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Levels, Scales, Linkages, and Other 'Multiples' affecting Natural Resources

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Abstract: Natural resources are affected by several types of "multiples". Some analysts emphasize linkages across multiple scales while others focus on interactions across multi-level institutions or multiple fields of action. Different ways of conceptualizing the "multiples" associated with socio-ecological systems are important because they influence what analysts see – and do *not* see. Given the complexity of these systems, a narrow frame of analysis increases the risk that critical issues will be overlooked. Framing analysis in terms of "multi-dimensional linkages" – including multiple scales, multi-level institutions, and other types of multiples – reduces that risk by directing attention to a broader range of factors, processes, and interactions.

Keywords: Scale, multi-level governance, institutional analysis

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1. Introduction

Socio-ecological systems involve several types of "multiples." Natural systems consist of numerous components, which interact in a variety of biological, chemical, social, and physical processes. Multiple human actors and organizations within various fields of action take decisions and actions at multiple scales that interact with bio-physical resources and processes. Actions are in turn

channeled through and influenced by institutions at many levels, including many organizations that are themselves designed as multi-level institutions. Scholars and practitioners characterize socio-ecological systems as complex largely because of the multiplicity of factors, actors, interactions, and processes within them. Failure to recognize important components and processes limits understanding of these systems and is an important source of uncertainty about the responses to management practices and policies. The first goal of analysis is often simply to identify the key elements of the system and the relationships among them. These goals are advanced by taking a broad perspective, at least as a point of departure.

Perhaps inevitably, despite agreement on the need to analyze various "multiples" affecting natural resources, there is no consensus as to how best to do so. This article considers two concepts that are widely used in research on socio-ecological systems: "multi-level institutions" and "multi-scale linkages". Neither concept represents a full theoretical framework. Neither is linked exclusively to a single framework. Nonetheless, these terms represent alternative frames for analysis, where a frame refers to a particular conceptualization of something that has multiple dimensions and can be viewed from several different perspectives (Chong and Druckman 2007). The choice of frame influences the types of "multiples" that are seen and given priority as well as how relationships among those "multiples" are understood. Does either conceptualization of the "multiples" in socio-ecological systems have an advantage in terms of either breadth of perspective or analytical leverage?

To answer this question, the article first discusses the elements that come into focus in the analysis of "multi-level institutions" and "multi-scale linkages". Second, recognizing that both concepts are decomposable, I then consider the implications of a shift in the frame of analysis from institutions to linkages and from scales to levels in terms of both inclusiveness and analytical leverage. The breadth of perspective increases with a shift from institutions to linkages, but a lack of conceptual clarity limits the analytical value of conceptualizing the multiples associated with socio-ecological systems in terms of either multiple levels or multiple scales. "Multi-dimensional linkages" combines elements of these concepts and goes beyond them to achieve a more comprehensive overview of the multiples inherent in socio-ecological systems, thereby decreasing the risk of overlooking important interactions. In conclusion, I argue in favor of "multi-dimensional linkages" as an initial frame of analysis in order to gain a broader perspective and reduce the likelihood that important interactions will be excluded. This broader perspective should be combined with further conceptual development to draw out distinctions among the variety of dimensions affecting socio-ecological systems.

2. Two common frames

The relationships among the multiple actors, social and natural conditions, and processes associated with natural resource systems are often analyzed in terms

of "multi-level institutions" or "multi-scale linkages". To some extent, the choice of terminology reflects differences in disciplinary background and the separate development of research traditions with overlapping theoretical and substantive concerns (Armitage 2008). Research on the commons blurs disciplinary boundaries and many analysts use both terms, sometimes treating them as synonymous. Even if "multi-level institutions" and "multi-scale linkages" refer to related phenomena, they are not truly inter-changeable terms. Each directs attention to somewhat different factors, processes, and relationships.

