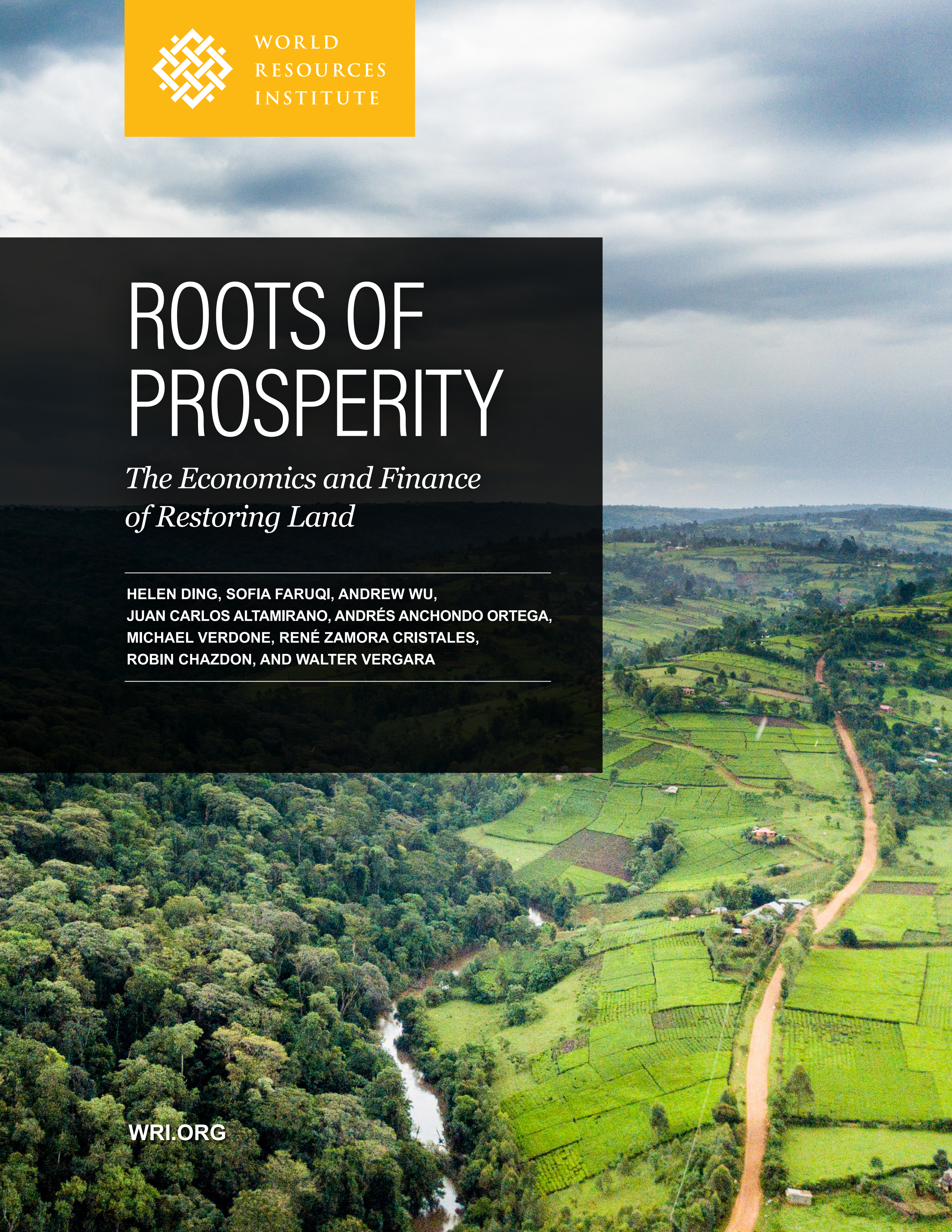

WORLD RESOURCES INSTITUTE

ROOTS OF PROSPERITY

The Economics and Finance of Restoring Land

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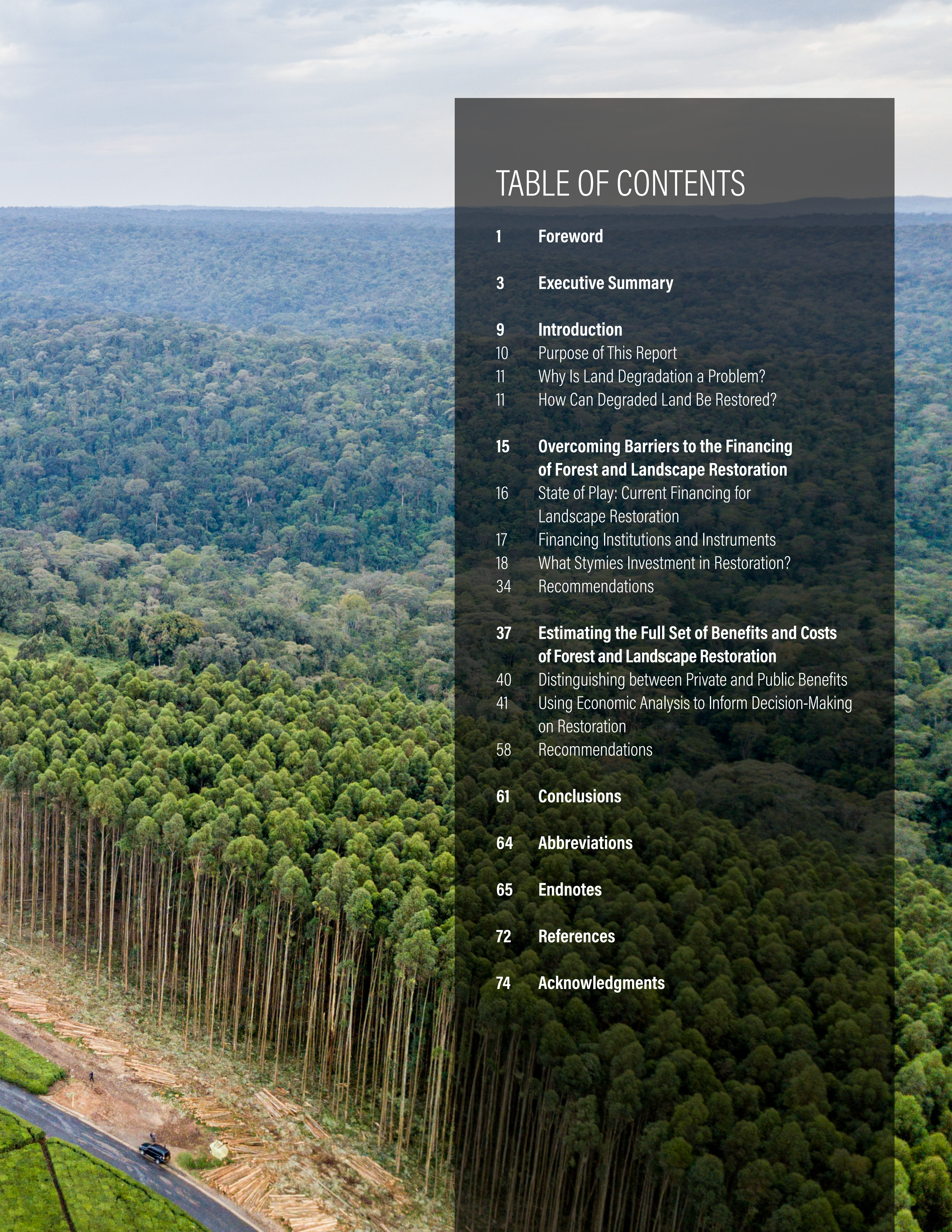

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FOREWORD

There has never been a more pressing moment to restore the world's degraded landscapes. Around 2 billion hectares of land—twice the size of China—was once forested but is now degraded, with little economic or ecological value. Rarely, if ever, have humans wasted a valuable resource with such abandon. It has been estimated that land degradation costs countries more than $6 trillion per year.

