

OPINION ARTICLE

Four approaches to guide ecological restoration in Latin America

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There is strong upswing in conservation and restoration efforts in Latin America (LA), particularly in the recent decades after several countries have committed to international agreements such as the Aichi targets of the Convention on Biological Diversity, Initiative 20×20, and the Bonn Challenge. To fulfill these agreements, the practice of ecological restoration has to be defined based on ecological knowledge, but also on the specific social, economic, and legal aspects of each country in the region. Here, we give some examples about the national understanding of ecological restoration in 10 countries of LA. We identify difficulties and opportunities to define restoration priorities and needs, and discuss some approaches to cope with economic constraints and agreements, including the potential role of restoration networks in this process. On the basis of the socioecological complexity of these countries and the expectations they have in relation to restoration, we proposed four approaches to guide restoration practice and policy in the region: (1) including biodiversity and ecosystem services approach into ecosystem restoration initiatives; (2) promoting restoration in their frequently human-modified landscapes; (3) accounting for cost–benefit trade-offs; and (4) assembling “horizontal” communication frameworks. These approaches should be based at national levels, but adapted to local-regional levels, in a bottom-up perspective. We consider that national and international restoration networks in the region can help to overcome difficulties, fostering a solid scientific community, helping to develop national approaches that better match the specific conditions of each country and enhancing communication among different groups of stakeholders.

Key words: biodiversity, ecosystem services, public policy, socioecological

Implications for Practice

- Integrating biodiversity and ecosystem services may help to define practices for restoration tailored to socioecological contexts of Latin America.
- It is critical to evaluate, improve, and disseminate ecological and economic cost–benefit relationships in different socioecological contexts to support national restoration plans.
- Useful knowledge to implement restoration must be shared in accessible communication frameworks that should be nonhierarchical or sectorized (not only academic).
- Restoration approaches should be based at national levels, but adapted to local-regional levels, in a bottom-up perspective considering the frequent human-modified landscapes of Latin America.
- The effectiveness of the many restoration programs promoted in Latin America relies on their integration with national and subnational restoration frameworks and organizations, which can be supported by restoration networks.

Introduction

Degradation of ecosystems is an ongoing process in Latin America (LA), where land use and land cover changes due to the expansion of urban areas and agro-industrial crops

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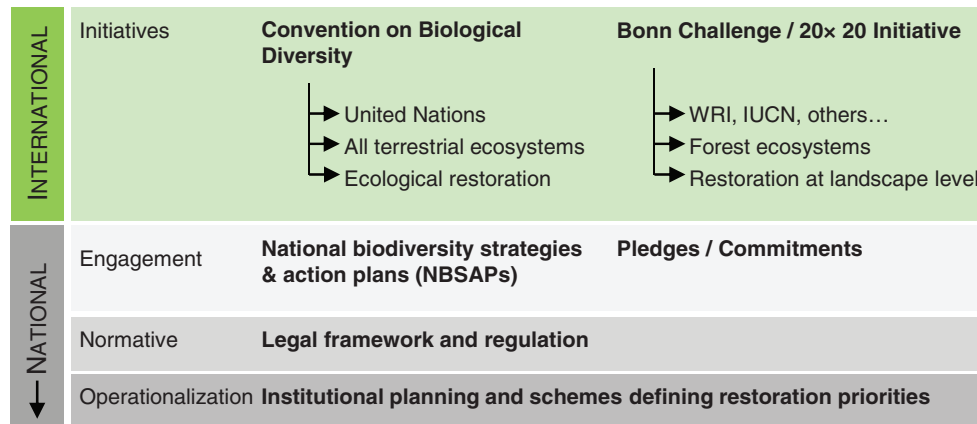


Figure 1. Two scales of definition and practice of ecological restoration: at global level, international commitments launched by different organizations define concepts and criteria for restoration priorities; at national levels, countries materialize their restoration plans engaging these commitments, defining their own normative, and implementing restoration through different planning schemes.

represent major threats (DeClerck et al. 2010). Ecological restoration has recently emerged in the region as an alternative not only to revert this historical trend, but also to promote a new paradigm of socioeconomic development better integrated with nature (Echeverría et al. 2015). The Ibero-American and Caribbean Society for Ecological Restoration (SIACRE) is currently playing a key role in this context by promoting national restoration networks, research, and practice at international, national, and subnational levels in LA. The 4th SIACRE International Conference, realized in April 2015 in Buenos Aires, Argentina, with participants representing both academic and nonacademic sectors from several countries, served as the catalyst for this contribution.

