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Natural Infrastructure in Belo Horizonte's Water System, Brazil

Solutions integrating rural and urban areas and generating benefits for society as a whole

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ACKNOWLEDGEMENTS

SUGGESTED CITATION

Foreword

Brazil is rich in forests and fresh water. Water and forests are assets that complement each other and guarantee the maintenance of biodiversity and climate, which support life on the planet.

The water crises, experienced in different regions of the country and increasingly severe, are responses to the environmental imbalance caused by deforestation, irregular land occupation and other human activities.

Studies such as the Aqueduct Water Risk Atlas, developed by WRI, place the country's large metropolitan regions among the most vulnerable in the world, due to difficulties in supply infrastructure and high demand. The Belo Horizonte Metropolitan Region (BHMR) does not escape this scenario. Its more than 6 million inhabitants have already faced severe water crises, the most recent in 2015, when a historical drought was experienced and directly affected water supply in several cities.

The most common response by public managers to water crises has been the conduction of works and investments in conventional infrastructure, such as drilling wells and construction of new treatment plants. These measures may provide a solution in the short-term, but they are not capable of guaranteeing lasting water supply for the population. Increasing the resilience of ecosystems is critical to ensuring sustainable water supply, reducing dependence on gray infrastructure that can be affected by extreme weather events.

Since 2018, WRI Brasil has been researching the impact of natural infrastructure in metropolitan regions, generating data and recommendations on how nature-based solutions can mitigate water crises and reduce water treatment costs.

Jointly developed with Companhia de Saneamento de Minas Gerais (COPASA MG), responsible for supplying water to a significant portion of the BHMR, this study focused on the two main watersheds that supply the region, Alto Rio das Velhas and Rio Manso, looking to identify priority areas for natural infrastructure, which, once implemented, can improve the water conditions experienced by the entire population. This work is the result of a partnership aimed at supporting the planning of actions and the allocation of resources so that solutions to the water crisis are effective and permanent over the long term.

Water security is the result of a number of factors and actions outlined in this study and can only be ensured by means of strengthened and inclusive governance, in which public authorities, the private sector and rural producers dialogue and reach common agreements. Its is still necessary to broaden the perspective on the water crisis, identifying the most affected populations. When considering policies that support the implementation of natural infrastructure and other nature-based solutions, it is crucial that such actions are primarily focused on these populations.

It is important to emphasize that the results for the BHMR are not isolated. This study is part of a sequence of research studies and assessments in the watersheds that serve the largest metropolitan areas in the southeastern region of Brazil, including São Paulo, Rio de Janeiro, Vitória and Campinas. And all these studies point in the same direction: restoring degraded areas around rivers and reservoirs is a worthwhile investment, generating financial and environmental returns for society. This partnership between the traditional and the natural, between gray and green infrastructure, could prove the missing combination to guarantee water security in large cities, income and employment for small producers in rural areas and a healthy environment for the entire population.

FERNANDA BOSCAINI
Interim Executive Director at WRI Brasil

Executive Summary

This report is part of extensive research and application of specific methodologies developed by WRI. It aims to support decision-making based on the identification of investment opportunities in natural infrastructure to improve water quality in metropolitan regions.

HIGHLIGHTS

- Investments in natural infrastructure in the two main watersheds that supply the Belo Horizonte Metropolitan Region can prevent a sediment discharge of up to 200 tons per day, benefiting 6 million people.

- The forest restoration of 900 hectares of highly degraded pastures has the potential to generate savings of BRL 2 million per year in avoided water treatment costs.

- Restoration aimed at low-income smallholdings can save up to BRL 53,000 per month in water treatment, which is equivalent to a 26.5% reduction in current costs with chemical products, in addition to an initial average increase of BRL 169 per month in household income – which represents a 28% increase in current income.

- Strengthening coordination among local governments, development agencies, civil society organizations and other actors involved in water management is crucially important. This participatory and multisectoral governance is essential to ensure the effectiveness of actions and the integration of policies in the territory, based on local laws, plans and programs.

The study focuses on identifying the best ways to provide ecosystem services resulting in avoided sedimentation and their impacts on the water supply in the Belo Horizonte Metropolitan Region (BHMR). Additionally, it proposes how and where natural infrastructure can also promote benefits to low-income populations in the territory.

The natural infrastructure considered in this study is forest restoration, with the reconstruction of native vegetation as one of the key strategies for addressing water management issues in different land use scenarios.

INTRODUCTION

The availability of water is directly linked to water flow in water catchment and supply sources. It is possible to observe a decrease in the quality of water captured as a result of changes in rainfall caused by climate change, the effects of which have been increasing in intensity every year, and associated with environmental degradation and erosion processes that increase the generation of sediments.

