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REVIEW

Scale-sensitive governance in forest and landscape restoration: a systematic review

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Abstract

Building on different bodies of the governance literature, we propose a conceptual framework specifying nine scale-sensitive governance arrangements that aim to (1) create cross-scale fit between the governance and ecological scales, and/or (2) foster cross-level alignment between different governance levels. To understand how scale-sensitive governance has played out in practice, our systematic review builds on 84 peer-reviewed empirical journal articles, which represent 84 cases of forest and landscape restoration governance. In the case studies, we identified eight out of nine scale-sensitive governance arrangements: moving tasks to other governance levels; task-specific organisations; polycentric governance; multilevel coordination; multilevel collaboration; multilevel learning; bridging organisations; and multilevel networks. These arrangements constitute important elements of the multilevel environmental governance landscape, and we analysed their role in promoting forest and landscape restoration. By using the proposed conceptual framework, a better understanding is created of how different scale-sensitive governance arrangements can support existing and future restoration efforts that are implemented as part of the UN Decade on Ecosystem Restoration.

Keywords Scale-sensitive governance · Forest and landscape restoration · Water · Policy

Introduction

Forest and landscape restoration (FLR) has been hailed as the solution to various intertwined crises, including climate change, biodiversity collapse, land degradation, water crises, food insecurity and rural poverty (Pörtner et al. 2021). FLR entails the restoration of multifunctional landscapes that, depending on local circumstances, may include large natural forest, grassland, peatland and coastal ecosystems, as well as smaller forest patches, riparian zones, agroforestry and remnant trees in non-natural landscapes (Chazdon et al. 2016; Temperton et al. 2019). In recent decades, FLR has gone from a process that focused mostly on biophysical aspects to one that deals with social and livelihood dimensions as well (Ota et al. 2020). A main focus of many restoration efforts has become the simultaneous improvement of ecological integrity and connectivity, and the strengthening of nature's contributions to people (Díaz et al. 2018) at landscape level (Holl 2017). Restoration at the landscape level, where a mix of land uses and competing claims exists, is arguably more challenging than conservation alone, and requires active interaction between actors across governance levels to identify and implement restoration pathways (Wilson and Cagalanan 2016; Mansourian et al. 2019).

Global momentum to restore hundreds of millions of hectares of deforested and degraded land has recently culminated in the declaration of the UN Decade on Ecosystem Restoration (2021–2030). This unprecedented attention for FLR calls for a careful examination of the governance arrangements that are used to translate high-level restoration targets into local action. To make sure that restoration efforts are locally viable while simultaneously meeting higher-level climate and biodiversity objectives, engagement of actors at different governance levels is important (Wilson and Cagalanan 2016; Holl 2017). This is not a straightforward process,

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as has been highlighted by recent studies that describe cross-scale and cross-level governance challenges that emerge when restoration policies and initiatives are implemented (Chazdon et al. 2020; Wiegant et al. 2020). To overcome such challenges, more evidence is needed of how 'scale-sensitive' governance arrangements that create better cross-scale fit and cross-level alignment play out in practice. A better understanding of cross-scale and cross-level governance options may broaden the set of implementation pathways that FLR governance actors have at hand.

The main question of this review is as follows: what scale-sensitive governance arrangements have been used in forest and landscape restoration, and how have they played out in different cases? Given that the scale-sensitive governance concept is still in its infancy and the FLR governance literature is also relatively young, we divided the main question into two sub-questions that have an exploratory character: (1) what evidence of scale-sensitive governance can be identified in the FLR literature; and (2) how have scale-sensitive governance arrangements played out to create fit between the governance and ecological scales or create alignment between governance levels?

In the theoretical framework, we briefly elaborate on the concepts of scales and levels, and conceptualise nine scale-sensitive governance arrangements that we identified from different bodies of the governance literature. In the 'Methods' section, we outline the steps that were followed during data collection, data management and interpretation. Subsequently, in the 'Results' section, we provide evidence of the scale-sensitive governance arrangements we identified in 84 restoration-related case studies, and how they played out to create cross-scale fit or cross-level alignment. Lastly, in the 'Discussion' section, we reflect on the review's key merits and implications for future FLR governance.

Theoretical framework

In this review, we refer to governance as 'the process of steering society […] through collective action and in accordance with some common objectives' (Torfing 2012). Governance has become increasingly multilevel over the past decades, due to the diffusion of decision-making authority from the national government towards international actors, local governments and non-state actors (Hooghe and Marks 2003). In addition, global environmental change has made interactions between governance and ecological processes so complex and multilevel in nature that national governments require the expertise and resources of other actors at different levels to implement public policy (Cash 2000; Gray and Purdy 2018). This makes it needed to study how governance actors aim to influence ecological processes, and how actors at different governance levels interact to translate high-level policies and programmes into local action. We use scale theory (Cash and Moser 2000; Cash et al. 2006) and scale-sensitive governance theory (Padt et al. 2014) as a framework to study cross-scale and cross-level interaction. A scale is a dimension with multiple levels that can be used to measure and study biophysical and social phenomena (Padt and Arts 2014). We distinguish the ecological and governance scales. While the ecological scale comprises the various levels at which an ecological phenomenon plays out, the governance scale entails the levels at which governance arrangements are positioned in relation to a particular issue (Termeer and Dewulf 2014). In the case of FLR, actors at multiple governance scale levels aim to influence relevant processes on the ecological scale (Wiegant et al. 2020).

Scale challenges emerge when different scales mismatch, or governance levels misalign with each other (Cash et al. 2006). Scale mismatches occur when actors do not address restoration processes at the most appropriate governance level. Cross-level misalignments happen when actors at one governance level do not properly consider limitations or conditions at another governance level. In both cases, the quality or sustainability of restoration processes is adversely affected. Scale-sensitive governance may facilitate dealing with scale challenges by addressing the interconnectivity between the ecological and governance scales, and between governance levels (Termeer et al. 2016). Governance arrangements that strengthen this interconnectivity help actors to find cross-scale fit and cross-level alignment.

To further develop the scale-sensitive governance concept (Padt et al. 2014), we present a framework of governance arrangements that facilitate cross-scale fit and cross-level alignment. We do so by building on four different bodies of governance literature: collaborative (Ansell and Gash 2007; Emerson et al. 2011; Gray and Purdy 2018), adaptive (McLain and Lee 1996; Folke et al. 2005; Cumming et al. 2013), multilevel (Hooghe and Marks 2003; Marks and Hooghe 2004; Stephenson 2013) and polycentric governance (Cash 2000; Ostrom 2010; Carlisle and Gruby 2019). We identified nine scale-sensitive governance arrangements, which are divided into a cross-scale (A,B,C,D) and a cross-level (D,E,F,G,H,I) category (Fig. 1):

1 *Governance arrangements that create fit between the governance scale and ecological scale by redesigning the governance scale*

A. *Adding, removing or moving a general-purpose jurisdiction* general-purpose jurisdictions are nested public entities that are durable and located at a limited number of levels — from international to national, regional and local level (Marks and Hooghe 2004). Examples are the provincial and municipal governments. They bundle

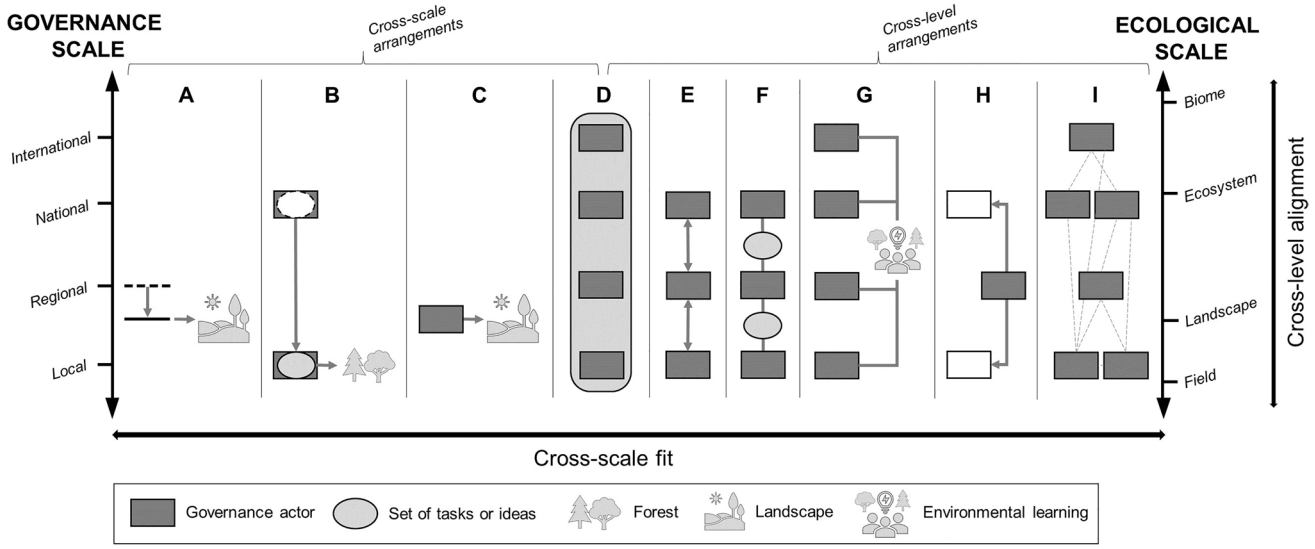

Fig. 1 Nine scale-sensitive governance arrangements are visualised in relation to the governance and ecological scales. Specific arrangements aim to create fit between the governance scale (left) and ecological scale (right), and/or alignment between different governance levels (e.g. international, national, regional and local levels). While arrangements (A), (B) and (C) aim to create cross-scale fit, (D) aims to create both cross-scale fit and cross-level alignment, and (E), (F), (G), (H) and (I) aim to create cross-level alignment. An example is visualised for each arrangement: (A) Adding, removing and moving a general-purpose jurisdiction; (B) Moving tasks to higher or lower governance levels; (C) Task-specific organisations; (D) Polycentric governance; (E) Multilevel coordination; (F) Multilevel collaboration; (G) Multilevel learning; (H) Bridging organisations and (I) Multilevel networks

together multiple functions including a range of policy tasks, and focus on the representation of, and legitimacy towards constituents who live in their jurisdiction. The boundaries of these jurisdictions do not overlap and are intended to be stable for many decades or longer. As part of jurisdictional modification however, it is possible to add a new jurisdictional level that did not exist before, like the region level (Vrangbæk 2010). Similarly, a general-purpose jurisdiction can be dismantled altogether, such as the county level. Lastly, the boundaries of general-purpose jurisdictions can be changed, by amalgamating or splitting them to better fit a governance level to the biophysical boundaries of an ecological unit.

B. *Moving tasks to other governance levels* while modification of general-purpose jurisdictions tends to be costly and unusual, the reallocation of policy competencies or tasks across existing jurisdictions is easier (Hooghe and Marks 2003). Moving tasks can occur as part of decentralisation or centralisation processes. Decentralisation refers to the transfer of competencies for planning, management and allocation of resources from the national to lower government levels, non-public organisations or local communities (Agrawal and Ribot 1999). It may improve policy efficiency and responsiveness at local level by enabling local governments — who are more familiar with local conditions and needs — to govern natural resources (Andersson and Ostrom 2008). This process would be in line with the subsidiarity concept, which entails the political desirability of policy action at the lowest possible level (Stephenson 2013). However, the outcomes of decentralisation may be limited when the moving of tasks is not accompanied with sufficient power and financial resources to make meaningful local decisions, or when local governments are upwardly instead of downwardly accountable to local communities (Ribot et al. 2006). Tasks can also be centralised from local to higher levels. This can be done to strengthen government control over natural resources, facilitate the achievement of policy objectives and encourage consistency in the way natural resources are governed. Moving tasks between governance levels can create fit between the ecological and governance scales by enabling actors at the most appropriate governance level to comprehensively govern an ecological unit, like a forest or a landscape.

