

**Design Principles are not Blue Prints, but are They Robust?
A Meta-analysis of 112 Studies**

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Abstract

Scholars in the social sciences are only recently recognizing and developing appropriate analytical tools to understand complex systems. The central problem is the extremely large number of variables, and their interactions, that affect how human systems operate at multiple levels. This complexity increases when social systems interact with natural systems. An example of this is the management of common-pool resources such as forests or fisheries by communities of users. Until the last several decades, many scholars have presumed that the users of such resources could not self-organize to manage that resource, and often recommended the imposition of either of two idealized property regimes -- government or private ownership.

In 1985, the National Research Council established a research committee to examine the problems facing the users of common-pool resources and brought together scholars from a wide diversity of disciplines to review the existing empirical evidence about common-pool resources and the impact of diverse governance arrangements. The NRC report (1986) argued that the complexity of the diverse systems used to manage common-pool resources in the field had confused scholars into thinking that chaos prevailed unless simple government or private property systems were imposed.

In light of the NRC's report, colleagues at the Workshop in Political Theory and Policy Analysis at Indiana University created a database to record key information from the growing number of case studies found in the literature related to how self-organized regimes managed common-pool resources. A core question pursued by the group was, What type of rules appeared to be most successful in sustaining the productive use of common-pool resources?

As a primary part of this effort Elinor Ostrom tried hard, but unsuccessfully, to find sets of rules that consistently enabled the sustainable management of a resource over time. It did appear that some common attributes were shared by the long surviving common-pool resource systems, but these were not in the form of specific institutional rules such as those propounded in the literature. Ostrom ultimately turned to asking whether any broad "principles" existed that appeared to characterize the sustainable systems. In *Governing the Commons* (1990), she posited a set of eight very general design principles that stipulated the efficacy of multiple types of rules and sets of rules.

The primary role of the design principles is to explain under what conditions trust and reciprocity can be built and maintained in order to sustain collective action in the face of collective action problems posed by common-pool resources. Given that many research papers have been written about the design principles since 1990, it seemed appropriate to conduct a meta-analysis of those studies to document their findings, and evaluate the robustness of the principles.

This paper has attempted to synthesize a surprisingly large number of studies that have been undertaken regarding the design principles that Ostrom originally formulated. The most trenchant critiques were theoretical, and not empirical. There was not one study we

found that was moderately or strongly negative on the design principles based on empirical evidence of their presence or absence in a particular case or set of cases. This does not mean that they are complete, or that other factors such as the size of user groups or different types of heterogeneity within them, or the type of governmental regime they operate within, are not important. These factors likely have interaction effects with local institutional arrangements that in part determine the efficacy of these arrangements. Similarly, the efficacy of one principle may be contingent on the presence or absence of another.

As such, a probabilistic, rather than a deterministic, interpretation of the design principles is warranted. Likewise, we remain uncertain as to whether or not the principles may apply to systems at a variety of scales. Ultimately, however, the design principles are robust to empirical testing via our meta-analysis of 112 studies. In sum, future research will be needed to further disentangle these components and their interaction effects both within and across multiple environmental and social scales.

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4. The Challenge of Complexity

Scholars in the social sciences are only recently recognizing and developing appropriate analytical tools to understand complex systems. The central problem is the extremely large number of variables, and their interactions, that affect how human systems operate at multiple levels. This complexity increases when social systems interact with natural systems. An example of this is the management of common-pool resources such as forests or fisheries by communities of users. Until the last several decades, many scholars have presumed that the users of such resources could not self-organize to manage that resource, and often recommended the imposition of either of two idealized property regimes -- government or private ownership -- based on the theories of Gordon (1954), Demsetz, (1967) and Hardin (1968). Scholarly reports during the mid 1980's, however, began to raise serious questions about the wisdom of massive efforts to impose institutional arrangements on the users of common-pool resources (Feeny, et al., 1990)

In 1985, the National Research Council established a research committee to examine the problems facing the users of common-pool resources and brought together scholars from a wide diversity of disciplines to review the existing empirical evidence about common pool resources and the impact of diverse governance arrangements. A report was published in 1986 that criticized the confusion related to property regimes for common-pool resources, and recommended the need for further research on how diversely structured systems for governing and managing common-pool resources performed in the field (NRC, 1986). The NRC report argued that the complexity of the diverse systems used to manage common-pool resources in the field had confused scholars into thinking that chaos prevailed unless simple government or private property systems were imposed.

5. Creating a Database to Analyze Common-pool Resources

In light of the NRC's report, colleagues at the Workshop in Political Theory and Policy Analysis at Indiana University created a database to record key information from the growing number of case studies found in the literature related to how self-organized regimes managed common-pool resources. Available studies describing patterns of interactions and outcomes had been written by historians, sociologists, engineers, economists, and policy analysts. The database included a large number of variables about the structure of the resource systems, the history of the people involved, the rules in use, the organizations involved, the amount of resource units harvested, and the conditions of the resource. A core question pursued by the group was, what type of rules appeared to be most successful in sustaining the productive use of common-pool resources.

