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Ecuadorian water funds' use of scale-sensitive strategies to stay on course in forest and landscape restoration governance

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ABSTRACT

Water funds are task-specific organisations that conserve and restore watersheds. The funds provide sustained finance and a collaborative space for actors at different levels to improve the water regulation functions of upstream ecosystems, safeguard water quality, and establish ecological connectivity with the aim of ensuring downstream water quantity and quality. However, while implementing conservation and restoration efforts at local level, water funds encounter scale challenges, consisting of mismatches between the ecological and the governance scale and misalignment between governance levels. This study's aim is to identify and unravel both the scale challenges with which two Ecuadorian water funds (FONAG and FORAGUA) were confronted and the scale-sensitive governance strategies that they planned and deployed to overcome them. We collected data through a document review, 48 semi-structured interviews, and participatory observation, and used content analysis methods to analyse the interview transcripts. Consequently, at both funds, we identified a blind spot towards rural livelihood realities, a temporal mismatch between short-term election cycles and long-term restoration timelines, and a spatial mismatch between the reach of restoration efforts and degradation processes. At FORAGUA, we also identified heterogeneity across levels regarding the purpose of restoration, with different spatial implications. We identified a total of 12 tailored strategies that the two water funds deployed or aim to deploy in reaction to these challenges in an attempt to re-create fit with ecological processes and alignment with other governance levels. Some of these strategies caused new scale challenges to emerge. By observing and acting on emerging scale challenges, water funds try to stay on course to achieve restoration objectives. We conclude that the water funds, which are governance arrangements designed to create spatial and temporal fit with ecological processes, have to continuously adapt their governance strategies to maintain cross-scale fit and cross-level alignment.

1. Introduction

Mountain forests and humid grasslands (*páramos*), as found in the Ecuadorian Andes, fulfil important ecosystem functions such as water regulation and water quality improvement, habitat provision, and carbon sequestration (Buytaert et al., 2006; Martín-López et al., 2019; Rolando et al., 2017). The ability of these forests – and particularly the *páramo* – to store, infiltrate, and slowly release large quantities of water reduces the adverse effects of drought and flooding, and their ability to retain sediments and nutrients ensures excellent water quality. *Páramo* water is used intensively for consumption, irrigation, and hydropower generation, and some Andean cities depend almost completely on it (Buytaert et al., 2006). In addition, the region is home to two biodiversity hotspots – the Tropical Andes and the Tumbes-Chocó-Magdalena Corridor (Mittermeier et al., 2011) – which enjoy high levels of endemism. Lastly, numerous rural communities rely on the rich soils and abundant grasslands of the highlands to sustain their agricultural livelihoods (Goldman-Benner et al., 2012).

The conversion of mountain forest and grassland ecosystems to make way for agriculture and livestock grazing has greatly jeopardised their water regulation and habitat provisioning functions (Buytaert et al., 2006; Magrin et al., 2014; Ochoa-Tocachi et al., 2016). The degradation of *páramos* through increased sedimentation, livestock manure, and pesticide use has lowered their water quality. Mountains are among the most vulnerable ecosystems, with low rates of recovery after disturbance (Rolando et al., 2017). Besides these land-use changes, biodiversity and

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water security will be increasingly affected by the potentially very high impact of climate change in the Andes region (Espinoza et al., 2020; Ilbay-Yupa et al., 2021; Kleemann et al., 2022). When this is combined with population growth, Ecuador faces growing challenges regarding adequate water quantity and quality and meeting urban water consumption and irrigation demands (Buytaert and De Bièvre, 2012; Kauffman, 2014). Given their importance in terms of hydrology and biodiversity, degraded *páramos* and mountain forests have become the target of landscape restoration efforts (Bremer et al., 2016, 2019).

In Ecuador, and Latin America more broadly, water funds have been on the rise since 2000 as a mechanism that links downstream water users and upstream land users. These funds are user- and externally funded mechanisms that invest in the conservation and restoration of natural ecosystems and sustainable land management in upstream areas (Bremer et al., 2016; Goldman-Benner et al., 2012; Joslin, 2020; Kauffman, 2014; Raes et al., 2012). Bremer et al. (2016) found that the primary objectives of water funds in Latin American relate mostly to water quantity and quality, including securing baseflows and reducing sediments. In addition, many funds explicitly pursue social and biodiversity objectives, in which conserving and restoring natural ecosystems is seen as a means to achieve water quality and quantity objectives. Three organisational models conceptualised in the context of water funds influence the governance strategies that water funds deploy to achieve their restoration objectives (Bremer et al., 2016). Water funds may follow an agency model, in which case they implement activities by themselves. An outsource model is followed when a water fund contracts third parties to carry out activities that it designed. Lastly, a grant model is followed when water funds review and fund proposals designed and submitted by other actors.

Their explicit focus on watershed conservation and restoration makes water funds task-specific organisations (Marks and Hooghe, 2004). The funds foster multilevel collaboration by providing an institutional space for actors at different governance levels to promote restoration processes (Emerson et al., 2011). Lastly, water funds function as bridging organisations (Berkes, 2009) by linking actors who aim to safeguard mountain ecosystem functions for upstream rural communities and private landowners. In these ways, water funds aim to create cross-scale fit and cross-level alignment and can hence be termed scale-sensitive governance arrangements (Wiegant et al., 2022).

Previous research has focused mainly on water funds' financial mechanisms and institutional structures (e.g. Goldman-Benner et al., 2012; Raes et al., 2012; Kauffman, 2014; Bremer et al., 2016). However, there is little empirical evidence confirming how water funds implement their restoration strategies and what the effects of these strategies are on creating fit with ecological processes and alignment with the needs and preferences of actors at other governance levels (Bremer et al., 2016; Joslin, 2019). This is crucial information, as the long-term success of restoration efforts depends both on the ability of governance strategies to fit the spatial and temporal reach of ecological processes and on the degree to which rural communities are willing and able to sustainably adapt their livelihoods to conservation-oriented land-use practices (Erbaugh and Oldekop, 2018; Kauffman, 2014).

Governance arrangements created to implement landscape restoration objectives are likely to be confronted with scale challenges (Cash et al., 2006) consisting of mismatches with the ecological processes that the arrangements aim to influence or misalignment with actors at other governance levels (Wiegant et al., 2020). Mismatches refer to challenges that play out across the ecological and governance scales, and misalignment refers to challenges that play out across governance levels. Both threaten to undermine the resilience of a human–environment system. To effectively deal with scale challenges that emerge in implementation processes, governance actors need to deploy governance strategies that aim to create cross-scale fit and cross-level alignment (Wiegant et al., 2022). Such scale-sensitive strategies can help actors to stay on course to achieve their restoration objectives in a context in which scale challenges continuously emerge. By analysing two Ecuadorian water funds – the Water Protection Fund (FONAG) and the Regional Water Fund (FORAGUA) – we obtained an understanding of the scale challenges that emerge in different institutional settings and the scale-sensitive strategies deployed to try to overcome these.

The research question that we pose is: what scale challenges do water funds encounter in the process of implementing their restoration strategies at local level and what scale-sensitive governance strategies do the funds and their implementing partners deploy to pursue their objectives? To answer this question, in section 2 we explain the scale challenge and scale-sensitive governance concepts in the theoretical framework. In section 3, we describe the two water funds and their restoration strategies, and we explain our data collection and data analysis process. In section 4, we present the scale challenges and the scale-sensitive governance strategies that we identified. In section 5, we focus on the meaning of our findings and their implications for future restoration efforts.

2. Theoretical framework

2.1. Scale challenges

Many of the pressing problems that society faces today, such as land degradation, biodiversity loss, and climate change, are cross-scale and cross-level in character (Termeer et al., 2010). These problems result from interactions between social and ecological systems (Cumming et al., 2006) and manifest themselves from global to local levels. Scale theory facilitates the structured analysis of complex cross-scale and cross-level interactions that occur between and within ecological and social systems. Padt and Arts (2014) defined scale as an analytical tool with a graduated range of values that can be used to measure and study ecological and social phenomena. The demarcation of a scale and its levels is an attempt to order inherently fuzzy and fluid ecological and social phenomena by fitting them within its boundaries (Padt and Arts, 2014). Levels are the units of analysis that exist at different positions on a scale (Cash et al., 2006). They are not quantitative units but rather a qualitative order of measurement, which can sometimes be ordered hierarchically (Padt and Arts, 2014).

We distinguish the ecological and the governance scale given that, in forest and landscape restoration (FLR), governance actors at various levels aim to influence relevant processes on the ecological scale (Wiegant et al., 2020). In our research, the ecological scale comprises the different levels at which processes of land degradation and restoration unfold, influencing the provision of ecosystem functions. The governance scale captures all relevant elements for governing the processes (Termeer and Dewulf, 2014) and facilitates the analysis of how tasks are distributed among actors at different levels. We identified the national, municipal, and community levels as the relevant governance levels regarding the restoration efforts of Ecuadorian water funds. Ecological phenomena and governance arrangements have a spatial and temporal dimension, that is, their spatial and temporal reach (Cash et al., 2006).

Scale challenges emerge as a result of a mismatch between scales or misalignment between levels and lead to undesirable situations for ecological or social systems, or both (Cumming et al., 2006). Such challenges may be caused by diverging spatial or temporal dimensions of ecological processes on the one hand, and the arrangements governing them on the other (Wyborn and Bixler, 2013). Cash et al. (2006) defined three types of scale challenges (A, B, and C):

A) Blind spot: refers to a failure to recognise crucial cross-scale and cross-level interactions, and hence comprehend the complexity of a social-ecological system. This scale challenge can emerge from inexperience, neglect of phenomena at other scales and levels, or an over-simplified understanding of the functioning of ecological or social phenomena. When part of the problem is isolated and focus is placed on only one level, while interactions of a phenomenon across scales and levels are left unquestioned, solutions may be ineffective.
B) Mismatch: refers to a persistent mismatch between the governance and the ecological scale. This typically emerges when a governance arrangement mismatches with the ecological process that it is meant to govern. A spatial mismatch emerges when the spatial reach of a governance arrangement does not fit the spatial reach of an ecological problem, and a temporal mismatch means that the arrangement does not fit the temporal reach of the problem (Termeer and Dewulf, 2014).
C) Plurality: refers to a failure to recognise and support heterogeneity in how problems are perceived by actors at different levels. It emerges from the flawed assumption that there is one single correct way – which is the same for all actors involved – to analyse or tackle a problem. Such a simplification has great consequences when it leads to the inclusion or exclusion of certain actors and places dominant actors at the centre of power (van Lieshout et al., 2011). This may result in ineffective decision making and unsustainable outcomes for those whose interests were not considered (Cash and Moser, 2000).

