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Review

# Priority setting for scaling-up tropical forest restoration projects: Early lessons from the Atlantic Forest Restoration Pact

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ABSTRACT

Ongoing conversion of tropical forests makes it urgent to invest in ecological restoration on grand scales in order to promote biodiversity conservation and ecosystem services. The 4-year old Atlantic Forest Restoration Pact (AFRP) aims to restore 15,000,000 ha of tropical forest in 40 years. The approaches and lessons learned appear transferable, and could help achieve the global restoration targets. Fundamental prerequisites for success include: effective technology undergoing continuous improvement, ongoing teaching, outreach and capacity-building efforts, presence of local intelligentsia, maintaining a clear and transparent legal environment, and presence of effective economic instruments and incentives for landowners. These prerequisites can be achieved by expanding and strengthening the network of stakeholders both in public and private forums that must be aware of macroeconomic and social/cultural shifts and trends which may provide opportunities and impose constraints to further restoration activities. Finally, environmental regulations imposing habitat protection and restoration are usually beyond individual land-owners' possibilities and level of interest. Therefore, forest restoration, even in a biodiversity hotspot, must be approached as a potentially sustainable economic activity. Otherwise, private landowners, and most other stakeholders, will not persevere.



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## 1. Introduction

Old-growth tropical forests continue to be converted and degraded worldwide, resulting into landscapes with impaired ecosystems yielding reduced quantity and quality of services to human society (Melo et al., 2013). Further, they harbor much less biodiversity than intact forests (Gardner et al., 2009). Sadly, this situation predominates in many or most tropical regions including the majority of the tropical biodiversity hotspots (Chazdon et al., 2009; Laurance, 2005; Peres, 2005). In this context, forest restoration has emerged as a post hoc approach to reverse the dismal situation, in order to promote biodiversity and ecosystem services simultaneously (Bullock et al., 2011). Concurrently, other initiatives are clearly required, including the extension of networks of protected area systems and facilitating new and more sustainable agricultural production activities, such as agroforestry, on already cleared lands. Finding a modus vivendi between conservation, restoration and ongoing food, fiber and fodder production is necessary to minimize further forest loss as human populations continue to grow and drive growing demand for natural resources globally (Angelsen, 2010).

The Aichi Target 15 of the Convention on Biodiversity states that we should increase ecosystem resilience and although ecological restoration is increasingly recognized as being essential and complementary to both conservation and sustainable development strategies (SCBD, 2011), it has to date been largely restricted to small-scale projects/initiatives worldwide (i.e. a few hundred hectares at most) (Menz et al., 2013). This reduces the potential of restoration to effectively contribute to long-term persistence of biodiversity and ecosystem services (Rodrigues et al., 2011). This is not surprising since large-scale initiatives face a variety of social, political, economic, juridical, and technological challenges (Aronson et al., 2011), adding complexity and uncertainty to restoration programs. In fact, the opportunity cost of land, restoration costs and the lack of a science-based, cost-effective approach have constrained the scaling-up of restoration in tropical forest biomes (Birch et al., 2010; Kettle, 2012). In this context, any large-scale initiative trying to overcome the above-mentioned barriers and constraints should be examined for insights, lessons and potential corrections. Indeed restoration is now being recognized as a global priority (Aronson and Alexander, 2013; Gonzales, 2013) and scientists and practitioners with experience are increasingly called upon to share their know-how.

Here we describe how an ambitious initiative, the Atlantic Forest Restoration Pact, has addressed and continues to address some of the major challenges for large scale forest restoration in a megadiverse, developing country like Brazil. Specifically, we address (1) articulation, consensus-building and coordination among diverse stakeholders including governmental agencies, private land owners, corporations, NGOs, and departments within academic institutions; (2) ongoing development, testing, and dissemination of science-based, cost-effective restoration technology; (3) the pressing need for training and capacity building; and (4) harmonization of legal regulations and economic opportunities for restoration on both private and public lands. We report on our experience and lessons learned thus far in order to contribute to a timely debate examining to what extent restoration projects can mitigate or even revert tropical forest degradation, provide ''green jobs'' in rural communities, and augment the provision of multiple ecosystem services to human society both medium- and long-term.

