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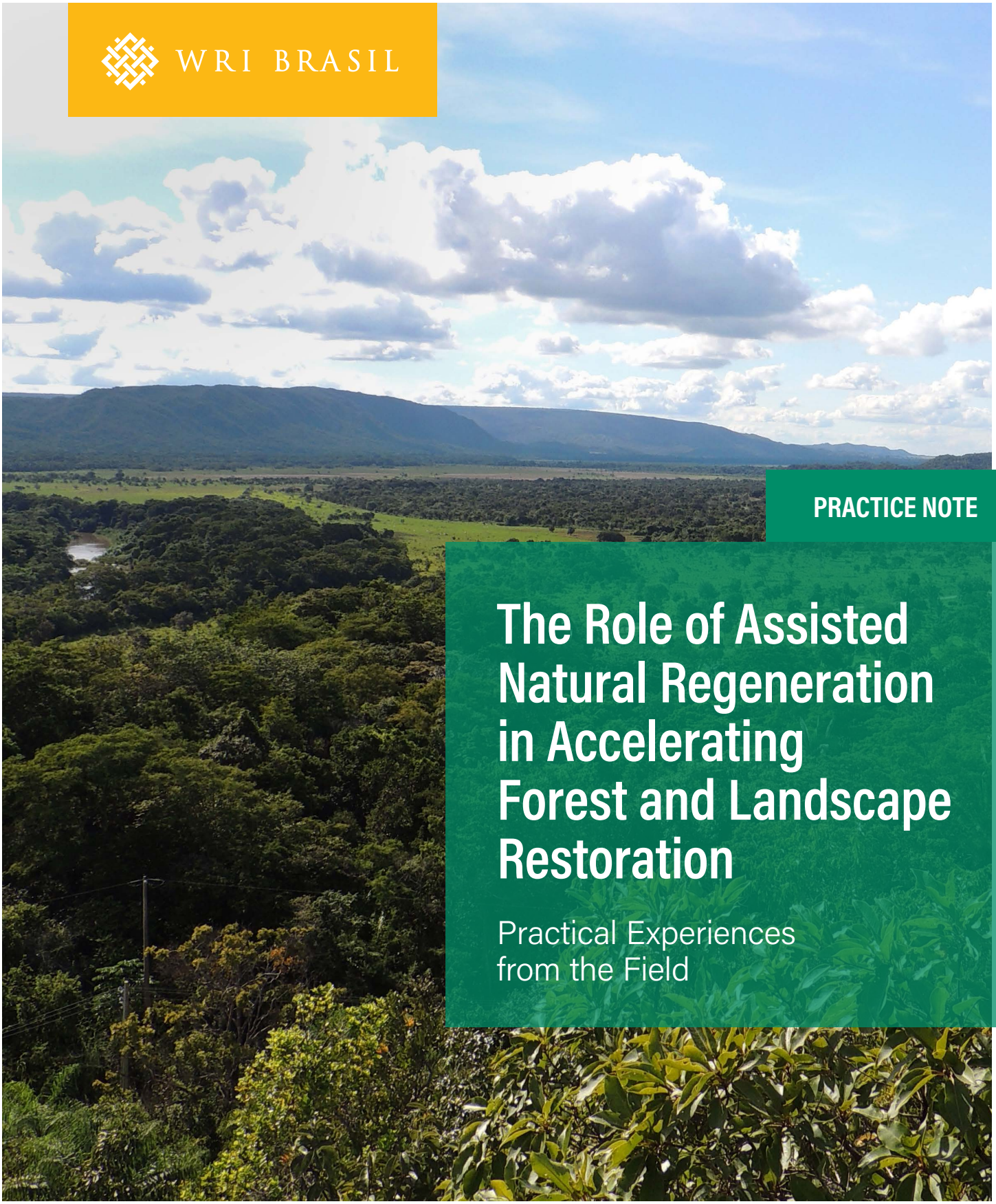

PRACTICE NOTE

The Role of Assisted Natural Regeneration in Accelerating Forest and Landscape Restoration

Practical Experiences from the Field

ICV INSTITUTO CENTRO DE VIDA

Imazon

suzano

Practice notes provide a quick review of experiences related to a specific project. Analysis and recommendations are limited to the specific context presented in the note and should not be interpreted for wider application.

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EXECUTIVE SUMMARY

HIGHLIGHTS

- This practice note analyzes 24 case studies of assisted natural regeneration (ANR) projects, 15 in Brazil and 9 elsewhere, to pinpoint the key factors that trigger success. With the goal of accelerating forest and landscape restoration (FLR) globally, these insights can improve the planning and implementation of new ANR projects.
- ANR usually has lower implementation costs and can be carried out at small, medium, and large scales, ranging from local projects led by small landowners to large-scale payment for environmental services programs. The cases all equip local communities with simple techniques to maintain or protect regenerating areas.
- ANR is a flexible restoration approach, easily adapted to different contexts and objectives. But the potential for natural regeneration varies in each landscape according to various environmental, social, and economic factors. Therefore, analyzing where ANR can work best is critical to its success. The research community must develop simple tools and approaches that help local planning organizations and agencies, along with communities, identify priority areas for ANR.

BACKGROUND

More and more people are restoring forest ecosystems by embracing the natural regeneration. When the land suffers damage from a fire, cattle grazing, or other disturbance, natural regeneration lets the landscape, and its forests use their own processes to recover lost ecosystem services and biodiversity and restore ecological balance (Holl and Aide 2011). The growing expanse of land occupied and modified by humans has inextricably linked agriculture and the conservation and exploitation of ecosystems (Rey Benayas et al. 2008).

Sometimes, nature needs a helping hand. A collection of approaches – called assisted natural regeneration (ANR) – seeks to remove human-caused environmental disturbances, such as deforestation and fire, in order to facilitate and accelerate the regeneration process (Chazdon 2014). ANR is a spectrum, starting as soon as people begin to intervene in the natural regeneration process and becoming more hands-on as the baseline state of the land is more degraded and less resilient (Chazdon et al. 2021).

Spanning the middle ground between active tree planting and natural forest regrowth, ANR is a promising approach for restoration practitioners, with biodiversity and climate action at its core. It includes the following activities: reducing the barriers to native species regeneration (such as the presence of cattle, which feed on the growing vegetation and compact the soil), controlling dominant grasses that prevent other species from thriving, and managing species that hinder natural succession as the landscape recovers (Shono et al. 2007). Despite its long history (Kartawinata and Abdulhadi 2015), ANR only became widespread in the 1970s, when it was used in the Philippines to recover degraded forests and grasslands. Since then, there has been a worldwide effort to develop, disseminate, and expand knowledge and applications of this strategy (FAO 2003).

ABOUT THIS PRACTICE NOTE

This practice note compiles effective, yet insufficiently documented cases of ANR in forest ecosystems, pointing out the key factors that encourage and facilitate its success. It intends to inspire people restoring landscapes around the world to use ANR to accelerate and scale-up forest and landscape restoration (FLR).

This publication does not provide detailed information on financial data, such as the total funds invested per program. For most projects, this information is restricted and unavailable to researchers due to its sensitive nature. Therefore, despite its centrality for understanding the ANR and its applicability, this work does not attempt a financial analysis of the collected projects. However, the literature points out that, compared to other techniques like tree planting, ANR can have a lower overall cost (FAO 2003, 2011; Benini and Adeodato 2017; Shono et al. 2020).

METHODOLOGY AND RESULTS

The methodology can be divided into three stages. First, the team gathered information on case studies and analyzed the literature already published on ANR. Second, they searched for and selected ANR cases in Brazil by contacting the leaders, organizations, and networks of the country's restoration sector. Finally, the team created and circulated a questionnaire to the leaders of the selected ANR initiatives to compile their information and experiences.

The survey of the scholarly literature and data sources collected information already published on ANR. This first stage captured cases from outside of Brazil, guided by compilation works such as FAO (2011) and Shono et al. (2007, 2020).

In Brazil, the team communicated with networks of organizations connected to the country's restoration agenda, such as the Atlantic Forest Restoration Pact (Pacto pela Restauração da Mata Atlântica; Pacto), the Alliance for Restoration in the Amazon (Aliança pela Restauração na Amazônia), and the Brazilian Coalition on Climate, Forests and Agriculture (Coalizão Brasil Clima, Florestas e Agricultura). This stage collected information about initiatives whose data had not been systematically published. The selection of these cases considered the availability of project leaders to answer the questionnaire, as well as the level of regeneration in the areas.

Based on the Restoration Diagnostic (Hanson et al. 2015), a questionnaire was prepared to collect information and practical experiences related to ANR. It did not intend to capture all of the technical details of each case study. The data was collected through email and phone calls, as well as during online conferences. Due to the limitations imposed by COVID-19, it was not possible to check the mapped cases in the field.

LESSONS LEARNED

This practice note points out several lessons learned from the implementation of ANR around the world.

ANR is a flexible way to restore a degraded landscape and is adaptable to the local environmental, social, and economic conditions.

The success of ANR depends on the natural regeneration potential of each landscape, the local land-use context, the tools available for the protection and monitoring of these areas, and the desire of landowners, governments, and the private sector to work together to establish and maintain successful initiatives.

The involvement of local communities proved to be important to project success, leading to better maintenance and long-term protection for regenerating areas. Much of that success rested on connecting forest products grown on the regenerated land to sustainable value chains that could improve local economies.

INTRODUCTION

In 2021, the Intergovernmental Panel on Climate Change (IPCC) published a report on the impacts of global warming (IPCC 2021). It analyzed what actions the world will need to take to achieve the goal established by the Paris Agreement: Keep global warming below 1.5°C compared pre-industrial levels (UNFCC 2015).

With its updated forecasts on climate change based on this call-to-action, the report also presents the key sectors where the world must present a strong response to climate change. Among the many strategies connected to land use, ecosystem restoration stands out. With its ability to combine food and fiber production with improved ecosystem services (Griscom et al. 2017), forest and landscape restoration (FLR) is one of the most prominent of these nature-based solutions. FLR is the process of recovering ecological functionality and increasing human well-being in deforested, degraded, or regenerating forest landscapes (ITTO 2005; Chazdon 2014).

The growing expanse of land occupied and modified by humans, especially for agriculture, has increasingly required people to consider the conservation and exploitation of ecosystems as inherently linked (Rey Benayas et al. 2008). To successfully recover ecosystem services and biodiversity in a landscape, more and more practitioners are embracing techniques that promote the natural recovery of ecosystems after a disturbance (Holl and Aide 2011). Assisted natural regeneration (ANR) lies in between natural forest regrowth and different levels of human-driven interventions, such as tree planting (Chazdon et al. 2021). This approach removes human-caused environmental disturbances, such as fire and removal of native vegetation, to facilitate the natural regeneration process (Chazdon 2014).

The specific ANR interventions that people employ depend on the degree of human intervention – ranging from minimal intervention (such as natural regeneration) to greater intervention (such as total planting) – needed to accelerate ecological succession, defined as the natural recovery process of a landscape's ecological structure, composition, and functions after a disturbance (Chazdon 2014; Holl and Aide 2011).

Figure 1 | **Experimental regeneration plots**

Photo: Henrique Andrade.

The needed level of human intervention also depends on other factors, like the state of conservation of the nearby reminiscent forests, the level of soil degradation, financial resources available, the desired results at the end of the project, and the time needed for vegetation to recover (Chazdon 2008).

As a middle ground, ANR identifies and reduces impediments to natural regeneration. For example, it can include removing cattle (which feed on the regenerating vegetation and compact the soil) and controlling dominant or invasive species, which can be strong competitors and prevent other species from

thriving (Shono et al. 2007; Brancalion et al. 2019). Despite its long history (Kartawinata and Abdulhadi 2015), ANR only became widespread in the 1970s, when it was used in the Philippines to the recover degraded forests and grasslands. Since then, there has been a worldwide effort to develop, disseminate, and expand knowledge and applications of this strategy (FAO 2003).

One of the main advantages of ANR is its positive cost-benefit ratio compared to other forest restoration approaches, which usually require a high upfront investment, e.g., for seedling production (Shono et al. 2007). In most cases, ANR has a lower cost because it involves little or no preparation of the project site, relies on natural reseeding, and establishes trees well adapted to the local environment that do not require the constant care needed by nursery-grown seedlings (FAO 2011). Although it requires less financial investment, ANR projects demand intense and continuous management from local communities to maintain the regenerating areas until the necessary species can thrive on their own (FAO 2011). Therefore, they have to heavily invest in building social capital. That is essential for ANR's success (Chazdon 2014) within and around the project site, especially when they work with small landholders and in community-managed areas. Many ANR projects do directly involve local communities in the maintenance, management, and conservation of regenerating areas, including species within the ANR mix that can create income-generating or livelihood-sustaining opportunities in the future (Durst and Spirovska-Kono 2011; Shono et al. 2020; Appanah et al. 2016).

This publication aims to collect and publicize these insights, with the support of the "Catalyzing and Implementing Assisted Natural Regeneration in Mato Grosso and Pará" project developed with support from Norway's International Climate

Figure 2 | **Community engaged in the maintenance of regenerating areas**

Photo: Mater Natura.

and Forest Initiative (NICFI). The project aims to design and test ANR solutions to restore degraded areas in priority landscapes in both of these states, located in the Brazilian Amazon. By scaling up ANR, this work can enhance carbon sequestration, improve the ecological and economic productivity of rural properties, and bring social, economic, and environmental benefits to entire landscapes

Within this context, the analyses conducted for this practice note had three objectives: compile and publicize cases of ANR in forest ecosystems, provide information on the factors that lead to successful ANR, and inspire people restoring land to use ANR to accelerate and scale up their work, when the conditions are right.

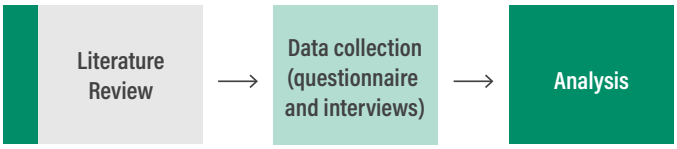
To this end, we seek to answer the following questions:

- What motivates people to choose ANR as a strategy to restore degraded land and forests?
- What are the key factors for the successful implementation of ANR within and across projects?

METHODOLOGY

The study followed three main steps (Figure 3).

Figure 3 | **How the ANR case studies were collected**



Source: Authors

In the first stage, the existing literature about ANR initiatives around the world was reviewed. Information was compiled on the benefits and drawbacks of ANR compared to other techniques and approaches, the different ways of implementing ANR, and success stories already brought to light.

In the second stage, data on ANR cases published by restoration networks in Brazil was surveyed, such as the Atlantic Forest Restoration Pact (Pacto), the Alliance for Restoration in the Amazon, and the Brazilian Coalition on Climate, Forests and Agriculture. To better understand the theory and practice of ANR, specialists in natural regeneration that have field experience were directly consulted.

Once the cases were identified, a standard questionnaire was prepared for these implementers to complete, with the goal of efficiently collecting as much information as possible about their projects and experiences. This questionnaire, developed by the authors and based on Hanson et al. (2015), was delivered through email, phone calls, and online conferences between March and December 2021. The limitations imposed by COVID-19 made it impossible to check the mapped cases in the field.

For each case, data was collected providing information on the project: implementation organization; its location and geographical context; its duration and goals; the ANR techniques it employed; its socioeconomic and environmental outcomes; and its key success factors. Detailed information about all 24 cases is presented in Appendix A.

In the third stage, the collected information was systematically analyzed by following *The Restoration Diagnostic* (Hanson et al. 2015), a structured method to assess the ability of a project to motivate action, situate itself in a strong enabling environment, and implement effectively. The goal was to use these insights to recommend concrete practices and public policies to scale up FLR. The summary of our analysis framework can be found in Appendix B, which details the key success factors and the assumptions behind them.

There are limitations to this type of analysis. First, only some of the implementing organizations answered the questionnaire and interview request, giving the respondents' perspectives more influence. However, the literature review and commitment to detail when reviewing the cases reduced that risk.

And second, this practice note does not present cases where the obstacles caused ANR initiatives to fail. Researchers are encouraged to fill these gaps and help deepen knowledge about ANR in Brazil and around the world.

EXPANDING ANR: OPPORTUNITIES AND CHALLENGES

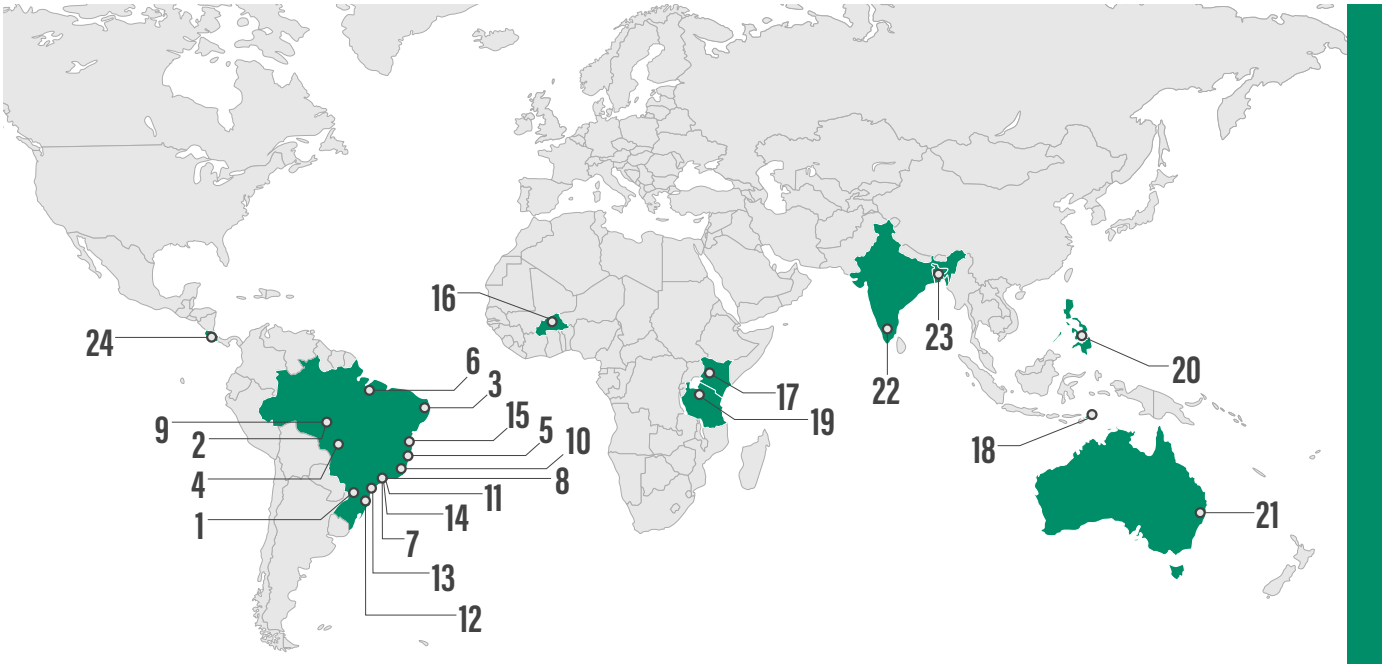
OVERVIEW

A total of 24 cases of practical ANR experiences in 10 countries were analyzed and included in this publication (Figure 4). In Brazil, 15 cases were identified in which ANR techniques were used and linked to the execution of small-scale projects and larger programs, including those carried out by individuals or organizations, or as part of a long-term action strategy related to the areas that received interventions. In the remaining countries, researchers and organizations compiled information on nine projects supported by different private or public ANR initiatives.

To better analyze and compare each mapped case study, we compiled all of the information in Table 1. Based on this tabulation, the topics of discussion were organized into the items in this section.

The Brazilian examples are located in three biomes – the Atlantic Forest, the Amazon Forest, and Cerrado (Brazilian Savanna) – that encompass eight states and cover all of Brazil's major regions. The analysis showed that each case involves different land uses, causes of degradation, land tenure regimes, actors, and techniques. These factors will be analyzed below.

Figure 4 | **Geographical distribution of the ANR case studies**



Note: Numbers refer to the cases described in Table 1 and Appendix A.
Source: Leonardo Barbosa (WRI Brasil).

LAND USE AND TYPES OF INTERVENTIONS

The natural regeneration capacity of a given area depends on the level of its degradation, which is directly related to the historical use of the land. Degradation can lead to compacted or eroded soil, the proliferation of invasive species, or the complete absence of seeds from the landscape. The regeneration capacity of a landscape can also depend on the proximity and quality of remaining natural areas, the initial composition of colonizing plant species, edaphoclimatic conditions and the presence of seed-dispersing animals and pollinators (Chazdon 2014).

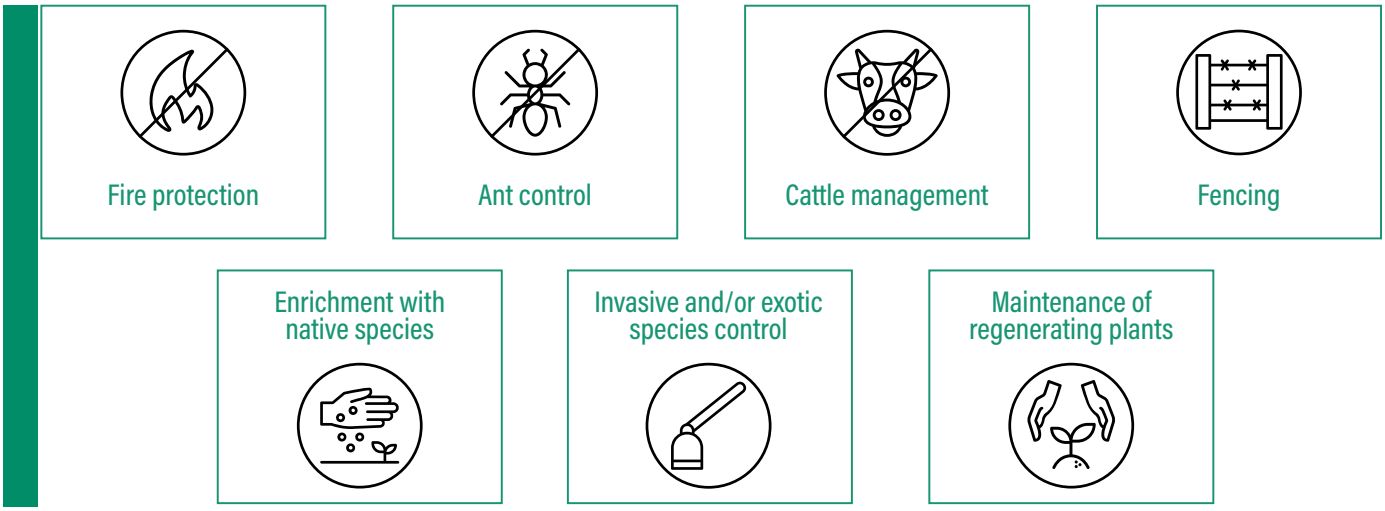
In the analyzed cases, the land use before ANR is generally pasture dominated by exotic grass species that prevent native seedlings from growing and natural regeneration from beginning. The presence of cattle on the pasture compacts and erodes the soil, reducing the ecosystem's resilience. In these cases, the most used ANR techniques were: (i) enrichment with native species (13 out of 24 cases), (ii) invasive and/or exotic species control (11 out of 24 cases), and (iii) fencing (9 out of 24 cases).

