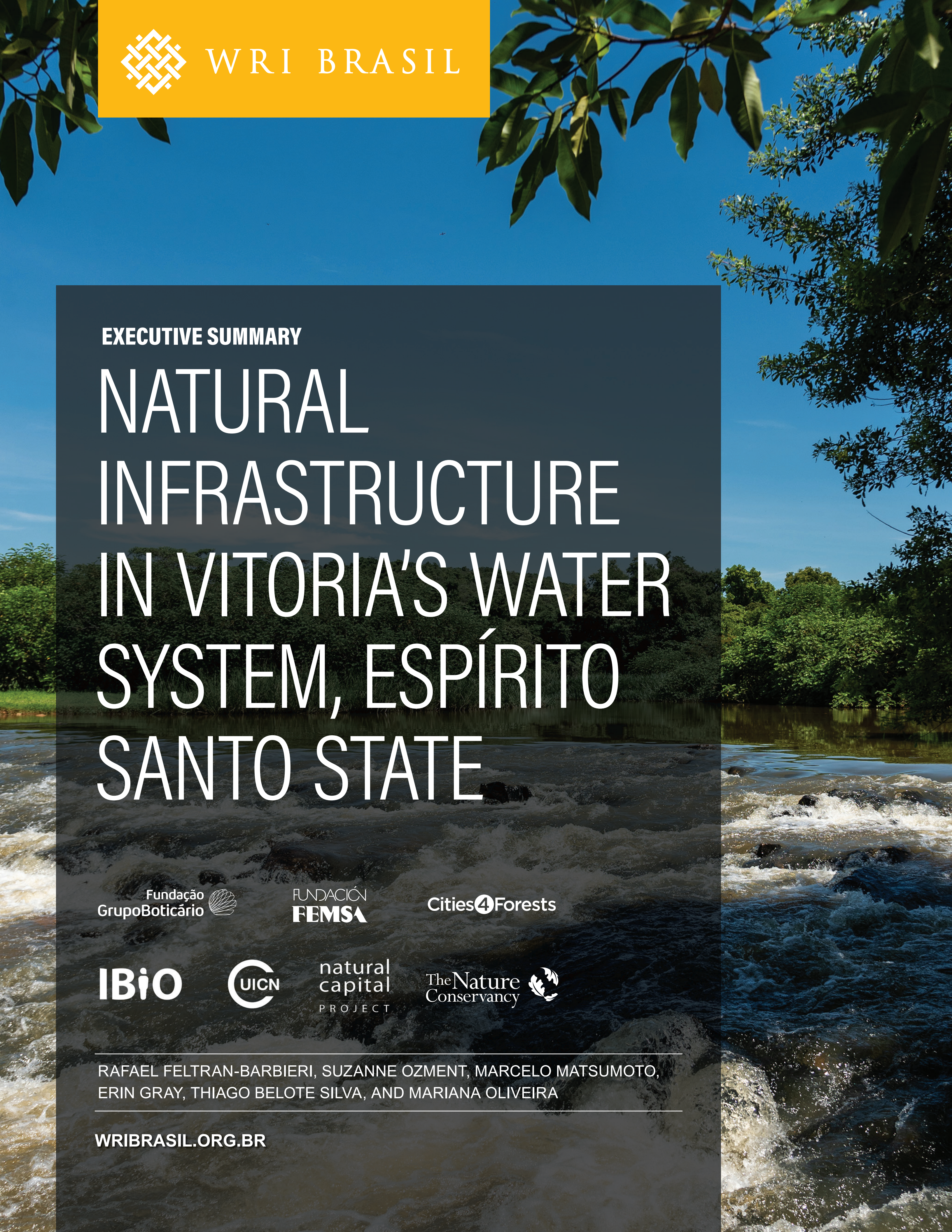

WRI BRASIL

EXECUTIVE SUMMARY

NATURAL INFRASTRUCTURE IN VITORIA'S WATER SYSTEM, ESPÍRITO SANTO STATE

Fundação GrupoBoticário

Fundación FEMSA

Cities4Forests

IBIO

UICN

natural capital PROJECT

The Nature Conservancy

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FOREWORD

Water crises are provoked by unusual weather conditions. But the causes themselves are structural. Brazil's water sanitation and supply infrastructure are recognized as both underdeveloped and flawed: 16 percent of Brazilians do not receive services and 46 percent do not have sewage. Annually, the country invests less than half of its expected investment and universal water access has been delayed to beyond 2050. The demand for water in the next 25 years is expected to grow between 18 and 25 percent, while electricity consumption is expected to triple by 2050, increasing the challenge of water management.