## 2. The Atlantic Forest Restoration Pact (AFRP)

### 2.1. *The origins of the AFRP*

The Brazilian Atlantic Forest region has long been recognized as a global biodiversity hotspot (Myers et al., 2000). Unfortunately, forest cover now represents less than 14% of the pre-European conquest area, it is highly fragmented, and less than 20% of surviving forest remnants are over 50 ha in size (Ribeiro et al., 2009). Additionally, more than 90% of the remaining Atlantic forest area occurs on private lands (Tabarelli et al., 2005). Consequently, a wide range of economic drivers, particularly production of primary commodities, and fluctuating markets, contribute to ongoing deforestation and fragmentation of the remaining forest fragments (Bernard et al., 2011). This situation has led conservation biologists and other scientists to advocate and test restoration initiatives able to augment forest cover, landscape connectivity and primary-type forest habitat for threatened and vulnerable species of animals and plants (see Melo et al., 2013; Silva and Tabarelli, 2000)

In April 2009, the Atlantic Forest Restoration Pact (hereafter AFRP) was launched by a large pool of stakeholders, including national and international NGOs, governmental agencies, private companies, and research institutions. The AFRP currently includes over 200 partner/stakeholders, who collectively promote, facilitate, and carry out restoration projects across eight Brazilian states (Fig. 1). In the legal context, the AFRP will soon achieve the status of a NGO, although it will continue to act as a network to mainstreaming members' projects, instead of competing with them for funding. Complementary, as a representative of many NGOs and private companies, the AFRP will have strength enough to apply for large international funding opportunities to support collective investments in restoration projects, which would not be accessible to each institution individually. At present, it already functions with a central coordination and a secretariat, both permanently funded by NGOs and private companies, plus a board of directors from academia, private and public sector and NGOs plus its pool of partners, all of whom have joined AFRP voluntarily. Partners fall into two broad overlapping categories. First, ''supporting partners'' are those directly committed to Atlantic forest restoration topic, e.g. NGOs, academic institutions and governmental agencies, but not directly involved in restoration projects/actions. They provide expertise, funding, articulation, and dissemination instruments as they are continuously challenged by scientific, technological, political, legal and economic constraints to restoration initiatives. Secondly, ''executive partners'' are those directly in charge of restoration projects, such as farmers, private companies and public agencies (Calmon et al., 2011). Executive partners are committed to plan and execute restoration projects according to a basic theoretical

