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POLICY PERSPECTIVE

Challenges and Prospects for Scaling-up Ecological Restoration to Meet International Commitments: Colombia as a Case Study

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Abstract

The field of ecological restoration (ER) is now challenged by the need to achieve recovery at large spatial scales. Such scaling up requires technological expertise, inclusiveness and clarity of goals, and correct governance schemes and monitoring protocols, which are often absent from ER projects in most countries. We analyze the case of Colombia by assessing the planning, governance, and monitoring practices of 119 ER projects, and discuss them in the context of scaling up efforts to meet international commitments. In a top-down approach, Colombia´s government is the biggest ER driver: setting up the necessary policy framework to promote ER, and initiating 64% and fully financing 78% of the projects in the country. However, projects lack depth in participatory governance and adequate planning and monitoring, limiting their potential for sustainability and knowledge sharing, both of which are necessary for scaling up. We propose three areas for improvement in order to scale-up and meet international ER targets in Colombia, as well as in other Latin American countries, such as Mexico, Chile, and Argentina, which are also in the process of consolidating a large-scale ER vision. The benefits of some of those improvements have already been demonstrated in Brazil.

Introduction

Ecological restoration (ER) is a rapidly growing field, advancing both in theory and practice (Suding 2011; Clewell & Aronson 2013) and gaining momentum in global policy fora (Pistorius & Freiberg 2014). International agreements such as Aichi Target 15 (CBD 2010), Convention on Biological Diversity´s Decision XI/16 (CBD 2012), Objective 3(b)(i) of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES 2013), Bonn Challenge (IUCN 2014), New York Declaration (UN 2014), and World Resources Institute´s Initiative 20 × 20 (WRI 2014) are motivating countries to implement ER projects to halt and reverse ecosystem loss and assist in adaptation to climate change. These global commitments will require allocating significant human and financial resources based on careful planning and prioritization, as well as scaling-up, i.e., increasing the spatial scale of existing or planned ER projects to maximize their national and regional relevance.

ER projects are multifaceted. They require technical and ecological knowhow for addressing threats to soil and species loss and for promoting ecological succession and ecosystem health. But, they also need to involve

stakeholders at different levels while addressing the social and economic drivers that led to degradation—a *sine qua non* for ensuring long-term sustainability. Furthermore, to achieve long-term relevance and impact, ER projects must also scale-up beyond site-specific actions and become integrated in landscape-level or regional programs driven by conservation and production objectives (Aronson *et al.* 2007; Neßhöver *et al.* 2011). Thus, the drivers to scale-up come from the top (as governments sign international agreements) and the bottom (from the realization that larger projects are more likely to have more impact and sustainability).

Furthermore, scaling up ER projects requires (a) expertise stemming from the collective experience of local restoration efforts and lessons learned (Rodrigues *et al.* 2009); (b) innovative multistakeholder governance structures (Pinto *et al.* 2014), (c) a framework of government policies, laws, and locally based regulations, and incentives to complement and support citizen-driven initiatives (Guariguata & Brancalion 2014), and (d) clarity over the acceptable trade-offs among competing objectives and constituencies likely to occur when politics of policy meet environmental reality (Baker *et al.* 2014).

As a result of the abovementioned restoration commitments, scaling up is rapidly emerging in many parts of the world including Latin America. In Brazil, for example, both bottom-up and top down approaches merge into a large-scale ER project aiming to restore 15 million hectares in the Mata Atlàntica biome (PACTO 2013). In contrast, in Colombia (MADS 2012b) and Ecuador (Ministerio del Ambiente de Ecuador 2014), scaling-up is largely being driven from the top, where governments have recently developed policy and legal frameworks to enable the design and implementation of nation-wide ER initiatives. In other countries like Mexico (Ceccon *et al.* 2015), Chile (Echeverría *et al.* 2015), and Argentina (Zuleta *et al.* 2015), awareness and networking among academic researchers and practitioners is increasingly becoming prominent; an essential element for scaling up ER projects at the national and regional level (Armesto *et al.* 2007).

In this article, we discuss the challenges countries face as they work to achieve the aforementioned international commitments in the next 20 years. We use Colombia as a case study, because it has a five decade-old history of ER. Using data from a previous study that characterized 119 ER projects in Colombia (Murcia & Guariguata 2014, see methods in Supporting Information), we analyze how the various projects were planned and governed. We seek to explore how the experience accumulated so far is preparing Colombia for scaling up ER projects to meet international targets. Lessons learned in Colombia can shed light on measures required to accelerate the capacity of other countries particularly in the Latin American region to achieve international restoration commitments and goals.