LA requires special consideration regarding the establishment of guiding approaches for national restoration plans due its high socioecological complexity. There are broad social differences among countries in LA regarding land tenure, democratic institutions, and income distribution (UNDP 2015). Even with this, many LA countries host exceptional ecosystems particularly rich in biodiversity as a consequence of a complex combination of climate and topographic variations and biogeographic processes (Marchese 2015). They also harbor culturally diverse populations, although in many countries more than 40% is below the poverty level (CEPAL 2016).

Although both technical aspects of restoration are well developed in LA, socioecological dimensions have not been properly assessed to guide restoration and its potential to support human needs through the provision of ecosystem services (Balvanera et al. 2012). Defining strategic approaches to guide restoration programs becomes crucial to leverage countries' engagement and obtain better socioecological outcomes. Here, we propose four approaches to guide the involvement of LA countries in the practice of restoration. We do not exhaustively review legal instruments and institutional frameworks regarding ecological restoration in the region. Rather, we present a general overview on restoration commitments, the regulatory framework supporting them, and the type of organizations leading restoration programs in 10 LA countries. We

expect these four approaches, based on particular socioecological characteristics, would help achieve better restoration outcomes in LA.

Who Defines Restoration Approaches in LA?

Restoration practice in LA is strongly influenced by an international agenda (Fig. 1). All countries have ratified the Convention on Biological Diversity, which mandates restoring at least 15% of degraded terrestrial ecosystems worldwide as part of its Aichi target 15 (CBD 2012). In parallel, the Bonn Challenge (2016) and the New York Declaration on Forests (UN 2014) were launched by international organizations such as the World Resources Institute (WRI) and the World Conservation Union (IUCN) at a ministerial scale. After the Convention of the Parties in Lima, Initiative 20x20 was launched as a country-led effort to restore more than 20 million hectares in LA (WRI 2014). Underlying these restoration aspirations human well-being are also intended through the establishment of multifunctional landscapes that improve the provision of ecosystem goods and services to people (Sabogal et al. 2015). But approaches and targets change when scale and perspectives vary. These large-scale international initiatives will only succeed when adequately integrated and nested within national and subnational programs.

Countries have engaged these initiatives through national strategies and action plans and some of them have committed to restore a given target area (Table 1). Although some countries have developed regulatory frameworks and some supportive instruments to guide restoration, they lack a common view that addresses the needs and expectations of different stakeholder groups, the capacity of institutions and organizations to operationalize large-scale restoration, and the special particularities of the high socioecological heterogeneity typical of LA. National and regional institutions must play a relevant role to effectively incorporate international restoration commitments into countries' initiatives, but they need guiding principles to define and prioritize the ecological restoration practice for optimizing the use of the limited human and financial resources.

Table 1. Commitments of 10 Latin America countries to international restoration initiatives, and meaningful legal frameworks and schemes to comply with them. ^aAll countries ratified the CBD. Source: <https://www.cbd.int/nbsap/targets/default.shtml>. ^bwww.bonnchallenge.org. ^cwww.wri.org.