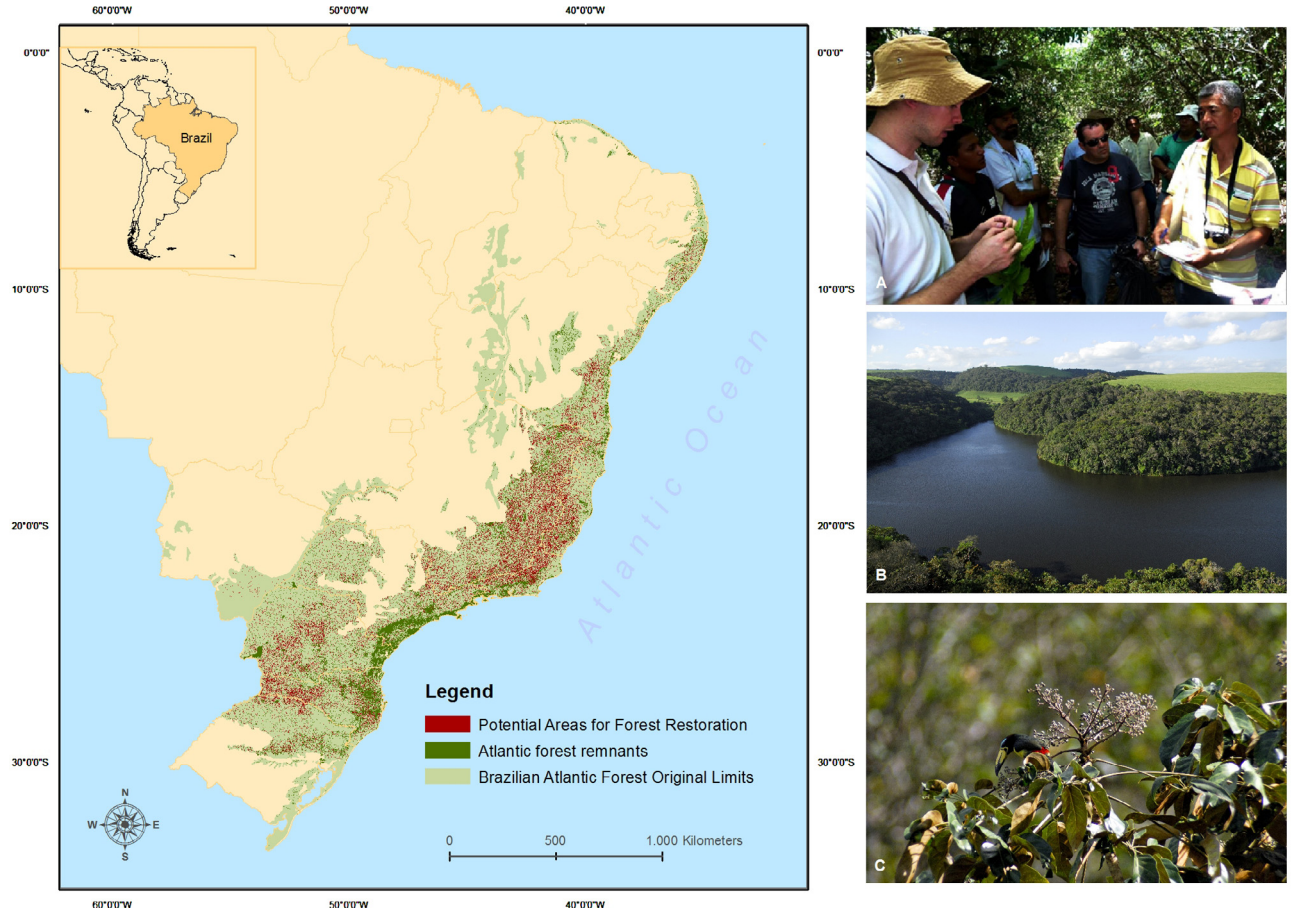


**Fig. 1 – Potential areas for forest restoration according to the AFRP mapping. They refer to areas where restoration or regrowth of forest can occur without penalizing existing and viable economic activities, since restoration will not compete for agriculturally productive lands. An outreach course on forest restoration for workers of sugar-cane companies in the state of Paraiba, Northeastern Brazil (A). At the Usina Serra Grande, Alagoas state, the potential for PES (payment for ecosystem services) programs that reward forest protection and forest restoration of degraded lands (B). Biodiversity persistence on restored forests of the Atlantic forest (C).**

framework, which is remarkably broad. This framework includes ongoing refinement of restoration techniques and supporting technology, overseeing attainment of socio-economic benefits for local communities (Brancalion et al., 2012a,b), and fulfillment of legal requirements, as well as furthering an ambitious scientific research agenda that will promote improved tropical forest restoration worldwide. Additionally, they help establish connections between restoration activities and biodiversity conservation programs at landscape, regional and national levels.

The AFRP has the ambitious target of restoring 15 million hectares of deforested lands to native forest by 2050; the majority of targeted lands consists of areas formerly covered by native forest, and that 'should' in future be forested, according to the Brazilian Forest Code, the main environmental law concerning forest protection and restoration (see below). Much of this land is currently degraded pasturelands and abandoned agricultural lands. The above-described outcome would increase self-sustaining forest cover from the current level (<14%) to ca. 30% of the pre-Colombian Brazilian Atlantic forest area. This goal is to be achieved without competing with, or impinging upon other, more immediately economically profitable land uses (Fig. 1). Indeed, the AFRP aims to take advantage of the third phase of forest transition, already in place in many regions of the Atlantic Forest (Baptista and Rudel, 2006), to support forest regeneration in lands with higher chances to be abandoned in the near future. Such a large-scale and long-term goal requires a wide consortium and the integration – or at least reconciliation through negotiation – of diverging interests, including those following predominantly social-economic, anthropogenic, or environmental, ecocentric, agendas. In fact, setting up the AFRP itself has only been possible thanks to its commitment to combine a large bundle of societal objectives and outcomes that may benefit – directly or indirectly – from successful forest restoration. These include: enhanced water supply and watershed protection (a target of public agencies and industries); flooding control (important to municipal, regional, and federal agencies); and commitments to comply with environmental regulations, including the Brazilian Forest Code, and green certification objectives (a large pool of industrial conglomerates such as producers of biofuel, soy bean and

