



Lessons and Challenges of a Restoration Flagship: The Trinational Atlantic Forest Pact

Science Task Force of the UN Decade on Ecosystem Restoration

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Introduction

The United Nations Decade on Ecosystem Restoration (2021-2030) underscores the urgent need of recovering degraded ecosystems on a global scale. In this context, the identification and analysis of successful initiatives, designated as restoration flagships, are crucial to inspire, guide, engage and accelerate restoration efforts worldwide.

The Trinational Atlantic Forest Pact (Trinational Pact from now), recognized as a World Restoration Flagship by the UN Decade on Ecosystem Restoration, was established by the Trinational Ecological Restoration Alliance (*Red Trinacional de Restauraci n del Bosque Atl ntico*) and the Atlantic Forest Restoration Pact (AF-PACT), representing a testament to cross-border cooperation, bringing together collaborative efforts between Argentina, Brazil, and Paraguay.

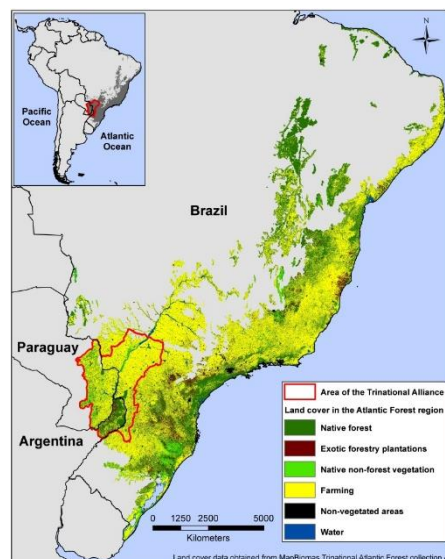


Figure 1: Land use and land cover of the South American Atlantic Forest and Trinational Ecological Restoration Alliance scope area.

This initiative was created through the mobilization of a diverse network of stakeholders to address the challenges of restoration in the Atlantic Forest, one of the planet's most threatened biodiversity hotspots, aiming to restore 1 million hectares of Atlantic Forest by 2030 (Figure 1). Within the trinational framework, the Trinational Pact emerges as a model of structure and collaborative bottom-up governance considered a successful and well-documented case regarding stakeholder involvement to promote large-scale restoration. The involvement of the AF-PACT in the Trinational Pact aimed to strengthen vision for the biome's restoration. An in-depth analysis of the strategies, governance mechanisms, and results of the Trinational Pact members offers valuable insights into the key factors contributing to the success of large-scale restoration programs.

Key Factors for Restoration Success

Governance, Multilateral Engagement, and Alliance of Interests

The strength of the Trinational Pact lies in the critical mass provided by multiple institutions and the confluence of interests ensured by the diversity of actors. This multiplicity is crucial for identifying opportunities and bottlenecks along the way, demonstrating a replicable model for ambitious conservation and restoration initiatives, especially in biodiversity hotspots that lack such articulation. Collaboration with public and private entities at all levels – national, ecoregional, and local – has been a central strategy for cross-border success. According to Adams et al. (2021), there is a diversity of collaborative governance models under development in Brazilian biomes such as the Atlantic Forest and the Amazon, indicating this approach is already recognized as valid in practice.

Currently, the Trinational Pact brings together about 360 organizations that have been working for over three decades in conservation and restoration actions. In this sense, the structuring example of the AF-PACT can be highlighted, as it is based on a multi-institutional and multi-partner coalition, representing all segments of organized civil society, including universities, the non-governmental organizations (NGOs), the private sector, and the governmental institutions. The AF-PACT was created with the goal of promoting large-scale restoration in the Brazilian Atlantic Forest, aiming to implement restoration in 15 million hectares by 2050, aggregating ideas, initiatives, and demands from various sectors of society, allowing a space for dialogue with public and private actors for the development of a proactive agenda (Pinto et al., 2014).

The success of large-scale restoration initiatives depends on a collaborative and participatory governance structure. In this sense, AF-PACT can be considered a successful model, formalized by a participatory governance created in a bottom-up manner since its foundation. Currently, AF-PACT has an internal structure composed of a National Coordinator that is guided by the coordination board (both elected by vote among all members), and an executive secretariat with the assistance of four thematic working groups and seven task forces. The coordination board is responsible for establishing norms, rules, principles, and policies for the management and operation of the movement. In addition to this central structure, AF-PACT established a network of Regional Units (RUs), which are considered crucial operational instances. These RUs are composed of partner institutions with local legitimacy and action, aligned with the movement's strategies. They play a vital role in identifying local barriers and opportunities, bringing these issues to the highest level of the AF-PACT, ensuring that the real demands of local actors are incorporated and that obstacles to scaling up are overcome. The working groups (public policies, knowledge, communication, and financial mechanisms) are essential for the development and planning of activities, and any signatory can voluntarily participate. These groups advise the Coordination Council and the Executive Secretariat in decision-making and scientifically address key themes in the restoration process. The WGs are responsible for creating task forces based on specific demands, defined in Council meetings and by the National Coordination, aiming at the production and delivery of content.

