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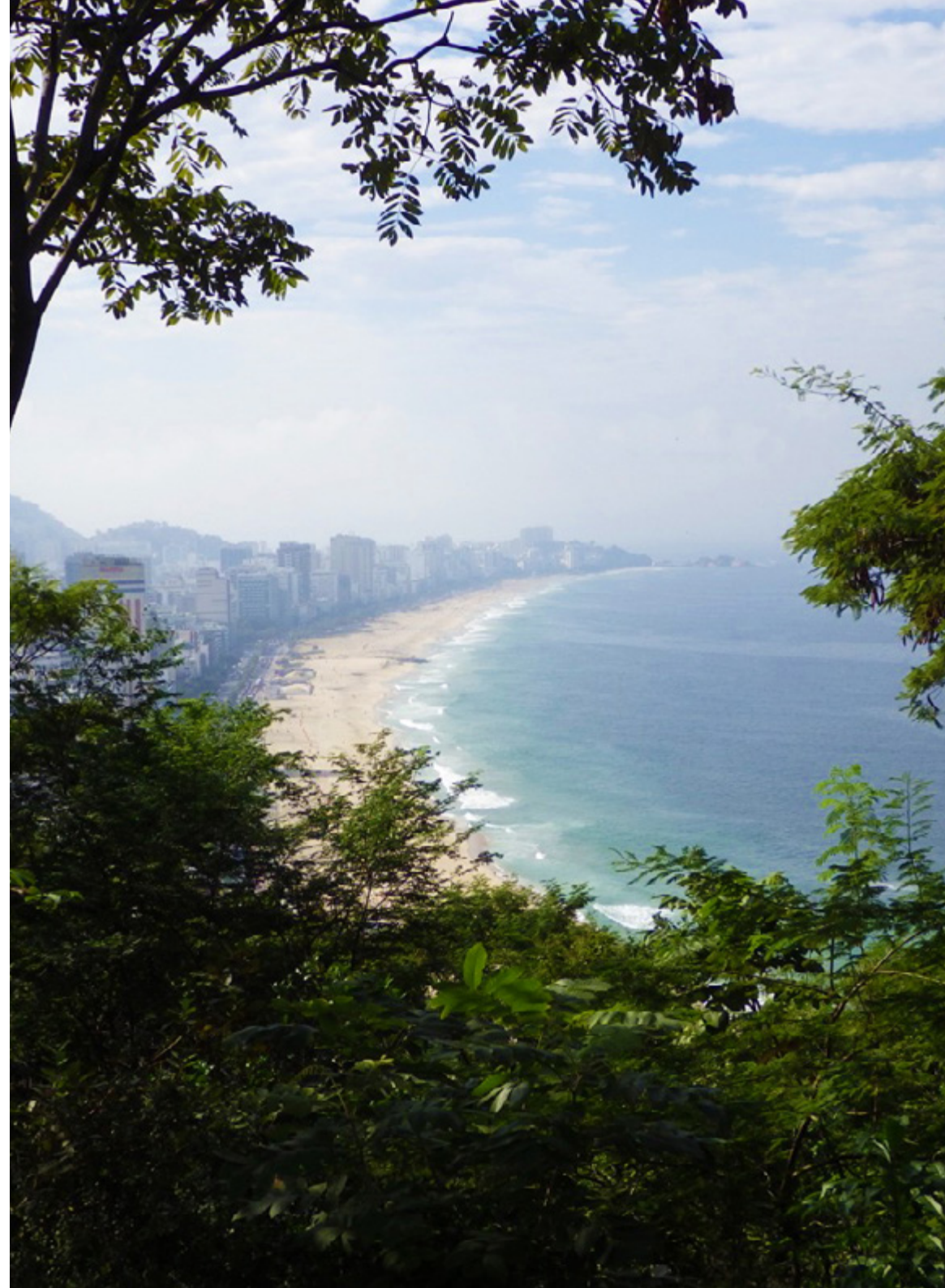
Mutirão Reflorestamento: a joint effort to restore forests in Rio de Janeiro, Brazil



*Reforested areas of Parque Natural Dois Irmãos in the City of Rio de Janeiro.
Photo credit: Angela Meurer*

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In brief

Overview

Initiated in 1986 by the Municipal Secretariat of Social Development (SMDS) of the Prefeitura do Rio (City Government), the Mutirão Reflorestamento (MR, Reforestation Joint Effort) aims to restore native Atlantic Forest vegetation cover and ameliorate social and environmental problems within low-income settlements (*favelas*) located on steep hillsides in areas highly vulnerable to landslides, rockfalls, and fires. Paid volunteers (*mutirantes*) from local communities prepare reforestation sites, plant seedlings, and maintain and protect sites after planting. In 1994, the MR was transferred to the Municipal Secretary of the Environment (SMAC). Steady efforts over 35 years led to significant reforestation and improvement in ecosystem services. By 2019, 10 million seedlings had been planted in over 3,400 ha in 92 neighborhoods across the Rio metropolitan area. The MR recruited and trained 15,000 paid volunteers who became agents of change that improved the quality of life and the environment of favela residents.

Exemplary practices

This pioneering joint effort established new partnerships between the City Government and local community associations. The project is executed by recruiting an unemployed workforce from the communities, emphasizing training and helping prepare workers for integration into the workforce. The project and its benefits are discussed by the favela communities, who elect a project manager to be responsible for the recruitment of labor, control of materials, and local participation. In addition to providing financial assistance and preparing and monitoring the project, SMAC provides equipment and supplies. Seeds are collected from diverse sources; 2,500 mother trees and native seedlings are grown in five nurseries across the Rio Metro area. A dedicated staff and the effective diffusion of information through media, newsletters, and conferences were effective strategies for institutionalizing the program and ensuring its continuity through changes in local administration and municipal government.