**Table 1 – Main challenges and opportunities for restoration initiatives according to the spatial scale at which they are planned.**

| Forest restoration scale | Main stakeholders | Socioeconomic constrains | Socioecological benefits |
|---|---|---|---|
| Small (up to a few hundred hectares) | Small farmers; municipalities; industrial corporations and agribusiness, but with isolated projects. | Limited funding, often in charge of landowners; high opportunity costs; diverse and at times inefficient restoration protocols. | Conservation of soil and water springs; improve connectivity among forest patches; small nurseries may respond to both local and more distant demand for seedlings, and generate extra income and jobs. |
| Medium (several hundred to a few thousand hectares) | Watershed committees; State governments; large agribusiness companies, with well-structured programs. | Achieve viable political arrangements; adoption of proven-to-be-efficient restoration techniques that guarantee results. | Funding is easier; association with PES (payment for ecosystem services) programs generate more social benefits; compatible with biodiversity conservation programs. |
| Large (several to many thousands of hectares) | Larger networks; international projects; REDD+ | Establishment of common goals among differing stakeholders; disseminate successful, cost-effective restoration technology; convincing funding agencies to provide financial incentives for the restoration chain | Diverse funding sources; Stronger stakeholder's network and restoration markets; multiple benefits through restoration supply chain (social, environmental & economic). |

wood pulp). Additionally, market demands for timber and non-timber forest products from native species; biodiversity protection, and poverty alleviation, especially through job creation (NGOs, social movements, small farmers, public agencies); and alternative uses for agriculturally marginal or already abandoned lands also represent direct socio-economic interests and benefits connected to ecosystem restoration projects and programs (Table 1). These multiple interests constitute a wide "basket" of opportunities and represent powerful drivers for scaling up forest restoration. Concurrently, the barriers constraining initiatives need to be addressed and mitigated, as described in the following sections.

### 2.2. *Restoration technology and capacity building*

Restoring tropical forest via assisted natural regeneration or plantation of native trees implies the adoption of effective protocols covering a large number of steps – from seed collection to the long-term management and monitoring of set-aside sites or newly re-planted stands. Otherwise, projects tend to achieve disappointing outcomes, what in turn discourages stakeholders and erodes both public and private support for forest restoration (Brancalion et al., 2010). In the last three decades, several restoration projects have been set up in the Atlantic forest region and generated a diverse set of guidelines that have permitted effective forest restoration resulting in biologically-viable forest patches (Rodrigues et al., 2009b). Taking advantage of this body of experience, the AFRP strives to keep abreast of all available information related to restoration technology, successes, and failures to date, and has made available a practical guide for those attempting Atlantic forest restoration (Rodrigues et al., 2009a). Thus, a comprehensive and field-tested framework for forest restoration in the Atlantic Forest is freely available on the AFRP website (http://www.pactomataatlantica.org.br). This user-friendly document provides basic guidelines relative to land-use planning, nursery, forestry techniques and legal aspects. This general framework has also been adapted to create regional restoration guides, which incorporates the particularities of each context for increasing projects effectiveness (Alves-Costa et al., 2008). To insure that any stakeholder may fully benefit from the recommendations and straightforward technology provided in the guide, and proceed with forest restoration in virtually any portion of the Atlantic Forest region, a team of AFRP 'veterans' and 'champions' provide numerous outreach training courses throughout the region on a regular basis. In 2011, the AFRP also convened a team of 80 restoration experts, stakeholders, and institutional representatives to develop and agree upon a standardized monitoring protocol, which should be applied to restoration projects. This protocol was reviewed in 2013 based on the challenges for its implementation and opportunities of improvement resulted from its wide use throughout the biome, thus resulting in a new and more robust protocol. This is now available on-line, at: http://www.pactomataatlantica.org.br/protocolo-projetos-restauracao.aspx. More specifically, all AFRP projects are now expected to be monitored with a comprehensive set of 87 indicators covering biological, economic, social, legal, environmental, and management themes (see Table 2). This protocol also makes it possible to continuously, and rigorously, examines and compares outcomes at a regional and national scale.