As a primary part of this effort Elinor Ostrom tried hard, but unsuccessfully, to find sets of rules that consistently enabled the sustainable management of a resource over time. It did appear that some common attributes were shared by the long surviving common-pool resource systems, but these were not in the form of specific institutional rules such as those propounded in the literature. Ostrom ultimately turned to asking whether any broad "principles" existed that

appeared to characterize the sustainable systems. In *Governing the Commons* (1990), she finally posited a set of eight very general design principles that stipulated the efficacy of multiple types of rules and sets of rules. The following list contains the design principles as Ostrom (1990, 90) originally formulated them:

1. Clearly defined boundaries: Individuals or households who have rights to withdraw resource units from the CPR must be clearly defined, as must the boundaries of the CPR itself
2. Congruence between appropriation and provision rules and local conditions: Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, material, and/or money
3. Collective-choice arrangements: Most individuals affected by the operational rules can participate in modifying the operational rules
4. Monitoring: Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators or are the appropriators
5. Graduated Sanctions: Appropriators who violate operational rules are likely to be assessed graduated sanctions (depending on the seriousness and the context of the offense) by other appropriators, by officials accountable to these appropriators, or both
6. Conflict-Resolution Mechanisms: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials
7. Minimal recognition of rights to organize: The rights of appropriators to devise their own institutions are not challenged by external governmental authorities
8. Nested enterprise: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises

While the discovery of principles that are associated with successful collective action in CPR governance is a challenging endeavor, it is equally important to understand the mechanisms behind these associations. A full account of the theoretical mechanisms and the models of human behavior involved is beyond the scope of this paper. The model of the individual Ostrom (1990, 185) relied on was “fallible, norm-adopting individuals who pursue contingent strategies in complex, uncertain environments.” The institutional design principles then adhere to North’s (1990) conception of institutions as mechanisms for reducing uncertainty in complex uncertain environments. By reducing uncertainty, trust and norms of reciprocity may be built and sustained, and collective action may become possible. The primary role of the design principles is thus: to explain under what conditions trust and reciprocity can be built and maintained in order to sustain collective action in the face of collective action problems posed by common-pool resources.

A substantial literature has developed concerning the usefulness and validity of the design principles. The types of reactions have been mixed. While there has been substantial support for the principles, some scholars have criticized their theoretical grounding or argued that they do not offer sufficiently concise solutions (while others argue that they are overly concise). Other scholars have unfortunately confused the effort to identify underlying organizational principles

with the imposition of narrow “blue prints” that should be always followed by resource users or managers. That, as we understand it, was not the intention of the original effort. Given that many research papers have been written about the design principles since 1990, it seemed appropriate to conduct a meta analysis of those studies to document their findings, and evaluate the robustness of the principles.

6. Methods for Meta-Analysis

6.1. DATA COLLECTION

There were two methods used to populate the list of studies analyzed in this project. The first involved conducting searches in standard academic databases and relevant journals, as well as the within library at the Workshop in Political Theory and Policy Analysis at Indiana University. This library is a type of special collection created over the last 30 years to form a thorough representation of writings on the commons. It includes the Digital Library of the Commons (DLC), which is an online repository of full-text articles (<http://dlc.dlib.indiana.edu/>). The method involved a snowball procedure wherein studies analyzed in the first step were used to find other studies that referenced them or were referenced by them and considered relevant to the project.

6.2. DATA CODING

We next looked for patterns in the studies by coding relevant variables for each study and entering them into a common database. A *study* is an article, book, or other work that is coded for the purposes of meta-analysis. A study may contain more than one *case*, depending on how many cases the author(s) analyzed. A study may have only one case if the author focuses on one community, or it may have many if it is a statistical analysis. Studies were not weighted in the analysis based on how many cases they contained. As each of the authors were involved in coding the studies, a subset of the studies were double-coded in order to ensure inter-coder reliability. Information was recorded for each study on several elements:

1. Sector, which included forestry, pasture, irrigation, fisheries, other, or multiple sectors.
2. General level of support for the design principles as a whole contained in the case.
3. Empirical support, or critiques, of specific design principles.
4. Suggested emendations to specific design principles or to the design principles as a whole.
5. Theoretical arguments in favor of, or critiques of, the design principles approach.

The majority of the studies fell into one of four sectors: forests, fisheries, irrigation, and pasture. The rest either examined combinations of these four sectors (e.g., forest and pasture), in which case the sector field was labeled “multiple”, or they examined a different resource altogether, in which case their sector was labeled “other”. Additionally, data on each design principle was coded to record whether the principle’s presence or absence was associated with success or failure in the study, or simply present or absent without any implication for performance.