These negative impacts generate various damages to the economy, although the most devastating effects are often not global, more prominently affecting populations in situations of environmental, social or economic vulnerability (IPCC, 2022). In this scenario, natural infrastructure plays a significant role, promoting various ecosystem services, including water quality.

The state of Minas Gerais has been suffering from water issues associated with climate change for many years. In 2015, the state, through the Minas Gerais Water Management Institute (IGAM), declared a critical water scarcity situation in several regions (Minas Gerais, 2015), including the BHMR. Since then, several initiatives have been implemented, including public policies, government programs and local initiatives. Of note is the Companhia de Saneamento de Minas Gerais (COPASA MG), which operates in 640 municipalities in the state, and in 2017 started the Socio-Environmental Program for the Protection and Recovery of Water Sources (Pró-Mananciais) with the aim of protecting and recovering watersheds and aquifer recharge areas in the water sources used for water capture in the cities covered by the company.

ABOUT THIS REPORT

This study is a contribution to the composition of water management in the BHMR and is limited to issues related to water quality, without addressing quantitative aspects of water flow in catchment areas. However, how and where should natural infrastructure be implemented? How to measure and evaluate the impact of investments in natural infrastructure actions in terms of savings generated in drinking water treatment? How can local communities benefit from restoration actions?

The work focuses on two areas that together are responsible for 80% of the BHMR's water supply: Alto Rio das Velhas Watershed and Rio Manso Watershed. The definition of the study area considered the contribution river basin based on COPASA MG's water collection point - the Bela Fama station in the Alto Rio das Velhas Basin and the Rio Manso reservoir in the Rio Manso Waterched[1].

The Green-Gray Assessment – GGA/WRI methodology was adopted for the conduction of this study and supported by a set of models of the InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) tool, enabling the analysis of environmental services generated by natural infrastructure. To this method, the Restoration Opportunity Assessment Methodology (ROAM) was added.

Financial, economic, and biophysical analyzes provide an overview of the actions that should be taken to improve water conditions in the river basins and where they should be applied. However, it is also essential to understand how the social landscape is established in the territory, what are the existing key success factors for the implementation of natural infrastructures and how to strengthen them.

FIGURE ES 1 | Definition of the study area
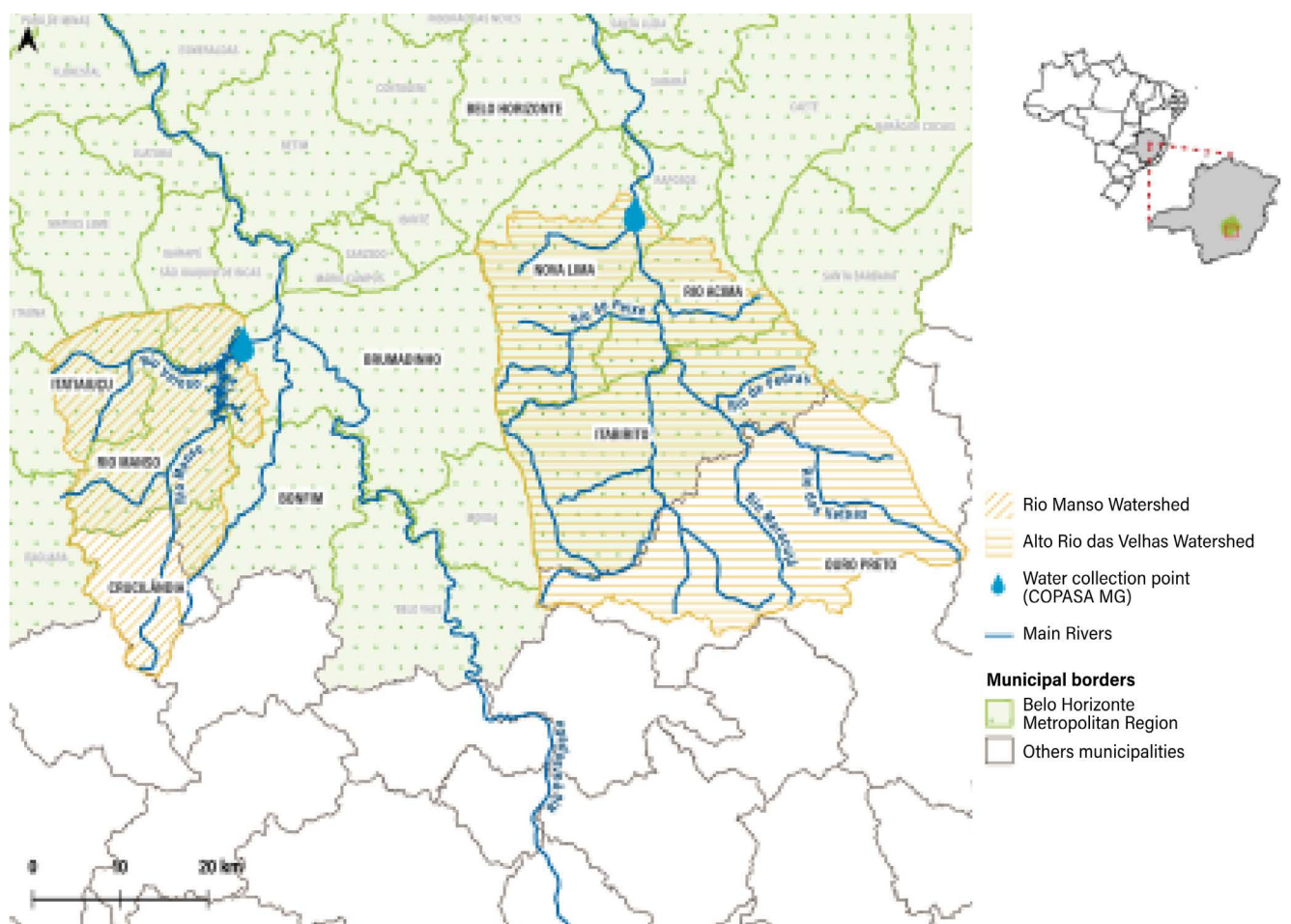
Source: Created by authors, based on IBGE (2020) and data provided by COPASA MG.