Enrichment with native species, a process through which locally important plants are added to the landscape, is critical in landscapes where there are no nearby forest fragments to supply seeds for natural regeneration or when natural colonization is limited or delayed. Planting native trees in key areas can accelerate the process of establishing the species that will remain in the system in the long term or that will be managed by local users.

Since exotic grasses are the dominant species in most ANR sites, and many species are considered invasive, their control is fundamental for the constitution and establishment of areas under restoration. In addition to controlling unwanted species, the protection and care of regenerating plants also appear in 26 percent of cases.

In examples where livestock are present in the area, people need to fence off the regenerating areas so that the cattle can't feed on the regenerating trees and shrubs, whose chance of survival is then increased. But in rare instances, cattle can accelerate the regeneration process. In SESC Serra Azul Park (Rosário Oeste, Mato Grosso, Brazil), the cattle herd eliminated the invasive grasses, clearing the way for native plants in the early stages of forest recovery. And in the late 1980s in Costa Rica, a project introduced 7,000 head of cattle to serve as "biotic cutting machines" and seed spreaders (Janzen and Hallwachs 2016, 2020).

Figure 5 | **Types of specific ANR interventions found in the cases**



Source: Authors.

PROJECT SIZE AND GOALS

This practice note evaluates projects taking place at three scales: across political jurisdictions, within large projects (a set of public and/or private properties), and on individual private properties.

The size of the projects in this analysis ranged from 2.23 to 378,000 hectares (ha), with the especially large Tanzania (22,000 ha) and India (378,000 ha) examples serving as outliers. Of the remaining 22 cases, all ranged from 2.23 ha to 7,000 ha, with no clear distribution pattern to their size. This variance is due to the flexible standards for ANR, as the cases vary in objective, arrangements, techniques, and size.

In cases where intensive land exploitation has led to degradation, e.g., in places with the elimination of native vegetation and extensive grazing, ANR programs and projects aim to recover ecosystem services, like a healthy water cycle, across large areas. On small and medium-sized properties, the restoration work seeks to recover ecosystem services, bring properties into compliance with local environmental laws, and boost the incomes and livelihoods of landowners as the forest regrows. In some jurisdictions, small and medium-sized landowners can also benefit from payment for environmental services (PES) programs, in which the institutions pay them to recover, maintain, and expand forest cover on their properties (Cases 10 and 12). In areas controlled by Indigenous and/or other local communities, projects consider how ANR could affect land tenure (Cases 1 and 13) and help to maintain traditional ways of life (Cases 17, 18, and 19).

THE SOCIAL LANDSCAPE

Many groups have embraced ANR, ranging from individual landowners and rural, Indigenous, and other local communities, traditional peoples, non-governmental organizations (NGOs), public sector institutions, and private companies. Often, individual projects include most or all of these groups of people, and all groups regularly exchange technical information, planting materials, or resources. Collaboration takes place between rural communities and local NGOs (Case 1); landowners and local NGOs (Case 3); and private companies and local NGOs (Case 2).

In most projects, local actors have a strong role because successful ANR relies on community involvement and knowledge of the landscape. A relevant point to be observed is the trained and qualified workforce in the implementation and maintenance of ANR projects, composed, in some cases, from local communities. Our analysis indicates that projects with deep local involvement are the most successful, with the most permanently regenerated land and the greatest income-boosting potential (often from the commercialization of non-timber forest products).

Projects that directly engage both private companies and rural landowners in the ANR process also seem to feature more permanently regenerated land. In these cases, the expansion of the forest is linked to the necessity of complying with environmental laws and the presence of a socially accepted private company in the project that can reinforce sustainable value chains, connecting ANR sites to the market and generating income for the people involved.

When investment in ANR is linked to a legal requirement to compensate for environmental damage elsewhere, the commitment to the initiative and the maintenance of the forests seem to be greater, creating opportunities for increased investment and ambition. These possibilities can vary even within the same area. The commitment to recovery and the likelihood of success depend on the amount and suitability of ANR interventions (Chazdon et al. 2021).

Many projects gather consistent data on changes in forest structure, ecosystem services, and species composition – and even track socioeconomic indicators like the amount of income generated or number of communities involved. Transparently monitoring sites with the aid of high-quality data can increase involvement from all the project's participants and can inform how ANR benefits, such as income from PES programs or ecotourism, are distributed. Most importantly, rigorous monitoring can indicate whether the regeneration is leading to permanent changes or is only temporarily improving the land.

PROJECT DURATION AND MONITORING

Forest growth involves an integrated set of ecological process that spur recovery at different rates (Poorter et al. 2021) and is linked to successional dynamics. A forest does not regrow in a year; it can take many decades (or more than a century) to reach maturity (Poorter et al. 2016; Chazdon et al. 2016; Poorter et al. 2021). Secondary forests regenerate largely through natural processes, but only after the cause of the damage to the original vegetation is removed or somehow degraded (FAO 2003). The cases focus on the length of active ANR work for each project, but some contain long-term data that unpack how the project has achieved or failed in bringing long-term benefit. However, our analysis does not consider forest recovery outside of the project timeframe.

The projects have lasted between 2 and 26 years (with the end of 2021 as the cutoff) and began between 1985 and 2020. Many projects have no predetermined end date, and many forecast up to 40 years of follow-up and monitoring (such as the Forest Carbon Sink and Reflorestar programs in Brazil, farmer-managed natural regeneration efforts in Kenya and work in the Monte Alto Forest Reserve in Costa Rica).

The analysis found that there was no correlation between the duration and the size of the projects. It was not possible to establish general standards about ANR projects based on their duration since information varies on the period reported (project time, time since the intervention, intervention permanence, among other factors).

ANR TECHNIQUES

The cases studied used dozens of ANR techniques, but we grouped those interventions into seven larger categories: fencing; cattle management (including removing cattle and controlling access to pastures); enrichment with native species (including native and mixed-species seed dispersal, *muvucas*[1] in nucleation, and seedling planting); invasive and/or exotic species control (including the removal of grasses and selective weeding); ant control; maintenance of regenerating individuals (including thinning, pruning, and other forms of protection for regenerating plants); and fire protection (including installing firebreaks). The interventions were analyzed according to the context of each landscape (see Appendix A).

Table 1 | **Synthesis of ANR case studies**

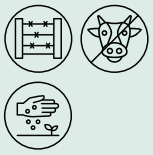
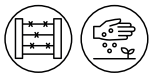
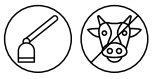
	PROJECT	TYPES OF INSTITUTIONS INVOLVED	LOCATION AND BIOME	AREA (HA)	TIMESPAN	FUNDING SOURCES	INTERVENTIONS	KEY SUCCESS FACTORS
1	Growing Hope (Mater Natura/ Institute of Environmental Studies)	NGO	Guarapuava and Inácio Martins, Paraná, Brazil Atlantic Forest	265	2012-2015	Brazilian Development Bank (Banco Nacional de Desenvolvimento Econômico e Social; BNDES)		▪ Crisis events ▪ Economic benefits ▪ Legal requirements ▪ Market conditions ▪ Policy conditions ▪ Social conditions ▪ Institutional conditions ▪ Technical design ▪ Feedback
2	Forest Carbon Sink (ONF Brasil)	NGO, Private	Cotriguaçu, Mato Grosso, Brazil Amazon Rainforest	2,103	1998-2038	Peugeot, National Forests Office (Office national des forêts; ONF)		▪ Environmental benefits ▪ Economic benefits ▪ Legal requirements ▪ Market conditions ▪ Social conditions ▪ Institutional conditions ▪ Knowledge ▪ Technical design ▪ Finance and incentives
3	Connectivity for Conservation (Cepan/Japungu Agroindustrial)	NGO, Private	Santa Rita, Paraíba, Brazil Atlantic Forest	25	2020-2022	Japungu Agroindustrial		▪ Environmental benefits ▪ Economic benefits ▪ Ecological conditions ▪ Institutional conditions ▪ Leadership ▪ Technical design ▪ Finance and incentives ▪ Feedback
4	SESC Serra Azul Park (SESC Pantanal)	Private	Rosário Oeste, Mato Grosso, Brazil Cerrado (Brazilian Savanna)	5,000	2015-2020	Social Service of Commerce (SESC)		▪ Environmental benefits ▪ Institutional conditions ▪ Leadership ▪ Technical design ▪ Finance and incentives ▪ Feedback
5	Large-Scale Resto-ration and Monitoring (TNC Brasil/Suzano)	NGO, Private	Caravelas, Nova Viçosa, Alcobaça, Teixeira de Freitas and Vereda, Bahia, Brazil; Aracruz, Linhares, Conceição da Barra, Rio Bananal, Jaguaré, São Mateus, Vila Valério, Montanha and Mucurici, Espírito Santo, Brazil Atlantic Forest	1,900	2010–on-going	Suzano S.A.		▪ Environmental benefits ▪ Awareness ▪ Ecological conditions ▪ Institutional conditions ▪ Technical design ▪ Finance and incentives ▪ Feedback

Table 1 | **Synthesis of ANR case studies (continued)**

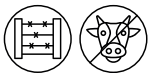
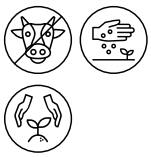
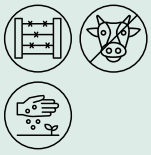
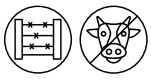
	PROJECT	TYPES OF INSTITUTIONS INVOLVED	LOCATION AND BIOME	AREA (HA)	TIMESPAN	FUNDING SOURCES	INTERVENTIONS	KEY SUCCESS FACTORS
6	Açucena and Rio Preto Farms (IMAZON)	NGO, Private	Paragominas, Pará, Brazil Amazon Rainforest	1,685	2008-2020	Farm owners		▪ Crisis events ▪ Legal requirements ▪ Policy conditions ▪ Institutional conditions ▪ Technical design ▪ Finance and incentives ▪ Feedback
7	Neblinas Park (Ecofuturo/ Suzano)	NGO, Private	Bertioga, São Paulo, Brazil Atlantic Forest	7,000	2004 – ongoing	Suzano S.A.		▪ Environmental benefits ▪ Ecological conditions ▪ Social conditions ▪ Institutional conditions ▪ Knowledge ▪ Technical design ▪ Finance and incentives ▪ Feedback
8	Peixe River Restoration (Copaíba Environmental Association)	NGO	Socorro, São Paulo, Brazil Atlantic Forest	7.7	2009-2011	State Water Resources Fund (Fundo Estadual de Recursos Hídricos; Fehidro)		▪ Environmental benefits ▪ Awareness ▪ Ecological conditions ▪ Institutional conditions ▪ Technical design ▪ Finance and incentives
9	Socioproductive Chains (The Life Center Institute)	NGO	Alta Floresta, Paranaíta, Nova Monte Verde, Nova Bandeirantes, Cotriguaçu, and Colniza, Mato Grosso, Brazil Amazon Rainforest	104	2018 – ongoing	Brazilian Development Bank (Banco Nacional de Desenvolvimento Econômico e Social; BNDES), Amazon Fund		▪ Social benefits ▪ Legal requirements ▪ Market conditions ▪ Social conditions ▪ Knowledge ▪ Finance and incentives ▪ Feedback
10	Reflorestar Program (Espirito Santo State Secretariat for the Environment and Water Resources)	Government	Espírito Santo State, Brazil Atlantic Forest	4,075	2018 – ongoing	Espírito Santo State Water and Forest Resources Fund (Fundo Estadual de Recursos Hídricos e Florestais do Espírito Santo; Fundágua)		▪ Economic benefits ▪ Awareness ▪ Policy conditions ▪ Institutional conditions ▪ Leadership ▪ Technical design ▪ Finance and incentives ▪ Feedback

Table 1 | **Synthesis of ANR case studies (continued)**

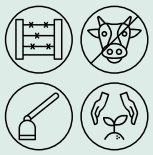
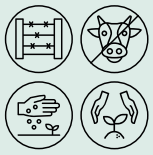
	PROJECT	TYPES OF INSTITUTIONS INVOLVED	LOCATION AND BIOME	AREA (HA)	TIMESPAN	FUNDING SOURCES	INTERVENTIONS	KEY SUCCESS FACTORS
11	Cachoeira-Piracaia (TNC Brasil/SABESP)	NGO, Mixed company	Piracaia, São Paulo, Brazil Atlantic Forest	31	2009-2015	Dow Foundation		▪ Environmental benefits ▪ Legal requirements ▪ Ecological conditions ▪ Social conditions ▪ Institutional conditions ▪ Finance and incentives ▪ Feedback
12	Camboriú River Water Producer (TNC Brasil/ EMASA)	NGO, Goverment	Camboriú, Santa Catarina, Brazil Atlantic Forest	15	2014 – ongoing	Sanitation Company of Balneário Camboriú (Empresa Municipal de Água e Saneamento; Emasa)		▪ Environmental benefits ▪ Economic benefits ▪ Ecological conditions ▪ Policy conditions ▪ Institutional conditions ▪ Finance and incentives
13	Salmoura Farm-Rio Turvo, Nascentes Barra do Turvo I (Iniciativa Verde)	NGO	Cajati and Barra do Turvo, São Paulo, Brazil Atlantic Forest	83.7	2016-2020	Programa Nascentes (Headwaters Program), São Paulo's State Government		▪ Environmental benefits ▪ Ecological conditions ▪ Social conditions ▪ Institutional conditions ▪ Technical design
14	Nascentes Jambeiro I (Iniciativa Verde)	NGO	Jambeiro, São Paulo, Brazil Atlantic Forest	2.23	2017 – ongoing	Programa Nascentes (Headwaters Program), São Paulo's State Government		▪ Environmental benefits ▪ Legal requirements ▪ Ecological conditions ▪ Policy conditions ▪ Leadership ▪ Finance and incentives
15	Oricó River Headwaters (OCT, Public Prosecutor's Office of the State of Bahia – Atlantic Forest Nucleus)	NGO, Public	Ibirapitanga, Bahia, Brazil Atlantic Forest	5	2017-2019	Public Prosecutor's Office of the State of Bahia – Atlantic Forest Nucleus		▪ Crisis events ▪ Legal requirements ▪ Policy conditions ▪ Institutional conditions ▪ Technical design ▪ Feedback
16	Assisted Natural Regeneration with Fencing (tiipaalga/ newTree)	NGO	Loroum, Soum, Sanmatenga, Oubritenga, Kadiogo, Kourwéogo and Boulkiemdé provinces, Burkina Faso Sub-Saharan semi-arid region	560	2003 – ongoing	newTree		▪ Economic benefits ▪ Awareness ▪ Market conditions ▪ Social conditions ▪ Technical design ▪ Finance and incentives ▪ Feedback

Table 1 | **Synthesis of ANR case studies (continued)**

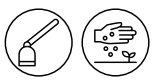
	PROJECT	TYPES OF INSTITUTIONS INVOLVED	LOCATION AND BIOME	AREA (HA)	TIMESPAN	FUNDING SOURCES	INTERVENTIONS	KEY SUCCESS FACTORS
17	BRACCE – Building Resilience to a Changing Climate and Environment (World Vision Australia)	NGO	Aileu, Timor-Leste Dry tropical and subtropical forests	50	2011-2016	World Vision Australia		▪ Economic benefits ▪ Awareness ▪ Crisis events ▪ Market conditions ▪ Social conditions ▪ Technical design
18	Farmer Managed Natural Regeneration (World Vision Australia)	NGO	Baringo County, Kenya Forested savanna	2,273	2015 – ongoing	Australian Aid, Australian Government		▪ Environmental benefits ▪ Social benefits ▪ Awareness ▪ Crisis events ▪ Social conditions ▪ Institutional conditions ▪ Technical design
19	Shinyanga Soil Conservation Programme – Hashi (Tanzania Government)	Government	Shinyanga region, Tanzania Miombo woodland and acacia savanna	378,000	1985-2004	Tanzanian Government, Norwegian Agency for Development Cooperation (NORAD), World Agroforestry Centre (ICRAF)		▪ Economic benefits ▪ Awareness ▪ Crisis events ▪ Policy conditions ▪ Social conditions ▪ Institutional conditions ▪ Leadership ▪ Technical design ▪ Finance and incentives
20	Danao Watershed (Department of Environment and Natural Resources, DENR/FAO)	Government	Bohol, Philippines Rainforest	25	2006 – ongoing	Food and Agriculture Organization of the United Nations (FAO)		▪ Economic benefits ▪ Crisis events ▪ Institutional conditions ▪ Social conditions ▪ Technical design ▪ Finance and incentives ▪ Feedback
21	Numinbah Conservation Area (Natural Areas Management Unit, NAMU/ Seqwater)	Government	Gold Coast, Queensland, Australia Subtropical humid and subtropical sclerophyll forests	200	2008-2014	City of Gold Coast, Government of Queensland		▪ Environmental benefits ▪ Ecological conditions ▪ Institutional conditions ▪ Policy conditions ▪ Technical design ▪ Finance and incentives ▪ Feedback
22	Anaimalai Hills (Nature Conservation Foundation)	NGO	West Gates, India Highland rainforest	22,000	2000 – ongoing	Rohini Nilekani Philanthropies, M. M. Muthiah Research Foundation		▪ Environmental benefits ▪ Ecological conditions ▪ Technical design ▪ Finance and incentives

Table 1 | **Synthesis of ANR case studies (continued)**

	PROJECT	TYPES OF INSTITUTIONS INVOLVED	LOCATION AND BIOME	AREA (HA)	TIMESPAN	FUNDING SOURCES	INTERVENTIONS	KEY SUCCESS FACTORS
23	Medhakachhapia National Park (Bangladesh Government)	Government	Chakaria Upazila, Bangladesh Rainforest	214	2012-2018	Bangladesh Government, U.S. Agency for International Development (USAID)		▪ Environmental benefits ▪ Ecological conditions ▪ Policy conditions ▪ Technical design ▪ Feedback
24	Monte Alto Forest Reserve (Fundación Pro Reserva Forestal Monte Alto)	NGO, Private	Guanacaste province, Costa Rica Submontane tropical and humid tropical forests	>300	1994 – ongoing	Tropica Verde, Ministry of Environment, Energy and Telecommunications; Ministry of Agriculture and Livestock; Centro Agrícola Cantonal de Hojancha (Cach)		▪ Environmental benefits ▪ Social benefits ▪ Awareness ▪ Crisis events ▪ Ecological conditions ▪ Policy conditions ▪ Social conditions ▪ Finance and incentives ▪ Technical design ▪ Feedback

LEGEND

Specific Interventions:

- Fencing
- Enrichment with native species
- Maintenance of regenerating plants
- Invasive and/or exotic species control
- Cattle management
- Ant control
- Fire protection

Key Success Factors:

- Motivate
- Enable
- Implement

SOURCES AND FINANCIAL MECHANISMS

The Brazilian cases were funded through both public and private investments. Private sector companies fund projects from compensatory funds linked to the country's environmental licensing processes[2], as in the cases associated with Programa Nascentes (Headwaters Programs), as well as voluntarily through their private foundations and directly by their corporate arms. In this second situation, some companies were interested in understanding how ANR could improve their business operations. This was the case for the Sanitation Company of Balneário Camboriú (Empresa Municipal de Água e Saneamento; EMASA) of Balneário Camboriú, who worked through the Water Producer Program (Programa Produtor de Água) to use ANR to improve water quality in the Metropolitan Region of Curitiba.

An example of a public funding mechanism is the State Water Resources Fund (Fundo Estadual de Recursos Hídricos; FEHIDRO) in São Paulo, created as a way to finance the implementation of the State Water Resources Policy. The fund's resources come from financial compensation and royalties that counterbalance the Itaipu Hydroelectric Power Plant's impact on natural ecosystems, as well charges for using water resources owned by the state. The projects that receive funding from this source must align with the objectives set out in the State Water Resources Plan and

Hydrographic Basin Plan. Therefore, all projects that improve water quality and quantity, such as traditional water treatment projects, ANR, and tree planting, can tap into this fund. This arrangement helps finance the public sector goals set out in the plans mentioned above, strengthening decision-making in official governance bodies and involving local organizations.

Some ANR projects founded are financed by the Brazilian Development Bank (Banco Nacional de Desenvolvimento Econômico e Social; BNDES) through grants for the restoration of biomes outside of the Amazon. The separate Amazon Fund covers projects in the Amazon Rainforest, issuing grants for actions that combat deforestation and that promote conservation and sustainable use, like ANR

KEY SUCCESS FACTORS

Successful restoration projects motivate people to begin restoring land, create a governance framework and enabling environment that generate long-term impact, and support implementation in the field (Hanson et al. 2015). The cases were accessed considering the achievement of each according to three aspects: motivation, enabling, and implementation.

Environmental benefits were the primary motivation for people engaging and investing in ANR. Many of the interviewed practitioners said that their priorities were improving the quality of the forest, its soil, and biodiversity; increasing and regulating the supply of water by limiting erosion and conserving natural springs and watercourses; improving environmental quality; and storing carbon dioxide in naturally regenerating vegetation to mitigate climate change.

Favorable institutional conditions, such as effective coordination and governance within the project (as in the Reflorestar Program), were equally important. The cases represent different governance structures and organizational styles and include a diversity of sectors, but also economic and civil society groups, including local communities. According to each unique setup, the roles and responsibilities within successful projects were clearly defined, and the different needs and characteristics of all those involved were considered.

Strong market conditions, such as the presence of established sustainable value chains, facilitated five of the cases (Cases 1, 2, 9, 16, and 17), in which non-timber forest products grown on ANR sites, such as Brazil nut (*Bertholletia excelsa*) and yerba mate (*Ilex paraguariensis*), generated extra income for communities.