	<i>NBSAP Includes Restoration?</i> ^a	<i>Bonn Challenge (million of hectares)</i> ^b	<i>Initiative 20x20 (million of hectares)</i> ^c	<i>National Strategy</i>	<i>Legal Normative Related to Restoration</i>	<i>Schemes Explicitly Defining Restoration Priorities</i>	<i>Sector Leading Restoration Initiatives</i>
Argentina	Yes	1	1	No	Several national laws including restoration, but there is not a specific one regulating as a practice	No	Nongovernment
Brazil	Yes	1 (Mata Atlántica)	2.9 (Mato Grosso), 0.3 (Sao Paulo), 0.08 (Espírito Santo)	Yes (2015)	The Native Vegetation Protection Law of 2012 is an instrument that regulates in which native ecosystems have to be protected and restored in private lands	Yes	Nongovernment
Chile	Yes	0.5	0.1	No	Law 20.283 on native forest recovery and forestry promotion, but it is not specific on ecological restoration	Only in Natural Protected Areas. It is going forward in forestry policy	Nongovernment
Colombia	Yes	1	1	Yes (2012)	Counts with a national forest recovery and restoration plan, and a strategic plan for restoring ecosystems	Yes	Nongovernment/ government
Ecuador	Yes	0.5	0.5	Yes (2014)	Right of nature restoration contained in the Constitution aims to restore fragile ecosystems is incorporated in the National Plan for Good Living. National Plan for Forest Restoration and creating financial incentives to encourage and restore 500,000 ha	Yes	Nongovernment/ government
Guatemala	Yes	1.2	1.2	Yes (2014)	Law of Establishment, Recovery, Restoration, Management, Production, and Protection of Forests (PROBOSQUE) constitutes the base for creation and implementation of forestry incentive program through the promotion of public and private investment	Yes	Government
Mexico	Yes	7.5	8.5	No	Restoration defined in the General Law of Environment and mentioned in other related laws. Governmental institutions leading restoration programs	Pronafor/Conabio	Nongovernment/ government
Paraguay	Yes	—	—	No	Law 4241/2010 is the only reference made to restoration. Historic and cultural contrasting legislation in East (“zero deforestation”) and West regions. The National Development Plan 2030 approved by decree 2794/2014 also includes an intention to restore 20% of degraded ecosystems	No	Nongovernment

Table 1. Continued.

	<i>NBSAP Includes Restoration?</i> ^a	<i>Bonn Challenge (million of hectares)</i> ^b	<i>20×20 Initiative (million of hectares)</i> ^c	<i>National Strategy</i>	<i>Legal Normative Related to Restoration</i>	<i>Schemes Explicitly Defining Restoration Priorities</i>	<i>Sector Leading Restoration Initiatives</i>
Peru	Yes	3.2	3.2	No	Supreme Decree 020-2015-MINAGRI that regulates the establishment of commercial and conservation-oriented tree plantations	A national restoration plan is being crafted	Nongovernment
Venezuela	No	—	—	No	Several initiatives toward restoration activities throughout the country. But not a national strategy or related laws	Misión Árbol	Nongovernment

Some restoration diagnosis tools, like the Restoration Opportunities Assessment Methodology (ROAM – WRI/IUCN 2014), have helped to identify challenges and opportunities for implementing restoration. However, once the diagnosis is done, it is necessary to address how to implement restoration, which includes the selection of which approaches will guide the process. An overview of restoration approaches may set the ground for the establishment of a common view on key guiding principles to plan restoration in LA.

In Argentina, Law 26.331 set up as its main purpose the minimum environmental protection directions for the enrichment, restoration, conservation, use, and sustainable management of native forests, and also promotes ecological restoration plans. There are also two laws regulating rehabilitation needs after mining activities, but there is not a specific one regulating ecological restoration. In Paraguay, Decree 9824 states the regulation of Law 4241/2010 and is so far the only reference made to restoration within a regulatory framework, but it is only directed to forests and omits the other natural occurring non-forest ecosystems. Other document engaging restoration is The Paraguay National Development Plan 2030 (2014) which mentions a specific restoration goal of 20% of degraded ecosystems of the country.