The Trinational Alliance (Brazil, Argentina and Paraguay) is composed by Management Nucleus and five thematic working groups. Members of the Trinational Alliance such as Fundación Vida Silvestre Argentina and WWF-Paraguay, have worked with municipal and provincial governments, in initiatives involving other NGOs, also working directly with local producers and landowners and indigenous communities in both Argentina and Paraguay, promoting restoration and conservation initiatives in the Atlantic Forest (Mansourian et al., 2020).

The effective participation of rural producers and local communities is considered imperative for scaling up restoration, as a large part of the restoration must occur in private areas (Chazdon et al., 2022, Mansourian et al., 2014). The engagement of these actors in strategy development and implementation, as well as the strengthening of social and cultural approaches, are fundamental for large-scale success. A notable example of this mobilization is the "Social Pact for the Conservation of the Atlantic Forest" in Paraguay, which brought together 139 organizations, demonstrating the capacity for multisector engagement beyond Brazilian borders (Hutchison & Aquino, 2011).

These governance strategies and internal structure adopted by the AF-PACT and by the Trinational Alliance allow for permanent dialogue and information flow between members and the coordination council, identifying demands, difficulties, and opportunities at different levels of the restoration chain. Finally, the joint effort of the Trinational Alliance and the AF-PACT resulted in the Trinational Pact which is led by a trinational committee composed by leaders of both movements.

Scientific Basis and Ecological Knowledge

The commitment to understanding ecological processes and developing operational techniques and actions based on scientific evidence is fundamental for the effectiveness and sustainability of restoration efforts in the Trinational Pact. In this sense, the involvement of research and teaching institutions plays a fundamental role in generating knowledge, validating methodologies, and training human resources. Academic expertise combined with the action and knowledge of NGOs and governmental agencies with great capacity to mobilize stakeholders directly contributes to the elaboration of reference materials and the promotion of training courses, which are vital for expanding knowledge and restoration actions in the field. The formalization of partnership between research centers, teaching institutions, NGOs and other actors encourages the co-production and updating of protocols, theoretical frameworks, other dissemination materials, and training courses adapted to regional ecological and socioeconomic conditions, aiming at adequate and effective restoration practices (Brancalion et al., 2013; Meli et al., 2016). Examples of these dissemination materials are the theoretical framework on the concepts and actions of forest restoration (PACT 2009), catalog of forest production models for medium and large producers (UNIQUE, 2014), guide to small scale restoration (Cinto & Marino, 2021) and monitoring protocol for forest restoration projects and programs (Viani et al., 2013; Viani et al., 2017).

Training and Knowledge Transfer

In addition to knowledge production, investment in professional training and information dissemination has been a key element to enable the Trinational Pact's action, being fundamental for gaining scale in restoration capacity and for involving rural landowners (Melo et al., 2013; Meli et al., 2016; Moreira da Silva et al.; 2017; Alarcon et al. 2017; Viani et al., 2019; Mansourian et al., 2020; Chazdon et al., 2022). The courses and webinars offered cover the entire productive chain of ecological restoration, from technical aspects to project management. This strategy aims to qualify the restoration practitioners and also to introduce the topic of restoration in regions and contexts where there is little tradition or practical experience. Training has been a central focus to improve knowledge about restoration implementation and understanding the ecosystem functioning in all countries with knowledge exchange activities between farmers and technicians from Brazil and Argentina, and training programs for nursery construction in Paraguay as concrete examples. Finally, there are in person meetings with members of the Trinational Pact and with AF-PACT's regional units' members to foster these knowledge and experience exchange opportunities.

Economic Viability, Value Generation and Public Policy

The transition of restoration from a merely environmental activity to a driver of socioeconomic development is one of the strategic differentials of AF-PACT and the Trinational Pact. By recognizing the cost of restoration can be a significant barrier, the initiative actively seeks to

integrate the economic dimension, promoting the view that forest restoration is not just an environmental obligation, but an economic opportunity capable of boosting the local economy and generating tangible benefits for local communities (Benini et al., 2017; Brancalion et al., 2022). Transforming environmental recovery into an opportunity for income and job generation, with the creation of new jobs and the diversification of income sources, especially in rural areas, is essential for scaling up restoration (Melo et al., 2013; Brancalion et al., 2022).