Deep knowledge about ANR among rural extension agents, project staff, and rural communities was the most frequently cited criterion for successful implementation. For example, Cases 2, 7, and 9 trained the rural communities or households involved in the project, building local support for the projects.

Projects that had adequate sources of finance and strong incentives for ANR could overcome the pressure to use the land for other ends, like conventional agriculture. In Cases 10 and 12, payment for environmental services (PES) programs remunerated landowners for their ANR work, replacing income they may have received from using the land to grow crops or raise cattle. In addition, Brazilian projects could access financial resources tied to the country's Forest Code and its legal compliance regime for rural properties, as well as compensation linked to rural licensing processes.

Successful ANR projects had robust monitoring and evaluation systems. With independent data, projects can track how ANR improves both ecosystem services, like water quality and carbon sequestration, and socioeconomic prosperity (through improved incomes). Transparently reporting the results of these evaluations helped some cases attract additional resources to expand their work. Many of the lessons learned from decades of monitoring remain buried within detailed project reports. However, there is more to be done. This publication addresses the need to systematize these experiences and disseminate the lessons learned within the scope of the cases presented, demonstrating the importance of communicating these learnings to the wider restoration community.

CONCLUSIONS AND RECOMMENDATIONS

The cases provide inspiration for the global restoration movement and offer concrete suggestions to improve the success and global expansion of ANR. Researching and writing this practice note has highlighted key lessons, such as that ANR is a flexible way to restore land. Its strength lies in its ability to adapt to each context and fulfil a variety of objectives.

The potential for natural regeneration depends on both the ecological and location conditions of each landscape, and understanding this potential is important for successful ANR implementation. We recommend that ANR programs conduct assessments of this potential when planning local restoration interventions in order to maximize positive impacts (Crouzeilles et al. 2019). Researchers need to develop accessible tools that help local planning organizations and agencies identify the best places for ANR and the barriers to success, together with local communities.

As its cost is relatively low, ANR requires only simple financial modeling before implementation starts. It can be led on a small scale by landowners either individually or together with their neighbors in important areas like biodiverse ecological corridors. In many cases, local or traditional knowledge is sufficient to embrace ANR, and minimal outside investment is needed.

Landowners and government agencies at multiple levels are largely unaware of the promise and impact of ANR. The current lack of knowledge-sharing globally and within most local contexts is a serious impediment to progress. Improving outreach can encourage more landowners to embrace ANR and tap into their ingenuity and knowledge of the land to develop new commercial timber and non-timber forest products from the restored land, such as timber for infrastructure, firewood, fruit, and medical products.

The global ANR community is growing. By working together practitioners, researchers, policymakers, and funders could help the restoration movement better understand the role of ANR in achieving climate, biodiversity, and rural development goals.

In the coming years, the "Promoting and Implementing Assisted Natural Regeneration in Mato Grosso and Pará" project will continue this research and analysis. Only by unlocking and sharing more knowledge can we realize the true promise of ANR all around the world.

APPENDICES

APPENDIX A. DESCRIPTION OF THE 24 CASES

CASE 1: GROWING HOPE (CULTIVANDO ESPERANÇA), BRAZIL

Organization in charge: Mater Natura
Location: Guarapuava and Inácio Martins, Paraná, Brazil
Biome: Atlantic Forest
Timespan: 2012–2015
Restored area: 265 hectares
Source of resources: Brazilian Development Bank (BNDES)

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Located in the Atlantic Forest in Paraná State, the Monte Alvão Community and the Assentamento Rosa (a property occupied by formerly landless workers) are areas of great social and environmental importance. In the region's Serra da Esperança Environmental Protection Area (Área de Proteção Ambiental; APA), more than 6,000 households live together, including Indigenous families, *faxinalenses*[3], *quilombolas*[4], and agrarian reform settlers[5]. The APA is also home to several forestry and agriculture production units. The region holds one of the world's few remnants of Araucaria Forest and is identified as a priority area for biodiversity conservation in the state of Paraná.

The degradation of Araucaria Forest is related to logging and yerba mate production and, more recently, to the conversion of forests for the livestock, agriculture, and forestry industries. On small properties, landholders grow Brazilian pine (*Araucaria angustifolia*) in plantations, along with yerba mate, and raise cattle. These activities maintain the forest canopy but compact the soil and hinder natural regeneration. To mitigate the impact of livestock in the Permanent Preservation Areas (Áreas de Proteção Permanente; APP) and accelerate forest recovery, Mater Natura created an initiative between 2012 and 2015 that fenced off riparian forests to keep livestock out and conducted enrichment planting with native plant species (like yerba mate), with the aim of reconciling the conservation of nature with income generation for small farmers.

Key factors

MOTIVATE

CRISIS EVENTS: Due to the intensification of deforestation and forest degradation, which lead to soil compaction, interventions that conserve and restore became necessary to guarantee the productivity and sustainability of the way of life.

ECONOMIC BENEFITS: The ANR interventions create income for the communities by allowing them to grow and process native plant species in the *araucaria* forest, including yerba mate and Brazilian pine.

LEGAL REQUIREMENTS: The ANR brought many rural properties into compliance with current environmental laws and, in particular, to Law 12.651/2012[6] (Brasil, 2012), which protects native vegetation in Brazil.

ENABLE

MARKET CONDITIONS: ANR considered the value chains of products that were already known and commercialized by the communities.

POLICY CONDITIONS: In 2020, the state of Paraná published a Normative Instruction[7] (Instituto Água e Terra nº 01, May 28) on its Environmental Regularization Program. Now, the legal framework encourages landholders to restore Permanent Preservation Areas and fence off properties where livestock graze.

SOCIAL CONDITIONS: The local community benefits directly from selling the products grown in that regenerated area on the market, enabling increased incomes and quality of life for the population.

INSTITUTIONAL CONDITIONS: Mater Natura is an NGO and a member of the Atlantic Forest Restoration Pact (Pacto) and taps into technical advice from that alliance to develop its activities. Supported by the Brazilian Development Bank through its Growing Hope project, Mater Natura's governance structure prioritized the interests of local communities and created an environment where information and technical assistance for ANR could be shared.

IMPLEMENT

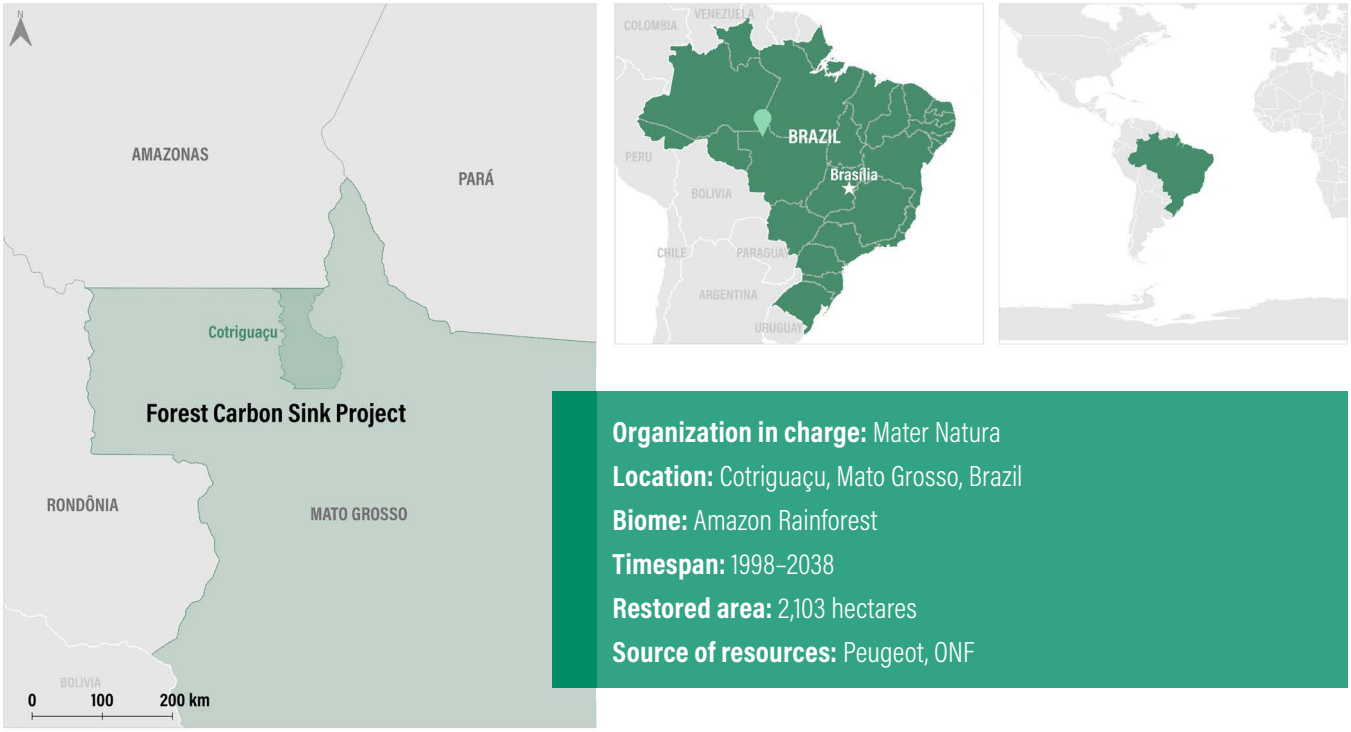
KNOWLEDGE: The project integrated in-depth knowledge about ecology and forest restoration, firmly grounding it in the science and the fight against climate change.

FEEDBACK: The areas were monitored using Pacto's Monitoring Protocol. That data was included in the Brazilian Restoration and Reforestation Observatory, led by the Brazilian Coalition on Climate, Forests and Agriculture. The project's leaders have communicated to the local media, produced videos about their work, and presented their progress at conferences.

Photo: Mater Natura.

Photo: Mater Natura.

CASE 2: FOREST CARBON SINK PROJECT (PROJETO POÇO DE CARBONO FLORESTAL), BRAZIL



Organization in charge: Mater Natura
Location: Cotriguaçu, Mato Grosso, Brazil
Biome: Amazon Rainforest
Timespan: 1998–2038
Restored area: 2,103 hectares
Source of resources: Peugeot, ONF

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

São Nicolau Farm is in the heart of Brazilian Amazon's "arc of deforestation," a region composed of 256 municipalities that have intensely converted forests into farms and pasture. This deforestation harms the functioning of the ecosystem, damages soil fertility and the water cycle, and releases planet-warming greenhouse gases into the atmosphere.

The property, whose 2,000 ha of forests the former owner had cut down, was restored by planting 50 native species associated with assisted natural regeneration, promoting forest succession and the restoration of the ecosystem. In addition to restoring the landscape, the initiative benefits the local population by directly employing them on the farm, by supporting the environmental education curriculum in the local public schools, and by allowing an association of Brazil nut (*Bertholletia excelsa*) gatherers to collect these high-value tree products across 5,000 ha of natural forest.

Another objective was to improve the capture of atmospheric CO_2, boosting the forest's capacity as a carbon sink. The captured carbon is stored and maintained within the forest system, improving the health of the soil and vegetation. In addition, the farm serves as a laboratory for innovative forestry techniques, sustainable rural development, and research on the role of forests in mitigating climate change and supporting the biodiversity of the Southern Amazon.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The project regenerated a continuous fragment of the forest so that fauna could travel along it. In addition, the restoration work recovered and conserved soil and water in the previously deforested areas. It also actively promotes research on biodiversity.

ECONOMIC BENEFITS: The initiative directly and indirectly supports the local population financially by employing community members on the farm and by structuring economically and ecologically efficient production systems for products like Brazil nuts.

LEGAL REQUIREMENTS: One of the objectives for restoration, which included areas of ANR, was to bring the land into accordance with the Forest Code (Brasil 2012), totaling approximately 1,260 ha in Permanent Preservation Areas (Área de Proteção Permanente; APP), 7,000 ha of Legal Reserve (Reserva Legal; RL), which include 1,800 ha in Private Natural Heritage Reserve, and 2,000 ha of regeneration area (where the Carbon Sink restoration project was carried out).

ENABLE

MARKET CONDITIONS: Some species used for enrichment are linked to existing value chains, such as Brazil nut.

SOCIAL CONDITIONS: The local population benefits directly and indirectly from forest restoration. An association of Brazil nut gatherers was organized with support from ONF Brasil and generates income for local communities. The Environmental Education Program (Programa de Educação Ambiental; PEA) has educated more than 5,000 students from local public schools over the past 18 years. The active participation of the Municipal Council for the Environment (Conselho Municipal de Meio Ambiente; CMMA) and the Municipal Council for Sustainable Rural Development (Conselho Municipal de Desenvolvimento Rural Sustentável; CMDRS) has helped to develop public policies related to socio-environmental and economic sustainability.

INSTITUTIONAL CONDITIONS: The parties that are responsible for implementation and monitoring are capacitated and well defined. Each partner knows what they have to do and how to do it to ensure that the property remains sustainable and productive.

IMPLEMENT

KNOWLEDGE: The local community participates in workshops, courses, and training focused on high-quality production practices, financial management, and the recovery of degraded areas.

TECHNICAL DESIGN: The restoration project is technically grounded, in addition to generating tradable carbon credits which are reinvested in the restoration work. Additionally, a restoration opportunity assessment for the APP areas of São Nicolau Farm was published, which identified the technical and quantitative parameters needed to accelerate restoration process.

FINANCE AND INCENTIVES: The Forest Carbon Sink project has a 40-year duration (1998–2038), with Peugeot as the main financial contributor in the implementation phase. The maintenance and monitoring stage was supported by the ONF head office, with the transition to economic sustainability beginning in the twentieth year. Carried out with European funding, the project aims to benefit the local community and São Nicolau Farm, with the goal of promoting practices with positive socio-environmental and economic impact and reducing deforestation in the Amazon Rainforest.

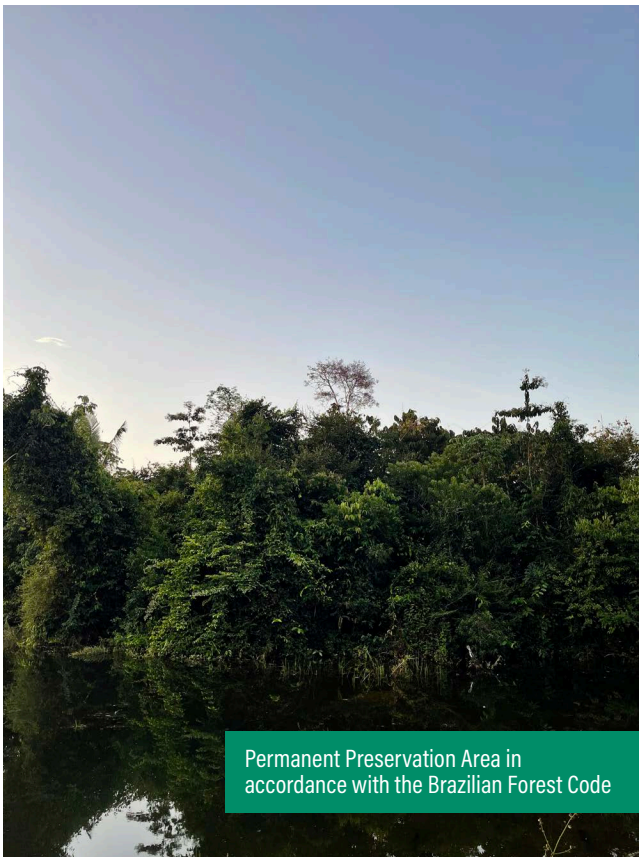
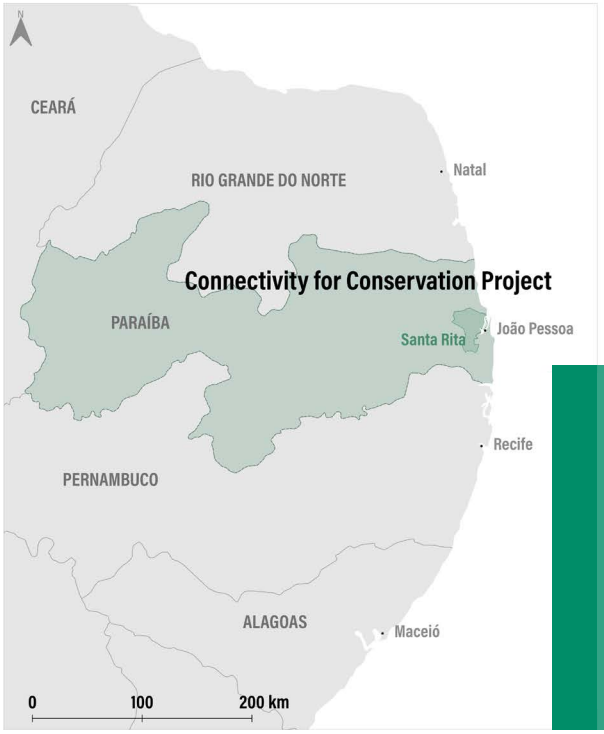


Photo: ONF Brasil.

Photo: ONF Brasil.

CASE 3: CONNECTIVITY FOR CONSERVATION PROJECT (PROJETO CONECTIVIDADE PARA CONSERVAÇÃO), BRAZIL



Organization in charge: Northeast Environmental Research Center (Centro de Pesquisas Ambientais do Nordeste; CEPAN), Japungu Agroindustrial

Location: Santa Rita, Paraíba, Brazil

Biome: Atlantic Forest

Timespan: 2020–2022

Restored area: 25 hectares

Source of resources: Japungu Agroindustrial

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

This project is located in Brazil's Pacatuba-Gargaú ecological corridor, an area of recognized biological importance that encompasses the Private Natural Heritage Reserves (Reservas Particulares do Patrimônio Natural; RPPN) of Fazenda Pacatuba and Engenho Gargaú, all located in the Japungu Agroindustrial territory. Extensive plantations of sugarcane dominate the landscape, but it also contains remnants of the Atlantic Forest. In addition to forest biodiversity, the reserves are home to rare and endangered animal species, such as the red-handed howler (*Alouatta belzebul*) and the blond capuchin (*Sapajus flavius*). The restoration focuses on the Permanent Preservation Areas (APPs) that connect the two reserves, aiming to increase the quantity and improve habitat quality.

The project area was mapped to identify the locations with the greatest potential for natural regeneration and the acceleration of forest succession. For this, the grasses and weeds that competed with the forest species in the regenerating areas were eliminated through the application of systemic herbicides and manual weeding.

The assisted natural regeneration of the area was supported by planting native tree seedlings grown in small nurseries throughout the region. In addition, the project formed a group of seed gatherers that will continue the forest recovery process in the future.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The identification of areas of highest restoration opportunity led to the establishment of an ecological corridor that connects two reserves located in the Japungu area. The connection of these forest fragments increased the quality of the habitat available for local fauna.

ECONOMIC BENEFITS: Forest inputs, such as seedlings and seeds for the implementation of the ecological corridor, were acquired from nurseries in the region, boosting the local forest restoration value chain.

ENABLE

ECOLOGICAL CONDITIONS: Seedlings and seeds of native species can be found scattered around the property's forest fragments and in the region's nurseries. This accelerates the natural regeneration process and provides the opportune conditions for establishing a local genetic bank that can kickstart high-quality forest succession.

INSTITUTIONAL CONDITIONS: Japungu, an agroindustrial company, donated the land and the investment necessary to create the ecological corridor. Cepan, the implementing partner, is follows the recommendations of the Atlantic Forest Restoration Pact (Pacto), which include the identification of strategic areas for joint efforts, the promotion of good practices for ecological restoration, and the implementation of socioeconomic surveys.

IMPLEMENT

LEADERSHIP: The project engages sugarcane producers in the region, providing potential for replication and scaling up with other local partners.

TECHNICAL DESIGN: The project is supported technically by the Cepan team and was developed based on detailed studies and surveys of the landscape.

FINANCE AND INCENTIVES: Japungu Agroindustrial provided the financial resources needed to acquire ANR materials and conduct research.

FEEDBACK: There is continuous monitoring of flora and fauna in the area through field surveys and remote sensing.

Regeneration connecting native forest fragments

Photo: Fabiane Santos/Cepan.

Regenerating site without grazing

Photo: Joaquim Freitas/CEPAN.

CASE 4: SESC SERRA AZUL PARK, BRAZIL

Organization in charge: SESC Pantanal

Location: Rosário Oeste, Mato Grosso, Brazil

Biome: *Cerrado* (Brazilian Savanna)

Timespan: 2015–2021

Restored area: 5,000 hectares

Source of resources: Social Service of Commerce (Serviço Social do Comércio; SESC)

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Located in the Cerrado, SESC Serra Azul Park is found on a former livestock production farm along the banks of the Cuiabá River. SESC (Social Service of Commerce) acquired the area intending to carry out socio-environmental practices, such as sustainable tourism and environmental education, as well as conserving and restoring the native ecosystem.

In view of the property's new use, the cattle were initially removed for a few months. Then, cattle were returned but under the condition that they did not interfere with the regenerating species. In 2015, when this new livestock model was adopted, the project demarcated different plots that monitored the impact of different experimental approaches to cattle management within the pasture. The reintroduction of cattle was based on the idea that they eat and eliminate the exotic grasses. The expected results were that the reduction of exotic biomass would favor the regeneration of native plants and reduce the risk of massive fires caused by the uncontrolled expansion of exotic grasses.

The presence of cattle did reduce the amount of combustible biomass and control the intensity of fires. In addition, it increased the diversity and coverage of native plants in the pastures, mainly shrubs, herbs, and native grasses. Compared to plots where there was no grazing, individual tree growth was lower; however, the number of regenerating tree species remained similar. In plots where there was no grazing, even after five years, the coverage with exotic grasses remained in 100 percent of the area evaluated, and native grasses were only present where cattle roamed. Thus, assisted natural regeneration with the management of cattle, in this case, helped restore the Cerrado with a greater diversity of species and habitats.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The initiative promotes the recovery and permanence of species of flora and fauna that are native to the Cerrado and, consequently, the elimination of invasive exotic species.

ENABLE

INSTITUTIONAL CONDITIONS: There is effective institutional coordination in the areas undergoing regeneration, with SESC assuming responsibility as the project's financier and executor.

IMPLEMENT

LEADERSHIP: The project features a long-term commitment to permanently regenerating the land. Toward this end, it has employed specialists and technicians to monitor restoration and conservation.