2.1. Multi-level institutions

Multi-level institutions are a central concern in policy-oriented research on decentralization, special-purpose organizations, urban politics, federalism, the European Union, and other international organizations. The analysis of multi-level institutions tends to focus on institutional design and the consequences of particular institutional arrangements for policy. This framing directs attention to the agency of policy elites, institutional arrangements, and alternative policy goals.

There are several strands of institutionalism that define institutions in somewhat different ways (Hall and Taylor 1996; Immergut 1998). North (1990) argued forcefully that institutions or rules should be distinguished from organizations as collective actors to enable analysis of interactions between the two. Many scholars, especially those working in the rational choice tradition, agree (e.g., Ostrom 2005). This distinction, however, can be difficult to apply since organizations involve durable sets of rules as well as actors. Thus, many policy analysts and scholars consider organizations to be institutions (Pierson 2004).[1] Despite broad agreement that informal institutions play an important role, studies of multi-level institutions typically examine formal institutions, especially formal jurisdictions.

Multi-level institutions refer to two types of institutional arrangements: (1) those based on territorial, usually multi-purpose jurisdictions and (2) those based on functional areas, usually with overlapping territories (Hooghe and Marks 2003). The territorial model of multi-level institutions involves a hierarchy of nested jurisdictions. Within a given territorially defined level in an organizational hierarchy, multiple jurisdictions exist but do not overlap (e.g., many municipalities or provinces). Moving within the hierarchy, each lower-level jurisdiction fits neatly within a single jurisdiction at the next territorial level (e.g., each municipality or province falls within a single country). In essence, in a territorial model of multi-level institutions, movement between levels means movement between

[1] This perspective is associated with historical institutionalism. For sociological (Hall and Taylor 1995) or organizational institutionalism (Immergut 1998), institutions encompass systems of symbols and moral codes as well as rules and organizations. Sociological or organizational institutionalism focuses more on dynamics within organizations and does not use the multi-level institution framing.

jurisdictions with smaller or larger territorial extent. Even if interactions across tiers of multi-purpose government receive more attention, the territorial model of multi-level institutions could be applied to other multi-purpose organizations with nested territorially based levels (e.g., large non-governmental organizations with local chapters, political parties, religious organizations).

In the functional model of multi-level institutions, movement across levels has a territorial dimension but cannot be reduced to changes in territorial extent. Jurisdictions are defined in terms of a specific task or field of action, such as the management of schools, the provision of public transportation, or the management of a river basin. The jurisdictions do have a defined territory, but are non-exclusive in terms of spatial extent and membership. For example, functional organizations such as school boards, public transportation networks, and river basin management committees have overlapping territories and membership. Functionally defined organizations include government agencies, voluntary organizations such as a neighborhood watch committee, and government sponsored organizations such as non-governmental user group committees and public-private stakeholder forums. Even if their functions are distinct, functionally defined jurisdictions coexist with each other and with multi-purpose jurisdictions. In the functional model of multi-level institutions, interactions across levels refer to interactions across jurisdictions that overlap partially in terms of territory, membership, or function.

Multiple levels of institutions can promote learning, adaptation, and coordination (Eaton and Connerley 2010; Hooghe and Marks 2003). Multi-level institutions may enhance accountability by more clearly defining relations between specific institutions and groups of stakeholders. Issues that might be overlooked in a multi-purpose organization (or a higher level of government) can receive more attention in an agency with a narrower agenda (or a more local level of government). Community-based organizations composed of stakeholders in a particular forest, for example, may focus more on issues of forest management than larger-scale and multi-purpose governments, whether municipal or national. Functionally defined organizations might be better positioned to address externalities than either territorial or multi-purpose organizations. Nesting local or specialized institutions within more encompassing organizations can help balance attentiveness to localized concerns or conditions with the management of externalities and inequalities.

