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Research, part of a Special Feature on Scale and Governance

Governance, Scale and the Environment: The Importance of Recognizing Knowledge Claims in Transdisciplinary Arenas

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ABSTRACT. Any present day approach of the world's most pressing environmental problems involves both scale and governance issues. After all, current local events might have long-term global consequences (the scale issue) and solving complex environmental problems requires policy makers to think and govern beyond generally used time-space scales (the governance issue). To an increasing extent, the various scientists in these fields have used concepts like social-ecological systems, hierarchies, scales and levels to understand and explain the "complex cross-scale dynamics" of issues like climate change. A large part of this work manifests a realist paradigm: the scales and levels, either in ecological processes or in governance systems, are considered as "real". However, various scholars question this position and claim that scales and levels are continuously (re)constructed in the interfaces of science, society, politics and nature. Some of these critics even prefer to adopt a non-scalar approach, doing away with notions such as hierarchy, scale and level. Here we take another route, however. We try to overcome the realist-constructionist dualism by advocating a dialogue between them on the basis of exchanging and reflecting on different knowledge claims in transdisciplinary arenas. We describe two important developments, one in the ecological scaling literature and the other in the governance literature, which we consider to provide a basis for such a dialogue. We will argue that scale issues, governance practices as well as their mutual interdependencies should be considered as human constructs, although dialectically related to nature's materiality, and therefore as contested processes, requiring intensive and continuous dialogue and cooperation among natural scientists, social scientists, policy makers and citizens alike. They also require critical reflection on scientists' roles and on academic practices in general. Acknowledging knowledge claims provides a common ground and point of departure for such cooperation, something we think is not yet sufficiently happening, but which is essential in addressing today's environmental problems.

Key Words: *environmental governance; knowledge claims; scale, science-policy interface; transdisciplinarity*

INTRODUCTION

Today, it is increasingly commonplace to speak of environmental problems and the management of social-ecological systems (SESs) as complex and necessarily adaptive. This is for a reason: environmental issues such as loss of biodiversity, climate change, air pollution or water shortages are multifaceted. Consensus has grown that governing ecological problems is about coping with cross-scale and cross-level dynamics (Cash et al. 2006). This means a different type of management at one level, such as the spatial scale, may bring about unforeseen changes at another level or scale. To understand these dynamics, the systems paradigm and its notions of embedded hierarchies of scales and levels have prevailed in significant parts of the literature, including the disciplines with which we have so far mostly been engaging, which are mainly landscape ecology, policy analysis and public administration. Also, types of reasoning that are scale- and level aware have brought about important insights. For example, climate change is considered a typical global problem that needs to be studied at the global level of the spatial scale, while coping with it requires diplomacy at the intergovernmental level at the jurisdictional scale. Another example is biodiversity governance, which is considered a

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global challenge that simultaneously requires taking the different specificities across scales and levels into account (Soberon and Sarukhan 2009). However, these notions of scales, levels and governance across scales and levels are not uncontested. There are significant paradigmatic differences that could frustrate an integrated approach. We will explore recent shifts in emphasis in bodies of literature about governance and scale and consider whether these shifts can be interpreted as precursors of a wider acknowledgement of the presence of different knowledge claims. This may then become the basis for future collaboration in transdisciplinary arenas.

In the literature on the governance of social-ecological systems, the 2009 Nobel laureated work of Elinor Ostrom is a prominent example of scale and level-aware thinking. Ostrom argues that environmental governance nowadays involves many parties and needs to cut across scales and levels in order to avoid overly simplistic “one-size-fits-all” recommendations (Ostrom 2009). According to Ostrom:

> *A core challenge in diagnosing why some SESs are sustainable whereas others collapse is the identification and analysis of relationships among multiple levels of these complex systems at different spatial and temporal scales (Ostrom 2009:420).*

In order to analyze outcomes achieved in SESs, Ostrom proposes a multilevel, nested framework consisting of four subsystems, namely, resource systems, resource units, governance systems and users, as well as multiple second-level variables (Ostrom 2009). Similarly, other authors have argued that a “systematic approach” is needed “that facilitates objective institutional analyses across space and time” Ekstrom and Young 2009:16). The development of such frameworks and approaches has indeed brought various disciplines together around commonly defined resource management questions. The meaningfulness of these studies derives partly from the idea that hierarchies, scales and levels are “real” entities. In this line of thought, the questions raised are mostly about the scales and levels at which environmental issues need to be analyzed and/or solved. However, the ways in which the scales and levels have been constructed remain unquestioned. Therefore other authors question this realist position.

They have criticized the aforementioned representational conceptualization of levels and scales, as if these representations mirrored reality. Instead they emphasize how scales are part of the socio-political processes, including science, in which they are constructed, reproduced or altered over time (Brenner 2001, Bulkeley 2005, Lebel et al. 2005). These differences of viewpoint could easily become unbridgeable, when realists consider scales strictly as objective truths, or, reversely, when constructionists emphasize that they are mere “figments of the mind”. An alternative is to move away from a scalar perspective altogether (Marston et al. 2005, see Jones 2009 for an overview). Some geographers argue for a relational approach that is based on concepts such as flows, process and fluidity, rather than scales and levels. These criticisms challenge the notions of hierarchy, scale, and level that are underlying a significant part of the work on cross-scale dynamics in social-ecological systems.

Such a move towards non-scalar approaches could easily estrange the valuable work on social-ecological systems to which we have just referred. Also, it would perhaps not be particularly helpful to bring the different viewpoints together. Rather, we would like to move beyond such polarization and seek to find a way to address the governance and scaling theme in the face of the mentioned paradigmatic differences. We do so in the spirit of recent efforts by some political geographers (Bulkeley 2005, see also Sayre 2005) and of “critical realism” (Archer 1995, Sayer 2000, Buizer 2008, Archer 2010).