Ongoing climate changes have made atypical conditions daily ones, leading to a new level of systemic water risk. Investing five times more in infrastructure to simply cover past deficits, for example, is not sufficient. It must be urgently recognized that conventional infrastructures such as reservoirs and water treatment plants can manage the water emanating from a water resource but are not capable of altering production capacity of such resources themselves. However, conservation and restoration of forests and native ecosystems, such as natural infrastructure, does provide essential and complementary services to the structure created through civil engineering.

With nature-based solutions, the natural infrastructure rehabilitates water sources to provide water with greater regularity and better quality. With better-protected springs, better-conserved valleys and floodplains, more riparian forests along the rivers, more hilltops covered by forest-sized vegetation and sustainably used, there will be more water to fill reservoirs, irrigate plantations, and supply industries.

The State of Espírito Santo has an inherently high water-vulnerability level and has suffered from water scarcity since the 2014 crisis. At the time of publication of this report, a new water crisis plaguing the Brazilian Southeast in 2021 is a national and regional focus. It mainly affects energy production, which is particularly expensive for economic recovery in times of the COVID-19 epidemic.

Fortunately, through the Reflorestar Program and other local initiatives, Espírito Santo has emerged as a national leader in recognizing the importance of natural infrastructure, including as part of the water management solution. This is, however, just the start of a long journey to reach water security. This report is intended to help assist in taking these first steps.

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EXECUTIVE SUMMARY

Natural infrastructure, that is, forests and other forms of native vegetation, can serve as among the most important strategies for nature-based solutions for water resource management. Such infrastructure enhances the performance and resilience of conventional structures, rehabilitating the landscape to provide more regular and better-quality water to springs. This report demonstrates how forest restoration of critically degraded areas in the Jucu and Santa Maria da Vitória watersheds could improve the operational performance of the water reservoir and treatment for the Metropolitan Region of Vitória. It indicates areas with the highest cost-effectiveness for the implementation of natural infrastructure, confirms the economic feasibility of investment in natural infrastructure, and offers recommendations on how to strengthen forest restoration programs and initiatives now underway in the State of Espírito Santo.

HIGHLIGHTS

- In the Jucu and Santa Maria da Vitória Watersheds in Espírito Santo State, a unified green-gray strategy of forest restoration and new water infrastructure can generate twice the net benefits compared to investments focused only on conventional infrastructure.
- Applying WRI's Green-Gray Assessment (GGA), this study found that targeted restoration of 2,500 hectares (ha) of degraded pastureland in the watersheds would require an investment of US$9.7 million[1] and generate benefits of $26.4 million in water treatment cost savings. Over 20 years the Internal Rate of Return (IRR) would be 13.9 percent and payback 11.6 years, on par with sanitation investments.
- Through the Reflorestar Program, the state already invests in forest restoration to protect its water supplies, though more resources are needed. The Espírito Santo State Water Company (CESAN from its initials in Portuguese), could be a key investor in Reflorestar, as it is the direct beneficiary of forest restoration.
- Local stakeholders pointed out the need to complement the present analysis with actions to create an enabling environment for green-gray strategies, including improved watershed monitoring, engagement of landowners, and exploring new and greater sources of financing.

Restoring Espírito Santo for Water Security

Since 2014 the Greater Vitória Metropolitan Region (Região Metropolitana da Grande Vitória; RMGV) has been suffering from chronic drought and occasional heavy rains, which has posed an enormous challenge for water management (INMET 2021). In response to these challenges, the Central Coast Water Resources Management (UGRH-Litotal Central from its initials in Portuguese) which manages the primary water source for the RMGV, has proposed a re-engineering of the water systems (AGERH, SEAMA, 2018). This has created an opportunity to rethink the role nature plays in the water supply.