C. *Task-specific organisations* these organisations are created to fulfil distinct functions at the most appropriate level, such as providing a public good or solving a common pool resource problem (Marks and Hooghe 2004). Examples are a watershed council that makes water management decisions at watershed level or a national park authority conserving habitat at landscape level. As opposed to general-purpose jurisdictions that are small in number and nested, task-specific organisations can be large in number and operate across jurisdictional

boundaries (Marks and Hooghe 2004). In this way, a large number of relatively self-governing organisations with a specific function overlap with the smaller number of nested general-purpose jurisdictions. Task-specific organisations are often lean and can respond flexibly to changing functional requirements and actor preferences. They can be created and abolished relatively easily, compared to general-purpose jurisdictions. However, as creating a new organisation is quite costly, this is mostly done to manage a complex issue for which ongoing dialogue is needed between a large number of actors over a longer period of time (Gray and Purdy 2018).

2. *Governance arrangements that create alignment between governance levels by facilitating multilevel interaction*

D. *Polycentric governance* this arrangement is characterised by a multiplicity of overlapping centres of decision-making that have some degree of autonomy in governing a resource, but that choose to act in ways that take each other into account through processes of cooperation, competition, conflict and conflict resolution (Ostrom 2010). A national government orchestrates polycentric governance when it commits to a restoration target and creates policy frameworks that enable actors at lowers levels to work towards achieving this target. These coexisting centres of decision-making may constitute diverse types of public, private and civic actors at multiple governance levels, and include both nested general-purpose jurisdictions as well as task-specific organisations (Carlisle and Gruby 2019). Polycentric governance tolerates redundancy between actors by giving space to overlap and blurred responsibilities between multilevel actors. This redundancy allows polycentric systems to better adapt to social and ecological change compared to centralised governance systems (Carlisle and Gruby 2019). By working at different levels, each actor is able to study or address different aspects of a common environmental problem (Cash 2000; Cumming et al. 2013), and thereby a good cross-scale fit with the respective ecological system is established. While high-level actors can exploit economies of scale, internalise policy externalities and facilitate effective redistribution, local actors are more sensitive to context-specific conditions at local level and can therefore produce place-specific responses (Hooghe and Marks 2003). An actor can try to orchestrate a polycentric governance landscape to reduce fragmentation and improve coherence.

E. *Multilevel coordination* this arrangement touches on the process of continuous negotiation by formally independent, but practically interdependent actors at various governance levels to design and implement policies (Stephenson 2013), without sharing any authority or responsibility in formal terms (Young 2006). Multilevel coordination, or vertical interplay, is omnipresent and occurs when international and national policy frameworks, or international development projects, are implemented at local level. It occurs when the decisions made by one actor consider the decisions made by other actors, and both attempt to avoid conflict and find ways to cooperate on solutions that all actors can benefit from (Peters 2018). Coordination between governance levels can generate positive outcomes and synergy when actors at various levels align in their values and objectives. However, since multilevel coordination is not consensus-oriented per se, outcomes are not necessarily positive for all governance actors. Finding trade-offs may be necessary when diverging objectives and knowledge systems exist (Folke et al. 2005). Multilevel coordination may be characterised by the dominance of one governance actor over others, as result of the allocation of authority and resources at one specific level. Dominance may also stem from an actor's ability to control a discourse or frame (Dewulf et al. 2007) on which a governance system is based and which defines 'what it is all about'.

F. *Multilevel collaboration* through this arrangement, multilevel actors engage in a collective, consensus-oriented and deliberative decision-making process (Ansell and Gash 2007) to 'carry out a public purpose that could not otherwise be accomplished' (Emerson et al. 2011). Such collaboration may occur between local governments and rural communities to govern natural resources in locally appropriate ways. The inclusion of all relevant actors from different governance levels that affect or are affected by an issue is a crucial condition for successful collaboration. It implies two-way communication and influence so that all relevant actors are directly engaged in problem and direction-setting and share responsibility for policy outcomes (Ansell and Gash 2007; Gray and Purdy 2018). The main objective is to achieve better informed, and more responsive and implementable solutions by developing a more comprehensive approach to planning, policy and implementation than one actor could achieve by itself (Emerson et al. 2011; Gray and Purdy 2018). A concept that is used synonymously with collaborative governance is co-management. It refers to a continuum of arrangements through which public and non-state actors negotiate and define a sharing of management functions, entitlements and responsibilities to govern a territory or set of natural resources (Cash et al. 2006; Gray and Purdy 2018). In this way, collaboration negotiates a kind of hybrid regime between multiple levels that allocates recognised roles to involved actors, and

establishes mutually agreed rules and procedures related to responsibility and authority sharing (Young 2006).

G. *Multilevel learning* learning happens when actors at multiple levels jointly engage in an iterative reflection process that occurs when experiences and ideas are shared (Keen et al. 2005). Exposure to experiences and ideas that exist at multiple levels can facilitate the convergence of actors' perspectives related to a particular problem and possible solutions. Multilevel learning can for example occur through joint knowledge acquisition by actors at multiple levels. This can subsequently give way to shared understandings and integrated solutions that depend on the concerted action of multiple actors (Gonzales-Iwanciw et al. 2019). A structured learning process can be facilitated with experimentation and monitoring to produce experience through trial and error, and by exchanging the knowledge obtained (McLain and Lee 1996; Cumming et al. 2013). Knowledge exchange and the deliberation between actors that follows determine their adaptive capacity to govern natural resources (Carlisle and Gruby 2019).

H. *Bridging organisations* intermediary or bridging organisations are important to catalyse and facilitate linkages between different governance levels and deliver different services that enable cross-level interaction (Olsson et al. 2006; Berkes 2009). These services include providing access to resources, building trust and resolving conflict between actors, and are often provided by civil society organisations. Since actors at different levels have their own ways to generate and store knowledge (Cash et al. 2006), bridging organisations can provide a forum in which these different knowledge types are translated and exchanged, and knowledge co-production, sense-making and learning are advanced (Folke et al. 2005; Berkes 2009). The leadership that is provided by bridging organisations can significantly reduce the otherwise high transaction costs of collaboration (Folke et al. 2005). Bridging organisations are different from collaborative governance arrangements because they constitute a separate organisation with its own objectives, rather than a platform that other organisations use to collaborate.

I. *Multilevel networks* networks constitute trust-based relationships between actors who are located at various governance levels. Informal networks, shadow networks (Olsson et al. 2006) or communities of practice (Pahl-Wostl 2009) offer a forum where experience, values and information are shared, and where the rules and norms are set that shape governance (Folke et al. 2005; Cumming et al. 2013). Multilevel networks often aim to promote the implementation of specific natural resource management practices. By sharing a common set of understandings, viewpoints and passions, and by demonstrating their shared skills and techniques, network members cultivate a sense of belonging to their microcultures of values and meanings (Goldstein and Butler 2010). Their informality and flexibility in membership makes networks important arrangements to foster learning and change (Pahl-Wostl 2009), and facilitate the flow of different kinds of knowledge. By focusing on learning they can generate alternative approaches to emerging problems (Olsson et al. 2006).

Methods

Systematic literature review is a method that facilitates the comprehensive assessment of a large body of scientific literature by applying rigorous and transparent steps and criteria to draw conclusions about the reviewed literature (Petticrew and Roberts 2006). The purpose of this systematic review is to find and define scale-sensitive governance arrangements in the forest and landscape restoration governance literature. With this aim, we systematically searched and selected scientific publications that focus on this theme. In this section, we provide details on how the literature was collected, managed and analysed.

Data collection

To find relevant scientific literature, we created a broad list of governance, restoration, cross-level and natural resource-related search terms (Annex A). While compiling the list of terms, we intended to be sensitive to the diversity of notions that are used in different sub-bodies of the restoration governance literature, including in the fields of biodiversity, climate change, forest, landscape and water. To direct our search to scale-sensitive governance, we included a number of scale-related terms. Inclusion of a diversity of notions allowed us to obtain the maximum variation sample needed to capture the multiple ways in which restoration-related, scale-sensitive governance processes can play out in practice, and further elaborate scale-sensitive governance theory (Bazeley 2013).

To obtain an initial body of literature, as a *first step*, we inserted the terms in the search engines Scopus and Web of Science. This yielded an initial sample of 1735 articles. After merging both databases and excluding duplicates in the *second step*, the number was reduced to 1344. To make sure that the main focus of the articles was on restoration governance, as a *third step*, we read the title and abstract of each article and subjected these to inclusion and exclusion criteria (Annex B). This yielded 196 articles for full-text review. We only included peer-reviewed, empirical articles and excluded theoretical articles without case study descriptions or conceptual articles, given that our aim was to find

and describe evidence of existing scale-sensitive governance arrangements in FLR literature. Articles that were focused on urban, marine and pollution remediation contexts were excluded due to their distinct features that are different from the review's focus on rural forest and landscape restoration governance. Articles focused on coastal ecosystems, such as mangroves and tidal marshes, were included. As a *fourth step*, we applied the criteria to the full-text of the remaining articles, which brought the number down to 84 articles that focused on scale-sensitive governance arrangements in FLR. The articles were imported into the qualitative data analysis software ATLAS.ti (version 8.4.24) for analysis (Table 1).

Data analysis

To analyse our review articles, we went through a data management phase, followed by an abstraction and interpretation phase (Spencer et al. 2014). Firstly, we coded the literature with deductively created codes that we derived from the scale-sensitive governance arrangements (Miles and Huberman 1994) and which we applied cross-sectionally, across the entire dataset. Since relevant segments related to governance arrangements appear with different lengths in the text, we used 'idea, regardless of length' as segmentation criterion (Coffey and Atkinson 1996). After coding all 84 articles, a dominant scale-sensitive governance arrangement was determined for each article to extract the strongest examples. In each case, dominance was decided based on the number of meaning units that were coded for a specific arrangement. A higher number of meaning units tended to facilitate shaping a thicker description, and hence better understanding, of the governance context in which the arrangement played out.

Cases were clustered according to their dominant arrangement and location, and based on the coded meaning units, the main author wrote a short narrative in table format for each case to capture the essence of the scale-sensitive governance arrangement. We undertook data management and interpretation simultaneously through an iterative process in which the data was compared and recombined (Tesch 1990). The summary tables facilitated discussion among the authors to see whether cases were properly categorised. Every case was assessed by at least one other author. The summary tables provided a basis for analysis in which meaning patterns were searched (Spencer et al. 2014). Cases were compared to detect and display recurring evidence of similarities and differences within each governance category. While writing the narratives and comparing cases, the dominant scale-sensitive governance arrangement of 13 case studies was changed. For cases in which two interconnected governance arrangements could be substantiated, we selected one dominant category while highlighting this connection in the results chapter.

In Annex C, we ordered cases according to dominant scale-sensitive governance arrangement. Within each arrangement, cases were ordered alphabetically according to continent, and within each continent, according to country. For each specific case, codes were developed that start with the letter of the arrangement and the number of the case within the arrangement. We added a two-letter internet country code to cases that are limited to one country, and a three-letter regional code to cases that are international. In this way, B14ec refers to the fourteenth case of the 'moving tasks to other levels' arrangement and is based in Ecuador. H3*ehi* refers to the third case of the 'bridging organisations' arrangement and focuses on the East Himalaya.

Results

In this section, we indicate how the scale-sensitive governance arrangements played out in the 84 FLR governance case studies (Annex C). Although not completely representative for all possible scale-sensitive governance variations, the cases facilitate an improved understanding of existing scale-sensitive governance arrangements.

Case studies of scale-sensitive FLR governance have been found on all inhabited continents (Fig. 2). Some geographies, most notably the USA with 14 cases, are strongly represented in the dataset, while others are underrepresented or absent, like the former Soviet Union, Middle East and Northern Africa, the Sahel, Southern Africa and Canada. This does not mean that no restoration efforts took place in these geographies, but rather that such efforts were not reported in the peer-reviewed literature that was retrieved with our scale-sensitive governance-oriented search terms.

