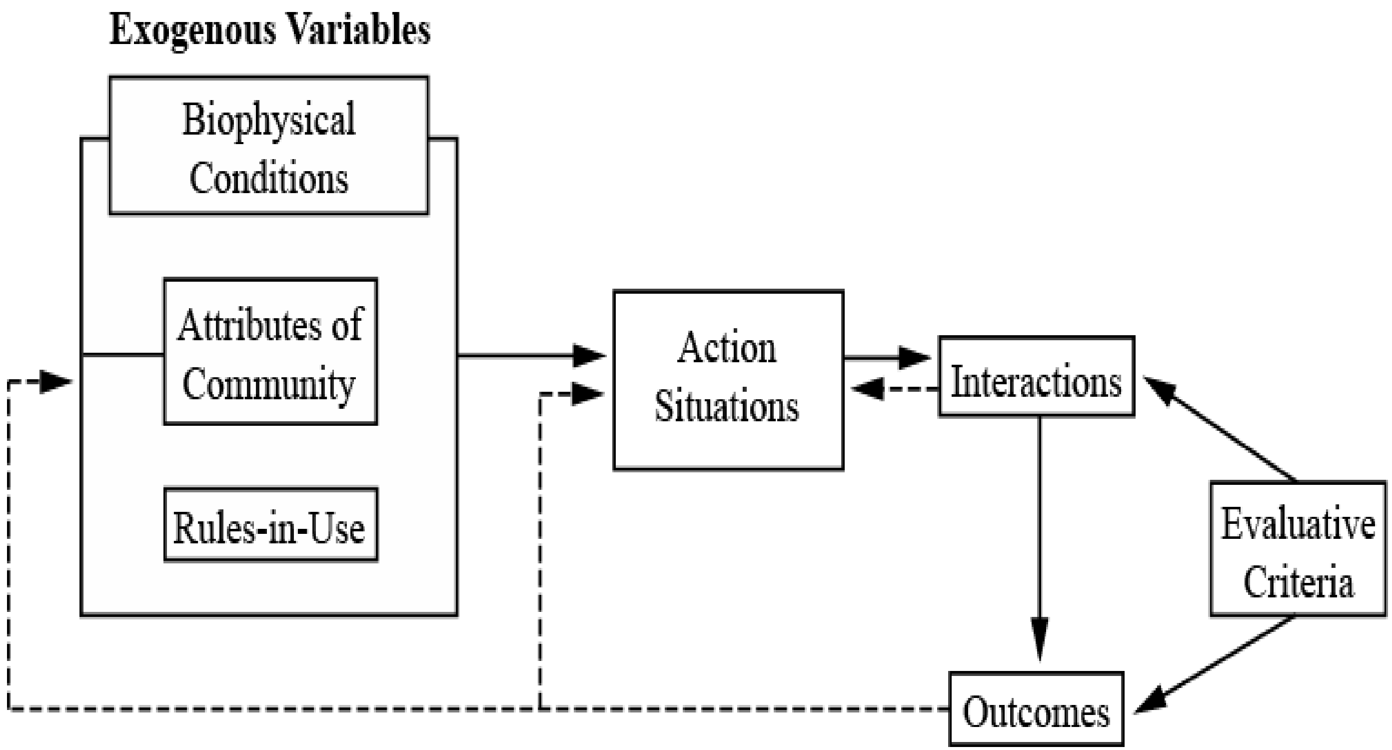


Figure 2. A framework for institutional analysis. Adapted from E. Ostrom (2005: 15).