To satisfy regulatory frameworks, some countries have developed legal instruments referring to restoration and have established organizations and programs to coordinate them. They are scaling-up public policies after the formalization of reforestation initiatives developed through the last 50 years. For instance, in Mexico the *PRONAFOR* program encourages and promotes productive activities, conservation, and restoration of forest ecosystems. In Venezuela, the national reforestation policies suffered a major shift with the creation of *Misión Árbol* program as an attempt to halt deforestation and generate environmental consciousness in society about the importance of conserving and restoring forests and their ecosystem services. This formalization of restoration approaches in the public policies process was particularly pushed forward in Ecuador, Colombia, and Guatemala, where their respective Environmental Ministries approved national ecological restoration strategies (Table 1). Ecuador got the inclusion of restoration in its political and legal

instruments both through the design and implementation of the National Plan for Forest Restoration and creation of financial incentives to encourage and restore 500,000 ha until 2017 (MAE 2014). Rights of nature restoration contained in its Constitution aim to restore fragile ecosystems is incorporated in the National Plan for Good Living, where a series of activities aimed at the recovery and restoration of natural processes and environmental services. In Colombia, from 2000s forward Ministry of the Environment established two policy frameworks for supporting restoration: (1) a national forest recovery and restoration plan and (2) a strategic plan for restoring ecosystems. Restoration objectives appeared in the 2010–2014 and 2014–2018 Government's National Development Plan with ambitious goals to restore over 200,000 ha of degraded ecosystems (MADS 2012). Recently, the Ministries of Agriculture and Environment joined together with research institutes, restoration networks, and academic groups to define national restoration priorities and protocols for Initiative 20×20. In Guatemala, the Bureau of Forest Restoration, led by the National Institute of Forestry, working with members of academia, communities, private sector, banking, and civil society, formulated in 2014 the National Strategy for Forest Landscape Restoration as a mechanism for rural development (MRF 2015).

Brazil and Guatemala constitute the only cases in which regulatory frameworks were specifically developed for restoration activities (Table 1). Brazil established the Native Vegetation Protection Law in 2012, which replaced the Forest Code of 1965. This legal framework regulates in which conditions native ecosystems must be kept or restored in private lands, according to several specific guidelines. In Guatemala the Law of Establishment, Recovery, Restoration, Management, Production, and Protection of Forests constitutes the base for creation and implementation of a forestry incentive program through the promotion of public and private investments, but is restricted to forest ecosystems.

However, compliance levels are generally low in these countries. Ecological restoration practice in LA still remains governed, induced, and implemented by a few specific social groups or stakeholders, such as the scientific community and nongovernmental organizations (NGOs), with reduced

participation of private companies and entrepreneurs (with the exception of the Atlantic Forest of Brazil—Table 1). Even though some restoration initiatives are explicitly aimed to diverse ecosystem types (see CONABIO 2011; MMA 2012), their inclusion in these initiatives is not always clear. LA countries have shown a strong forest-centered perspective of restoration that neglects the conservation value of nonforest ecosystems and their importance for supplying ecosystem services to society and conserving endemic species.

Challenges to Define Restoration Approaches

Most LA countries lack a specific instrument or document defining basic concepts, criteria, and standards, required actions, or regulations to implement, evaluate, and monitor ecological restoration. Difficulties to define restoration approaches can be related to social perceptions, including costs and potential economic benefits. Social aspects of restoration still remain crucial to be included, especially considering that most restoration efforts depend on perceptions, main goals, and expectations of several stakeholders (Brancalion et al. 2013; Cáceres et al. 2015). The benefits of restoration can be reflected in improved ecosystem services in disturbed areas, but they require to be evenly distributed among stakeholders and across spatial and temporal scales to achieve programs' success. Whether private or public, social perception of valuation given to a particular service, ecosystem, or group of species would influence the interest on conserving or restoring them.

Restoration feasibility depends also on restoration costs, and political will (Orsi et al. 2011). The links between restoration, economic development, and societal well-being should be made explicit whenever possible. For instance, the benefits from active restoration can be outweighed by the relatively high costs involved. Active restoration methods should be carefully tailored to the specific context of any project to most effectively allocate scarce economic resources to restoration interventions (Holl & Aide 2011), a very relevant issue for LA countries with many other social demands related to education, security, poverty alleviation, and many others.