2.2. Scale-sensitive governance arrangements and strategies

Scale-sensitivity describes the ability of governance actors to observe and act upon cross-scale and cross-level challenges when these emerge (Termeer and Dewulf, 2014). In FLR, scale-sensitivity is based on understanding the spatial and temporal requirements of ecological processes and on actively listening to and observing the needs of actors at different levels. Scale-sensitive governance can reduce the adverse effects that cross-level misalignment and cross-scale mismatches can produce. For example, it can draw attention to the needs and priorities of local actors who were previously overlooked by higher-level actors as a result of a blind spot. To increase policy effectiveness, scale-sensitive governance can also aim to better fit an existing policy to the spatial or temporal dimensions of the ecological process that it aims to influence.

Scale-sensitive governance can manifest itself in creating new arrangements or in deploying new strategies. Wiegant et al. (2022) showed that different governance arrangements have the potential to create cross-scale fit. Moving tasks between governance levels or creating task-specific organisations can create fit between the ecological and governance scales by enabling actors at the most appropriate governance level to comprehensively govern an ecological phenomenon, such as a forest or a landscape. Polycentric governance arrangements can create cross-scale fit when actors at multiple governance levels address a common ecological problem (Cumming et al., 2013). In addition, there are various arrangements that can create alignment between governance levels. These are coordination, collaboration, and learning that take place between actors at different governance levels, as well as between bridging organisations and multilevel networks (Wiegant et al., 2022).

However, even when governance arrangements are in place that have the potential to create cross-scale fit and cross-level alignment, governance actors are likely to encounter unforeseen mismatches or misalignments that emerge when they implement their policy objectives. These challenges reveal the adverse side-effects of the actors' initial strategies, which hamper the attainment or sustainability of their policy objectives. Governance actors will then have to deploy different strategies that create cross-scale fit or cross-level alignment to stay on course in a context of emerging scale challenges. We term governance strategies designed to create cross-scale fit and cross-level alignment as scale-sensitive. This starts with observing the interdependencies between scales and across levels to tackle a blind spot, understanding possible mismatch and misalignment, and – to tackle challenges relating to plurality – identifying cross-level issues that influence the inclusion of actors at other levels whose views have not been sufficiently considered (Termeer and Dewulf, 2014). Scale-sensitive governance arrangements and strategies are two components of an iterative governance process in which fit and alignment are continuously created and recreated.

3. Methods

3.1. Research approach

Our research builds on an exploratory case study design to ascertain perceptions about how restoration strategies are implemented, the cross-scale and cross-level challenges that emerge in the process, and the strategies that water funds deploy to overcome them. Bennett (2016) argued that perceptions are particularly valuable evidence to gain knowledge on conservation outcomes. In our fieldwork, we focused on understanding the multilevel context of landscape restoration governance by building on the lived experience of actors involved in, and affected by, water funds' landscape restoration efforts. By analysing governance strategies in two case studies, we generated practical and contextually rich knowledge that aligns closely with the level of conservation and restoration action and builds an understanding of governance processes from the ground up (Wyborn and Evans, 2021). To ensure comparability, in both cases we followed the same research design and methods and applied the same sensitising concepts regarding scales, levels, scale challenges, and scale-sensitive governance.

3.2. Case selection

With the aim of studying the interaction of scale challenges and scale-sensitive governance strategies in differing institutional contexts, we selected two water funds that follow different institutional models. FONAG follows the agency model, meaning that it implements restoration efforts by itself. This requires the water fund itself to have substantial technical and human resources. Following its establishment, FONAG gradually expanded its capacity in terms of technology, tools, expertise, and knowledge (FONAG, 2019). Restoration efforts are implemented by its technical secretariat consisting of around 65 staff members. FORAGUA follows the grant model, meaning that it reviews and approves restoration proposals made by partners or members. In the FORAGUA case, restoration projects are planned and implemented by the environmental management departments of member municipalities. To become a member, municipalities need to pass a municipal ordinance that institutes an environmental tax on water use (Kauffman, 2014), which is then transferred to the fund. Members submit annual investment plans to the fund in which they propose conservation and restoration projects and which they implement with technical support from FORAGUA.

To study the local implementation of FONAG's and FORAGUA's restoration strategies, we identified rural communities and member municipalities that represent typical cases in terms of interaction between the funds and local actors (Lichtman, 2014). Given the scant documented history of restoration efforts, verbal recommendations by the funds' technical secretariats and other actors were important for identifying local restoration efforts. For FONAG, we focused on the indigenous Oyacachi community, where the water fund has worked since 2004 and negotiated a voluntary conservation agreement that promotes sustainable land use in the upper parts of the *páramo*. The long-term relation between the community and the fund and the establishment of a conservation agreement were important selection criteria because they point to a rich collaboration history that can be studied. In the FORAGUA case, we selected five member municipalities with which the water fund implements restoration efforts – Celica, Loja,

Palanda, Pindal, and Zamora. Municipalities were selected with the aim of representing municipalities that demonstrate different types of interactions with FORAGUA, ranging from constructive to conflictive. In Loja municipality, a watershed was identified that involved multiple landowners and purchased land with the aim of understanding the local impact of the fund's restoration efforts, and in which a FORAGUA member had conducted restoration efforts for over 10 years.

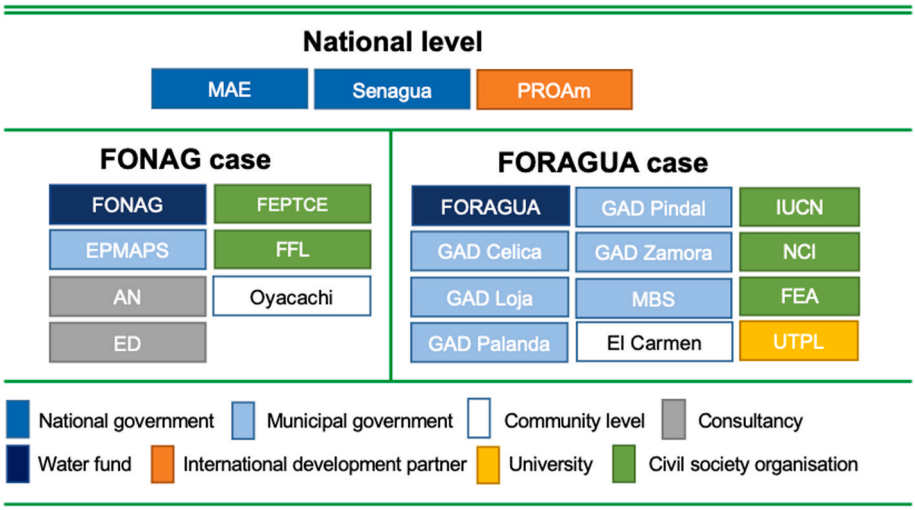
3.3. Data collection

We base our results on three data collection methods. We conducted a review of documents related to the two water funds, 48 semi-structured interviews, and participatory observation during fieldwork between August and December 2019. One researcher was embedded at the technical secretariat of each water fund for several months; this helped in accessing relevant documents, such as strategic and action plans, proposals, conservation agreements, and data sheets. The extent to which the restoration efforts were well documented differed per water fund. We conducted semi-structured interviews to capture the lived experience of actors involved in, or affected by, the two water funds' restoration strategies. In this way, we created a thick description of the implementation process for restoration efforts.

We used purposive and respondent-driven sampling to find relevant respondents (Russell Bernard, 2011). Purposive sampling is based on the researcher's judgement of who can best provide important knowledge and critical perspectives, whereas respondent-driven sampling is based on a chain-selection of respondents, with one respondent recruiting others. We applied the latter method in local contexts where it was more difficult to find respondents. Such respondent-driven sampling (Russell Bernard, 2011) can create bias, as it can lead to the researcher being referred to a respondent's family members and acquaintances who share similar opinions and experiences. The ways in which this possible bias was overcome include a large sample size comprised of different groups and perspectives in the community, gender and age balance, and cross-checks of information to verify respondents' answers where possible.

Fig. 1 indicates the affiliation and position of respondents. To guarantee anonymity, we gave respondents a code consisting of the abbreviation of their organisation or the name of their community, as well as a number when more than one person from an organisation were interviewed. For example, FONAG2 refers to the second person interviewed at the Water Protection Fund. In the results, references to respondents are indicted by initials or by community (see Fig. 1) between brackets […].