Multi-level institutions involve trade-offs. Common problems include (1) poor alignment of institutional boundaries with community or functional boundaries, (2) coordination problems associated with institutional complexity, and (3) blurred lines of accountability. "Community" is a multi-dimensional concept (Agrawal and Gibson 1999). In the context of multi-level institutions, it may refer to the people residing within the jurisdiction of a territorially defined general-purpose government, a community of interest as recognized by a functionally defined organization, a self-defined community of interest, or a self-defined community based on identification (e.g., shared past, common culture, similar

structural position). To some extent, institutions define community by recognizing particular bases of identification (Skelcher 2005; Ribot et al. 2008). However they are defined, institutional and community boundaries frequently do not coincide with the boundaries of natural systems such as forests, watersheds, or the global climate. Analysts often blame policy failures on poorly aligned institutions and argue that multi-level institutional designs based on functional boundaries could facilitate the management of these systems.

Improved alignment between institutions and policy functions implies a proliferation of institutions, which in turn gives rise to coordination problems. There are two types of coordination problems across institutions. First, coordination problems arise from the need for agreement across institutions. As the number of institutions that act as veto points increases, so does the difficulty of reaching agreement (Tsebelis 1995). Particularly for natural resource systems that cross international boundaries, it is common for multiple institutions with veto authority to participate in policy-making. In such situations, the risk of a joint decision trap is very real (Scharpf 1988). A joint decision trap refers to the production of systematically suboptimal outcomes that can occur when two levels of government exist and policy decisions require agreement at both levels. Such situations arise when an improvement for the group as a whole involves costs for some participants because those who stand to lose from the change can block it. Second, coordination problems arise when institutions at various levels fail to *acknowledge* each other, so that actions taken within the context of one institution competes with actions and decisions taken within the context of other institutions. Such situations may reflect a problem of institutional design, resulting in a lack of "nesting" (Ostrom 1990, 2005). Alternatively, inattention or blind spots may produce poor coordination. Organizations concerned with watersheds or agriculture, for example, may not pay attention to the initiatives of organizations concerned with climate change or conservation, and yet decisions within these different fields of action interact. In yet other situations, overt competition exists between organizations, as when state bureaus compete for resources (Moe 1990; Poteete 2009) or traditional authorities challenge agents of the modern state (Lund 2006). These organizations are very much aware of each other. They do not acknowledge each other in the sense that they deny one another's authority; each claims that its own authority has priority over that of its rivals.

Multi-level institutions also present challenges for accountability. Accountability requires a clearly defined constituency, clear criteria for assessing accountability to that constituency, and mechanisms for enforcing accountability (Grant and Keohane 2005; compare Ackerman 2004). Institutional membership or constituencies can be defined in different ways, and the choice of criteria for membership or representation has implications for accountability (Ribot et al. 2008). By definition, functionally defined institutions such as user groups will not be accountable to those who have no recognized standing, including people who may be affected by their decisions and actions (Manor 2004). Multi-level

institutions also undermine accountability by making it more difficult to discern who is responsible for what (Papadopoulus 2003). Who should be held responsible for outcomes that reflect the decisions and actions of two or more organizations or the interactions of several policies? Mechanisms for accountability include audits, provisions for consultation, and elections. Many of these mechanisms are, on their own, relatively blunt tools. Even in combination, they cannot fully compensate for the lack of transparency associated with the involvement of many institutions. Relations of dependency, uneven access to information, and sporadic attention to public affairs further limit their effectiveness. When any level in a multi-level system lacks effective mechanisms of accountability, accountability is weakened within the system as a whole (Bardhan 2002).

Policy analysts recognize these challenges and typically respond by proposing strategies for improving institutional design (e.g., Ackerman 2004; Haas 2004). Framing analysis in terms of multi-level institutions thus directs attention to the interaction of institutions with social, economic, and ecological conditions. The institutions are understood as products of human agency. Institutions may be sticky, but are subject to change. This conceptualization treats social, economic, and ecological conditions as background conditions that influence and are influenced by the development and operation of institutions. Despite this recognition of interaction between the various factors and processes, most research on multi-level institutions trains attention on human action over relatively short periods of time.[2]

2.2. Multi-scale linkages

Multi-scale linkages feature prominently in both ecological research and analyses of socio-ecological processes. This concept directs attention to relationships and processes that cross seemingly distinct spheres of activity or organization. The central concerns include the multi-directional influence of organization and activity at different scales, the social production of scales, power relations within and across scales, how agency interacts with structural dynamics, and, more generally, sources of systemic reproduction and dynamism.