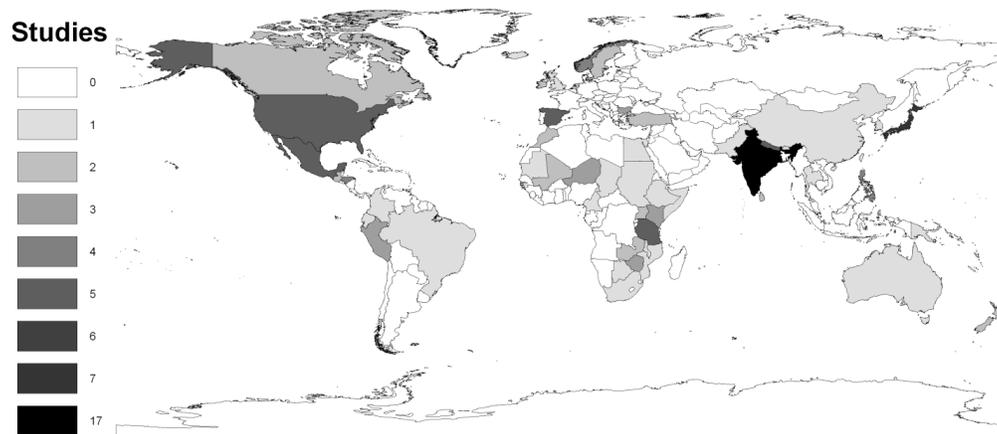
6.3. DESCRIPTION OF THE CASES

A total of 112 studies were analyzed. Table 1 illustrates the breakdown of the studies by sector. Figure 1 illustrates the geographic distribution of the studies¹. The country with by far the largest number of studies is India, with 17.

Table 1: Distribution of coded cases by sector

Cases Coded by Sector	
Forestry	23
Pasture	7
Irrigation	28
Fishery	23
Multiple	19
Other	12
Total:	112

Figure 1: Geographic distribution of the studies analyzed



7. Results of the Meta-Analysis

7.1. GENERAL RESULTS

By and large the literature examined is supportive of the design principles. If there is a consistent critique it is implicit rather than explicit, and would be that they are incomplete rather than incorrect. Many studies suggest additional criteria for successful collective action or similar outcomes. Several critiques argue for a more constructionist or “historically, socially and environmentally embedded” perspective that departs from viewing actors as rational decision-makers, and communities of users as coherent wholes without internal conflict or heterogeneity (Leach et al., 1999; Mosse, 1997). Similarly, they suggest that the design principles are biased

¹ Studies that did not arrive at conclusions specific to a particular country were not included in this map.

towards formal rules and strategies, and abstract too much from the complexity of the environment and the social context of the actors (Blaikie, 2006; Cleaver, 1999, 2000; Steins, 1999; Steins and Edwards, 1999).

Another set of critiques (Berkes, 2005; Bruns, 2005; Pomeroy et al., 1998; Weinsten, 2000; Young, 2002) questioned the applicability of the principles to cases larger than those from which Ostrom (1990) derived them. Similarly, Agrawal (2002), Johnson (1997), Steins et al (2000), and Steins and Edwards (1999) argue that analyses of community-based CPR management have generally tended to under-emphasize external factors, treating them as a black-box. Berkes (2002, 2005) agrees, and stresses the need to understand cross-scale linkages and the potential for *co-management* between local and national governance regimes.

The following table offers a simple summary of the data based on one of the fields coded, which recorded each study’s overall evaluation of the design principles. The final row gives the average score per sector, based on a numerical ranking between 1 (strongly negative evaluation of the design principles) and 5 (highly supportive evaluation of the principles). Studies on irrigation are most supportive of the principles, while studies in the “other” category are the least. However, the differences between each sector are not large. The average across sectors is 4, or “moderately supportive.”

Table 2: Evaluation by Sector and Overall Evaluation

	Forest	Pastoral	Irrigation	Fishery	Multiple	Other	Total
Highly supportive (5)	5	2	12	10	10	3	42
Moderately supportive (4)	13	3	9	5	6	5	41
Neutral (3)	5	1	7	3	1	3	20
Moderately negative (2)	1	1	0	2	2	0	6
Strongly negative (1)	1	0	0	1	0	1	3
Total	25	7	28	21	19	12	112
Average	3.8	3.86	4.18	4.00	4.26	3.75	4.01

7.2. RESULTS BY DESIGN PRINCIPLE

In addition to these general results, we coded support or critiques of individual design principles within each case. The primary method of doing this was to code whether or not each principle was present or absent in a case, and whether or not its presence or absence was correlated with a success or failure in CPR management for that case, based on whatever metric for this the author employed. This analysis was conducted at the level of a case, rather than a study, as multiple cases within a particular study sometimes had different results for particular principles. There are two possible ways for a case to be supportive of a principle: first, by being present in a successful case, and second by being absent in an unsuccessful case. Likewise, a principle can be unsupported by being present in an unsuccessful case, or absent in a successful case. These data are presented in table 3. Note that principles 1, 2, and 4 are subdivided into separate components, which will be discussed in their respective sections. What follows in this section is a discussion of each of the design principles as they are treated in the studies. The examples

included are not meant to be exhaustive, but representative of the kinds of statements made by, and issues brought up by, the authors of the studies.

Table 3: Results by principle

Principle	1A	1B	2A	2B	3	4A	4B	5	6	7	8
Supportive	72	51	51	45	53	54	49	40	44	46	34
Unsupportive	13	16	5	3	9	10	5	8	2	17	16

7.2.1. PRINCIPLE 1 – Well-Defined Boundaries

This principle, as Agrawal (2002) notes, originally stipulated two separate conditions: first, that there are boundaries around a community of users, and second, that there are boundaries around the resource this communities uses. These components were coded separately, with community boundaries coded as principle 1A and resource boundaries coded as 1B. Both are well supported by the empirical literature analyzed, but are also the most frequent targets of (primarily theoretical) criticisms.