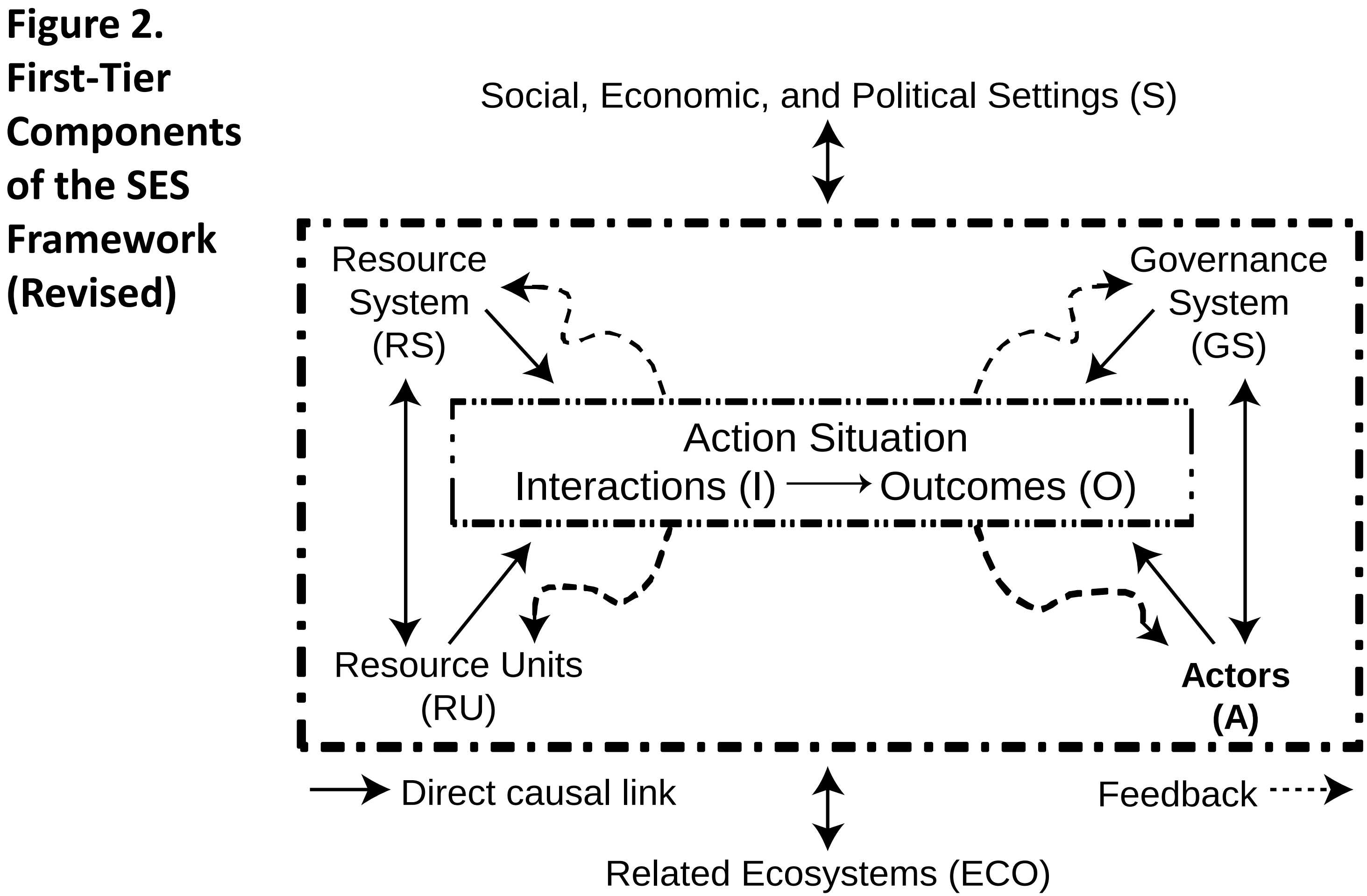


Figure 6. Action Situations Embedded in Broader Social-Ecological Systems

Source: Adapted from E. Ostrom (2007: 15182).

Figure 3. Second-Level Components in SES Framework: (Ostrom 2009: 421)

Table 1. Examples of second-level variables under first-level core subsystems (S, RS, GS, RU, U, I, O and ECO) in a framework for analyzing social-ecological systems. The framework does not list variables in an order of importance, because their importance varies in different studies. [Adapted from (*12*)]

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 systems (RS)	*Governance systems (GS)*
RS1 Sector (e.g., water, forests, pasture, fish)	GS1 Government organizations
RS2 Clarity of system boundaries	GS2 Nongovernment organizations
RS3 Size of resource system*	GS3 Network structure
RS4 Human-constructed facilities	GS4 Property-rights systems
RS5 Productivity of system*	GS5 Operational rules
RS6 Equilibrium properties	GS6 Collective-choice rules*
RS7 Predictability of system dynamics*	GS7 Constitutional rules
RS8 Storage characteristics	GS8 Monitoring and sanctioning processes
RS9 Location	
Resource units (RU)	*Users (U)*
RU1 Resource unit mobility*	U1 Number of users*
RU2 Growth or replacement rate	U2 Socioeconomic attributes of users
RU3 Interaction among resource units	U3 History of use
RU4 Economic value	U4 Location
RU5 Number of units	U5 Leadership/entrepreneurship*
RU6 Distinctive markings	U6 Norms/social capital*
RU7 Spatial and temporal distribution	U7 Knowledge of SES/mental models*
	U8 Importance of resource*
	U9 Technology used
Interactions (I) → outcomes (O)	
I1 Harvesting levels of diverse users	O1 Social performance measures (e.g., efficiency, equity, accountability, sustainability)
I2 Information sharing among users	
I3 Deliberation processes	
I4 Conflicts among users	O2 Ecological performance measures (e.g., overharvested, resilience, bio-diversity, sustainability)
I5 Investment activities	
I6 Lobbying activities	
I7 Self-organizing activities	O3 Externalities to other SESs
I8 Networking activities	
Related ecosystems (ECO)	
ECO1 Climate patterns. ECO2 Pollution patterns. ECO3 Flows into and out of focal SES.	

*Subset of variables found to be associated with self-organization.