Interviews were semi-structured, using interview checklists (Berg, 2001; Russell Bernard, 2011). Space was given to respondents to expand



AN	AquaNature
ED	EcoDecisión
El Carmen	Current and former landowners in the El Carmen catchment
EPMAPS	Public Water Utility Company of Quito
FEA	Arcoíris Foundation
FEPTCE	Plurinational Community Tourism Federation of Ecuador
FFL	Futuro Latinoamericano Foundation
FONAG	Water Protection Fund
FORAGUA	Regional Water Fund
GAD Celica	Celica municipality
GAD Loja	Loja municipality
GAD Palanda	Palanda municipality
GAD Pindal	Pindal municipality
GAD Zamora	Zamora municipality
IUCN	International Union for the Conservation of Nature
MAE	Ministry of Environment
MBS	Mancomunidad del Bosque Seco
NCI	Nature and Culture International
Oyacachi	Rural community members of Oyacachi
PROAm	PROAmazonía initiative
Senagua	National Water Secretariat
UTPL	Private Technical University of Loja

Fig. 1. Overview of interviewed actors, their affiliation, and their position in the case study.

on the restoration-related topics that were most relevant to them. Interviews were recorded with informed consent and transcribed by an Ecuadorian national to increase data accuracy (MacLean et al., 2004). Spanish was the primary interview language, which only changed for respondents who were native English or Dutch speakers. We transcribed the English and Dutch interviews ourselves. Participatory observation (Russell Bernard, 2011) occurred while the researchers were embedded at the technical secretariats and in interactions with rural community members. We accompanied water fund employees to social events and monitoring activities in the field, joined in discussions at landscape restoration conferences, and participated in community events. This helped to build trust relationships and rapport with respondents, shaped intuitive understanding of what was occurring, and gave meaning to the interview data (Russell Bernard, 2011).

3.4. Data analysis

We used content analysis methods (Salkind, 2010) and analysed the transcribed texts using ATLAS.ti software (version 8.4.24). In line with the exploratory character of our study, content analysis lets the data recount a narrative, rather than viewing the data through fixed themes (Russell Bernard, 2011). We adopted an inductive approach and used open coding to systematically search for themes and patterns in the interview transcripts (Bowen, 2006), while deductively using 'scales', 'levels', 'scale challenges', and 'scale-sensitive governance' as sensitising concepts to guide the analysis. Sensitising concepts are interpretive devices that facilitate seeing, organising, and understanding lived experience (Bowen, 2006; Charmaz, 1996). As themes and patterns are usually abstract and difficult to identify in interview transcripts, our sensitising concepts were an important point of departure to think analytically about the data and develop the scale challenges and scale-sensitive governance strategies. Perspectives were identified and compared to determine commonalities and differences, and short memos were written to summarise the main points and understand patterns. Codes were compared, and related codes were merged under an umbrella code. Interview data were not always coherent, especially when respondents referred to numbers and hard facts. Statements were generally assessed against what other respondents said but also compared to information found in available documents. We aimed to ensure data reliability by triangulating documents, interviews, and observations (Carter et al., 2014; Russell Bernard, 2011). In November 2021, we conducted a validation workshop at the FONAG and FORAGUA offices to discuss their scale challenges and the scale-sensitive governance strategies that they deployed. The discussions that followed facilitated reflection on, and refinement of, the results.

4. Results

We analysed FONAG's and FORAGUA's implementation of restoration efforts through time to understand the scale challenges that emerged and the scale-sensitive governance strategies deployed to overcome them. We start by listing four scale challenges that we identified in both cases. This is followed by an analysis of how emerging scale challenges and the funds' scale-sensitive governance strategies are temporally linked.

4.1. The water funds' scale challenges

We identified four scale challenges that emerged as part of the FLR implementation process, comprising the three types of scale challenges conceptualised by Cash et al. (2006). Three of the four identified challenges applied to both water funds, although the way in which the challenges manifested themselves differed. In Table 1, we briefly explain how the scale challenge types unfolded at FONAG and FORAGUA.

In response to these scale challenges, the funds planned or deployed different governance strategies to address them. Some scale-sensitive strategies have already been implemented, but others are only planned. In sections 4.2 and 4.3 respectively, we show how the identified scale challenges and scale-sensitive strategies are chronologically linked in the FONAG and FORAGUA cases. This increased our understanding of how the water funds react to emerging scale challenges and try to stay on course in the implementation of their FLR efforts.

Table 1
Scale challenges linked to FONAG's and FORAGUA's restoration efforts.

No.	Scale challenge	FONAG	FORAGUA
1.	**A blind spot related to alternative livelihoods has led to local discontent with restoration efforts and made it harder to sustain restoration processes** Type A: failure to recognise crucial cross-scale and cross-level interactions	FONAG underestimated the time it took, and the input it required, to go from traditional livestock-dependent livelihoods to alternative livelihoods. As a result, its restoration efforts caused short-term livelihood losses for particularly the most vulnerable groups at community level: older people, women, and less-educated community members.	FORAGUA and member municipalities neither acknowledged nor addressed the livelihood dependence of some rural landowners on private properties targeted for restoration. The adverse livelihood impact of restoration efforts that focused on declaring municipal reserves or on land acquisition has caused (former) landowners to actively counter the water fund's efforts.
2.	**Short-term municipal election cycles created instability in the funds' relation with constituents or members and impeded long-term restoration processes** Type B: temporal mismatch between the governance scale and the ecological scale	Municipal elections caused a replacement in the leadership of Quito's water utility company and created subsequent instability in the relation with FONAG. A shift in priorities from biodiversity to water supply ended the water fund's restoration efforts in the buffer zone of protected areas.	Because of the electorate's lack of interest in, or resistance to, restoration, municipal elections made mayors hesitant to invest in new restoration efforts. Elections also led to new mayors terminating ongoing restoration contracts that their predecessors had established and halting the transfer of tax revenues to FORAGUA.
3.	**The limited spatial reach of restoration efforts mismatches with the extent of landscape degradation processes** Type B: spatial mismatch between the governance scale and the ecological scale	The limited spatial reach of FONAG's conservation agreement displaced livelihood-related land degradation drivers to an area located beyond the water utility company's water extraction area and could therefore not be addressed by FONAG.	The lack of human and financial capacity in FORAGUA's technical secretariat and member municipalities to regulate and monitor land-management practices in municipal reserves resulted in a limited spatial reach of restoration efforts to protect water sources and create ecological connectivity.
4.	**Heterogeneity regarding the purpose of restoration, with different spatial implications** Type C: failure to recognise and support plurality in how problems are perceived at different levels		Whereas FORAGUA's development partners see landscape restoration as a solution for climate change and biodiversity loss, member municipalities see it as a solution for local water quantity and quality challenges. This creates diverging views about the spatial dimension at which solutions need to be sought.

4.2. FONAG's strategies to stay on course to realise its restoration efforts

To meet urban water needs, Quito Metropolitan District has depended on *páramo* ecosystems that surround the city and are often located in protected areas or their buffer zones (Buytaert et al., 2006; FONAG, 2019). In the 1990s, various international development projects underlined the importance of protecting the *páramo* to safeguard water supply and, although plans were created to improve protected-area management, these were not backed by sizeable funding. Quito's municipal water utility company (EPMAPS) had specific projects to protect the water catchments it used to extract water but lacked the capacity to implement larger initiatives. The Nature Conservancy (TNC) and Antisana Foundation therefore proposed to EPMAPS the joint creation of a funding mechanism with enough capacity to undertake the specific task of conserving the *páramo* ecosystems surrounding Quito (Goldman-Benner et al., 2012). TNC saw the ecosystems' importance for water supply as an opportunity to generate funding for biodiversity conservation by instituting a water consumption tax (Joslin, 2020).

In 2000, FONAG was created with the task of conserving and restoring the *páramo* (Kauffman, 2014). TNC and EPMAPS, FONAG's founding constituent members, were later joined by the municipal electricity company, two beverage companies, and a development partner (FONAG, 2019). The fund was created with the idea of generating long-term funding and was hence established for a period of 80 years to match restoration timelines. Thus, multiple actors were involved in creating a task-specific organisation designed to create spatial and temporal fit with ecological processes. Despite this intention, we identified various scale challenges that emerged since FONAG's establishment, and to which the fund has reacted or plans to react with strategies to create cross-scale fit and cross-level alignment. We depict FONAG's scale challenges and scale-sensitive governance strategies chronologically in Fig. 2 and then describe their connection.

4.2.1. Dealing with the temporal mismatch of short-term election cycles that created instability in the relationship with EPMAPS and impeded long-term restoration processes (SC2)

For the first 10 years after its establishment, FONAG enjoyed relative autonomy from EPMAPS to grow and develop its mission and focused mainly on biodiversity conservation [FONAG1]. The fund worked mostly in rural communities located in the buffer zone of protected areas to ensure sustainable land-management practices. From 2010 onwards however, EPMAPS exerted more influence on the trust board [FFL; FONAG1]. In line with a municipal ordinance of 2007, the water utility company had been transferring 2% of its collected water fees to FONAG and has currently contributed over 90% of the total financial investment in the fund (Bremer et al., 2016; Joslin, 2019). Quito's municipal elections of 2009 proved to be an important turning point in FONAG's development, as they led to the replacement of EPMAPS' leadership [FONAG1; FONAG2]. Incoming staff expressed serious doubts about FONAG's protected area focus and questioned its relevance for managing water supply, given that some communities with which FONAG worked were located far away from the water supply infrastructure [EPMAPS]. In addition, overlap had emerged between FONAG's and EPMAPS' efforts relating to restoration and community engagement that had to be resolved.