The members of these initiatives have been working on training small farmers and local communities, promoting their empowerment and formal integration into the restoration chain. This integration benefits these local actors by increasing income from their involvement in fundamental stages of the restoration chain such as the collection and production of seedlings and seeds and the creation of a market opportunity for products from agroforestry and sustainable activities (Pinto et al., 2014; Mansourian et al., 2020).

The identification of legal and regulatory bottlenecks that hinder the transformation of restoration into an economic activity generating employment and income is one of the Trilateral Pact's premises with members directly acting to remove these barriers and encourage the creation of public policies and economic mechanisms to make restoration an employment and income-generating activity (Pinto et al. 2014). Members of the Trilateral Pact contribute to the creation and revision of public policies and international agreements such as the Brazilian National Plan for Native Vegetation Restoration, the National Plan of Forests from Paraguay, are members of the 20x20 initiative and participate in the Convention of Biological Diversity.

In this sense, market mechanisms have been useful tools to engage and maintain small producers in restoration initiatives in the three countries, with examples of payment or compensation for environmental services obtained from restoration initiatives, such as biodiversity conservation, carbon sequestration and stock, and water production and protection (Richards et al., 2015; Mansourian et al., 2020, Guedes & Seehusen, 2011).

In addition to income generation and payment for environmental services for local communities and small producers, large companies have also invested significantly in restoration in the region to increase the supply of environmental services, reduce their carbon footprint, or for environmental certification processes, especially in the case of the pulp and paper industry, with relevant operations in the region (Mansourian et al., 2020). An example is Itaipú Binacional, which since its creation in the late 1970s has invested in forest conservation and restoration actions to protect the reservoir and its associated waterways, reducing sediment input and ensuring the maintenance and extension of the useful life of its hydroelectric power generation operation. Such actions resulted in more than 100,000 hectares of restored forests and more than 24 million seedlings planted.

Transparency, Monitoring and Dissemination

The ability to collect, organize, and disseminate information about restoration actions is a fundamental pillar for credibility, transparency, and continuous learning of the Trilateral Pact. This strategy not only allows for monitoring progress towards goals but also serves as an engagement and accountability tool.

AF-PACT, through its Knowledge Working Group and its Geospatial Task Force, develops and maintains a spatial database and recently launched an online platform (<https://pacto.geobit.com.br/>) that allows for the registration and visualization of its members' restoration actions. The platform currently has over 140,000 ha of restoration areas implemented by its members and also serves as a repository of information about the projects, including coordinates, methodologies, and project managers. Also, the Trinational Alliance has an online platform (<https://panda.maps.arcgis.com/apps/MapSeries/index.html?appid=5828703417424be7bfb75f5df94cf08e&folderid=7c64684ff3dc4e9882990946ecfeb820>) focused on the upper Paraná region, with members' activities, spatial database to subsidize planning and monitoring actions. These tools are crucial for transparency, allowing the public to monitor the progress of actions and the engagement of partners. In addition to actively registering implemented restoration areas, members of the Trinational Pact also participate in mapping and monitoring deforestation and natural regeneration (e.g., Fundación Vida Silvestre Argentina & WWF, 2017; Fundação SOS Mata Atlântica & Instituto Nacional de Pesquisas Espaciais, 2024). Understanding these processes has gained strength in recent years with the members directly contributing to the development of the Trinational Atlantic Forest annual land use and cover maps provided by the Mapbiomas initiative (<https://bosqueatlantico.mapbiomas.org/en/>), allowing for the monitoring and evaluation of the persistence of forest recovery areas in the Atlantic Forest (Rosa et al. 2021; Piffer et al., 2022) and the consolidation of a secondary vegetation database, resulting in the identification of more than 1 million ha of secondary vegetation originating mainly from natural regeneration in the last decades (Crouzeilles et al. 2019, Tonetti et al., in review). Such initiatives for identifying and monitoring the persistence of natural regeneration are essential since scaling up restoration should be achieved by combining areas of natural regeneration resulting from land abandonment and active restoration strategies targeted at areas with low natural regeneration capacity (Crouzeilles et al., 2020; Chazdon & Uriarte, 2016).