How can we acknowledge that there is no one coherent uncontested knowledge base covering an ultimate set of scales that can be matched with policy making at the appropriate levels? How can we acknowledge that the choice of scales and the knowledge claims supporting these choices are themselves contestable and that there is something like a “politics of scale”? We will do so by means of the concept of “knowledge claims” (Rydin 2007a, 2007b, 2008, Rydin et al. 2007). We will argue along constructionist lines that there is no one reliable source of knowledge; actors with different knowledge claims will try to leave their mark on how issues are analyzed and addressed. This view resonates with the literature in the field of Science and Technology Studies and the Sociology of Knowledge. Authors in this field have emphasized that knowledge is co-produced in the interfaces of science, society, politics, and nature (Gibbons 2000, Nowotny et al. 2003, Jasanoff 2004, Turnhout et al. 2007).

However, the question is whether there is sufficient ground for such a reconciliatory move. We will reflect on the shifts of emphasis that we have recently seen in the two bodies of literature on governance and scale. Although it can be argued that any thinking in terms of shifts is itself an expression of the realist paradigm when the shift is interpreted as a binary feature, we recognize shifts as contestable developments towards new foci. We consider these new foci as potential contributors to the development of a collaborative space in which knowledge claims are acknowledged and can be contested. To illustrate our argument we will describe how analysts of scale and scaling in the field of ecology have predominantly addressed scaling issues, and how they have witnessed a shift in their thinking and practices. Similarly, we will describe how policy analysts have looked at governance in the past and in the present time and how they have identified various shifts in the development of governance. Although not exhaustive, this will present a picture of how, within these knowledge domains, the mounting environmental problems at the level of landscapes have been understood and explained. The last section will discuss how we think that the acknowledgement of knowledge claims is likely to facilitate the creation of a "science-society-policy" interface that takes these developments in the scaling and governance literature into account and that is also open to different types of knowledge.

SCALE AND SCALING

The scale issue: an introduction

In the ecological sciences, scale and scaling have predominantly not been considered as social constructs, but as real entities. As such, scales and scaling as determining factors behind many environmental problems have become prominent issues in literature (Verburg et al. 2006, Wu and Li 2006, Kok et al. 2007). Scale theorists argue that current environmental problems manifest themselves at multiple scales and that, in order to deal accurately with them, action should reckon with these scales. The multitude of scale-sensitive issues, such as climate change, pollution, and ecological processes; the sheer complexity of the issues; and the potentially large number of scales that can and sometimes should be considered have spawned an impressive body of literature (see, e.g., Gibson et al. 2000, Van der Sluijs et al. 2005, Biggs et al. 2007).

Hierarchy Theory: the initial way of regarding scales

Unambiguous definitions of scale and scaling are lacking. Scale has often been defined as the spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon (Gibson et al. 2000), or simply: the "measuring rule". Scaling can consequently be regarded as the translation of information across scales (see Wu and Li 2006). It is important to distinguish levels from scales. The term, level, indicates the units on a scale, or the levels of organization. For example, an ecosystem is a level of organization. This implies that what is being observed strongly depends on how it is being measured. Ecologists agree that levels of organization exist and if properly instrumented by means of scales, they can be correctly recognized. This kind of thinking clearly represents a realist paradigm.

In the environmental sciences, the scaling problem was initially tackled using ecological theories based on the notions of hierarchical systems, scale dynamics and organizational levels. Key publications include the Hierarchy Theory introduced by Allen and Starr (1982) and later elaborated upon by Allen and Hoekstra (1990), and Robert O'Neill (O'Neill 1988, O'Neill and King 1998). Hierarchy Theory roughly posits that a system needs to be described at a minimum of three separate levels. The level of interest (level 0) will itself be a component of a higher level (level +1) with slower dynamics acting over larger distances, forming constraining boundary conditions. Level 0 is divided into constituent components at the next lower level (level -1). Processes operating at this level are generally faster moving and lesser in spatial extent, providing the mechanisms that regulate level 0 behavior (see Easterling and Kok 2003). A common graphical representation of the Hierarchy Theory is provided in Figure 1. The Figure is an archetypical representation of the scale units of space (meters to kilometers) and time (days, months, etc.), and the positioning of levels of organization along these scales (for additional examples, see Holling et al. 2002). The notion that processes tend to be slower when larger spatial extents are included in the analysis is a fundamental scale assumption in most environmental sciences.

The Hierarchy Theory has influenced a range of disciplines, including landscape modelers (Veldkamp and Fresco 1996, Verburg and Veldkamp 2005); scenario developers (Millennium Ecosystem Assessment 2003, Kok et al. 2006); and other spatially oriented disciplines such as erosion studies (Schoorl and Veldkamp 2006). Following realist lines of reasoning, discussions about scale issues in the environmental and landscape ecology sciences mostly revolve around developing scale-sensitive tools and methods to facilitate a better description of existing levels of organization. In this context, it has often been recommended that models needed to become more sophisticated, covering a larger and more nuanced set of scales. Authors have emphasized the need for improved methods for upscaling, such as iterative cross-scale scenario methods, or for links to other models, or for the improvement of data and parameters in models. This resulted in a number of multiscale models, usually including at least three scales (see e.g. the CLUE modeling framework, Verburg et al., 1999). Another good example of a spatially-oriented technique is the widespread use of cellular automata in land use models, such as the DINAMICA model (Almeida et al. 2008) and the SLEUTH model (Dietzel and Clarke 2006).