Fig.4. Mistaken Interpretation Using Hierarchical Nested Levels of Aggregation

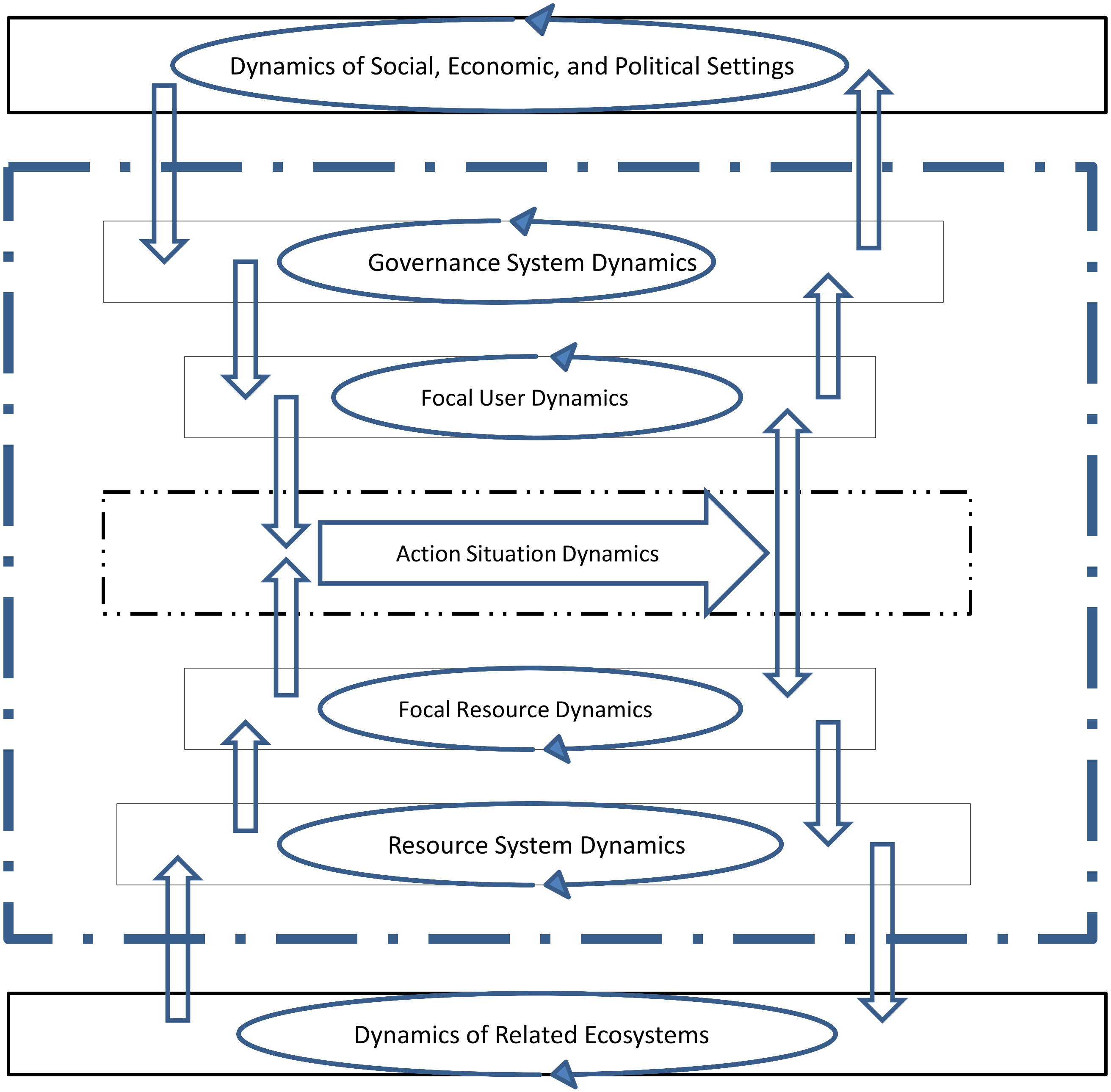


Figure 5. SES Framework With Multiple First-Tier Components

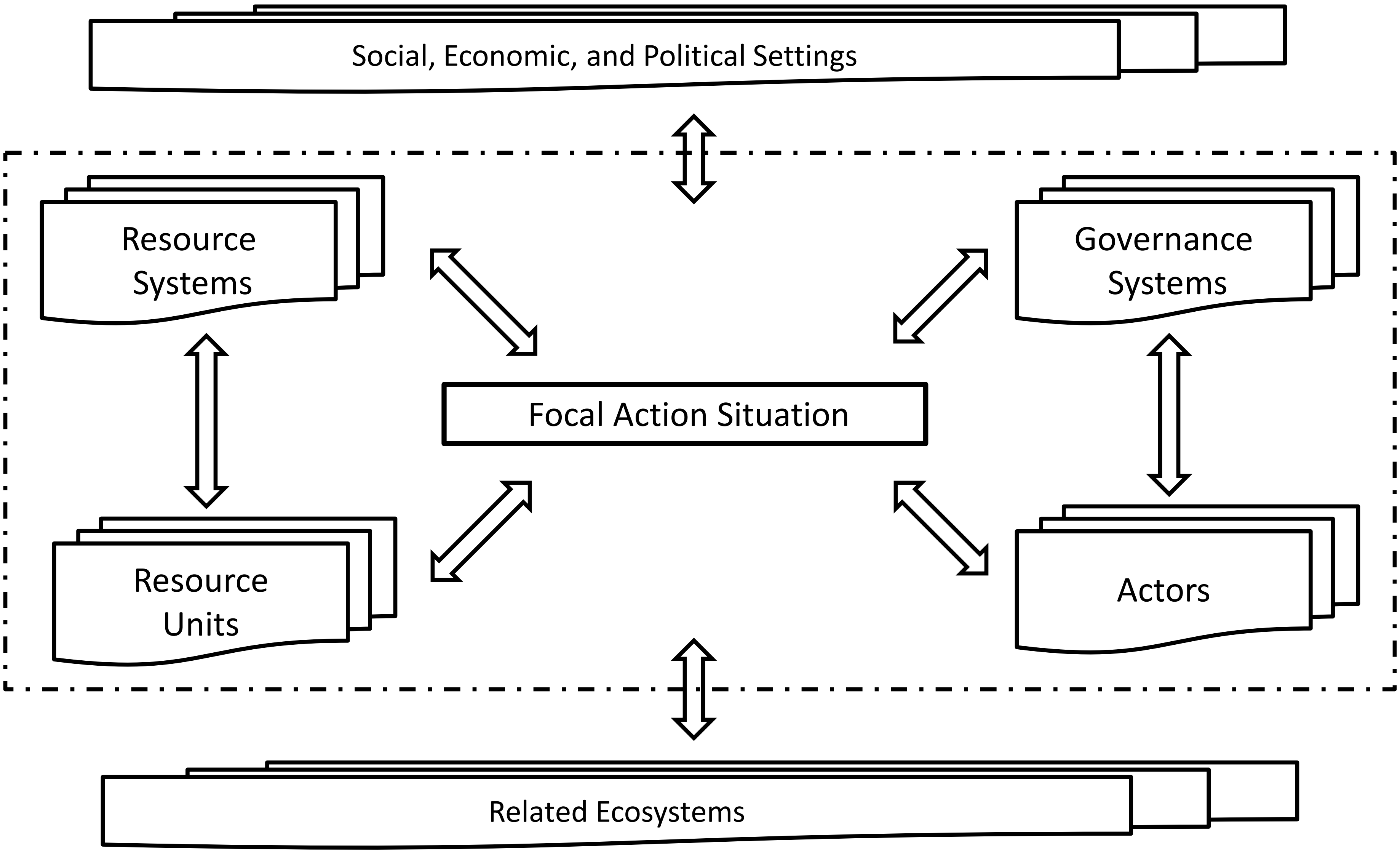


Figure 6. Types of Interactions Between First-Tier Components

	Resource System	Resource Units	Actors (formerly known as Users)	Governance Systems
Resource System	• Ecological linkages, spillovers between sectors • Subsystem modules and composition of systems	NA	NA	NA
Resource Units	• Aggregations of units as attributes of resource systems • Centrality of focal resource units to sustainability of resource system as a whole	• Interactions between different products of a given resource system (multiple uses of forestry resources) • Predators, symbiosis, etc.	NA	NA
Actors (the category formerly known as Users)	• Systemic effects of harvesting levels • Investment (in infrastructure and maintenance) • Learning about ecosystems; mental models of SES	• Harvesting levels • Dependence on resource units by livelihood groups • Specific property rights held by individual or collective actors • Local knowledge of behavior of resource units	• Monitoring and sanctioning • Information sharing • Deliberation processes • Conflicts (between different types of actors)	NA
Governance Systems	• Fit between scales of resource and governance systems (watershed management, etc.) • Time scales of ecological dynamics and policy response • Property rights systems (example: publicly protected forestry area)	• Definition of property rights over specific units • Limits on what goods and services can be exchanged via market processes • Regulations on trading or transfer of certain products	• Lobbying activities • Self-organizing activities (as in a user group) • Networking activities • Laws, regulations • Operation of dispute resolution mechanisms • Citizenship and membership in units • Elections	• Interactions between alternative governance systems (general vs. special purpose, local-national-federal, etc.) • Polycentric orderings • Contracting out to other producers (public, private, voluntary, or community-based organizations)

Source: Matrix comes from Pieter Bots; examples by Mike McGinnis, June 14, 2010, Revised 7-8-10

Note: NA Not Applicable. Bots emphasized that interactions should be treated as non-directional in nature, so these cells are duplicates of other cells.