Key lessons learned

- ▶ *Communities and favela residents' associations should be the focal point for environmental education and restoration efforts.*
- ▶ *A single coordinating agency should govern the reforestation project.*
- ▶ *In urban neighborhoods, planting trees that produce fruit, medicines, or other useful timber and non-timber products can contribute to local food security, enhance livelihoods, and promote community engagement and stewardship of local forest areas.*
- ▶ *Alleviating urban poverty is essential to ensuring urban environmental restoration.*
- ▶ *Strong civil society and grassroots initiatives are essential for lasting solutions to poverty and environmental degradation.*





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Restoration narrative

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Geography and ecological setting

The Marvelous City (a Cidade Maravilhosa) of Rio de Janeiro (22.9028°S, 43.2078°W), the capital of Rio de Janeiro State, Brazil, extends between the coastal mountains and the Atlantic Ocean. Rio is the second-most populous city in Brazil with 6.7 million residents in 2020 (IBGE, 2020). The city proper covers a total surface area of 122,400 ha, while the metro region covers 453,980 ha and encompasses 22 municipalities (Figure 1). An estimated 13.5 million people live in the greater metropolitan area (World Population Review, 2022). Within the city, urbanized areas compose 64,400 ha and non-urbanized areas (forests, agricultural lands, and other land covers) cover 60,000 ha (Sandholz et al., 2018).

The city was founded in 1565 by Portuguese colonists and was the colonial capital from 1763 to 1808 (Wikipedia, 2021). When Brazil declared independence from Portugal in 1822, Rio became the capital of the new empire of Dom Pedro I. Political importance and economic prosperity led to large-scale urban development projects, while the abolition of slavery in 1888 generated a massive inflow of poor migrants and the emergence of low-income settlements (Lange et al., 2018).

The core of Rio lies on the plains of the western shore of Guanabara Bay (Figures 1 and 3), divided into five zones by partially forested massifs (Herzog and Finotti, 2013). These mountains and hills are offshoots of the Serra do Mar to the northwest, an ancient gneiss-granite mountain chain that forms the southern slopes of the Brazilian Highlands.

The unique geography of Rio de Janeiro's urban landscape is both a blessing and a curse. The mountainous topography presents unparalleled scenic beauty, making Rio one of the most visited cities in the Southern Hemisphere (Figure 2). Rugged topography, heavy summer rainfall, and unstable geological features make Rio de Janeiro prone to landslides and debris-flows (Lange et al., 2018; Sandholz et al., 2018). Close to 20% of the population lives in one of the more than 1000 informal settlements, or *favelas* (Cavallieri and Vial, 2012), precariously perched on steep hillsides. Compacted soil causes runoff and flooding, and disease-carrying mosquitoes prosper in the wet and muddy conditions (Perlman, 2000). In 1966 alone, hundreds of landslides killed 70 people and injured 500 (Ancin, 2008).

Rio de Janeiro is located within Brazil's Atlantic Forest region, a global biodiversity hotspot and priority area for conservation (Rezende

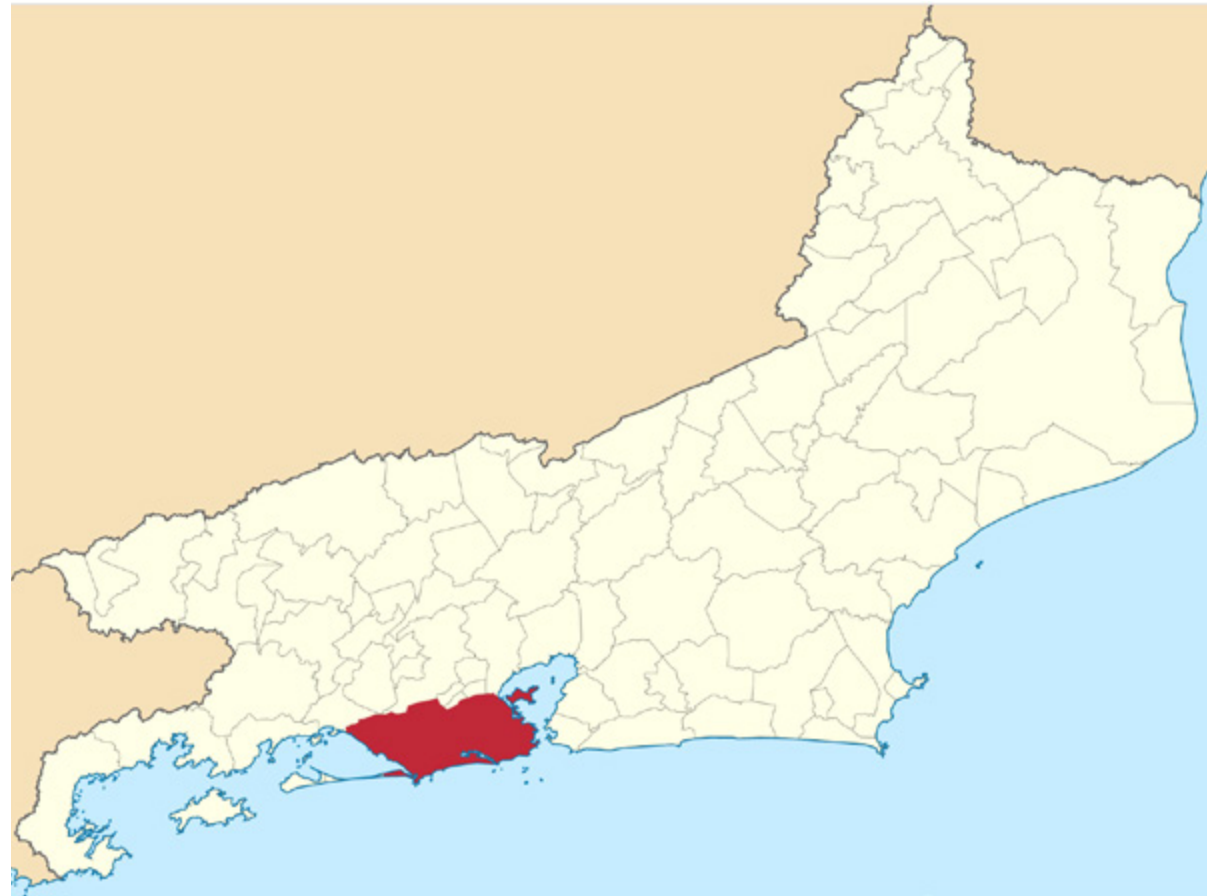


Figure 1. Map of the Rio de Janeiro metropolitan area within Rio de Janeiro State. The city was founded on an inlet of this stretch of the coast, Guanabara Bay (Baía de Guanabara). Source: Rio de Janeiro Wiki