To create a complementary relationship between the two actors, EPMAPS demanded rigorous restructuring of FONAG's mission and restoration efforts and insisted that financial resources should be strictly invested in protecting catchments that were important to Quito's water supply, rather than maintaining a focus on protected areas [FFL; AN]. FONAG became absorbed in a process of building trust and aligning its activities with EPMAPS' demands [FONAG2]. During this period, the fund discontinued almost all its community-level activities [AN]. This harmed its trust relationship with rural communities and affected the continuity and sustainability of restoration processes. Only in 2016 were

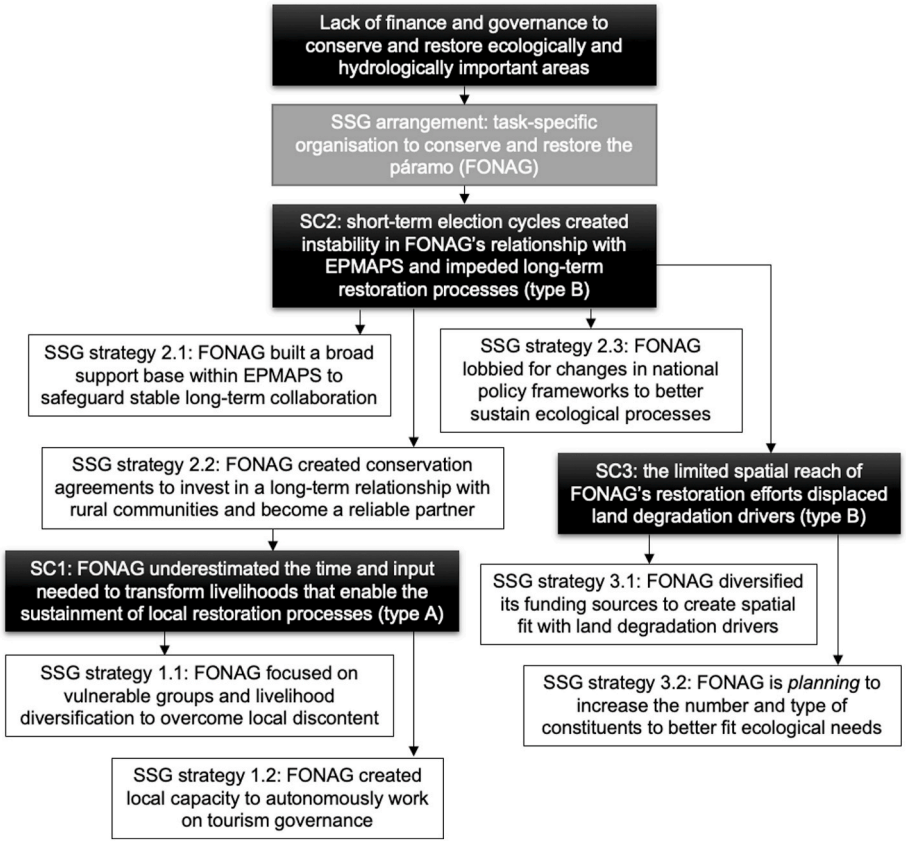


Fig. 2. Scale challenges (SC) and scale-sensitive governance (SSG) strategies at FONAG.

restoration efforts resumed in some communities, started in communities located in EPMAPS' priority catchments, and terminated in communities that were no longer a priority [AN].

The temporal mismatch between short-term municipal election cycles and long-term restoration processes made FONAG aware that it had to be more resilient to the changes in EPMAPS leadership that resulted from municipal elections [FFL]. First, FONAG built a broad support base within EPMAPS to safeguard and stabilise its long-term cooperation (SSG strategy 2.1). It built connections and complementarity with technical staff in different departments, besides maintaining narrow contact with the EPMAPS leadership [FONAG1]. In addition, the fund conducted a 'return on investment' study in 2018 to analyse the economic benefits of conservation and restoration efforts in one intervention area. The study found that each US$1 invested in watershed protection generated US$2.15. The study is meant to convince future leaders of EPMAPS that water extraction and treatment is more costly in the long run when the *páramo* is degraded. The strategy strengthened FONAG's reputation within EPMAPS and augmented the fund's visibility within the water company [FFL].

Second, FONAG created conservation agreements with rural communities as a way to invest in a long-term relationship with those communities and become a reliable partner for them (SSG strategy 2.2). The internal crisis and subsequent unstable relation with rural communities highlighted the value of creating such agreements, which formalise FONAG's involvement in a community for a 10-year period [AN]. The agreements are based on hydro-social diagnostics that map local natural-resource problems, conflicts, opportunities, and priorities [FONAG1]. Annual action plans are then created with that rural community to reduce existing ecosystem pressures, such as livestock grazing, which affect water quantity and quality [FONAG2]. To promote more conservation-oriented land-use practices and livelihoods, investments are made in selected productive activities for the first three years of the agreement (Joslin, 2020). Since 2017, FONAG has so far signed 10 conservation agreements, providing a longer-term perspective for the rural communities (FONAG, 2020).

Third, to further facilitate the long-term continuity of restoration processes in its intervention areas, FONAG made efforts to establish supportive national policy frameworks (SSG strategy 2.3). FONAG assisted the National Water Secretariat (Senagua) to give the Water Protection Area (*Área de protección hídrica*) legal status [FONAG1]. These areas can be created on the initiative of actors at sub-national level, on the condition that those who promote their creation can also contribute to maintaining the areas. FONAG elaborated a large part of the guidelines that stipulate how the areas should be declared. FONAG's rationale for promoting this policy is that a water-oriented conservation area with national recognition and a legal character can better protect the fund's conservation areas and hence safeguard water supply in the long term. Currently, the Water Protection Area is integrated in the Water Resources Law, and 14 of these areas have been created at national level since 2018 [FONAG1].

4.2.2. Dealing with the blind spot that caused FONAG to underestimate the time and input needed to transform livelihoods that enable the sustainment of local restoration processes (SC1)

The productive activities that FONAG has promoted as part of its conservation agreements aim to promote alternative livelihoods that reduce pressure from the ecosystem and enable natural regeneration; reintroduction of native tree, shrub, and grass species; and wetland restoration to recover *páramos*' water regulation function. Projects have provided materials for pasture improvement, guinea pig husbandry, and community tourism (FONAG, 2019). Oyacachi is one of the communities with which FONAG created a conservation agreement. Here, community members used to rely on dairy farming and keep some of their cattle in the *páramo* as a financial insurance. However, the same *páramo* is important for supplying water to Quito. As part of the conservation agreement that FONAG negotiated with the community, almost all families significantly reduced the number of cattle held in the *páramo* and therefore needed alternative income sources. When FONAG started working in Oyacachi, it observed an existing transition towards community tourism that had been started by civil society organisations who assisted the community in the construction of thermal pools [Oyacachi6]. The fund therefore committed to further strengthen community tourism by facilitating gastronomy workshops for family-owned restaurants and handicraft workshops for community members to cater better for the tourism market and by constructing hiking paths, signposts, and hanging bridges [FONAG2].

FONAG's rationale was that more income from tourism would reduce Oyacachi's livestock dependence and remove grazing pressure from the *páramo*. However, the transition time and input needed to go from livestock-dependent livelihoods to alternative livelihoods turned out to be longer and more than what FONAG was providing. As a result, community members faced short-term livelihood losses between when they sold their livestock and when they could start reaping the fruits from new livelihood activities. Some in Oyacachi raised the concern that the investments in tourism infrastructure and capacity building made as part of the conservation agreement would not be sufficient to guarantee income for all families [Oyacachi6]. This was particularly the case for vulnerable groups in the community, such as older people, women, and less-educated community members, who felt less prepared to deal with the changes that FONAG's intervention provoked [Oyacachi4; Oyacachi7]. At the time of this research, tourism was a main livelihood for about one third of the community [Oyacachi7; FEPTCE], as a restaurant or family hostel owner, guide, handicraft artist, ticket seller, or maintenance worker. Consequently, some community members developed strong feelings of injustice. They felt insufficiently compensated for protecting the *páramo* to deliver clean water to Quito [Oyacachi2].

Following years of experience with working in rural communities, FONAG staff became aware that the transition from traditional to alternative livelihoods caused income loss for vulnerable groups. To deal with this existing blind spot, FONAG firstly started setting specific livelihood targets to better include and address the needs of vulnerable groups [FONAG1] (SSG strategy 1.1). In Oyacachi for example, FONAG promoted the role of women in community tourism [FONAG2]. Despite the prevalence of traditional gender roles, FONAG insisted on incorporating a clause in its conservation agreement that secured women's participation in tourism activities, in both decision making and income generation. FONAG staff also observed the need to have a more diversified portfolio of activities, with the idea that, if one livelihood is not sufficiently developed to generate substantial income, other income-generating activities can fill the gap [FONAG1]. However, investments in other activities are still marginal and the main focus is still on community tourism. Second, FONAG has worked to create local capacity to better organise the local tourism sector (SSG strategy 1.2) by providing assistance to establish a legally registered tourism office led by community members. The office is directly linked to the Ministry of Tourism and has helped the community to get more exposure at national level through promotional materials [FONAG2]. This strategy shows FONAG's strong focus on enabling community members to build their own capacity and income-generating opportunities, to become less and less dependent on external actors for support. However, community engagement has been challenging for FONAG – with steps forward being followed by steps backward – for example in terms of women's empowerment and the prevalence of traditional roles.

4.2.3. Dealing with the spatial mismatch that caused the spatial reach of FONAG's restoration efforts to displace land degradation drivers (SC3)

A third scale challenge emerged following the municipal elections when FONAG's restoration mandate became strictly linked to the *páramos* from where EPMAPS extracts water for Quito. A consequence of this strict spatial focus has been the displacement of livelihood-related land degradation drivers to areas lying beyond EPMAPS' priority catchments. The conservation agreement that FONAG signed with the

Oyacachi community focused on strictly conserving the *páramo* at 3500 m above sea level [FONAG3], with lower parts of the catchment designated for sustainable livelihood practices such as trout farming, dairy production, and tourism activities [FONAG2; Oyacachi6]. However, community members logged wood from a cloud forest located in the lower-lying part, not only to construct houses, obtain fuelwood, and make wooden handicrafts sold in a community-managed shop that FONAG helped establish [Oyacachi7], but probably also to sell wood to external markets, given the large quantities of trees being felled [FONAG1]. Around the same time that livestock pressure in the *páramo* was reduced to ensure higher water quality for EPMAPS, the considerably increased deforestation in the cloud forest took FONAG by surprise [FONAG1]. Although the fund saw a need to intervene, it was unable to address this displacement of degradation drivers, given that the forest lies beyond EPMAPS′ water extraction area and was hence not included in the conservation agreement.