In spite of the growing attention to scaling issues, theorists felt that the understanding of ecological levels such as watersheds, ecosystems, or agro-ecological zones within the hierarchical system of interlinked levels remained relatively poor. Until recently, they have continued to develop new, scale-sensitive methods and tools that would have to disclose ecological realities more accurately.

Complex systems: a new paradigm

Initial changes

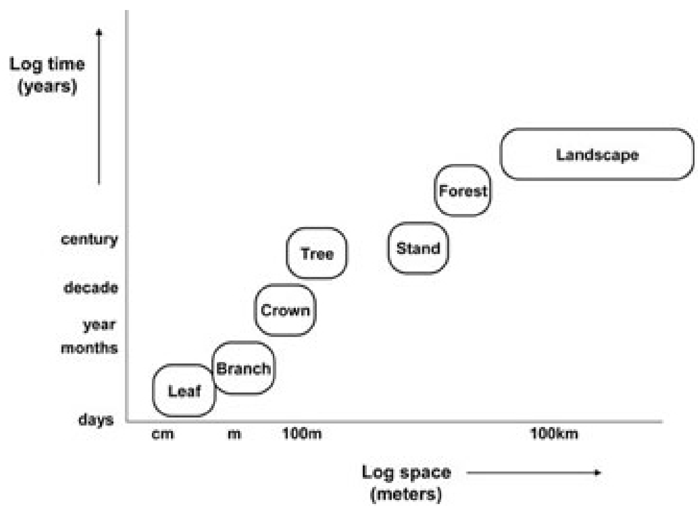
In the meantime, interest in the inclusion of social factors in modeling techniques has increased. An example is the land use modeling community, where about a decade ago literature started to appear on “socializing the pixel and pixelizing the social in land-use and land-cover change” (Geoghegan et al. 1998:51). More recently, the introduction of Agent-Based Models has generated interest into social factors within spatial models. Agent-based models became widespread in the 1990s when computational power increased (Bonabeau 2002), combining biophysical and social information (see Verburg et al. 2006).

Coupling human and biophysical systems: the social-ecological system

Since the early 1990s, various scientific communities using complex systems theory as a basis for research started to influence scale-related research in environmental sciences. Examples are the Global Land Project that spoke of the coupled human–environment system (Turner et al. 2003), and the Resilience Alliance (www.resalliance.org), which addressed social-ecological systems (SES). Over the past decade, SES has become the leading paradigm in linking complex system thinking to the scale issue.

Of crucial importance was the publication of the book *Panarchy* (Gunderson and Holling 2002), in which SES is linked to resilience. Panarchy is one of the heuristics of resilience and assumes that social-ecological systems have structures and functions that cover wide ranges of spatial and temporal scales. Panarchy theory does not differ from Hierarchy Theory in the sense that it assumes that “most structures are not scale invariant, but rather occupy discrete domains in space or time” (Walker et al. 2006:13). However, rather than considering the slow and broad structures at the higher level in a hierarchy as constraining the faster smaller structures at the lower, focal level, all relevant levels are considered as influencing each other in a top-down, hierarchical as well as a bottom-up fashion. These complex dynamics create a system that is far less hierarchical than Hierarchy Theory proposes, hence the emergence of terms like complex cross-scale dynamics. Thinking in terms of complexity of systems was further deepened by the more explicit acknowledgement of a wider variety of scales. A paper by Cash et al. (2006) has been instrumental on this point, by listing not only a spatial and a temporal scale, but also acknowledging jurisdictional, institutional, management, network, and knowledge scales, all with their own distinct levels. Illustrative of this broader view on scale, is a figure similar to Figure 1 in Cash et al. (2006). In contrast with Figure 1, the version in Cash's paper does not show any clear dependency between space and time, thus also abandoning the notion of hierarchies. A multitude of papers have

Fig. 1. Scales and levels of organization



been published recently attempting to further the discussion on SES, resilience, and scale (see Anderies et al. 2006, Folke 2006, and Janssen et al. 2007).

Involving human actors in research

Key to the SES literature is the notion that systems are complex and should be managed by means of adaptive management. Rather than focusing on discovering reality, attention is shifted to developing methods that could facilitate the analysis of complex SESs. Though some have been critical of adaptive management (McLain and Lee 1996), the change of orientation toward the uncertainties connected to complexity has had its effect on the research agenda in various environmental sciences. Importantly, a large number of methods have been employed that aim to either understand actor behavior, or to include stakeholders directly in the scientific process. Examples include multiagent simulation; social network analyses; system dynamic models; and a range of participatory tools and methods. This in turn, gave rise to approaches that attempt to combine various methods in one framework. Atwell et al. (2009), for example, attempted to link resilience theory and technology innovation. Another example of a method that combines methods is the Story-And-Simulation method (Alcamo 2008), which advocates the combined development of narrative storylines and quantitative models, while specifically focusing on participatory methods, including a broad range of stakeholders.