But a revolution is brewing. Governments from around the world have committed to restore 160 million hectares. This is because smart politicians are now recognizing that they can gain up to 30 times their initial economic investment by restoring land. It's good for the economy, for jobs, food security, and the planet—and it provides resilience in the face of a changing climate. However, despite these extraordinary benefits, restoration remains markedly underfunded, and the sector faces a funding gap of around US$300 billion per year.

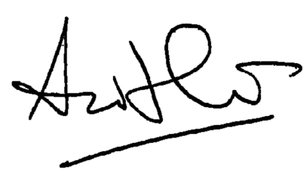
This report provides a comprehensive analysis of the benefits and costs of restoring land in countries around the world, from Costa Rica to Norway, and from Ethiopia to the United States, demonstrating how smart policies and innovative financing can turn the tide.

The opportunity for restoration is clear. More than 20 percent of the world's forests, agricultural land, and pastures have suffered degradation since the mid-twentieth century, impoverishing those who live off the land and contributing to greenhouse gas emissions. The report finds that finance, both public and private, for restoration is inadequate for several reasons. Environmental and social benefits are difficult to monetize, and the short-term incentives to degrade land often outweigh those to restore it. A poorly designed livestock subsidy, for example, may promote overgrazing and lead to devastating erosion. In addition, restoration projects are often small and perceived as risky investments that take too long to deliver a payout. Climate finance is inadequate and hard to access.

The authors show how these barriers are surmountable. For example, ministries of finance, agriculture, environment, and energy should work collaboratively to integrate restoration activities and offer tax credits to support the initial cost of restoration projects. Development banks can provide guarantees to mitigate risk, attracting new investors to the sector. Investors can aggregate restoration projects, diversifying their portfolios and improving financial returns.

Policymakers can use this report to better understand the economic implications of restoring land. The authors outline the main steps involved in carrying out economic analyses, bringing to light the full value of ecosystem services and social benefits as well as the costs of degradation. These insights can help governments to develop policy instruments and financing mechanisms that promote restoration on the ground. They can also help financial institutions incorporate non-monetized public benefits into financing decisions. Clean air, freshwater, and fertile soil may seem priceless, but government economists must put an accurate dollar value on their supply if their countries are to meet their restoration targets and support the hundreds of millions of people whose livelihoods depend on forests and land.

Land health is national wealth. I hope that, in reading this report, policymakers will recognize restoration as an amazing opportunity for growth, and design policy to inspire change.



Andrew Steer
President
World Resources Institute

EXECUTIVE SUMMARY

Almost one-quarter of the world's land area has been degraded over the past 50 years because of soil erosion, salinization, peatland and wetland drainage, and forest degradation. The resulting damage, in terms of lost ecosystem goods and services, costs the world an estimated US$6.3 trillion a year.

HIGHLIGHTS

- Forest and land degradation is estimated to cost the world more than US$6.3 trillion a year—equivalent to 8.3 percent of global GDP in 2016—and jeopardizes the livelihoods of half a billion people who depend on forests and land resources.
- Restoring degraded forests generates an estimated $7–30 in economic benefits for every dollar invested. Despite this favorable benefit-cost ratio, funding for landscape restoration falls short by about $300 billion a year.
- Investment is inadequate for several key reasons. For example, many of the benefits are public goods, which are difficult to monetize; the long-term nature of investments does not match investors' desire for liquidity; and projects are perceived to be risky.
- Policy solutions and financial mechanisms exist to address these factors. Governments can shift incentives from land degradation toward restoration, implement carbon taxes and direct revenues to restoration, adopt an integrated approach across ministries, and support risk mitigation mechanisms that attract private investment.
- Adopting a standardized economic valuation framework would enable comparison among site- or country-level studies. Collecting analyses in a central repository would help prevent duplication of effort and provide policymakers and practitioners with access to knowledge that could lead to better decision-making.

Almost a quarter of the world's land area has been degraded over the past 50 years. This is the result of soil erosion, salinization, peatland and wetland drainage, and forest degradation. The scale of the resulting damage is staggering: It costs the world an estimated $6.3 trillion a year (8.3 percent of global GDP in 2016) in lost ecosystem service value, which includes agricultural products, clean air, fresh water, climate regulation, recreational opportunities, and fertile soils (Sutton et al. 2016). Land degradation also jeopardizes the livelihoods of half a billion mostly poor people who depend on forests and agricultural lands. Declining land productivity undermines sustainable development, threatens food and water security, and leads to involuntary human migration and even civil conflict.

At the global scale, land degradation compromises the integrity of the biosphere. Biodiversity loss represents a reduction of the world's genetic resources as well as an incalculable diminution in the richness of life on earth. Forests help to regulate the global hydrological cycle, and plant vegetation and soils are a major carbon sink helping to offset human-caused emissions of carbon dioxide. Restoring forests and other landscapes should be an urgent global priority.

In 2011, the Bonn Challenge was launched in recognition of the importance of land restoration. The goal is to restore 150 million hectares of the world's deforested and degraded land by 2020 and 350 million hectares by 2030. As of November 2017, 39 countries had made commitments. These governments now need to turn the pledges they made into action on the ground by implementing feasible, affordable solutions that provide multiple benefits to society.

About This Report

The premise of this report is that there is an urgent need to increase financing for restoration, and there are many pathways to make this happen. This publication explains seven key barriers to investment in restoration and highlights policy solutions and financial mechanisms—many of which are already in play—that can be used to overcome these barriers. Through a discussion of the financial and economic issues surrounding restoration, the report encourages governments and practitioners to conduct analyses and enact strategies that support forest and landscape restoration.

Economic analysis can encourage investment in restoration by clearly laying out the benefits and costs of restoration projects and their distribution among stakeholders. This report helps policymakers understand the full suite of benefits and costs associated with restoration and outlines the four main analytical tools that can be used to carry out this economic analysis. The report also summarizes existing research on the economic costs and benefits of restoration in Africa and Latin America and makes the case for developing a central database of research findings on restoration.

Key Findings

Restoration can be a good investment. Studies estimate that every $1 invested in restoring degraded forests can yield between $7 and $30 in economic benefits (Verdone and Seidl 2017). The impact extends well beyond the environmental sphere: Restoring 150 million hectares of degraded agricultural land could generate $85 billion in net benefits to national and local economies,[1] and provide $30–40 billion a year in extra income for smallholder farmers and additional food for close to 200 million people (GCEC 2014).

Although the economic case is clear, financing for restoration activities falls well short of the need. For example, public climate finance totaled $128 billion in 2015, of which only $7 billion (about 5 percent of total climate finance) was used for financing land-use projects (Buchner et al. 2015). Funding for restoration-specific projects was a small fraction of the land-use category. In contrast, annual funding needs for conservation and restoration are estimated to range from $300 to $400 billion per year, indicating a massive financing gap (Credit Suisse et al. 2014).