Figure 7. SES Framework With Multiple Action Situations

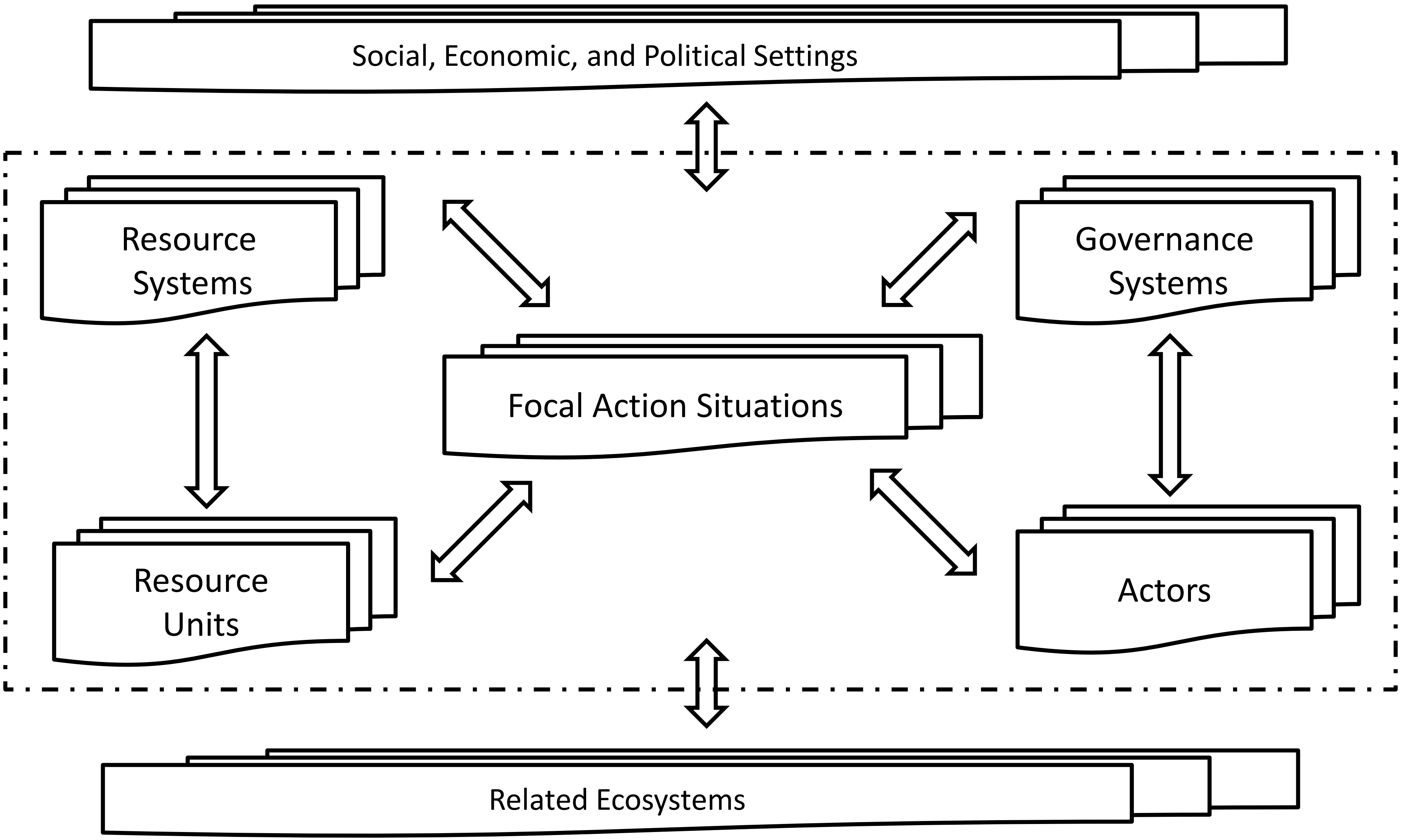


Figure 8. Multi-Level Representation of IAD Framework

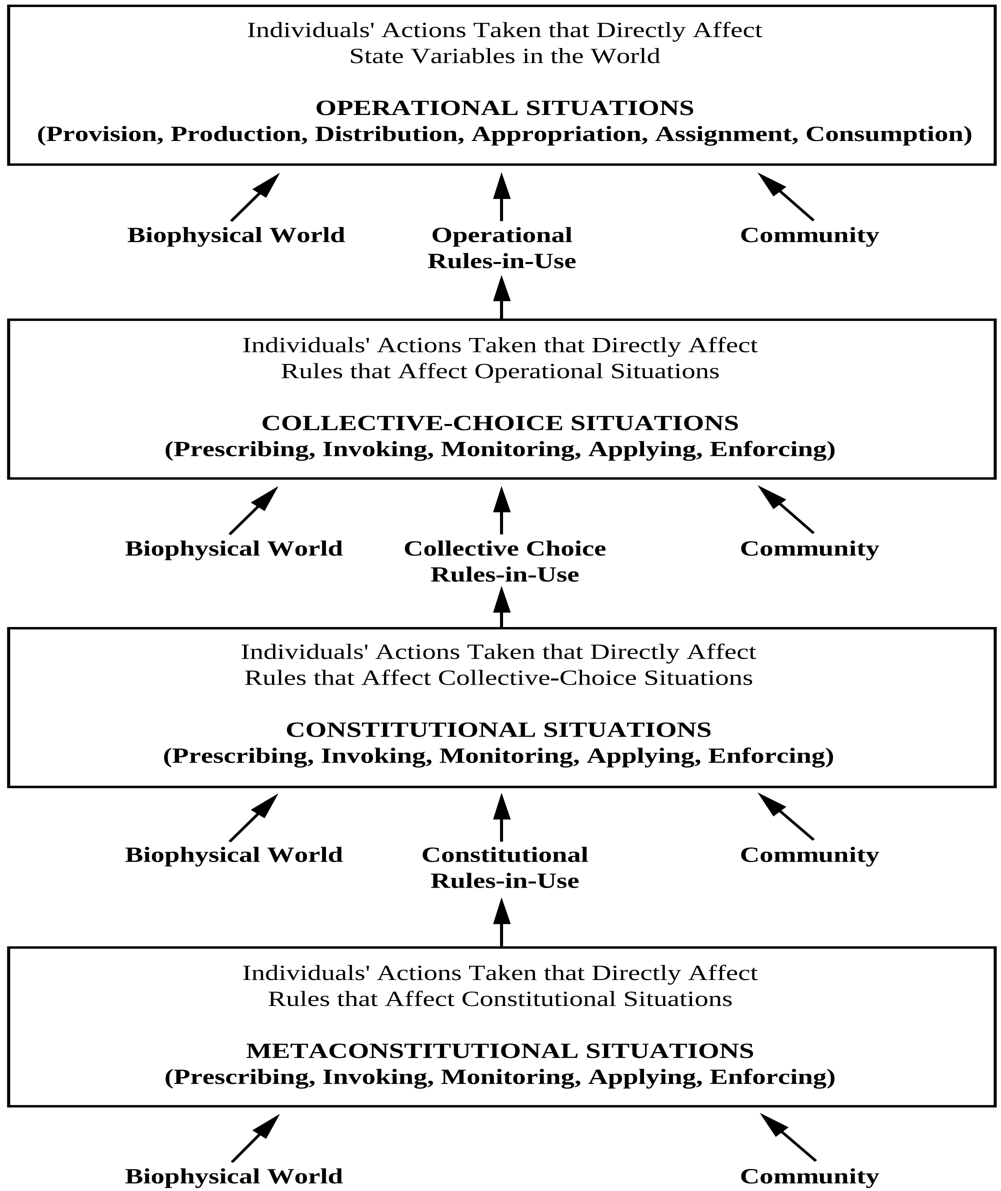


Figure 2.3 Levels of analysis and outcomes. *From E. Ostrom [1999, 60]*.