Table 1 Steps to define the final sample

Steps	Number of articles
Step 1: literature search using governance, restoration, cross-level and natural resource-related terms	Initial scoping of literature through *Web of Science* and *Scopus* on October 6th 2020 (1735 articles)
Step 2: merging of databases and exclusion of duplicates	Primary body of literature (1344 articles)
Step 3: applying inclusion and exclusion criteria to title and abstract	Secondary body of literature (196 articles)
Step 4: applying inclusion and exclusion criteria to full text	Tertiary body of literature (84 articles)

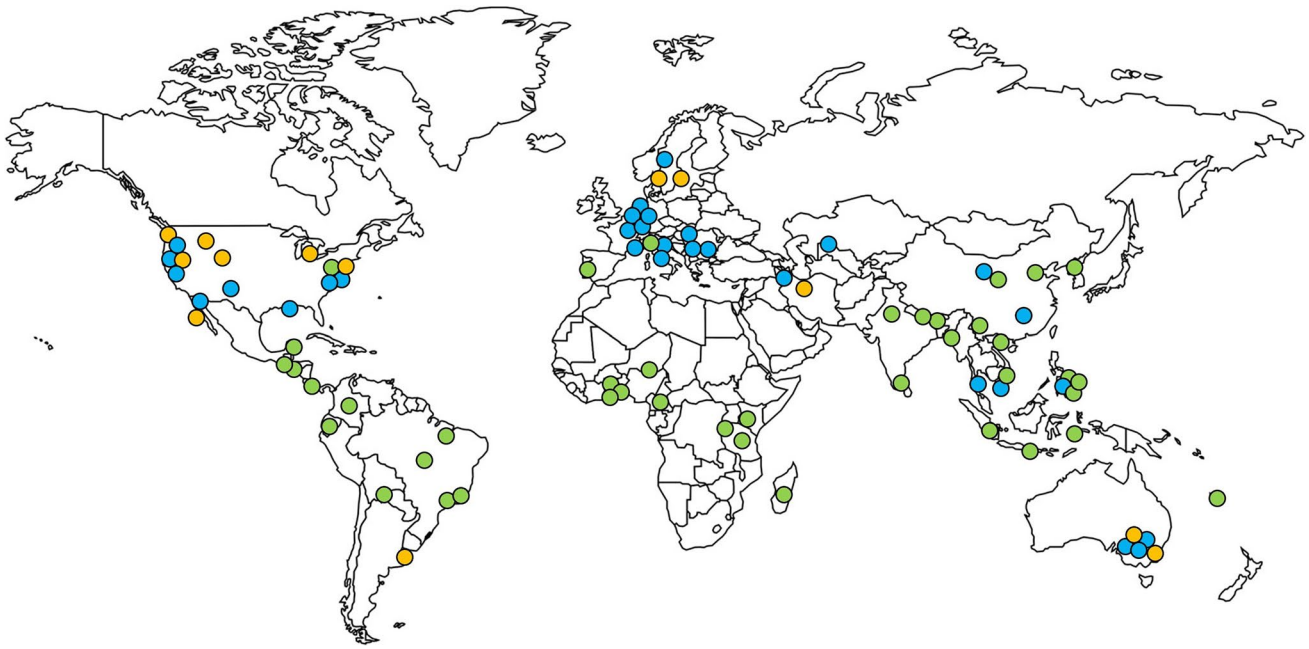

Fig. 2 Locations of the case studies that are described in the 84 articles (national level case studies are positioned at national capitals, and one global case is positioned in the city where the reported initiative's secretariat is located). Green dots refer to forest-related case studies, blue dots refer to water-related case studies and yellow dots refer to cases with a multiple ecosystems or biodiversity focus

What can also be observed from Fig. 2 is a divide between the global South and the global North. A larger share of forest-related restoration governance is seen in the global South (Africa, Central and South America, and South, East and Southeast Asia), while in the global North (USA, Europe and Australia), a larger share of water, and ecology and biodiversity-oriented restoration cases were found.

With regard to the occurrence of scale-sensitive governance arrangements across resource types and continents (Fig. 3), a number of observations can be made. While cases that focus on forest resources make up the lion's share of cases that describe moving tasks to other levels, the other scale-sensitive governance arrangements show a more or less equal division between the different resource types. This could indicate that the governance arrangements are relevant to a diversity of restoration processes, regardless of the resource they target. Differences are clearer though when it comes to the continents in which scale-sensitive governance arrangements were found. While types B and F are mostly found in Asia, type E is mainly found in Europe. Type D is mostly found in South America, while North America takes up most of types G and I. A fairly equal spread of governance arrangements can be found in Africa and Oceania. In the following sections, evidence is presented of how the different scale-sensitive governance arrangements played out in the context of forest and landscape restoration.

A. Adding, removing or moving a general-purpose jurisdiction

No evidence of adding, removing or moving a general-purpose jurisdiction was found in our FLR literature set. A possible explanation is that forest and landscape restoration is not a core task of general-purpose jurisdictions, and would hence not justify such a drastic governance measure.

B. Moving tasks to higher or lower governance levels

Evidence for moving tasks to higher or lower governance levels was found in 14 case studies. Of these cases, 13 described processes of decentralisation from the national government level to sub-national governments at regional (state, province) and local level (county, municipality, township), and to rural communities. One case study focused on task centralisation from the sub-national state level to the national level.

Restoration-related tasks were decentralised from national to regional level in four cases (B5in, B7ir, B10vn, B11vn), and decentralised even further to local government level in four other cases (B1cm, B3cn, B4cn, B14ec). In six cases, decentralisation occurred as part of national restoration programmes, to double the area for afforestation and ecological restoration (B5in); regreen 12 million ha of barren lands and establish 5 million ha of new forest (B10vn, B11vn); convert over 13 million ha of farmland to forest or

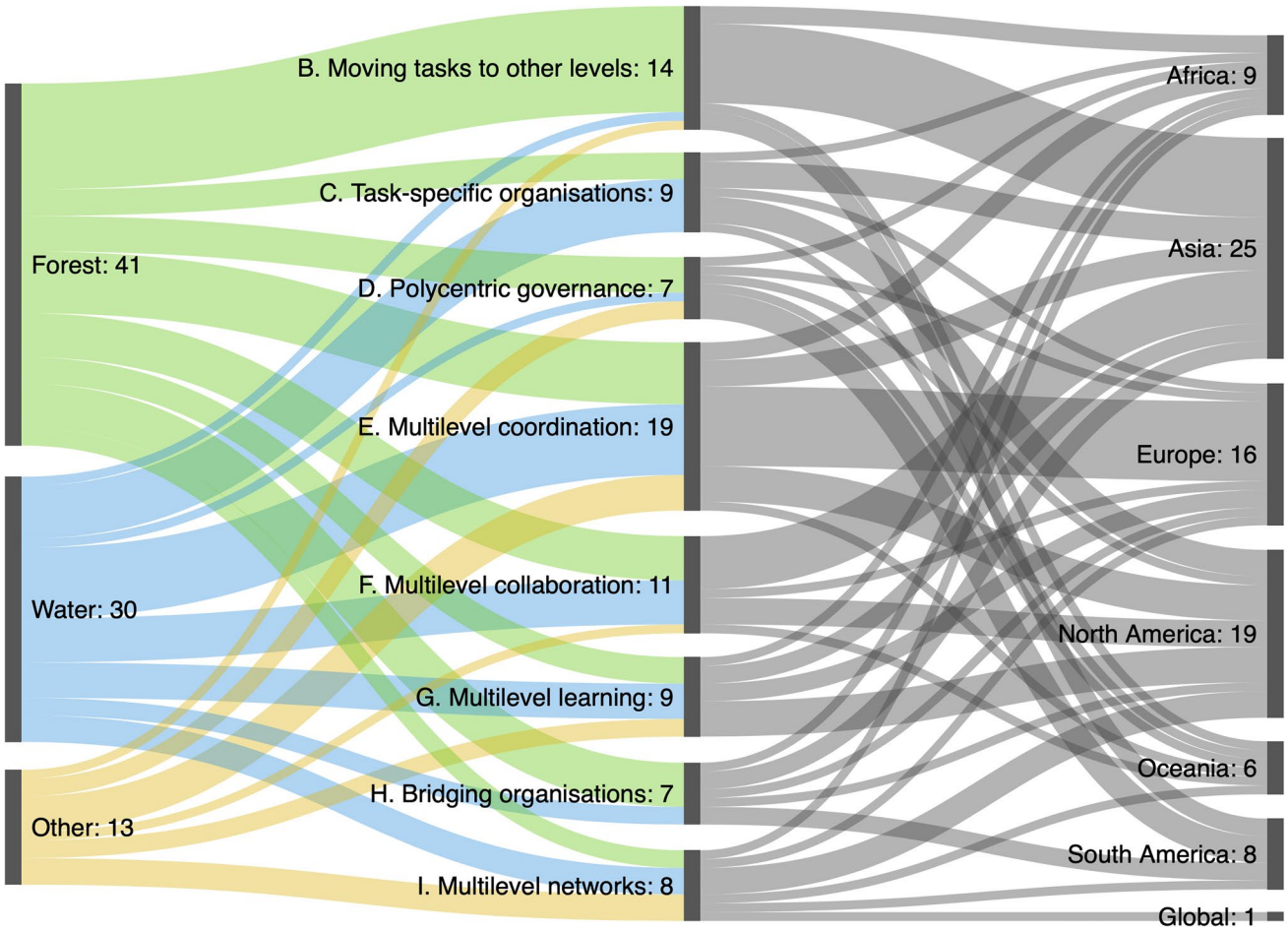

Fig. 3 Occurrence of scale-sensitive governance arrangements in articles, across resource types and continents

grassland (B3cn, B4cn); and restore 500.000 ha of native forest (B14ec). In addition, decentralisation of restoration tasks happened as part of wider forest management tasks transfer to local level (B1cm) or following a national plan that was prepared to the UNCCD (B7ir). Decentralisation of restoration tasks from national to sub-national government level was often done with the idea to better engage local actors, respond to local preferences and needs, and increase local benefits. However, the cases also describe a list of new challenges that emerged after tasks were moved. National governments imposed unfeasible restoration targets on local governments or formulated forest management rules that did not consider local conditions and interests (B10vn, B11vn, B14ec). In some cases, local governments receiving restoration tasks remained primarily accountable to high level governments and could not always ensure meaningful community participation to select restoration sites and tree species (B3cn, B4cn, B5in). Conversely, when national level checks-and-balances and monitoring was absent or inadequate following decentralisation, this opened the door for local governments to deviate from approved restoration plans (B1cm). It also happened that local government capacity was not enhanced by national actors to ensure adequate restoration-related extension services, or to meet biodiversity and water-related restoration objectives at local level (B10vn, B11vn, B14ec).

In five cases, restoration-related tasks were decentralised from the national government level to rural communities (B2ke, B6id, B8kp, B9ph, B13br). This happened by establishing community forest associations (B2ke), community forest groups (B9ph) and sloping land user groups (B8kp); by reforming forest tenure that introduced social forestry (B6id); and by tasking rural landowners to restore native vegetation on their property (B13br). While decentralisation to community level often gave communities collective land rights and better options to reap ecosystem benefits and improve livelihoods, several challenges were also highlighted in these cases. Decentralisation was not accompanied with clear indications of how local actors with restoration tasks would be financially and technically supported, or how groups could engage with international efforts to promote reforestation

and avoid forest degradation (B2ke). In other cases, the decentralisation process was (i) contested because local groups would not recognise government authority over ancestral land (B6id); (ii) incomplete because the government would retain tasks related to tree species selection and land use planning (B8kp) or only involve local groups to implement tree planting activities, not to plan them (B9ph); or (iii) weak due to the low quality of extension services (B13br).

One case describes centralisation of restoration-related tasks from regional to national level (B12au). This occurred to better deal with water scarcity, water pollution and salinity concerns in a river basin. Failure of state level governments to handle growing water-related challenges within their jurisdiction led to the transfer of basin management tasks to a Basin Authority, which became a national government agency in the process. This created a new restoration-related task-specific organisation. Centralised management ensured state level water plans were aligned to an overarching and enforceable integrated basin plan. However, imposing a technocratic solution also came at the cost of reduced legitimacy among land and water management groups at regional and local level, and an increased implementation deficit.