Being aware of the limitations and challenges that a strict spatial focus entails, as is the case in Oyacachi, FONAG has come up with other strategies to create better spatial fit between land degradation drivers and restoration efforts. First, FONAG has focused on diversifying its funding sources (SSG strategy 3.1). FONAG is practically limited to using constituents' permanent contributions to work in EPMAPS′ priority catchments, but external funding enables restoration efforts to take place outside these catchments. The more external funding FONAG receives, the more flexible the fund is to recreate fit in situations where the spatial and the temporal reach of its restoration strategies form a mismatch with land degradation processes. In 2019, external funding accounted for a quarter of FONAG's annual budget [FONAG1]. The Integrated Amazon Programme for Forest Conservation and Sustainable Production (PROAmazonía) initiative, which started in 2017 and aims to reduce emissions from deforestation, has made the highest contribution. Another way to increase external funding is the water fund's corporate water footprint initiative that enables companies to compensate their water use by financing projects that restore parts of the *páramo*. In 2019, FONAG signed the first agreement with General Motors. Second, FONAG highlighted that the fund plans to increase the number and types of constituents on its trust board (SSG strategy 3.2) to complement EPMAPS′ focus on water quantity and quality objectives. New constituents could facilitate the broadening of the scope of FONAG's work and enable the fund to choose intervention areas where the ecological restoration needs are highest.

4.3. FORAGUA's strategies to stay on course to realise its restoration efforts

The tropical mountain forests of southern Ecuador have fulfilled important water regulation and habitat provisioning functions. However, a growing population, agricultural expansion, and road construction have fragmented mountain forests into ever-smaller and isolated forest remnants (Keese et al., 2007). In the region's dry forest ecosystem, 95% of the natural vegetation cover has been lost (NCI, 2021). Observing the effects of deforestation and unsustainable agricultural practices on water scarcity and quality, several development projects have worked with multiple municipalities on integrated watershed management planning and payment for ecosystem service projects (Kauffman, 2014). These earlier initiatives led in 2009 to the establishment of FORAGUA by five municipalities (Celica, Loja, Pindal, Puyango, Macará) and the civil society organisation Nature and Culture

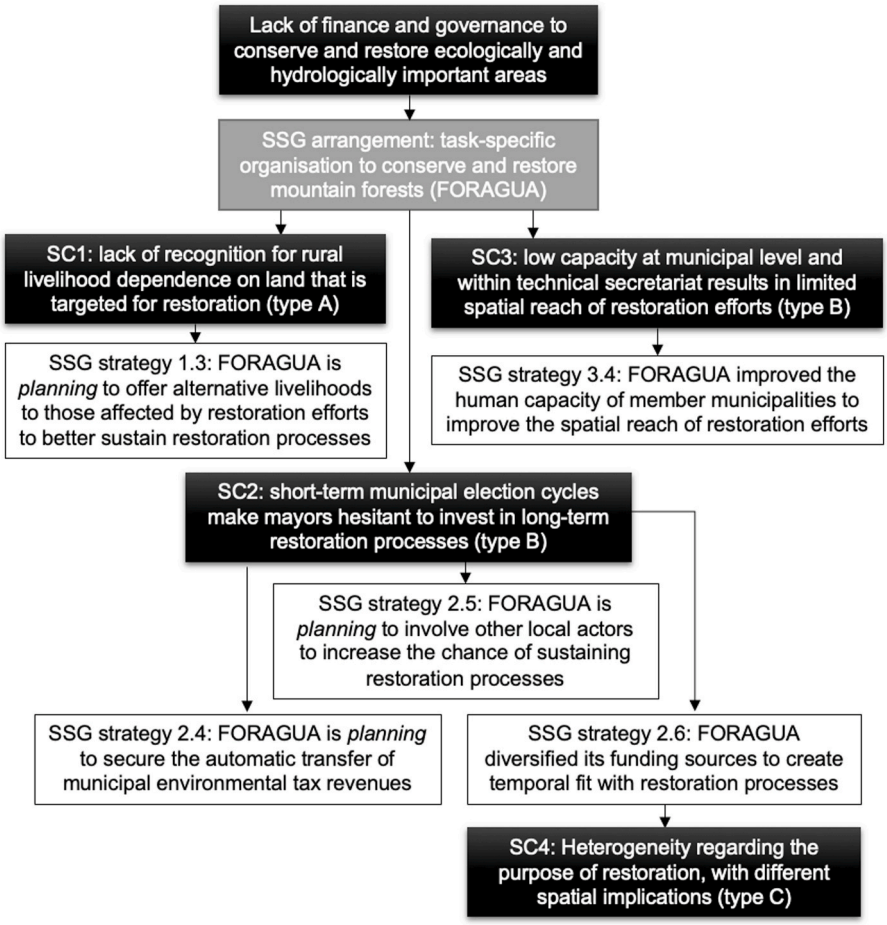


Fig. 3. Scale challenges (SC) and scale-sensitive governance (SSG) strategies at FORAGUA.

International (NCI) (FORAGUA, 2019; Goldman-Benner et al., 2012). The water fund's task is to secure, sustain, and upscale the generation of financial resources to conserve forest remnants and restore degraded forests in hydrologically important areas (FORAGUA, 2018; Raes et al., 2012). As a result of the earlier experiences with municipal watershed management projects, FORAGUA has a decentralised set-up in which municipalities play a pivotal role.

FORAGUA assists member municipalities to create municipal ordinances that enable the institution of an environmental tax on water use and to establish municipal reserves with the aim of protecting water sources and creating ecological connectivity. Within municipal reserves, private landowners are permitted to apply only sustainable land-management practices (Raes et al., 2012). Most restrictions are placed on areas surrounding water sources, where landowners tend to keep livestock for easy water access [FORAGUA3; Carmen2]. Member municipalities collect the environmental tax on water use and transfer the revenue to FORAGUA (Raes et al., 2012). Of these revenues, 90% flow back to the municipalities and are used for two purposes. One is to create voluntary conservation agreements between FORAGUA, a member municipality, and rural landowners. These last for five years and financially compensate landowners who implement sustainable land-management practices on their property. The second purpose is land purchase, which FORAGUA and member municipalities see as the most effective restoration strategy in the long term, given that such land becomes part of a permanent restoration process. Landowners may voluntarily agree to sell their property or a municipality may declare their property a public utility and expropriate it. A landowner then has to sell it for a price established by cadastral appraisal, which tends to be lower than the market price. Subsequently, the property is placed into FORAGUA's trust fund for 80 years to prevent future politicians from selling the land or using it for unsustainable land-use practices. Municipalities remain responsible for managing the land in terms of fencing, signposting, and monitoring it and sanctioning those who encroach on it.

Following FORAGUA's establishment, various scale challenges have emerged to which the fund has reacted, or plans to react, with strategies to create cross-scale fit and cross-level alignment. We depict FORAGUA's emerging scale challenges and scale-sensitive governance strategies chronologically in Fig. 3 and then describe their connectedness.

4.3.1. Dealing with the blind spot that caused FORAGUA to give no recognition to livelihood dependence on land targeted for restoration (SC1)

An important blind spot for FORAGUA and member municipalities was landowners' dependence on properties that became part of municipal reserves and were restricted regarding land-management practices. The failure by the fund and its members to financially compensate for livelihood loss or to provide alternative livelihoods when landowners were restricted in their use of their hydrologically important land [Carmen1; Carmen2] caused landowners to actively break regulations and restrictions, for example by cutting fences around conserved land to let their livestock graze illegally again [Carmen2; Carmen6; MBS; NCI1; FORAGUA2]. In the El Carmen micro-catchment for example, frustration related to restrictions was high and the feeling of unfair treatment was common [Carmen1; Carmen2; Carmen4; Carmen7]. Between 2008 and 2014, landowners' livelihoods in El Carmen were affected because they were pushed to sell their land for a price well below the actual market value [Carmen4; Carmen7; Carmen8; MBS]. On several occasions, municipal civil servants signalled to landowners that their land would be expropriated without compensation if they did not accept the offered price [GAD-Loja1; Carmen3]. FORAGUA and member municipalities framed the majority of landowners with whom they worked as rich individuals with enough resources to buy another property and without need to be supported with alternative livelihoods [FORAGUA3; FORAGUA4; GAD-Celica]. However, no livelihood impact study was conducted to substantiate this frame [FORAGUA2; FORAGUA3; NCI1]. This blind spot ultimately created a distance between FORAGUA and its members on the one hand, and landowners on the other [FFL].

In recent years, FORAGUA has become increasingly aware that its restoration efforts affect rural livelihoods and that this reflects negatively on the fund's reputation and effectiveness. Although FORAGUA has not yet formulated specific livelihood targets [FORAGUA3; NCI1], it is planning to offer alternative livelihoods to those affected by its restoration efforts (SSG strategy 1.3). For example, the fund launched a pilot in El Pangui municipality to compensate landowners for lost opportunity costs. FORAGUA did so by developing agroforestry activities in the lower parts of the watershed to hire landowners who sold their land or were restricted in their land-use practices within water sources in the upper watershed [FORAGUA1]. By providing employment, FORAGUA hopes to prevent livelihood loss and lower the risk of landowners engaging in illegal land-use practices on their former property [FORAGUA2; FORAGUA3]. The fund is also working more closely with municipalities on community engagement to prevent past mistakes from recurring and guarantee that landowners receive adequate livelihood alternatives.

4.3.2. Dealing with a spatial mismatch in which low capacity at municipal level and within the technical secretariat resulted in the limited spatial reach of restoration efforts (SC3)

FORAGUA's objective to declare municipal reserves was severely hampered by the inability of member municipalities to put regulations into practice. Municipalities lacked the human and the financial capacity to regulate sustainable land-management practices in their reserves, maintain fences and signposts, and monitor restoration processes [NCI3]. On becoming members, several municipalities approached FORAGUA's technical secretariat for assistance in the management of water resources and municipal reserves. However, FORAGUA had to turn many requests down because of its limited capacity.