Colombia's restoration policy framework

ER in Colombia began formally in the 1950s, following enactment of a law establishing areas for forest reestablishment and allocating funds for land purchase and tree planting (Ley 4 1951). By the turn of the 21st century, Colombia's Ministry of the Environment had generated two policy frameworks: a national forest recovery and restoration plan (MinAmbiente 1998) and a strategic plan for restoring ecosystems within its National Biodiversity Strategy (Murcia *et al.* 1998). More recently, the Ministry of the Environment issued a National Restoration Plan (MADS 2012b), plus a manual that includes ER as one option for offsetting biodiversity losses related to development or extractive projects (MADS 2012a). In addition, ER was part of the previous presidential government (DNP 2010), and Colombia has pledged to restore 300,000 ha of degraded terrestrial ecosystems by 2018 (DNP 2010), and one million hectares by 2020 (WRI 2014).

Implementation and monitoring of ER projects in Colombia

Project size and land tenure

Total area reported by 108 ER projects was 87,870 ha (mean: 861 ha, range: 1–28,000 ha). The size distribution was heavily skewed toward small size (median: 29 ha): 67% of the projects were less than 100 ha, only 11% were larger than 1,000 ha, and only three were larger than 10,000 ha.

Two thirds of the projects were located on public lands: i.e., national parks, or departmental or municipal lands (mainly in the capital city of Bogotá), as well as in (municipal) facility companies. The remaining projects were located on privately owned lands (owned mostly by individuals and by companies), and on indigenous territories.

Project ownership and governance

Government agencies have been the most important driver for the implementation of ER projects in Colombia (Figure 1). Government agencies were responsible for all projects conducted in public lands plus 45% of projects implemented in private lands. Furthermore, 78% (of 115 projects) were initiated and funded by government agencies, with either national (National Parks), departmental, or municipal jurisdictions. Additionally, government agencies contributed with either all or part of core