Figure 2. View of Rio de Janeiro from Parque da Cidade in Niterói in 2014.
Photo credit: Leonardo Ferreira Mendes (This photo (with no modifications) is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license.)

et al., 2018; Schweizer and Chazdon, 2021). Forest areas within the Metro area contain 293 tree species, including 20 species considered endangered or critically endangered; 33 faunal species were rated as critically endangered, and 52 as endangered (PCRJ, 1997; Herzog and Finotti, 2013). A variety of ecosystems are found within the city, including coastal sand bars (*restinga*), mangroves, inselbergs, lagoons, and fluvial and marine associated systems (Scarano, 2014). The north and south zones of the city are separated by Tijuca National Park, one of the largest urban forests in the world, home to several endemic and threatened amphibians, birds, mammals, epiphytic orchids, and bromeliads (Scarano, 2014; Scarano and Ceotto, 2015; Stålhammar and Brink, 2021).

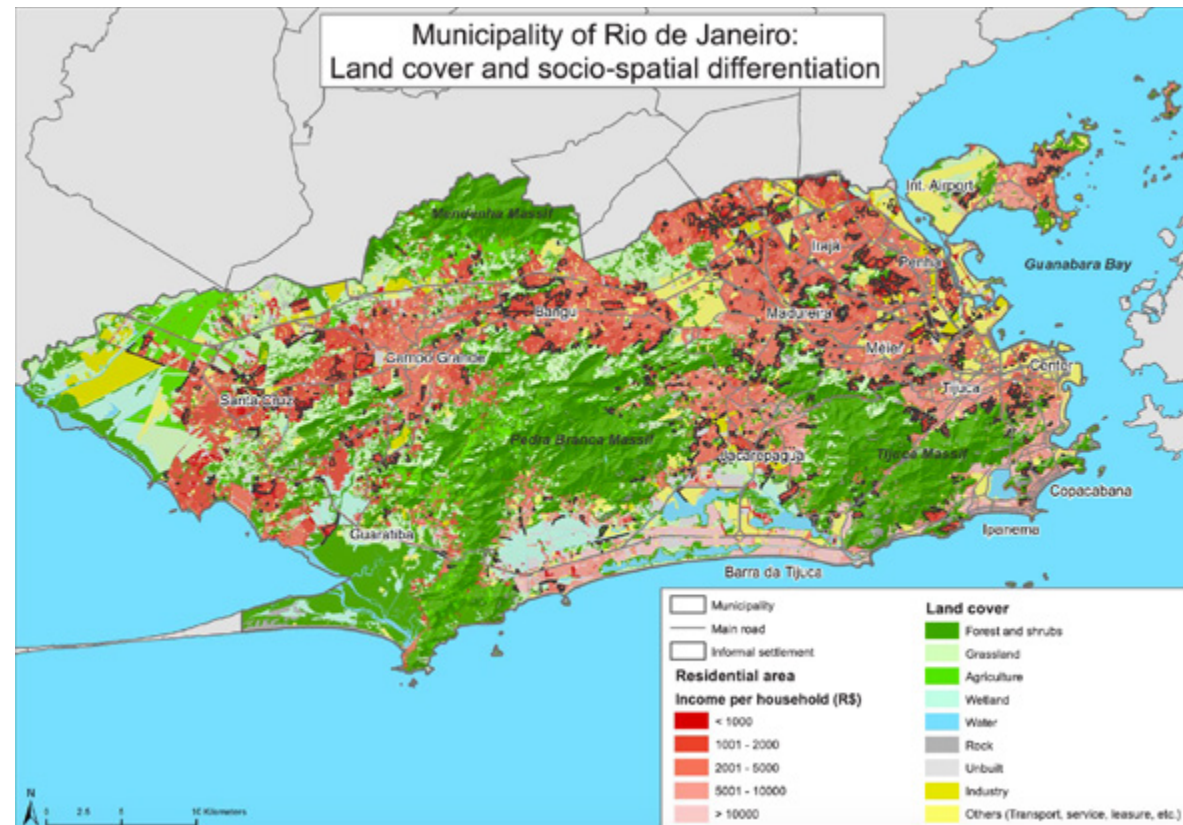


Figure 3. Land cover and socio-spatial differentiation of the Municipality of Rio de Janeiro. Source: Instituto Pereira Passos, 2012; Cartography: W. Lange

Deforestation history

In Rio de Janeiro city, from 1984 to 2001, Atlantic Forest cover was reduced to approximately 28% of its original extent (Rio de Janeiro, 2002). The original mangroves in the estuarine areas, lagoons and bay margins covered an estimated 25,790 ha, of which approximately 8,000 ha remains (Amador, 1996). Brought to Rio around 1760, coffee was planted on the small hills that emerge from the urban plain. The first large plantations were established in the Gávea Pequena river basin, which drains into the Tijuca Lagoon (Solorzano et al., 2017). Much of the area that became modern Rio was directly converted from forest to coffee plantations (Drummond, 1996). Remaining forests were exploited for production of charcoal, which fueled the development and infrastructure of Rio de Janeiro from the nineteenth century to mid-twentieth century.

The coastal massifs of Rio de Janeiro witnessed extensive forest use by enslaved populations and freemen for the production of charcoal as a means of subsistence (Solorzano et al., 2021). Charcoal production allowed the establishment of marginalized populations within the forest and reached a peak from the early nineteenth to mid-twentieth century, after the decline of coffee

monocultures and the abolition of slave labor. In the Pedra Branca and Tijuca Massif (Figure 3), jackfruit (*Artocarpus heterophyllus*)—a fruit species native of southeast Asia—was introduced to feed the enslaved populations in the farms and was also consumed by the charcoal workers owing to its abundance and low cost (Figure 4; Solorzano et al., 2021).

The 3,900 ha of forest in Tijuca National Park is the outcome of the first large-scale forest restoration project in Brazil, implemented between 1862 and 1892 by Emperor Dom Pedro II. Thousands of seedlings of native and exotic species (including jackfruit) were planted on the deforested hills surrounding the city in an effort to alleviate severe drought conditions (Drummond, 1996; Rodrigues et al, 2009; Zaú et al., 2021).