The cases indicate that decentralisation of restoration tasks played an important role to create local ownership, respond to local preferences and needs, and increase the benefits that local actors obtained from FLR. On the other hand, the cases sum up a diverse list of challenges that emerge following the moving of restoration tasks to other levels. Their prevalence may be the result of a difficulty for national governments to anticipate or control new challenges. It indicates that moving tasks to other levels alone is not enough to improve FLR governance.

C. Task-specific organisations

Evidence of task-specific organisations was found in 9 case studies. Six water cases dealt with lake habitat, river habitat and watershed restoration. Three forest cases focused on plantation forestry, reforestation and natural regeneration. While several organisations were specifically created for restoration purposes, others were established for natural resource management purposes and received restoration tasks later. The organisations were found at various levels.

International level task-specific organisations were found in three cases (C2*cas*, C5*eeu*, C6*cam*). In these cases, task-specific organisations united multiple national governments to prevent desiccation and promote rehabilitation of a transboundary lake (C2*cas*), rehabilitate former floodplains and create river connectivity for barrier-free fish migration (C5*eeu*) and promote sustainable forest management and restoration in a transboundary biosphere reserve (C6*cam*). While the international level organisations enabled national governments to work on transboundary restoration efforts, they mainly had convening and proposal-writing roles, with national or sub-national actors being in charge of implementation. Meeting restoration tasks has been difficult as a result, due to differing attitudes and communication challenges among countries (C5*eeu*), and because of difficulties with attracting national and international funds (C2*cas*, C6*cam*).

National level task-specific organisations were found in two cases (C1gh, C4ir). At this level, a national development fund worked on expanding forest plantations at landscape level (C1gh) and a national committee sought to reverse water level decline of a lake and achieve minimal ecological flows to revive its biodiversity (C4ir). Establishment of both organisations increased the attention that was given to restoration efforts. Despite the increased attention to fulfil restoration tasks however, they both failed to achieve their objectives. The plantation development fund (C1gh) lacked transparency and accountability because it did not have a system in place to communicate eligibility criteria and information on funding cycles to intended beneficiaries. Meanwhile, the national committee (C4ir) fell short of its restoration goals since it was unable to control illegal water withdrawals, and because it did not plan non-agricultural livelihoods to decrease local dependence on agriculture. Neither organisation was sensitive to the needs of local actors.

Sub-national level task-specific organisations were found in four cases (C3cn, C7us, C8us, C9nc). At watershed level, organisations played a role in reversing water level declines (C3cn) and restoring instream fish habitat and riparian habitat (C7us, C8us). At ecoregion level, a task-specific organisation played a role in restoring parts of a fragmented dry forest (C9nc). Two organisations created positive impact by providing financial (C7us) and institutional (C9nc) stability to local actors to plan and implement restoration efforts. A state level watershed enhancement board provided long-term support and competitive project grants to watershed groups, and soil and water conservation districts to manage watersheds and recover salmon in the state (C7us). Similarly, the creation of a legally recognised natural areas conservancy gave more institutional and financial stability to an informal partnership of government and civil society actors, as it brought actors from various jurisdictions across an ecoregion together under the same umbrella (C9nc). Conversely, in two other cases, challenges emerged with local actors, either because task-specific organisations did not show downward accountability and imposed restoration targets from the top-down (C3cn), or because of a perception of restoration targets being imposed from the top-down (C8us). In conclusion, while there may be clear benefits to create restoration-oriented task-specific

organisations, their existence alone does not guarantee a smooth restoration process.

D. Polycentric governance arrangements

Evidence of polycentric governance arrangements was found in 7 case studies. Four forest cases focused on reforestation and natural regeneration, one water case dealt with river habitat restoration and two other cases focus on ecosystem restoration. Polycentric governance arrangements typically span a variety of governance levels and types of actors, both public and non-state. What makes the cases differ from each other is the level at which they are orchestrated or catalysed. In all cases, public actors orchestrated polycentric governance.

One internationally orchestrated polycentric governance arrangement was found (D2*weu*). An international river basin commission that united national governments adopted a programme to bring back salmon and other indigenous species to the river. The governments decided that intergovernmental agreements concerning the programme would be executed by the lowest possible government level in each country, and that countries could decide for themselves on the measures to achieve improved water quality and habitat connectivity. A similar governance logic was later followed to restore the river's floodplains and habitat.

Nationally orchestrated polycentric governance arrangements were found in two cases (D7co, D6br). National governments created enabling policy frameworks by making zero-deforestation and restoration pledges (D7co) and by creating federal action plans that improve forest cover monitoring (D6br). The policy frameworks enabled public and non-state actors at other levels to implement and monitor zero-deforestation and restoration efforts, pioneer new policy instruments and create synergy between levels (D7co, D6br). A sub-national policy instrument that was catalysed is the Rural Property Registry that delineates private properties and monitors whether legal forest cover requirements are met. The Registry, which was later expanded to national level, enabled federal public actors to strengthen law enforcement in high-deforestation municipalities, and embargo properties with illegal deforestation until restoration measures were taken (D6br).

Sub-nationally orchestrated polycentric governance arrangements were found in four cases (D1ne, D3us, D4au, D5br). Regional and local public actors enabled rural communities (D1ne, D4au), watershed groups (D3us) and municipalities (D5br) to play relevant roles in local restoration efforts. Both a regional government and a river basin commission worked directly with rural communities to help them create their own bylaws to guide farmer-managed natural regeneration (D1ne), and encourage them to engage in restoration efforts following awareness activities about local environmental problems (D4au). A regional estuary management agency created and funded watershed organisations to strengthen the capacity of local actors to work on local ecosystem recovery priorities (D3us). Lastly, a municipality created a legal framework that made it possible to use municipal funds to provide technical assistance and payments to landowners to conserve and restore private property (D5br). This framework is now replicated by other interested municipalities throughout the country.

Government actors at different levels have been instrumental to give direction to restoration processes. By setting targets, raising awareness or creating enabling policy frameworks, public and non-state actors at lower or the same governance level were stimulated to play relevant roles in restoration efforts, while retaining their autonomy.

E. Multilevel coordination

We found evidence of multilevel coordination in 19 case studies. Six forest cases dealt with reforestation, natural regeneration and forest landscape restoration, while nine water cases focused on wetland, estuary, mangrove, river habitat and floodplain restoration. The remaining four dealt with ecological restoration where forest and river habitat are targeted simultaneously. Multilevel coordination differed from case to case in terms of the number of governance levels and actors involved. While in three cases, coordination occurred exclusively between public actors (E3cn, E13*nor*, E14se), in the other 15 cases, coordination took place between a mix of public and non-state actors.

Multilevel coordination to implement international policy frameworks was observed in seven cases (E6fr, E7it, E9it, E10nl, E11nl, E13*nor*, E16mx). In European Union member states, cases referred to the implementation of the EU Water Framework Directive (E6fr, E9it, E10nl, E11nl, E13*nor*) and Habitat Directive (E9it, E10nl, E11nl, E13*nor*). The cases touch on the role of public and non-state actors at different levels to implement the directives for wetland restoration (E9it) and floodplain restoration (E10nl, E11nl). One case referred to how Integrated Coastal Zone Management principles, which are adopted at EU level, are followed by governments at multiple levels to restore the ecological balance and improve productivity of shellfish farming in a lagoon (E7it). In other countries, multilevel coordination occurred to implement UNFCCC frameworks that promote carbon sequestration through revegetation, reforestation and wetland restoration (E13*nor*, E16mx). Implementation of international policy frameworks resulted challenging when trade-offs had to be found, such as when reconciling hydropower interests with restoring minimum flows and creating better conditions for migratory fish (E6fr). Another challenge related to difficulties to bring together multiple planning efforts of federal, state and

municipal actors to reduce and reverse deforestation and forest degradation emissions, and which were implemented in isolation from each other (E16mx).

Multilevel coordination occurred to implement national policy frameworks in six cases (E3cn, E5th, E14se, E15gt, E17us, E19au). One case described how a national government actor engaged in both upward and downward coordination, to mobilise resources from global funding mechanisms, and implement restoration projects and build capacity of local natural resource management collaborations (E15gt). In five other cases, national government actors engaged in downward coordination with regional and local governments (E3cn, E14se), rural communities (E5th) and indigenous communities (E17us, E19au) to implement restoration efforts. Coordination of national governments with regional and local governments has often not resulted in stronger local competence and expertise because of the high-paced, campaign-style character of restoration efforts (E3cn) or because of the short-term planning horizon of restoration projects, without guarantee for follow-up funding (E14se). This has made it difficult for local governments to build their capacity to design appropriate restoration projects. As a result, national funds were mainly disbursed to local public actors that already had the ability to write successful restoration project proposals (E14se). In one case, the national government overcame the capacity challenges of local public actors by coordinating directly with rural community associations and making sure that the associations could meet national mangrove tree planting targets with corporate social responsibility funds (E5th). Meeting national targets with private funding caused a selection bias however, in which corporate finance mainly flowed to communities with strong informal institutions that guaranteed success, while communities with weak informal institutions were neglected. In two other cases, national policy frameworks enabled indigenous communities to develop tribal visions to land management and restoration. The visions are based on indigenous values and holistic land management practices that are in line with traditional law, customs and culture, while also being consistent with national environmental requirements (E17us, E19au).

Multilevel coordination occurred to implement subnational policy frameworks in three cases (E8it, E12nl, E18us). Coordination occurred to promote reforestation in historically deforested plains at regional level (E8it), develop and maintain a multi-functional floodplain (E12nl), and restore fish stocks and species diversity, unhealthy forest stands and habitat connectivity in a river basin (E18us). In one case, a river basin council was instrumental to coordinate both a federal level restoration plan focused on public land, as well as a state level restoration plan that focused on private land (E18us). Since the plans created a complex institutional structure, watershed councils and federal agencies established the council to coordinate both plans at basin level. In another case however, actors at national, provincial and local level could create a development plan that integrated both nature management and flood prevention functions in a floodplain, but then disagreed on how and through which actors the floodplain should be maintained (E12nl).

Multilevel coordination as a result of international development projects was observed in three cases (E1gh, E2mg, E4id). The development projects provided funds to implement national restoration mechanisms, being an agroforestry system to interplant crops with timber trees (E1gh) and an Ecosystem Restoration Concession (E4id). Funds were also provided to implement a restoration project in a landscape that was prioritised by a national working group (E2mg). The international development projects produced both positive and negative vertical interplay. A donor-funded agroforestry scheme established positive interplay by investing in the social organisation and capacity of farmers. This improved farmers' negotiation skills to accommodate their interests in the scheme, while a nationally funded scheme gave farmers little space to select tree species and establish interplanting rules (E1gh). Negative interplay emerged from a project financing the establishment of an Ecosystem Restoration Concession. The project gave rise to strong disputes between the donor-funded company that managed the concession and indigenous groups who claimed customary rights over parts of the concession (E4id). The dispute made development actors aware that they cannot delegate responsibility for adhering to environmental and social standards to implementing parties, if they want to prevent negative vertical interplay.

Concluding, multilevel coordination was mostly found in cases that describe how international, national and subnational policy frameworks are implemented locally, besides cases that describe the implementation of international development projects. Both positive and negative vertical interplay was found, with positive interplay emerging when coordination expanded the human and financial capacity of local actors, while negative interplay emerged when high-level actors were not aware of the dynamics, interests and lack of capacity at lower levels.

F. Multilevel collaboration

Evidence was found of multilevel collaborative arrangements in 11 case studies. Five forest cases revolved around reforestation and natural regeneration, while five water cases dealt with estuary, wetland, mangrove and river restoration. One case focused on meadow restoration. Three different actor constellations were found: eight collaborations between governments and rural communities; two between governments at multiple levels; and two between

governments at multiple levels, civil society organisations and private actors.