Investment is currently falling short for seven main reasons:

- Environmental and social benefits usually have no market value. Evaluated strictly in terms of financial gains, most restoration projects generate returns that are too low to attract private investors.
- Incentives to degrade land outweigh incentives to restore it. Agricultural subsidies and poor enforcement of laws banning illegal logging encourage harmful practices.
- Land restoration is essential to mitigate climate change, yet climate finance is difficult to access. Transaction costs and bureaucracy make it time-consuming and costly for governments and other stakeholders in developing countries to access these funds.
- Funding for restoration is sometimes limited to small environmental budgets. Lack of awareness and coordination among ministries of environment, agriculture, and other sectors means that restoration projects tend to be underfunded.
- Many restoration projects are too small to be attractive to institutional investors. They may require only $1–10 million in capital, while institutional investors often look for minimum investment sizes of at least $50–100 million.
- Many restoration projects have very long investment horizons of 10 to 20 years because restoration is a multiyear process. This long time frame significantly limits investor interest.
- Restoration is considered risky as there is no investment track record, and countries where restoration is needed most may have governance and land tenure issues.

Estimating the full benefits and costs of restoration can help to prioritize projects. Economic analysis can document successes, help prioritize projects based on specific objectives, and estimate the effects of restoration on job creation, GDP growth, poverty alleviation, food security, and greenhouse gas emissions. Analyses should cover not only restored sites but also their surrounding areas, so that conclusions can be drawn about the impacts at the landscape level. The results can be used to engage a wide range of stakeholders, such as water utilities and municipal governments, that might benefit from restoration efforts coordinated at a landscape scale.

Economic analysis can identify who benefits from restoration and who pays the costs. Benefit and cost estimates should be disaggregated across stakeholders to better understand who gains and who pays. Furthermore, costs and benefits can be entered into various economic tools and analytical models—such as cost-benefit analysis, cost-effectiveness analysis, spatial restoration optimization analysis, and macroeconomic analysis—that can be used to support policy and financing decisions.

Quantifying the multiple public benefits of restoration can provide the basis for blending different sources of capital. Quantification can help to allocate capital by identifying who bears the upfront costs and tailoring the structure of an investment to provide incentives for landowners. Quantification can also help to scale investment in landscape restoration by blending different sources of capital, including climate, conservation, and development finance.

Recommendations

To increase investment in forest and land restoration, governments need to take the following actions, among others:

- Remove perverse incentives—such as agricultural subsidies—that make it profitable to degrade land and introduce new mechanisms that incentivize restoration.
- Explore the extent to which climate and development finance and revenues from carbon taxes can be directed toward restoration. This will unlock billions in funding from existing sources.
- Integrate restoration actions into many government bodies—such as ministries of agriculture, finance, energy, and the treasury—because land generates benefits for many areas of the economy and should not be treated as a purely environmental concern.
- Work with multilateral banks, philanthropic organizations, and civil society to develop financial mechanisms to leverage public and philanthropic capital and attract private investment. Mechanisms that reduce risk—including insurance guarantees, tax credits, and first-loss capital structures—can help to bring in new investors.

An improved information base and a standardized evaluation framework would enhance restoration planning and implementation in the following ways:

- Creating a standardized valuation framework that assesses restoration benefits and costs at both the national and community levels would enhance the robustness and comparability of economic estimates and identify where large investments in restoration could pay dividends for current and future generations.

  A high-level panel of social scientists—similar to the NOAA Blue Ribbon Panel created to evaluate the robustness of nonmarket valuation methods—could be established to provide guidance in the context of landscape restoration (Arrow et al. 1993).
- A database that includes information on the estimated costs and benefits of restoration would allow practitioners and decision-makers to share and develop knowledge. Such a repository would reduce duplication of effort, direct scarce resources to activities where more research is needed, and allow practitioners and decision-makers to quickly access the information they need. The database would be particularly useful for parties that cannot afford to conduct their own research.

  To do this, a global initiative that is similar to The Economics of Ecosystems and Biodiversity (TEEB), could be developed to gather evidence of restoration interventions in different regions and to make the benefits of restoration visible to the world.

Given the strong political impetus for restoration, now is the time to accelerate action on the ground. We hope this report will help to develop the foundation of a thriving restoration economy.

SECTION 1

INTRODUCTION

The world is at a critical juncture. There is momentum to accelerate restoration implementation on the ground, and the demand for forest and landscape restoration is expected to grow exponentially; yet financial resources for new investments for restoration must still be found and justified.

Degradation of forests and other landscapes is undermining ecosystem functions, reducing agricultural productivity, and compromising human well-being. The problem is most severe in tropical countries—in Africa, Asia, and Latin America—where it directly affects the livelihoods of half a billion people who depend on these resources for their livelihoods. Land degradation indirectly affects the planet as a whole, contributing to civil conflict, reducing biodiversity, and increasing greenhouse gas emissions (GHGs).

Recognition of the problem—and of the value of forest and landscape restoration—is growing, but financing has not grown in parallel. The task of restoring the world's degraded agricultural lands and forests is not attracting sufficient investment largely because many of the benefits cannot be monetized; incentives to degrade land outweigh incentives to restore it; farmers and landowners are often capital constrained; transaction costs are high; the long-time horizon is inconsistent with investors' desire for liquidity; and projects are perceived to be risky. The urgency of the problem makes it critical that these constraints be removed.

Purpose of This Report

This publication seeks to help policymakers and practitioners around the world better understand financing strategies that can help remove barriers and accelerate restoration progress on the ground. It also discusses the potential for incorporating economic analysis in the design of policies that support restoration, using a holistic approach.

The report summarizes methodological approaches for assessing the economics of restoration, discusses their drawbacks and limitations, and suggests necessary steps for better integrating economic analysis to inform policy and financial decisions. It discusses the players and capital instruments relevant to restoration and the financial mechanisms and incentives that can unlock public and private funding for restoration.

The report focuses on forest and landscape restoration as a balanced approach to regain ecological integrity and enhance functionality and human well-being in landscapes that have lost forest cover and land productivity (Maginnis and Jackson 2007; Sabogal et al. 2015). This approach aims to improve economic and ecological outcomes by sustainably increasing tree cover and enhancing local economic growth through land-management practices that increase productivity and support livelihoods.

Why Is Land Degradation a Problem?

Degraded land has lost some of its natural productivity as a result of human-caused processes, natural disturbances, and their interaction. Land degradation is driven by unsustainable management practices adopted by individuals, communities, governments, companies, and financial institutions. These practices suffer from the "tragedy of the commons" (Hardin 1968), which occurs when stakeholders of a shared resource act independently, based on their own self-interest, and those actions collectively result in the depletion or degradation of the resource.

About 25 percent of global land area is subject to some degree of degradation, including soil erosion, salinization, peatland and wetland drainage, and forest degradation (FAO 2011a). More than one-quarter of agricultural lands are classified as severely degraded (FAO 2011b).

Agriculture is the most significant driver of deforestation (DeFries et al. 2010). Increasing demand for beef, soy, and palm oil have put tremendous pressures on native forests in emerging and developing countries, causing deforestation and degradation. At the same time, unsustainable timber harvesting and hunting pressures are eroding the last remaining intact forests. Globally, the intact forest landscape area decreased by 91.9 million hectares—7 percent—between 2000 and 2013, with tropical regions contributing 60 percent of the reduction (Potapov et al. 2017).

A direct consequence of deforestation and land degradation is the decline in the productivity of forest and agricultural ecosystems (Turner et al. 2016), which can cost the world as much as $6.3 trillion a year in terms of lost ecosystem service value, which includes agricultural products, clean air, freshwater, disturbance regulation, climate regulation, recreational opportunities, and fertile soils (Sutton et al. 2016). Landscape degradation and deforestation also contribute to global warming and exacerbate losses in biodiversity. They pose major threats to local communities and drive global trends such as rural unemployment, mass migration, and civil conflict as productive and healthy land becomes increasingly scarce (Potapov et al. 2017; Hansen et al. 2013; Venter et al. 2016).