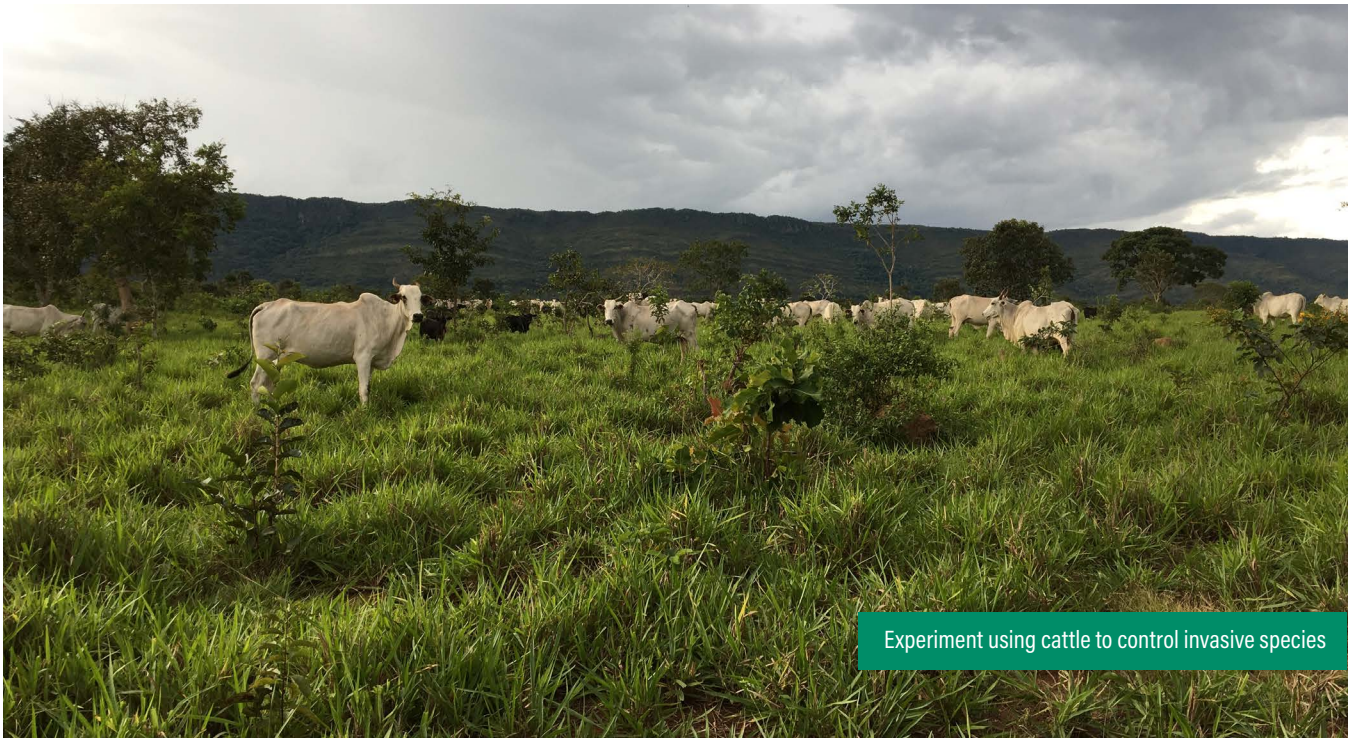
TECHNICAL DESIGN: The area combines the more sustainable version of the land's former use (pasture for raising cattle) with natural regeneration. As this approach is still under development in the Cerrado, the project also functions as a research hub, with different plots testing different experimental approaches to cattle management that promote natural regeneration.

FINANCE AND INCENTIVES: The project relies on long-term investment in improving the area's environmental conditions and, at the same time, in scientific research into different restoration approaches.

FEEDBACK: The project monitors the impact of a variety of cattle management practices on the naturally regenerating land, providing lessons for future projects (Andrade 2021).

Regenerating site without grazing

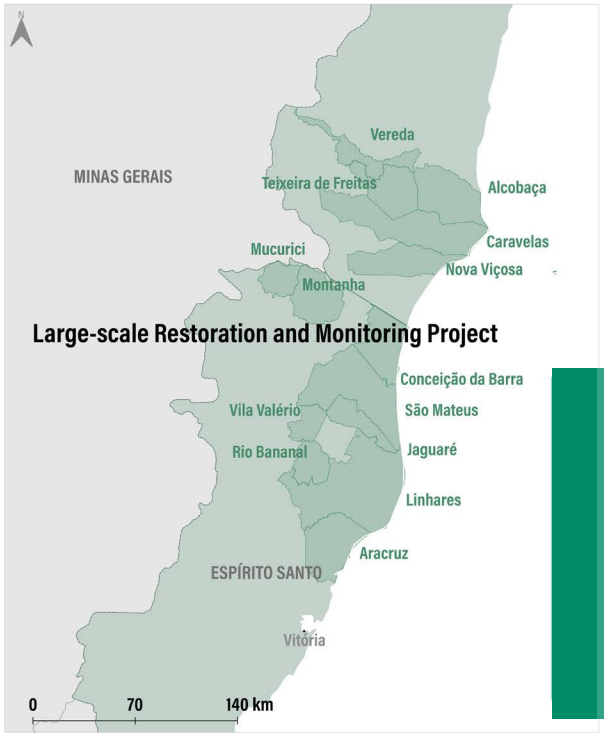
Photo: Henrique Andrade.



Experiment using cattle to control invasive species

Photo: Henrique Andrade.

CASE 5: LARGE-SCALE RESTORATION AND MONITORING PROJECT (RESTAURAÇÃO E MONITORAMENTO EM LARGA ESCALA), BRAZIL



Organization in charge: The Nature Conservancy (TNC) Brasil, Suzano S.A.

Location: Mesoregion of the South of Bahia and Mesoregion of the North Coast of Espírito Santo, Brazil

Biome: Atlantic Forest

Timespan: 2010 – ongoing

Restored area: 1,900 hectares

Source of resources: Suzano S.A.

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

In Brazil, the south of Bahia State and the north coast of Espírito Santo State have a history of degradation. Several crops are produced, such as coffee, sugarcane, and papaya, in addition to livestock, which reduced the region's biodiversity and led to the dominance of exotic grasses throughout the landscape.

Suzano S.A., a company that grows eucalyptus trees for the pulp industry, is restoring land across the region. Those projects are in different stages of regeneration, from completely degraded pastures to forests in an advanced stage of succession. In partnership with The Nature Conservancy (TNC), it began the Large-Scale Restoration and Monitoring project, with the objective of restoring 35,000 ha of forest areas in the states of Bahia and Espírito Santo, developing methods and tools to monitor restoration, and applying an adaptive management approach to accelerate the recovery process. These interventions include controlling invasive vegetation, controlling leaf-cutter ants, protecting the forest, and removing livestock.

The initiative is also helping to improve ecological monitoring methodologies across the Atlantic Forest Restoration Pact (Pacto). In addition to improving methods and field evaluation, the project helped develop the first protocol for monitoring restoration areas via remote sensing for the Atlantic Forest and Amazon Rainforest biomes.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The project led to the recovery of degraded areas, improved the structure and fertility of soils, increased the quality and connectivity of forest fragments, and restored ecosystem services.

AWARENESS: Opportunities for restoring degraded areas and accelerating forest succession in regenerating areas are now identified, with detailed maps of different areas of the landscape and their qualities.

ENABLE

ECOLOGICAL CONDITIONS: Degraded and regenerating areas are located near forest fragments, facilitating, and accelerating the natural regeneration process.

INSTITUTIONAL CONDITIONS: Suzano and TNC are members of Pacto and benefit from partners in its wide support network, such as the Luiz de Queiroz Higher School of Agriculture (ESALQ) of the University of São Paulo (USP), that have a high degree of technical and scientific knowledge on project execution. In the arrangement between Suzano and TNC, the institutions work together, and their roles and responsibilities are clearly defined.

IMPLEMENT

TECHNICAL DESIGN: The project has a research component focused on designing a protocol for monitoring restoration that evaluates progress using remote sensing techniques, such as satellite imagery interpretation, Lidar technology and hyperspectral sensors. In addition, the initiative is committed to testing a variety of restoration techniques, including ANR, for different ecosystem conditions in order to maximize benefits.

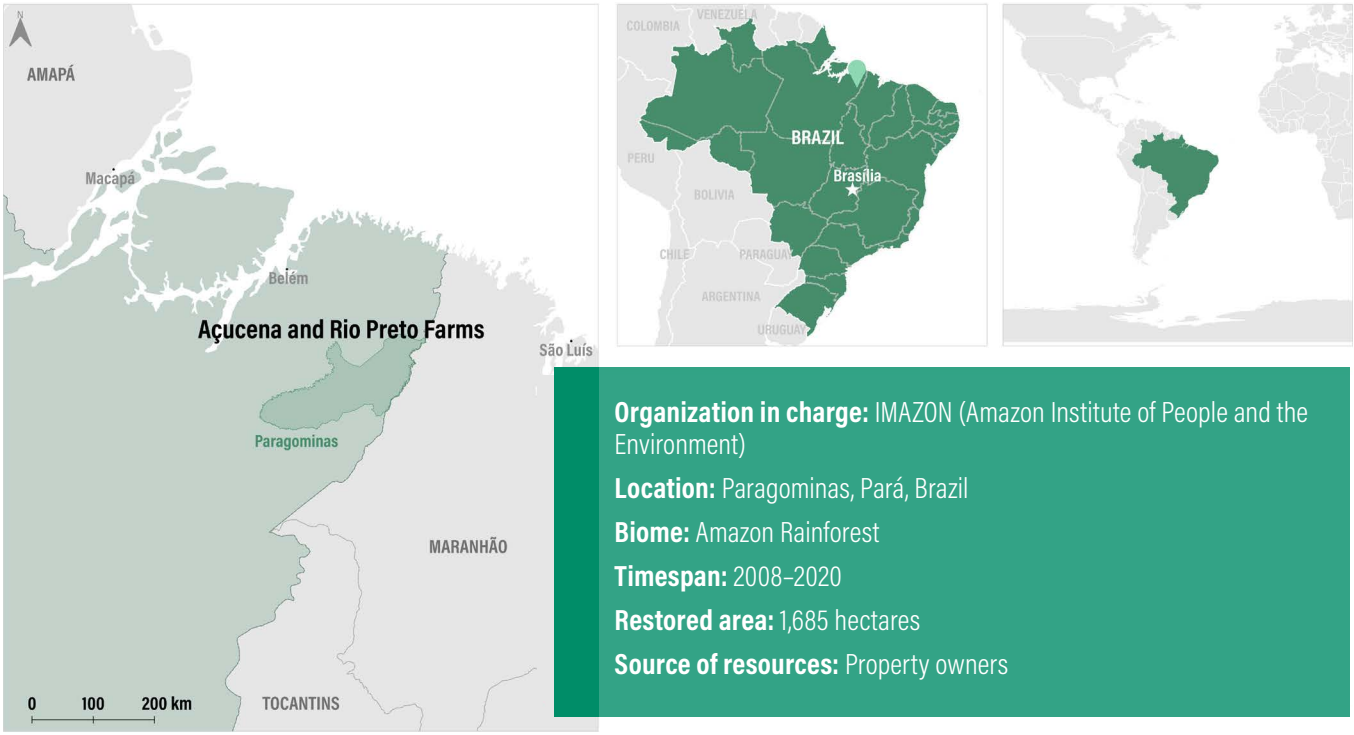
FINANCE AND INCENTIVES: Since the land is a private property owned by Suzano, the institution has a financial incentive to commit significant resources to the project's execution and complete its implementation.

FEEDBACK: Through the evaluation and monitoring systems proposed by Pacto, in addition to the project's efforts in the same direction, the areas are properly monitored. About 70 percent of the area monitored by the TNC, corresponding to 1,300 ha, has already reached satisfactory levels of native vegetation coverage (above 50 percent).

Regeneration in a former pasture

Photo: TNC Brasil.

CASE 6: AÇUCENA AND RIO PRETO FARMS, BRAZIL



Organization in charge: IMAZON (Amazon Institute of People and the Environment)

Location: Paragominas, Pará, Brazil

Biome: Amazon Rainforest

Timespan: 2008–2020

Restored area: 1,685 hectares

Source of resources: Property owners

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

In 2008, when the federal government published the first list of 36 Amazonian municipalities considered priority areas for combating and controlling deforestation, Paragominas was one of them (Brasil 2007). Those municipalities were subjected to intensive inspections of their land and were prohibited from accessing rural credit. To be removed from that list, the municipalities needed to reduce their annual deforestation rates to below 40 square kilometers/year and carry out a Rural Environmental Registry[8] (Cadastro Ambiental Rural; CAR) of at least 80 percent of their eligible area. Paragominas was the first municipality to meet these goals and to leave this critical list in 2010. To this end, it sought strategic partnerships, built a pact with local productive segments and with civil society, and prepared and implemented a set of actions within the "Paragominas: Green Municipality" project.

The environmental advances of Paragominas between 2008 and 2020 are also observed at the scale of individual rural properties, which must comply with environmental protection rules set out in the country's Forest Code (Brasil 2012). Medium and large properties, especially, use natural regeneration as an ally in the restoration of each Permanent Preservation Area (Área de Preservação Permanente; APP) and Legal Reserve (Reserva Legal; RL). As an example, forest cover increased on two rural properties in the municipality of Paragominas: Açucena and Rio Preto Farms.

Both are large properties, with a history of occupation and intensive and degradation-inducing land use. However, in the last decade, environmental advances have occurred that are illustrative of the municipality's trajectory, following the diversification of rural production and/or the adoption of good agricultural practices disseminated throughout the municipality. Currently, Açucena Farm is home to the following economic activities: beef cattle, annual grain farming, forestry, and fish farming. Rio Preto only maintains beef cattle, but it also limits cattle access to areas with other land uses.

Both farms had RL and APP deficits, and their owners chose to settle this liability by leaving part of the land to naturally regenerate. To achieve this, they prevented cattle access to the areas under recovery and therefore removed the driver of degradation.

From 2008 to 2020, Açucena farm increased its naturally regenerated area by more than 11 times (from 66 to 757 ha). This secondary vegetation, along with the property's remnant natural forest, covered 55 percent of the land in 2020, which is sufficient to make the property complaint with the law, provided that the natural regeneration continues to be assisted. For its part, the Rio Preto farm increased its natural regeneration area by 60 percent (from 577 to 928 ha). Similar to the previous case, this secondary vegetation, along with the remnant natural forest, covers 55 percent of the property in 2020, exceeding the percentage necessary to make it compliant with the RL, as long as this detected natural regeneration is maintained.

Key factors

MOTIVATE

CRISIS EVENTS: In 2008, Paragominas was included in the list of priority municipalities for combating and controlling deforestation in the Amazon, which banned access to rural credit for producers and other sanctions (Brasil 2007). By reducing its annual deforestation rate, implementing the CAR, and investing in the restoration of priority areas, it was the first municipality to leave this list.

LEGAL REQUIREMENTS: The restrictions imposed on Paragominas included requiring rural properties to comply with environmental legislation (Brasil 2012), which became a strong motivation for the actors to engage with the project's goals.

ENABLE

POLICY CONDITIONS: The local government signed strategic partnerships to facilitate and accelerate the compliance of smallholders with environmental legislation. The priority areas were mapped, and some of them are already regenerating and are legally protected from deforestation.

INSTITUTIONAL CONDITIONS: The municipal government, research institutions, and rural landowners all have well-defined roles concerning the execution of the restoration project, facilitating engagement and increasing the commitment of the actors involved.

IMPLEMENT

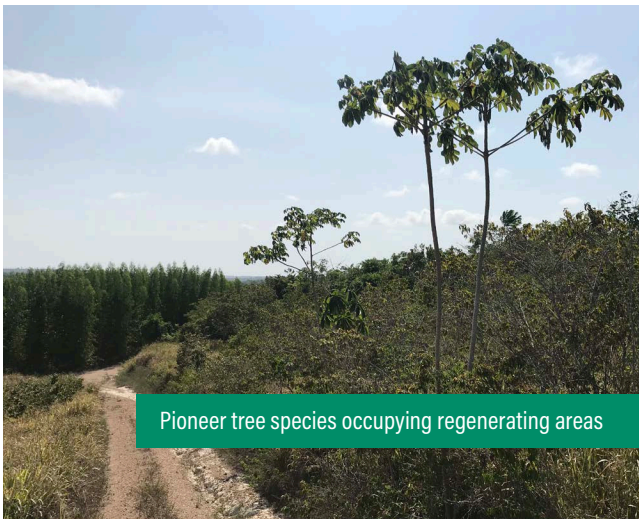
FINANCE AND INCENTIVES: The improvement of properties' compliance with the law and the subsequent removal of Paragominas from the list of priority municipalities in the Amazon once again allowed producers to access rural credit.

TECHNICAL DESIGN: When the project made important decisions, it could rely on a strong foundation of technical analysis, including a mapping of priority areas for restoration and their qualities, along with an analysis of the properties' Rural Environmental Registry (CAR).

FEEDBACK: Regenerating areas are constantly monitored and evaluated in terms of size and expansion, quality of regeneration, and other criteria.

Fencing to stop cattle from entering

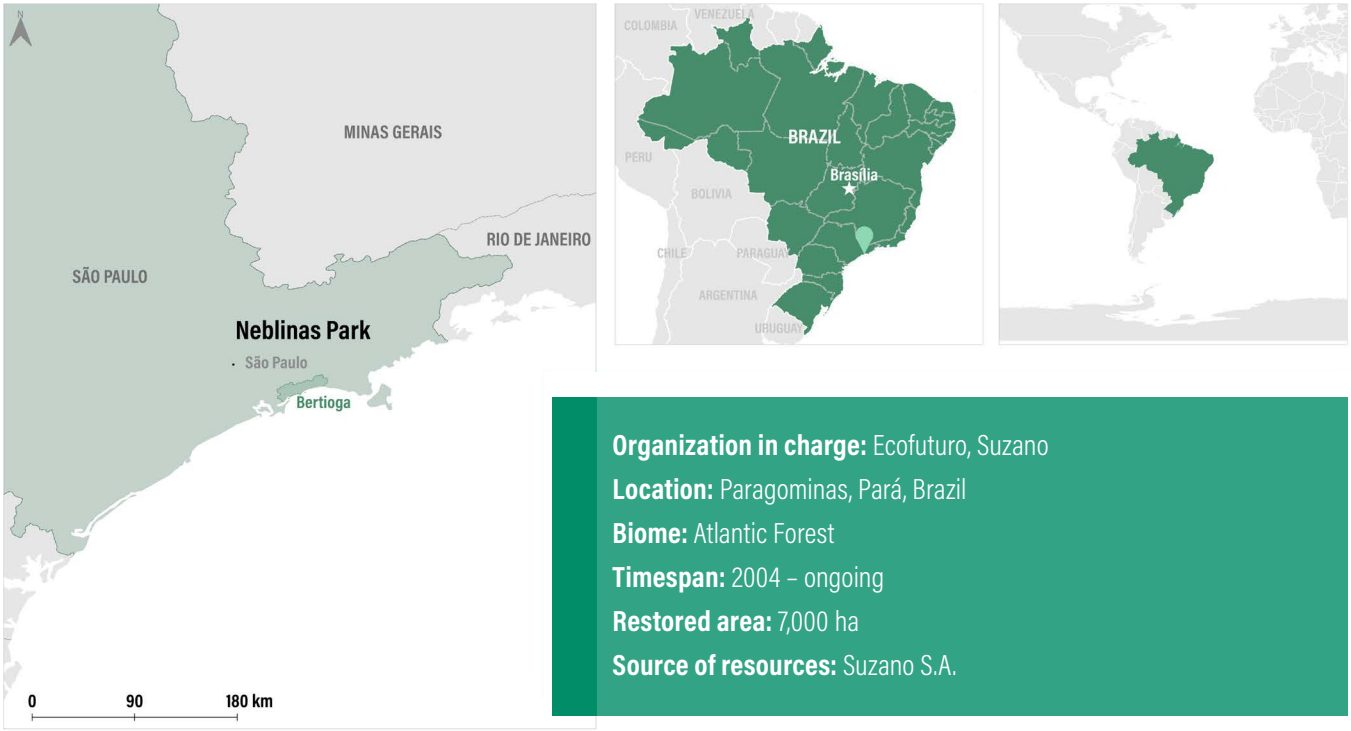
Photo: Acervo IMAZON.



Pioneer tree species occupying regenerating areas

Photo: Acervo IMAZON.

CASE 7: NEBLINAS PARK (PARQUE DAS NEBLINAS), BRAZIL



Organization in charge: Ecofuturo, Suzano
Location: Paragominas, Pará, Brazil
Biome: Atlantic Forest
Timespan: 2004 – ongoing
Restored area: 7,000 ha
Source of resources: Suzano S.A.

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Neblinas Park, an environmental reserve owned by Suzano S.A., comprises an area of 7,000 ha of forests in different stages of regeneration. The primary vegetation was cleared in the 1940s and 1950s by the coal industry. Then the area was planted with eucalyptus trees for the pulp and paper industry. It was later acquired by Suzano, which turned it into a special testing area for sustainable land management in the late 1980s. The reserve became a space for experimental techniques and strategies for restoration and environmental conservation and hosted programs on environmental education, scientific research, sustainable management, ecotourism, and community involvement.

When the area was turned into a reserve, the *juçara* palm (*Euterpe edulis*), a species threatened by illegal palm heart extraction, was nearing extinction in the region. In 2008, the assisted natural regeneration of the forest began, supported by the dispersion of seeds of this palm tree. The fruits that the seeds generate are bought from landowners working around the Park, supporting the local economy and tying the community's income directly to the restoration of the forest.

Neblinas Park also counts its proximity to the heavily forested Serra do Mar (Sea Ridge) mountain range as a success factor. As forest succession advanced, the fauna began to travel more between the Serra do Mar and the Park, increasing the dispersal of seeds and accelerating the process the recovery of the forest's biodiversity.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The transformation of a pulp and paper production area into an environmental reserve through restoration has generated environmental benefits for the region. The Park now serves as a key protector of the region's biodiversity.

ENABLE

ECOLOGICAL CONDITIONS: Due to its proximity to Serra do Mar and other conservation areas, native seeds and seedlings are readily available and abundant. This facilitates and accelerates biodiverse forest succession within the ANR sites.

SOCIAL CONDITIONS: The local community will benefit from restoration, as the seed and seedling trade of native species like juçara is based on the local market. As it strengthens these traditional value chains, the project helps the community by tying income generation to forest restoration.

INSTITUTIONAL CONDITIONS: When establishing Neblinas Park, Suzano founded the Ecofuturo Institute, the organization responsible for managing the property. The arrangement between Suzano, Ecofuturo, and the local community has well-defined roles and responsibilities, which are important for the implementation of the project, increasing the commitment and quality of the restoration process.