Multilevel collaboration between governments and rural communities occurred in seven cases (F1bd, F2in, F3id, F4np, F5ph, F6vn, F7pt). Four cases in the global South described co-management arrangements that were established by international development projects to restore natural resources and concurrently improve livelihoods. To improve forest conservation and increase tree cover in protected areas, forest and environment departments (F1bd, F2in, F5ph) and a National Park authority (F3id) established community forest conservation and patrolling groups (F1bd, F3id), created micro-watershed management partnerships with rural communities (F2in) and issued mangrove stewardship contracts (F5ph). These collaborations detailed the respective roles and responsibilities of public and community actors, and focused on the sustainable management and restoration of public lands, and on alternative livelihoods to reduce local dependence on the forest. In three other cases, co-management arrangements were not part of development projects but embedded in national policy frameworks. These included forest user groups through which communities can manage and restore forests, based on a negotiated and approved management plan with district forest offices (F4np), and community mangrove management that allows communities to use planted and protected mangroves for livelihood activities, based on ownership contracts with local governments (F6vn). However, co-management did not always work out well (F7pt). One case describes the dissatisfaction of a community group with the lack of intervention by the National Forest Service in a co-managed forest that was degraded by fires, tree diseases and invasive species. The community ended the co-management status and initiated its own forest recovery plan.

Multilevel collaboration between governments was found in two cases (F8us, F9us). Both focus on efforts to restore coastal ecosystems, and involve both state level governments and federal agencies. In one case, a bay-wide management structure was created by three state level governments, a federal level agency and a task-specific organisation, to develop and implement multi-jurisdictional plans to improve water quality, and restore seagrass areas, oyster beds and wetlands in an estuary (F8us). Similarly, five state level governments founded an alliance to implement an action plan for healthy and resilient coasts, which was supported by 13 federal agencies. The plan included coastal ecosystem conservation and restoration as a priority, and involved federal, state and local governments to implement related efforts (F9us).

Multilevel collaboration between governments, civil society organisations and private actors was found in two cases (F11au, F10us). In both cases, governments at federal and regional level collaborated with civil society and private actors to engage in restoration efforts covering both public and private lands. In one case, a degraded meadow was restored through a commercial timber harvesting and meadow restoration plan that was initiated by corporate members of a Community Forest and Watershed Collaborative Group. By including the goals and concerns of state and federal level agencies at an early stage, a coherent, large-scale timber production and meadow restoration plan was created that encompassed both private and federal land (F10us). A similar public–private collaboration took place to restore threatened species in a river basin (F11au). A federal agency, which was tasked with buying back water entitlements from private actors and undertaking environmental watering events, created water delivery partnerships with civil society and private actors. The aim of these partnerships was to recover threatened plant and fish communities in wetlands and on floodplains that are both publicly and privately owned.

Most multilevel collaboration cases occurred between governments and rural communities who shared responsibilities to sustainably manage and restore natural resources, and improve livelihood benefits. The collaborations were established by international development projects and by national policy frameworks. In addition, collaboration between governments at different levels and between public, private and civil society actors has facilitated tapping into capacities that exist at different levels, and creating coherent restoration projects that cover both public and private land. Few challenges were reported in cases where multilevel collaboration was a dominant arrangement.

G. Multilevel learning

Evidence was found of restoration-related multilevel learning in 9 case studies. Three forest cases focused on reforestation, while four water cases dealt with river habitat, coastal habitat and wetland restoration. One case focused on ecological restoration, and another on invasive species eradication. Three forms of multilevel learning were distinguished: joint knowledge acquisition, experimentation and knowledge exchange.

Joint knowledge acquisition by actors at multiple levels occurred in three cases (G4fr, G5se, G7us). Joint knowledge acquisition helped building trust, positive relationships and create common understanding in cases where actors at different levels had diverging interests related to river habitat restoration (G4fr, G5se). In one case, a national water agency brought watermill owners, local elected officials and flood management experts together with scientists. Through interactive modelling of human and natural systems and role-playing games, the scientists created an understanding of the effects that certain decisions have, helped to find compromises and encouraged actors to elaborate a shared

watershed vision (G4fr). While multilevel learning helped actors in this case to converge flood management and restoration goals and redefine problems on common ground, similar learning-based efforts in another case failed to overcome power imbalances between hydropower companies and government actors when trying to reconcile different river uses and functions (G5se). Joint knowledge acquisition has been used to shape new restoration practices, such as when federal and state agencies, and civil society organisations engaged in blue carbon assessments and pilot projects to learn how to integrate blue carbon sinks, such as salt marshes, seagrass and mangroves, in national carbon accounting (G7us).

Experiments involving actors at multiple levels occurred in three cases (G3ph, G6mx, G9us). Experiments were conducted to eradicate invasive mammals from biodiverse islands (G6mx), reintroduce grey wolves in a declining ecosystem (G9us) and identify attractive agroforestry practices for farmers near a natural park (G3ph). In the case of invasive mammal eradication, experiments helped public, scientific and civil society actors to build experience and skills on small islands, and leverage success for eradication campaigns on larger, more complex islands. In another case, federal agencies reintroduced grey wolves in a National Park under experimental conditions, which meant that the wolves would not be protected under the Endangered Species Act in case they would cross the park's boundaries. This made ranchers surrounding the park accept the reintroduction, since wolves that would attack their livestock could be taken care of (G9us).

Knowledge exchange between actors at multiple levels was found in three cases (G1tz, G2ph, G8us). Knowledge and best practices were exchanged between national government officers and district extension officers to improve the delivery of soil conservation knowledge and promote farmer participation at community level (G1tz), between development project staff and a rural community to improve forest restoration (G2ph) and between national wildlife refuge managers and scientists to guide native habitat restoration (G8us). While joint knowledge acquisition enabled building trust and creating common understanding to introduce new restoration practices, experiments helped to gain experience and skills, and reduce uncertainty associated with new restoration practices. Lastly, knowledge exchange helped to improve local restoration practices by tapping into knowledge that is present at other levels.

H. Bridging organisations

Evidence was found of 7 bridging organisations, operating at different levels. The organisations appeared in five forest cases focused on natural regeneration and reforestation, including of riparian zones and forested corridors, and two water cases dealing with wetland and river habitat restoration. Three types of bridging roles were found: organisations bridging between international ideas or frameworks and local conditions; organisations bridging between national policy and private land users; and organisations bridging between rural communities and higher-level actors. In all cases, the bridging organisations were civil society organisations that engaged in knowledge sharing, agenda setting and brokering between governance levels.

Organisations bridging between international ideas or frameworks and local conditions were found in three cases (H1gh, H2cn, H4*eeu*). Conservation and development-oriented civil society organisations played an important role in translating global REDD + frameworks to local contexts. At the same time, they also transformed global frameworks by highlighting local conservation-related challenges and the need for social safeguards in REDD + (H1gh). In two other cases, the World Wide Fund for Nature linked international ideas related to integrated river basin management (H2cn) and floodplain conservation and restoration (H4*eeu*) to national policy processes. Through successful local demonstration projects, the Fund gained credibility among policy-makers and considerably contributed to the high-level acceptance of both ideas.

Organisations bridging national policies and private landowners were described in one case (H5cr). Associations, cooperatives and district centres in the agriculture, forestry and conservation sector were instrumental to connect a national payment for ecosystem services scheme to private landowners (H5cr). They recruited landowners and facilitated agreements between landowners and the National Forestry Fund to promote land management practices for which payment could be obtained, such as conservation, natural regeneration, reforestation and agroforestry. Additionally, they supplied complementary services that made landowners benefit economically from land management, beyond the payment for ecosystem services.

Bridging organisations that function as intermediaries between rural communities and higher-level actors were found in three cases (H3*ehi*, H6bo, H7br). In all cases, bridging organisations aimed to strengthen the role of rural communities in higher level restoration and land use planning processes. As part of an initiative to restore forested corridors between protected areas, a multilateral organisation advocated a multilevel approach and organised numerous participatory planning processes to involve rural communities, besides working with high-level actors (H3*ehi*). Similarly, civil society organisations connected previously excluded indigenous communities to local governments (H6bo) and agribusiness actors (H7br) to work on land use planning and reforestation. In conclusion, while playing different roles in different contexts, the various organisations have been instrumental in promoting restoration efforts by

tapping into ideas and linking to actors that are located at different governance levels.

I. Multilevel networks

We found evidence of 8 networks composed of actors at multiple levels. Two forest cases dealt with reforestation and forest landscape restoration; three water cases focused on a floodplain, river and river delta; and three other cases focused on addressing diverse ecoregions, fire-dependent ecosystems and native ecosystems. The identified networks comprised only public actors (I1rw, I7au), a mix of public and civil society actors (I2hu, I8ar, I5us, I6us, I3*glo*) or only civil society actors (I4us). Five networks had formal institutional structures, fixed events, set goals and budgetary support, while three others were informal groups with no fixed activities. While some networks emerged at local level, others were initiated at a higher level.

Formal networks were found in five cases (I3*glo*, I2hu, I8ar, I5us, I6us). One network had global outreach, bringing together national governments, multilateral actors and conservation-oriented civil society and research actors to exchange knowledge and strengthen conditions for forest landscape restoration to meet public restoration commitments (I3*glo*). Two networks were established at national level by both civil society and public actors, to promote landscape restoration efforts in different sub-national ecoregions (I8ar) and to develop and implement fire-dependent ecosystem restoration plans across administrative and managerial boundaries (I5us). The latter network received federal funding and involved over 650 actors, united in 150 landscape collaboratives and 14 regional communities of practice, to design and implement restoration plans. Lastly, two formal networks emerged at local level and were convened by civil society actors (I2hu, I6us). One network started by protecting and restoring biodiversity in one specific watershed, and later expanded its scope to regional level and facilitated the launch of a multitude of local clusters involving landowners, community groups, conservation organisations, scientists and tribal, municipal, state and federal agencies (I6us). In another case, a coalition of municipalities, civil society organisations and scientists emerged in a river basin to advance the integrated floodplain rehabilitation concept among national policy-makers and achieve flood prevention, rural development and nature conservation at local level (I2hu).

Informal networks were found in three cases (I1rw, I4us, I7au). Two networks were formed to exchange information. This varied from a WhatsApp group of national level and district level civil servants exchanging information on forest landscape restoration and reforestation policy challenges (I1rw), to state level scientific experts and catchment level extension staff informally exchanging information on recovery-based river management after staff and budget cuts had ended formal relationships between the two groups (I7au). Lastly, scientific and civil society actors formed a network to address water overallocation and restore environmental flows to restore bird habitat in a transboundary river delta (I4us). The network helped to shape public programmes and policies, and managed to establish a water trust that acquired permanent water rights to restore habitat.

All eight networks were instrumental to build skills, exchange knowledge and experiences, and create a professional identity. Often through informal face-to-face interaction, they facilitated a shared understanding of challenges and the pursuit of common restoration goals.

Discussion

First, we identified nine scale-sensitive governance arrangements that aim to create cross-scale fit and cross-level alignment. Second, we started this review to find evidence of these arrangements in the FLR literature. We wanted to understand their characteristics and how they have played out in practice. Based on 84 peer-reviewed, empirical articles, we found that eight of the nine types of scale-sensitive arrangements are used in FLR governance. The eight arrangements occurred in cases that targeted different natural resource types, indicating their prevalence in a wide variety of landscape restoration efforts. In addition, arrangements that are part of the same category were found at different governance levels or spanning different levels, which underlines the relevance of the arrangements from international to local level.

Evidence of cross-scale arrangements (B,C) showed how better fit can be created between the governance and ecological scales, by changing governance arrangements in such a way that ecological phenomena are governed at appropriate levels. When it comes to moving tasks to other levels (B), we found that for most cases, restoration tasks had been decentralised from the national level to regional and local governments, and down to rural communities, while only one case reported the centralisation of restoration tasks. It turned out to be difficult for national governments to anticipate or prevent new challenges and difficulties from emerging after such drastic governance measures. Still, decentralisation played an important role in engaging local actors, responding to local needs and preferences, and increasing local benefits. Meanwhile, centralisation of tasks enabled stronger government control in a context where this was judged to be required. We found task-specific organisations (C) at international, national and sub-national levels. It shows that this type of arrangement is seen as having an added value at multiple governance levels, to provide a public good or solve a common pool resource problem. However, similar to moving tasks to other levels, we found a number of challenges

associated with task-specific organisations, suggesting that their existence alone does not guarantee a smooth restoration process.