The main complaint concerning this principle is that it is too rigid, and that in many systems fuzzier social or geographic boundaries are needed to facilitate more flexible, ad hoc arrangements between participants with some level of mutual understanding (Blaikie, 2006; Cleaver 1999, 2000; Turner, 1999; Haller and Helbling, 2006; Mandodo, 2001). The following quote from Cleaver (1999, 603) is representative: “A concentration on boundaries highlights the need in development for clear administrative arrangements, more to do with the delivery of goods and facilities than a reflection of any social arrangement”. Likewise, Turner (1999, 649) states: “practitioners tend to expect the ‘community’ to be an immutable group of people jointly managing a delimited common resource through uncontested, clearly defined rules of access. Agropastoral reality strongly diverges from this model. Rules of access are often politically malleable and spatial boundaries fluid.” Thus community boundaries are seen as an external bureaucratic imposition.

Another critique argues that boundaries should be sufficiently fluid to adjust to resource mobility and seasonal availability (Haller and Helbling 2006). In rejecting Ostrom’s ostensibly more strict definition, Ruddle (1997) suggests that this principle requires “boundary closure.”

Critics who favor a looser conception of geographic boundaries are quick to note, however, that they do not mean that the resource should be open access and boundary free, but merely that boundaries should be more fluid than they believe Ostrom (1990) conceptualizes them (e.g., Turner 1999). Other authors argue that a looser understanding of user group boundaries also may be necessary. Haller and Helbling (2006) observe that tenure systems concerning access to various CPRs and membership in associated groups can change with seasonal fluctuations in the mobility and accessibility of a resource. Niamir-Fuller (2001) describes how the boundaries between different groups of pastoralists in Sahelian Africa are fuzzy, containing overlapping, jointly managed zones and areas to which access is negotiated ad hoc among interested parties.

7.2.2. PRINCIPLE 2 -- Congruence Between Appropriation and Provision Rules and Local Conditions

Ostrom's (1990, 92) second design principle refers to the "congruence between appropriation and provision rules and local conditions." Like the first principle, this principle stipulates two separate conditions, that Agrawal (2002) again recognizes. The first condition is that a congruence exists between appropriation and provision rules. The second condition is that both appropriation and provision rules conform in some way to local conditions, where Ostrom emphasizes local conditions of the resource, such as its spatial and temporal heterogeneity.

7.2.2.1. *Appropriation and Provision Rules*

Congruence between appropriation and provision rules is confirmed in the literature as a congruence between costs incurred by users and the benefits they receive via their participation in collective action. Pomeroy et al. (1998, 4) echo Ostrom's finding, stating that "individuals have an expectation that the benefits to be derived from participation in and compliance with community-based management will exceed the costs of investments in such activities. Similarly, Klooster (2000) compared seven communities that have been successful in managing logging activities and found that a common feature in these communities is their efforts to reinvest benefits back in the community by paying for work in reforestation and providing public goods such as road maintenance. Adams et al. (1997) find that in an indigenous irrigation system in Kenya, participants who contribute more labor are generally thought of more highly when decisions of water allocation are made.

Additionally, some scholars have pointed to the importance that users perceive that the match between appropriation and provision rules as fair. In community forests in the Indian district of Amora, rules specifying how much fodder each user can withdraw from the resource are matched to users' contributions. Agrawal (1994) observed that, while there was variability in the ratios of appropriation and contribution levels across sustainable communities, the participants involved considered these ratios to be equitable. Similarly, in the Andean irrigation system of Huayncotas, all farmers have to contribute to maintenance of the system, but they have to do it in proportion to the land each of them irrigates. Trawick (2001) found that the fact that appropriation and provision rules are applied to everybody while varying with each farmer's needs reinforced a commonly shared sense of equity and facilitates the sustainability of the management system. The acequia irrigation communities of New Mexico use a "peon system" that proportionally matches labor inputs with benefits. Rodriguez (2007) also notes the importance the acequias place on equity and shared sacrifice in times of shortage.

7.2.2.2. *Congruence to Local Conditions*

The literature predominately reflected Ostrom's emphasis on the resource condition when it analyzed a congruence between rules and local conditions. In the Kafue floodplains of Zambia, the Ila community developed a herding system adapted to seasonal changes in the floodplains as well as to the timing of agricultural activities. During the wet season, cattle stayed close to the villages, within herding camps that each family in the community could use. During the dry season, access to the richer floodplain zones, was restricted to families that paid a fee. In this way, the Ila

community had reached an equilibrium between the changing carrying capacity of the ecosystem and the needs of the community (Haller 2004). Gupta and Tiwari (2002) refer to the case of irrigation communities in Ladakh, India, where the rules for the distribution of water are most strictly enforced during late spring. Late spring is a critical moment, when water from the melting of glaciers is not yet available but the agricultural cycle is starting. During this time pre-sowing irrigation is strictly regulated. Only when glacier water becomes available for cropping are allocation rules less evident.