With little affordable housing available, many migrants settled on marginal lands, such as riverbanks or steep mountain slopes, forming the *favelas* (Stålhammar and Brink, 2021). Between 2000 and 2010 the population growth of the *favelas* (19%) was almost four times higher than that of the formal city (5%) (Sanholz et al., 2018).



Figure 4. A jackfruit tree growing in Parque Natural Municipal Penhasco Dois Irmãos.
Photo credit: Robin Chazdon

The turning point

The confluence of social and environmental problems in Rio de Janeiro reached a critical point during the 1980s. Brazil was experiencing a time of great economic crisis and stagnation. Unemployment in the *favelas* was high, and those that were employed generally had low-paying, unskilled jobs, often in the informal economy and lacking labor contracts and social benefits. Real wages and standards of living dropped, with over half of the residents of Rio living below the official poverty line (SMDS, 1994). On steep hillsides stripped of vegetation cover, soil became saturated, leading to landslides and rockfalls. In 1988 landslides killed nearly 300 people, injured 1000 people, and left thousands homeless (SMDS, 1994).

Twenty years of military dictatorship in Brazil came to an end in 1985, ushering in a new period of social engagement, political consciousness, and progressive public policies. The Mutirão program started in 1984 as a set of community task forces (*“mutirões”* in Portuguese) implemented by the newly formed Municipal Secretariat of Social Development (SMDS) including the Sanitation Task Force and the Housing Task Force. Collectively known as the Self-Help Project, these programs

were part of a larger effort to raise political consciousness and improve lives of *favela* residents and to strengthen civil society in support of democratic governance (SMDS, 1994). The overall goal was to transform *favelas* through infrastructure and upgrading projects that involved coordinated efforts by government and community organizations. In 1986, the Mutirão Reflorestamento (MR) was created under the administration of Mayor Saturnino Braga, motivated by a request by the municipal body that oversees slope stabilization and risk prevention and under pressure from the Forest Engineers Union who sought a greater role within the municipal government (SMDS, 1994).

The MR became one of the most important municipality assets for community engagement. It was a pioneering initiative that hired local labor to work on reforestation projects in areas adjacent to vulnerable *favelas* (Santana, 2021). These changes signaled a recognition that environmental problems and poverty were inextricable and that “reforestation and the stabilization of risk areas should involve the participation of the community where the project is undertaken” (SMDS, 1994, p. 13).

Actors and arrangements

The MR was initiated by the Municipal Secretariat of Social Development (SMDS) in 1986 with the aim of recovering native Atlantic Forest vegetation and ameliorating social and environmental problems within low-income settlements. A further goal was to provide job opportunities for community residents (Lemgruber et al., 2021). Other names of the Program include, the Program for the Preservation and Reforestation of Low-Income Areas, the Paid Self-Help Reforestation Project, or the Favela Reforestation Program (SMDS, 1994). This collaborative philosophy formed the basis of the project, stemming from the definition of “*mutirão*” as a joint effort involving new partnerships between the Prefeitura do Rio (City Government) and local community associations.

The MR coordinates and implements reforestation measures. Overall, the project is led by the City Government, but the implementation and sub-governance arrangements across neighborhoods is tailored to specific needs and capacities. The United Nations Conference on Environment and Development (UNCED), also known as the “Earth Summit,” was held in Rio de Janeiro

in June 1992, and led to the creation of the Municipal Secretary of the Environment (SMAC). The MR was transferred to this new agency in 1994 (Barboza, 2016) and developed a strong technical team that maintained continuity over 34 years (Figure 5).

Community leaders and managers were heavily integrated within the MR. Individuals were selected by communities to recruit and manage local workers for the project. They participated in technical decisions and were partly responsible for community environmental education and for generating local support for reforestation activities (SMDS, 1994). Local work crews prepared reforestation sites, planted seedlings, and maintained and protected sites after planting until the sites became self-sustaining. The program engages local NGOs and associations such as the Associação dos Amigos do Parque Nacional da Tijuca and the Amigos do Parque Estadual da Pedra Branca to assist with implementation of reforestation projects. The NGO Verdejar initiated reforestation efforts in a number of hilltop locations in Misericórdia massif in 1995 (Herzog and Finotti, 2013) and remains actively engaged in environmental and agroforestry activities.

In deforested areas located far away from local communities, third-party contracts



Figure 5. The Mutirão Reforestamento technical team in 2019. Photo credit: Angela Meurer

were arranged with specialized companies to implement reforestation activities. In some cases, companies provided compensatory payments to mitigate environmental damages. Some companies also received financial incentives from the municipality through investments in long-term reforestation activities (Sandholz et al., 2018; Santana, 2021).

Several municipal agencies and centers have an integral role in MR. Species selection and reforestation practices were the responsibility of the Center for the Production of the Forest (Centro de Produção de Essências Florestas), a model farm located in Guaratiba in the western part of Rio. Seedlings were grown here by a workforce of individuals experiencing mental or physical disabilities, homelessness, or unemployment (SMDS, 1994). Federal and state research institutions and public corporations, such as the Botanical Gardens, the Rural University of Rio de Janeiro, and the Brazilian Agropecuary Research Center provided technical support (SMDS, 1994). Within SMDS, the risk-mapping and water management units actively collaborated in the establishment of restoration projects (Sandholz et al., 2018).

In 2010 the Government of Rio formed its own reforestation program, Rio Capital Verde, with the planting of 950 ha of degraded lands with seedlings grown in local nurseries

(World Bank, 2013). The World Bank became a partner in this effort. The program plants trees in remote areas of Rio, and the project will earn carbon credits under the Rio Low Carbon City Development Program.