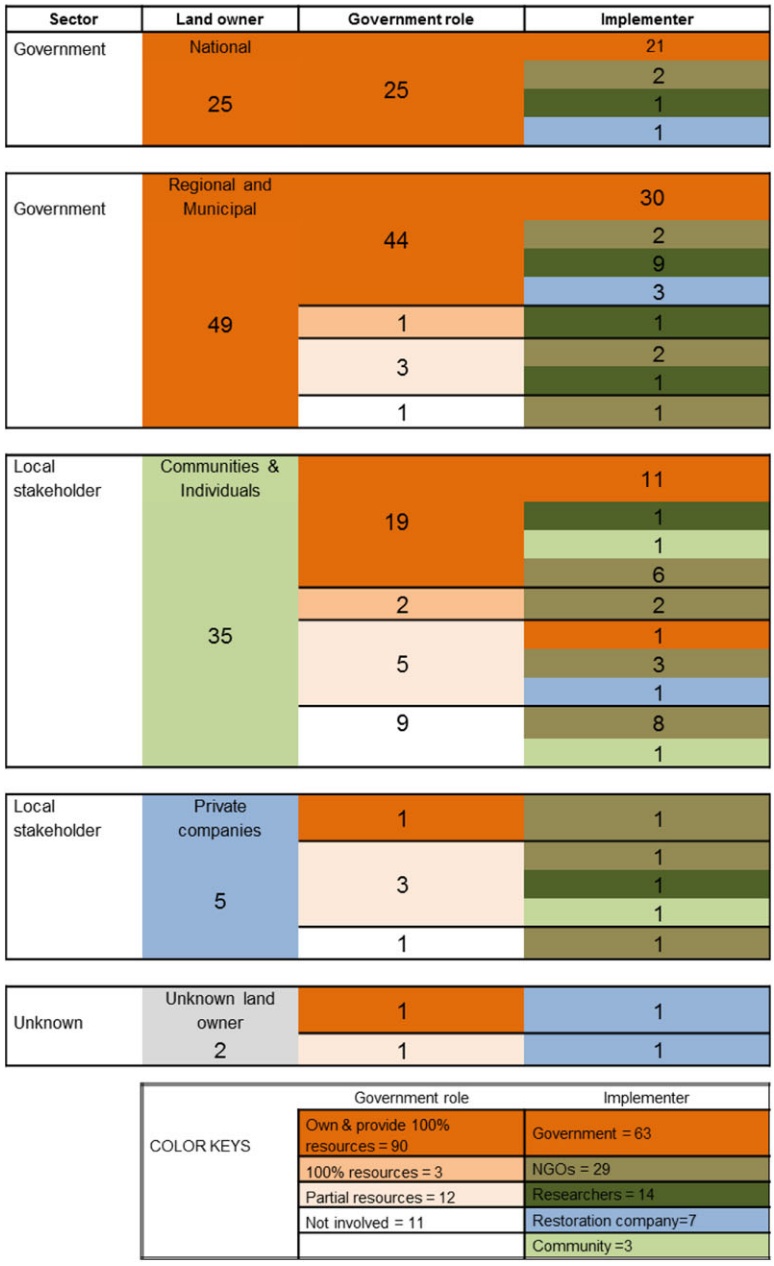

Figure 1 Hierarchical distribution of the number of projects from a total of 116, according to land tenure (who owns the land), government participation in the ER project (to what extent the Government owned and/or supported financially the ER project), and implementer (Government and other non-government institutions). The color coding for the last two vertical sections is at the bottom of the image.

financial resources to 50% the projects initiated privately. The role of the government was most pronounced since 2004, due to the impetus from two governmental agencies: National Parks and Bogotá´s Secretaría Distrital de Ambiente (i.e., Bogota´s municipal environment office). Together, they funded 68% of the projects in the 2004–2012 period.

Project design followed a top down approach. For example, of 90 projects initiated by government agencies, 58% were designed by the same agency, and 37% were designed by external implementers, in both cases mostly without participation from other actors. Only twice were communities involved in project design. Projects not initiated by the government were designed either by the project owner (NGOs and one community) of by the implementing institution (mostly NGOs or academic researchers).

Government agencies implemented 69% of both government-initiated and -funded projects (Figure 1). Otherwise, implementation was outsourced to NGOs or

academic groups (39% each), and to a lesser extent to private restoration companies (18%). Only once was implementation outsourced to a local community. For projects not initiated by government agencies, implementation was done mostly by NGOs (68%), and to a much lesser extent by academic groups, communities, private companies and, in one case, by a government agency.

Active participation of local actors in project implementation was limited to three projects. Yet, 50% of project respondents indicated that local communities were key partners because they contributed knowledge, labor, resources, or lands. In an additional 32% of the projects, local communities' involvement was reduced to participating as hired labor, openly approving the project, or simply expressing general interest. In the remaining projects, communities did not participate because they were not contacted or were absent from the area.

Local participation changed with project phase (Figure 1). The highest level of participation was in the execution phase (50% of projects), largely due to hiring of local labor. In 44% of projects, respondents indicated that local communities were engaged in the planning. It was unclear, however, whether such participation was passive (e.g., attending informative meetings), moderately active (e.g., providing baseline information), or significantly active (e.g., contributing to the project´s design). Community participation in monitoring activities was moderate (21% of projects), but almost nil in the initial work to establish a baseline (2%).

Project goals and ecological and geographical focus

As a whole, projects' goals largely focused on ecological aspects, both at the plot and landscape scales (Table 1). Goals related to socioeconomic, cultural, and spiritual aspects were present in only 22% of the projects. The goal of risk reduction was present in 20% of the projects.

Within those ER projects with an ecological focus, 89% dealt with recovery of water delivery and regulation at the watershed level. A second ER motivation was to increase the area of a threatened ecosystem or augment its connectivity within the surrounding landscape, followed by biodiversity recovery or elimination of exotic or invasive species.

The goal of watershed restoration observed in most projects explains their concentration in the Andean montane region (94%), with 50% of those located in the immediate vicinity of Bogotá, which harbors over 7 million people (Figure S1), and 14% in the Central Andean region, the heart of Colombia´s coffee-growing activity. Other ecosystems, such as mangroves, lowland dry forests, and wetlands were poorly represented (15%).