Figure 9. Working Parts of an Action Situation and Associated Rules

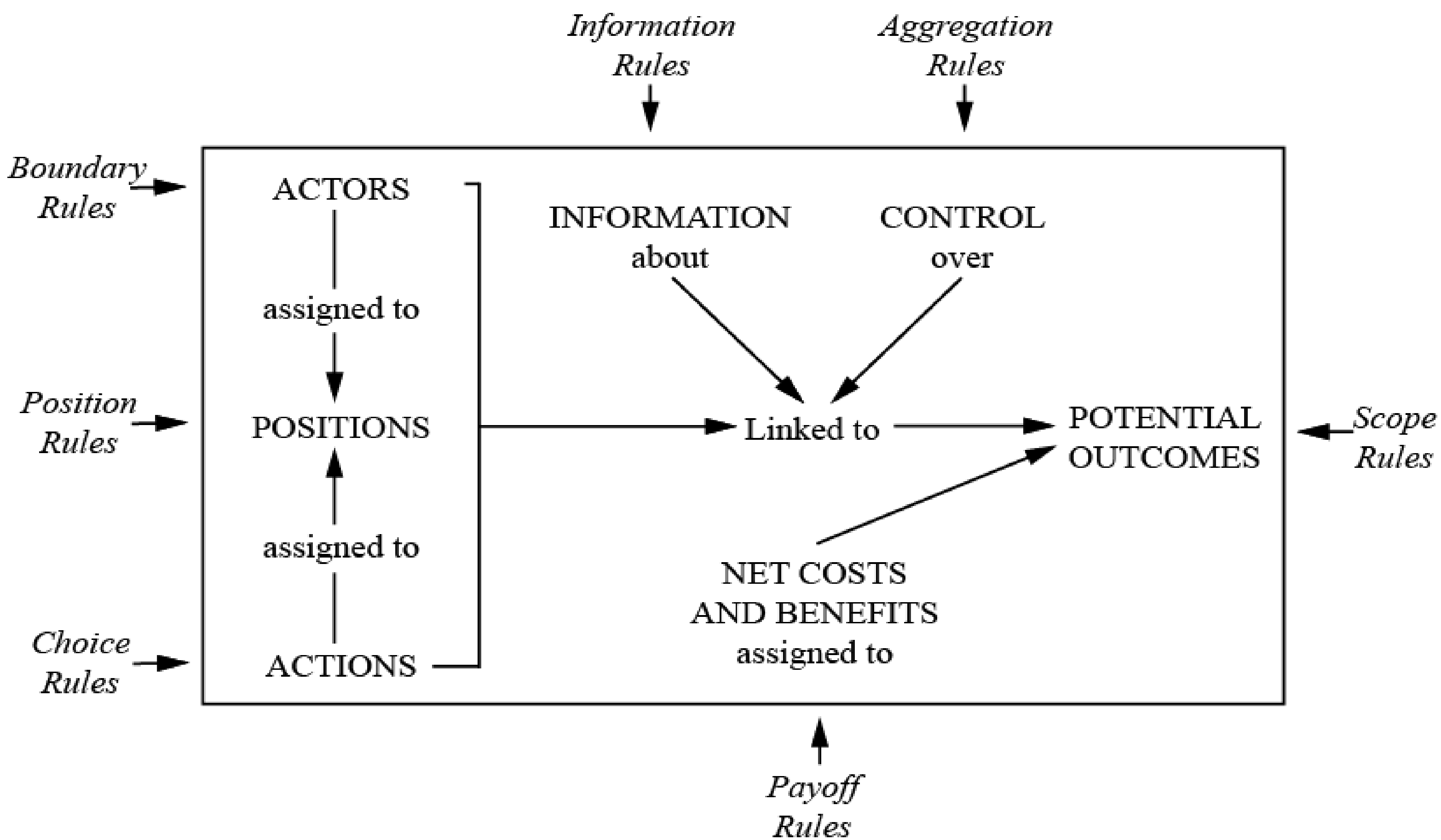
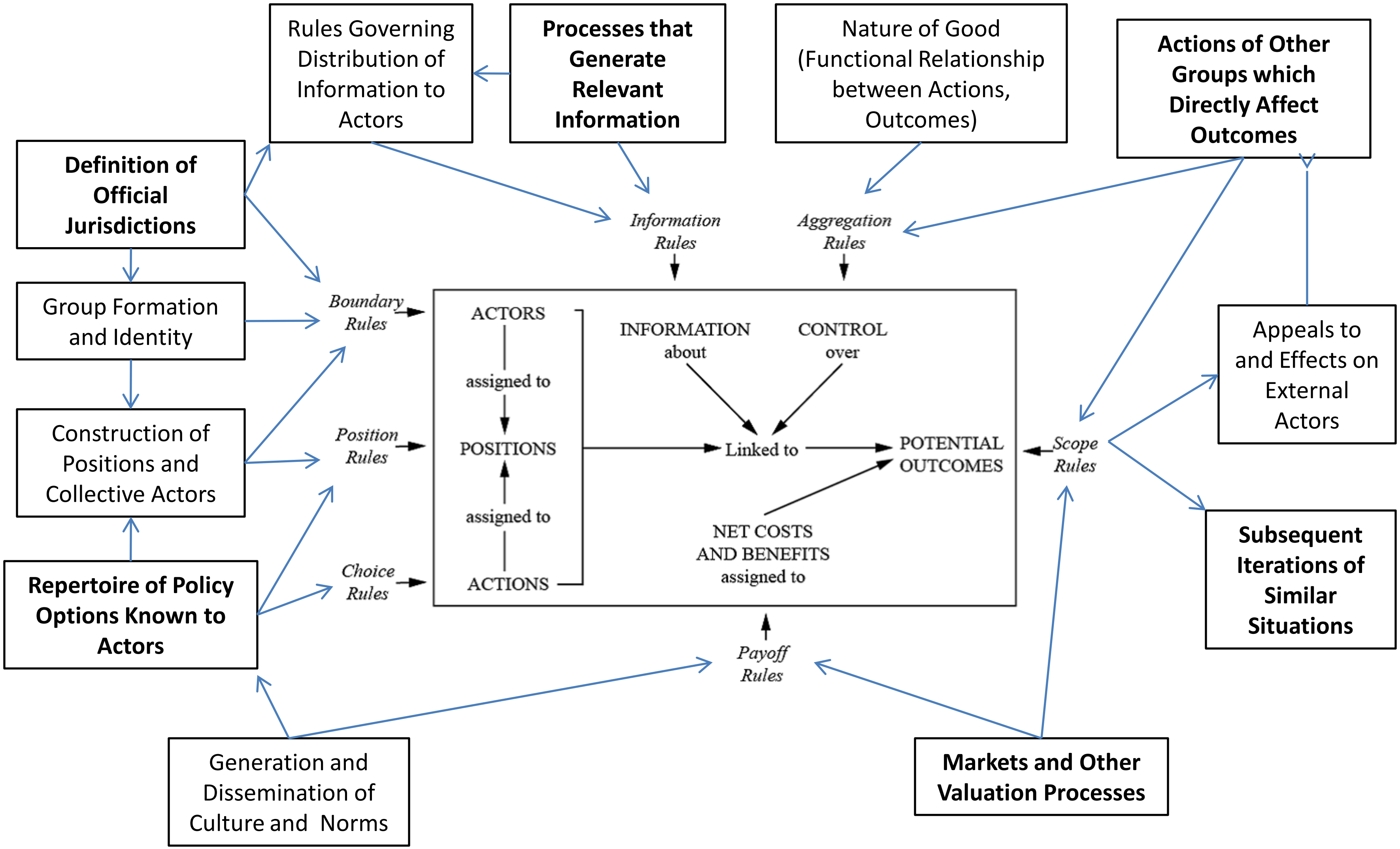