To address the observed capacity challenge, FORAGUA developed a training curriculum in 2016 to improve the capacity of technical staff in municipal environmental management departments to protect and restore water sources and establish ecological connectivity (SSG strategy 3.4). This Water School (*Escuela del Agua*) is implemented in collaboration with Senagua, NCI, the Water Fund for the Conservation of the Paute River Basin (FONAPA), and the Private Technical University of Loja (UTPL). Municipal staff have been taught to work on the required ordinances that establish municipal reserves and institute an environmental tax on water use in their municipality. In addition, they have gained basic skills to work with geographical data related to water and forest cover, as well as a multi-criteria methodology to demarcate municipal conservation areas. From 2017 onward, technical specialists could be hired by NCI and FORAGUA with funding from PROAmazonía and the Green Climate Fund (GCF) to work closely with municipal staff and socialise and approve the municipal ordinances and reserves. About 180 civil servants graduated from the Water School in 2019 and FORAGUA's relation with both member and non-member municipalities in southern Ecuador improved significantly [FORAGUA4].

Despite FORAGUA's efforts to build local capacity, considerable challenges remain to manage declared reserves effectively. Although the spatial extent of municipal reserves in the water fund's member municipalities approached 400,000 ha in 2021 [FORAGUA2], it is recognised that this effort is only on paper and that these declarations cannot guarantee the end of unsustainable land-use practices [GAD-Celica; GAD-Loja1; FORAGUA2; AN]. FORAGUA's focus is now mainly on preventing deforestation in declared reserves by monitoring satellite imagery with Global Forest Watch, and restoration is restricted to areas of hydrological importance.

4.3.3. Dealing with a temporal mismatch in which short-term election cycles make mayors hesitant to invest in long-term restoration processes (SC2)

One of the main threats to the continuity of FORAGUA's restoration efforts is the mismatch between short-term municipal election cycles

and long-term restoration timelines. Mayors are often hesitant to invest in long-term restoration processes because they experience a lack of interest in, or resistance to, this among the electorate. Following municipal elections, new mayors will review all regulations instituted by their predecessor [GAD-Celica; GAD-Pindal; GAD-Zamora2]. It often happens that they put the adoption of municipal ordinances on hold, stop transferring environmental tax revenues to FORAGUA, and terminate restoration contracts with the water fund, notwithstanding recommendations made by their own technical staff who have attended the Water School [GAD-Celica; GAD-Zamora2]. Given that their temporal reach is limited to five years, restoration agreements are terminated and landowners no longer receive compensation for allowing natural regeneration to occur on their property when a new mayor does not renew them, causing restoration processes to be disrupted.

Mayors do not sufficiently assess the long-term benefits of restoration efforts [FORAGUA1; FORAGUA2; FEA]. Even though water source restoration greatly improves water quality and thereby lowers the costs of drinking water treatment in the medium term, in the short term this means that citizens need to pay an environmental tax, for which no broad support exists [GAD-Loja1; GAD-Zamora1; NCI3]. Funds are rarely allocated to maintain purchased land or regulate municipal reserves, as such efforts are invisible to the electorate. Instead, mayors prefer to profile themselves with infrastructure investments that show short-term results, as a way to gain popular support [MBS; GAD-Celica; GAD-Zamora2]. In addition, some mayors, to avoid conflicts that could reduce their re-election chances, refrain from sanctioning landowners who apply unsustainable land-use practices within municipal reserves, such as the cutting of trees [GAD-Celica; FORAGUA2]. In 2019, FORAGUA had 11 member municipalities, of which, in five, the mayor was in conflict with the water fund [FORAGUA3].

The temporal mismatch between short-term municipal elections and long-term restoration processes has greatly reduced FORAGUA's ability to promote restoration efforts [FORAGUA1; FORAGUA2]. To become more resilient towards the uncertainties associated with municipal elections, FORAGUA has developed various strategies. First, the fund plans to secure the automatic transfer of municipal environmental tax revenues (SSG strategy 2.4). Mayors would have to sign a long-term agreement with the public agency (CFN) administering the financial resources in FORAGUA's trust fund. CFN could then automatically transfer the municipality's environmental tax revenues to the fund. This would remove the possibility of new mayors discontinuing their tax payments to the fund. The idea was approved by FORAGUA's board of trustees and negotiations have already started with the Ministry of Economics and Finance to set up the mechanism. When the mechanism is installed, FORAGUA can focus on sustaining existing, and starting new, restoration efforts, rather than on constantly convincing mayors to transfer their tax revenues [FORAGUA2; FORAGUA3]. Simultaneously, FORAGUA is engaged in conversations with municipalities to underline their legal obligation to transfer the environmental tax, stressing that all delayed payments are being registered as debt and that an audit by CFN could conclude misappropriation of funds. This strategy helped solve delayed transfers in one municipality.

Second, FORAGUA plans to involve other local actors to sustain restoration processes (SSG strategy 2.5), thereby making restoration efforts more resilient towards a possible lack of willingness by municipalities to collaborate [FORAGUA3]. The water fund has started working with parishes – the most decentralised government level – in two member municipalities: Valladolid parish in Palanda municipality and Vilcabamba in Loja municipality. In addition, the fund is planning to include community-based water boards (*juntas de agua*) in its strategy to implement, regulate, and monitor restoration efforts [FORAGUA2]. Apart from capacity-building activities, the boards are not yet included in restoration efforts. Working with parishes and water boards provides an alternative way in which to sustain restoration efforts when FORAGUA's relationship with a municipality turns unproductive, although this does not need to be the case.

Third, FORAGUA has diversified its income sources (SSG strategy 2.6) in order to be less dependent on member municipalities and to increase its technical capacity to implement restoration efforts. Through active fundraising, FORAGUA has attracted external funding from civil society organisations and international development partners, such as TNC, PROAmazonía, the United States Agency for International Development, and GCF. To attract this funding, FORAGUA aligned its objectives with those of development and conservation organisations; this implied going beyond a narrow water focus towards a focus on ecological connectivity [FORAGUA4]. The fund also ventured into climate finance and, together with the National University of Loja, refined the methodology to study the carbon sequestered in municipal reserves and on purchased land, with the aim of being more visible at national and global level and receiving financial support [FORAGUA2]. With external funding, the water fund was able to give technical assistance and complement member municipalities' environmental tax revenues [FORAGUA2]. Particularly smaller municipalities benefited from this, as they face difficulties in building capacity and generating enough resources to invest meaningfully in restoration efforts. External funding helped the technical secretariat convince other mayors to join the water fund [GAD-Pindal; GAD-Zamora2] and ensure that mayors transfer their tax revenues on time. FORAGUA's board adopted a resolution in 2017 stating that no investments were to be made in municipalities that did not transfer all revenues.

4.3.4. Scale challenge related to plurality, in which heterogeneity exists regarding the purpose of restoration, with different spatial implications (SC4)

Linked to FORAGUA's strategy to diversify funding sources, a new scale challenge has emerged. The reliance on external funding has given rise to heterogeneity in relation to how restoration is framed by different actors. FORAGUA's development partners are primarily concerned with tackling landscape degradation on large tracts of land and see restoration as a solution for global problems such as climate change and biodiversity deterioration [PROAm]. Meanwhile, member municipalities are worried mostly about water-related challenges at local level [NCI4] and see restoration as a solution to local problems of water scarcity and quality [GAD-Celica; MBS]. This has led to different understandings regarding the relevant spatial reach at which solutions need to be sought.

Whereas member municipalities focus primarily on conserving and restoring water sources at micro-catchment level, development partners such as PROAmazonía focus on declaring large municipal reserves to promote carbon sequestration and ecological connectivity [FORAGUA2; PROAm]. As the declaration of these reserves is a condition for the disbursement of funds [AN; PROAm], FORAGUA's technical secretariat has been dedicating its human and financial capacity mainly to reaching PROAmazonía's target of protecting 50,000 ha in southern Ecuador by 2025 [FORAGUA2]. Thus, FORAGUA prioritises the solutions promoted by development partners, and on-the-ground restoration efforts to improve water supply and quality at micro-catchment level are deprioritised [GAD-Celica; GAD-Loja1; GAD-Zamora1]. No conditions are set on the location of municipal reserves in relation to water resources, and water is perceived as a co-benefit for which no specific targets are set by the PROAmazonía initiative [MAE; PROAm; FORAGUA2]. Success is measured by the number of hectares declared as a municipal reserve, with this number equated to a deforestation reduction [PROAm]. However, if regulations are not enforced, actual conservation does not occur. Although all municipal reserves are supported by an environmental tax, the revenue is still too low to make a significant impact. FORAGUA has recently started planning to expand its agroforestry activities to generate revenue that can finance its restoration efforts, but the fund's dependence on development partners is still too great to overcome this challenge and give more attention to the conservation and restoration of water sources.

5. Discussion

5.1. Interaction between scale challenges and scale-sensitive governance strategies

Over the past two decades, water funds have gained traction as organisations specifically tasked (Marks and Hooghe, 2004) to conserve and restore watersheds. These funds can be understood as a type of scale-sensitive governance arrangement (Padt et al., 2014; Wiegant et al., 2022). First, they have been established at a governance level that facilitates creating spatial fit with the relevant ecological processes that they seek to influence. Second, by adopting a long-term perspective, they are designed to create temporal fit with restoration timelines. In these ways, water funds create fit with FLR's large spatial reach and long-term character (Mansourian and Parrotta, 2019). However, despite water funds being designed to create temporal and spatial fit, our results show that water funds have to continuously adopt new strategies to deal with emerging scale challenges and stay on course to implement objectives.