Water resources for RMGV come from the Jucu, Santa Maria da Vitória (SMV) and Reis Magos watersheds. Jucu and SMV supply 59 percent and 38 percent of the water treated and distributed to the region, respectively. Recent investments to secure water supply have led to the construction of traditional built infrastructure (referred to as gray infrastructure), such as the "Imigrantes Reservoir", the largest water-storage reservoir in the region (AGERH, SEAMA 2018).

Healthy forests can help maintain water supply systems by controlling erosion and sediment pollution. Reservoirs are important for storing water and trapping of sediments, while forests, in turn, reduce the sediments exported to reservoirs and water systems, thus reducing the costs of water treatment, dredging, and depreciation of water treatment equipment (Ozment et al. 2018). These cost savings primarily accrue to CESAN, the water and sanitation company.

Espírito Santo has a rich history of forest restoration through its Reflorestar Program, a statewide forest conservation and restoration initiative that helps rural landowners comply with environmental legislation. Reflorestar recognizes the benefits of native forests for hydrological systems and offers payments for environmental services (SEAMA 2020). The program is the main executor of forest restoration in other strategic programs led by the State of Espírito Santo, such as the Integrated Water and Landscape Management Program and Forests for Life (Espírito Santo Government 2013).

To take advantage of the potential synergies between forest restoration and water benefits, the Reflorestar Program and UGRH-Litoral Central (UGRH-LC) management system must know where to prioritize forest restoration in order to optimize the improvement of water quality. To address this need, this study points out priority areas and analyzes how Reflorestar's restoration strategies could financially benefit CESAN by reducing water treatment costs. It finds that pairing forest restoration with the new water supply reservoir could be significantly more cost-effective compared to the current plan of installing the reservoir alone.

Evaluating the Role of Natural Infrastructure in Urban Water Supply

This study is a financial analysis using WRI's GGA, a six-step method that helps incorporate natural infrastructure through forest restoration into water investment decisions. In this case, the GGA was applied to estimate the costs and benefits that would accrue to sanitation companies with implementation of targeted natural infrastructure restoration strategies in the UGRH-LC, and to compare the results to a scenario only using built infrastructure.

The ideal type and location of natural infrastructure investments depends on which benefits are sought. The study identifies priority areas for restoration to maximize erosion control using the Natural Capital Project's Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) biophysical model. Forest conservation, agroforestry, silvopastoral systems, or management of other natural areas may also contribute to reduce erosion and sedimentation but were excluded from this version of the study for simplicity (though future versions of this study could incorporate such scenarios). Natural areas may also provide other ecosystem services to communities such as food production, carbon sequestration, disaster risk mitigation, recreation, etc. While important, the study narrowly focuses on the sediment management benefits of native restoration.

This study provides an approximate account of potential costs and benefits. Ideally, an analysis of natural infrastructure's return on investment (ROI) would be based on local observed biophysical and financial data. In this study we did not have access to data on costs with chemical products incurred in the operations of the sanitation companies. As a result, the study often approximated key data inputs, based on literature, nearby sites, or local expert opinion. While the results likely represent a realistic order of magnitude, they are approximations that could be improved through additional local data collection for future iterations of this analysis. Values are primary estimated in Brazilian currency (R$) and then converted into dollars without rounding. Not rounding the figures may give the impression that the numbers are more precise than they in fact are.

Natural Infrastructure Enhances and Complements Gray Infrastructure

Forest restoration in strategic areas of the watershed is likely to result in substantial cost savings for the water utilities. The study shows that restoring 2,500 ha of native forest currently occupied by degraded pasturelands (scenario LC2500) encompassing the restoration of 1600 ha in Jucu and 900 ha in **SMV** would require an investment of about $9.7 million. This investment could reduce turbidity by as much as 9 percent, generating cost savings of about $22.4 million over 20 years and achieving a Net Present Value (NPV) of $3.2 million (Table 1, Figure 1).