Finally, the AFRP has stimulated its partners to approach restoration projects as both carefully planned, and *monitored*, research experiments that also provide training and capacity-building platforms and help improve restoration technology and cost-effectiveness going forward. Project managers and researchers also document and monitor potential impacts of forest restoration relative to (1) long-term viability of forest stands, (2) conservation value and provision of ecosystems services, and (3) provide training for local restoration practitioners. For example, in northeastern Brazil, in the state of Paraiba, several practical workshops have been run recently in order to increase local interest for forest restoration in one of the poorest and degraded Atlantic forest areas (see Fig. 1). Briefly, adopting the AFRP approach, NGOs and governmental

**Table 2 – Major themes, topics and indicators included in the monitoring protocol adopted by the Atlantic Forest Restoration Pact (http://www.pactomataatlantica.org.br).**

| Monitoring themes | Topics | Indicators |
|---|---|---|
| Biological | Forest structure<br>Plant assemblage | Number of plant stems, basal area, vegetation height<br>Number of plant species<br>Presence of invading species<br>Area covered by herbaceous species |
| Economic | Cost of restoration<br>Revenue scores | Budget distribution among: direct sowing; fences; manpower<br>Timber production<br>PES |
| Social | Employment | Number of jobs created<br>Wealth insurance<br>Training programs<br>Compliance with labor legislation |
| Legal | Accomplishment with Brazilian Forest Code | Presence of legal reserve, project registration on regulation agencies |
| Environmental | Ecosystem services (e.g. water supply) | Protection of riparian forest and water springs, water quality |
| Landscape management | Habitat connectivity<br>Site selection | Connection between isolated forest patches<br>Environmental diagnostic of sites to be restored |
| Project management | Technical staff | Presence of a qualified technical team |

agencies have already trained hundreds of stakeholders regarding landscape planning, nursery production and protocols for ecological restoration (Fig. 1). In sum, such initiatives across the entire Atlantic forest region have resulted and benefited from a network of planned experiments (e.g. 400,000 ha of restoration area assisted by the Laboratory of Forest Ecology and Restoration of the University of São Paulo), which are under way and represent a permanent ''experiment'' addressing restoration-related topics.

### 2.3. *Legal instruments and economic opportunities*

Legislation has proved to be essential to (1) regulate land use in the light of environmental safeguards (Ruiz-Jaen and Aide, 2005), (2) guarantee that best practices are incorporated within restoration projects and initiatives (Aronson et al., 2011), and (3) offer a juridical environment in which stakeholders can proceed with restoration activities conscious that their efforts will be properly recognized by public agencies and those institutions in charge of certification and financial credit (Calmon et al., 2011; Rodrigues et al., 2011). Accordingly, AFRP members are permanently engaged into initiatives toward the improvement of either land-use or restoration-related regulation. One example is illustrative: in São Paulo, the richest state in Brazil, legislation covering topics from the required restoration technology to minimum levels of native plant diversity (Aronson et al., 2011) has benefited directly from the experience gained and reported in the scientific literature by AFRP restoration scientists and practitioners. Such official guidelines for restoration now proscribe a minimum of 80 native tree species per hectare in restored forests, and require the use of seedlings originating from the same vegetation type, collected asnear as possible to the actual restoration site, along with a rigourous monitoring program. The AFRP has also publicly criticized recent, pernicious proposals to change and 'water down' the Brazilian Forest Code, (Calmon et al., 2011; Tollefson, 2011) and is engaged in a successful public payment for ecosystem services program provided by small farms via forest restoration and forest protection (Brancalion et al., 2012a).

In addition to a ''clear legal environment'', forest restoration also relies on financial resources and economic support. In this context, the AFRP has been engaged in three tasks: (1) analysis, synthesis and transference to society of information relative to restoration costs and restoration-related economic opportunities as contrasted to traditional land uses; (2) development of economic instruments for supporting restoration; (3) dissemination of information relative to social benefits offered by restoration initiatives. The AFRP has estimated a minimum cost of US$5000 per hectare for forest restoration in significantly degraded sites requiring active reforestation with native tree species (Brancalion et al., 2012b). These values include direct planting and three years of post-planting site management and have been estimated based on the average cost of thousands of hectares restored in São Paulo state where decades of restoration experiences have generated practical guidelines to public policies currently adopted by both public and private sector (Brancalion et al., 2010). However, direct planting at such a cost usually responds to less than 20% of the area to be restored in most cases in the Brazilian Atlantic Forest and successful restoration can be achieved in many landscapes at lower costs just by ceasing the drivers of disturbance (especially proscribed fire and grazing) and stimulating natural regeneration through simple procedures, such as soil fertilization and weeding, which dramatically reduce the costs of restoration. This low-investment situation corresponds to approximately half of the lands currently undergoing restoration in the Atlantic forest biome with assistance from the AFRP. This low-investment situation corresponds to approximately half of the lands currently experiencing restoration in the Atlantic forest and assisted by the AFRP, which is evidenced by frequent cases of forest re-growth following land abandonment (Baptista and Rudel, 2006).