Reliability of institutions and frameworks can be also an important obstacle for defining approaches. Actors degrading and restoring an ecosystem are not often the same, and thus they give different legitimacy to the restoration needs, goals and process, and also to the legal framework in which restoration is based. Effective legal instruments and programs should be robust, regulating degrading activities and safeguarding their mitigation and compensation through restoration, in spite of the historical economic and political forces' pressure in the other direction.

Finally, political conjuncture is also important to explain the socioecological complexity that results in difficulties to prioritize and implement restoration. Most countries of LA had gone through dictatorships in the recent past, and participation of society in political processes is a recent phenomenon. Land tenure is another important bottleneck to establish restoration projects in some countries such as Colombia (Aguilar

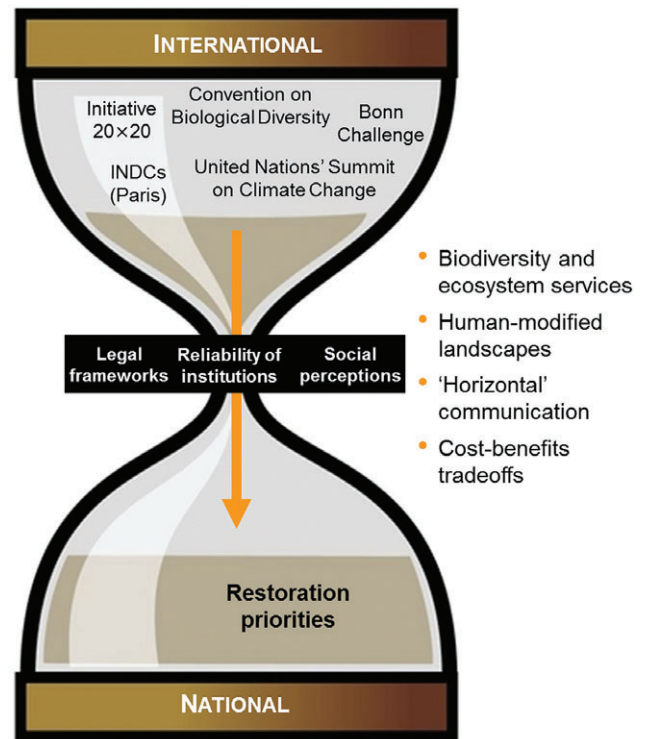


Figure 2. Obstacles (black rectangle in the middle) and opportunities (orange arrow and bullets) to define national approaches for restoration practice in Latin America. INDC, Intended Nationally Determined Contribution, framework of Convention on Climate Change.

et al. 2015) or Mexico (Ceccon et al. 2015), and highlights the challenges that some countries may present to restore native ecosystems at large spatial scales. Defining approaches to guide restoration can greatly contribute to better match the existing opportunities for effective, long-term, and large-scale restoration in the region.

Some Perspectives to Define Restoration Approaches

Interactions between the ecological, social, and economic dimensions of restoration are imperative. Some guiding principles can help to optimize the investment of limited economic resources to inform research and policy for restoration (Chazdon et al. 2016). We present here four approaches that may help national restoration programs to take the best advantage of the specific socioecological conditions of LA to support ecological restoration (Fig. 2).

Integrating Biodiversity and Ecosystem Services in Restoration Initiatives

Although the biodiversity and ecosystem services relationship is a debated topic in ecological theory (not linear and varying at different spatial and biological scales), it has been considered generally positive (Tilman et al. 2014). Trade-offs and synergies

among multiple ecosystem services also need analysis (Maskell et al. 2013). These issues have been discussed in the scientific literature produced in LA (Balvanera et al. 2012). However, they are not discussed in terms of ecological restoration and need to be bolstered. With the exception of the state resolution in Brazil, restoration regulatory frameworks do not pay special consideration to the link between biodiversity and ecosystem services. Some schemes such as payment for ecosystem services (PES), REDD+, and biological corridors can be an incentive for restoration because they offer an opportunity to recover services and benefits (Brancalion et al. 2013). They have been successfully incorporated in some agendas but their ecological, economic, and social impacts have not been clearly assessed (Kinzig et al. 2011). These require monitoring and adaptive management to ensure biodiversity and services are enhanced and the needs of different stakeholders are met. They also may be useful to find mechanisms to direct the flow of benefits to the poor, indigenous, and rural communities. The economic valuation of an ecosystem service is difficult to apply in practice and is highly subjective, and the enactment of a specific law about PES might generate unexpected consequences (Richards et al. 2015).