Figure 4. Rules as exogenous variables directly affecting the elements of an action situation.
Source: Adapted from E. Ostrom (2005: 189).

Figure 10. Games Adjacent to an Action Situation, with Examples of Connections to Working Parts and Associated Rules



Source: Interior figure taken from Ostrom 2005: 189; additional components added.

Figure 11. Actor Types and Action Situations (Maine Lobster Fisheries)

Actor Types	Primary Motivations	Consumption	Production	Provision (Goal Setting)	Financing	Rule-Making	Monitoring, Sanctioning	Evaluative Information	Dispute Resolution	Co-ordination
Consumers	Best value, lowest price	Individuals, households			Prices – retail			Through prices, demand		
Fishermen	Sustainable livelihood	Important part of diet	Harvesting		Prices – wholesale	Rules-in-use	Routine observation, minor sanctions	Regular observation		
Harbor Gangs	Protect territory			Informal goals		Rules-in-use	Regular interactions, impose direct sanctions	Regular sharing of information	Informal channels	Local, informal basis
Merchants	Profit, reputation				Profits		Can be sanctioned for rule violations	Through prices		
State Regulators	Maintain health of state economy			Context of overall state policies		Formal regulations	Sporadic monitoring, can start legal proceedings		Formal procedures	Minimal role
Co-Management Boards	Coordination			Sustainable rules		Formal regulations		Important forum for information exchange	Formal procedures	Important role
National Regulators	Implement environmental policy			Context of national priorities		General guidelines	Dependent on other sources of information		Federal courts as final resort	
Environmental Activists, Scientists	Ecological health, sustainability			Advocate specific limits	Donations, Grants		Focus on environmental conditions	Advise on capacities		
Ecological Dynamics (non-strategic)	(Growth, reproduction)		(Growth, Repro-duction)					(Reality check)		(Complex eco-dynamics)