In this context, the use of ROAM aims to substantiate the analysis, providing a comprehensive view of the actors that make up the social landscape of the assessed territories. Complementarily, it provides data on the dynamics of information, financial resources and inputs and materials flows. It also allows a better understanding of how the regulatory framework and programs are structured and whether or not they support restoration actions or other natural infrastructure approaches.

The generated information directly contributes to supporting the prioritization and better application of financial resources based on the definition of different scenarios for the restoration of landscapes and forests. It also points out ways for restoration and other nature-based solutions to be effectively implemented and generate biophysical, social, and economic benefits.

Chapter 1 presents general information about the studied territory, applied methodology, challenges associated with water management and how natural infrastructure can contribute to improving the current scenario. Chapter 2 brings data on sedimentation generated by the current form of land occupation and use in the territory, as well as possible scenarios for restoration and the benefits associated with natural infrastructure in terms of avoided sediments and opportunity-cost monetary values. Chapter 3 describes forest restoration implementation strategies, considering the projects and initiatives in progress as a basis for territorial planning and the focus on low-income smallholding areas. Chapter 4 analyzes the situation of the key success factors for restoration, the legal framework underlying the theme, the social landscape and the governance of the studied watersheds territories. Finally, Chapter 5 brings recommendations on how efforts can be directed to ensure that natural infrastructure actions are considered in local plans and strategies that contribute to the water quality of the metropolitan region.

This study was conducted through a partnership between WRI Brasil and COPASA MG, with financial support from the UK Department for Environment, Food & Rural Affairs – DEFRA, through the Cities4Forests initiative[2].

BENEFITS OF NATURAL INFRASTRUCTURE TO URBAN WATER SUPPLY IN THE BHMR

The study measured the ecosystem services provided by the native vegetation currently existing in the two watersheds. This vegetation comprises an area of 135 thousand hectares, the largest in the Alto Rio das Velhas watershed, and prevents the discharge of 21.8 thousand tons of sediment per year. In terms of sediment retention and impacts on water quality, they reduce spending on chemical products used in water treatment by around BRL 2.5 million per year. Such benefits impact the company in charge and also the 6 million people who live in the BHMR.

> Investments in the implementation of natural infrastructure compatible with the budgets currently available for restoration could bring positive net benefits.

The investment of BRL 12 million in 900 hectares of highly degraded pastures could generate net benefits of BRL 59 million and a net present value (NPV) of BRL 8 million at a discount rate of 4.5% per year (social discount rate suggested for Brazil by Moore, Boardman and Vining (2020)) over a 50-year project horizon. Around 170 thousand people living in the rural areas of the two watersheds would be directly benefited by the reconstruction of native vegetation on their properties, restoring degraded areas identified as environmental liabilities in the Environmental Rural Registry (CAR) or implementing Agroforestry Systems (AFS). These actions would positively impact soil and water conditions, directly contributing to the improvement of agricultural production.