Planning and engagement

In addition to achieving the general objectives within the broader Mutirão Programs, the MR had specific objectives and targets (SMDS, 1994; Santana, 2021):

- ▶ Reforest areas at risk of landslides originally occupied by *favelas*
- ▶ Restrict horizontal expansion of *favelas*
- ▶ Regulate water fluxes through increasing infiltration of water on slopes and decreasing surface run-off and restoration of freshwater springs
- ▶ Provide a source of nutrition for *favela* residents by growing fruit trees and vegetable gardens on adjacent hillsides
- ▶ Ameliorate microclimates and fire risk in areas dominated by exotic grasses
- ▶ Improve the landscape and provide natural areas for recreation and return of fauna
- ▶ Provide social benefits to *favela* communities through creation of jobs, provision of income, access to water,

reduction of erosion, improved drainage, and attraction of external investments

- ▶ Engage the local community in the fight for the preservation of the environment, demonstrating the benefits of reforestation through a program of environmental education
- ▶ Increase connectivity of forest fragments
- ▶ Increase wildlife refuge



Figure 6. Digging holes in preparation for enrichment planting of seedlings in Amigos do Parque Dois Irmãos. Photo credit: Camila Rocha

The MR selected target areas for reforestation based on the following criteria: 1) steep slopes with degraded vegetation and soil, close to poor communities and subject to landslides; 2) valleys with irregular occupation and with flooding risks, due to the silting of rivers and channels; 3) areas that included streams and springs that supply drainage canals and rivers; 4) areas adjacent to Protected Areas or Areas of Permanent Protection; and 5) communities with a well-organized resident's association and potential for further mobilization (SMDS, 1990; SMDS 1994; Lemgruber et al., 2021). SMAC's technical team (Figure 6) prepares specific projects with a list of species, spacing and maintenance methodology based on the type of soil, slope, vegetation cover, and presence or absence of forest fragments.

Community participation was essential to the project's sustainability (SMDS, 1994). The project and its benefits were presented at assemblies of residents' associations and discussed by the *favela* communities, who elected a project manager to be responsible for the recruitment of labor, control of materials and local participation (SMDS, 1994). The entire project is executed by recruiting an unemployed workforce from the communities, with an emphasis on training, which helped to prepare workers for integration into the general workforce (Salgado, 1988).

Costs, funding, and other support

The MR has been implemented since 1986 using municipal financial resources. During the 1990s the MR received additional funds from the Inter-American Development Bank as compensation for the improvement of *favela* urbanization and job creation (Herzog and Antuña Rozado, 2019). Santana (2021) estimated that the total costs of planting and maintenance per hectare (including salaries, transport, and maintenance) was around R\$60,000 (US\$11,087 in August 2021), but in areas with difficult access the per ha costs of transporting seedlings and materials could be as high as R\$150,000 (US\$27,727 in August 2021). Maintenance costs constitute about 70% of the total budget.

Implementation

Over the past 35 years, the MR passed through several phases. Initially, a pilot phase began in 1986 in Morro São Jose Operário (Jacarepaguá) with the planting of 14,725 seedlings in 5.9 ha, in a joint effort with volunteers from the community itself. Community associations were just beginning to become organized for planting projects, particularly in older and well-known communities (Figure 7; Santana, 2021). Local favela residents were recruited and managed by community leaders as planting and maintenance crews in the reforestation sites, and were paid for their “volunteer work,” thus “ensuring community participation and fulfillment of many of the development needs of the favelas that are only indirectly connected with deforestation” (SMDS, 1994, p. 14). These individuals became known as *mutirantes* (Figure 8). Generally, they are people facing difficulties in finding formal employment opportunities with ages from 18 to 58 years old. A survey conducted by the Municipal Secretariat for the Environment revealed that half of the volunteers worked with the program for over 10 years. Payments from this program were the only source of income for 60% of the workers’ families (Prefeitura do Rio, 2019). Site preparation before planting took a year or more and included: construction of ditches

and channels to surround and divide the lots to be reforested and reduce risk of fire; clearance and plowing of land; demarcation of lots in accordance with the characteristics of the area, degree of slope instability and angle, soil fertility, and species to be planted; terracing of land for tree planting; preparation of the land for the seedlings; and fertilization and planting in accordance with soil type and conditions (Figure 6; SMDS, 1994).

Prior to the construction of the nursery at Fazenda Modelo in 1986 (Figure 9), seedlings were provided through a technical agreement with the Botanical Garden of Rio de Janeiro (SMDS, 1990). Now, seedlings are grown in five nurseries across the Rio Metro area. Seeds are collected from 2,500 mother trees that are registered in a database, and the fruits are collected and processed for immediate planting or storage (Romar, 2013; SMAC, 2021). Combined, these nurseries have the capacity to produce more than one million seedlings per year representing 200 tree species and 130 species of shrubs, herbs, and climbing plants (SMAC, 2021). Tree species for reforestation are selected based on the following criteria: rapid growth and ability to resist invasion by other plant species, especially grasses; extensive root system capable of binding and stabilizing the soil; large and dense leaf cover to intercept rain and shade the forest floor; good



Figure 7. Site preparation started in Morro São José Operário in 1987 (above). By 2019 (below), 5.89 hectares of land have been reforested. Photo credit: Acervo CAV



deposition of organic matter to protect and improve soil quality; and ability to grow in eroded soils with low fertility and resist pests and diseases (SMDS, 1994; Santana, 2021). Legumes with rapid growth and high survival rates are planted extensively to recuperate soil. Native species of Brazil's Atlantic Forest were prioritized for the restoration of vegetation cover; but some exotic species were planted as they grew well in nurseries and were adapted to climatic conditions and steep slopes. Species with edible fruits are also commonly planted (SMDS, 1994). The MR works with a set of 200 species native to the region, including herbs, treelets, climbers, and vines, spanning a range of functional groups.