IMPLEMENT

KNOWLEDGE: The local community acts as the main source of labor in the area and participates in workshops, courses, and training that support the sustainable practices carried out in the park, such as planting and managing juçara and ecotourism.

TECHNICAL DESIGN: Ecofuturo Institute has a technical team dedicated to the permanent monitoring of areas undergoing regeneration. In addition, the area houses several studies and scientific experiments from partner institutes and universities, strengthening the scientific foundation of the park.

FINANCE AND INCENTIVES: In addition to the area's significant conservation value, Neblinas Park has a strong ecotourism economy. The income returns to the local community, in addition to subsidizing the park's maintenance.

FEEDBACK: The regenerating areas are monitored by the Ecofuturo Institute, and Neblinas Park is open to visitors, so the benefits of restoration are amplified and presented to the public.

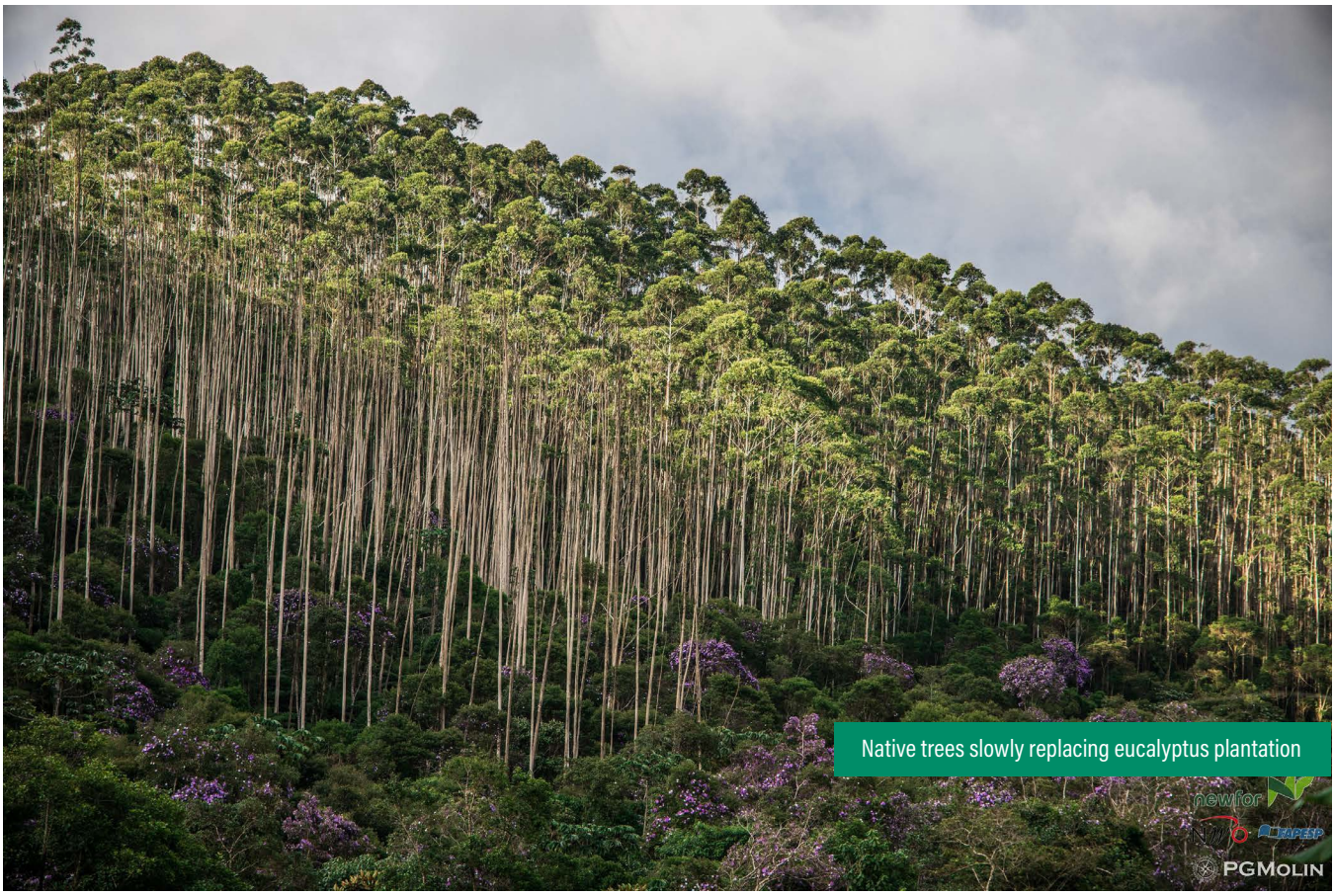


Photo: Paulo Guilherme Molin.

CASE 8: PEIXE RIVER RESTORATION, BRAZIL

Organization in charge: Copaíba Environmental Association
Location: Socorro, São Paulo, Brazil
Biome: Atlantic Forest
Timespan: 2009–2011
Restored area: 7.7 ha
Source of resources: State Water Resources Fund (FEHIDRO)

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Peixe River basin, near Socorro, in the Brazilian state of São Paulo, supported beef cattle activity for decades, leaving a trail of degraded and abandoned pastures and riparian forests. The presence of gullies and other areas of intense surface erosion, especially on hillsides, has destabilized the landscape, silted up drainage sites in the landscape, and hindered the process of ecological succession in regenerating forests.

Through funding from the State Water Resources Fund (FEHIDRO), Copaíba led an effort to encourage landowners and ranchers to help recover lost ecosystem services, with a focus on soil conservation. Through ANR techniques, such as cattle management and enrichment with native species, forest fragments in the region have stabilized, protecting springs and mitigating soil leaching.

The hillside that is the project's focus suffered from severe degradation but is now stabilized and at an advanced stage of regeneration. Continuous efforts are still applied to reduce further erosion on the hill's edge, especially by enriching the outer portion of the fragment. This approach controls the establishment of invasive species and helps the forest develop.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: Restoration generates environmental benefits in the region, especially in restoring trees to groundwater recharge areas. This recovery increases the quality and quantity of water available in the Peixe River basin.

AWARENESS: The municipality of Socorro is part of São Paulo's "Water Circuit" in the Mantiqueira Mountains, a region known for its high water quality. Ecotourism tied to the clear water is a fundamental source of income in the region, making forest restoration crucial for the continued provision of this key ecosystem service.

ENABLE

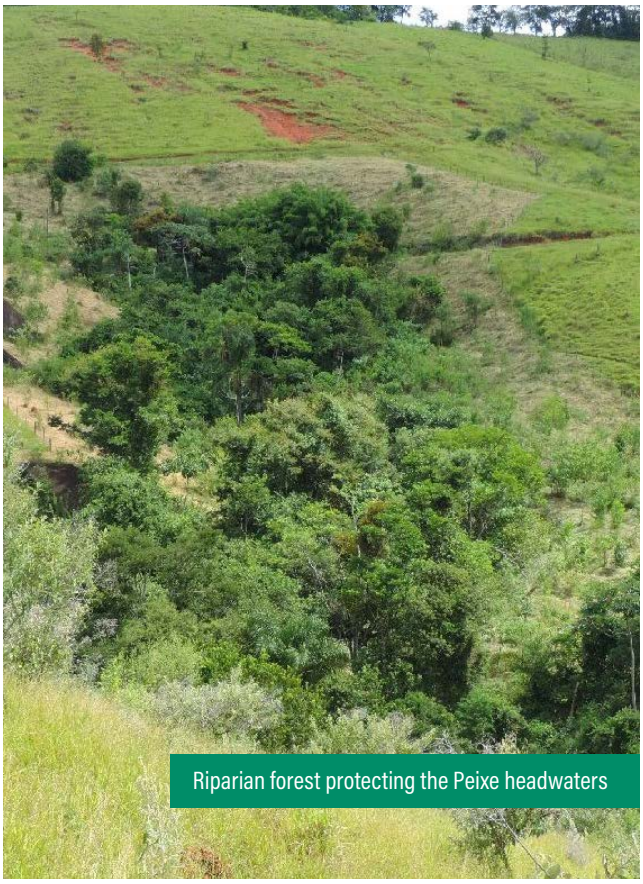
ECOLOGICAL CONDITIONS: The hill is unsuitable for agriculture due to the steepness of the slope. Thus, it was suitable for forest restoration, which improved the land's function and controlled erosion.

INSTITUTIONAL CONDITIONS: The area falls within the scope of Atlantic Forest Restoration Pact (Pacto) and the Mantiqueira Conservation Plan, giving it access to a wide support network, a high degree of technical and scientific knowledge, and support from the public, private and civil society sectors for project execution.

IMPLEMENT

TECHNICAL DESIGN: The project mapped the area's suitability for forest restoration as an appropriate land use. Once the ANR approach was defined as adequate, it generated effective results.

FINANCE AND INCENTIVES: FEHIDRO provided the necessary financial resources to carry out the project. In this arrangement, Copaíba contributed to the analysis and execution, while the landowner provided the area.



Riparian forest protecting the Peixe headwaters

Photo: Copaíba Environmental Association.

CASO 9: SOCIOPRODUCTIVE CHAINS (REDES SOCIOPRODUTIVAS), BRAZIL

Organization in charge: The Life Center Institute (Instituto Centro de Vida; ICV)

Location: Alta Floresta, Paranaíta, Nova Monte Verde, Nova Bandeirantes, Cotriguaçu, and Colniza, Mato Grosso, Brazil

Biome: Amazon Rainforest

Timespan: 2018 – ongoing

Restored area: 104.1 hectares

Source of resources: Brazilian Development Bank (BNDES)

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

In Brazil's Mato Grosso State, the Socioproductive Chains project was created in 2018 and focused on strengthening the agricultural value chains of Brazil nut (*Bertholletia excelsa*), *babaçu* (*Attalea speciosa*), fruit and vegetables, milk, cocoa, and coffee. More than 600 families from different organizations and cooperatives are socially vulnerable, suffering from low employment and invisibility in the conventional agricultural production chain. In addition, they are inhabitants of areas of high environmental importance in the Amazon.

In order to strengthen these farmers' livelihoods, the project established sustainable production systems, combined with the restoration of degraded forest areas. It also brought the properties into compliance with the country's environmental laws. Restoration gained strength in these areas by fencing off pasture areas, allowing for the re-establishment of secondary forest.

With the regeneration of the forest and the inclusion of the local community in sustainable supply chains, bringing the rural properties into legal compliance allowed social organizations and landowners to access rural credit and establish commercial agreements to access markets.

Key factors

MOTIVATE

SOCIAL BENEFITS: Economically oriented forest restoration is strengthening and empowering the region's communities, which have historically suffered from economic exclusion, low incomes, and invisibility in the conventional production chain.

LEGAL REQUIREMENTS: The rural properties involved in the project underwent a process of becoming compliant with the laws that govern Brazil's Legal Reserves (RLs) and Permanent Preservation Areas (APPs). That improved access to credit that helps producers adapt to the requirements of organic certification.

ENABLE

MARKET CONDITIONS: The forest restoration project strengthens the supply chain for milk, coffee, cocoa, fruits, and vegetables already established in the region by organizing and focusing on logistics that facilitate the flow of sustainable production from local rural properties. In addition, the forest management areas provide products like Brazil nuts and *babaçu*.

SOCIAL CONDITIONS: The project improved productivity the quality of life and work. Cooperatives and associations are involved, improving the representation and organization of the actors involved in the restoration process.

IMPLEMENT

KNOWLEDGE: Farming families participate in capacity building and training programs and receive technical assistance that helps them adopt low-carbon production practices, including ANR.

FINANCE AND INCENTIVES: The project is linked to the Amazon Fund, managed by the Brazilian Development Bank (BNDES). Embracing forest restoration and regenerative agriculture by building organic agroforestry systems allows producers to access credit lines that subsidize these purposes.

FEEDBACK: There is an ongoing effort to promote products from sustainably managed and restored areas. That ecological value addition needs to be communicated to the general public as they consider buying locally grown products.

Fences to promote forest regeneration

Photo: ICV.

CASE 10: REFLORESTAR PROGRAM, BRAZIL

Organization in charge: State Secretariat for the Environment and Water Resources (Secretaria Estadual do Meio Ambiente e Recursos Hídricos; SEAMA), Espírito Santo State Government

Location: Espírito Santo, Brazil

Biome: Atlantic Forest

Timespan: 2018 – ongoing

Restored area: 4,075 hectares

Source of resources: Espírito Santo State Water and Forest Resources Fund (Fundo Estadual de Recursos Hídricos e Florestais do Espírito Santo; FUNDÁGUA)

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Reflorestar Program aims to promote the restoration of the water cycle in Espírito Santo State, Brazil through the conservation and recovery of forest cover. The goal is to generate opportunities and income for smallholders and encourage the adoption of sustainable soil use practices. The project includes rural landowners, with priority given to smallholders who are interested in dedicating part of their land to environmental preservation and/or sustainable land management practices. These landowners benefit through a public Payment for Environmental Services (PES) program and receive financial assistance that can be used to purchase the necessary inputs to conserve or restore forested areas.

The project offers several ways for landowners to improve their land: protecting standing forest, recovering forest cover by planting seedlings, building agroforestry and silvopasture systems, sustainably managing production forests (without clearcutting), and natural regeneration.

Within the natural regeneration approach alone, more than 4,000 ha of forests have begun to regenerate, generating income for their owners and ecosystem services for the community. The main tools to accelerate ecological succession in these cases are fencing and improved cattle management.

Key factors

MOTIVATE

ECONOMIC BENEFITS: Through the PES, the program pays landowners for adopting sustainable rural practices and protecting (and naturally regenerating) the forest. The PES provides helps landowners purchase inputs and technical support for the execution of their projects.

AWARENESS: Restoration opportunities throughout the state of Espírito Santo were identified based on the biophysical factors found in the landscape. Decision-making on restoration is aligned with the state's desire to recover water resources and conserve priority areas.

ENABLE

POLICY CONDITIONS: The Espírito Santo state government leads the program. Therefore, the policies that guide the restoration are optimized to improve implementation and ensure that the restored areas are permanently protected.

INSTITUTIONAL CONDITIONS: The Reflorestar Program has a diversity of restoration techniques that can benefit from the PES, with the role of each defined according to the qualities of each area. The program also has several partnerships with research institutes, river basin committees, and larger movements, like the Atlantic Forest Restoration Pact (Pacto).

IMPLEMENT

LEADERSHIP: The Government of Espírito Santo committed to restoring 80,000 ha through the recovery and conservation of native vegetation, avoided deforestation, and sustainable forest management. This goal is aligned with Brazil's commitment to Initiative 20x20, proposed by Latin American and Caribbean nations at the UNFCCC Conference of the Parties (COP20), in Peru in 2014.

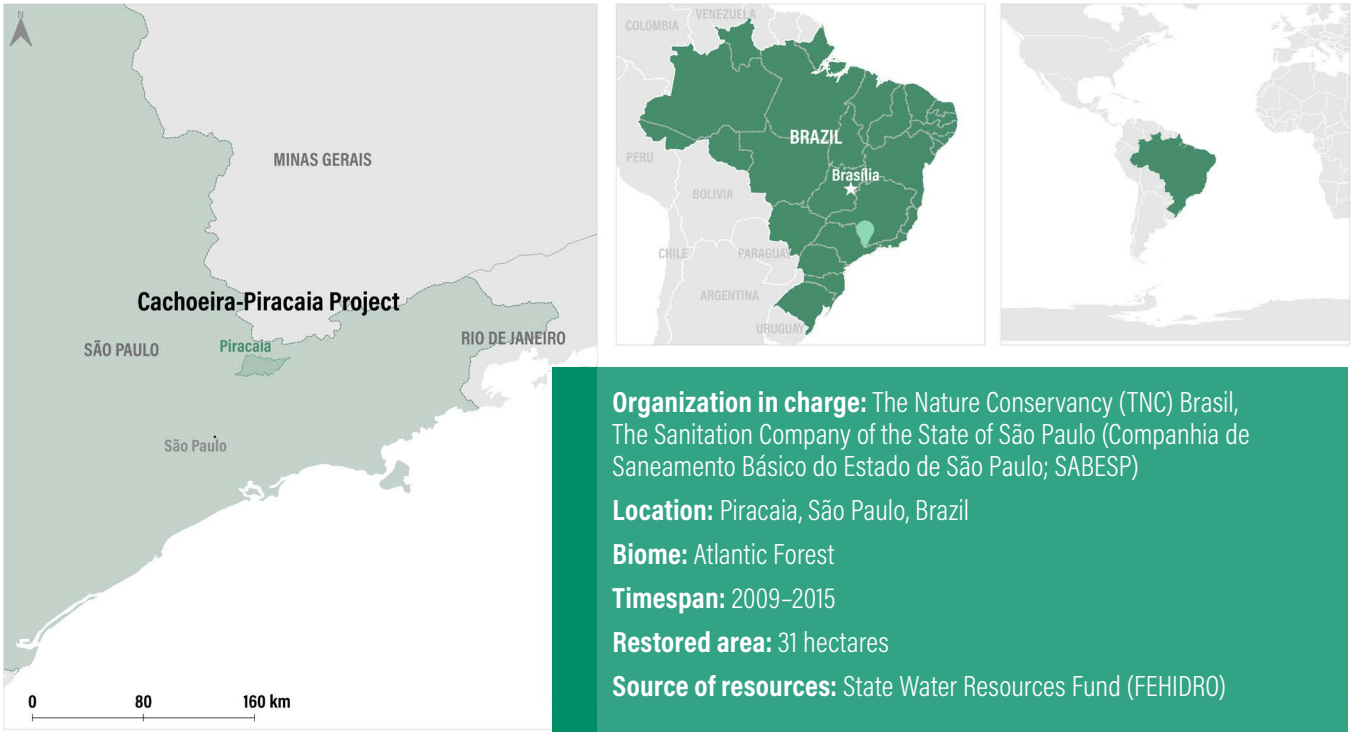
TECHNICAL DESIGN: The program's strategy is based on actions to identify, monitor, and inspect forest areas with high natural regeneration rates. The development and implementation of this strategy were made possible by carrying out a detailed mapping of Espírito Santo's land carried out, with each 1 cm on the map representing 10,000 cm of land, between 2012 and 2015. That allowed the establishment of a reliable baseline for 25 forms of land use in the state. The restoration models adopted for each property are based on their suitability to each area, increasing the chances of success.

FINANCE AND INCENTIVES: FUNDÁGUA spends 3 percent of oil and natural gas royalties to finance improvements to the state's water resources. Among these actions are the establishment and financing of the Reflorestar Program, ensuring the continuity of the project (Espírito Santo and SEAMA 2018).

FEEDBACK: The program has a public management and monitoring platform, where data related to PES contracts and the areas under recovery are frequently updated and published.

Photo: Leonardo Sá.

CASE 11: CACHOEIRA-PIRACAIA PROJECT, BRAZIL



Organization in charge: The Nature Conservancy (TNC) Brasil, The Sanitation Company of the State of São Paulo (Companhia de Saneamento Básico do Estado de São Paulo; SABESP)

Location: Piracaia, São Paulo, Brazil

Biome: Atlantic Forest

Timespan: 2009–2015

Restored area: 31 hectares

Source of resources: State Water Resources Fund (FEHIDRO)

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

There are more than 12 million people currently living in the São Paulo Metropolitan Region (IBGE 2021). To guarantee the supply of water to the entire population, water from five watersheds (Jaguari, Jacareí, Atibainha, Juquery, and Cachoeira) follow a complex path: six reservoirs interconnected by 48 kilometers of artificial underground tunnels, channels, and pumps, forming the Cantareira System (Sistema Cantareira; or SC).

Although a large part of the areas that surround the SC are identified by the Forest Code (Brasil 2012) as Permanent Preservation Areas (APPs), long stretches feature only bare soil. Of the 38,000 ha of APPs mapped in 2011, only a quarter had forests protecting them (TNC 2011). In 2009, TNC, in partnership with Sabesp and the Dow Foundation, started a project to restore 350 ha around the Cachoeira Reservoir, a dam located on the Cachoeira River, in the municipality of Piracaia, São Paulo, which is part of the SC.

In addition to stopping livestock activity in the regenerating areas, the project used other ANR interventions, such as the control of invasive grass species and the active maintenance of regenerating species.

The project encouraged the creation of the Cooperativa Ambiência (Ambience Cooperative), providing equipment, tools, and environmental training courses for cooperative members. It also established the cooperative's first employment contract: the restoration project of 350 ha on the banks of the Cachoeira Reservoir. Two years after its founding, Cooperativa Ambiência expanded to other municipalities and is now an important ally in the broad conservation work of the SC (TNC 2011).

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The restoration of sensitive areas within the Cachoeira Reservoir led to a decrease in the erosion of the dam's slopes and the transport of drain-clogging sediment, as well as an increase in water infiltration in the soil in recharge areas. The same benefits could be extended across the SC, influencing the entire supply system (Ozment et al. 2018; Feltran-Barbieri et al. 2021).

LEGAL REQUIREMENTS: Between the Permanent Preservation Areas (APPs) and the restored degraded areas, such as pastures, the project brought 350 ha on the banks of the Cachoeira into compliance with environmental protection laws.

ENABLE

ECOLOGICAL CONDITIONS: Regenerating areas are close to the remaining forest fragments, which are sources of relevant seeds and seedlings for accelerating the natural regeneration process.

INSTITUTIONAL CONDITIONS: The project consortium has defined roles: the water management company is responsible for managing water resources, the cooperative is responsible for planting seedlings and managing the areas, and the research institute is responsible for technical support.

SOCIAL CONDITIONS: Cooperativa Ambiência assembles the local community, which has knowledge of the region and training in restoration techniques. The cooperative also works in other areas of the SC.

IMPLEMENT

FINANCE AND INCENTIVES: Financed by the Dow Foundation, the project also supports the implementation of public policies connected to water security. As the main water supplier in the São Paulo Metropolitan Region, SC is strategic for the maintenance of the population of the southern hemisphere's largest city.

FEEDBACK: Regenerating areas are monitored in compliance with Joint Resolution number 03/2020 of the Secretariat of Agriculture and Supply (Secretaria de Agricultura e Abastecimento; SAA) and Secretariat for Infrastructure and Environment (Secretaria de Infraestrutura e Meio Ambiente; SIMA) of the State of São Paulo (São Paulo 2020), which supports the regeneration, recovery, and monitoring of native vegetation in Legal Reserve (RL) areas and degraded and altered areas. This work is completed through regular reports, photographs, and spatial data collection.