Due to its comprehensive nature, polycentric governance (D) is an arrangement that has both cross-scale and cross-level characteristics. We found that government actors at different levels have been active in orchestrating restoration processes that involve multiple actors at different levels. By setting targets, raising awareness and creating enabling policy frameworks, government actors stimulated other public and non-state actors at lower or similar governance levels to play relevant roles in restoration efforts while retaining their autonomy.

Evidence of cross-level arrangements (E,F,G,H,I) showed how increased alignment can be created between different governance levels by enhancing human and financial capacities to restore at other levels, sharing restoration responsibilities, and by connecting actors at different levels to facilitate learning, and share ideas and experiences. Multilevel coordination (E) mostly occurred in cases that focused on implementing international, national and sub-national policy frameworks, next to cases focused on international development projects. Cases highlighted both positive and negative interplay between actors at different governance levels, with the latter emerging when actors at one level were unaware of the dynamics, interests or lack of capacity that exist at other governance levels. In most cases, multilevel collaboration (F) has enabled governments and rural communities to share responsibilities to sustainably manage and restore natural resources. We found that different forms of collaboration facilitated tapping into capacities that are present at different levels and in some cases enabled creating coherent restoration projects that comprise both public and private land. When it comes to multilevel learning (G), joint knowledge acquisition among actors at multiple levels built trust and created a common understanding to introduce new restoration practices. Meanwhile, experiments that involved actors at multiple levels helped to gain experience and skills, and reduce uncertainty associated with new restoration practices, while knowledge exchange facilitated tapping into knowledge that is present at other levels. Lastly, bridging organisations (H) and multilevel networks (I) were instrumental to promote restoration efforts by tapping into ideas and linking to actors at different governance levels, and by exchanging experiences, facilitating learning and building skills.

Although we identified one dominant scale-sensitive governance arrangement for each case, the arrangements are not necessarily mutually exclusive but rather overlap in several cases. Different arrangements may occur simultaneously or sequentially. For example, a multilevel network of civil society organisations successfully lobbied for the establishment of a water trust, which is a task-specific organisation, to acquire permanent water rights to restore habitat in a river delta (I4us). In another case, a task-specific organisation that managed an estuary created a polycentric governance arrangement by establishing and funding watershed organisations that empowered local actors in different watersheds to work on local restoration priorities.

The scale-sensitive governance framework, which we elaborated and specified further based on the original notion (Padt et al. 2014), turns out to be well applicable to the FLR governance literature. The only arrangement that was not found is 'adding, removing or moving a general-purpose jurisdiction' (A). General-purpose jurisdictions, such as municipalities and provincial governments, fulfil a multitude of tasks that have no relation with the implementation of FLR, including education, healthcare, infrastructure maintenance and waste collection. Given the low priority that is generally given to environmental management by public actors, it is unlikely that a measure like category A would be justified to reach ecological objectives. The impact that this governance arrangement would have on other tasks of a jurisdiction makes this option impractical. Such a drastic measure might also not needed, given that there are other options to aim at creating better fit with ecological processes that do not impact the functioning of other government departments.

For each of the other eight governance arrangements, a minimum of seven and a maximum of nineteen cases was found, giving a rich picture of how FLR has been advanced by different scale-sensitive governance arrangements. While some of the arrangements, such as task-specific organisations or multilevel networks, were easily recognisable, others were harder to distinguish, given that the way in which they play out in practice is relatively similar. An example is polycentric governance and multilevel coordination that represent fairly loose interactions between different governance levels, and hence require a relatively thick description of the governance context to be distinguished.

In Table 2, we summarise the contributions and related challenges of the eight arrangements we found in the FLR literature. Different suggestions can be made to overcome the challenges. First, the presence of governance arrangements that aim to create fit with ecological processes seems to be not enough to guarantee smooth restoration efforts. The high prevalence of cross-level challenges suggests that additional governance arrangements are needed that are aimed at cross-level alignment; so that actors at multiple levels can interact and provide feedback about the challenges that follow a redesign of the governance scale. Second, it seems crucial that restoration governance efforts take a long-term perspective in which there is room to acknowledge and balance the needs and interests that exist at different levels, and iteratively manage challenges that arise. To overcome cross-level challenges, it is necessary that both higher level as well

Table 2 Summary of the main contributions of, and challenges related to, the identified scale-sensitive governance arrangements in the FLR literature

Arrangement	Main contribution	Challenges encountered
B. Moving tasks to higher or lower governance levels	Decentralisation: Increased local ownership; Improved response to local preferences and needs; Strengthened local land rights; Increased local options to benefit from ecosystem functions and improve livelihoods Centralisation: Increased consistency and control to deal with natural resource management challenges	Decentralisation: High-level targets and rules lacked consideration for local conditions, capacities and interests; Impeded community engagement because of upward accountability; Caused inadequate local practices because of absent national monitoring and support mechanisms, as well as checks-and-balances Centralisation: Reduced local legitimacy and enlarged implementation deficit
C. Task-specific organisations	Facilitated transboundary efforts; Increased public attention for environmental governance; Created financial and institutional stability to plan and implement environmental governance	Lacked effectiveness when missing transparency and accountability towards local actors, and when not being sensitive towards local needs; Lacked impact when being in a convening instead of an implementing role
D. Polycentric governance	Higher-level policy frameworks, awareness raising and target setting encouraged implementation of locally appropriate measures, new policy instruments and cross-level synergy	*No challenges were identified in the polycentric governance cases*
E. Multilevel coordination	Facilitated the implementation of policy frameworks and international development projects across levels; Facilitated synergy between public and private efforts at various levels	Resulted challenging when trade-offs between economic and ecological uses had to be found, planning efforts occurred in isolation or disputes arose about legitimacy or maintenance; Did not result in stronger local implementation capacity, when it was short-term
F. Multilevel collaboration	Facilitated tapping into capacities at different levels to promote environmental governance and strengthen livelihoods; Facilitated synergy between public and private efforts at various levels	Resulted challenging when the efforts of one actor did not meet the expectations of another actor
G. Multilevel learning	Created trust, positive relations and common understanding between actors at different levels, through joint knowledge acquisition; Created experience and skills, and reduced uncertainty through experimentation; Facilitated tapping into knowledge at other levels through exchange	Failed to overcome power imbalances when actors sought ways to reconcile economic uses and ecological functions
H. Bridging organisations	Connected international ideas and frameworks to local conditions; Connected higher-level policy frameworks and actors to rural communities and landowners	*No challenges were identified in the bridging organisation cases*
I. Multilevel networks	Facilitated building skills, exchange knowledge and experiences, and creating a professional identity by bringing actors together; Facilitated shared understanding of challenges and pursuit of common goals among actors at different levels	*No challenges were identified in the multilevel network cases*

as lower level restoration actors show genuine willingness to work together to make restoration efforts a success.

While the 84 cases offer a comprehensive overview of how scale-sensitive governance arrangements have played out in practice, this review does not give an exhaustive overview. More examples can likely be found in both the scientific and grey literature that fell outside our search terms' reach. In addition, to obtain the dataset for this review, we selected search terms that capture arrangements that create better spatial fit between the governance and ecological scales, and arrangements that better align different governance levels. While also relevant, we did not focus on cases that specifically create better temporal fit between the governance and ecological scales.

When it comes to the cases that are reported in the literature, there is a bias towards countries in the global North where strong restoration-related policies exist (e.g. the US and European Union member states) and relatively safe countries in Latin America, Sub-Saharan Africa and Southeast Asia where international development partners implement FLR efforts. There are few reported cases from the former Soviet Union, the Middle East and Northern Africa, or from conflict regions like Afghanistan, the Sahel, Horn of Africa and the Congo Basin. Nevertheless, it is important to also capture lessons from these regions related to how FLR is governed. When efforts of civil society organisations or international actors are studied, it is possible that most emphasis is placed on the achievements, positive impact and future potential of the restoration strategies they implement, while less attention is given to the challenges associated with these strategies. This could explain the lack of challenges reported as part of some governance arrangements, like bridging organisations and multilevel networks. Furthermore, underlying motivations are likely to influence how restoration efforts are carried out. Actors will make different choices when they primarily have soil and water conservation, ecological connectivity, carbon sequestration or rural livelihoods in mind. This will not only influence their restoration strategies but also the spatial and temporal reach of their strategies. In arid regions, soil and water conservation are likely to be a main motivation, while in tropical regions, ecological connectivity and carbon sequestration are more prominent.

The governance arrangements that are used across multiple governance levels to promote FLR at local level, as well as the challenges these arrangements face, have often been overlooked in the FLR literature (Wiegant et al. 2020). By presenting evidence of how scale-sensitive governance arrangements were used to promote FLR, we aim to give practical ideas to improve ongoing and future environmental governance efforts, while informing governance actors about the challenges that are found as part of specific arrangements. However, a better understanding of the scale-sensitive governance arrangements that aim to create cross-scale fit and cross-level alignment to promote FLR is not enough. Our review shows that new mismatch and misalignment can follow the establishment of a scale-sensitive governance arrangement. This suggests that it can be hard to create sustainable cross-scale fit and cross-level alignment. Hence, future research efforts need to focus on the governance strategies that are implemented by governance arrangements to overcome new challenges that emerge in the FLR implementation process. Exploratory case study research could help in identifying such governance strategies and clarify their relationship to the challenges they aim to address.

Conclusion

We proposed a conceptual framework of nine scale-sensitive governance arrangements that are relevant for the wider natural resource management community. By applying the scale-sensitive governance framework to the FLR literature, we obtained evidence for how eight of these scale-sensitive governance arrangements played out in practice, to create better fit between the governance and ecological scales, and/or better alignment between governance levels. The 84 case studies on which this review builds gave a grounded understanding of how cross-scale fit and cross-level alignment can be created in forest and landscape restoration governance. For several scale-sensitive governance arrangements, we identified a number of related challenges, indicating that the presence of scale-sensitive governance arrangements is not enough to guarantee a smooth restoration process. Rather, continuous effort and follow-up action are needed to address new challenges that emerge when governance arrangements are altered. Our comprehensive overview of the different governance arrangements can be helpful to improve environmental governance across scales and levels, and could contribute to make the UN Decade on Ecosystem Restoration a success.

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Declarations

Conflict of interest The authors declare no competing interests.

References

Agrawal A, Ribot J (1999) Accountability in decentralization: a framework with South Asian and West African cases. J Dev Areas 33:473–502. https://doi.org/10.2307/4192885

Aguirre-Muñoz A, Croll DA, Donlan CJ, Henry III RW, Hermosillo MA, et al (2008) High-impact conservation: invasive mammal eradications from the islands of Western México. Ambio 37:101–107. https://doi.org/10.1579/0044-7447(2008)37[101:HCIMEF]2.0.CO;2

Alcorn JB, Zarzycki A, de la Cruz LM (2010) Poverty, governance and conservation in the Gran Chaco of South America. Biodiversity 11:39–44. https://doi.org/10.1080/14888386.2010.9712645

Andersson KP, Ostrom E (2008) Analyzing decentralized resource regimes from a polycentric perspective. Policy Sci 41:71–93. https://doi.org/10.1007/s11077-007-9055-6

Ansell C, Gash A (2007) Collaborative governance in theory and practice. J Public Adm Res Theory 18:543–571. https://doi.org/10.1093/jopart/mum032

Atela JO, Quinn CH, Minang PA, Duguma LA, Houdet JA (2016) Implementing REDD plus at the national level: stakeholder engagement and policy coherences between REDD plus rules and Kenya's sectoral policies. For POLICY Econ 65:37–46. https://doi.org/10.1016/j.forpol.2016.01.003

Barthélémy C, Souchon Y (2009) A sociologist's and an ecologist's critical view of the Rhone river restoration programme | La restauration écologique du fleuve Rhône sous le double regard du sociologue et de l'écologue. Natures Sci Soc 17:113–121. https://doi.org/10.1051/nss/2009025

Baynes J, Herbohn J, Dressler W (2016) Power relationships: their effect on the governance of community forestry in the Philippines. Land Use Policy 54:169–176. https://doi.org/10.1016/j.landusepol.2016.01.008

Bazeley P (2013) Qualitative data analysis: practical strategies. Sage Publication Ltd.