Figure 12. Network of Adjacent Action Situations in Maine Fisheries

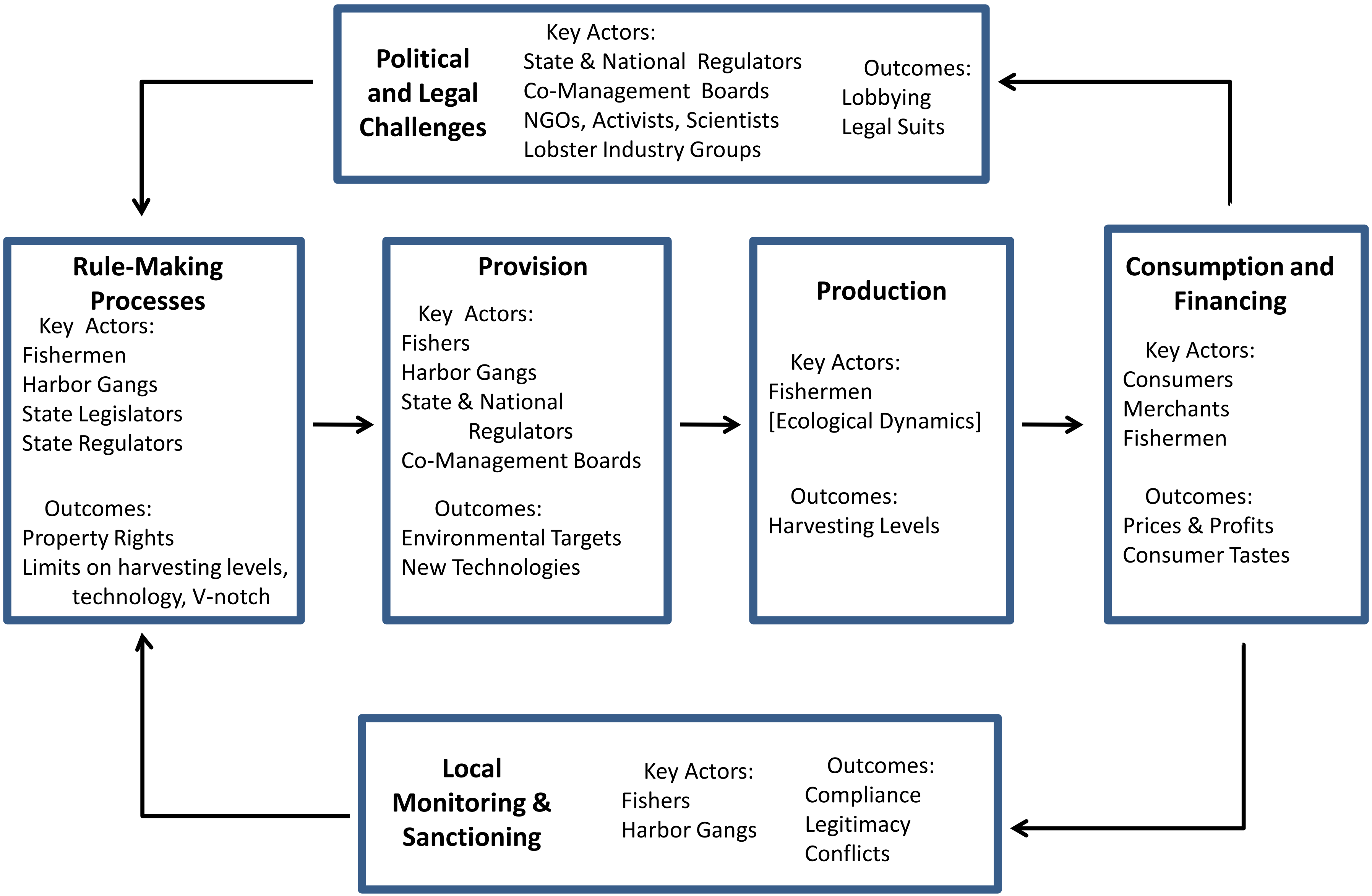


Figure 13. SES Framework With Multiple Action Situations (and revised systems terminology)

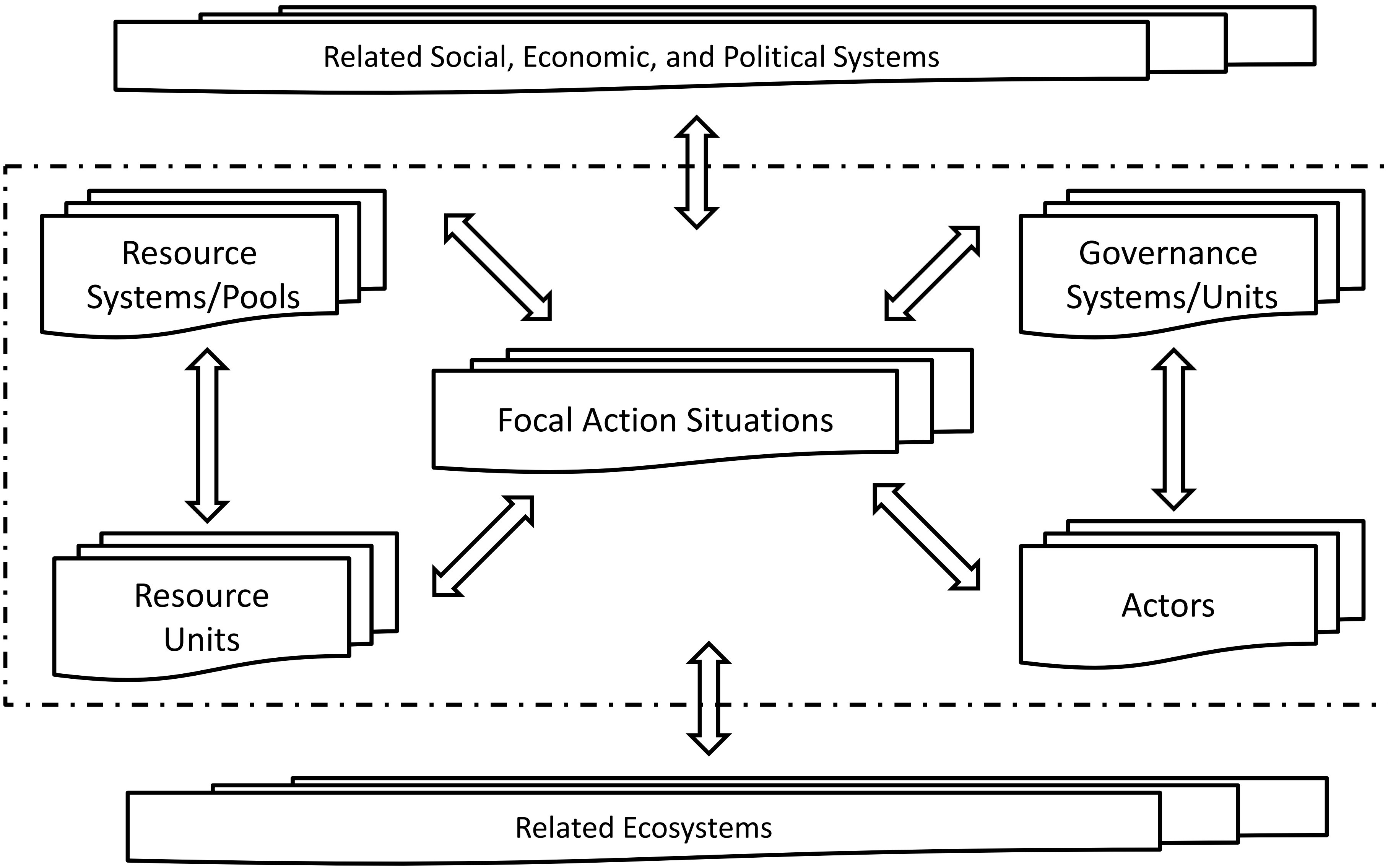


Figure 14. Revised SES Framework With Multiple First-Tier Components