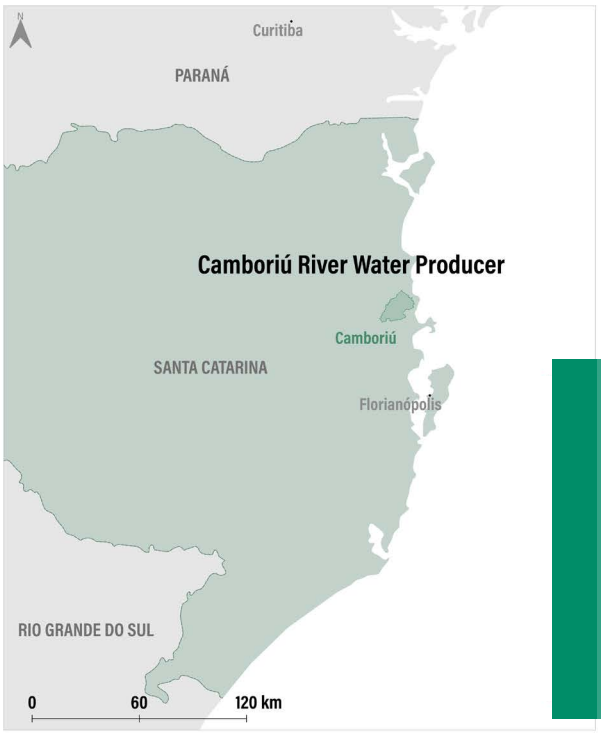
Vegetation regrowth near the Cachoeira river

Photo: Henrique Bracale.

Regenerating forests near a reservoir

Photo: Pedro Matarazzo.

CASE 12: CAMBORIÚ RIVER WATER-PRODUCING PROJECT (PRODUTOR DE ÁGUA DO RIO CAMBIORIÚ), BRAZIL



Organization in charge: The Nature Conservancy (TNC), Sanitation Company of Balneário Camboriú (Empresa Municipal de Água e Saneamento; EMASA)

Location: Camboriú, Santa Catarina, Brazil

Biome: Atlantic Forest

Timespan: 2014 – ongoing

Restored area: 15 hectares

Source of resources: EMASA

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Camboriú River Basin is located mostly in the municipality of Camboriú, with the mouth of the river located in the municipality of Balneário Camboriú, both in the Brazilian state of Santa Catarina. The basin's ecosystem is of great importance for both municipalities, which depend on water from the river and its tributaries for public supply. This basin, whose water is becoming increasingly scarce and of lower quality, has suffered from environmental degradation, mainly associated with damaging land use practices.

The Camboriú River Water Producer project (Produtor de Água; PdA), a partnership of The Nature Conservancy (TNC) and Emasa with the municipalities of Balneário Camboriú and Camboriú and numerous agencies and organizations , was created in 2013. It seeks to improve the quality, quantity, and regulation of water flow within the Camboriú River Basin by encouraging rural landowners to adopt sustainable conservation practices. The project also seeks conserve native forests and restore degraded areas.

The project's main line of action, a financial incentive program that via direct Payments for Environmental Services (PES) to rural landowners, enabled them to improve their properties. As a result, by 2021, around 15 ha have been restored using ANR techniques, such removing livestock in regenerating areas and controlling invasive grass species and leaf-cutter ants.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The restoration of sensitive areas of the Camboriú River Basin focuses on improving the natural infrastructure needed to protect water resources (Ozment et al. 2018; Feltran-Barbieri et al. 2021). The goals include increasing water infiltration in the system and stopping erosion and sediment build-up.

ECONOMIC BENEFITS: The PES is the main stimulus for landowners to maintain regenerating areas. This measure encourages the adoption of sustainable practices, native forest conservation, and the restoration of degraded areas by providing a direct financial return.

ENABLE

ECOLOGICAL CONDITIONS: The Camboriú River Basin is near forest fragments, functioning as a source of seeds and seedlings that accelerates and increases the chances of success of the natural regeneration process.

POLICY CONDITIONS: EMASA provides, based on Municipal Law number 2498 (Balneário Camboriú 2005), the mandatory investment of at least 1 percent of its gross annual income in environmental preservation and recovery programs. PdA Camboriú receives this amount, which consolidates it in the long term and guarantees its legally appropriate use.

INSTITUTIONAL CONDITIONS: PdA Camboriú involves 12 institutions, from trade unions to public and private companies, along with research and education institutes. This arrangement strengthens the involvement of these institutions and increases the level of commitment of the actors involved in the project.

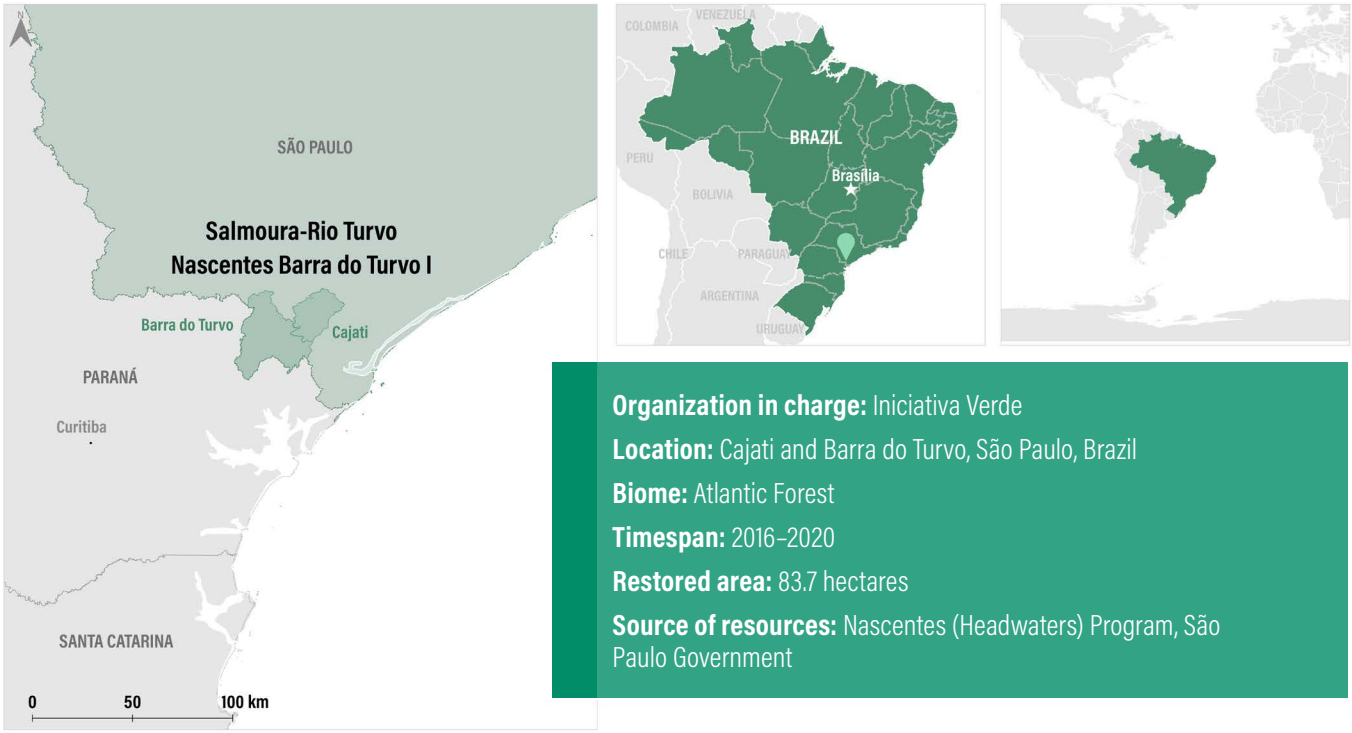
IMPLEMENT

FINANCE AND INCENTIVES: The project's PES program helps landowners to invest in natural infrastructure for water resources. This stimulates the growth and engagement of actors in the process, in addition to providing legal guarantees for its execution.

Photo: Andre Luiz Campos da Silva.

Photo: Gustavo Egg.

CASE 13: SALMOURA RIO TURVO, NASCENTES BARRA DO TURVO I, BRAZIL



Organization in charge: Iniciativa Verde

Location: Cajati and Barra do Turvo, São Paulo, Brazil

Biome: Atlantic Forest

Timespan: 2016–2020

Restored area: 83.7 hectares

Source of resources: Nascentes (Headwaters) Program, São Paulo Government

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Rio Turvo State Park (Parque Estadual do Rio Turvo; PERT) used to belong to the Jacupiranga State Park, but today is part of the Jacupiranga Mosaic along with thirteen other Conservation Units for Integral Protection and Sustainable Use (São Paulo 2008). The Mosaic is in the region with the lowest human development index (HDI) in Brazil's São Paulo state. The focus of this project is the restoration of an area in Núcleo Capelinha, a part of the PERT that featured abandoned banana plantations and pastures and other land in the initial stages of regeneration.

Linked to the Restoration of the Former Salmoura Farm Project, around 65 ha were restored using ANR techniques, including selective control of grasses and ferns, enrichment with native species, banana plantation management, and the sowing of native juçara palm seeds.

Also in the PERT, the Nascentes Barra do Turvo I Project focuses on the restoration of two abandoned pastures, marked by dense collections of ferns and exotic trees such as pine. The ANR approaches used in these areas included the removal of exotic trees, the selective control of grasses and ferns, the maintenance of regenerating plants, enrichment with native species, and the installation of firebreaks.

The restoration of these areas is part of the effort to consolidate the Rio do Turvo State Park, converting areas previously used for agricultural production into forests to protect the Park from future incursions. In addition, it generates employment and income by hiring local teams and acquiring inputs like seeds and seedlings from the traditional communities of the Ribeira Valley Conservation Units Mosaic, strengthening the local forest restoration value chain.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The projects sought to recover areas within the Pert, improving biodiversity and increasing the quality of the forest. They also contributed to the consolidation of the park as an environmental preservation area.

ENABLE

ECOLOGICAL CONDITIONS: The areas undergoing regeneration are inserted in the larger PERT forest matrix, increasing the chances of success for natural regeneration.

SOCIAL CONDITIONS: The project generates income for local community members that are employed in the restoration and maintenance of the PERT. Inputs for the projects, such as seedlings and seeds, were acquired in the region, stimulating trade in the community linked to forest restoration.

INSTITUTIONAL CONDITIONS: The arrangement adopted for the projects includes the local community, the Iniciativa Verde team, and the PERT management team. The involvement and collaboration of the different actors increase commitment to the project.

IMPLEMENT

TECHNICAL DESIGN: Restoration techniques and approaches were determined based on the land-use history of each plot, providing greater quality and a higher chance of success in the process.

Photo: Iniciativa Verde.

Photo: Iniciativa Verde.

CASE 14: NASCENTES JAMBEIRO I, BRAZIL

Organization in charge: Iniciativa Verde

Location: Jambeiro, São Paulo, Brazil

Biome: Atlantic Forest

Timespan: 2017 – ongoing

Restored area: 2.23 hectares

Source of resources: Nascentes (Headwaters) Program, São Paulo Government

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The municipality of Jambeiro, in the Brazilian state of São Paulo, is located in an area of high priority for forest recovery according to regulations published by the Secretariat of Infrastructure and Environment of the State of São Paulo (São Paulo 2017). In order to comply with the United Nations Sustainable Development Goals (SDGs) (UN 2015), SMA Resolution 32/2014 requires that environmental agencies monitor compliance with commitments to recover ecologically appropriate vegetation. In this context, the government created the Nascentes (Headwaters) Program to direct public and private investments to comply with these legal obligations, counterbalance carbon emissions, reduce water use, or implement voluntary restoration projects (CETESB 2020).

Matinha Farm, located in Jambeiro, features many abandoned pastures. Through funding from the Nascentes Program, ANR techniques were implemented, such as selective control of grasses, confinement of cattle in paddocks, and enrichment with native species. Thus, just over two hectares of pastures were converted into forested areas, contributing to the recovery of springs and bringing the property into legal compliance with the Forest Code.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The focus of this project was to improve water quality and restore the property's springs.

LEGAL REQUIREMENTS: Given its status as a Permanent Preservation Area (APP), the Matinha Farm did not have enough forest cover to protect its springs. With forest restoration implementation through ANR, the property became legally compliant with the Forest Code (Brasil 2012)

ENABLE

ECOLOGICAL CONDITIONS: The area undergoing regeneration is part of an agricultural matrix with a large number of forest fragments. This factor, when combined with an effort to enrich the land with native species, accelerates natural regeneration.

POLICY CONDITIONS: The restoration of the property increases the forest density of the municipality of Jambeiro, considered a high priority for recovery according to SMA Resolution 07/2017 (São Paulo 2017).

IMPLEMENT

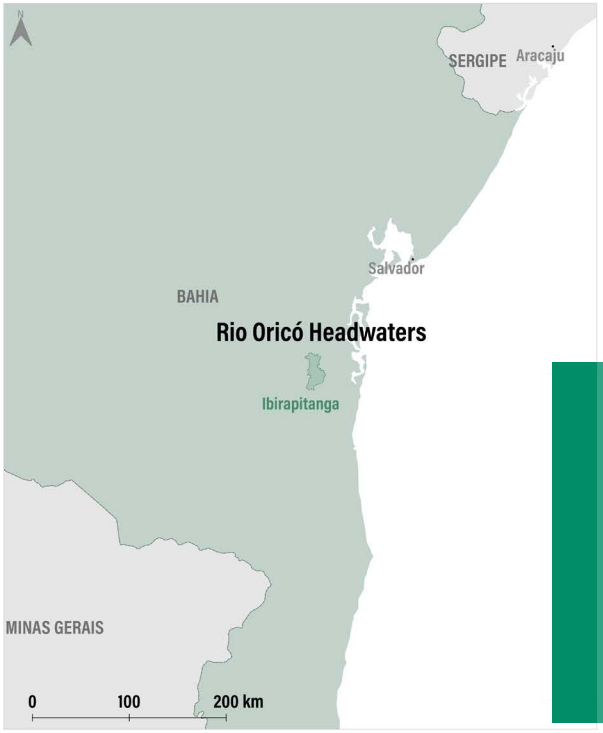
LEADERSHIP: The landowner was directly involved in the forest restoration process, which increases the chances of the permanence of the natural regeneration.

FINANCE AND INCENTIVES: The Nascentes Program facilitates access to and use of public resources to restore forests in the state of São Paulo.

Forest structure after fencing

Photo: Iniciativa Verde.

CASE 15: ORICÓ RIVER HEADWATERS, BRAZIL



Organization in charge: Land Conservation Organization (Organização de Conservação de Terras; OCT)

Location: Ibirapitanga, Bahia, Brazil

Biome: Atlantic Forest

Timespan: 2017–2019

Restored area: 5 hectares

Source of resources: Public Prosecutor's Office of the State of Bahia – Atlantic Forest Nucleus

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Oricó River, located in the south of Brazil's Bahia State, supplies water for the municipality of Ibirapitanga and part of the municipalities of Ubaitaba and Camamu, benefiting around 80,000 people. Historical land use in the region was marked by the conversion of forested areas, including springs, into pastures. This scenario has led to a decline in the quality and quantity of water available for consumption and supply, increasing the risk of a local water crisis.

The reversal of the water shortage risk framework is part of the scope of the project "Oricó River Headwaters: Monitoring Different Forest Restoration Actions" (Nascentes do Rio Oricó: Monitoramento das Diferentes Ações de Restauração Florestal), led by OCT in partnership with the Municipality of Ibirapitanga, the National Water Agency (Agência Nacional das Águas; ANA), Braskem, and the Public Prosecutor's Office of the State of Bahia. The project aims to engage rural landowners in the adoption of sustainable production practices and compliance with environmental regulation. To this end, the initiative added 250 property registrations to the country's Rural Environmental Registry (CAR) and invested in the restoration of forests near 242 degraded springs. Of this total, 20 springs were recovered exclusively through ANR. The project also used ANR techniques to construct 40,000 meters of fences and plant 28,000 native trees.

ANR was included as part of an experiment to compare the merits of several restoration techniques: assisted natural regeneration, native seedling planting, and passive natural regeneration. In all the techniques used, cattle were excluded from the regenerating land. As of this writing, studies evaluating these experiments are ongoing, but initial results indicate a positive trajectory.

Key factors

MOTIVATE

CRISIS EVENTS: Due to the region's intensive land use, the quality and quantity of available water were impaired. Forest restoration that boosts water production is fundamental for the recovery of agricultural production and the maintenance of the water cycle.

LEGAL REQUIREMENTS: Restoring the forest brought rural properties into compliance with current environmental legislation.

ENABLE

POLICY CONDITIONS: The initiative had political support from the Ibirapitanga City Hall and the Public Prosecutor's Office of the State of Bahia, providing support up from the local level to the entire state.

INSTITUTIONAL CONDITIONS: The collaboration between OCT, Ibirapitanga City Hall, ANA, Braskem, and the Public Prosecutor's Office, with representatives from public, private, and civil society sectors, helps ensure the project's positive impact and the commitment of these various actors to the maintenance and expansion of regenerating areas.

IMPLEMENT

TECHNICAL DESIGN: The restoration project is supported technically by OCT and partners and specifically targets actions that mitigate climate change.

FEEDBACK: Results are monitored by the various partners involved in the project, and disseminated in the public, private, and civil society spheres.

Pioneer species occupying areas after fencing

Photo: Adoree Grave Bonfim/OCT.

Aerial view of an initial regeneration area

Photo: João Maximo/OCT.

CASE 16: ASSISTED NATURAL REGENERATION WITH FENCING, BURKINA FASO

Organization in charge: tiipaalga and newTree

Location: Loroum, Soum, Sanmatenga, Oubritenga, Kadiogo, Kourwéogo, and Boulkiemdé Provinces, Burkina Faso

Biome: Sub-Saharan semi-arid

Timespan: 2003 – ongoing

Restored area: 560 hectares (through 2012)

Source of resources: newTree

References: Belem et al. 2017; Shono et al. 2020

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

In Burkina Faso, forests are important providers of food and medicinal security, providing edible fruits and leaves and protecting soils and water resources. In addition, they provide income to the most vulnerable communities through harvesting of timber and non-timber forest products. Despite this importance, the country's forests are degrading and losing biodiversity. Climate change, deforestation for agriculture, the felling of trees and bushes for firewood and construction, the conversion of forested areas to pastures, and the predatory harvesting of non-timber forest products are the main causes of land and forest degradation.

The Swiss philanthropic organization newTree works with farmers in central and northern Burkina Faso to regenerate forests and help communities maintain their traditional way of life. Through ANR – employing techniques such as fencing and the establishment of agroforestry buffer zones around forests – approximately 200 areas were fenced off and underwent regeneration between 2003 and 2012.

Local farmers are deeply involved in the conservation of these areas, being the main actors in the participatory management of forests. ANR contributed to a 21-23 percent increase in community income through the sale of products from regenerating areas

Key factors

MOTIVATE

ECONOMIC BENEFITS: Forest restoration generates income for the community through the sale of timber and non-timber forest products.

AWARENESS: Restoration opportunities were identified in the areas of greatest human pressure, and the land was recovered by building awareness training the local community.

ENABLE

MARKET CONDITIONS: Products from regenerating areas are purposefully connected to local and regional value chains.

SOCIAL CONDITIONS: Income generation and the maintenance of the traditional way of life, in line with the recovery of the forest, bring direct improvements in the local social conditions.

IMPLEMENT

TECHNICAL DESIGN: The community was involved, received technical training, and now directly maintains regenerating areas, applying scientific and traditional knowledge to improve the environmental and social conditions of the forest.

FINANCE AND INCENTIVES: The project was financed by newTree, which provided resources for community empowerment and the maintenance of the regenerating areas.

FEEDBACK: The project's achievements are public and published by newTree and have been assessed in scientific publications, showing how ANR can help solve social and environmental problems found in the region.

Fodder production generating income

Photo: Franziska Kaguembèga-Müller/tiipaalga.

Tree grown after eight years of ANR

Photo: Franziska Kaguembèga-Müller/tiipaalga.

CASE 17: BRACCE – BUILDING RESILIENCE TO A CHANGING CLIMATE AND ENVIRONMENT, TIMOR-LESTE

Organization in charge: World Vision Australia
Location: Aileu, Timor-Leste
Biome: Dry tropical and subtropical forests
Timespan: 2011–2016
Restored area: 50 hectares
Source of resources: World Vision
References: FMNR, n.d.; Rinaudo 2014; Shono et al. 2020

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Frequent burning and intensive grazing in Timor-Leste's Aileu region have led to a decline in soil fertility and quality, more frequent erosion, reduced water capacity, and increased landslides. While the region's traditional way of life was previously based on slash-and-burn agriculture, population growth combined with the rapidly declining forests have made this practice unsustainable.

ANR was implemented by farmers as a land management strategy to boost agricultural resilience and local livelihoods. In Aileu, this centered on enrichment with native species with a focus on fruit, foraging and timber. The strategy also incorporated a structured community training program on the principles of ANR, including demo installations to inspire rural community members.

Key factors

MOTIVATE

ECONOMIC BENEFITS: Farmer participation was high, with reports of increased vegetable, fruit, and livestock production.

AWARENESS: The promotion of this strategy involved identifying the main environmental problems faced by the community and the changes in cultural practices that could solve them.

CRISIS EVENTS: The community's prior slash-and-burn technique has degraded the region's forests. ANR was adopted as a solution to restore the landscape's ability to generate ecosystem services

ENABLE

MARKET CONDITIONS: Value chains for timber and non-timber forest products already existed and improved with the help of ANR practices.

SOCIAL CONDITIONS: The local community was included, consulted, and given leadership in the decision-making process. In addition, women's participation in community decision-making increased after the ANR adoption process.

IMPLEMENT

TECHNICAL DESIGN: Technical knowledge on restoration was shared through a structured community training program on basic ANR techniques. World Vision provided technical expertise as well as financial support.