Others, such as Cash et al. (2006), have emphasized that in the study of cross-scale, cross-level dynamics, human characteristics and interests determine the choice of scales. They have coined ignorance, mismatch and plurality as crucial scale challenges. These challenges have since become familiar issues to the Ecology and Society audience. Ignorance refers to a lack of understanding of how a solution to a problem at one scale or level may generate new problems at other levels or at another scale. The plurality challenge refers to the acknowledgement that there is no one scale or level representing the whole system that is best to focus solutions on. These would be best only to a select group, and so, Cash et al. argue, “procedures for scale choice, explanation, and resolution themselves need to be devised in ways that allow for the appropriate representation of scale-related interests" (Cash et al. 2006:8). According to these authors, mismatch or “misfit” occurs when there is a lack of fit between ecological processes and the scope and mechanisms of institutions that are aiming to address ecological problems (for an overview, see Cumming et al. 2006, Folke et al. 2007, and Soberon and Sarukhan 2009). In this respect, Young has recently spoken of these problems in terms of “institutional stress” and “arthritis” and has proposed the timely analysis of institutional alternatives in order to respond adequately when mismatches “cross a threshold or reach a tipping point, generating crises in prevailing institutional arrangements” (Young 2010:384). The idea of fit or misfit implies the possibility of objectively choosing proper scales of institutions that match the scale of an ecological problem. There is a strong concept of hierarchy behind these analyses.

We argue that in spite of this, the perspective that considers systems, hierarchies, scales, and levels in landscape ecology as real, has partly softened. Human perceptions and experiences, which were formerly regarded as irrelevant, have now been taken on board in research agendas. Scales and levels are increasingly being considered as co-produced in processes in which scientists and laypeople work together. In fact, the idea coming from human geography that the nested hierarchy as a key organizing principle is an absurd scale-dependent notion (see Jones 2009), is gaining ground.

Summarizing, giving expression to a realist viewpoint, the Hierarchy Theory has spurred scale research, yielding various scaling techniques and models in the search for appropriate scales to detect relevant levels of organization. The shift to coupling human and biophysical systems, culminated in an important role for research into Social Ecological Systems. Systems came to be considered as naturally complex and socially constructed, and interdisciplinarity became a necessity. Even though various environmental scientists continue to contest the notion that scales are a social construct, the above development has implied a new research paradigm that advocates cross-scale, integrated methods and collaboration with a broad range of stakeholders, and hence accepts that scales and scaling are products of the interaction between scientists and other stakeholders.

GOVERNANCE

One of the buzzwords of the 2000s in political sciences, public administration, political geography, and human ecology alike is the concept of governance (Ostrom 1999, Pierre 2000, Hooghe and Marks 2001, Van Kersbergen and Van Waarden 2004, Folke et al. 2005, Ostrom 2009). To most, it refers to a paradigm shift in the way we govern postmodern societies. Due to processes such as Europeanization, neoliberalization, individualization, and decentralization, traditional command and control steering by the state seems to have become obsolete (Van Tatenhove et al. 2000). Also, governance is a response to the mounting complexity and multilayered nature of environmental problems, which are assumed not to have been adequately addressed by hierarchical government (Bulkeley 2005, Görg 2007). As a consequence, scientists observe and often advocate various new modes of governance: multilevel governance by various administrative levels, network-like arrangements of public and private actors, self-regulation by business organizations, self-organization by neighborhoods, co-management of natural resources by regional governments and local communities, and adaptive governance in social-ecological systems, among others. Some refer to this as a “shift from government to governance”, others to “governance without government” (Van Kersbergen and Van Waarden 2004). Part of this literature addresses the scale issue in particular, notably European public policy and political geography (Brenner 2001, Hooghe 2003, Jessop 2005, Arts et al. 2009). Here topics like the effects of “time-space compression” on government and governance as well as the best organization of public administration across temporal-spatial scales are extensively addressed. Whereas the public administration literature generally takes the administrative levels as pre-given, or real, most scholars from political geography take a more constructionist stance, emphasizing the socio-political construction of territories, borders, temporal-spatial scales, and administrative levels.

There are many definitions of governance (Pierre and Peters 2000). Van Kersbergen and Van Waarden (2004) for instance distinguish between nine forms of governance. Pierre (2000) speaks of a governance continuum, with state-centric approaches at the one end and society-centered perspectives at the other. State-centric approaches focus on the question of how states govern. From this perspective, states do things differently nowadays because they operate in different network formations and use other instruments. However, according to this perspective, the state is still the engine that keeps the motor running. In contrast, society-centered perspectives even consider the possibility of governance without government (Rhodes 1996). In such situations, citizens, their organizations, the business sector, or combinations of these have taken the lead in organizing aspects of social life. Self-governance is the term often used for the latter form of governance (Ostrom 1999, Arts 2002, Ostrom 2009). More and more analysts recognize the relevant roles of both states and non-state actors in governance practices (see for example Lemos and Agrawal 2006).

The term governance may be used in a normative manner, expressing preferred modes for governing societal issues, or it may be used for analytical purposes, to describe how society is actually governed. Thus, terms like corporate governance, good governance, and democratic governance have been used in both descriptive and prescriptive ways to point either at a perceived trend or at a desirable development.

A particular type of governance that has been thriving in research since the 1990s in the policy sciences, public administration, political science, and geography is "multilevel governance" (MLG). Under this and similar banners, the multilevel character (in organizational terms) as well as multiscale character (in time-space terms) of societal problems and potential policy responses have been addressed (Hooghe and Marks 2001, Jessop 2005). While some are primarily focusing on the formal, bureaucratic and juridical dimensions of MLG, for example in the EU (Hooghe and Marks 2001), thus in fact analyzing multilevel government, others focus more on flexible informal issue networks, which are emerging and organizing themselves over multiple scales (Jessop 2005). For an overview of the debate, see Hooghe and Marks, 2003. In addition, some authors focus particularly on MLG in relation to environmental problems and policy (e.g. Fairbrass and Jordan 2004, Görg 2007). Authors dealing with MLG often equate the concept of scaling to the dynamics of MLG itself, hence to organizational multilevel settings. With respect to forest policies for instance, MLG-analysts emphasize that governments at relevant levels should cooperate to tackle the deforestation problem and most of all, learn about and adapt to complex social-ecological circumstances (Armitage 2008). They may, for instance, direct their recommendations at the necessary conditions for effective multilevel coordination with respect to National Forestry Programs (Hogl 2002). In this kind of literature, level and scale are mostly used interchangeably and hardly critically reflected upon.