Considering the restoration in Jucu alone, the investment required would reach $6.2 million over a period of 20 years (see JUCU1600 scenario in Table 1). By reducing

Table 1 | Financials of Restoring 2.500 Hectares Combined with Building a New Reservoir, over 20 Years

NET BENEFITS			
	LC2500	JUCU1600	SMV900
TOTAL	**16,706**	**12,503**	**4,203**
NATURAL INFRASTRUCTURE BENEFITS (USD THOUSANDS)			
TOTAL	**26,404**	**18,710**	**7,694**
Avoided costs – chemical products[a]	2,590	1,773	817
Avoided costs – filter	156	109	47
Avoided costs – dredging and sludge removal	3,002	2,102	900
Avoided costs – energy	16,936	11,694	5,242
Avoided depreciation[b]	3,720	3,032	688
NATURAL INFRASTRUCTURE COSTS (USD THOUSANDS)			
TOTAL	**9,698**	**6,207**	**3,491**
Investments	5,830	3,731	2,099
Transaction costs	58	37	21
Opportunity costs	3,810	2,438	1,372
FINANCIAL PERFORMANCE (Discount Rate = 8.5% p.y.)			
NPV (USD THOUSANDS)	**3,165**	**2,745**	**420**
IRR (%)	**14**	**15**	**10**
PAYBACK (YEARS)	**12**	**11**	**16**

Note: a) Chemical products. filters. and energy refer to costs incurred for water turbidity treatment only. b) Depreciation of equipment is also applied as wear and depreciation of equipment used in water treatment processes only. See Appendix C for more details. All values in this report were estimated in Brazilian currency (R$) and converted into US at an exchange rate of R$ 1 = $ 0,2841.
Source: Authors.

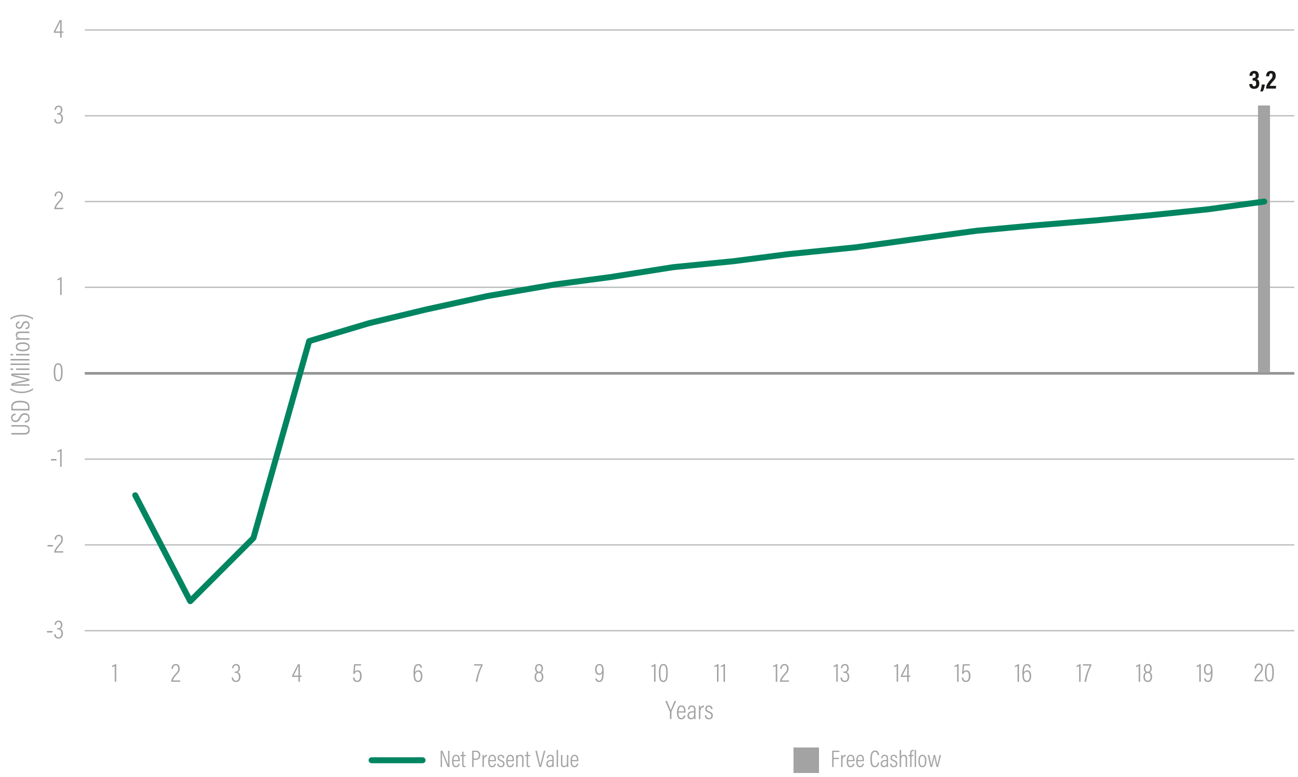
turbidity in the watershed up to 15 percent, this investment could generate benefits of around $18.7 million and a Net Present Value (NPV) of $2.7 million (Table 1, Figure 1). **In SMV, the restoration of 900 ha would require $3.5 million in investments** over the same period (see SMV-900 scenario). By reducing sediment pollution of up to 5 percent, it could generate benefits of $7.7 million and NPV of $420,000.