Following planting, maintenance is undertaken for 2–3 years led by community members. Maintenance tasks include clearing drainage channels and ditches, replanting, fertilizing, weeding, pruning and trimming, and the control of pests and diseases. After this maintenance period the forest is sufficiently well established to become self-sustaining (SMDS, 1994). In 1995, after being relocated to the environmental municipality bureau (Secretaria Municipal de Meio Ambiente da Cidade, SMAC), the program implemented a performance pay scheme in which community members received payments in proportion to the tree

plantings executed. This system increased their permanence in the program. In the same year, communities affected by tidal dynamics close to mangrove areas (e.g., Jequiá River Estuary, Ilha do Governador) were included in the project. In 2005, inspired by the success of “Eco Orla”, a municipality project focused on the restoration of *restinga* (i.e., coastal dune vegetation), MR engaged local communities in



Figure 8. A local group of mutirantes working together. Photo credit: Camila Rocha



Figure 9. Fazenda Modelo native tree nursery.
Photo credit: Angela Meurer

restinga plantings (Prefeitura do Rio, 2019). From 2011 onwards, new types of reforestation projects joined forces with the MR, operating where there are no communities, through tax exemptions and contracts with private companies involving environmental compensation. The companies execute reforestation projects that are monitored and inspected by technicians from the City of Rio's Department of Environment. As of 2019, these reforestation actions became part of the Rio Verde Novo Program, which in partnership with the MR forms the Refloresta Rio (SMAC, 2021). Reforestation is now implemented based on two main strategies: community engagement under the MR and private contractors for executing reforestation projects through the program Rio Verde Novo. By 2019, a total of 189 projects had been implemented; 182 in Atlantic Forest, 2 in restinga, 1 in marsh, and 4 in mangrove ecosystems (SMAC, 2021) (Figure 10).

Apart from tree planting, the Environmental Education Center of the Municipality of Rio offers an Environmental Education Program in Reforestation Areas, (Programa de Educação Ambiental em Áreas de Reflorestamento, PEAR). This program works with local residents called Environmental Agents, which conduct local diagnoses to develop the action plan in the community, bring educational materials to schools and promote networking with other actors in the region (Figure 11; SMAC, 2021).

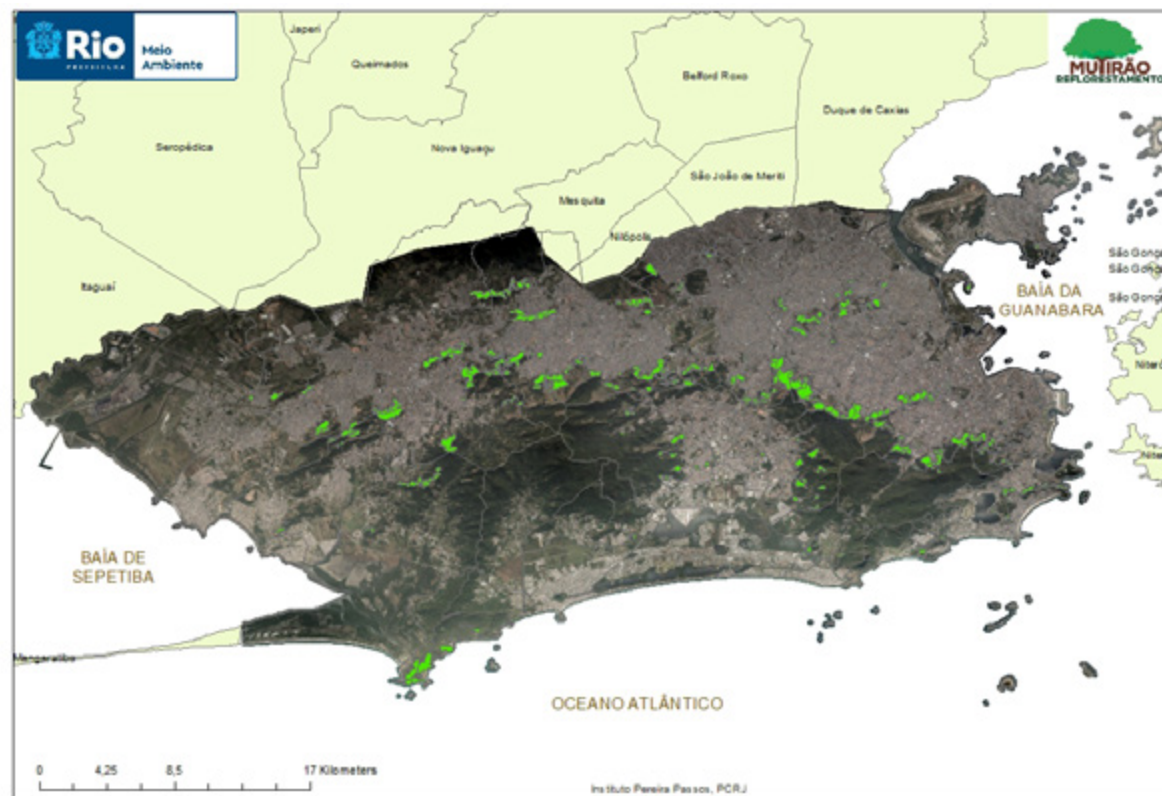


Figure 10. Map of 189 projects of the Mutirão Reflorestamento (in green).
Source: Luiz Carlos Pereira Lourenço, SMAC

Reforestation monitoring is carried out through a methodology developed by program technicians from the Rio de Janeiro State Environmental Institute's Rapid Environmental Diagnosis and adapted to the particularities and challenges in the recovery of forests in urban areas. Qualitative and quantitative assessments of the reforested areas are carried out at predetermined points within project areas, with the goal of classifying each area into one of the four development stages. Indicators for development stages include: vegetation height and life-form diversity, species composition, organic matter deposition, and establishment of natural regeneration (SMAC, 2021). The city of Rio developed a monitoring tool named SIG Floresta that mapped the ecosystem fragments in 2010, 2014, and 2016 (Instituto Pereira Passos, 2016).



Figure 11. Public environmental education activities organized by PEAR.
Photo credit: Acervo CAV

Outcomes and impacts

Before and after photos in reforested areas (Figures 12 and 13) clearly demonstrate the impacts of the MR interventions (SMAC, 2021). Steady efforts over 35 years led to significant reforestation in favelas as well as less populated areas. By 1994, nearly 300,000 seedlings were planted in 241.8 ha in 25 favelas across the Metro Area, benefiting 90,000 residents plus nearby neighborhoods affected by the impacts of deforestation (SMDS, 1994). In 1998, 600 ha were reforested in over 50 favelas (Barboza, 2016), and by 1999 2 million seedlings had been planted across 1,000 ha of plantations, benefitting 64 communities (SMAC, 2021). By 2010, the MR had successfully reforested 1,920 ha on deforested slopes susceptible to landslides (Herzog and Finotti, 2013) and by 2013: 2,200 ha were reforested, with more than 6 million seedlings planted (Romar, 2013). In 2019, 33 years after the MR was first initiated, 10 million seedlings had been planted in over 3,400 ha in 92 neighborhoods (Figure 10).