**Table 3 – Simulation of economic revenues resulting from extensive cattle ranching and different income opportunities proposed for tropical forest restoration, based on overall values estimated for the Brazilian Atlantic forest. Given that the proposed values may vary dramatically according to species selection, system of production, response of the plants to specific site conditions, and the socio-economic context in which the project is included, these values provided are merely illustrative.**

| Source of income | Annual revenue[a] (US$/ha/year) | Timeline (years) 1 2 3 4 5 6 7 8 9 10 11–19 20 21–29 30 | Total accumulated revenue (US$) |
|---|---|---|---|
| Opportunity cost of land for cattle ranching | −100.00 | | −3000.00 |
| Income opportunities through restoration | | | |
| Crops produced in agri-successional schemes[b] | 300.00 | | 900.00 |
| Payment for ecosystem services – water[c] | 118.00 | | 1180.00 |
| Payment for ecosystem services – carbon[d] | 330.00 | | 3300.00 |
| Non-timber forest products[e] | 200.00 | | 5000.00 |
| Timber – fast growing species[f] | 2500.00 | | 2500.00 |
| Timber – intermediate species[f] | 4000.00 | | 4000.00 |
| Timber – slow-growing species[f] | 6000.00 | | 6000.00 |
| Sum of opportunities | | | 22880.00 |
| Total (US$) | | | 19880.00 |

Adapted from (Brancalion et al., 2012b).
Gray shading means both costs and benefits applicable to each year and/or period.
[a] For activities providing an annual income, represented in the table by income inputs in consecutive years, the annual revenue represents the average income obtained during the period proposed for the activity. In the case of timber exploitation, annual revenue is restricted to the year of harvesting, i.e. 10, 20 and 30 years for fast-, moderate- and slow-growing species, respectively.
[b] Based on the income provided by annual crops traditionally planted in small landholdings, such as beans, corn, cassava, pumpkin, etc. These crops can be cultivated between planting lines of trees for a period of three years; after three years, shading provided by trees may hamper commercial production of annual crops.
[c] Considered as the same as the opportunity costs of land for expensive cattle ranching, based on the model program of Extrema, Minas Gerais, southeastern Brazil. Although payments for ecosystem services for water may last indefinitely, we propose that they should be limited to a period of 10 years if other sources of income are included in the project.
[d] Based on the estimated stocking rate of 30 tons of carbon in 30 years and a market price of US$10 per ton of carbon. The total value to be paid in the 30 years period was concentrated in the first 10 years, in order to anticipate income generation.
[e] Although some native species may provide a much higher income than US$200/ha/year, we use this conservative value to avoid over estimation.
[f] Values based on the economic evaluation for the Brazilian Atlantic forest, in which very conservative estimates were made of both timber prices, and tree growth rate, and without considering any type of value aggregation.

Brancalion et al. (2012b) provides a detailed analysis of a ''basket of opportunities'' related to forest restoration including, for example, (1) crop production in agro-successional restoration schemes, (2) exploitation of timber as non-timber forest products in restored areas, and (3) payment for providing ecosystem services (PES), i.e. water- and carbon-related services among others (see Table 3). Briefly, annual revenue provided by cattle ranching on steep slopes achieve US$ 100/ha/yr, while revenue varies from US$ 300 (crop production via agroforestry) up to US$ 4000/ha/yr via timber production or alternatively US$ 11,800/ha/yr to protect riverbanks and natural springs via restored forests; i.e. the water-related PES supported by the Extrema municipality (Minas Gerais state). A figure of 30.5-million ha currently devoted to low-revenue cattle-ranching (IBGE, 2003; PROBIO, 2009), in addition to increasing levels of urbanization and industrialization (Baptista and Rudel, 2006), represents an opportunity for moving land use toward restoration-based activities or even a 'restoration economy', where previous valuable timber and non-timber forest products over-exploited in the past in native forests are reintroduced in the market through their production in restoration projects. For example, the recently created investment company Symbiosis (http://www.symbiosisinvestimentos.com.br) has already planted 800 ha of about 30 high valuable native timber species as long-term investments, and plans to reach 100,000 ha in the next years supported by international pension funds.