There is considerable debate around the conceptualization of scale. Especially in policy circles and interdisciplinary work, scale is often a synonym for "level" defined in terms of spatial extent[3]. When used in this manner, interactions across scales refer to interactions that span the local, regional, national, and international or global. The conflation of scale with spatial extent or size, however, has been sharply critiqued (Gibson et al. 2000; Neumann 2009). Geographers and

[2] The co-existence of processes with variable time horizons has important implications for institutional analysis, as discussed by Pierson (2004, esp. Ch. 3) and Wilson (2002).

[3] Young (2002), for example, operationalizes "the concept of level of social organization as a means of describing scale delimited in spatial terms" (296). He has since moved away from this conceptualization of scale (e.g., Cash et al. 2006).

the natural sciences understand scale in terms of the grain or resolution of observation. Gibson et al. (2000, p. 218), for example, define scale as "the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon." "Level" refers to the units on the scale. Even when referring to a single dimension (e.g., distance or temperature), there may be a choice of scales (e.g., miles v. kilometers and Celius v. Fahrenheit). Cash et al. (2006) identify a number of scales that are relevant for socio-ecological systems, including spatial, temporal, jurisdictional, management, and knowledge. When scale is understood as the dimension used in observations, movement along a single scale – perhaps from an ecologically defined patch to a landscape on a spatial scale – involves a change in levels, not a change in scale. By implication, local-national or local-global interactions do not involve multiple scales but multiple levels on a single scale. Cross-scale interactions play out in multiple dimensions of analysis, such as spatial, jurisdictional, and temporal.

Many political ecologists and geographers go further, insisting that scale is a product of social and ecological processes (Neumann 2009). Given the existence of multiple relevant scales, social actors must choose which scale or scales are relevant in a given situation. From this perspective, scaling refers to the socio-ecological processes that influence the choice of a particular scale (or set of scales) and re-scaling refers to changes in the resolution or dimension of observation and analysis. Lebel et al. (2006), for example, discuss how the Thai government rescaled water development as an international regional issue rather than an issue of local development.

Multiple scales are linked in several respects. First, many processes are scale dependent in the sense that the relationships observed at one scale may not hold at other scales of analysis (Gibson et al. 2000; Ostrom and Nagendra 2006; Rudel 2008). Cross-national studies suggested that population growth contributed to deforestation, for example, but that pattern does not hold up in comparisons of localities or regions within countries. Likewise, observations over a few years might link changes in resource conditions to patterns of resource extraction while missing the influence of long-term changes in bio-physical conditions or climate. Patterns of human behavior, the mobilization of knowledge, and responses to institutional arrangements, for example, may be scale-dependent (Cash et al. 2006). Consequently, the choice of scale influences what is seen in analysis. Second, interactions between processes at different scales are pervasive if unpredictable.[4] Policy processes that unfold within a jurisdictional scale interact with ecological and socio-economic processes within a spatial scale. All processes also play out on a temporal scale. Even when processes have independent drivers, they coexist and often interact. Interactions across scales alter processes within scales. These unavoidable multi-scale linkages are important sources of dynamism. Third,

[4] See Cash et al. (2006) for a graphical depiction of several climate-related processes operate on spatial and temporal scales.

while the social production of scale may generate a self-reinforcing dynamic that contributes to stability, there are often powerful incentives to push for rescaling and it occurs regularly. In the Thai example mentioned above, for example, rescaling water development as a regional issue had several benefits for the government; it deflected the opposition of domestic environmentalists, appealed to Thais who would benefit from less expensive imported water, and shifted the costs of water development projects to neighboring countries (Lebel et al. 2005).