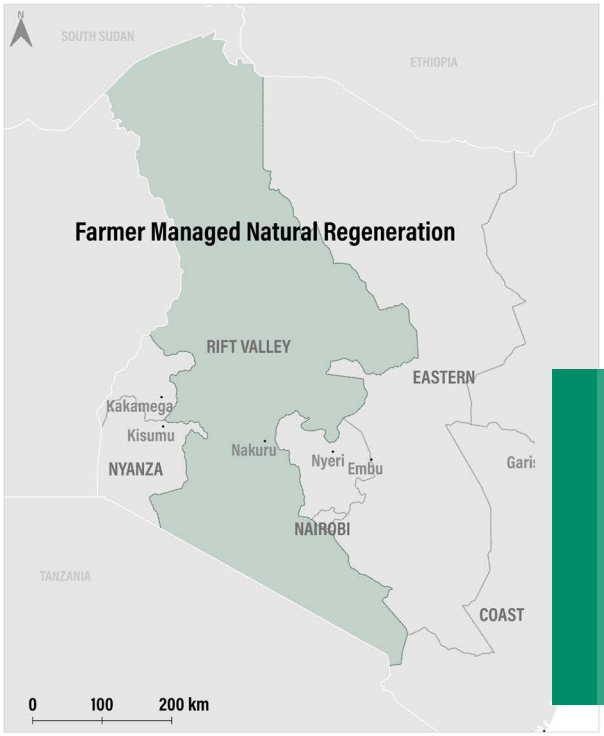
Forest restored through ANR implemented by local farmers

Photo: World Vision Australia.

Farmer conducting a tour in a regenerated forest area

Photo: World Vision Australia.

CASE 18: FARMER-MANAGED NATURAL REGENERATION, KENYA



Organization in charge: World Vision Australia
Location: Baringo County, Kenya
Biome: Forested Savanna
Timespan: 2015 – ongoing
Restored area: 2,273 hectares
Source of resources: Australian Aid, Australian Government
References: Rinaudo 2019; Wanjira et al. 2020

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Kenya's Baringo County is an arid and semi-arid area mostly occupied by farmers. It has a history of destructive farming practices dating back to the 1970s, such as clearing all trees from a plot of land, believing it would benefit pasture growth. The result of these practices was a series of successive droughts and consequent food insecurity.

The farmer-managed natural regeneration (FMNR) approach was implemented in the region by the NGO World Vision. The main ANR technique used was the clearing of undergrowth around naturally regenerating trees to enhance their growth and survival. In addition to removing the limiting factor of tree growth, the shade provided by these trees benefitted the development of grasses under their canopy.

Farmer-managed natural regeneration reduced the cost of seedling production and, combined with training for the local population to manage the area, was a more cost-effective method of ecological restoration compared to other available techniques. This new strategy brought new economic opportunities to community members and allowed them to resume their pastoral traditions, which are more suited to the local way of life than crop-based agricultural systems.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: Restoration generates environmental benefits by renewing the ecosystem services intrinsic to forests, such as greater quantity and quality of water and pasture.

SOCIAL BENEFITS: Restoration generates social benefits for the local population, who have returned to their traditional agropastoral systems, in addition to improving food security in the region.

AWARENESS: Restoration opportunities were identified and local people were involved in the forest restoration process, strengthening community ties around sustainable value chains.

CRISIS EVENTS: The water scarcity and food insecurity generated by the improper management of natural resources was identified and resolved through forest regeneration.

ENABLE

SOCIAL CONDITIONS: The local community was involved in the process of transformation and recovery of the landscape, adopting productive practices aligned with long-term forest management.

INSTITUTIONAL CONDITIONS: The arrangement coordinated by World Vision in the region was effective in aligning community interests with forest recovery.

IMPLEMENT

TECHNICAL DESIGN: The local community received training on sustainable practices and the maintenance of areas under ANR, ensuring that they remain in line with traditional ways of life.

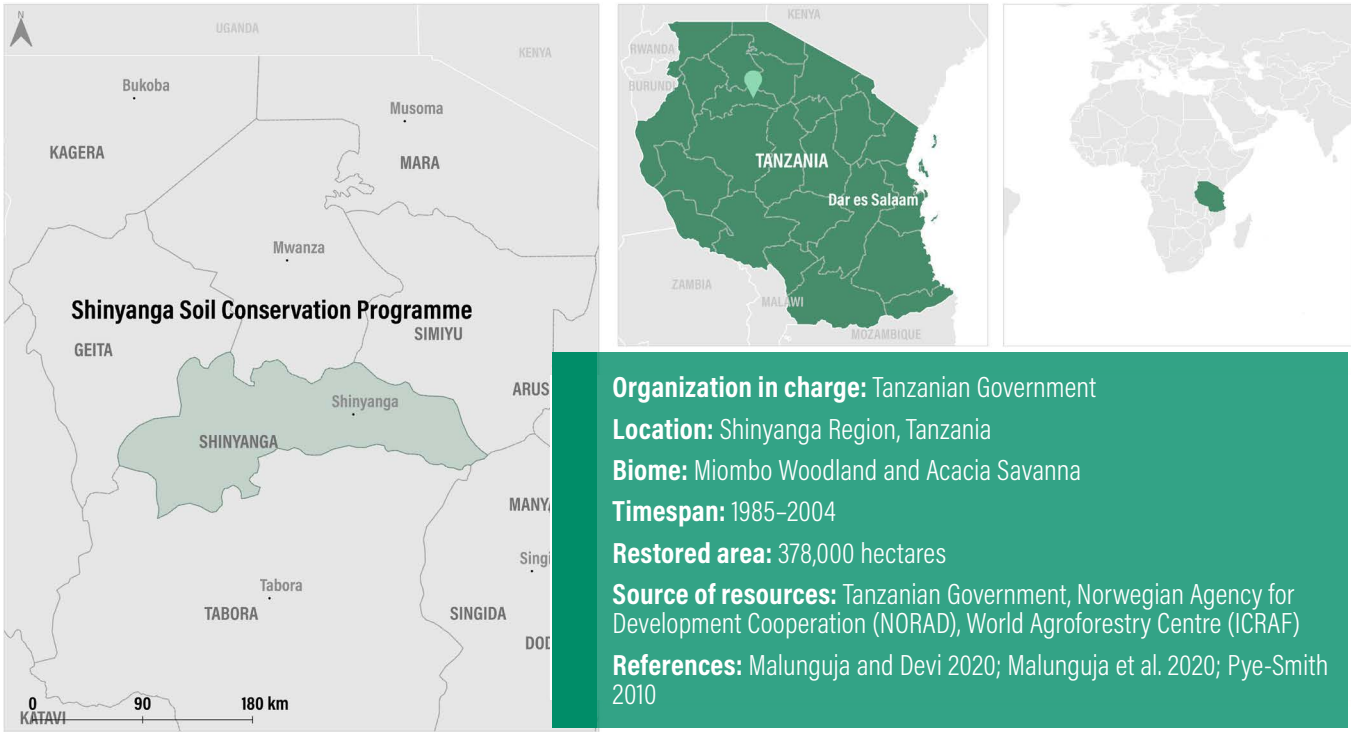
Youth learning about ANR

Photo: World Vision/Global Landscape Forum.

Rural family proud of their regenerated forest

Photo: World Vision/Global Landscape Forum.

CASE 19: SHINYANGA SOIL CONSERVATION PROGRAMME, TANZANIA



Organization in charge: Tanzanian Government
Location: Shinyanga Region, Tanzania
Biome: Miombo Woodland and Acacia Savanna
Timespan: 1985–2004
Restored area: 378,000 hectares
Source of resources: Tanzanian Government, Norwegian Agency for Development Cooperation (NORAD), World Agroforestry Centre (ICRAF)
References: Malunguja and Devi 2020; Malunguja et al. 2020; Pye-Smith 2010

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Shinyanga Soil Conservation Programme, or HASHI (*Hifadhi Ardhi Shinyanga*), aimed to restore degraded forests in the Shinyanga region of northwestern Tanzania. Known in the 1980s as the "Desert of Tanzania", the region was home to a vast forest of miombo trees (*Brachystegia spp.*) that was decimated by years of deforestation and human settlement.

The HASHI has helped tens of thousands of smallholders restore degraded land and significantly improve their incomes and well-being. By growing trees and using ANR to restore the forest, the project has helped protect local biodiversity, improved the water supply, increased farmer incomes, and boosted agricultural production and the availability of firewood and medicinal plants. Under the system of *ngitili* – rotational grazing and fodder reserves for livestock – between 378,000 and 472,000 hectares of land were restored across the Shinyanga region by the year 2000, benefitting 833 villages and approximately 2.5 million people.

HASHI brought together several government actors and international partners but found its success in involving local communities at the forefront of these efforts. The project has revived the traditional land management system that emphasizes assisted natural regeneration of trees in degraded forests and grasslands, increasing the supply of fodder for livestock for use during the dry season. When work began, there was only 600 ha of documented *ngitili* in the region. Today, there is more than 500,000 ha of these reserves, regenerated through the application of ANR.

Key factors

MOTIVATE

ECONOMIC BENEFITS: The regenerated areas made it possible to increase agricultural production and farmer income through an emphasis on the recovery and rotation of pastures and forests.

AWARENESS: Restoration opportunities have been identified in the region, which for years had been heavily degraded by deforestation and human settlement. The use of the traditional technique of *ngitili* reinforced the way of life and engagement of local communities.

CRISIS EVENTS: The degraded land did not support the local communities' traditional way of life. Restoration returned the livelihoods, cultural traditions and financial resources to the local community.

ENABLE

POLICY CONDITIONS: The partnership between the Government of Tanzania and international agencies proved to be an effective catalyst to implement and sustain the project.

SOCIAL CONDITIONS: The local community benefitted from the restoration through the recovery of goods and services provided by forests, such as better water supply and the availability of firewood and medicinal plants.

INSTITUTIONAL CONDITIONS: The institutional coordination was effective in aligning the performance of international agencies, the presence of the Tanzanian government, the use of scientific knowledge, and the incorporation of the local community's traditional knowledge and practices.

IMPLEMENT

LEADERSHIP: The government and local leaders are committed to the process of recovery and maintenance of forest areas.

TECHNICAL DESIGN: Through training sessions and workshops, local community members and rural extension specialists were able to share their knowledge on restoration.

FINANCE AND INCENTIVES: Incentives and financial resources are readily available through the alliance between the Government of Tanzania, NORAD, and World Agroforestry Centre (ICRAF).

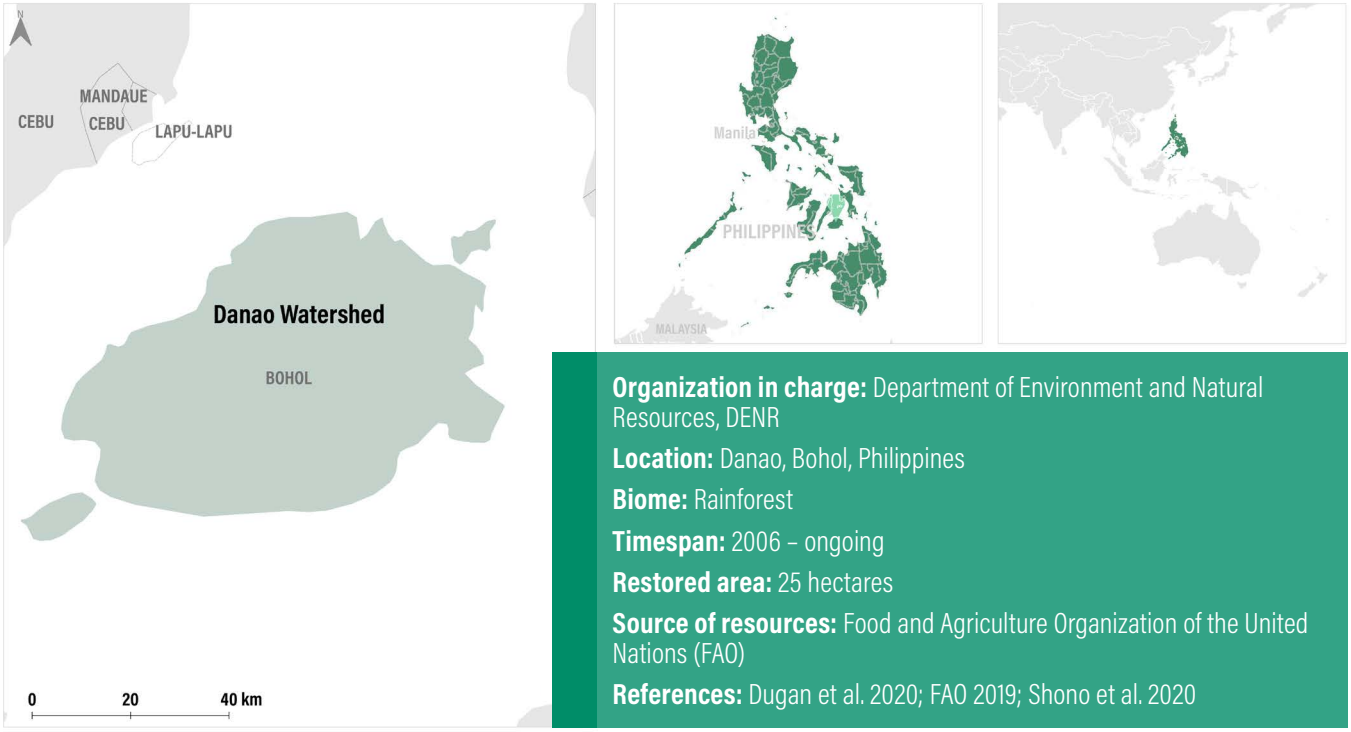
Restored *Ngitili* system

Photo: Lalisa A. Duguma.

Ngiliti provides ecosystem services for the local community

Photo: Obadia Mugassa.

CASE 20: DANAO WATERSHED, PHILIPPINES



Organization in charge: Department of Environment and Natural Resources, DENR

Location: Danao, Bohol, Philippines

Biome: Rainforest

Timespan: 2006 – ongoing

Restored area: 25 hectares

Source of resources: Food and Agriculture Organization of the United Nations (FAO)

References: Dugan et al. 2020; FAO 2019; Shono et al. 2020

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Increasing population pressure has made the local way of life, traditionally slash-and-burn agriculture, unsustainable in the Danao watershed of Bohol, Philippines. Demand for food and other products has increased exponentially in recent years, leading to deforestation and degradation of land and water resources in the region as new productive areas are created. In 2006, a 25-ha demonstration unit based on the ANR approach was implemented. ANR interventions included the selection and protection of naturally regenerated shoots and seedlings, the reduction of competitors through weeding of the aggressive *Imperata* grass, the control of cattle access to regenerating pastures, and the installation of firebreaks, as well as employment of the local community in conducting fire patrols (FAO 2019; Shono et al. 2020).

Notable changes in biodiversity began to appear 18 months after the project was implemented. In addition, the income of farmers increased through the harvesting of cassava, bananas, pineapples, and peanuts planted inside of firebreaks. With the advance of forest regeneration, Danao began to receive a growing market linked to ecotourism, becoming an attraction in the region.

Key factors

MOTIVATE

ECONOMIC BENEFITS: Forest restoration led to an increase in farmers' income from harvesting products grown in regenerating areas, in addition to promoting the ecotourism market in the region.

CRISIS EVENTS: Slash-and-burn agriculture had degraded the region and made it unviable, but ANR techniques replaced this practice, creating sustainable products and a new economy based on ecotourism.

ENABLE

INSTITUTIONAL CONDITIONS: The government is committed to maintaining regenerating areas, ensuring the permanence of the forest.

SOCIAL CONDITIONS: The local community benefits from increased income through agriculture and ecotourism, in addition to enjoying the ecosystem services provided by the forest.

IMPLEMENT

TECHNICAL DESIGN: The community received training for the implementation and maintenance of the regenerating areas, in addition to acting in fire patrols.

FINANCE AND INCENTIVES: The technical and financial partnership between the local government, FAO, and the community strengthens the permanence of regenerating areas.

FEEDBACK: Danao's case is public and publicized by both FAO and the Philippine government as a successful case of forest restoration.

Defining a fire line to protect the site from forest fires

Photo: Noel Celis.

Forest restored through ANR

Photo: Patrick Durst.

CASE 21: NUMINBAH CONSERVATION AREA, AUSTRALIA

Organization in charge: Natural Areas Management Unit (NAMU)
Location: City of Gold Coast, Queensland, Australia
Biome: Subtropical humid and subtropical sclerophyll forests
Timespan: 2008–2014
Restored area: 190 hectares
Source of resources: NAMU, City of Gold Coast, and Seqwater
References: EMRPS 2016; Uebel et al. 2017

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Numinbah Conservation Area is one of many natural areas managed by the City of Gold Coast's Natural Areas Management Unit (NAMU) in Queensland, Australia. This area is home to a wide variety of ecosystems, including subtropical forests, rocky outcrops, and riparian zones. In 2008, there were large areas of degraded pastures and regenerating forests, all impacted by invasive grasses, inherited from a process of deforestation for timber extraction and the subsequent presence of cattle.

A detailed ecological restoration plan was carried out in the area, with the collection of data on regeneration capacity, fire management, and the identification of threatened species. Through the ANR approach, which included fencing and grass control, the recruitment of native trees and shrubs was successful, significantly accelerating the rate of recovery of forest areas. Pasture areas are continuously managed to reduce the portion dedicated to cattle raising and increase the regenerating forest.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: The adoption of ANR for forest restoration is a low-cost approach and returns ecosystem services to the region, such as improved water quality and quantity.

ENABLE

INSTITUTIONAL CONDITIONS: Government agencies are aligned to ensure the establishment and permanence of political guidelines that support the process of forest regeneration in the Numinbah area.

ECOLOGICAL CONDITIONS: Seedlings, seeds, and relevant propagules are available in forest fragments already established in the area. A survey was carried out on the regeneration capacity in the landscape, optimizing the ANR.

POLICY CONDITIONS: The project is established in an area of biodiversity conservation, guaranteeing protection for the regenerating forest

IMPLEMENT

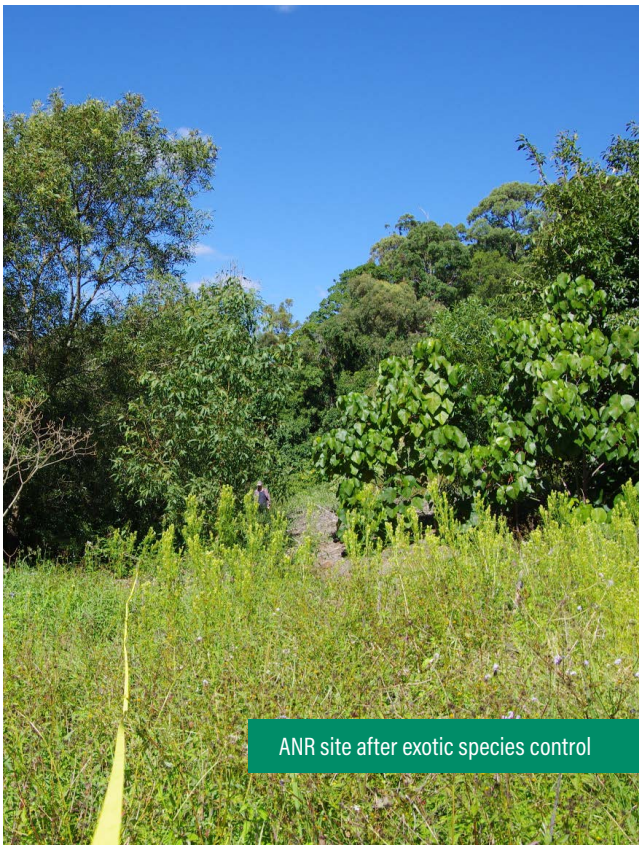
TECHNICAL DESIGN: The restoration project is technically grounded, with the participation of competent government agencies in the field of natural resources and forest restoration.

FINANCE AND INCENTIVES: The financial support from the Australian government ensured the execution of the project in its various phases.

FEEDBACK: The recovery rate of forest areas is monitored, including possible future forest expansion and reduction of pastures.

Regenerated trees supporting the forest structure

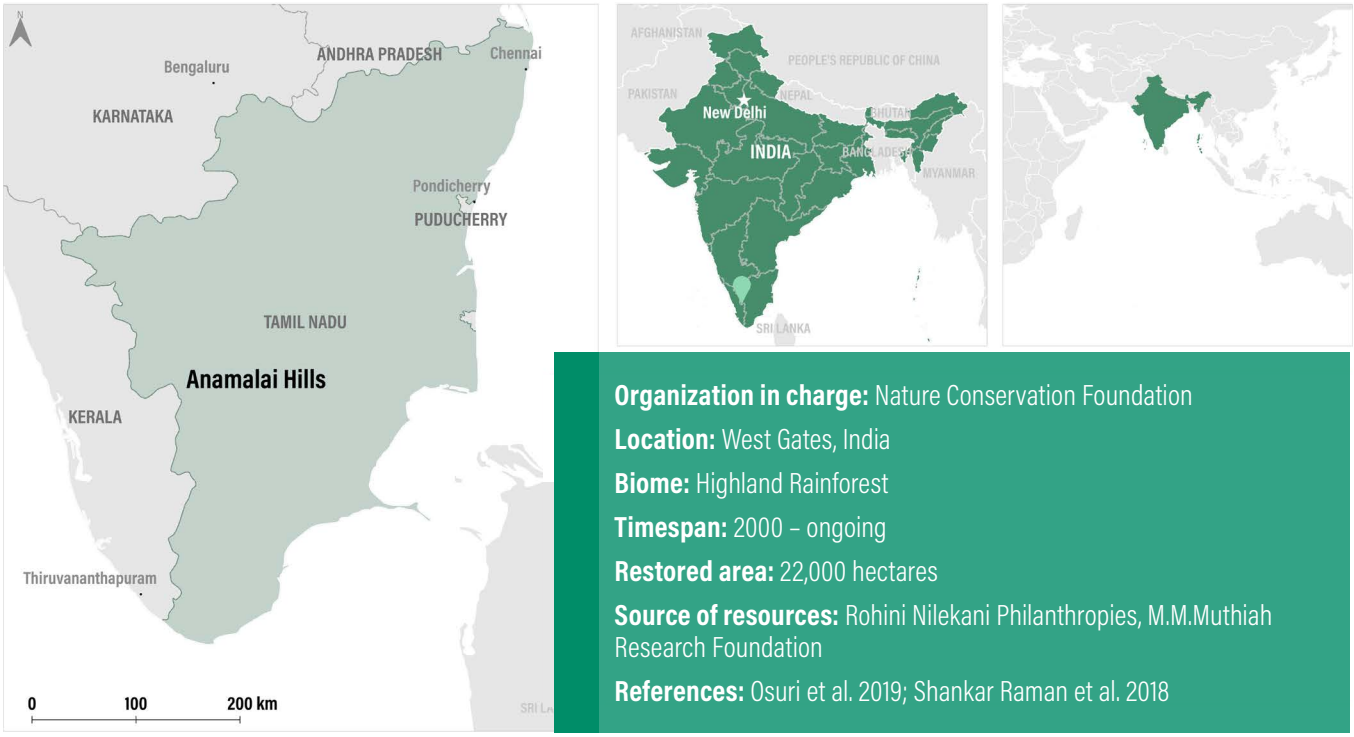
Photo: Luke Shoo.