Table 1 Goals listed by managers of 119 ecological restoration projects in Colombia

Goal	Number of projects
Increase in area and connectivity	
Increase ecosystem area	64
Promote ecological connectivity	62
Ecological processes and biodiversity	
Recover ecological processes	76
Recover biodiversity	37
Elimination of exotic/invasive species	35
Recover habitat for threatened species	12
Carbon sequestration	8
Socioeconomic processes	
Threat reduction	24
Recreation/eco-tourism	18
Recover agricultural land	12
Job creation	9
Cultural and spiritual values	6
Land reclamation after mining	5

Monitoring

Ninety five percent of projects had a monitoring plan. Further, 90% of respondents indicated that their projects' monitoring variables matched project objectives. However, when monitored variables were cross-referenced with project goals, this perception was not supported. Typically (96%) projects monitored only short-term changes such as early survival and growth of planted seedlings, changes in plant ground cover, and erosion control. Mid-term change, such as colonization by different plant and wildlife groups, was monitored only in one-fourth to one-third of the projects, respectively. Variables related to the goals (i.e., landscape change or water availability) were monitored in only 5% of the projects. Likewise, social and political change was monitored in just 5% of the projects.

Monitoring plans were most often (90%) designed by the project´s owner. Explicit scientific input and local participation occurred in one and two projects respectively. Monitoring was conducted either by government agencies (51%) or NGOs or academia (40%). Communities participated in 9% of the projects, but always in association with researchers, government staff, or external consultants.

Discussion

ER in Colombia is mostly done at a small scale and driven by government efforts and funds, largely focusing on recovering watershed services in areas of both high population density and agricultural production in the Andean region. Thus, to date, the span and focus of

government-led ER projects shows lack of systematic spatial planning and ecosystem prioritization. Project governance is largely top-down, with little participation of local stakeholders. When projects are not implemented by the government (at all hierarchical levels), they are delegated to NGOs and academic groups. Project monitoring has focused mostly on short-term ecological indicators that do not relate to the primary goal of most projects, namely to improve water quality and supply. In light of current international commitments adopted by Colombia (and other Latin-American countries), the following issues relating to essential aspects of an ER project need to be addressed for scaling-up (Rieger *et al.* 2014).

A coherent and spatially explicit national strategy that prioritizes ER nationwide

The current version of the National Restoration Plan (MADS 2012b) does not include a plan to prioritize ER across the country. Also, the existing bias towards both the Andean region and watershed ER needs to be analyzed in the context of country-wide strategic planning. Colombia's Humboldt Biodiversity Institute is addressing this bias by generating a country-wide assessment of ER needs based entirely on biophysical information. The resulting map and report should be useful for revising the current National Restoration Plan to make it more comprehensive and spatially explicit. However, it would benefit from incorporating socioeconomic criteria as well (e.g., Hyman & Leibowitz 2000; Cipollini *et al.* 2005; Wilson *et al.* 2011) and from increasing its spatial resolution to allow meaningful planning at departmental and municipal levels. Ecuador's plan (Ministerio del Ambiente de Ecuador 2014) does have an spatially explicit prioritization, but it is focused exclusively on forests, to the detriment of nonforested ecosystems.

Progressively, ER should be included in territorial planning processes at national, regional, and municipal scales to allow the country to align itself with current international agendas. Because ER start-up costs can be high (Erskine 2002), prioritization helps to ensure optimal financial resource allocation at the country level. Wilson *et al.* (2011) have developed a return-on-investment prioritization framework for ER which could be applied in Colombia and elsewhere. This framework is spatially and temporally explicit, and accounts for the benefits as well as the costs of restoration, and likelihood of project success.

All relevant actors and governance approaches should be considered

Governance creates the conditions for decision-making and coordination of socioecological systems (Folke *et al.* 2005). It also determines the vision and direction of projects and the way they are designed, implemented, and monitored (Lebel *et al.* 2006). Reconciling multiple scales and views and reducing power imbalances are essential for effective landscape management governance systems (Kozak *et al.* 2014). We found local communities participation to be marginal at best, often relegated to provision of local resources, knowledge or labor, and excluded from formal decision-making processes despite the fact that community buy is critical for long-term restoration success.

Horizontal synergies between government (especially at the provincial and municipal level) and the private, nonprofit, academic, and grass-roots sectors, such as that observed in South-Eastern Brazil (Wuethrich 2007; Brancalion *et al.* 2010), should be promoted in Colombia. To this end, an enabling environment is needed to facilitate such broad participation. Moreover, in order to scale up, countries will have to promote (a) interdisciplinary thinking in restoration training and university-level teaching that is available to students and young and mid-career professionals, (b) inter-disciplinary ER research, and (c) mechanisms for sharing and distilling lessons learned.