Linkages across multiple scales are sources of complexity, resilience, and dynamism. Because they are sources of complexity and dynamism, multi-scale linkages represent obstacles to understanding and reduce predictability. As such, multi-scale linkages make policy-making more challenging. The cognitive challenge of discerning cause-effect relations varies, but can be substantial (Poteete and Welch 2004; Wilson 2002). Cash et al. (2006) highlight three further challenges: mismatch across scales, ignorance of multi-scale linkages, and the plurality of scales. A mismatch of scales occurs when scales affected by human action (e.g., ecological, economic) do not correspond with scales that guide human action (e.g., jurisdictional, temporal, management). Some policy makers respond to complexity by attempting either to limit interactions across scales or, through the social construction of scale, impose a monolithic scale. Such strategies often fail miserably (e.g., Scott 1998). When policy-making (or scientific activity) is organized around sectors (or disciplines), ignorance of interactions across sectors becomes more likely. Ignorance also arises from the cognitive challenge of grappling with complex systems. A dominant policy paradigm creates additional blind spots by ignoring the inherent plurality of scales.

The challenges identified by Cash et al. (2006) parallel the concerns about the poor alignment of institutional boundaries with functional tasks and poor coordination across multi-level institutions. Where the multi-level institutions framing then turns to questions of accountability, research conceptualized in terms of multi-scale linkages asks questions about power relations. Power – the ability to get others to do what they might not do otherwise – may be derived from diverse sources: political or administrative position, material wealth, structural position, and control over information and procedures, among others (Poteete and Ribot 2011).[5] Power dynamics motivate and influence the social construction of scale (Lebel et al. 2005; Neumann 2009) as well as efforts to create cross-scale linkages and the ability to sustain those linkages (Adger et al. 2006). Rescaling issues alters what is seen and what is overlooked. Establishing new linkages across scales defines new audiences or constituencies. These changes generate shifts in power dynamics as they reshape alliances, reveal new options, and alter the flow of resources. Both rescaling and connecting scales require some initial

[5] Accountability is a type of power relation. Accountability implies that one actor *should* act on behalf of another, but might not; assessments of accountability evaluate the extent to which such action can be ensured. Power relations do not rule out action on behalf of others but emphasize the prevalence of competing interests and related struggles.

power. Powerful actors have access to a variety of resources through which they can influence the social construction – or reconstruction – of scale. They also have greater ability to identify and establish potentially beneficial cross-scale linkages (Adger et al. 2006).

The multi-scale linkage framing directs attention to interactions among a variety of distinct yet linked processes over some period of time. The approach adopts a fairly macro perspective. Recognition of the social construction of scale and power relations highlights the agency of collectivities such as interest groups, industries, or agencies. Analyses vary considerably in the emphasis given to social versus economic versus ecological processes, but they always consider interactions across at least two distinct sets of processes.

3. What happens when we change frames?

Multi-scale linkages and multi-level institutions train attention on partially overlapping sets of concerns. These overlaps are most prominent in policy-oriented analyses of multi-scale linkages, which often recommend multi-level institutions as a strategy for managing these linkages. And yet, these concepts differ in important respects. To draw out how these differences influence analysis, this section decomposes these concepts and considers the implications of (1) an emphasis on institutions or linkages and (2) the organization of observations and analysis around *scales* versus *levels*.

3.1. What happens with the shift from institutions to linkages?

Framing analysis with reference to *institutions* directs attention to formal institutions, actors, and relations of authority. The emphasis is on institutional structure and institutional design. This approach offers valuable insight into the sorts of institutional layering characteristic of socio-ecological systems. Since institutional arrangements interact with socio-economic and ecological processes, it is also important to consider other factors. Framing analysis in terms of *linkages* offers a broader perspective. It encompasses various types of relationships, including but not limited to those involving institutions.