Nowadays, policy analysts often speak of the "shift from government to governance", suggesting a replacement of one with the other. The shift is mostly explained in terms of changes in the relations between governing levels, which no longer represent a hierarchy. To put it simply, government is depicted as the "old" situation in which institutions of governments, mostly in a hierarchical manner, give direction to what has to be governed at national levels, whereas governance stands for newer, networked forms of collaboration in public-private partnerships or other, less hierarchical arrangements, within or beyond the nation state (Pierre 2000, Van Tatenhove et al. 2000). In addition to the nine forms of governance that Van Kersbergen and Van Waarden (2004) have distinguished, they have identified nine shifts of governance: upward shifts from nation-states to international public institutions; a shift from national to supranational courts; a downward vertical shift from national and international to subnational and regional levels; increased importance of international markets, multinational corporations and agencies that regulate international economic transactions and international standardization bodies; a horizontal shift in the public sector from the executive and the legislative powers to the judiciary; a shift from public to semi-public organization and governance (another horizontal shift); and a shift away from the three branches of government, for instance from parliaments to semi-autonomous state agencies. Furthermore, in economic governance, they observe a shift from coordination through the market towards more coordination through hierarchies and inter-firm networks; a shift from trade associations to large business firms, and last but not least, changes in styles of government, for instance from command-and-control policies towards negotiations in networks.

Obviously, what has often been described as the shift from government to governance is in fact a multisided phenomenon. This presumed shift is misleading because it makes it seem as if government were being replaced by something new and different that we call governance, whereas what is defined as governance today already existed before the term became popular, and the phenomena that were defined as specific traits of government are definitely not wiped out today (Van der Zouwen 2006). It is therefore not surprising that authors differ in opinion on the ways and extent to which governance has indeed replaced government (Arts et al. 2009). Despite these nuances, we nevertheless argue that there are some key features of a shift from government to governance upon which most authors seem to agree. That is, the position of the state is gradually becoming less central at different levels of policy making and steering, and non-governmental stakeholders have started to play more authoritative roles, not least when they form networks with government organizations at different spatial scales.

Another branch of MLG literature, besides public administration, is political geography. This literature differs from the previous one in the sense that spatial-temporal scales are at the core of theorization and analysis. These scales are not considered as pre-given, objective entities. Brenner (2001), for instance, gives an overview of how scale and scaling issues have been debated in political geography. Since the late 1990s, various authors emphasized that geographical scales, in light of globalization and decentralization processes, are not self-evident but socially constructed in highly politicized processes. In this context, geographers speak of the politics of scale (Brenner 2001). Some public administration scholars have always been receptive to such social-constructionist claims and are willing to accept social constructionism nowadays (Kickert et al. 1997). Also, some public administration scholars advocate the need for interdisciplinary work to overcome these dualisms between disciplines.

A recent edition of the Journal of Economic and Social Geography is entirely dedicated to geographical notions of scale and rescaling (Mamadouh et al. 2004), and a somewhat older special issue of the Journal of Urban Affairs (Martin et al. 2003) focuses on three main themes: scale, governance, and representation. In addition to methodological questions of scale (inquiry framed at local scales yields different results than inquiry at larger scales), these special issues argue that scale itself has become an object of inquiry. They emphasize that a simultaneous globalization and localization of the political economy, which has also been labeled “glocalization”, underlines the urgency of such an examination. Earlier, Howitt (1998) also addressed scale as an object of inquiry; he emphasized the relational dimension of scale, which he distinguished from the size and level dimensions. According to Howitt, the relational dimension of scale was undervalued in geography, giving rise to insufficient recognition of the relations between, for instance, global thinking and local action and vice versa and all other involved scales. In a similar line of thought, Jessop (2005, 2006, 2009) recently emphasized that scalar issues are important for all forms of governance. He criticized the term multilevel governance because it still heavily draws on the notion of hierarchy and vertical relations, whereas, according to Jessop, present day politics and policy making are characterized by a plurality of levels, scales, areas and sites (2006) in which relations are horizontal, transversal and vertical at the same time. Moreover, institutions are not monoliths but “tangled” and “interwoven”, meaning that they are highly permeable (Jessop 2006:151). For these reasons, Jessop prefers to use the term “multiscalar meta-governance” (Jessop 2006:151).

Summarizing, the concept of governance, which generally distances itself from traditional top-down government by the state, stems from structural trends such as globalization and individualization as well as from the complexity and layered nature of current environmental issues. As an alternative, new modes of governance, building upon multiscalar, multilevel and multiactor styles of governing, are analyzed and advocated. While doing so, the notions of system, level, and scale are differently conceptualized. Whereas public administration scholars generally tend to take temporal-spatial scales and organizational levels as pre-given, various political geographers emphasize the social-relational origin of these phenomena. This is a position, by the way, which seems more accepted today, also in the science of public administration. Hence, we observe a double shift: from government to governance in thinking about and practicing the coordination of public goods, as well as from realism to constructionism in conceptualizing governance and related scale issues.

SCIENCE–POLICY INTERFACES ON SCALING AND GOVERNANCE

We have articulated two distinct vocabularies: one with regard to scale and one with regard to governance. In each of these domains we noted important shifts in scientific discourses and social practices.