BOX 1.1 | WHAT IS THE BONN CHALLENGE?

Launched in September 2011, the Bonn Challenge is a global effort to restore 150 million hectares of the world's deforested and degraded land by 2020 and 350 million hectares by 2030. Since its inception, the Bonn Challenge has attracted 47 commitments submitted by national governments, states and regional programs to restore 156 million hectares of land and leveraged billions of dollars of public and private finance for implementation on the ground. The International Union for Conservation of Nature (IUCN) estimates that the annual net benefit to national and local economies of restoring 150 million hectares is approximately $85 billion per year. About 90 percent of this value is market-related benefits, bringing direct additional income opportunities for rural communities. It is estimated that achieving the 350-million-hectare goal will generate about $170 billion per year in net benefits from watershed protection and improved crop yields and forest products and could sequester up to 1.7 gigatons of carbon dioxide equivalent annually.

Source: http://www.bonnchallenge.org/content/challenge.

How Can Degraded Land Be Restored?

Forest and landscape restoration is not only about recovering the ecological functionalities of degraded terrestrial ecosystems. It is also about changing land-management practices in ways that sustain local economic growth—through rotational grazing or reductions in stocking rates on degraded pastures, for example (Calle et al. 2012). For severely degraded landscapes, restoration may require the replacement of existing land uses with alternative land uses that support the recovery of landscape functionality, provide habitats for biodiversity, stop losses from degradation, and provide economic benefits to stakeholders (Brancalion and Chazdon 2017).

Generally speaking, land restoration efforts can be classified as active or passive. Active restoration includes reforestation, silvopastoral practices, forest conservation, agroforestry, and soil conservation practices whereas passive restoration may require the land to be set aside to recover naturally for a period of time, making it a difficult approach when the land is critical to local livelihoods. Often, active restoration approaches cost more than passive restoration practices, and the cost of preventing land degradation is much lower than the cost

BOX 1.2 | RESTORING LAND IN AFRICA AND LATIN AMERICA AND THE CARIBBEAN

AFR100 partner countries have committed to restore 83.3 million hectares of land by 2030. Nearly $1 billion of public finance and $500 million of private investment has been earmarked to support the effort. In the Sahel dryland region, millions of hectares have already been restored by smallholders through planting and stewarding the growth of billions of trees on land that had been barren for decades. In East Africa, countries have committed to restore tens of millions of hectares through multiple restoration interventions that create ecosystem benefits. Site-level analyses of individual restoration activities—such as agroforestry, improved woodlot management, and improved farm fallows—show that these activities can increase the annual incomes of individual smallholders by $111–125 per household (Franzel 2005).

In Latin America and the Caribbean, 16 national governments, three states, and three regional programs have pledged to restore 53.2 million hectares through Initiative 20x20. They have attracted $2.1 billion in impact investment pledges from 19 financial partners. Since 2014, with the support of Initiative 20x20, nearly 40 private finance projects are now at various stages of implementation, with close to 10 million hectares under restoration.[a] These projects have restored intact and/or degraded forested lands and nonforested lands, including cropland and pasture.

The common goal of restoration in the region is to improve livelihoods in rural areas and reduce poverty. Practices and priorities vary across countries. In Mexico, for example, about 88 percent of restoration pledges focus on improving agricultural land with climate-smart practices. Guatemala plans to fulfill its pledge to restore 1.2 million hectares with agroforestry, silvopastoral practices, and reforestation activities. Agroforestry and silvopastoral practices have helped increase agricultural productivity in Costa Rica, El Salvador, and Mexico. Reforestation (including natural regeneration of forests) has significantly increased carbon sequestration and improved flood control in Brazil and Guatemala and generated substantial economic benefits from ecotourism and recreation in Colombia and Costa Rica.

Note: [a] http://www.wri.org/news/2017/11/statement-landmark-21-billion-earmarked-restore-degraded-lands-latin-america-offering.

of rehabilitating already severely degraded lands or physically replacing lost soil and nutrients (Shiferaw et al. 2015; Chazdon and Uriarte 2016).

The international community, including the private sector, recognizes the urgent need to restore forests and other lands. As of November 2017, 39 countries have committed to restore more than 150 million hectares through the Bonn Challenge (Box 1.1).

Several regional initiatives have emerged to support countries' efforts to achieve the Bonn Challenge. They include Initiative 20x20 in Latin America and the Caribbean, AFR100 in Africa, and ministerial roundtables in Latin America, East and Central Africa, and the Asia-Pacific region. As of October 2017, there were 47 commitments to the Bonn Challenge to restore 156 million hectares of land.[2] The largest commitments were from AFR100[3] (53 percent) and Initiative 20x20[4] (34 percent), both of which were country-led restoration efforts chaired by World Resources Institute (Box 1.2).

However, implementation of the pledges made by countries has lagged, in part due to a major shortfall in funding. For example, only a tiny fraction of climate finance goes to restoration, despite the strong link between forests and climate. Mobilizing financing has been difficult partly because there are systemic barriers in place: Most of the value generated by restoration is not monetized, and there are perverse incentives that support degradation rather than restoration. Fortunately, there are solutions to these problems, and some countries have already begun to act on them.

This report discusses how to accelerate flows of public and private capital to support restoration programs of strategic importance to countries and regions. For instance, governments can adopt carbon taxes and direct tax proceeds to restoration, while climate funds can incorporate restoration projects into their investment pipeline because planting trees and other vegetation is a critical solution for climate change. At the same time, there are ways to bring more private investors to the table through risk mitigation instruments and aggregation of projects.

Economic analysis is needed to make the full value of ecosystem services and the costs of degradation visible. Such analysis should estimate the full benefits and costs of investing in restoration—not only the benefits and costs to the people making the investment but also the benefits to the world as a whole (such as carbon sequestration, biodiversity, and improved water and soil retention); not only the short-term returns but also the benefits over the long term (including benefits that may not accrue for decades or longer). Economic analysis should describe the time frame for both investments and benefits and incorporate the cost of inaction because doing nothing will cost more in the long run.

Landscape restoration must thus be approached as an integral part of national green growth strategies. It requires a holistic approach to strengthen collaboration among government ministries and channel financial support from climate funds, environmental defense funds, and sustainable development funds into restoration initiatives.

Given the strong political impetus for restoration, now is a critical moment to accelerate restoration implementation on the ground. Any postponed action or inaction is the most expensive course in the long run—not only in terms of money, but also in the form of human progress.

Landscape restoration must thus be approached as an integral part of national green growth strategies. It requires a holistic approach to strengthen collaboration among government ministries and channel financial support from climate funds, environmental defense funds, and sustainable development funds into restoration initiatives.

SECTION 2

OVERCOMING BARRIERS TO THE FINANCING OF FOREST AND LANDSCAPE RESTORATION

Funding to restore degraded land falls far short of what is needed. Governments and investors have an opportunity to expand both public and private finance for restoration, making it possible for people and the planet to benefit from healthier landscapes around the world.

State of Play: Current Financing for Landscape Restoration

Restoring degraded land has the potential to offer numerous environmental, social, and economic benefits, from carbon sequestration to job creation and improved agricultural productivity. However, financing of forest and land restoration is inadequate, with possibly catastrophic implications for sustainable development and the environment.