Although restoration activities are already partially/totally affordable through a combination of mechanisms, additional possibilities are welcome. The AFRP has continuously provoked many governmental agencies to incorporate forest restoration as part of their either economic, development, research or environmental agenda (Joly et al., 2010; Wuethrich, 2007), extending the possibilities to afford restoration initiatives. For instance, the Brazilian Bank of Development, which is well known for funding large infrastructure projects, recently created a program in partnership with the AFRP to make significant investments in ecological restoration projects in the Atlantic Forest biome. Dissemination of PES instruments involving public agencies is underway in the Atlantic forest region with the leadership of several AFRP members.

As Brazilian society becomes aware about social benefits from restoration-related activities and initiatives, more stakeholders are expected to become engaged, including

governments. The AFRP estimates that by 2050 the supply chain of forest restoration could generate up to 6 million jobs for rural and traditional communities via sustainable exploitation and supply of forest products in the Atlantic forest region (Brancalion et al., 2012a). Currently, in São Paulo State alone, more than 40 million seedlings of native trees and shrubs are produced each year, in more than 200 private forest nurseries managed principally by private sector and some community-based ones. This provides a cornucopia of jobs and new livelihood opportunities as more people are obtaining on-the-job training and capacity-building. The AFRP is conscious that all this social and economically-related information must be continuously updated and communicated to society in order to illustrate that restoration can in fact become an economically- and socially-attractive land use as compared to more traditional activities such as extensive cattle-raising (Rodrigues et al., 2011).

### 2.4. *The generality of the AFRP experience in Brazil*

The degree to what AFRP experiences in Brazil can be applied to other tropical countries will depend on how involved stakeholders perceive both bottlenecks and opportunities for forest restoration. In many tropical countries of African continent, for example, recent changes on land-tenure model creates uncertainties on the availability of lands to be restored (Njoh, 2013). Also, ecological constrains of arid environments (van der Vyver et al., 2012) and lack funding sources (Crookes et al., 2013) should be effective bottlenecks to achieve large-scale ecological restoration in South Africa, although successful initiatives have also been reported in this country (Hobbs, 2004). However, in many African countries communal land tenure still predominates and schemes of payment for ecosystem services and REDD+ mechanisms should be effective in conserve and recreate forests. The Greenbelt Movement in Kenya is an example of a promising initiative that can benefit from the AFRP case study (http://www.greenbeltmovement.org/). In Asian countries such as China and Vietnam predominates afforestation with non-native pulp species as it constitutes a good economic opportunity but has limited impact on the conservation of biodiversity and ecosystem services (de Jong, 2010; Lambin and Meyfroidt, 2010). However, these countries have probably developed good techniques of both forest planting and landscape management. Finally, in poorer regions of Latin America, the lack of a well-established legal environment for ecological restoration may limit afforestation to natural regeneration after abandonment of marginally productive lands due to rural exodus of human populations (Lambin and Meyfroidt, 2010; Parry et al., 2010), but economic rewards to remaining farmers through PES may stimulate forest re-growth (Sanchez-Azofeifa et al., 2007). However, urbanization of Latin American countries may represent more capacity building and available land to forest restoration. Probably, the main lesson of the AFRP for other tropical countries is the intense dialog among diverse stakeholders at different spatial and temporal scales. Passing the barriers of opposing interests among stakeholders is surely the ultimate outcome of the AFRP and this might be possible to be replicated in any country.

## 3. Partial outcomes and lessons learned

We are not yet able to report on the effectiveness of the AFRP initiative as only recently has a standardized monitoring protocol been adopted by the well-established restoration projects in the network. However, several successes listed in the AFRP First Evaluation Report (available on http://www.pactomataatlantica.org.br) should be mentioned, including the coordinated management of no less than 80 projects, which represent almost 60.000 ha under restoration. Research projects, scientific publications and calls for greater public policies and environmental regulations have also emerged via the expertize joined together in AFRP; see for example the debate on public regulation relative to a minimum number of native tree species to be adopted by restoration projects (Aronson et al., 2011). Although the AFRP only came into existence three years ago, some lessons have emerged and these can be summarized into six guidelines.