MR reduced the public expenditure for costly civil engineering works that were applied to reduce hillside erosion (SMDS, 1994). The reforestation effort also positively impacted biodiversity within the Rio Metro region. Collectively, reforestation plantings were



Figure 12. (left) Sumaré in 1998, before restoration efforts and (right) in 2019, after reforestation efforts. Photo credits: Acervo CAV (1988) and Angela Meurer (2019)



Figure 13. Before (left) and after (right) reforestation near Rocinha. Photo credits: Acervo CAV (1996) and Angela Meurer (2019).

composed of over 900 plant species, from herbs to large trees, including 66 species under some degree of threat (SMAC, 2021). Recovering vegetation provides homes and food for mammals (Figure 14), reptiles, birds, insects and other animals who enrich the areas by dispersing seeds (SMAC, 2021). Reforested areas serve as biological corridors connecting the Tijuca Forest (Federal Conservation Unit), the Pedra Branca Massif (State Conservation Unit) and the Maciço Gericinó-Mendanha (State and Municipal Conservation Unit) and its foothills, as well as in highlands (SMAC, 2021).

The species composition in reforested areas near *favelas* partly reflects choices made by local residents, with a large presence of species planted for fruit and ornamental trees. A tree survey in a reforested area of 30 ha in the *favela* Morro da Formiga found 1,042 individuals belonging to 148 species and 42 families (Sartori et al., 2019). The five most abundant species were fruit trees: mango (*Mangifera indica*), guava (*Psidium guajava*), avocado (*Persea americana*), jackfruit (*Artocarpus heterophyllus*; Figure 4), and coconut (*Cocos nucifera*). In this site, native species represented 54% of the tree species, 40% of the individuals sampled were established through natural regeneration (not directly planted), and the majority of individuals (75%) are consumed and dispersed

by birds and mammals (Sartori et al., 2019). In some areas, exotic arboreal early successional species such as Leucena (*Leucaena leucocephala*) and thrush (*Mimosa caesalpiniiifolia*) form homogeneous populations and hinder the establishment of other species (SMAC, 2021). A vegetation assessment in a 55-ha reforestation site in Campo Grande found that exotic species accounted for approximately 25% of the basal area and density of canopy and small trees (Muler et al., 2017). Even 12 years after planting, the reforested site showed high cover of exotic grasses in the understory. Despite the high density of exotic tree species, the restoration plantation showed a similar vegetation size structure for small trees and seedlings and similar richness levels for seedlings. The restoration plantation showed a trajectory of increasing colonization of native species from the surrounding landscape; unplanted native species composed 66% of canopy trees, 68% of small trees, and 82% of seedlings (Muler et al., 2017).

All residents in the Campo Grande study acknowledged some improvement in provisioning ecosystem services after the implementation of the restoration project. Approximately 70% of men and 55% of women reported some type of use of the restored forest, mainly gathering fruits and leisure

activities (Muler et al., 2017). Additionally, 52% of men and 39% of women reported harvesting medicinal plants in the forest. Many different services were recognized as direct consequences of the restoration project, such as air cleaning, scenic beauty, and climate improvement (Muler et al., 2017).

*Figure 14. A sloth (*Bradypus variegatus*) hanging out in the reforested area of Amigos do Parque Dois Irmãos. Photo credit: Acervo CAV*



The MR recruited and trained 15,000 paid volunteers (*mutirantes*) from communities. The *mutirantes* became agents of change that improved the quality of life and the environment of *favela* residents (SMAC, 2021). According to a survey of residents of eight communities in 72 active reforestation projects, the main positive contributions of the MR were job creation and increased income (Lemgruber et al, 2021). In those eight communities, 11.5 ha of land were reforested, completely changing the vegetation cover in those areas. Interviewed project participants associated forests with increased income and a decrease of environmental disasters. The MR provided jobs and income to a chronically depressed sector, helping low-income workers meet the basic needs of their families (SMDS, 1994). Residents in project neighborhoods also perceived better air quality, closeness to nature, and a pleasant work environment as important benefits (Lemgruber et al., 2021).

Rio's community reforestation program was so successful that SMAC started a new urban forestry project called Rio Capital Verde ("Rio Green Capital") in 2010. The new project plants trees in remote areas of Rio and will earn carbon credits under the Rio Low Carbon City Development Program (LCCDP) (Braun, 2013). Over the past three decades, the MR Program has gained international recognition and

partnered with research institutions, producing scholarly research papers and student dissertations on various aspects of the reforestation activities (SMAC, 2021). The effort has promoted the development of new techniques for revegetation, aiming at faster soil coverage, reduction of invasive fire-prone grasses, enhancement of native biodiversity, and cost reduction in restoration (Salgado, 1988).

The MR was selected by the Project UN Megacities to integrate the publication "Environmental Innovation for Sustainable Mega-Cities: sharing approaches that work in 1990." It was also chosen as one of 100 Brazilian Experiences in Sustainable Development and Agenda 21, from the Ministry of Environment in 1997, and as one of the 20 best projects in Public Management and Citizenship, from the Getulio Vargas Foundation/Ford Foundation in 1997. MR also received a model project award for forest restoration from the Society for Ecological Restoration.

Key challenges

The innovative aspects of the MR also came with many challenges. In the beginning there was little knowledge regarding how to restore Atlantic Forest in urban areas, so the MR learned by trial and error. Hiring and retaining labor were difficult because of legal and institutional obstacles with the city government with regard to formally contracting with workers (Herzog and Antuña Rozado, 2019). Participation in the MR is not classified as employment but rather paid volunteer work. The paid volunteers, *mutirantes*, lacked a formal contract with the City Government Agencies, so they were not guaranteed labor rights such as paid vacation, health insurance, meals, personal protection equipment and assistance in case of accidents (Lemgruber et al., 2021). The informal employment process generated insecurity in the workforce (Salgado, 1988).

Fires and deforestation of reforested areas remain a major challenge (Figure 15), as illegal activities related to occupations and cattle grazing continue to threaten both reforested and originally forested areas within the larger Rio metropolitan area. Recent funding cuts have reduced the ability to patrol and reduce these threats, resulting in significant financial losses within the MR Program.