What can be done to increase finance for restoration? How can both the public and private sectors be mobilized? In this section, we cover the key barriers to restoration finance, including those mentioned above, and present financial mechanisms and policy solutions that can bridge the investment gap. We start by providing a brief background on the investors and financial instruments that are relevant to restoration.

Financing Institutions and Instruments

Finance is a branch of the economy that consists of capital (i.e., money, assets, investments, credits, etc.), institutions, instruments, markets, and investors that make up the financial system. The words *finance*, *capital*, *investments*, *funds*, and *funding* are often used interchangeably.

The finance world can be divided into three categories:

- Private finance, which is capital managed with the primary goal of earning a financial return for the investor.
- Public finance, which is funding from government bodies. While a financial return to the government agency providing the funds may be present in some cases, public investments are largely made to generate social, environmental, and economic benefits for the public.

Table 2.1 | **Investors Likely to Invest in Restoration**

PRIVATE FINANCE				
Financial Institution	**Type of Investor**	**Investment Stage**	**Strategy**	**Example**
Traditional Investors	Venture Capital	Early	Finance early-stage businesses with substantial risk, but long-term growth potential. Often seek very high returns to compensate for risks taken.	Vectr Ventures invested in Land Life Company (a Dutch business that develops technology to reduce tree-planting costs) in Land Life's Series A round of funding, which totaled €2.4 million (Gool 2017).
	Private Equity	All stages	Invest in privately held companies with the primary goal of generating above-market-rate financial returns.	TerViva, an American company planting pongamia trees on degraded land, raised $2 million from private equity investors in its Series B round of funding in 2015 (Burwood-Taylor 2015).
	TIMOs	Middle/Late	Timber Investment Management Organizations (TIMOs) analyze and acquire timberland on behalf of institutional clients.	In its first three funds, The Lyme Timber Company LP raised a cumulative $410 million and invested in 24 properties totaling 373,000 ha (923,000 acres) in the United States (The Lyme Timber Company 2017).
Sustainable Investors	Impact Investors	Early	Invest directly in early-stage businesses with the goal of generating financial, environmental, and social returns. Often seek at least a market-rate return.	EcoEnterprises Fund has financed over 30 companies engaged in conservation and sustainable development. For example, it has invested in Sambazon which sells organic products that help preserve the Amazon rainforest (EcoEnterprises Fund 2017).
Retail Investors	Crowdfunding	Early	Individuals pool small sums of money to invest in businesses and ideas, typically through a crowdfunding platform. May or may not seek financial returns.	Better Globe Forestry, a Kenyan company planting native trees in the drylands, has been financed through crowdfunding in Scandinavia for the past 11 years (*CV Magazine* 2017).
Commercial Banks		Middle/Late	Finance businesses by providing loans, bonds, and other financial products.	JP Morgan has committed to facilitate $200 billion in clean financing worldwide between 2017 and 2025, including tax equity, underwriting green bonds, etc. (Zwick 2017; JP Morgan 2017).

Source: WRI.

- Philanthropic finance, which is charitable giving by individuals or organizations, typically with no intention of earning a financial return. In this regard, philanthropic finance and public finance are similar; subsequent references to "public finance" in this report refer to both public and philanthropic capital.

Table 2.1 summarizes the institutions and investors that are most likely to invest in restoration.

Table 2.1 | **Investors Likely to Invest in Restoration (continued)**

PUBLIC FINANCE AND PHILANTHROPY				
Financial Institution	**Type of Investor**	**Investment Stage**	**Strategy**	**Example**
National Banks		Middle/Late	Government-owned banks that provide financing for projects that further national interests. Financing may be at market or below-market rates.	BNDES (National Bank for Economic and Social Development) launched its Atlantic Forest Initiative in Brazil, investing R$36 million ($12 million) to restore 3,000 ha across 14 projects (BNDES 2015).
Multilateral Development Banks		Early/Middle	Finance projects and businesses for the purpose of economic development, typically with social and/or environmental benefits in mind. Often provide financing at below-market rates, including grants and no-cost loans.	The $775 million Forest Investment Program, managed by the Climate Investment Funds (CIF) under the World Bank, provides grants and low-interest loans to reduce deforestation and forest degradation in developing countries (CIF 2017).
Governments	Bilateral Governments	Early/Middle	Assistance from one government to another in order to achieve development, philanthropic, and/or political goals. The assistance may take the form of financial aid, capacity building, or other forms of structural support.	In 2016, the government of Norway pledged $50 million to continue its environmental funding partnership with the government of Indonesia, which aims to restore 2 million ha of peatland by 2020 (Ecosystem Marketplace 2016).
	Municipal & State Governments	Early	Develop programs and implement projects at the municipal or state level. The government is primarily interested in creating public benefit and is interested in a mix of economic, social, and environmental returns.	Reflorestar is a statewide program in Espirito Santo, Brazil, that pays farmers to implement sustainable land-use practices that restore land. Through the program, the state seeks to restore 80,000 ha by the end of 2018 (De Miranda Benini et al. 2015; Padovezi 2015).
	Federal Governments	Early	Develop policies and programs and implement incentives and projects at the national level. The government is primarily interested in creating public benefit and is interested in a mix of economic, social, and environmental returns.	In 1997, Costa Rica's government implemented a 3.5% tax on fossil fuels to fund environmental services, including reforestation and conservation (GOCR 1996).
Philanthropy	Civil Society	Early	Engage in a wide variety of actions, from implementing projects and fundraising to research and advocacy.	The Nature Conservancy has developed a portfolio of 32 Water Funds worldwide, where water users provide funding to reforest and conserve watersheds. More than 2.8 million ha of watersheds stand to benefit (TNC 2017).
	Foundations	Early	Develop programs to implement projects directly or build capacity through research and policy. Foundations may contribute their own funds or attract investment from public and private partners.	The Restore the Earth Foundation is collaborating with stakeholders to restore 400,000 ha of land in the Mississippi River Basin. To date, the foundation has raised $40 million from public and private partners and restored over 20,000 ha of land (Restore the Earth Foundation 2016).
	Wealthy Individuals	Wealthy Individuals	Finance projects through a variety of means, either by donating to existing groups and projects or developing their own organizations. Projects are developed based on their personal interests and typically do not seek a financial return.	The Inikea Sow-a-Seed Project, a personal endeavor for IKEA's founder, Ingvar Kamprad, has been restoring a degraded forest in Borneo and plans to reach 18,500 ha by 2020 (IKEA 2017).

Source: WRI.

BOX 2.1 | WHAT DO IMPACT INVESTORS WANT?

Impact investors are private investors that invest in early- and mid-stage companies with the intention of generating financial, social, and environmental returns. In a recent survey conducted by the Global Impact Investing Network (GIIN), the pool of impact investing capital is greater than $114 billion, with over $22 billion invested in 2016 (Mudaliar et al. 2017). This pool has grown significantly, increasing by 18 percent compounded annually between 2013 and 2015 (Mudaliar et al. 2016).

Like other private investors, most impact investors look for attractive financial returns. In a survey of impact investors conducted by GIIN, only a third of respondents indicated that they were interested in investments that might yield below-market-rate returns.

Impact investors are already involved in restoration. Through WRI's Initiative 20x20 and AFR100, impact investors have earmarked over $2 billion to invest in restoration. Given the potential for restoration to deliver on the triple-bottom line—yielding social, environmental, and financial returns—impact investors may play an increasing role in financing.

Different investors have different expectations with respect to returns (Figure 2.1). Their goals also differ. Some investors in the public sector, such as the government, may be primarily driven by social and environmental benefits. On the other hand, most traditional investors in the private sector focus on financial returns. For example, only 26 percent of all professionally managed assets globally are related to sustainable investing (GSIA 2017). Notably, impact investment seeks to invest in private companies that earn a financial return and also have social and environmental impact (Box 2.1).