Improving Monitoring and Protocols

In addition to identifying and mapping areas undergoing restoration, rigorous monitoring is considered a fundamental element among members of the Trinational Pact. Although often neglected, monitoring is essential for learning and implementing adaptive management to ensure the success of restoration, as well as allowing for the quantification of restoration results. Thus, the development and application of monitoring protocols that ensure data comparability and reliability have been one of AF-PACT's key activities, with its first protocol being built in a participatory manner by more than 50 partner institutions, possessing criteria, indicators, and verifiers covering themes ranging from ecological aspects to economic viability and social gains (Viani, 2013; Viani et al., 2017). In addition to the field monitoring protocol, members have been working to develop tools and protocols that allow for the monitoring of areas undergoing restoration by using remote sensing techniques (Albuquerque et al. 2024), an essential strategy to enable efficient large-scale monitoring, fundamental for achieving the monitoring of millions of hectares of restoration targets, including natural regeneration in abandoned areas.

Communication and Awareness

Communication is considered a key approach to foster ecological restoration (Meli et al., 2016) and has been an important component of Trinational Pact members, using different means,

including campaigns, events, and publications. WWF and Fundación Vida Silvestre, for example, emphasized a combined communication and education campaign to raise awareness, while in Paraguay communication campaigns were launched via television and radio to focus on the impacts of deforestation, and surveys indicated an increase in awareness about the Upper Paraná Atlantic Forest (Mansourian et al., 2020). AF-PACT, through its Communication Working Group, has been working on disseminating knowledge and raising awareness, with the aim of increasing quality and scaling up restoration (available at <https://www.pactomataatlantica.org.br/o-movimento/acervo/>). For this purpose, the "Saberes da Restauração" (Restoration knowledges) series with its 7 volumes presents the state of the art of Restoration Science, addressing topics such as general aspects of restoration, monitoring of ecological and socioeconomic processes, geographic information systems, landscape ecology and natural regeneration, carbon, and forest businesses, in accessible language for all audiences. Another communication strategy adopted was the creation of the "Tom da Mata" (Voices of the Forest or Sounds of the Forest) podcast with two seasons and 18 episodes available online.

Social Inclusion and Gender Equity

Ecological restoration, to be truly comprehensive and fair, must adopt a holistic approach that includes gender equality as an essential component for success. This means going beyond biophysical and economic aspects, fully incorporating social and cultural dimensions, with particular attention to diverse communities. The members of the Trinational Pact seeks to integrate the needs of vulnerable groups into its strategies by promoting the involvement of various traditional communities (indigenous, caiçaras, caboclas, quilombolas), legitimizing their ways of life and guaranteeing their rights, as well as through the empowerment of women and their participation in projects, workshops, training, and entrepreneurship and cultural valorization groups across the three countries (Mansourian et al., 2020). The Social and Gender Task Force within the Knowledge Working Group of the AF-PACT, complementing communication and knowledge dissemination strategies, published the "Semeando Equidade" (Sowing Equity) series of booklets, to specifically address the gender perspective in restoration. This integration of concrete and measurable strategies maximizes social and environmental benefits, directly contributing to the Sustainable Development Goals (Siqueira et al., 2021).

Lessons Learned and Recommendations

The experience of the Trinational Pact in cross-border collaborations offers a valuable set of lessons that can guide and inspire other large-scale restoration initiatives, both in South America and globally. These insights, rooted in practice and multisectoral collaboration, highlight effective pathways for overcoming complex challenges and maximizing socio-environmental outcomes.

1. Empowering Governance through Participation

Effective large-scale restoration is driven by inclusive, bottom-up, and decentralized governance structures. These models, which actively engage diverse stakeholders—from governments and civil society to the private sector, academia, and local communities—are crucial for fostering continuous dialogue, building trust, and maintaining momentum. Prioritizing such participatory frameworks, including regional units and thematic working

groups, ensures actions are representative, adaptable, and aligned with a shared, proactive agenda.

2. Restoration as a Catalyst for Socioeconomic Development

Ecological restoration should be strategically framed as a significant economic and social opportunity, rather than merely an environmental cost. By integrating job creation, income generation, and the valuation of environmental products and services, restoration becomes inherently more attractive and viable for local actors and private companies. Projects should proactively incorporate strategies for socioeconomic value generation, including productive chains, Payment for Environmental Services (PES) mechanisms, and fiscal incentives, to ensure scalability and broad engagement.

3. The Imperative of Scientific Rigor and Transparent Monitoring

A robust scientific foundation coupled with transparent and rigorous monitoring systems is fundamental for effective and accountable restoration. This necessitates strong partnerships with academia and research centers to ensure the scientific basis of actions. Furthermore, implementing user-friendly monitoring protocols, leveraging advanced technologies like Geographic Information Systems (GIS) and remote sensing, and making data publicly accessible are crucial for evaluating progress, enabling adaptive management, and effectively communicating results.