Some scholars have also identified local conditions as involving the predominant culture, ideology, customs, and livelihood strategies of a community (Guatam and Shivakoti 2005; Morrow and Hull 1996; Young 2002). Other authors have highlighted the negative consequences that result when externally imposed rules do not match local customs and livelihood strategies. Gautam and Shivakoty (2005) observed that forest conditions in Dhulikhel, India, allowed active management of the resource; however, rules designed by the municipality imposed a total ban on the harvest of forest products. These rules did not match the resource conditions, and contradicted customary rules of villagers, which had traditionally allowed activities such as the collection of leaf litter for animals' bedding and fallen twigs for firewood. In turn, the effectiveness of monitoring and compliance with rules was very low, and the forest came under high extraction pressure.

Morrow and Hull (1996) studied a donor-initiated forestry cooperative in the Palcazu valley of Peru and came to similar conclusions. The cooperative rules were not congruent with local customs and norms in several ways. For example, the groups belonging to the cooperative did not match historical communities, and the hierarchical, profit-motivated rules of the cooperative were against local norms about gift-giving and reciprocity. As a result of this and other factors, the cooperative collapsed. Thus, Morrow and Hull suggest that it is important that "Appropriation and provision rules are congruent with the resource and with the cultural norms and social and economic patterns of interaction of the appropriators" (1643).

7.2.3. PRINCIPLE 3 – Collective-Choice Arrangements

Ostrom's third principle is "most individuals affected by the operational rules can participate and modifying the operational rules" (Ostrom 1990, 90). Pomeroy et al. (1998, 4) phrase the principle as "most individuals affected by the management arrangements are included in the group that makes and can change the arrangements", and argue that this principle is strongly correlated with successful management of common pool resources

Furthermore, a lack of a functional collective choice arrangement is frequently correlated with CPR management failure. For example, in discussing the management of communal grazing land in rural Tanzania, Nilsson (2001) describes a failure case. Residents of Endabeg Village were members of the village assembly, but the assembly did not have effective control over land management issues. Other venues for collective management, though they existed, were weak. Concerning the case of failed community-based forest management in the state of Maharashtra, India, Rucha (2008, 18) says of the supposed collective choice venue: "There are very few who attend meetings and disinterested men and most of the women do not participate in rule-making".

Generally, critics of this principle do not disagree that it would be efficacious if properly implemented. Rather, they are concerned with situations wherein the principle exists in form but in practice has been co-opted or undermined (Cooke and Kothari 2001, Skolsvold 2008), or the participation specified by the principle exists but is inequitable, perhaps along gender lines (Tucker 1999). Haller (2004) and Kathuria and Sterner (2006) indicate that the contribution of participatory collective choice arenas to the robustness of CPR systems may be mediated by the heterogeneity of participants and particularly by their relative bargaining power. Sandstrom and Widmark (2007) illustrate this concern by describing the inequities in bargaining that resulted from an unequal power distribution among those who used areas of northern Sweden for forestry versus reindeer herding. Most individuals with a stake in the resource may be able to participate in the collective choices, but if some individuals are more powerful than others, this inequity may be perpetuated in the decisions made. Similarly, Sekher (2001) argues that if there is a leader of the collective choice forum, he or she must be representative of and accountable to appropriators; this advice is in the spirit of Ostrom's articulation of the third principle.

7.2.4. PRINCIPLE 4 – Monitoring

This principle, like 1 and 2, was treated as two for this analysis. 4A stipulates the presence of monitors, while 4B stipulate the condition that these monitors are members of the community or otherwise accountable to those members. Monitoring makes those who do not comply with rules visible to the community, which facilitates the effectiveness of rule enforcement mechanisms and informs strategic behavior of those who comply with rules. In many cases, monitoring is a natural by-product of using the commons and the costs of monitoring are low. Trawick (2001) analyzed a community irrigation system in Peru where the farmers developed a contiguous pattern for irrigating one section of the system at a time before moving to other sections. This system was effective at conserving water, but it also made irrigation a public affair and facilitated effective decentralized monitoring.

In other cases, monitors constitute a separate position that are compensated. Agrawal and Yadama (1997) studied the strength of forest *panchayats* institutions in Kumaon Himalaya, India, and found that monitors hired by communities not only promoted better forest conditions, but were important to represent the commitment of the *panchayat* and the village community to protect their forests. Monitors may not perform satisfactorily if they do not directly benefit from improved resource conditions. In those cases, it is important that monitors are accountable to those who most depend on the resource. Gautam and Shivakoti (2005) studied two forests located in the Middle Hills of Nepal and found that the ability of local users to oversee monitor's performance makes a difference in resource conditions. In Jylachitti forest, local users hired two people for regular monitoring and paid them through contributions of each member household. In Dhulkhel forest, guards were also hired, but they were paid by local authorities. While Jylachitti local users were engaged in supervising guards' performance to control timber extraction levels, this was not the case in Dhulkhel, where over-extraction was becoming an issue at the end of the study.