Institutional analysis understands institutions as both products of intentional action and constraints on choice.[6] Thus, analysis involves identification of the various actors involved in institutional design or with an interest in attempting to influence institutional design. Two sets of actors are central: those directly involved in institutional design and those affected by a particular set of institutional arrangements. Collective actors and policy elites – organizations such as government agencies and bureaus, NGOs, interest groups, and international organizations – feature prominently in institutional design. Groups affected by

[6] Many but not all scholars who recognize limitations in the knowledge, cognitive capacities, and foresight of actors assume that they act intentionally. The concern here is not with assumptions about rationality but the emphasis given to agency.

institutions are generally conceptualized in terms of social categories such as gender, ethnicity, caste, class, and livelihood strategy (e.g., farmers, timber producers). The prominence of agency encourages a focus on either comparative statics (e.g., before and after an institutional change) or periods of institutional design.

Institutional analysis links actors and institutions through interests that influence participation in institutional design, incentives created by institutions, and relations of authority among actors and institutions. Relations of authority take diverse forms. Debates center on the trade-offs of alternative relations of authority such as nesting institutions, hierarchy or its absence, and exclusive versus overlapping jurisdictions. For better or for worse, non-exclusive jurisdictions with no clear hierarchy exist in many situations. Research on multi-level institutions directs attention to the possibilities these sorts of arrangements present for both forum- or venue-shopping, in which actors direct conflicts and claims to the institutions expected to yield the most favorable outcomes (Baumgartner and Jones 1991; Berry 1993), and shopping forums, in which authorities associated with different institutions compete to address the concerns of disputants or claimants (Lund 2006; von Benda Beckmann 1981).

Linkages refer to relationships, connections, and interactions. Analysis concerned with *linkages* considers relationships among institutions and organizations, but may also include relationships between other types of factors (e.g., actors, structures) and various processes. The boundary on the types of relationships under consideration depends on whether and how "linkages" is combined with another concept. Institutional linkages, for example, narrow attention to relationships among institutions. Multi-scale linkages include a greater variety of relationships that affect socio-ecological systems. The next section addresses the relative merits of framing analysis in terms of scales.

Intentional efforts to establish linkages have gained attention as sources of dynamism and shifts in power relations (Adger et al. 2006). But agency is not the only source of linkages. Some processes are inherently linked. Biological and physical processes within an ecosystem, for example, cannot be fully separated. Nor is it possible to isolate social, economic, and political processes. Other processes that are generally independent may intersect in some situations. When such processes do intersect, the linkage may alter one or more of the processes.[7]

The greatest overlap with the concerns of institutional analysis occurs in research on intentionally created institutional linkages. Even here, however, reframing analysis in terms of linkages rather than institutions implies a broader understanding of power relations and may encourage greater attention to the unfolding of processes over a longer period of time. Institutional analysis encourages an equation of power relations with relations of authority, defined by institutions, especially formal institutions.[8] In refocusing on linkages rather than

[7] Pierson (2004) discusses some examples.

[8] As noted before, although the importance of informal institutions is generally recognized in theory, many applications focus on formal institutions.

institutions, non-institutional sources of power may become visible. Similarly, because institutional design occurs in an episodic manner, institutional analysis encourages a focus on relatively narrow periods of time. Linkages – even institutional linkages – develop and operate over time. Although a study of the establishment of new linkages might focus on a shorter period, the linkage framing encourages attention to longer periods of time.

A shift from institutions to linkages broadens the frame of analysis. As such, it reduces the likelihood that important aspects of socio-ecological systems will be overlooked. Much depends, however, on the type of linkages under consideration.

3.2. Multiple levels or multiple scales?

What happens when analysis is framed in terms of multiple scales rather than multiple levels? Is one framing more encompassing than the other? Does either offer an edge in terms of analytic leverage? Are there complementarities between these concepts? Responses to these questions depend in part on how each concept is defined, given that both concepts have multiple meanings. However they are defined, neither concept emerges as clearly superior.

Depending on how "scale" and "level" are conceptualized, multi-scale linkages may subsume multi-level institutions, multi-level may subsume multiple scales, or the concepts may refer to very similar phenomena. Multiple scales subsume multiple levels if each scale involves multiple levels, and analysis is concerned with movement and linkages across levels as well as across scales. When institutions, defined as territorial jurisdictions, represent just one of several scales, specific institutions might be placed at different levels in terms of the jurisdictional hierarchy. Multi-level institutions organized along functional lines might be associated with alternative scales.