4. Prioritizing Social Inclusion and Equity

Sustainable restoration is achieved when social inclusion and equity are central components of project design. This involves actively integrating the needs and particularities of diverse and vulnerable groups, including small producers, women, indigenous peoples, and traditional communities. Promoting their economic and social empowerment through targeted training and support strengthens the social fabric and ensures that the benefits of restoration are equitably distributed, with project teams possessing essential human qualities for effective engagement.

5. Adaptive Governance for Long-Term Success

The complexity of large-scale restoration demands adaptive governance instruments and continuous articulation. Fostering a culture of continuous learning and adaptation, supported by flexible strategies, robust evaluation mechanisms, and multisectoral and multiscale dialogues, is essential. Strong leadership and articulation capacity are vital to navigate dynamic challenges, maintain cohesion among diverse actors, and ensure a sustained focus on long-term objectives.

Challenges and Limitations

Despite the notable advances and success of the Trinational Pact, the initiative still faces significant challenges and limitations inherent to the complexity of the biome and the socioeconomic and political context of the countries involved. Overcoming these obstacles is

fundamental to achieving the ambitious goals established and consolidating the region as a global model in restoration.

High Cost of Restoration

Atlantic Forest restoration is a high-cost activity, which represents a substantial barrier to scaling up, especially considering the great number of rural landowners with limited resources. Although the development of new technologies and research can reduce costs in the long term, current values are still significantly high, requiring massive investments combined with the use of natural regeneration for scaling up. The Atlantic Forest, despite being a biodiversity hotspot, has a history of centuries of occupation, generating landscapes with a high degree of degradation and fragmentation, which can compromise the success of restoration actions, especially if based on natural regeneration, demanding more costly restoration actions in several regions. Furthermore, the cost difference between restoration carried out by local communities and by outsourced companies, mainly due to the tax burden, points to the need for economic incentive policies to enable scaling up and implementation by small actors.

Barriers to Scaling Up - Dependence on Public Policies and Incentives

Large-scale restoration faces regulatory, institutional, and engagement obstacles that hinder the expansion of actions. Historically, excessive bureaucracy, a top-down approach, and the lack of dialogue and participation of researchers and restoration practitioners in the construction of public policies have inhibited the involvement of social actors and are pointed out as causes of failure in governance mechanisms. The effectiveness of the Trinational Pact and the achievement of its goals are intrinsically linked to the stability and continuous support of public policies and governmental incentives in the three countries. The lack of clarity in law implementation procedures and the collapse of voluntary mechanisms due to funding cessation are examples of recurrent challenges. The engagement of landowners, especially small producers, is strongly conditioned by the alignment of projects with their needs and the stability of environmental legislation (Joglekar et al., 2025). Land tenure insecurity and legislative changes are factors that restrict landowner engagement and maintenance in restoration programs.

Restoration Target Underway and Implementation Challenges

Despite efforts, the ambitious goal of restoring 15 million hectares by 2050 by AF-PACT and the goal of restoring 1 million hectares determined by the Trinational Pact still represent an enormous challenge, with a relatively small fraction of the area already undergoing restoration. In the Upper Paraná, annual deforestation still exceeds restoration efforts (Fundación Vida Silvestre Argentina & WWF, 2017), and in the Atlantic Forest in general restored areas are young, do not yet exhibit all the necessary ecological qualities, and often, when derived from natural regeneration, do not persist for more than a decade. The lack of a local supply chain for forest restoration with native species in some regions, including nurseries and skilled labor, is a bottleneck that affects progress.

Conclusion

The **Trinational Pact** emerges as a paradigmatic example of a restoration flagship for the United Nations Decade on Ecosystem Restoration. Its innovative approach, which integrates

multisectoral governance, a robust scientific basis, economic viability, and social inclusion, offers a replicable and inspiring model for large-scale restoration initiatives worldwide. The experience of the Trinational Pact demonstrates that effective restoration transcends the ecological dimension, consolidating itself as a driver of socioeconomic development and equity. The lessons learned over years of collaborative effort in the Atlantic Forest – from the power of bottom-up articulation and the essentiality of a scientific basis, to the importance of economic value generation and social inclusion – are invaluable. They underscore the need for adaptive, transparent, and deeply rooted approaches in local realities for restoration to truly scale up and be sustainable in the long term. In summary, the Trinational Pact not only contributes directly to global restoration goals but also illuminates the path for other regions and biomes to replicate and adapt its strategies. In doing so, it reinforces the message that ecosystem restoration is a fundamental investment for human well-being, biodiversity conservation, and the construction of a more sustainable and fair future for the planet.

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