These shifts share a number of similarities:

1. Both acknowledge the growing importance of multilevel or multiscalar interactions in their field of inquiry;

2. Both seem to recognize that the scientific construction of levels and scales themselves needs to be part of the research agenda;

3. Both stress the need for enlarged interdisciplinary work; and

4. Both address the need for increased stakeholder involvement in scaling and governance issues.

The highlighted developments imply that in order to deal with some of the most pressing present-day environmental problems, scale and governance are to be considered as constructed and contested concepts, which need deliberation in discursive arenas in order to form a basis for policy making. This observation resonates with the current Science and Technology (STS) literature, in which knowledge is considered to be co-produced in the interface of science, nature, society, and policy (Gibbons et al. 1994, Gibbons 2000, Jasanoff 2003, Nowotny et al. 2003, Jasanoff 2006, Turnhout et al. 2007). This literature is a response to the classical idea that science produces truths, to be used by politicians in order to underpin and legitimize their decisions, that is, bringing truth to power. Current practice, however, shows a quite different picture, in which scientists play political roles, such as by articulating the research questions for the policy makers, and politicians and other stakeholders often produce relevant knowledge for the policy analyst or policy adviser. Hence knowledge is co-produced in the interface between science and society. The term co-production has been used in different ways. Some have emphasized the process dimension. These analysts have stressed that “knowledgeable publics” should be brought to the front end of knowledge production (Jasanoff 2003:235). Co-production also exhibits substantive dimensions. Some claim that such co-production processes hint at another type of knowledge than the classical scientific one. Nowotny et al. (2003:179) speak of the transition from Mode 1 to Mode 2 knowledge:

> *The old paradigm of scientific discovery (‘Mode 1’) – characterized by the hegemony of theoretical or, at any rate, experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities – was being superseded by a new paradigm of knowledge production (‘Mode 2’), which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities”*.

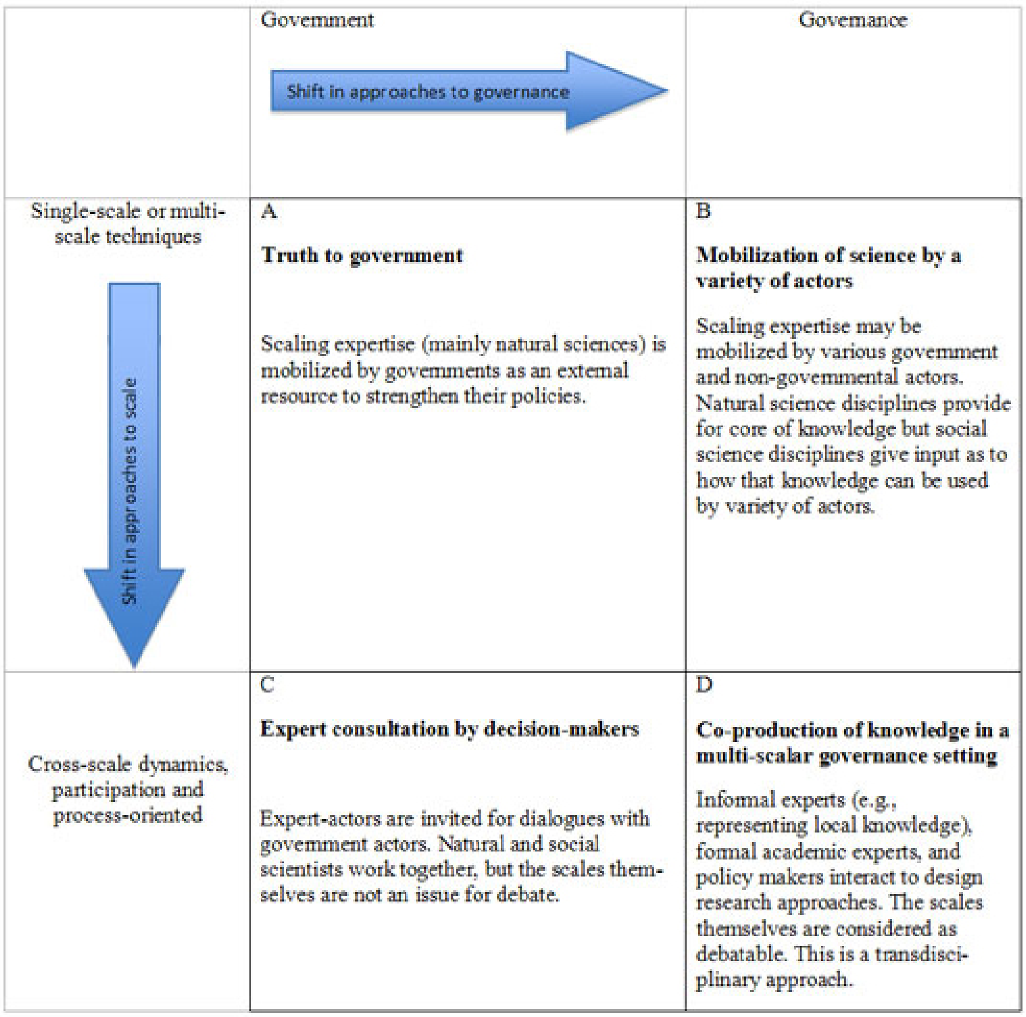
This is also referred to as transdisciplinary science, in the sense that experts from multiple disciplines, together with policy makers, stakeholders and representatives of various publics, produce practice-oriented knowledge to address complex societal problems. The transition from mode 1 to mode 2 knowledge can also be recognized in the matrix in Figure 2.