These restoration efforts align with the Reflorestar Program and similar program goals and budget for forest restoration of degraded areas in Espírito Santo. The Reflorestar Program, the Integrated Water and Landscape Management Program, and the Forests for Life Project, which have focused on Jucu and SMV watersheds, planned to invest approximately $53.7 million in Jucu and $38.1 million in SMV for forest restoration in headwaters, gallery forests, and water recharge areas. The investments required for the restoration of 2,500 ha evaluated in this study will be equivalent to one-third of that planned for the watersheds through these three initiatives.

Conventional gray infrastructure for water storage may also contribute to sediment control. A new reservoir in the Jucu Basin would most greatly reduce sediment pollution. While the primary purpose of the reservoir is to store 20 million cubic meters (m^3) of water, it will also act as a sedimentation tank, which in turn will reduce downstream water treatment costs. According to this report, the reservoir alone could reduce the sediments entering the treatment plants in Jucu by 28 percent. On the other hand, the siltation of the reservoir will require maintenance costs of $1.4 million over 20 years.

Natural infrastructure can cost-effectively complement and enhance the performance of gray infrastructure. The reservoir may trap sediments, but it cannot change soil erosion

Figure 1 | Financial Performance of the Natural Infrastructure for Water in the LC2500 over 20 Years



Note: In the first three years of the project the costs include the implementation of the restoration. The benefits (avoided costs in water treatment and depreciation of equipment) are gradually accumulated and increased with the development of the forest and, consequently, of services ecosystems. NPV over 20 years (using a discount rate of 8.5% p.a.) is about R$ 11.1 million.
Source: Authors.

from the landscape that makes its way into waterways. Restoring 1,600 ha of degraded pasture to native forest cover in the Jucu Basin would reduce the sediment discharge to the reservoir by approximately 1,800 tons/year, equivalent to load of 40 dump trucks per year. Total economic benefits from water treatment cost savings, avoided depreciation, and dredging costs would be $22.4 million over 20 years, 50 percent higher than the benefits achieved in water treatment costs provided by the reservoir alone.

Established public programs already investing in natural infrastructure could share risk with water sector investors. The Reflorestar Program has established the necessary administrative infrastructure to incentivize and manage state-wide restoration, but requires funding. CESAN could benefit from investing in the Reflorestar Program to implement targeted restoration. To seize this investment opportunity, stakeholders need to communicate the business case for investment to key decision-makers at CESAN, the water agency, and the Reflorestar Program, and develop a coherent long-term financing strategy. The Watershed Committees of Santa Maria da Vitória (CBH SMV from its initials in Portuguese) and Jucu (CBH Jucu from its initials in Portuguese) have already been consolidating an integrated financing plan and deciding priorities for investment in the watersheds. Different objectives may overlap in the same restoration actions to boost raising capital for investment in the forest to maximize the environmental and social benefits.