ANR site after exotic species control

Photo: Luke Shoo.

CASE 22: ANAIMALAI HILLS, INDIA



Organization in charge: Nature Conservation Foundation

Location: West Gates, India

Biome: Highland Rainforest

Timespan: 2000 – ongoing

Restored area: 22,000 hectares

Source of resources: Rohini Nilekani Philanthropies, M.M.Muthiah Research Foundation

References: Osuri et al. 2019; Shankar Raman et al. 2018

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The tropical forests of the Valparai Plateau, in the Anaimalai Hills, West Gates, India, were cleared between the 1890s and 1940s to establish commercial crops of eucalyptus, coffee, tea, and cardamom and experienced logging by companies and the local population. Most of the forest remnants are on coffee and tea-producing properties or in environmental preservation areas.

These remnants were heavily fragmented. Therefore, active restoration was implemented in isolated areas, while ANR was applied in areas close to the fragments. In smaller fragments, after assessments of forest structure and vegetation, invasive herbs were removed throughout the area, taking care to retain all naturally established native plants (Shankar Raman et al. 2018). In larger and remaining fragments, restoration has focused on degraded edges to protect the forest interior and promote natural regeneration. During the rainy season, between 20 and 80 native species were planted in each location, according to the initial conditions of the areas.

Techniques such as the prevention of wood cutting, grass control, and enrichment with native species were adopted according to the suitability of each landscape unit. After 15 years, areas restored using enrichment with native species and invasive weed control techniques are ecologically closer to pristine tropical forests than the abandoned areas that didn't benefit from restoration interventions (Shankar Raman et al. 2018; Osuri et al. 2019).

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: Restoration generates environmental benefits by restoring the connection between forest fragments in the Valparai Plateau, contributing to the quality of gene flow in the ecosystem and increasing the resilience of the forest.

ENABLE

ECOLOGICAL CONDITIONS: Seedlings, seeds, and relevant propagules are available in the region's forest fragments, accelerating the process and increasing the quality of forest succession.

IMPLEMENT

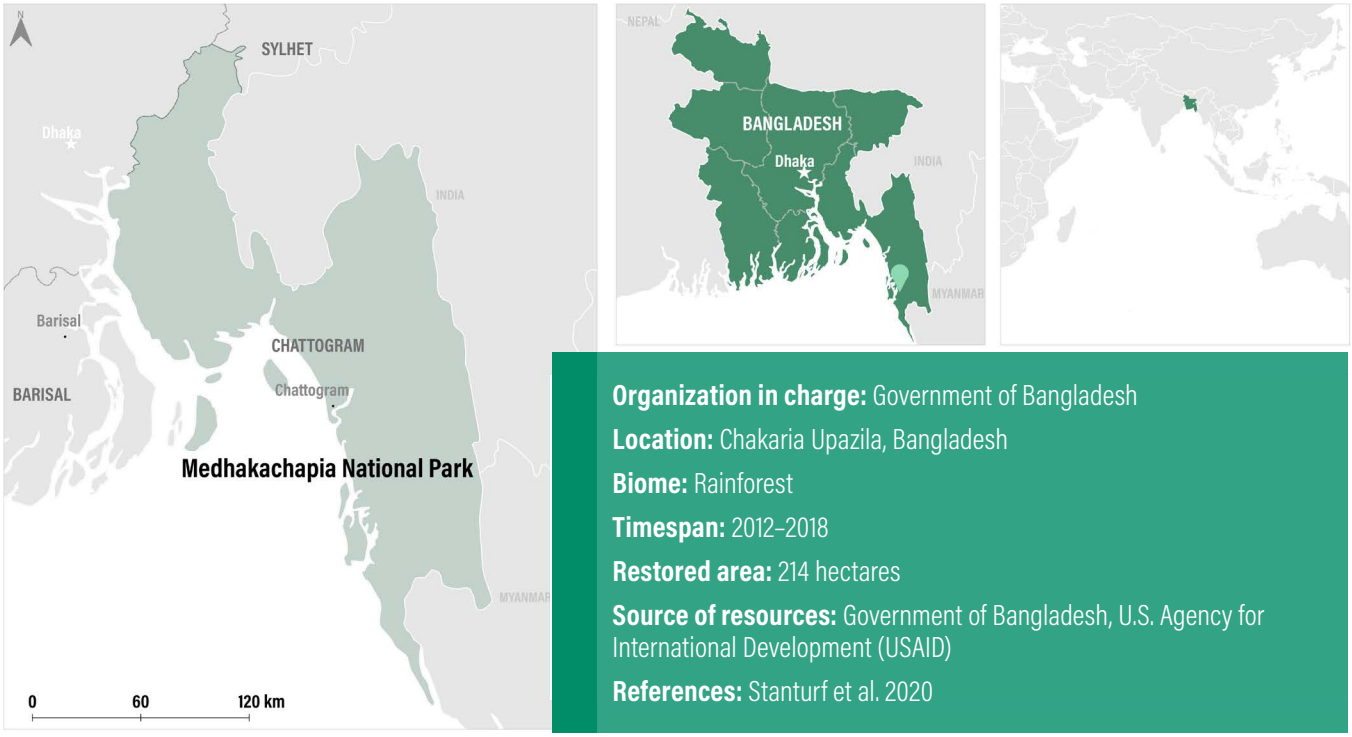
TECHNICAL DESIGN: The restoration project received technical support from the Nature Conservation Foundation and included several analyzes to determine areas for ANR based on their biophysical potential. This approach increases the chances of the ecological succession continues successfully.

FINANCE AND INCENTIVES: Incentives and financial resources were provided by Rohini Nilekani Philanthropies and M.M. Muthiah Research Foundation, ensuring the execution of all stages of forest restoration.

Photo: Nature Conservation Foundation.

Photo: Nature Conservation Foundation.

CASE 23: MEDHAKACHAPIA NATIONAL PARK, BANGLADESH



Organization in charge: Government of Bangladesh

Location: Chakaria Upazila, Bangladesh

Biome: Rainforest

Timespan: 2012–2018

Restored area: 214 hectares

Source of resources: Government of Bangladesh, U.S. Agency for International Development (USAID)

References: Stanturf et al. 2020

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

The Medhakachapia National Park region in southeastern Bangladesh is an area of tropical forest marked by the abundant presence of gurjan (*Dipterocarpus spp.*). These forests have been degraded by extensive logging and land conversion for agriculture. Despite the number of parks and conservation areas in the region, most of the forests were in the initial stage of regeneration or completely degraded due to disturbances such as fire, pasture, and felling for wood fences on nearby rural properties (Stanturf et al. 2020).

Among several forest restoration techniques, ANR was the most successful intervention. Areas with high regeneration potential were identified and patrolled to prevent grazing and felling. Firebreaks were installed, and regular weeding optimized the growth of tree seedlings and shoots. In places with a high density of seedlings, more recurrent species were removed to encourage the growth of less frequent ones. Seedlings of native tree species generated in nurseries and other rarer species were planted manually to fill the open spaces of the park (Stanturf et al. 2020). In forest fragments, ANR showed a good degree of induction of trees and shrubs to degraded regions. The patrolling of these areas, whose regeneration has improved the quality of the habitat for wildlife, has also improved, reducing human interference, grazing spaces for cattle, and forest fires.

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: Restoration generates environmental benefits, such as improved water quality and quantity in the region. Regeneration also improved the quality of habitat for wildlife.

ENABLE

ECOLOGICAL CONDITIONS: Seedlings, seeds, and relevant propagules were available in the forest fragments of the region, accelerating the process and increasing the quality of forest succession.

POLICY CONDITIONS: Medhakachapia National Park is a conservation area with restricted access, which strengthens the permanence of areas in regeneration.

IMPLEMENT

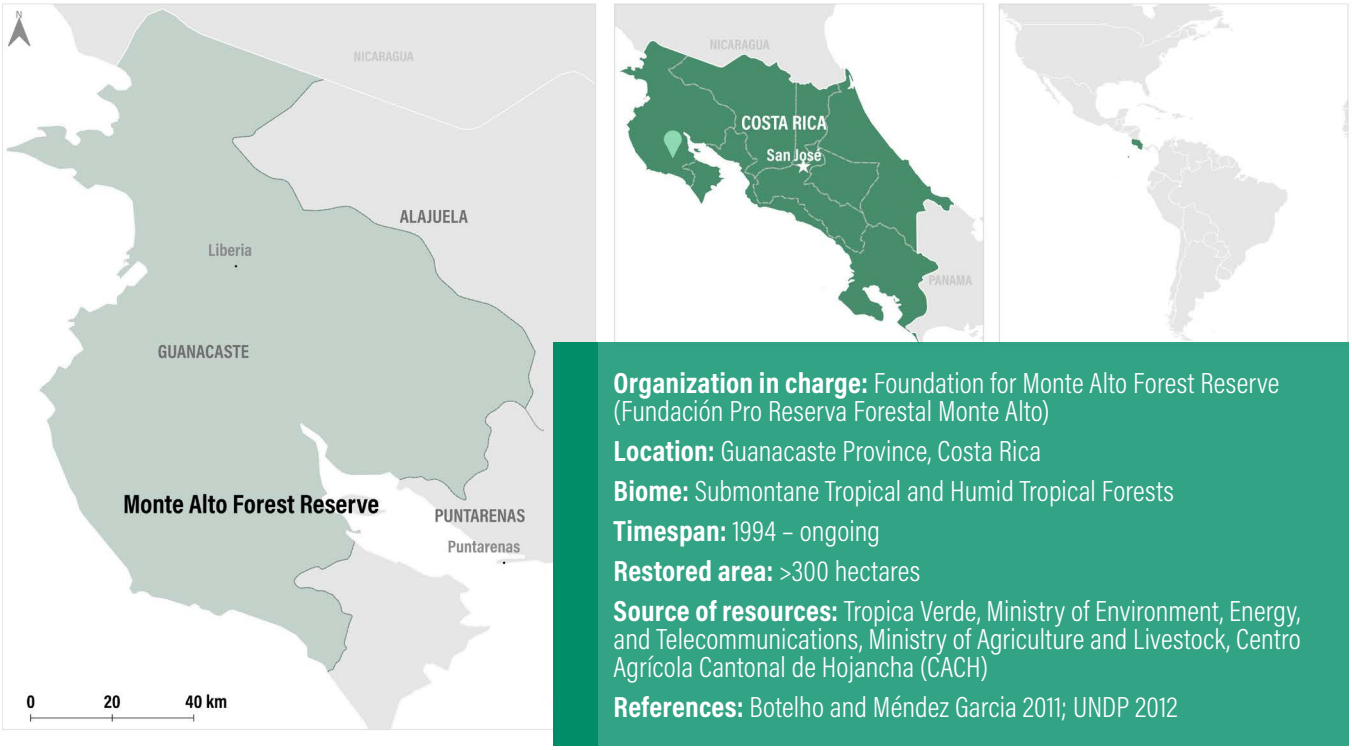
TECHNICAL DESIGN: The project relied on spatial intelligence surveys in order to determine different restoration techniques for different environmental conditions, which increased the chances of success of the ANR areas.

FEEDBACK: The Medhakachapia National Park area is monitored by the Government of Bangladesh, ensuring that forest regeneration continues.

ANR site after implementation

Photo: Norman Al Moktadir.

CASE 24: MONTE ALTO FOREST RESERVE, COSTA RICA



Organization in charge: Foundation for Monte Alto Forest Reserve (Fundación Pro Reserva Forestal Monte Alto)

Location: Guanacaste Province, Costa Rica

Biome: Submontane Tropical and Humid Tropical Forests

Timespan: 1994 – ongoing

Restored area: >300 hectares

Source of resources: Tropica Verde, Ministry of Environment, Energy, and Telecommunications, Ministry of Agriculture and Livestock, Centro Agrícola Cantonal de Hojancha (CACH)

References: Botelho and Méndez Garcia 2011; UNDP 2012

Source: Authors. Developed by Leonardo Barbosa (WRI Brasil).

Description

Between 1968 and 1992, the flow of the Nosara River in the Guanacaste Province of Costa Rica was reduced by 90 percent, leading to severe water shortages and the emigration of 57 percent of the resident population (UNDP 2012). In 1993, families living in Hojancha in the central highlands of the Nicoya Peninsula came together to improve the conservation of the local forest in response to this water shortage caused by deforestation over many decades. In 1994, the families purchased 276 ha of old pastures and small areas of forest, creating the Monte Alto Protected Zone and the Monte Alto Forest Reserve. Today, an area of 924 ha is co-administered with the Costa Rican Ministry of the Environment (Botelho and Méndez Garcia 2011).

As a result of forest protection and restoration, largely through assisted natural regeneration, currently 60 percent of the Monte Alto Protected Zone has significant forest vegetation today, making it the main source of water supply for around 1,200 families in Hojancha. The acquired pastures regenerate naturally or are reforested with endemic, native, and mixed cultures of trees ecologically adapted to the region. More than 300 ha of forest have regrown, and ecotourism has increased dramatically, providing additional sources of income for local families (UNDP 2012).

Reforestation and expansion of native forests have made it possible for local wildlife to recover. Over 27 years, the Foundation has improved the quality, quantity, and consistency of drinking water for local people. Forests have regenerated, ecosystems have been restored, and land conversion for livestock has declined. The Monte Alto Reserve is visited by many local school groups and residents from neighboring regions of Costa Rica, serving as an inspiration to many people (UNDP 2012).

Key factors

MOTIVATE

ENVIRONMENTAL BENEFITS: Forest restoration generates environmental benefits by increasing wildlife habitat and the environmental and climate resilience of the region.

SOCIAL BENEFITS: Forest restoration generates social benefits for the community, generating income through ecotourism and ensuring the enjoyment of environmental services such as quality water.

AWARENESS: Restoration opportunities were identified as a solution to the water crisis and involved the local community.

CRISIS EVENTS: The water crisis in the region was overcome through forest restoration, increasing the production and the quality of water resources.

ENABLE

ECOLOGICAL CONDITIONS: Forest remnants in the reserve area, protected by the local community, provide genetic material and propagules for the consolidation of areas undergoing natural regeneration.

POLICY CONDITIONS: There are restrictions on deforestation of remaining native vegetation and the government provides support for the permanence of the forest through payment for environmental services to landowners.

SOCIAL CONDITIONS: The community is united, organized, and shares a common vision for forest restoration.

IMPLEMENT

TECHNICAL DESIGN: The restoration project has a strong scientific basis and several restoration techniques, determined from the analysis of the biophysical potential of each area.

FINANCE AND INCENTIVES: Financial resources and incentives are available and guarantee the execution of all activities related to the maintenance and expansion of areas undergoing regeneration.

FEEDBACK: Results of forest restoration are monitored, and related data are public.

Monte Alto Reserve entrance

Photo: Robin Chazdon.

View of ANR site in 2017

Photo: Robin Chazdon.

APPENDIX B. SUMMARY TABLE OF THE RESTORATION DIAGNOSTIC

THEME	KEY SUCCESS FACTOR	DESCRIPTION
MOTIVATE	**Environmental benefits**	Areas undergoing restoration contribute, or are expected to contribute, to the generation of ecosystem services related to biodiversity, water, carbon, and/or others.
	Economic benefits	Areas undergoing restoration generate, or are expected to generate, income or some type of economic return.
	Social benefits	Areas undergoing restoration bring, or are expected to bring, benefits to people, their culture, and/or wellbeing.
	Awareness	Areas undergoing restoration are located in priority regions and connected with landscape planning strategies.
	Crisis events	Crisis events (water, energy, production, and/or others) triggered actions to promote restoration.
	Legal requirements	Current legislation is understood and drives restoration actions.
ENABLE	**Ecological conditions**	Conditions related to the proximity of remnants, fires, climate, water, and soil are favorable for restoration.
	Market conditions	Areas undergoing restoration are, or are expected to be, associated with existing or established value chains.
	Policy conditions	There is government and public policy engagement and direction to support long-term restoration actions.
	Social conditions	Landowners, rural communities, and other stakeholders participate in decision making and are mobilized for restoration.
	Institutional conditions	There are effective coordination of organizations and people involved in the restoration process.
IMPLEMENT	**Leadership**	There are publicly assumed commitments or a person/organization that are recognized as the drivers of restoration actions.
	Knowledge	Training programs and capacity development processes were established with people directly involved in the restored areas.
	Technical design	Technical design and local knowledge were considered in the planning of restoration actions.
	Finance and incentives	Mechanisms or arrangements were established to transfer resources (financial, inputs, and/or others) to landowners whose areas have been restored.
	Feedback	Follow-up actions for the restored areas are in progress, associated with monitoring platforms and/or strategies to communicate the results.

Source: Adapted from Hanson et al. (2015).

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ENDNOTES

1. A *muvuca* is a mixture of seeds of native species that have different growing rates and serve as fertilizers and soil substrate (such as soil and sawdust). This technique is usually implemented through direct seeding and stands out for its low need for maintenance and its ability to rapidly recreate natural forests.

2. Environmental licensing is one of the instruments of the National Environmental Policy (PNMA) in Brazil. The objective is to ensure social and economic development compatible with the preservation of the environment. For this, any activity or establishment classified as polluting or potentially polluting and/or causing environmental degradation, requires environmental licensing process.

   One of the main areas of action of the PNMA is the recovery of degraded areas. Forest restoration is a common solution that landowners embrace to bring properties into compliance with environmental laws. In order to achieve these restoration goals, the enterprises and companies involved usually employ specialized companies, research institutes, environmental agencies and incentive programs, such as the Nascentes Program of the Government of the State of São Paulo.

3. Traditional rural communities, defined by communal land use and livestock rearing.

4. Rural communities inhabited by descendants of people seeking freedom from slavery.

5. The Agrarian Reform Policy is the set of measures carried out by the federal government to promote the distribution of land and land rights among rural workers, as provided for in law number 4,504/64 (Land Statute). The National Institute of Colonization and Agrarian Reform (INCRA) is responsible for helping landholders achieve formal recognition of their land tenure. An "agrarian reform settlement" gives access to land to farming families or rural workers that reside and develop productive activities on the land.

   The Landless Workers' Movement (MST) is the main organization advocating for Brazil's popular agrarian reform movement. Despite the country's constitutional guarantee of land rights, the process of land distribution is violent, slow and bureaucratic. The MST helps people distribute and use the land to maximize the well-being of rural communities, in addition to fighting for the production of healthy food and against pesticides, genetically modified seeds and the depletion of natural resources.

6. The Forest Code is the law that establishes the general rules for the protection of vegetation, determining the areas that must be preserved and which regions are authorized for productive activities. Its first version dates from 1934, and its last revision was carried out in 2012.

   Two types of preservation areas were established by the Forest Code: Legal Reserve (RL) and Permanent Preservation Area (APP). A Legal Reserve is the portion of a property that must be preserved within each property because of its importance for local biodiversity. The RL areas of each property must observe the guidelines established for the biome where the area is located. A Permanent Preservation Area protects vulnerable areas of the landscape, such as riverbanks, hilltops and water sources. These areas cannot be explored, built on or cultivated.

7. An administrative act that aims to clarify issues already present in the law.

8. The Rural Environmental Registry (CAR) is a mandatory electronic public record for rural properties in Brazil. Its objective is to integrate environmental information from rural properties as they attempt to comply with Permanent Preservation Area (APP) and Legal Reserve (RL) requirements. It also demarcates where native vegetation and forests can be productively used before the law came into force on July 22nd, 2008. This database supports the environmental and economic monitoring and planning of the rural land in Brazil.

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NICFI Norway's International Climate and Forest Initiative

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ABOUT WRI BRASIL

WRI Brasil is a non-profit research institute that transforms big ideas into actions to promote environmental protection, economic opportunity, and human well-being. It is focused on research and applications of sustainable solutions oriented towards forests, cities, and climate. WRI Brasil combines technical excellence with political articulation and works in close collaboration with governments, private companies, universities, and civil society.

WRI Brasil is part of the World Resources Institute (WRI), a global research organization whose work extends to over 50 countries. WRI encompasses the work of approximately 1,400 professionals in offices in Brazil, China, the United States, Europe, Mexico, India, Indonesia, and Africa.

ABOUT ICV

Founded in Mato Grosso, on April 14, 1991, The Life Center Institute (Instituto Centro de Vida; ICV) is a non-partisan, non-profit Civil Society Organization of Public Interest (OSCIP), recognized as being of public utility by state law 6,752/96. The actions reach international, national, and state levels in the areas of transparency, environmental governance, and public policies, as well as the municipal level through practical experiences. Its objective is to disseminate these innovations to broaden and influence other actors beyond the territories in which we operate. Its performance is based on studies and analyses, as well as on-field experiences, always seeking the effective participation of the actors in this process. For more information access: https://www.icv.org.br/.

ABOUT IMAZON

IMAZON is a Brazilian non-profit research institute, founded in 1990 and headquartered in Belém, Pará. Its mission is to promote conservation and sustainable development in the Amazon through studies, support for the formulation of public policies, wide dissemination of information, and professional training. Since 2006, IMAZON has maintained the qualification of Civil Society Organization of Public Interest (OSCIP), granted by the Ministry of Justice of Brazil. In 31 years of research in the Amazon, IMAZON has published around 700 works, of which almost a third were published as articles in international scientific journals, in addition to technical studies and strategic documents for public policies. For more information access: www.imazon.org.br.

ABOUT SUZANO

Suzano is a global reference in the sustainable use of natural resources. As a world leader in the manufacture of market pulp and one of the largest paper manufacturers in Latin America, it exports to more than 80 countries and, through its products, is present in the lives of more than 2 billion people. With eleven factories, in addition to the *joint operation* Veracel, it has an installed capacity of 10.9 million tons of market pulp and 1.4 million tons of paper per year. The company has invested for more than 90 years in innovative solutions based on the planting of eucalyptus to replace fossil materials with renewable sources. The company, resulting from the merger between Suzano Papel e Celulose and Fibria, is proud of its team, composed of more than 35,000 direct and indirect employees, and stands out for having the highest levels of Corporate Governance in B3 (Brazil) and the NYSE – New York Stock Exchange (United States), markets where its shares are traded. For more information access: www.suzano.com.br.

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