Investments in natural infrastructure can be financially justified by the savings associated with water treatment costs. The economic benefits clearly show that investments in restoration can, in addition to directly benefiting urban and rural populations, lead to expense reductions resulting from lower water treatment costs.

Even if investments are made in conservation and restoration of degraded pastures, mining activities continue to be the main source of sediment generation in the two watersheds. According to the study, it is estimated that the activity currently contributes around 79.4 thousand tons of sediments per year in the Alto Rio das Velhas Watershed and 9.5 thousand tons per year in the Rio Manso Watershed. The estimated cost of treating the turbidity resulting from these sediments stands around BRL 38.5 million per year.

Thus, as a complementary effort, mining companies must improve their tailings management and sediment control techniques, seeking to reduce their impact on the river basins. In addition, the environmental licensing process, which follows criteria according to the size and polluting potential of the enterprise (Copam Normative Deliberation No. 217/2017), must measure and channel the environmental compensations, considering the contribution of sediments generated by the enterprise.

By considering that natural infrastructure can generate income and contribute to poverty reduction, the study adds an additional perspective to the cost-benefit-opportunity analysis. The replacement of degraded pastures by AFS in areas where low-income smallholdings are located may be less efficient in retaining sediments, but this is offset by the generation of direct income to more vulnerable populations, thus complementing the ecosystem services.

TABLE ES 1 | Financial performance of natural infrastructure with restoration of 900 ha of degraded grassland

	RIO MANSO	ALTO RIO DAS VELHAS	TOTAL
SERVICES PROVIDED BY NATURAL INFRASTRUCTURE (AVOIDED WATER TREATMENT COSTS)			
AVOIED TOTAL COSTS	**44,334**	**14,983**	**59,317**
Avoided costs with chemicals	31,787	2,508	34,295
Avoided costs with filtering materials	121	195	315
Avoided costs with sediment removal	5,377	1,002	6,379
Avoided costs with extraction of saturated	0	7,436	7,436
Avoided wear and tear and depreciation	7,050	3,843	10,893
COSTS OF FOREST RESTORATION			
TOTAL COSTS	**6,699**	**5,359**	**12,058**
Investments in planting	3,999	3,199	7,198
Maintenance operating costs	2,700	2,160	4,860
NET BENEFITS			
TOTAL	**37,635**	**9,624**	**47,259**
FINANCIAL PERFORMANCE (MARR = 4.3% P.A.)			
NPV (BRL)	8,184	57	8,241
IRR (%)	9.28	4.36	7.36
Payback (years)	18.7	47.9	19.0

Source: Created by the authors.

NATURE-BASED SOLUTIONS ALREADY UNDERWAY IN THE BHMR: MAIN ADVANCES AND CHALLENGES

The water insecurity scenario in the BHMR has given rise to several natural infrastructure initiatives and nature-based solutions. One of such initiatives is the Pró-Mananciais program. Established in 2017 by COPASA MG in partnership with the Regulatory Agency for Water Supply and Sewage Services of the State of Minas Gerais (ARSAE), the program promotes actions to restore springs and watercourses, in addition to implementing soil and water conservation solutions, such as the construction of small dams[3], terracing on contour lines, conservation of rural roads and rural sanitation throughout the state. In the river basins covered by the study, COPASA MG works in partnership with the subcommittees of the Rio das Velhas River Watershed and with the Local Environmental Collectives (Colmeias), which are established governance spaces in the municipalities. In addition, the Rio das Velhas River Watershed Committee relies on the charging for the use of water, implemented in 2011, to finance restoration actions in the watershed, among other objectives.

Local organizations are implementing restoration actions through projects funded by the federal government and other funding sources. These actions have a common motivation, directly related to climate change, and also share a commitment to promoting new ways of occupying rural areas. These initiatives seek to consolidate agricultural production and restoration through soil and water conservation actions, in addition to disseminating productive practices that generate ecosystem services, such as AFS.

Companies that use water resources or that cause significant impacts on water quality due to their activities have a responsibility to act forcefully in terms of restoration. This responsibility must be established through environmental compensation in environmental licensing processes, requiring such companies to invest in projects or establish partnerships with local governments to mitigate damages and promote the recovery of affected ecosystems.

RECOMMENDATIONS

Forest restoration programs and projects in watersheds are essential to recover priority areas in terms of water security. Strengthening the articulation between the networks involved, aiming to increase the effectiveness of actions and the benefits of restoration for the community, is of vital importance. It is necessary to invest in communication and social mobilization, as well as guarantee technical assistance and continuous training both for technicians who work in the territory and for all directly affected parties.