In addition to monitoring of appropriator behavior, scholars have pointed to the importance of environmental monitoring, i.e. the continual provision of information about the CPR conditions. With environmental information, community members can elaborate and adapt appropriation and

provision rules that help to guarantee the sustainability of the resource (Johnson and Nelson, 2004; López Gunn and Hernandez Mora, 2001; McKean, 1992; Raju et al., 1993; Sandstrom, 2007; Young, 2002). López Gunn and Hernández Mora studied three ground water irrigation systems and pointed up that the irrigation community whose members were engaged in environmental monitoring enjoyed higher levels of information sharing and collective preparedness than those communities that depended on the information provided by multiple external authorities. Wilson (2002) has expanded on the importance of environmental monitoring by pointing to the need of information about CPR in complex ecological systems, and the design of the monitoring systems at multiple scales.

Finally, as some scholars have noticed, monitoring is different from the enforcement of rules, which can happen through the application of sanctions or other mechanisms (Kim, 2004; Lopez Gunn, 200; Pomeory, 1998). In a study of more than 60 irrigation communities in Korea, Kim (2004) reports that the existence of rules that are easily enforceable was correlated with higher levels of water supply predictability and efficiency.

7.2.5. PRINCIPLE 5 – Graduated Sanctions

McKean (1992) describes the usage by three Japanese villages on the northern slope of Mount Fuji of commons that provide grasses, game, and wood. Two villages assign members to rotating patrols for violation of rules governing resource use and the third grants all citizens the right to make “citizen’s arrests” upon seeing a violation. An initial violation merits confiscation of the contraband and a fine, and “penalties escalated with the severity of the violation and the arrogance of unremorseful offenders, and on rare occasions culminated in exclusion or banishment . . .” (256). McKean infers that these sanctioning systems are quite effective, noting that significant violations of rules are extremely rare and that she could only identify two examples of major violations in the last century. Describing the successful collective governance system established by fishermen over lobster berths at Cribbon’s Point, Nova Scotia, Chisholm (2002) observes the violations of locally established territory-based rules are infrequent and are generally resolved with a simple warning to the offender. Punishment for violation of rules can escalate to use of physical violence, but Chisholm observes that such punishments are quite rare.

Schweik et al. (1997) explore the institutional contexts of dramatic reductions in forest cover observed in two sub-basins in the southern Siwalik Hills of Nepal between 1978 to 1992. Forest users in both sub-basin communities ostensibly faced graduated sanctions that linked the gravity of a forest-use violation and the history of a user’s prior violations to the severity of the penalty. However, interviews with villagers in both communities and review of relevant records revealed that sanctioning, the provenance of guards employed by the local district forest office rather than appropriators, was implemented intermittently at best. Guards could be bribed fairly easily and there was little evidence that they patrolled upland, less-accessible areas of the sub-basins. Official records showed minimal collection of fines and no violations penalized at the most serious penalty level. Ghate and Nagendra (2005) describe the failure of efficacious forest management in two communities in Maharashtra, India, relative to successful management in a third. Although graduated sanctions existed in form in all three communities, only the successful community had a strictly implemented graduated penalty structure, wherein the penalty amounts were determined via voting by an executive committee whose members were community

members and the sanctions were enforced by officials of the forest management association. Clearly, existence of graduated sanctioning rules *in form* is not enough; the spirit of the fifth principle, and not just the letter, needs to be implemented.

In several cases, successful CPR management was achieved despite a lack of graduated sanctions. Sarker (2001) argues that in the Japanese irrigation systems he studies, sanctions do not exist and are unnecessary due to strong community norms that dissuade violations. Tucker (1999) describes forest management in a rural Honduran community and finds that while graduated sanctions exist in form, in practice authorities have been unwilling to levy sanctions except in the case of a few egregious violations. Although the community has thus far managed the forest successfully despite this lenience, Tucker argues that market penetration and agricultural changes have the potential to make this system less tenable as time goes on.

7.2.6. PRINCIPLE 6 – Conflict Resolution Mechanisms

This principle is extremely well supported by the empirical literature. In describing the successful forest management activities of a Honduran community, for example, Tucker (1999, 12) notes the involvement in conflict resolution of a municipal council, municipal constable, and a civil judge, all elected by community members. These entities or individuals “perform mediation and arbitration for disputes...the council usually suggests a resolution to which both parties publicly agree. In presenting a decision, the mayor and council members provide an explanation based upon locally accepted principles, precedents from previous cases, and municipal laws.”

When conflict resolution mechanisms are not available or not easily accessible, successful CPR management appears more difficult. Theesfeld (2005) describes generally unsuccessful attempts to manage irrigation in post-socialist Bulgaria, and notes the unavailability of conflict resolution mechanisms as a barrier to effective management. Skolsvold (2008) describes how, in an unsuccessful irrigation initiative in rural Malawi, disagreements between two groups of appropriators effectively shut down the irrigation operation for days. Rout (2006) describes conflicts among different user groups of Chilika Lake in Orissa, India. In the 1990s, non-fishermen began to compete with traditional cultural fishing communities over access and resource use, leading to major conflict and unrest and, in 1999, violence that resulted in the shooting of four community members. Although the national government subsequently stepped in to mediate, the author observes that this mechanism for conflict resolution has not yet proven itself viable.