Berkes F (2009) Evolution of co-management: role of knowledge generation, bridging organizations and social learning. J Environ Manage 90:1692–1702. https://doi.org/10.1016/j.jenvman.2008.12.001

den Besten JW Arts B Behagel J (2019) Spiders in the web: understanding the evolution of REDD plus in Southwest Ghana. FORESTS 10:. https://doi.org/10.3390/f10020117

te Boekhorst DGJ, Smits TJM, Yu X, Li L, Lei G, et al (2010) Implementing integrated river basin management in China. Ecol Soc 15:

Borgström S, Zachrisson A, Eckerberg K (2016) Funding ecological restoration policy in practice-patterns of short-termism and regional biases. Land Use Policy 52:439–453. https://doi.org/10.1016/j.landusepol.2016.01.004

Buergin R (2016) Ecosystem restoration concessions in Indonesia: conflicts and discourses. Crit Asian Stud 48:278–301. https://doi.org/10.1080/14672715.2016.1164017

Carlisle K, Gruby RL (2019) Polycentric systems of governance: a theoretical model for the commons. Policy Stud J 47:921–946. https://doi.org/10.1111/psj.12212

Carollo C, Reed DJ (2010) Ecosystem-based management institutional design: balance between federal, state, and local governments within the Gulf of Mexico Alliance. Mar Policy 34:178–181. https://doi.org/10.1016/j.marpol.2009.06.002

Carre C, Haghe JP, De Coninck A, Becu N, Deroubaix JF, et al (2014) How to integrate scientific models in order to switch from flood control river management to multifunctional river management? Int J River Basin Manag 12:231–249. https://doi.org/10.1080/15715124.2014.885439

Cash DW (2000) Distributed assessment systems: an emerging paradigm of research assessment and decision-making for environmental change. Glob Environ Chang 10:241–244. https://doi.org/10.1016/S0959-3780(00)00031-5

Cash DW, Moser SC (2000) Linking global and local scales: designing dynamic assessment and management processes. Glob Environ Chang 10:109–120. https://doi.org/10.1016/S0959-3780(00)00017-0

Cash DW, Adger WN, Berkes F, Garden P, Lebel L, et al (2006) Scale and cross-scale dynamics: governance and information in a multilevel world. Ecol Soc 11:8. https://doi.org/10.5751/ES-01759-110208

Chazdon RL, Brancalion PHS, Laestadius L, Bennett-Curry A, Buckingham K, et al (2016) When is a forest a forest? Forest concepts and definitions in the era of forest and landscape restoration. Ambio 45:538–550. https://doi.org/10.1007/s13280-016-0772-y

Chazdon RL, Wilson SJ, Brondizio E, Guariguata MR, Herbohn J (2020) Key challenges for governing forest and landscape restoration across different contexts. Land Use Policy 104:104854. https://doi.org/10.1016/j.landusepol.2020.104854

Chen C Matzdorf B Zhen L Schröter B (2020) Social-Network Analysis of local governance models for China's eco-compensation program. Ecosyst Serv 45:. https://doi.org/10.1016/j.ecoser.2020.101191

Chettri N, Sharma E, Shakya B, Bajracharya B (2007) Developing forested conservation corridors in the Kangchenjunga landscape, Eastern Himalaya. Mt Res Dev 27:211–214. https://doi.org/10.1659/mrd.0923

Chowdhury FI, Islam K, Faroque MA, Islam KN, Rahman MF, et al (2020) Assessing the impacts of co-management on protected area landscape under socio-imagery lens: evidence from Bangladesh. J Sustain For. https://doi.org/10.1080/10549811.2020.1747497

Clement F (2010) Analysing decentralised natural resource governance: proposition for a "politicised" institutional analysis and development framework. Policy Sci 43:129–156. https://doi.org/10.1007/s11077-009-9100-8

Coffey A, Atkinson P (1996) Making sense of qualitative data: complementary research strategies. Sage Publications, Thousand Oaks, CA

Le Coq J-F, Segura FS (2016) The local intermediary organizations, a key actor for the implementation and results of the program of payment for environmental services in Costa Rica. Dev DURABLE Territ 7:

Corbau C, Munari C, Mistri M, Lovo S, Simeoni U (2016) Application of the principles of ICZM for restoring the Goro Lagoon. Coast Manag 44:350–365. https://doi.org/10.1080/08920753.2016.1155040

Cumming GS, Olsson P, Chapin FS, Holling CS (2013) Resilience, experimentation, and scale mismatches in social-ecological landscapes. Landsc Ecol 28:1139–1150. https://doi.org/10.1007/s10980-012-9725-4

Danesh-Yazdi M, Ataie-Ashtiani B (2019) Lake Urmia crisis and restoration plan: planning without appropriate data and model is gambling. J Hydrol 576:639–651. https://doi.org/10.1016/j.jhydrol.2019.06.068

Dang TKP, Van Der Zouwen M, Arts B (2019) Challenges of forest governance: the case of forest rehabilitation in Vietnam. Public Organ Rev 19:425–452. https://doi.org/10.1007/s11115-018-0414-x

de Boer C, Bressers H (2012) New strategies for implementing locally integrated stream restoration projects. Environ Pract 14:26–34. https://doi.org/10.1017/S1466046611000500

de Boer C, Bressers H (2013) Water resource co-management and sustainable regional development. Manag Res Rev 36:1238–1251. https://doi.org/10.1108/MRR-07-2013-0160

Dewulf A François G Pahl-Wostl C Taillieu T (2007) A framing approach to cross-disciplinary research collaboration: experiences from a large-scale research project on adaptive water management. Ecol Soc 12:. https://doi.org/10.5751/ES-02142-120214

Díaz S, Pascual U, Stenseke M, Martín-López B, Watson RT, et al (2018) Assessing nature's contributions to people: recognizing culture, and diverse sources of knowledge, can improve assessments. Science (80-.). 359:270–272

Emerson K, Nabatchi T, Balogh S (2011) An integrative framework for collaborative governance. J Public Adm Res Theory 22:1–29. https://doi.org/10.1093/jopart/mur011

Erickson A (2015) Efficient and resilient governance of social-ecological systems. Ambio 44:343–352. https://doi.org/10.1007/s13280-014-0607-7

Fischer AP (2015) A boundary-spanning organization for transdisciplinary science on land stewardship: The Stewardship Network. Ecol Soc 20:. https://doi.org/10.5751/ES-08121-200438

Fliervoet JM, van den Born RJG, Meijerink SV (2017) A stakeholder's evaluation of collaborative processes for maintaining multi-functional floodplains: a Dutch case study. Int J River Basin Manag 15:175–186. https://doi.org/10.1080/15715124.2017.1295384

Folke C, Hahn T, Olsson P, Norberg J (2005) Adaptive governance of social-ecological systems. Annu Rev Environ Resour 30:441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Furumo PR Lambin EF (2020) Scaling up zero-deforestation initiatives through public-private partnerships: a look inside post-conflict Colombia. Glob Environ Chang 62:. https://doi.org/10.1016/j.gloenvcha.2020.102055

Garrity DP, Amoroso VB, Koffa S, Catacutan D, Buenavista G, et al (2002) Landcare on the poverty-protection interface in an Asian watershed. Conserv Ecol 6:

Gautam AP, Shivakoti GP, Webb EL (2004) A review of forest policies, institutions, and changes in the resource condition in Nepal. Int for Rev 6:136–148. https://doi.org/10.1505/ifor.6.2.136.38397

Gerlak AK (2015) Resistance and reform: transboundary water governance in the Colorado River Delta. Rev Policy Res 32:100–123. https://doi.org/10.1111/ropr.12114

Godden L, Cowell S (2016) Conservation planning and indigenous governance in Australia's Indigenous Protected Areas. Restor Ecol 24:692–697. https://doi.org/10.1111/rec.12394

Goldstein BE, Butler WH (2010) Expanding the scope and impact of collaborative planning. J Am Plan Assoc 76:238–249. https://doi.org/10.1080/01944361003646463

Gonzales-Iwanciw J Dewulf A Karlsson-Vinkhuyzen S (2019) Learning in multi-level governance of adaptation to climate change–a literature review. J Environ Plan Manag. https://doi.org/10.1080/09640568.2019.1594725

Gray B, Purdy J (2018) Collaborating for our future : multistakeholder partnerships for solving complex problems. OUP Oxford, Oxford

Gregorio N Herbohn J Tripoli R Pasa A (2020) A Local initiative to achieve global forest and landscape restoration challenge-lessons learned from a community-based forest restoration project in Biliran province, Philippines. Forests 11:. https://doi.org/10.3390/F11040475

Hagen D, Svavarsdottir K, Nilsson C, Tolvanen AK, Raulund-Rasmussen K, et al (2013) Ecological and social dimensions of ecosystem restoration in the nordic countries. Ecol Soc 18:. https://doi.org/10.5751/ES-05891-180434

Harada K, Prabowo D, Aliadi A, Ichihara J, Ma H-O (2015) How can social safeguards of REDD+ function effectively conserve forests and improve local livelihoods? A case from Meru Betiri National Park, East Java, Indonesia. Land 4:119–139. https://doi.org/10.3390/land4010119

He J (2014) Governing forest restoration: local case studies of sloping land conversion program in Southwest China. For Policy Econ 46:30–38. https://doi.org/10.1016/j.forpol.2014.05.004

He J, Xu J (2017) Is there decentralization in North Korea? Evidence and lessons from the sloping land management program 2004–2014. Land Use Policy 61:113–125. https://doi.org/10.1016/j.landusepol.2016.11.020

Herawati T, Mwangi E, Liswanti N (2019) Implementing forest tenure reforms: perspectives from Indonesia's forestry agencies. Indones J For Res 6:117–132. https://doi.org/10.20886/ijfr.2019.6.2.117-132

Holder CD (2016) Multiscale forest governance structures within a transboundary biosphere reserve in Central America. World Dev Perspect 3:22–24. https://doi.org/10.1016/j.wdp.2016.11.005

Holl KD (2017) Research directions in tropical forest restoration. Ann Missouri Bot Gard 102:237–250

Hooghe L, Marks G (2003) Unraveling the central state, but how? Types of multi-level governance. Inst Adv Stud

Jankju M (2016) Potential and constraints on dryland restoration: case studies from Iran

Katon BM, Pomeroy RS, Garces LR, Ring MW (2000) Rehabilitating the mangrove resources of Cogtong Bay, Philippines: a comanagement perspective. Coast Manag 28:29–37

Kaushal KK, Melkani VK, Kala JC (2005) Sustainable poverty alleviation through a forestry project in Tamilnadu State of India. Int J Sustain Dev World Ecol 12:347–352. https://doi.org/10.1080/13504500509469644

Keen M, Brown VA, Dyball R (2005) Social learning in environmental management - towards a sustainable future. Earthscan, Taylor and Francis Group, London

Kelly E, Kusel J (2015) Cooperative, cross-boundary management facilitates large-scale ecosystem restoration efforts. Calif Agric 69:50–56. https://doi.org/10.3733/ca.v069n01p50

Koontz TM (2019) The science–policy nexus in collaborative governance: use of science in ecosystem recovery planning. Rev Policy Res 36:708–735. https://doi.org/10.1111/ropr.12362

Kumeh EM, Kyereh B, Oduro KA, Brobbey LK, Nketiah SK (2019) Transparency in the governance of landscape restoration finance: a case study of Ghana's Forest Plantation Development Fund. Sci African 6:. https://doi.org/10.1016/j.sciaf.2019.e00185

Lane R, Wills J, Vanclay F, Lucas D (2008) Vernacular heritage and evolving environmental policy in Australia: lessons from the Murray-Darling Outreach Project. Geoforum 39:1308–1320. https://doi.org/10.1016/j.geoforum.2007.08.002

Langridge S (2016) Social and biophysical context influences county-level support for collaborative watershed restoration: case study of the Sacramento River, CA, USA. Ecol Restor 34:285–296. https://doi.org/10.3368/er.34.4.285

Magaudda S, D'Ascanio R, Muccitelli S, Palazzo AL (2020) "Greening" green infrastructure. Good italian practices for enhancing green infrastructure through the common agricultural policy. Sustain 12:1–22. https://doi.org/10.3390/su12062301