Restoring Ecosystems in Human-Modified Landscapes

Regions targeted for ecological restoration in LA are mostly comprised of fragmented landscapes in which protected areas, agricultural lands, smaller ecosystem remnants, urban zones, and several other land uses coexist and have direct impacts on biodiversity, ecosystem services, and human well-being (Chazdon et al. 2009). Successful restoration of these landscapes demand distinctive efforts in terms of time, costs, and methodological approaches, mainly because their biological and cultural diversity can show different responses to disturbances as well as to restoration interventions (Montoya et al. 2012). In this context, regeneration of natural ecosystems plays an essential role for conserving biodiversity and can foster stabilization of pristine habitats' cover (Chazdon & Guariguata 2016). The small scale of landholdings and the diversity of land uses frequently featured in the region, while contributing to biodiversity conservation due to their structural and floristic complexity, present challenges for biodiversity monitoring and management (DeClerck et al. 2010) and for the application of laws and policies. Growing and competing demands for ecosystem benefits and services will pose severe challenges to effective management in the future. A greater role for community, organizations, and other actors in ecosystem management and restoration and deeper attention to the factors that lead to effective forest management, beyond ownership patterns, is necessary to address future governance challenges (Guariguata & Brancalion 2014). This is particularly important in scenarios of social conflict commonly found in LA (Aguilar et al. 2015).

Thinking on Cost–Benefit Trade-offs

Restoration practitioners undersell the evidence of benefits of restoration as a worthwhile investment for society (Aronson

et al. 2010). Huge efforts trying to understand economic issues related to restoration supply chains and induce management mechanisms at the landscape level need to be drawn as to promote large-scale restoration in LA. Including analysis of the economic factors will allow showing the economic feasibility of the different approaches to restoration, and pondering resources, and objectives for making decisions (Bullock et al. 2011). It is necessary to consider the resilience of the ecosystem, past land use, and the matrix of the surrounding landscape to define restoration approaches in a socioecological perspective. There are significant differences in the cost-effectiveness of passive versus active restoration that have to be analyzed in each case (Holl & Aide 2011). Cost–benefit trade-offs may also prevent wasting resources in restoration approaches or contexts in which restoration outcomes are not compensated by investments, and indicate alternative strategies to obtain the best results with the same funding.

Assembling “Horizontal” Communication Frameworks

Information access within and among countries still needs improvement. Sometimes, scientific knowledge is not available to practitioners. Much information and knowledge are not produced in scientific arena and are incompletely communicated. In many cases, they are housed in theses, technical publications, forums, and other media products. On the other hand, high quality information published in scientific journals is not translated, literally, to end users, or is not presented in a way that favors its general understanding and application to solve problems in restoration practice. Public consultation is sometimes critical, because restoration is often a response to human degrading actions. This is particularly important considering that priorities can be defined by multiple interests. For instance, priorities to restore mined-sites would be truly different to those defined by governmental restoration initiatives in natural protected areas or in areas involving local communities.

We need to strengthen relationships among scientists and other stakeholders through training and capacity-building programs to involve multiple institutions and inform public policy (Chazdon et al. 2016). Options to reduce tensions on social demands require opening to local and indigenous knowledge and expectancies through public participation in scientific assessment processes, especially when considering that expert knowledge, which is usually situated in a specific political and cultural context, could be dissimilar to local cultures established in or benefiting from natural ecosystems (Bäckstrand 2012). One of the main challenges of LA countries is to create a common platform for communication that “spreads the word” on the lessons learned by different networks acting on ecosystem restoration that can be able to offer guidelines for practitioners and policymakers.