7.2.7. PRINCIPLE 7 – Minimum Recognition of Rights

While somewhat less so than the other principles, the empirical evidence was supportive of principle 7. As McKean (1992, 275) states: “the co-owners of the commons have to be a self-conscious and self-governing community with the political independence to manage de commons as it sees fit even with the context of an otherwise authoritarian polity”. She illustrates this point with the case of long lasting common land management systems in Japan, which have been given full recognition of their legitimacy both by democratic and authoritarian regimes since the Medieval Age. Padge et al. (2006) reach a similar conclusion. In their meta-analysis of

69 case studies of forest management worldwide, they found that local authority was associated with tenure security, a key element for sustainable forest management.

There also exists significant evidence in the case studies that violations of this principle have been associated with less successful community-based resource management regimes. Sometimes NGOs and government agencies that intend to help local groups actually ignore the importance of local users. Community-based resource management projects developed in Sudano-Sahelian West Africa in the 1990s, which involved the devolution of resource management authority to rural communities through the assistance of NGOs, failed in part by not recognizing local knowledge and existing institutions at the early stages of the devolution process (Turner 1999). Haller and Helbling (2006) reviewed the history of floodplain wetlands management in Mali, Cameroon, Tanzania, Zambia and Botswana, finding that nationalization of CPR management led to de facto open access regimes due to the erosion of local institutions and the incapacity of the states to enforce laws on the field.

Some scholars have pointed out cases wherein the state recognized the legitimacy of local users, but not to the degree the authors believed was sufficient for successful local management. In Campbell et al. (2001), the lack of successful CPR management cases in the communal areas of Zimbabwe was partially due to national policies and legislation that were did not enable management at the local level. Similarly, Meenakshisundaram (2001) describes how a lack of legal recognition prevented Village Forest Committees in India to have representation in other governance bodies and suggested that this gap could be filled through the assistance of the local political authorities.

7.2.8. PRINCIPLE 8 – Nested Enterprises

Scholars focusing on pastoral and irrigation systems have stressed the importance of nesting smaller common-property systems in larger and still larger ones, given the high probability of their having cross-scale physical relationships and the need to share resources (Lane and Scoones 1993; Niamir-Fuller 1998). Marshall (2005, 2008) has described the challenge of applying this principle in designing more effective community-based environmental governance systems in Australia while agreeing with its importance. He stresses that the “principle of subsidiarity”, or defaulting to local management jurisdictions unless exceptions are required, is an important basis for institutional nesting and organizing a division of labor across levels of social organization (see also Gatzweiler 2006).

One additional clarification that should be made regarding this principles is that the nesting may occur either between user groups and larger governmental jurisdictions, or between user groups themselves. Many traditional irrigation systems, for example, have been found to contain multiple levels of organization that mirror the branching properties of an irrigation system (Coward 1977). This is somewhat different than a co-management arrangement between user groups and a larger governmental body, which has been described in its own extensive literature (Berkes 2002; Berkes 1998 and Folke).

8. Conclusions

8.1. Design Principles and the Blueprint Critique

Three things remain to be accomplished with respect to this analysis. First, we need to address the most common critique of the design principles that appeared in the literature. This critique argues that the principles are part of a “blueprint” approach to policy formulation and implementation. Blaikie (2006), for example, argues that design principles for community-based natural resource management are a Trojan horse for imposing a set of management blueprints that ignore local knowledge and context, and falsely presume the superiority of scientific generality over that context. Secondly, a reformulation of the principles themselves in light of the meta analysis will be presented. Finally, we briefly present our conclusions for the paper.

To understand the blueprint charge we need to consider what is actually meant by “blueprint”. A blueprint is a set of reasonably detailed, often visualized, instructions for the construction of a physical or, in this case, social system. Blueprints also connote a degree of formality, and a critique from a subset of the literature is that constructing institutional theories such as the design principles at least implicitly favors formalized rules or informal or more ad hoc arrangements (Cleaver 1999).

What is at issue are two closely related potential problems. First, there is a theoretical concern with over-reaching into a level of precision across heterogeneous cases that may not be warranted. Criticizing an institutional prescription as being a blueprint approach is actually stating that it operates at too high a level of precision, not recognizing small-scale heterogeneity between the instances to which it might be applied. It is then the combination of a certain degree of precision along with a claim to some degree of generalizability across cases that strikes some as presumptuous or pernicious.

Ostrom’s design principles indeed are more precise than many popular policy analyses, which operate in accordance to the basic market-state dichotomy (Weimer and Veining 2005). They are, however, less precise than a theory regarding particular rules. Each design principles stipulates a range of conditions that could satisfy it, rather than a particular rule, which might stipulate the exact number of members a community ought to have, or what the exact monetary penalty for leaving that group might be. *This* would be probably too precise, as Ostrom recognized when she scaled-up her analysis to the level of an institutional design principle. She did this to obtain a degree of generalizable accuracy across a range of cases. Like all policy analysts, Ostrom faced this basic trade-off between precision and generalizability (Cox 2008). As policy analysts we need to recognize this, and the costs and benefits of operating at different levels of precision and generalizability. If we forsake either one entirely, we abandon our involvement in a scientific community struggling to find important patterns across a range of situations where humans interact with their environment.