For money to flow, a financial instrument or mechanism is required to channel funding from investors to investees. Private-sector financial instruments include equity, loans, and bonds (including green bonds, see Box 2.2). Fiscal instruments include grants, subsidies, taxes, and other incentives (Table 2.2).

What Stymies Investment in Restoration?

Upholding the targets set by the Bonn Challenge of restoring 150 million hectares of degraded lands globally by 2020 could create $84 billion in annual material benefits (IUCN 2012). But the investment needed to generate these benefits is not being made. Indeed, it is estimated that approximately $350 billion is needed for conservation and restoration, but only $50 billion is available (Credit Suisse et al. 2014), and 80 percent of that comes from public sources (Parker et al. 2012). Private investment is only about $10 billion a year (Figure 2.2).

Figure 2.1 | **Expectations of Returns Vary across Investor Types**

Source: Adapted from FAO and UNCCD 2015.

Table 2.2 | **Financial Instruments and Fiscal Measures Relevant to Restoration**

TYPE	INSTRUMENT	CHARACTERISTICS	RELEVANCE TO RESTORATION	EXAMPLE
PRIVATE	**Equity**	■ Investor provides capital in exchange for ownership stake in the business ■ Value of equity is tied to performance of underlying venture	Investment in commercial activities where there may be significant risk	Komaza raised over $4 million in equity from Novastar Ventures and Mulago Foundation during its Series A investment round (AngelList 2017).
	Loan	■ Investor lends capital to borrower, who repays the principal amount, with a specified rate of interest, over a period of time ■ Loan is provided by a single lending source ■ Periodic interest payments, typically twice a year	Suited to restoration projects that generate regular cash flow	The U.S. Small Business Administration offers loans up to $5 million for small and medium-size businesses (SBA 2017).
	Bond	■ Debt instrument where issuer borrows funds, to be repaid with interest over a specified period of time ■ Similar to loans, but is often syndicated among many lenders and is thus suited to raise large amounts of capital ■ Periodic interest payments, typically twice a year	Large-scale restoration businesses that produce regular cash flow	In 2013, the state of Massachusetts issued $100 million worth of green bonds, $24 million of which financed environmental remediation and habitat restoration projects (duPont et al. 2015).
PUBLIC	**Grant**	■ Funds given to an organization or individual for a particular purpose ■ Grants are nonrepayable ■ May be one-time or renewable	Can help projects reach an investment-ready stage	Brazil's Amazon Fund makes grants to projects that contribute to reducing deforestation in the Amazon forest (Amazon Fund 2017).
	Subsidy	■ A financial benefit from governments to groups or industries, lowering costs for the producer ■ Typically in the form of a cash payment or tax break	Improves the economic returns as the government bears a portion of the cost	From 2011 to 2014, the Indonesian government subsidized around $12 billion in infrastructure investments annually for palm oil-producing regions (McFarland et al. 2015).
	Tax	■ Imposed by governments on individual's or organization's incomes or profits ■ Can also be added to the price of goods and services ■ Goal is to redistribute benefits equitably and to fund government programs	Includes taxes on carbon and fossil fuels	The Brazilian state of Espírito Santo levies a 3 percent tax on oil and gas products. With the revenues from the tax, the state's government aims to restore 80,000 ha of Atlantic Forest by the end of 2018 (Padovezi 2015).
	Other Incentives	Direct or indirect payment to procure a desired behavior or return	Includes interest rate concessions and credit guarantees	The World Bank Group offers multiple incentives, such as Partial Credit Guarantees, to cover debt investments in private projects (World Bank Group 2016).

Source: Adapted from FAO and UNDCC 2015.

Given the sheer size of private capital markets, the potential of private finance to fund restoration has been a topic of much debate. The world's private financial stock, including stock market capitalization, bonds, and loans, rose to $171 trillion in 2010, compared to $63 trillion of world GDP in the same year (Roxburgh et al. 2011; World Bank 2011). However, investor interest in a specific restoration project will depend on what benefits are generated and to whom they accrue. For example,

BOX 2.2 | THE BURGEONING MARKET FOR GREEN BONDS

Green bonds are bonds issued to fund projects that have positive environmental benefits. With the exception of its green label and associated certification and reporting costs, a green bond is identical to a conventional bond. In 2016, 56 percent of bond sales financed clean energy and infrastructure projects. Agriculture and forestry projects (including restoration projects) received just 2 percent of green bond investment (Climate Bonds Initiative 2017a).

Green bonds were first issued in 2007. The global market for them took off in 2012, when issuances more than tripled from $3 billion to $11 billion in 2013 and $36 billion in 2014 (Climate Bonds Initiative 2017b). Green bond market issuances reached $81 billion in 2016 (Climate Bonds Initiative 2017a), and are projected to reach $206 billion by the end of 2017 (Hirtenstein 2017). Market growth signals that institutional investors want to finance green projects. However, while the green aspect of the bonds generates publicity, attracts new investors, and increases overall demand for the bond,[a] continued expansion of the green bond market is contingent on the existence of a green premium. Bond issuers should have a lower cost of capital by issuing a green bond, instead of an otherwise-identical bond, that justifies the cost of green certification, reporting, and monitoring. Evidence for the existence of such a price premium is mixed. While some industry experts state that no premium exists (Climate Bonds Initiative 2017c), a 2015 study by Barclays found a small premium of 0.20 percent for green bonds (Preclaw and Bakshi 2015).

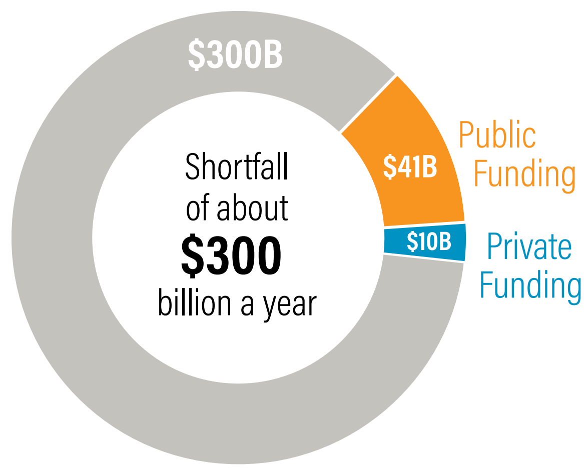
Note: [a] Sanders, Sarah, and Bettina Bronisz. 2017. Telephone conversation between the authors and Sarah Sanders, assistant treasurer, Connecticut Office of the State Treasurer, and Bettina Bronisz, debt management specialist, Connecticut Office of the State Treasurer, Hartford, CT. April 25.

projects that generate only public benefits such as carbon and biodiversity will not be interesting to private investors, who prioritize financial returns. Many restoration projects generate benefits that are difficult to monetize and capture; this is partly why public investment, with its focus on social and environmental benefits, has dwarfed private investment in restoration to date.

This report identifies seven main barriers that have prevented finance from flowing to restoration (Figure 2.3).

Many of the problems are interrelated. For example, the fact that environmental and social benefits are not valued by the financial system (barrier 1) affects policies that incentivize continued degradation (barrier 2), and the long-time horizon (barrier 6) increases the perception of risk (barrier 7). The following sections discuss each of these barriers and present solutions with real-life case studies from around the world.