The literature on multi-level institutions explicitly encompasses institutions defined based on territory or function, those that are organized hierarchically and those that have overlapping authority. It might be appropriate to equate territory with level and function with scale, but the institutional patchwork cannot be reduced to matters of level and scale. Even if the scholarship on multi-level institutions distinguishes among levels related to territory, function, and scope of jurisdiction, it obscures the differences between relationships across different scales and those involving organizations with varying scope. Nor does it fully capture concerns with interactions across different fields of action – say climate change mitigation and the development of non-timber forest products (NTFP) as a poverty alleviation strategy, or environmental policy and electoral considerations.

The conceptualization of scale as a dimension of observation or analysis is clear enough when thinking of the choice between metric and English scales of spatial measurement or interactions between spatial and temporal scales. The concept is not always very clear, however, when applied in social scientific and interdisciplinary research. Confusion arises in part from a lack of conceptual

consensus. Despite repeated critiques (Gibson et al. 2000; Neumann 2009), the conflation of level and scale remains widespread, as can be seen in a quick review of titles and abstracts of recent articles in interdisciplinary journals. The equation of "scale" with "extent" follows every-day use and is likely to persist, especially in interdisciplinary outlets, even as more precise conceptualizations gain wider adoption in some disciplines and interdisciplinary research traditions.

Even in research traditions that conceptualize scale as a dimension of observation or analysis, there is considerable variation in the precision with which the concept is applied. Use of the same terms (e.g., local, global) to refer to levels on different scales (e.g., spatial, jurisdictional) creates confusion. Likewise, reference to changes in levels on a single scale as "rescaling" obscures the distinction between levels and scales. In some studies, all linkages are conceptualized as involving multiple scales. Indeed, definition of scale as "the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon" (Gibson et al. 2000, p. 218) invites application of the concept to a wide variety of phenomena. Many scholars bemoan the problem of conceptual stretching: If every linkage is a multiple scale linkage, the concept ceases to distinguish among different types of phenomena and becomes less valuable analytically. Some have gone so far as to advocate the total avoidance of "scale" as an analytical concept, but most accept that the term is too firmly entrenched to uproot.[9] The same criticisms apply to the conceptualization of "level".

The ambiguities in conceptualization of multiple levels and multiple scales limit their analytical value. Neither framing offers a clear analytical advantage. Nor does either fully subsume the other.

4. Let's recognize multi-dimensional linkages

At a minimum, the lack of conceptual consensus underlines yet again the importance of defining terms clearly for any particular analysis. Framing analysis in terms of linkages encourages a broader perspective, but what kinds of linkages should be examined to understand socio-ecological systems? Both multiple scales and multiple levels are important, but neither concept captures all important linkages. The limitation of these two common frames indicate the need for a more radical conceptual redevelopment. I argue for the recognition of multi-dimensional linkages, combined with the development of a more extensive conceptual menu to distinguish among the various dimensions that characterize and influence socio-ecological systems.

Definitions establish conceptual boundaries. Precise definitions increase analytical value by distinguishing clearly between phenomena that are and are not covered by a concept. Stretching concepts reduces their analytical value by reducing the set of phenomena that fall outside the conceptual boundary (Sartori 1991). Concept stretching may seem to be inherent in any effort to broaden the frame

[9] See review of this debate in Neumann (2009).

of analysis, as advocated in this article. It is not. The frame of analysis should be broad enough to include the essential features of phenomenon of interest – socio-ecological systems, in this case. But breadth of perspective does not preclude the development of precise concepts to distinguish among those features. Indeed, broadening the frame of analysis to recognize multiple dimensions can contribute to conceptual refinement.