The related issue is the ability of the resource users themselves to adapt to their changing local circumstances. If an excessively precise theory is thought to be generalizable and is actually be applied to a case on the ground, this level of precision may inhibit the actors from adapting to the particularities of their situation. The principle for community and resource boundaries in

particular seems to have evoked images of excessive local level constraints. However, we would argue here that user groups need a balance between order and flexibility in a way analogous to the balance scholars seek between precision and generalizability.

The field of complexity has addressed this balance at great length, and it has been popularized by the concept of the *edge of chaos*, which recognizes that “systems that are too simple are static and those that are too active are chaotic, and thus it is only in the edge between these two behaviors where a system can undertake productive activity” (Miller and Page 2007, 129). Similarly from a network perspective, Carroll and Burton (2000, 320) state that “most adaptive natural systems exist at a poised state between too much and too little connection, often referred to as the ‘edge of chaos’. Systems that are only sparsely connected are too static, while those that are overly connected are inherently unstable.” Likewise, communities of resource users, as complex adaptive social systems, must find a balance that maintains their identity as a group, while adapting to inevitable changes in their social and biophysical environment. We would argue that the design principles, and the user boundary requirement specifically, are consistent with achieving this balance, and do not advocate for excessive order or maladaptive stasis.

8.2. Reformulation of the Design Principles

The principles we reformulate are 1, 2, 4, and 7. Principles 3, 5, 6, and 8 we propose to remain as they are. The first two principles were each divided into two components for the sake of this analysis. We found this division to be reflective of the literature and to be useful in our meta-analysis, and we believe that this division is ultimately appropriate in reformulating the principles. Thus, we recommend dividing each of these into their component parts. Regarding principle 4 (monitoring), we slightly modify the principle to make explicit the two types of monitoring that appeared in the literature: social and environmental. For principle 7 (external recognition of rights to organize), we believe that a generalization is warranted from external political organizations to both internal and external organizations that may threaten the ability of the users to design and modify their own institutional arrangements. This discussion leads us to the following reformulation of the design principles²:

Principle 1a. User Boundaries: Clear boundaries between legitimate users and non-users are present.

Principle 1b. Resource Boundaries: Clear boundaries that separate the appropriated common-pool resource from other environmental phenomena are present.

Principle 2a. Congruence with local conditions: Appropriation and provision rules are congruent with local social and environmental conditions.

Principle 2b. Appropriation and Provision: Appropriation rules are congruent to provision rules; the distribution of costs is proportional to the distribution of benefits.

Principle 3. Collective-choice arrangements: Most individuals affected by the operational rules can participate in modifying the operational rules.*

Principle 4: Monitors who are accountable to the users monitor the condition of the resource as well as the appropriation and provision levels of the users.

Principle 5. Graduated Sanctions: Appropriators who violate operational rules are likely to be

² * indicates identical language to that from Ostrom (1990, 90)

assessed graduated sanctions (depending on the seriousness and the context of the offense) by other appropriators, by officials accountable to these appropriators, or both*

Principle 6. Conflict-Resolution Mechanisms: Appropriators and their officials have rapid access to low-cost local arenas to resolve conflicts among appropriators or between appropriators and officials.*

Principle 7. Minimal recognition of rights to organize: “The rights of appropriators to devise their own institutions are not challenged by any other authorities, internal or external, that have the ability to undermine the institutions” (Morrow and Hull 1996, 1643).

Principle 8. Nested enterprise: Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises*

8.3. Conclusion

This paper has attempted to synthesize a surprisingly large number of studies that have been undertaken regarding the design principles that Ostrom originally formulated. We believe that the principles have been well-supported empirically, which is shown most clearly in Table 3. The most trenchant critiques were theoretical, and not empirical. There was not one study we found that was moderately or strongly negative on the design principles based on empirical evidence of their presence or absence in a particular case or set of cases.

This does not mean that they are complete, or that other factors such as the size of user groups or different types of heterogeneity within them, or the type of governmental regime they operate within, are not important. These factors likely have interaction effects with local institutional arrangements that in part determine the efficacy of these arrangements. Similarly, the efficacy of one principle may be contingent on the presence or absence of another. Ostrom (2005, 267) herself notes this:

“When the users of a resource design their own rules (design principle 3) that are enforced by local users or accountable to them (design principle 4) using graduated sanctions (design principle 5) that clearly define who has rights to withdraw from a well-defined resource (design principle 1) and that effectively assign costs proportionate to benefits (design principle 2), collective action and monitoring problems tend to be solved in a reinforcing manner”.

As such, a probabilistic, rather than a deterministic, interpretation of the design principles is warranted. Likewise, we remain uncertain as to whether or not the principles may apply to systems at a variety of scales. Ultimately, however, the design principles are robust to empirical testing via our meta-analysis of 112 studies. In sum, future research will need to further disentangle these components and their interaction effects both within and across multiple environmental and social scales.

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