Restoration Networks Roles in LA

A generally applicable set of criteria and indicators for restoration will be difficult to achieve in practice. We need to promote consensus-building among the different perceptions of

the actors involved in restoration, and we also need reliable knowledge available for decision-making. Restoration could still be seen as proof of ecological theory, but perhaps it has become a more general challenge of sustainability. To overcome these difficulties, we need fostering a solid community studying national approaches and enhancing communication among different groups of stakeholders. Several international (e.g. SIACRE) and national networks (e.g. Rede Brasileira de Restauração Ecológica [REBRE], the Red de Restauración Ecológica de Argentina [REA], the Red Colombiana de Restauración Ecológica [REDCRE], and the Red Mexicana de Restauración Ambiental [REPARA]) promoting and implementing restoration in LA can act as stakeholders helping to overcome these difficulties by:

- 1 Bolstering the assemblage of a solid community through its members, through academic interchange, human-resources training initiatives, and the creation of a platform for information access. Strengthen the “horizontal communication” of knowledge in every way (i.e. nonhierarchical and not separated by sectors such agriculture, environment, forestry, and energy) and building capacity.
- 2 Helping to speed up the study of degradation for many ecosystems in order to generate national priorities for restoration among those members of society and for each of the expected socioecological outcomes. These priorities must be adapted to regional level (i.e. built from a bottom-up approach) and to different ecosystems.
- 3 Enhancing communication: evaluate, improve, and disseminating economic and ecological cost–benefit relations implied in the restoration practice.
- 4 Promoting effective restoration policies: help countries to benchmark policy solutions for promoting restoration based on the experience of other countries with developed regulatory frameworks for restoration.
- 5 Developing stronger societal awareness on the importance of restoration of nonforest ecosystems, which have been historically marginalized in national and subnational policies, research, and communication.
- 6 Coordinating cross-national research and capacity-building networks, helping countries to find solutions for the problems they have in common.

Multisectorial coalitions are also very important in creating a dialog on restoration approaches and priorities. For instance, forest restoration in the most threatened ecosystem of Brazil has been pushed up by a joint initiative of NGOs, academia, government, and private sectors called Atlantic Forest Restoration Pact, a multi-institutional, and multipartner, bottom-up initiative, which aggregates ideas and actions that had been previously operating solo (Pinto et al. 2014). With an alignment of interests, this form of operation gives voice to different sectors and interests of the society, and creates a forum for public and private agendas that does not only respond to impositions or lack of action by the government, but promotes a proactive collaboration to foster restoration programs in different socioecological contexts.

Conclusions

Spatial and temporal variability in the complex social–ecological contexts of LA highlights the difficulty in using short-term responses to indicate long-term recovery. Although some LA countries have developed regulatory frameworks and some supportive instruments to guide restoration, they lack a common view that addresses the needs and expectations of different stakeholder groups, the capacity of institutions and organizations to operationalize large-scale restoration, and the special particularities of the high socioecological heterogeneity typical of the region. Restoration approach in LA must be based in socioeconomic and legal dimensions if it aims to accomplish with a win–win agenda that maximizes both social and ecological benefits of restoration.

Historically, several countries have tried to solve their environmental problems through legal and regulatory instruments, which sometimes are excessively bureaucratic, not exactly democratic, and praise punishment instead of reward to encourage better practices. This official top-down approach is almost exclusively used by state agencies and usually hinders the involvement and participation of different actors in terms of planning, management, command, and control (McConnachie et al. 2013). This situation is more critical in the case of LA countries where ecological restoration is a very novel activity, which still needs a juridical, technological, and economic environment able to give momentum to the initiatives (Melo et al. 2013).

Even considering its socioecological complexity, there are in LA common issues that promote similar conditions for its countries that can partially represent a potential context to construct ecological restoration approaches in the region, leverage investments in this activity, and unlock the potential of native ecosystems to spontaneously regenerate in degraded sites. The challenge is not solely to demonstrate the economic or social benefits of restoration, but its feasibility in these terms.

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