Recognition of multi-dimensional linkages acknowledges the importance of interactions between levels and scales, but also that levels and scales are not the only important features of these relationships. The next step is to develop concepts to distinguish among other important dimensions of these linkages. Lebel et al. (2005) take a step in this direction by distinguishing three dimensions of spatial relationships: scale, position, and place. They argue persuasively that important spatial dynamics related to position (e.g., upstream versus downstream, side of a river or boundary) or place (e.g., particular localities) cannot be reduced to matters of scale. Indeed, characterization of these interactions as cross-scale linkages would be misleading.

The previous section suggests that scale is often conceptualized in a manner that conflates the resolution of observation with the choice of metric of dimension of observation. Arguably, discontent over concept stretching reflects differences in the weight given to two aspects of its underlying meaning: the *resolution* of observation and the *framing* of observation. Distinguishing between resolution of observation and choice of metric for observation would increase analytical leverage. Conceptualization of scale in terms of resolution corresponds with long-established practices in a variety of fields, including those like cartography and photography that are at least superficially familiar to scholars regardless of their own disciplinary background. While people do choose scales for measurement or observation, conceptualizing these sorts of choices as rescaling depends on a less intuitive understanding of scale. As such, it is less accessible to an interdisciplinary audience. Conceptualizing the choice of metric as the choice of frame and distinguishing it from the choice of scale as resolution may encourage cross-fertilization with the well-established interdisciplinary literature on framing and framing effects (Chong and Druckman 2007). After all, the explanatory role attributed to the choice of metric for observation hinges on its framing effects.[10] As discussed above, for example, the rescaling of water development projects in Thailand prevented the mobilization of political mobilization by framing the issue in a manner that obscured environmental costs.

A further distinction might be made between both scale and frame of observation and the field and scope of action. These distinctions are inspired by functionally defined multi-level institutions. Where the term "function" suggests something innate and immutable, "field of action" alludes to social definition of these

[10] Framing theory characterizes this sort of rescaling as a change in the "frame of communication": a deliberate effort at persuasion by emphasizing some aspects of a situation or choice and downplaying others (Chong and Druckman 2007: 106 ff.).

functions. Socially constructed fields of action vary in scope, where scope refers to how narrowly or broadly a field of action is defined (e.g., management of invasive species versus agriculture, forestry or water resources versus the environment). At first glance, issues of framing would seem to subsume fields of action. In fact, the two concepts refer to distinct if related dimensions. The difference comes to the fore when we consider linkages between different fields of action (e.g., range and wildlife management) that occur even in the absence of any effort to link them through reframing. Strategies for range management, such as the erection of disease control fences or the promotion of capital-intensive ranching, reduces both the land available for wildlife and the possibilities for wildlife migration. The promotion of wildlife, especially efforts to protect predators and mega-fauna, increases the risk of predation and other forms of wildlife damage (e.g., trampled fences or buildings) and reduces the prospects for livestock production. These interactions occur even if nobody draws attention to them, perhaps by reframing these management strategies in terms of land use or rural development. The array of recognized fields of action can be expected to influence possibilities for reframing. This possibility, however, can only be explored if fields of action and framing effects are recognized as distinct dimensions. The possible distinctions presented in this article are far from exhaustive. Indeed, reflecting my background as a social scientist, they focus on social linkages.

Concepts matter. They frame analysis, influencing both the breadth of perspective and the interpretation of what is seen. Complex dynamic systems such as socio-ecological systems present an analytical challenge precisely because they involve many elements, interaction effects, and non-linear processes. A broad perspective, at least as a point of departure, decreases the risk of overlooking important elements and interactions (Armitage 2008). This article has evaluated how two concepts widely adopted in interdisciplinary research concerned with the "multiples" characteristic of socio-ecological systems – multi-level institutions and multiple scale linkages – influence the types of "multiples" included in the analysis. Each term has advantages, but also important limitations. I have argued that framing the analysis of socio-ecological systems in terms of multi-dimensional linkages offers a broader perspective and is less likely to overlook important elements, relationships, or processes. A broader framing will be most effective if combined with conceptual refinements to distinguish among the various dimensions of linkage that characterize socio-ecological systems.

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