The articulation and prioritization of actions are important to increase the effectiveness of restoration programs and other nature-based solutions. The government recognizes the role of these strategies in adapting to extreme hydrological events and invests in environmental programs using resources from water supply charges, water tariffs and other public sources or environmental compensation funds. However, adequate planning is needed to channel resources to priority areas, ensuring coordination and optimization of actions. This will ensure a more efficient approach to implementing restoration and other nature-based solutions.

Municipal policies are also structured in the territory based on water demand. Public-private partnerships play an important role in this context, allowing the expansion of soil restoration and conservation actions. To promote these partnerships, the state government, through the Belo Horizonte Metropolitan Region Development Agency (BHMR Agency) and river basin committees, should incorporate the information contained in this study into its management plans.

The information flow network on forest restoration existing in the territory, made up of organizations from the public and private sectors and with the participation of civil society, has the potential to structure strategies for the implementation of natural infrastructure at different scales. The data generated in the study should be incorporated into the restoration actions already in progress, expanding them and shifting their focus to areas where, in addition to the biophysical benefits, there is potential to improve income generation and the quality of life to the low-income population.

Consideration should be given to focusing investments in natural infrastructure on regions with low-income populations through AFS characterized by permanent crops established in highly degraded pastures. The study shows that integrated approaches to water management and territorial development, with an emphasis on improving the living conditions of vulnerable populations, are not only economically viable, but also need to be expanded.

The study reveals that mining activities are the major source of sedimentation in both watersheds, corresponding to 78% in the Alto Rio das Velhas Watershed and 50% in the Rio Manso Watershed. Sedimentation assessments and costs associated with water treatment are crucial information for establishing conditions for licensing and environmental compensation. Therefore, it is important to promote actions that improve the environmental quality of water bodies, which implies discussing the economic activities present in the territory. To mitigate water impacts, a joint effort by the agencies responsible for environmental licensing is necessary, even on a scale beyond the limits of direct influence by the relevant enterprise.

Currently, the mining sector is responsible for generating four times more sediments than the native vegetation present in the watersheds manages to avoid. This disparity underscores the importance of forest restoration along with efforts to conserve existing forests and adoption of conservation practices in land use. Investments should be primarily channeled to technical assistance and to locations where there is a better cost-effectiveness ratio, also taking socioeconomic aspects into consideration.

NOTES

1. The territorial delimitations of the study area are associated with the catchment basin and not necessarily with the classification system of the National Water and Basic Sanitation Agency (ANA) and the Minas Gerais Water Management Institute (IGAM).

2. Cities4Forests is a global network of cities that seeks to integrate inner, nearby and faraway forests into master plans and municipal development programs. For more information: https://www.wribrasil.org.br/projetos/cities4forests.

3. Small dams are excavated in the soil to capture and infiltrate rainwater along rural roads or agricultural plantations, with the aim of controlling erosion processes, retaining sediments and favoring water recharge.

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ABOUT WRI BRASIL

WRI Brasil is a research institute that turns great ideas into action to promote the protection of the environment, economic opportunities, and human well-being. We develop studies and implement sustainable solutions for the climate, forests, and cities. We combine technical excellence with political coordination and work in partnership with governments, companies, academia, and civil society.

WRI Brasil is part of the World Resources Institute (WRI), a global research organization whose work extends to over 60 countries. WRI encompasses the work of almost 1,700 professionals in offices in Brazil, China, the United States, Mexico, India, Indonesia, Europe, Turkey and Africa.

ABOUT COPASA MG

Companhia de Saneamento de Minas Gerais (COPASA MG) is a public-private company that operates in the basic sanitation sector in the state of Minas Gerais, Brazil. With more than 50 years of experience, it plays a key role in providing drinking water and sewage treatment in several cities in Minas Gerais. The company seeks to guarantee access to quality water and promote the preservation of water resources, adopting advanced technologies and sustainable practices. Since 2017, COPASA MG has been spearheading the Pró-Mananciais program, an initiative aimed at the preservation and recovery of water sources in the state. The main objective of the program is to protect water and foster actions aimed at ensuring the availability of quality water resources for future generations. Through the program, the company works in partnership with government agencies, environmental institutions and the local community to develop strategies for conservation, such as restoring riparian forests, recovering springs and raising awareness about the responsible use of water. With Pró-Mananciais, COPASA MG seeks to ensure the protection of springs and the sustainable management of water resources, contributing to the preservation of the environment and the well-being of the population.

Photo credits

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