Expanding zones of forest cover provided coverage, hiding places, and escape routes for drug dealers and thieves, while violence escalated in the *favelas* (Lemgruber et al., 2021), impeding broader implementation of the reforestation program (Sandholz et al., 2018). Some of the MR projects on the northern slopes of the Tijuca Forest are within the territories of violent drug dealers that control the *favelas*.

Despite many efforts to engage community members, in many cases the rate of engagement was low and residents had little input into tree species selection or reforestation methods (Muler et al., 2017). In some areas, particularly on northern hillsides, fires from trash burning or deliberate actions destroyed reforestation plantings (Lange et al., 2018), and local herders brought their sheep, goats, or cows to graze in the reforested sites (SMDS, 1994; SMAC, 2019). Local people continue to illegally dispose of waste and misuse the reforested area, thus hindering the reforestation effort (Lange et al., 2018). Reforestation areas did not completely succeed in containing the expansion of *favelas* or illegal construction of buildings, causing deforestation in some cases (SMAC, 2019).

Sustaining a long-term effort such as MR is not an easy task. Obtaining sufficient financial resources and support from government agencies for MR has been a constant challenge, particularly since 2016 (Herzog and Antuña Rozado, 2019). Dedicated staff and effective diffusion of information through media, newsletters, and conferences were effective strategies for institutionalizing the program and ensuring its continuity through changes in local administration and municipal government. The City Hall produced widely disseminated pamphlets, videos, and websites to publicize the work and successes of the MR and to gain support and collaboration from the broader public within the Rio metro area.



Figure 15. Burned area in a reforested plot. Photo credit: Acervo CAV

Enabling factors

Institutionalizing the MR within the Rio government created the opportunity for long-term success and continued partnerships with other governmental agencies, non-governmental organizations, and the private sector. The program has grown over time through broadening partnerships that align with reforestation activities. The MR remains focused on active participation of community residents and local job creation as well as establishing a dedicated staff of diverse and highly capable technicians and public servants (SMAC 2019).

The MR Project was an alternative to traditional reforestation projects that tended to be implemented by profit-driven private contractors and that kept the economic benefit and control of the project out of local hands, undermining its sustainability. By promoting community pride in and support of reforested areas, the MR helped to contain the indiscriminate spread of *favelas* in a manner that was preferable to the previously used methods of forceful eviction and punishment of favela residents (Salgado, 1988).

The high visibility of the reforestation work within the striking Rio de Janeiro landscape continues to generate support and inspire

enthusiasm for continued tree planting and restoration activities. The reforestation work not only benefited the local *favela* residents but also generated a sense of pride among the residents of Rio de Janeiro (SMAC, 2019).

Parting shot

“I think this work of mine is very important, as we depend on trees to breathe, they are the ones that bring our oxygen. The cool thing is to go to the big city, see a tree and think that that seedling may have passed through my hands.”

—Gelson Gancia, nursery worker

Photo credit: Acervo CAV





Key lessons learned

- ▶ *Communities and favela residents' associations should be the focal point for environmental education and efforts that motivate people to preserve and protect the benefits derived from reforestation projects.* Reforestation efforts need to represent the will of the community to enhance social justice and equity, based on democratic practices and inclusive public policies. Communities must have leaders that are capable of recruiting and managing local labor forces, working with government and technical advisors and addressing problems as they arise (Salgado, 1988).
- ▶ *A single coordinating agency should govern the reforestation project, avoiding dependence on complex political alliances and partnerships.* It is important that the governing agency has a certain degree of independence and the ability to forego bureaucratic entanglements and established regulations or practices that could stand in the way of legally employing workers (SMDS, 1994). Governments should also institute labor policies that take into account the legal and social implications of paid “volunteers”, facilitating and providing incentives for hiring workers.
- ▶ *In urban neighborhoods, planting trees that produce fruit, medicines, or other useful non-timber and timber products can contribute to local food security, enhance livelihoods, and promote community engagement and stewardship of local forest areas.* Participatory and bottom-up approaches that include residents in the design, implementation and monitoring phase of the project are critical (Lemgruber et al., 2021).
- ▶ *Alleviating urban poverty is essential to ensuring urban environmental restoration.* The urban poor tend to occupy the most ecologically fragile and service-deprived areas of cities. Without alternative locations to settle, and adequate food, water, and personal security, survival of the urban poor can increasingly be pitted against urban environmental needs. In addition, urban environmental, social, and economic sustainability is essential for global sustainability (Perlman, 2000).
- ▶ *Strong civil society and grassroots initiatives are essential for lasting solutions to poverty and environmental degradation.* However local innovations cannot scale up without cross-sectoral partnerships involving government, business, NGOs, academia, media, and grassroots groups whose collective action creates a climate conducive to experimentation, mutual learning, and collaboration (SMDS, 1994).



Learn more

Further information and resources

Pamphlet: 33 Anos Plantando Florestas no Rio de Janeiro

<http://www.rio.rj.gov.br/dlstatic/10112/10678442/4261915/33anosPLANTANDOFLORESTASSITE.pdf>

Website: Story Map Refloresta Rio; Programa de Reflorestamento do Município do Rio de Janeiro

<https://storymaps.arcgis.com/stories/7afa6040cd4e46b48720e280b7238434>

Video: Reflorestamento Comunitário Rio de Janeiro 20 anos

<https://www.youtube.com/watch?v=5aBuxbt7hp0>

Video: Programa Mutirão Reflorestamento 33 anos

<https://www.youtube.com/watch?v=PfkuME0HXJk>

Video: Projeto Mutirão Reflorestamento 35 anos

<https://www.youtube.com/watch?v=eMBwTCMvsAo>

Website: Verdejar Socioambiental

<https://www.verdejar.org/>

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Acknowledgements

We thank Daniella Schweizer for her assistance with arranging interviews for this case study. Luiz Carlos Pereira Lourenço, Director of the Mutirão provided the map in Figure 10 and access to photos from several municipal sources. This case study is made possible by funding from the World Economic Forum and was edited and managed by Rebecca J Cole and ETH Zurich's Crowther Lab.

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