When the shifts in governance and scaling are confronted in a matrix, four “ideal-type” science-policy interfaces can be recognized (Figure 2). In these four interfaces, different approaches to governance and scaling come together. The matrix consists of three rows and three columns. The first column represents the shift from single scale techniques toward cross-scale dynamics. The first row, in turn, represents the shift from a government toward a governance perspective. Importantly, the arrows and the related cells reflect a shift in attention in the scale and governance literature. Thus, regarding scale, cell A represents a mode of knowledge production that assumes that single scales exist “out there”, whereas cell D represents a mode of knowledge production that challenges how scales are being constructed. The cells represent the way that these two developments relate to each other in terms of knowledge production and policy making, including a transition from mode 1 to mode 2 science. We will now elaborate on the four ideal types of science–policy interfaces.

A: Speaking truth to government

“Speaking truth to government” refers to the classical, ideal, and typical situation in which valid and reliable scientific findings are meant to determine what policy decisions are to be made by state officials. Decision making powers are considered to be concentrated within governmental bodies and clearly distributed among national and international levels. The scientific process remains a black box for policy makers, and scientists are not directly involved in the governmental decision making process itself. Scales and levels are not contested. Outcomes of such research are supposed

Fig. 2. Shifts in the scale and governance literature



to be ready for direct use by governments and especially the central state.

B: Mobilization of science by various actors

"Mobilization of science by various actors" refers to political practices that are to be characterized as governance. Various types of both public and private actors do play active roles in decision making. Coalitions of NGOs, enterprises, or others seek and gain access to scientific data. Social science disciplines are more important in approach B, compared to approach A, in order to analyze, facilitate and improve the use of knowledge and implementation of policy in a multiactor setting. The scales and levels as scientists use them are not contested. This approach can also be referred to as "governance without co-production".

C: Expert consultation by decision makers at various levels of government

In this variant, governments call in experts more actively to discuss policy aims and related research needs. These discussions are not just technical, but include the social aspects of environmental problems, so that the social science disciplines become much more important than in the A variant. Unlike B however, participation is limited to the formal institutions of government and to those who are invited by them. In a normative sense, this approach builds on the idea that a government at any level is still the most appropriate facilitator of processes of change and is capable of judging which expert knowledge is best to bring in. Generally, the problem situation is more complex than in the A variant. Peters and Pierre speak of "intergovernmental political relations in which subnational authorities engage in direct exchange with supranational or global institutions, and vice versa" (Peters and Pierre 2004:75). Levels and scales can be a topic of discussion, but only between the governments and the scientists who have been invited by them.

D: Co-production of knowledge in a multiscalar governance setting

This is the variant in which the scales themselves, underlying the knowledge that is being debated by a variety of actors, are considered as human constructs. Also, the organizational levels that these actors represent are not to be taken for granted. Those included and excluded in the knowledge production process depend on what scales are considered relevant for the environmental problem at hand and vice versa; relevancy of scales is dependent on who is involved. In this interface D, social and natural scientists as well as so-called lay experts have to work closely together to make the process of scale construction and the argumentations behind it transparent. This is also referred to as mode 2 or transdisciplinary science, in the sense that experts from multiple disciplines, together with policy makers, stakeholders, and representatives of the general public, produce practice-oriented knowledge to address complex societal problems (Horlick-Jones and Sime 2004).

The next question is how we could deal with this move towards interface D in the conduct and governance of science itself, especially because it is not an absolute move that completely precludes other conceptions of scale and governance. We will elaborate on the implications of recognizing knowledge claims. What does it mean to recognize knowledge claims in practice, for instance by working in transdisciplinary arenas?

RECOGNIZING KNOWLEDGE CLAIMS IN TRANSDISCIPLINARY ARENAS

This implies that levels and scales are constructed and that they consequently need to be the object of conversation among scientists of various disciplines, policy makers, politicians, citizens, or their representatives. The scales and levels that are considered relevant for the analysis and addressing of environmental problems can then, no longer be imposed on the policy process by "objective" scientists (like in "A"). Rather, it is then acknowledged that a multitude of actors need to be included in a social learning process in order to identify the levels, scales, and governance modes that they find relevant (like in 'D'). These may have a global emphasis for some, for others a local, or a mix. Thus, scales, levels and governance practices now have to become scientifically and socially deliberated phenomena.

Rydin (2007b) describes the transition from mode 1 to mode 2 science as a shift from the "knowledge as object" paradigm, similar to category A, truth to power, towards the "knowledge as embedded in social relations" paradigm, similar to category D. Writing in the context of planning theory, she argues that this shift should have implications for planning practice, but this did not sufficiently happen yet. We observe a similar insufficient translation of the new knowledge as embedded in social relations paradigm into environmental governance practices. For example, Van Bommel (2008) recently related shifts in governance to possible shifts in the role of science and experts in the policy process. On the basis of a Dutch case study on nature conservation policy, she argued that the increase of multiactor governance has not come together with a change in the "cultural assumptions with regard to science and expertise" (Van Bommel 2008:177). Hence, current science-policy practices often seem to reflect a "B" approach ("governance without co-production").

Rydin argues for "a pragmatic approach to knowledge, which focuses on creating arenas for the testing and recognition of knowledge claims within planning processes" (Rydin 2007b:53). This is not much different for environmental governance processes in which cross-level and cross-scale dynamics complicate finding adequate responses to complex and uncertain developments. Here the development of a science-policy-society interface that recognizes and pragmatically deals with knowledge claims is equally important. Like planning, environmental governance and associated theories of scale have witnessed shifts toward a greater involvement of a highly diverse set of “knowledge developing” actors, such as experts and practitioners, policy makers and citizens, professionals and laypersons. Also, with respect to our domain of environmental governance and scale, the various types of knowledge claims that Rydin distinguishes can be recognized. These involve knowledge claims about the current state of the environment, about its predicted state, about the transition from current state to predicted state, about planning processes, about its outcomes, about the ways in which societal processes and environmental governance have interacted to produce new situations, and about preferred future situations.