Figure 2.2 | **The Annual Shortfall in Global Funding for Restoration and Conservation Is about $300 Billion**



Source: Adapted from Parker et al. 2012; Credit Suisse et al. 2014.

Figure 2.3 | **Main Barriers to Scaling Up Restoration Finance**

Source: WRI authors.

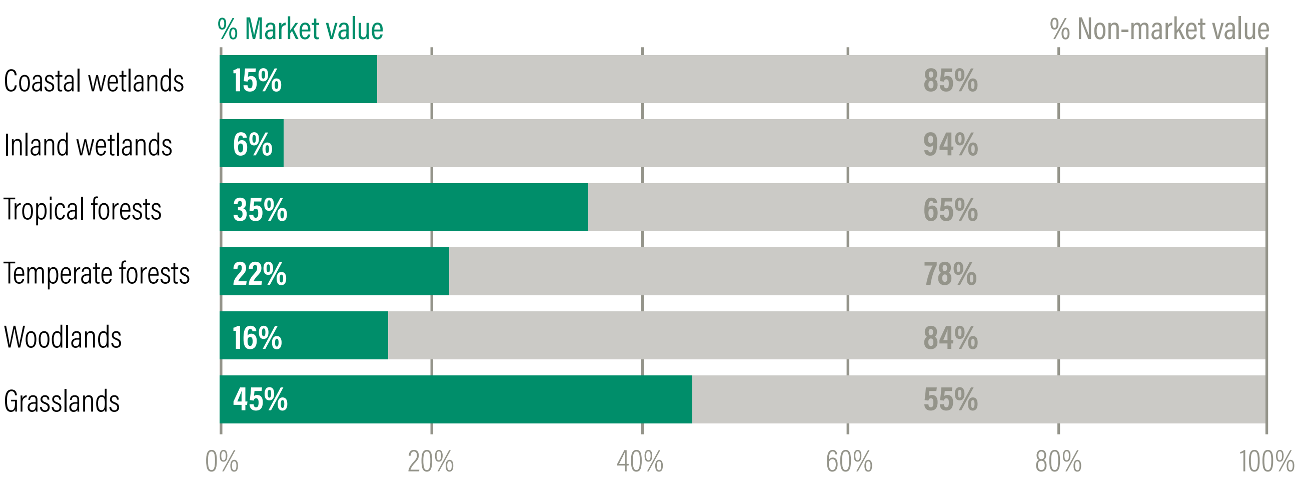
Barrier #1: Environmental and Social Benefits Usually Have No Market Value

Problem

Restoration creates a plethora of benefits for society, but many of them do not translate into financial returns (Milcu et al. 2013). Only a small share of the benefits from natural landscapes accrue to the market (Figure 2.4).

By excluding restoration's environmental and social benefits from the calculation and focusing only on monetary benefits, financial analysis portrays restoration as delivering lower returns than other investments. Without policies or mechanisms to remedy this problem, many restoration projects will remain unattractive to private investment.

Figure 2.4 | **Average Proportion of Market vs. Non-market Value by Land Type**



Source: Adapted from De Groot 2012.

Solutions

QUANTIFYING THE FULL NET BENEFITS OF RESTORATION BY INTERNALIZING ENVIRONMENTAL AND SOCIAL BENEFITS

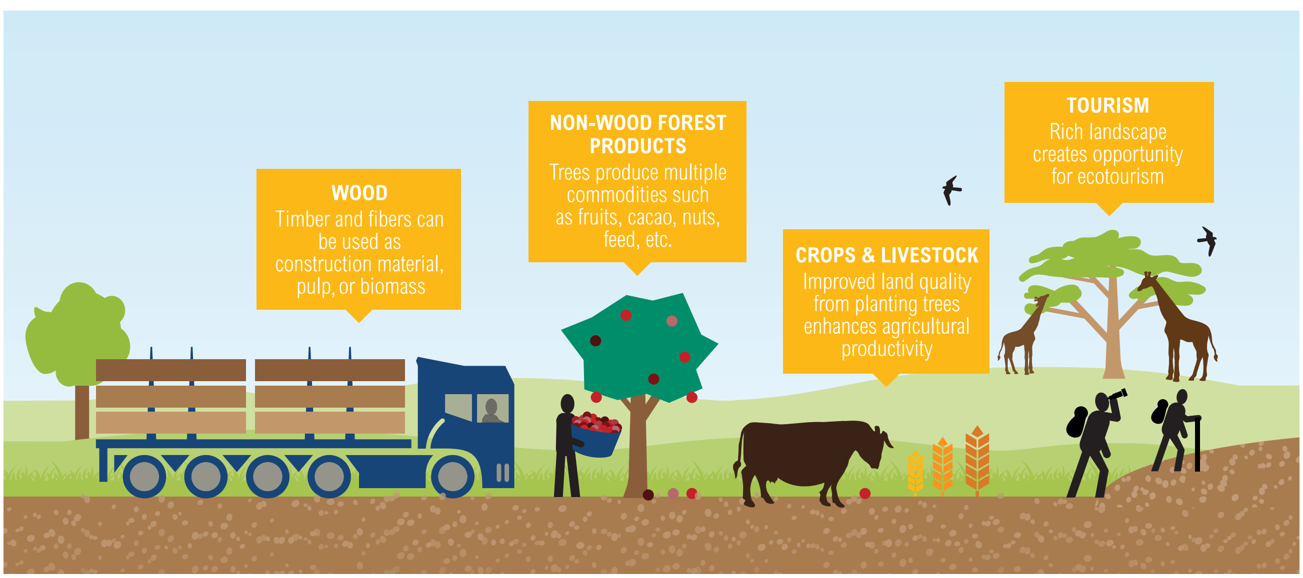
Quantifying the full set of benefits of restoration is crucial. (Section 3 discusses the various methods that can be used to do so.) Private investors may be willing to finance a subset of restoration projects that provide clear revenue streams. Figure 2.5 shows four potential ways in which restoration can generate commercial returns.

To shift the financing paradigm in a way that allows restoration to be financed at scale, financial systems must internalize the environmental and social benefits of restoration projects. Where markets do not exist, government intervention is required to put institutions and markets in place to reflect these public goods.

To shift the financing paradigm in a way that allows restoration to be financed at scale, financial systems must internalize the environmental and social benefits of restoration projects.

One strategy is to develop favorable policy instruments that will reallocate financial resources and/or redirect incentives toward restoration activities. In a Payments for Ecosystem Services (PES) system, the government pays farmers and landowners to implement practices that deliver a bundle of ecosystem benefits. PES has been widely applied to capture the values of carbon sequestration and water yields, improving the financial returns from restoring land. Carbon pricing is another common approach to channel financing into low-carbon projects, including restoration, and can be used by public and private actors alike (Box 2.3).

Figure 2.5 | **Sources of Revenue from Restoration**



Source: Faruqi and Wu 2017.

BOX 2.3 | REDUCING GHGS THROUGH CARBON TAXES AND INTERNAL CARBON PRICING

Several financial instruments have been used to spur the development of a low-carbon economy. These fall into two main categories: emissions trading systems (ETS) and carbon taxes. Under an ETS, the government sets a limit on the total carbon emissions allowed and then develops a trading system for companies with low emissions to sell carbon credits, which fluctuate in price based on market supply and demand. Carbon taxes specify a particular carbon price, requiring entities to pay a tax proportional to their carbon emissions. The concept of carbon taxes can be applied at a smaller scale via internal carbon pricing.

CARBON PRICES

A carbon tax is a tax imposed on products that are carbon-intensive. It helps countries achieve their climate-related goals. In recent years, a number of countries have implemented carbon taxes, including Chile, Colombia, and Mexico.