The practice of ER requires accountability, and progress needs to be adequately measured

Evaluating ER outcomes is not always straightforward, and projects can take several decades to deliver desired outcomes (Rey Benayas *et al.* 2009; Moreno-Mateos *et al.* 2012). Extensive debates persist on what characterizes, and how best to measure, a successful ER project (Ruiz-Jaén & Aide 2005; Aronson *et al.* 2010; Suding 2011; Wortley *et al.* 2013). However, evaluation and monitoring of biophysical as well as socioeconomic variables at several spatial scales is necessary for (1) determining whether project goals were achieved, (2) managing the project to adapt to unforeseen threats or unexpected results, and (3) learning from the process. The fact that only 50% of projects identified a baseline and a reference state or "model" ecosystem (Murcia & Guariguata 2014), and that variables measured do not assess medium or long-term goals, reflects both lack of foresight and planning based on a clear conceptual framework. It also precludes determination of whether the remaining restoration projects actually achieved, or are achieving, their goals. All of this has implications for the projects' ability to document and report on lessons learned (see Rodrigues *et al.* 2009 for an example in Brazilean Atlantic Forest Pact), and to assess whether or not objectives have been attained. It is not just the number of hectares undergoing restoration, nor the numbers of trees planted (e.g., Contraloría General de la República 2012), that should be used to assess the depth, breadth, and effectiveness of

a nation-wide program in recovering its natural capital. Instead it should be the achievement of pre-determined biological and socioeconomic goals (e.g., Pinto *et al.* 2014), as well as ensuring the persistence in time and space of an ecosystem restored to its historical trajectory and adapting to rapidly changing climate and ecological conditions.

Conclusion

Colombia's efforts to promote ER projects have been largely driven by the government at different levels and on different fronts (from policy design to implementation and monitoring). However, in spite of the various current legal frameworks enabling and promoting ER, Colombia still lacks a coherent agenda that prioritizes the allocation of financial resources and the ecosystem types to be restored, while taking into account the fundamental socioeconomic aspects all too often overlooked (Aronson *et al.* 2010). In our view, effective national restoration plans need to address some of the issues raised here. Furthermore, solely relying on top-down approaches, like the one observed in Colombia, may restrict broader societal participation and links with NGOs, academia, local communities, and the various private sectors. Concurrently, Latin American countries responding to international restoration calls should balance bottom-up initiatives and approaches with explicit policy frameworks and national-level planning to provide the necessary large-scale context.

In addition to dictating ER policy, the active participation of the government may be necessary. In Colombia, for example, government agencies are uniquely positioned to innovate. First, they have the capacity to acquire and allocate significant economic resources that come from payment for ecosystem services, royalties from oil extraction, bilateral or multilateral funds (Ponce de León & Rodríguez Becerra 2000; Gómez-Torres 2005) and, more recently, from biodiversity offsets (MADS 2012a). Second, they own strategically located land integrated into the National System of Protected Areas (SINAP). Finally, they have the capacity to convene and coordinate projects at large scales (Andrade 2000). Hence, it behooves national governments to (a) lead the ER agenda, (b) collaborate regionally and internationally, (c) actively promote a new generation of socially inclusive models that engage local stakeholders in planning, execution and monitoring, and (d) integrate ER into complementary development strategies and programs.

In light of the ambitious restoration commitments recently made by many Latin American nations to restore millions of hectares of degraded land by 2020 (e.g., WRI 2014), there is an urgent need to discern both the opportunities and barriers to implement these targets across different scales of governance and socioecological contexts (Baker *et al.* 2014). That said, in Mexico (Ceccon *et al.* 2015), Argentina (Rovere 2015), and Chile (Echeverría *et al.* 2015), scientists and practitioners are actively calling for promoting interdisciplinarity in the practice of ER, for harmonizing policy and regulatory aspects at the national level, for generating effective dialogue between government, academia, NGOs and the private sector, and for assessing critical knowledge gaps from a technical and practical standpoint. We hope that the lessons learned in the case of ER in Colombia are useful to this end.

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Author Contributions

MRG conceived the project. CM and MRG designed the study. CM analyzed the data and led the writing in collaboration with MRG. EM collected and compiled the data. AA, GIA, JA, EME, AE, FM, and WR contributed to the writing.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

S1. Methods.

Figure S1. Geographic distribution of restoration projects underway in Colombia.

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