By addressing knowledge as “claims”, it becomes essential that all of the assumed relationships, such as between management at one scale and level, and consequences at other scales and levels, obtain testable formats (Rydin 2007b). While testing knowledge within a positivist paradigm is interpreted as finding scientific proof for the existence or absence of causal relationships and generalized truths, something quite different is meant here. When different knowledge claims have been acknowledged first, then testing these claims means that the criteria accompanying these claims need to be explicated. These are not just the traditional scientific criteria, but include cultural standards and any other claim that may make the knowledge claim defendable in the eyes of the participant, and hence worthy of recognition. Social and political contexts become relevant and questions of desirability may make part of an argument to support and test a knowledge claim for its relevance. Finding the arguments and the ways to share these with others becomes a major challenge. For scientists this means that they become co-responsible for creating the spaces in which these different knowledge claims and the related criteria and standards for testing them can be expressed. To be successful, they have to start doing so themselves.

Still, an important question is how this claimed constructionist acknowledgment of knowledge claims can incorporate a realist perspective. Or, phrased more fundamentally: how can a constructionist approach possibly incorporate something that is based on the opposite: assumptions about what exists out there in reality? At this point, a comment by Alexander (2008:208) on Rydin’s 2007 article offers some useful insight:

> *The ‘social construction’ model does not recognize any absolute truth-claims - it implies that there’s no single observable reality out there - while ‘engagement with material reality’ must acknowledge that some absolute truth-claims may be valid (), based as they are on a material reality that exists. Resolving this paradox as suggested by the ‘co-constructionist’ theorists of knowledge necessarily implies a societal discourse that deploys and combines various kinds of knowledge, which differ in the foundation of their respective truth-claims and their attitude to material reality”*.

Alexander praises the inclusionary possibility of “co-construction” or “heterogeneous/realist constructivism”, meaning that knowledge is socially constructed and “emerges from an active engagement with material reality” (Alexander 2008:208).

In our view, an approach “D” that we have defined does indeed deploy and combine various kinds of knowledge. So the important next question is: how can the science–policy–society interface be coordinated in such a way so as to facilitate the acknowledgement and testing of different knowledge claims? To start, there is work to do between the sciences, and perhaps that should come first if it does not delay more intensive engagement with society. Scientists from different disciplines seem to discuss the differences between the ontologies and epistemologies that they employ much less rigorously than the commonly and often debated distinction between scientific and lay knowledge (Fischer 2000). Typically, in the context of our own joint endeavor to integrate policy analysis, landscape ecology and public administration for addressing the governance and scale dimensions in environmental issues, we ourselves could only make progress after we had explicated the truth claims that we found generally embedded in our disciplinary backgrounds and in our own positions with regard to these. Hence, in order to produce a “space D”, scientists should explicitly discuss their paradigmatic positions, though in a reflexive way, in order to be open to other positions and critical towards one's own.

Several authors have emphasized that transdisciplinary approaches imply institutional transformations. Rather than creating "bridges" between science and practice presuming a linear relationship between them, they argue for the formation of "spider webs", whereby policy brokers and intermediaries traverse these nets to match scientific information with decision needs (Vogel et al. 2007:360). Vogel et al., referring to other authors, suggest a different design of management processes, such as Cash and Moser (2000), who promote a greater role for boundary organizations that are to "straddle and mediate the divide between science and policy" (Cash and Moser 2000:114). However, the question related to the governance of science continues to be "how to bring knowledgeable publics into the front end of scientific and technological production, a place from which they have historically been strictly excluded" (Jasanoff 2003:235).

We have considered the described developments in the governance and scaling literature as a step towards the elaboration of a more transdisciplinary space. However, such a step also implies the inclusion of various values and knowledge claims that go beyond those of the scientific mainstream. This "opening of the door" to other values and types of knowledge is unlikely to happen automatically. If there will be a continued chasm between the scientists who argue that scales are real, while others argue that they are human constructs, the door between the different sciences is likely to remain closed. Nor is a meaningful exchange of ideas between scientists and practitioners likely. However, if they familiarize themselves with the debate "realism versus and/or constructionism", a debate that has been extensively addressed in political geography and critical realism, and identify different types of knowledge claims and work towards the translation of these claims into testable formats, then issues of scale and governance can inspire relevant, joint and transdisciplinary research questions. For example, with regard to the sustainable governance of Social Ecological Systems, system boundaries may be identified and explained according to a realist ecological logic, but they may also be contested by others, who are claiming that the setting of such boundaries and the governance of the system should rely as much on local appreciation and experience.

CONCLUSION

We argue that fundamental shifts are occurring in the way researchers currently deal with the issue of scale and governance in distinct domains. Scale techniques in landscape ecology have been socialized, while scientific perspectives on the government of complex environmental issues have been "scalar-ized". We have furthermore shown that these shifts have remarkable similarities and complementarities, in terms of the emphasis on multiple scales, multiple actors, social construction and contestation of scales, and co-production of knowledge. From this we can conclude that there is sufficient common ground for future collaboration, not only among scientists, but with policy makers and other relevant stakeholders too. We argue that it is crucial for collaboration to actually come about, and that different knowledge claims on scale and governance need to be recognized and acknowledged first, before they can be reflected upon and discussed in transdisciplinary arenas. This, however, requires fundamental changes in scientific practices, including our own.

Responses to this article can be read online at:
http://www.ecologyandsociety.org/volXX/issYY/artZZ/responses/

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