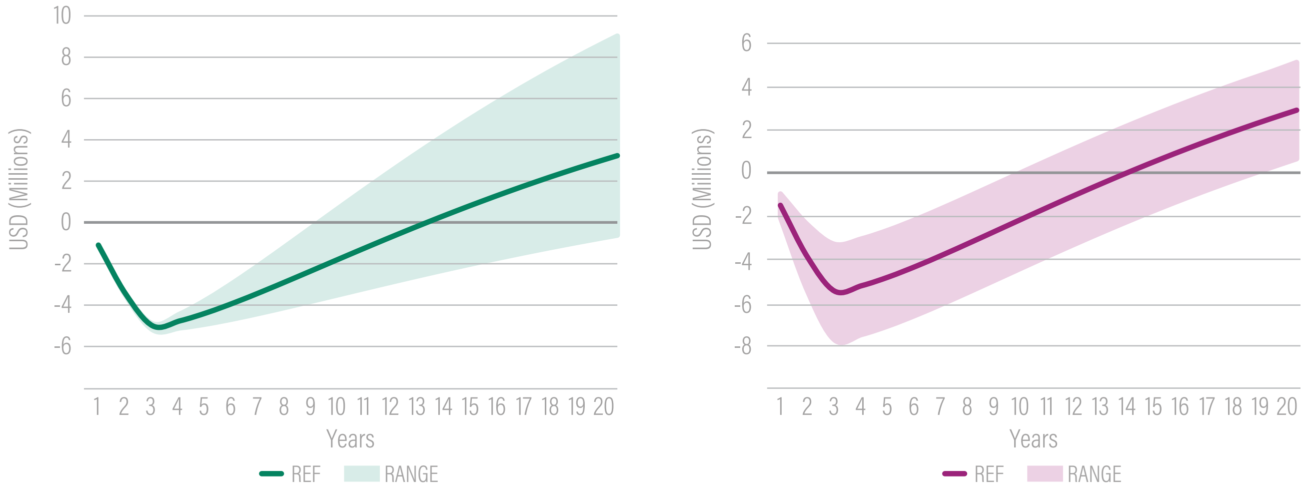
Sensitivity Analysis Results

Location and pace of restoration impact financial performance of natural infrastructure. The LC2500 proposed herein was designed to maximize sediment retention in water-critical areas—the 2,500 priority hectares contribute more than one-third of all sediment from pastureland in the watersheds. The pace of implementation also has a major impact on results—if LC2500 were completed in the first year of the project (rather than following a three-year restoration schedule), the project's NPV would be 20 percent higher. Accelerating the pace of restoration or targeting specific areas may not be feasible if local landowners in those areas are not interested in reforesting their land.

The sensitivity analysis shows that the capacity of the forest to retain sediments is the main risk factor. Natural infrastructure has demonstrated solid financial performance even under variations in discount rates, restoration cost, land opportunity cost and inclusion of labor

costs. However, the performance of the projects is very sensitive to variations in sediment retention capacity estimated during forest growth. If the sediment retention is 31 percent lower than estimated, the project's NPV is negative. This level of performance is unlikely but possible. On the other hand, if 59 percent more sediments are retained (the estimated upper bound of performance), then the NPV increases to $9 million. Restoration cost is the second variable that most affects the financial performance of natural infrastructure, while water treatment costs have no major impact. The magnitude of these differences is determined by turbidity levels, and therefore forest capacity for sediment retention, rather than by different treatment cost values.

Figure 2 | Financing Performance and NVP over 20 Years, LC2500 Scenario



Note: The figure on the right shows NPV over 20 years, main output (REF) and output band based on range of sediment retention (41% lower to 59% higher retention than the REF). On the left, NPV over 20 years, main output (REF) and output band based on restoration costs for active restoration (48% less expensive compared with 50% more expensive than the REF).
Source: Authors.

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ABOUT WRI BRASIL

WRI Brasil is a research institute that transforms big ideas into actions to protect the environment and foster Brazil's prosperity in an inclusive and sustainable fashion. It is focused on research and applications of sustainable solutions oriented towards climate, forests, and cities. 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 World Resources Institute (WRI), a global research organization whose work extends to over 50 countries. WRI encompasses the work of almost 1000 professionals in offices in Brazil, China, the United States, Mexico, India, Indonesia, Europe, Turkey and Africa.

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