- Our concept of scaling-up restoration implies not only increasing the number of projects but also the average size of restoration projects. This is possible through restoration planning at the landscape and regional scales and is crucial to improve the prospects of achieving the ultimate restoration goals of conserving biodiversity and ameliorating ecosystem services.
- Scaling-up restoration depends upon several basic prerequisites being in place, namely appropriate technology, an infrastructure to aid in capacity-building, presence of a local intelligentsia, clear legal environment (i.e. reduced juridical uncertainties), and effective economic instruments and incentives being operational.
- Restoration prerequisites are better achieved by an expanding network of stakeholders with shared, restoration-related interests and collectivized activism in both public and private forums.
- Forest restoration initiatives, especially large-scale ones, should not be recommended or promoted unless appropriate technological prowess can be demonstrated. In other words, restoration is a professional, technical and economic activity that involves both economic and social investments and trade-offs over a long period, even for community-based initiatives. Stakeholders and potential project 'owners' should be encouraged to do 'due diligence' on existing know how and cost-effectiveness, just as investors regularly do when approached by an entrepreneur seeking new partners and investments.
- The restoration 'community' must be aware of, and remain attentive to, evolving macro-economic and socio-political and cultural scenarios as these may represent opportunities but also constraints to restoration activities.
- Environmental regulations imposing habitat protection and restoration are usually beyond individual land-owners' possibilities and level of interest. Overall, forest restoration must be approached as a sustainable economic activity and society must be continuously informed about the full range of benefits provided by restoration projects and programs, both short-term and also medium- and long-term.

## 4. Final remarks

Restoration ecology is flourishing worldwide and ecological restoration as a profession and an enterprise is a growing component of international environmental and corporate policy debates and economic planning and negotiations. The U.N. Convention for Biological Diversity (CBD) explicitly addresses restoration in two of its Aichi Biodiversity Targets as follow: ''*Target 14: By 2020, ecosystems that provide essential services,. . ., are restored and safeguarded; and Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification*'', making it timely to consider restoration science, policy, and practice (Benayas et al., 2009). Indeed, in October, 2012, the CBD ratified these targets in its Decision XI/16 (Convention on Biological Diversity, 2012) and over a dozen major agencies, several far-sighted governments, and two other international conventions signed on (Aronson and Alexander, 2013). The endeavor of restoring 150 million ha by 2020 is estimated to provide U.S. $84 billion per year to the international economy (Menz et al., 2013), and the existence of another 2 billion ha of deforested and degraded lands available for restoration provides a favorable scenario for long-terms investments in this emerging field of activity (http://www.wri.org/project/forest-landscape-restoration). The AFRP, with 1 million ha, with both the United States Department of Agriculture Forest Service (15 million ha) and the Government of Rwanda (2 million ha) were the first groups to officially establish, at the Rio+20 United Nations Conference on Sustainable Development, the a compromise to contribute with a share of the global goal of restoring 150 million ha. This 1 million ha of the AFRP represents the area expected to be restored collectively by its members by 2020, according to the program of goals of the movement.

Fortunately, economic development, increasing social concern with environmental issues, new economic instruments for restoration (e.g. carbon market), and land-use shifts (e.g. forest transition) represent opportunities for scaling-up forest restoration and restoration community must take advantage of this emerging scenario, via integrated and large-scale projects (Melo et al., 2013). For instance, the consolidation of Brazilian environmental regulation with increasing law enforcement, the abandonment of agriculturally marginal lands associated to urbanization/industrialization (Baptista and Rudel, 2006), and the continuous expansion of green markets (i.e. a global concern to environmentally-wealth products), represent the best scenario for restoration initiatives ever experienced by the Atlantic forest region. However, in the absence of major scaling-up of restoration, this rare opportunity, and more generally, the ambitious CBD Aichi targets will not be achieved. In that case, society will probably pay the immense 'extinction debt' already accumulated across degraded tropical – and also extratropical – landscapes elsewhere. We hope that this essay about the AFRP can help move the global restoration 'agenda' forward, stimulate new restoration initiatives and policies and provide some guidance to those embarking or small, medium or large scale programs or projects in other parts of the world.

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