Mansourian S, Razafimahatratra A, Ranjatson P, Rambeloarisao G (2016) Novel governance for forest landscape restoration in Fandriana Marolambo, Madagascar. World Dev Perspect 3:28–31. https://doi.org/10.1016/j.wdp.2016.11.009

Mansourian S, Walters G, Gonzales E (2019) Identifying governance problems and solutions for forest landscape restoration in protected area landscapes. Parks 25:83–96. https://doi.org/10.2305/IUCN.CH.2019.PARKS-25-1SM.en

Mao K, Zhang Q (2018) Dilemmas of state-led environmental conservation in China: environmental target enforcement and public participation in Minqin County. Soc Nat Resour 31:615–631. https://doi.org/10.1080/08941920.2017.1422063

Margerum RD, Whitall D (2004) The challenges and implications of collaborative management on a river basin scale. J Environ Plan Manag 47:407–427. https://doi.org/10.1080/0964056042000216537

Marks G, Hooghe L (2004) Contrasting visions of multi-level governance. In: Bache I, Flinders M (eds) Multi-level governance. pp 15–30

McLain RJ, Lee RG (1996) Adaptive management: promises and pitfalls. Environ Manage 20:437–448. https://doi.org/10.1007/BF01474647

Miles MB, Huberman AM (1994) Qualitative data analysis; an expanded sourcebook. SAGE Publications Inc, Second Edi

Mould S Fryirs K Howitt R (2020) Relationships, social networks and the emergence of recovery-based river management: implications for practice and policy. Mar Freshw Res. https://doi.org/10.1071/MF20065

Ofoulhast-Othamot G (2015) The quest for sustainable and decentralized forest governance in Eastern Cameroon: the Dimako Council Forest case examined. Small-Scale for 14:363–379. https://doi.org/10.1007/s11842-015-9293-y

Olsson P, Gunderson LH, Carpenter SR, Ryan P, Lebel L, et al (2006) Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. Ecol Soc 11:18. https://doi.org/10.2307/26267806

Ostrom E (2010) Polycentric systems for coping with collective action and global environmental change. Glob Environ Chang 20:550–557. https://doi.org/10.1016/j.gloenvcha.2010.07.004

Ota L, Chazdon RL, Herbohn J, Gregorio N, Mukul SA, et al (2020) Achieving quality forest and landscape restoration in the tropics. Forests 11:. https://doi.org/10.3390/f11080820

Owens K (2016) Reimagining water buybacks in Australia: non-governmental organisations, complementary initiatives and private capital. Environ Plan Law J 33:342–355

Padt F, Arts B (2014) Concepts of scale. In: Padt F, Opdam PFM, Termeer CJAM, Polman N (eds) Scale-sensitive governance of the environment. Wiley, p 344

Padt F, Opdam P, Polman N, Termeer C (2014) Scale-sensitive governance of the environment. Wiley Blackwell

Pahl-Wostl C (2009) A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. Glob Environ Chang 19:354–365. https://doi.org/10.1016/j.gloenvcha.2009.06.001

Peters BG (2018) The challenge of policy coordination. Policy Des Pract 1:1–11. https://doi.org/10.1080/25741292.2018.1437946

Petticrew M, Roberts H (2006) Systematic reviews in the social sciences: a practical guide. Blackwell Publishing

Piketty M-G, Poccard-Chapuis R, Drigo I, Coudel E, Plassin S, et al (2015) Multi-level governance of land use changes in the Brazilian Amazon: lessons from Paragominas, State of Pará. Forests 6:1516–1536. https://doi.org/10.3390/f6051516

Pörtner H., Scholes RJ, Agard J, Archer E, Arneth A, et al (2021) IPBES-IPCC co-sponsored workshop report on biodiversity and climate change

Randall CW (2001) Nutrient reduction policies and management strategies of the Chesapeake Bay water quality restoration program. Water Sci Technol 44:25–32. https://doi.org/10.2166/wst.2001.0006

Rantala S, Hajjar R, Skutsch M (2014) Multilevel governance for forests and climate change: learning from Southern Mexico. Forests 5:3147–3168. https://doi.org/10.3390/f5123147

Ribot JC, Agrawal A, Larson AM (2006) Recentralizing while decentralizing: how national governments reappropriate forest resources. World Dev 34:1864–1886. https://doi.org/10.1016/j.worlddev.2005.11.020

Richards RC, Rerolle J, Aronson J, Pereira PH, Gonçalves H, et al (2015) Governing a pioneer program on payment for watershed services: stakeholder involvement, legal frameworks and early lessons from the Atlantic forest of Brazil. Ecosyst Serv 16:23–32. https://doi.org/10.1016/j.ecoser.2015.09.002

Ross A Connell D (2016) The evolution and performance of river basin management in the Murray-Darling Basin. Ecol Soc 21:. https://doi.org/10.5751/ES-08664-210329

Ros-Tonen MAF, Derkyi M, Insaidoo TFG (2014) From co-management to landscape governance: Whither Ghana's modified taungya system? Forests 5:2996–3021. https://doi.org/10.3390/f5122996

Rudberg PM Smits M (2018) Learning-based intervention for river restoration: analyzing the lack of outcomes in the Ljusnan River Basin, Sweden. Ecol Soc 23:. https://doi.org/10.5751/ES-10472-230413

Saint-Laurent C, Carle J (2006) Looking at the bigger picture: the global partnership on forest landscape restoration. Unasylva 57:40–42

Sales E, Rodas O, Valenzuela O, Hillbrand A, Sabogal C (2016) On the way to restore Guatemala's degraded lands: creating governance conditions. World Dev Perspect 4:16–18. https://doi.org/10.1016/j.wdp.2016.11.010

Schwartzman S, Zimmerman B (2005) Conservation alliances with indigenous peoples of the Amazon. Conserv Biol 19:721–727. https://doi.org/10.1111/j.1523-1739.2005.00695.x

Schweizer D, van Kuijk M, Meli P, Bernardini L, Ghazoul J (2019) Narratives across scales on barriers and strategies for upscaling forest restoration: a Brazilian case study. Forests 10:. https://doi.org/10.3390/f10070530

Secco L, Pettenella D, Gatto P (2011) Forestry governance and collective learning process in Italy: likelihood or utopia? For Policy Econ 13:104–112. https://doi.org/10.1016/j.forpol.2010.04.002

Serra R, Ferreira P, Skulska I, Alavez-Vargas M, Salgado A, et al (2016) Education for sustainability in the context of community forestry

Shrestha RP, Ligonja PJ (2015) Social perception of soil conservation benefits in Kondoa eroded area of Tanzania. Int Soil Water Conserv Res 3:183–195. https://doi.org/10.1016/j.iswcr.2015.08.001

Smith LM, Euliss NH Jr, Wilcox DA, Brinson MM (2008) Application of a geomorphic and temporal perspective to wetland management in North America. Wetlands 28:563–577. https://doi.org/10.1672/07-155.1

Sommerwerk N, Bloesch J, Paunovi M, Baumgartner C, Venohr M, et al (2010) Managing the worlds most international river: the Danube River Basin. Mar Freshw Res 61:736–748. https://doi.org/10.1071/MF09229

Spencer L, Ritchie J, Ormston R, O'Connor W, Barnard M (2014) Analysis: principles and processes. In: Ritchie J, Lewis J, McNaughton Nicholls C, Ormston R (eds) Qualitative research practice. Natcen, SAGE Publications Ltd, London

Stephenson P (2013) Twenty years of multi-level governance: "where does it come from? What is it? Where is it going?" J Eur Public Policy 20:817–837. https://doi.org/10.1080/13501763.2013.781818

Stumpff LM (2006) Research article: Reweaving earth: an indigenous perspective on restoration planning and the National Environmental Policy Act. Environ Pract 8:93–103. https://doi.org/10.1017/S1466046606060121

Sutton-Grier AE, Moore A (2016) Leveraging carbon services of coastal ecosystems for habitat protection and restoration. Coast Manag 44:259–277. https://doi.org/10.1080/08920753.2016.1160206

Tankibayeva A, Adibayeva A (2019) Relational equity management in water-energy-food nexus governance the case of the aral sea basin restoration programmes

Temperton VM, Buchmann N, Buisson E, Durigan G, Kazmierczak L, et al (2019) Step back from the forest and step up to the Bonn Challenge: how a broad ecological perspective can promote successful landscape restoration. Restor Ecol 27:705–719. https://doi.org/10.1111/rec.12989

Termeer CJAM, Dewulf A, Karlsson-Vinkhuyzen SI, Vink M, van Vliet M (2016) Coping with the wicked problem of climate adaptation across scales: the Five R Governance Capabilities. Landsc Urban Plan 154:11–19. https://doi.org/10.1016/j.landurbplan.2016.01.007

Termeer CJAM, Dewulf A (2014) Scale-sensitivity as a governance capability: observing, acting and enabling. In: Padt F, Opdam PFM, Termeer CJAM, Polman N (eds) Scale-sensitive governance of the environment. Wiley, p 344

Tesch R (1990) Qualitative research: analysis types and software tools. The Falmer Press, New York

Thompson BS (2018) The political ecology of mangrove forest restoration in Thailand: institutional arrangements and power dynamics. Land Use Policy 78:503–514. https://doi.org/10.1016/j.landusepol.2018.07.016

Torfing J (2012) Interactive Governance. Oxford Univ Press 91:1689–1699

Tougiani A, Guero C, Rinaudo T (2009) Community mobilisation for improved livelihoods through tree crop management in Niger. GeoJournal 74:377–389. https://doi.org/10.1007/s10708-008-9228-7

Turnock D (2001) Cross-border conservation in East Central Europe: the Danube-Carpathian complex and the contribution of the World Wide Fund for Nature. GeoJournal 55:655–681. https://doi.org/10.1023/a:1021709515847

van Oosten C, Uzamukunda A, Runhaar H (2018) Strategies for achieving environmental policy integration at the landscape level. A framework illustrated with an analysis of landscape governance in Rwanda. Environ Sci Policy 83:63–70. https://doi.org/10.1016/j.envsci.2018.02.002

Veettil BK, Ward RD, Quang NX, Trang NTT, Giang TH (2019) Mangroves of Vietnam: historical development, current state of research and future threats. Estuar Coast Shelf Sci 218:212–236. https://doi.org/10.1016/j.ecss.2018.12.021

Verweij M (2017) The remarkable restoration of the Rhine: plural rationalities in regional water politics. WATER Int 42:207–221. https://doi.org/10.1080/02508060.2017.1278576

Vijge MJ, Gupta A (2014) Framing REDD+ in India: carbonizing and centralizing Indian forest governance? Environ Sci Policy 38:17–27. https://doi.org/10.1016/j.envsci.2013.10.012

Vrangbæk K (2010) Structural reform in Denmark, 2007–09: central reform processes in a decentralised environment. Local Gov Stud 36:205–221. https://doi.org/10.1080/03003930903560562

Werners SE, Matczak P, Flachner Z (2010) Individuals matter: exploring strategies of individuals to change the water policy for the Tisza River in Hungary. Ecol Soc 15:

Wiegant D Peralvo M van Oel P Dewulf A (2020) Five scale challenges in Ecuadorian forest and landscape restoration governance. Land use policy 96:. https://doi.org/10.1016/j.landusepol.2020.104686

Wilson SJ, Cagalanan D (2016) Governing restoration: strategies, adaptations and innovations for tomorrow's forest landscapes. World Dev Perspect 4:11–15. https://doi.org/10.1016/j.wdp.2016.11.015

Yin R, Yin G (2009) China's ecological restoration programs: initiation, implementation, and challenges

Young O (2006) Vertical interplay among scale-dependent environmental and resource eegimes. Ecol Soc 11:

Zahniser A, Singh A (2004) Return of the wolves to yellowstone national park, USA: a model of ecosystem restoration. Biodiversity 5:3–7. https://doi.org/10.1080/14888386.2004.9712742

Zuleta G, Rovere AE, Pérez D, Campanello PI, Guida Johnson B, et al (2015) Establishing the ecological restoration network in Argentina: from Rio 1992 to SIACRE2015. Restor Ecol 23:95–103. https://doi.org/10.1111/rec.12198