We studied two water funds, FONAG and FORAGUA, which follow different institutional set-ups. Even so, our results show overlap in the kinds of scale challenges that emerge when the funds implement restoration efforts. First, rural livelihoods were a blind spot (type A) in both cases. Whereas FORAGUA did not acknowledge the impact of its restoration efforts on rural livelihoods, FONAG was initially unaware that vulnerable groups at community level had difficulties adapting to the land-use and livelihood changes provoked by its conservation agreements. In both cases, the blind spot led to local discontent vis-à-vis restoration efforts. Second, both water funds experienced discontinuity of their restoration efforts following municipal election cycles (type B), as these caused instability in their relation with their members or constituents. Besides this temporal mismatch, a spatial mismatch became evident in both cases, in the sense that restoration efforts did not fit with the extent of landscape degradation processes (type B). In the FONAG case, the limited spatial reach of their conservation agreement resulted from the fund's inability to work outside EPMAPS′ priority catchments. In the FORAGUA case, the limited spatial extent of restoration efforts resulted from a lack of capacity within the technical secretariat and member municipalities to regulate and monitor restoration efforts in municipal reserves. Third, a plurality challenge was observed in the FORAGUA case (type C), with development partners seeing landscape restoration as a way to address climate change and biodiversity loss, whereas its members saw it as a solution to reduce local water scarcity and quality problems. This led to different interpretations of the preferred spatial extent of restoration efforts.

Previous restoration governance research has shown that scale challenges emerge during the implementation of restoration efforts (Wiegant et al., 2020). However, limited research has been undertaken regarding how actors deal with these challenges. We identified various strategies that water funds deployed or were planning to deploy to overcome emerging scale challenges. These strategies fall into two broad categories. The first category aims to change the water funds' relation with actors with whom they already work. This can be seen when FONAG strengthened its relationship with EPMAPS to build a broader support base, when FORAGUA aimed to change its relationship with member municipalities, or when the water funds gave or planned to give more attention to alternative livelihoods to assist those affected by restoration efforts. The second category aims to build relations with new actors, either because the relation with existing actors has become unproductive, or because new actors can fulfil a function that can improve the sustainability of restoration efforts. To reduce the risk of a temporal or a spatial mismatch, FONAG and FORAGUA started engaging with international development partners and conservation organisations to attract finance, which they can apply more flexibly than the funds they receive from their constituents or members. In addition, FORAGUA sought to establish new relationships with community-based water boards to have alternative implementing partners when mayors lacked willingness to collaborate. Lastly, FONAG built a relationship with Senagua to lobby for a policy change that can increase the sustainability of its conservation areas.

The FONAG and FORAGUA cases show that FLR governance is an iterative process in which new scale challenges emerge during the implementation process and which need to be tackled to stay on course to meet restoration objectives. To address these scale challenges, actors need to deploy scale-sensitive governance strategies. By tracing the process of scale challenges and scale-sensitive governance strategies, we show that FLR governance is not static but needs a continuous process of recreating fit and alignment. This is in line with the wicked problem literature that describes challenges that have no definitive solution (Head and Alford, 2015; Rittel and Webber, 1973). Seeing scale-sensitive governance as a process has implications for the ways in which restoration efforts are designed and for their temporal reach.

5.2. Implications and limitations

Despite their different institutional set-ups, we found similarities in the scale challenges with which FONAG and FORAGUA are confronted. Being able to observe and act on such challenges when they emerge can greatly improve the success of restoration efforts. FONAG's agency model has allowed it to implement local restoration efforts by itself, learn through trial and error, and develop strong technical capacity. By actively listening to and observing the needs and priorities of rural communities as part of its hydro-social diagnostics, FONAG seems in a good position to adapt its strategies and find fitting solutions to emerging scale challenges. Learning from experience is what shaped FONAG's restoration strategies over time, and the fund is recognised for this at national level. Meanwhile, FORAGUA's grant model has caused scale-sensitive strategies to take longer to formulate, and several are only in the planning stage. The limited ability of FORAGUA and its member municipalities to observe cross-scale and cross-level challenges emerging as part of the implementation process has reduced the water fund's effectiveness in addressing landscape degradation.

Studying the differing agency and grant models followed by FONAG and FORAGUA increases the transferability of our results to other water funds. However, additional research is needed given the limited geographical reach of this study, in which only two cases were analysed in the same country. As regards water funds as task-specific organisations, other water funds exist within Ecuador, in other Latin American countries, and in Africa, and analysing the similarities and differences in how other funds address emerging scale challenges would facilitate the categorisation of scale-sensitive governance strategies in more detail. Describing the interaction between scale challenges (Cash et al., 2006) and scale-sensitive governance strategies (Termeer and Dewulf, 2014) is, to the best of our knowledge, novel, and more empirical research will create a more robust understanding of the governance strategies that work well to create cross-scale fit and cross-level alignment. Research efforts should not just focus on task-specific organisations, but also venture into the strategies of other scale-sensitive governance arrangements (Wiegant et al., 2022).

A limitation relating to describing the interaction between scale challenges and scale-sensitive governance strategies at FONAG and FORAGUA is that results are time sensitive. Kauffman (2014), for example, initially assumed that the contractual agreements that water funds set with their constituents or members, and which were innovative at the time, would be able to provide protection against political instability. Our results indicate, however, that fund constituents and members can alter or discontinue their relation with a water fund, despite these agreements. This requires water funds to constantly deploy new strategies to stay on course when implementing their restoration objectives. Regarding our results, particularly the FORAGUA case is time sensitive, given that a number of scale-sensitive governance strategies are only in the planning stage. It is hence not known whether and how

these strategies will actually be implemented and what their effect will be on creating cross-scale fit and cross-level alignment.

6. Conclusion

We studied the scale challenges encountered by two Ecuadorian water funds in the process of implementing their FLR efforts at local level and the scale-sensitive governance strategies that the funds and their implementing partners deployed to stay on course and realise their restoration objectives. Building on a document review, 48 semi-structured interviews, and participatory observation, and following the scale challenge types proposed by Cash et al. (2006), we identified four scale challenges in the cases of FONAG and FORAGUA: 1) a blind spot towards rural livelihood realities (type A), 2) a temporal mismatch between short-term election cycles and long-term restoration timelines (type B), 3) a spatial mismatch between the reach of restoration efforts and land degradation processes (type B), and 4) heterogeneity across levels regarding the purpose of restoration with different spatial implications (type C).

With attention on, and investments in, FLR rising during the United Nations Decade on Ecosystem Restoration 2021–2030, it is important to understand the governance strategies deployed to overcome scale challenges in the process of implementing restoration efforts. We identified a total of 12 scale-sensitive strategies that the two water funds deployed or aim to deploy in reaction to identified scale challenges in an attempt to re-create cross-scale fit and cross-level alignment. Whereas one set of strategies aims to change the water funds' relationship with actors with whom they already work, a second set aims to build relations with new actors, either because the relationship with existing actors is becoming unproductive or because new actors' actions can improve the sustainability of restoration efforts.

We found similarities in the type of scale challenges confronting both FONAG and FORAGUA, but also observed varying degrees of success between the two water funds in terms of formulating and deploying scale-sensitive governance strategies. The results seem to suggest that FONAG, which follows the agency model, is better equipped to engage in an iterative process of re-creating cross-scale fit and cross-level alignment. FORAGUA, which follows the grant model, appears to have more difficulties observing and addressing cross-scale and cross-level challenges. However, the results are time sensitive, and multiple strategies were still in the planning stage at the time of the research. Given our novel approach, more empirical research will be needed – covering longer timelines, more water funds, and ideally other countries – to obtain a robust understanding of the governance strategies that effectively create cross-scale fit and cross-level alignment. Given that scale challenges and scale-sensitive governance strategies have alternated since the water funds were established, it seems that no lasting solution for fit and alignment can be obtained. To stay on course in FLR governance, a long-term, iterative process is required through which cross-scale fit and cross-level alignment are continuously sought.

CRediT author statement

Daniel Wiegant: Conceptualization, Methodology, Writing – original draft, Visualization, Validation, Supervision. **Jara Bakx:** Methodology, Investigation, Formal analysis, Writing – review & editing. **Nina Flohr:** Methodology, Investigation, Formal analysis, Writing – review & editing. **Pieter van Oel:** Conceptualization, Writing – review & editing. **Art Dewulf:** Conceptualization, Writing – review & editing

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Bennett, N.J., 2016. Using perceptions as evidence to improve conservation and environmental management. Conserv. Biol. 30, 582–592. https://doi.org/10.1111/cobi.12681.

Berg, B.L., 2001. In: Berg (Ed.), Qualitative Research Methods for the Social Sciences, fourth ed. Allyn & Bacon, Needham Heights, United States of America.

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

Bowen, G.A., 2006. Grounded theory and sensitizing concepts. Int. J. Qual. Methods 5, 12–23. https://doi.org/10.1177/160940690600500304.

Bremer, L.L., Auerbach, D.A., Goldstein, J.H., Vogl, A.L., Shemie, D., Kroeger, T., Nelson, J.L., Benítez, S.P., Calvache, A., Guimarães, J., Herron, C., Higgins, J., Klemz, C., León, J., Sebastián Lozano, J., Moreno, P.H., Nuñez, F., Veiga, F., Tiepolo, G., 2016. One size does not fit all: natural infrastructure investments within the Latin American Water Funds Partnership. Ecosyst. Serv. 17, 217–236. https://doi.org/10.1016/j.ecoser.2015.12.006.

Bremer, L.L., Farley, K.A., DeMaagd, N., Suárez, E., Cárate Tandalla, D., Vasco Tapia, S., Mena Vásconez, P., 2019. Biodiversity outcomes of payment for ecosystem services: lessons from páramo grasslands. Biodivers. Conserv. 28, 885–908. https://doi.org/10.1007/s10531-019-01700-3.

Buytaert, W., Célleri, R., De Bièvre, B., Cisneros, F., Wyseure, G., Deckers, J., Hofstede, R., 2006. Human impact on the hydrology of the Andean páramos. Earth Sci. Rev. 79, 53–72. https://doi.org/10.1016/j.earscirev.2006.06.002.

Buytaert, W., De Bièvre, B., 2012. Water for cities: the impact of climate change and demographic growth in the tropical Andes. Water Resour. Res. 48, 1–13. https://doi.org/10.1029/2011WR011755.

Carter, N., Bryant-Lukosius, D., Dicenso, A., Blythe, J., Neville, A.J., 2014. The use of triangulation in qualitative research. Oncol. Nurs. Forum 41, 545–547. https://doi.org/10.1188/14.ONF.545-547.

Cash, D.W., Adger, W.N., Berkes, F., Garden, P., Lebel, L., Olsson, P., Pritchard, L., Young, O., 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.

Cash, D.W., Moser, S.C., 2000. Linking global and local scales: designing dynamic assessment and management processes. Global Environ. Change 10, 109–120. https://doi.org/10.1016/S0959-3780(00)00017-0.

Charmaz, K., 1996. Grounded theory. In: Smith, J.A., Harré, R., Van Langenhove, L. (Eds.), Rethinking Methods in Psychology. SAGE Publications.

Cumming, G.S., Cumming, D.H.M., Redman, C.L., 2006. Scale mismatches in social-ecological systems: causes, consequences, and solutions. Ecol. Soc. 11 https://doi.org/10.5751/ES-01569-110114.

Cumming, G.S., Olsson, P., Chapin, F.S., Holling, C.S., 2013. Resilience, experimentation, and scale mismatches in social-ecological landscapes. Landsc. Ecol. 28, 1139–1150. https://doi.org/10.1007/s10980-012-9725-4.

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

Erbaugh, J.T., Oldekop, J.A., 2018. Forest landscape restoration for livelihoods and well-being. Curr. Opin. Environ. Sustain. 32, 76–83. https://doi.org/10.1016/j.cosust.2018.05.007.

Espinoza, J.C., Garreaud, R., Poveda, G., Arias, P.A., Molina-Carpio, J., Masiokas, M., Viale, M., Scaff, L., 2020. Hydroclimate of the Andes Part I: main climatic features. Front. Earth Sci. 8, 1–20. https://doi.org/10.3389/feart.2020.00064.

FONAG, 2020. Acuerdos de conservación - Comunidad El Carmen. Quito, Ecuador.

FONAG, 2019. The Path of Water - FONAG: Work and Lessons. Quito, Ecuador.

FORAGUA, 2019. Plan de restauración forestal de las fuentes de agua bajo el mecanismo financiero FORAGUA mediante la compensación por servicios ambientales.

FORAGUA, 2018. Resumen ejecutivo: Fondo de agua para la conservación de las fuentes de agua y biodiversidad.

Goldman-Benner, R.L., Benitez, S., Boucher, T., Calvache, A., Daily, G., Kareiva, P., Kroeger, T., Ramos, A., 2012. Water funds and payments for ecosystem services: practice learns from theory and theory can learn from practice. Oryx 46, 55–63. https://doi.org/10.1017/S0030605311001050.

Head, B.W., Alford, J., 2015. Wicked problems: implications for public policy and management. Adm. Soc. 47, 711–739. https://doi.org/10.1177/0095399713481601.

Ilbay-Yupa, M., Ilbay, F., Zubieta, R., García-Mora, M., Chasi, P., 2021. Impacts of climate change on the precipitation and streamflow regimes in equatorial regions: guayas river basin. Water (Switzerland) 13. https://doi.org/10.3390/w13213138.

Joslin, A., 2020. Translating water fund payments for ecosystem services in the Ecuadorian Andes. Dev. Change 51, 94–116. https://doi.org/10.1111/dech.12542.

Joslin, A.J., 2019. Unpacking 'success': applying local perceptions to interpret influences of water fund payments for ecosystem services in the Ecuadorian Andes. Soc. Nat. Resour. 32, 617–637. https://doi.org/10.1080/08941920.2018.1559379.

Kauffman, C.M., 2014. Financing watershed conservation: lessons from Ecuador's evolving water trust funds. Agric. Water Manag. 145, 39–49. https://doi.org/10.1016/j.agwat.2013.09.013.

Keese, J., Mastin, T., Yun, D., 2007. Identifying and assessing tropical montane forests on the eastern flank of the Ecuadorian Andes. J. Lat. Am. Geogr. 6.

Kleemann, J., Koo, H., Hensen, I., Mendieta-Leiva, G., Kahnt, B., Kurze, C., Inclan, D.J., Cuenca, P., Noh, J.K., Hoffmann, M.H., Factos, A., Lehnert, M., Lozano, P., Fürst, C., 2022. Priorities of action and research for the protection of biodiversity and ecosystem services in continental Ecuador. Biol. Conserv. 265, 109404. https://doi.org/10.1016/j.biocon.2021.109404.

Lichtman, M., 2014. Qualitative Research for the Social Sciences. https://doi.org/10.4135/9781544307756.

MacLean, L.M., Meyer, M., Estable, A., 2004. Improving accuracy of transcripts in qualitative research. Qual. Health Res. 14, 113–123. https://doi.org/10.1177/1049732303259804.

Magrin, G.O., Marengo, J.A., Boulanger, J.-P., Buckeridge, M.S., Castellanos, E., Poveda, G., Scarano, F.R., Vicuña, S., 2014. Central and south America. In: Barros, V. R., Field, C.B., Dokken, D.J., Mastrandrea, M.D., Mach, K.J., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A. N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 1499–1566.

Mansourian, S., Parrotta, J., 2019. From addressing symptoms to tackling the illness: reversing forest loss and degradation. Environ. Sci. Pol. 101, 262–265. https://doi.org/10.1016/j.envsci.2019.08.007.

Marks, G., Hooghe, L., 2004. Contrasting visions of multi-level governance. In: Bache, I., Flinders, M. (Eds.), Multi-Level Governance, pp. 15–30. https://doi.org/10.1093/0199259259.003.0002.

Martín-López, B., Leister, I., Cruz, P.L., Palomo, I., Grêt-Regamey, A., Harrison, P.A., Lavorel, S., Locatelli, B., Luque, S., Walz, A., 2019. Nature's contributions to people in mountains: a review. PLoS One 14. https://doi.org/10.1371/journal.pone.0217847.

Mittermeier, R.A., Turner, W.R., Larsen, F.W., Brooks, T.M., Gascon, C., 2011. Global biodiversity conservation: the critical role of hotspots. In: Zachos, F.E., Habel, J.C. (Eds.), Biodiversity Hotspots. Springer-Verlag Berlin Heidelberg, pp. 3–22. https://doi.org/10.1007/978-3-642-20992-5.

NCI, 2021. Bosque seco biosphere reserve [WWW document] accessed 9.17.21. https://natureandculture.org/reserves-completed/bosque-seco/.

Ochoa-Tocachi, B.F., Buytaert, W., De Bièvre, B., Célleri, R., Crespo, P., Villacís, M., Llerena, C.A., Acosta, L., Villazón, M., Guallpa, M., Gil-Ríos, J., Fuentes, P., Olaya, D., Viñas, P., Rojas, G., Arias, S., 2016. Impacts of land use on the hydrological response of tropical Andean catchments. Hydrol. Process. 30, 4074–4089. https://doi.org/10.1002/hyp.10980.

Padt, F., Opdam, P., Polman, N., Termeer, C., 2014. Scale-Sensitive Governance of the Environment. Wiley Blackwell. https://doi.org/10.1002/9781118567135.

Padt, Frans, Arts, B., 2014. Concepts of scale. In: Padt, F., Opdam, P.F.M., Termeer, C.J. A.M., Polman, N. (Eds.), Scale-Sensitive Governance of the Environment. Wiley, p. 344. https://doi.org/10.1002/9781118567135.

Raes, L., Rengel, E., Romero, J., 2012. Inter-municipal Cooperation in Watershed Conservation through the Establishment of a Regional Water Fund - FORAGUA - in Southern Ecuador.

Rittel, H.W.J., Webber, M.M., 1973. Dilemmas in a general theory of planning. Pol. Sci. 4, 155–169. https://doi.org/10.1007/BF01405730.

Rolando, J.L., Turin, C., Ramírez, D.A., Mares, V., Monerris, J., Quiroz, R., 2017. Key ecosystem services and ecological intensification of agriculture in the tropical high-Andean Puna as affected by land-use and climate changes. Agric. Ecosyst. Environ. 236, 221–233. https://doi.org/10.1016/j.agee.2016.12.010.

Russell Bernard, H., 2011. Research Methods in Anthropology: Qualitative and Quantitative Approaches, fifth ed. Altamira Press, Plymouth, United Kingdom.

Salkind, N., 2010. Encyclopedia of Research Design. https://doi.org/10.4135/9781412961288 NV - 0.

Termeer, C.J.A.M., Dewulf, A., 2014. Scale-sensitivity as a governance capability: observing, acting and enabling. In: Padt, F., Opdam, P.F.M., Termeer, C.J.A.M., Polman, N. (Eds.), Scale-Sensitive Governance of the Environment. Wiley, p. 344. https://doi.org/10.1002/9781118567135.

Termeer, C.J.A.M., Dewulf, A., Lieshout, M. Van, 2010. Disentangling scale Approaches in governance research: comparing monocentric, multilevel, and adaptive governance. Ecol. Soc. 15, 29.

van Lieshout, M., Dewulf, A., Aarts, N., Termeer, C., 2011. Do scale frames matter? Scale frame mismatches in the decision making process of a "mega farm" in a small Dutch village. Ecol. Soc. 16.

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.

Wiegant, D., van Oel, P., Dewulf, A., 2022. Scale-sensitive governance in forest and landscape restoration: a systematic review. Reg. Environ. Change 21. https://doi.org/10.1007/s10113-022-01889-0.

Wyborn, C., Bixler, R.P., 2013. Collaboration and nested environmental governance: scale dependency, scale framing, and cross-scale interactions in collaborative conservation. J. Environ. Manag. 123, 58–67. https://doi.org/10.1016/j.jenvman.2013.03.014.

Wyborn, C., Evans, M.C., 2021. Conservation needs to break free from global priority mapping. Nat. Ecol. Evol. 5, 1322–1324. https://doi.org/10.1038/s41559-021-01540-x.