Norway imposed a carbon tax beginning in 1991, which has since become a key part of the country's climate policy. The carbon tax varies by industry, with the petroleum and natural gas extraction, electricity, and road transportation sectors subject to the highest tax rates. The carbon tax has had a modest impact on the economy and tax revenue, due to the number of exemptions from the carbon tax allowed by the government (Bruvoll and Merethe Larsen 2004). Still, GHG emissions in Norway rose only 3 percent from 1990 to 2016, compared to a 7 percent increase in U.S. GHG emissions from 1990 to 2014 (Statistics Norway 2017; US EPA 2016).

In comparison, Canada's GHG emissions have risen at a much faster rate: 18 percent from 1990 to 2015 (Environment and Climate Change Canada 2017). To address this, the country has also turned to carbon taxes. In 2016, the federal government acknowledged the importance of carbon regulation in mitigating climate change. Building on carbon pricing mechanisms already in place in various provinces, it announced a new nationwide carbon tax, which will go into effect in January 2018. The plan applies a tax on carbon generated by transportation and heating fuels that starts at $10 per metric ton in 2018 and rises to $50 per metric ton by 2022. With this carbon tax, Canada aims to achieve the commitment it made in the Paris Climate Agreement, and also to support low-income families and innovative businesses (Government of Canada 2016).

While incorporating the cost of carbon into financial analysis is an effective way of internalizing environmental costs, the impact of carbon taxes or auctioned permits can be furthered by applying tax revenues to funding restoration programs. Around $28.3 billion was raised through carbon price revenues globally in 2016, of which about 27 percent ($7.8 billion) was used for green spending, 36 percent ($10.1 billion) was returned to tax payers through tax cuts or rebates, and the remainder was used for general government spending (Carl and Fedor 2016). Because restoring land is a natural climate solution (Griscom et al. 2017), it would be sensible for countries to allocate carbon tax proceeds to national or state-level restoration programs where relevant.

INTERNAL CARBON PRICING

According to a 2017 report by the Carbon Disclosure Project, more than 1,400 companies priced carbon emissions internally or planned to do so soon. These policies vary by structure; some companies, like Microsoft, mandate that each business group pay a fee based on its carbon emissions into an internal fund, which is then used to fund carbon offset and energy-efficiency projects. Others, like ConocoPhillips, factor country-specific carbon prices into the financial evaluation of their investments, depending on existing or imminent regulations. Companies see an internal carbon price as a mechanism to systematically reduce emissions by improving the financial returns of low-carbon investments relative to carbon-intensive investments.

The prices used by companies are often influenced by carbon regulation within the country or region, and some corporations choose to go above legal mandates. For example, Swiss health care giant Novartis set an internal price of $100 per metric ton, based on the World Bank's "cost of climate change to society" calculations (Bartlett et al. 2016). This figure exceeded the Swiss carbon tax of $89 per ton, enabling the company to sell surplus allowances and generate additional revenue (Le News 2015). In nations where there is no legal directive on carbon, prices exhibit a wide range and depend on the company's judgment (Bartlett et al. 2016).

Given the different investment goals of public and private investors, blended finance, which combines public and private capital, can also be used to raise capital by allowing beneficiaries to capture the benefits of restoration (Box 2.4).

Land tenure must be clearly defined if market participants—from smallholder farmers to institutional investors—are to capture the benefits of land restoration. This is a particularly relevant issue in many developing countries, where the lack of clarity over land tenure deters private investment. With a robust legal framework that secures investments, such as a legal reserve (Box 2.5), landowners have more incentive to ensure the long-term sustainability and profitability of their land. This makes them more likely to invest in restorative activities instead of exploitative activities that generate short-term returns at the cost of degrading land. In one example, Ding et al. (2016b) estimated that securing land rights in the Amazon would generate up to $1.5 trillion in returns.

Barrier #2: Incentives to Degrade Land Outweigh Incentives to Restore It

Problem

Making the economic case for restoration is very difficult when governments provide incentives for continued land degradation by promoting and subsidizing unsustainable practices. Such incentives are common in agriculture, where governments pay farmers directly and subsidize the inputs they use (e.g., water, fertilizers, electricity, fuel) (OECD 2010; ITC 2017). Partly as a result, 73 percent of forest loss in tropical and subtropical countries is caused by agricultural expansion (FAO 2016).

BOX 2.4 | FINANCING RESTORATION THROUGH FOREST RESILIENCE BONDS

In the western United States, forest fires are a major environmental hazard, devastating ecosystems and communities while releasing massive amounts of carbon into the air. Restoration treatments, typically carried out by the U.S. Forest Service, are essential to keep forest fires under control. However, in recent years, tightening budgets have forced the government agency to shift funds away from restoration, spending it on fighting existing fires instead. This forms a vicious cycle, as worsening forest fires prevent the U.S. Forest Service from investing in restoration needed to keep the fires in check.

The Forest Resilience Bond—a blended finance model developed by the American Forest Foundation, Blue Forest Conservation, and WRI—uses private capital to fund restoration activities that deliver long-term cost savings for water utilities, electric companies, and the U.S. Forest Service. Beneficiaries pass along savings to investors through payments to the Forest Resilience Bond. This public-private partnership effectively breaks the cycle of worsening forest fires by funding restoration projects that otherwise would not occur (Blue Forest Conservation 2017).

Countries in the Organisation for Economic Co-operation and Development (OECD) provided $672 billion in support to agriculture between 2013 and 2015 (OECD 2016). Between 2010 and 2012, China provided $160 billion, the United States $145 billion, and Europe $121 billion. Annual subsidies to the agricultural sector in Indonesia and Brazil—the countries that have suffered the greatest forest loss since 2000—are currently estimated at $27 billion and $10 billion, respectively (McFarland et al. 2015). These figures represent 3 percent of Indonesia GDP and 0.6 percent of GDP in Brazil (World Bank 2017a). These subsidies dwarf the economic incentives to reduce deforestation and land degradation.

Agricultural subsidies are often justified on the grounds that they help small farmers. For example, the Malawi government has invested great sums in its Agricultural Inputs Support Programme ($117 million in 2007–2008, equivalent to 9 percent of the government budget) on the basis of improving smallholder self-sufficiency in maize production (Baltzer et al. 2012). But many programs are structured as direct payments to farmers on a per-hectare basis, disproportionately benefiting large industrial farms. In the United States, for example, the top 1 percent of crop subsidy recipients received an average subsidy of $227,000 a year in crop insurance in 2011, whereas the bottom 80 percent received just $5,000 (EWG 2016).

To compound the problem, in the forestry sector, governance and enforcement are often lacking. People who illegally harvest timber face very little risk of getting caught (FAO and ITTO 2005). A 2015 investigation by Greenpeace revealed that a Brazilian logging company, Agropecuaria Santa Efigenia Ltd., exploited the anonymity of the global timber market to sell more than $7 million of illegal wood, filing fraudulent paperwork to claim unreasonably high levels of logging in legal areas, and then illegally deforesting other parts of the Amazon (Greenpeace 2015). Without sufficient incentives to halt deforestation and to start restoration, high prices for endangered tree species will continue to drive land degradation.

BOX 2.5 | PROMOTING CONSERVATION AND RESTORATION THROUGH ESTABLISHMENT OF A "LEGAL RESERVE" IN BRAZIL

Brazil's forest code requires all private rural properties to maintain a fixed proportion of their land in natural vegetation. This share ranges from 20 percent in the Atlantic forest to 80 percent in the Amazon (May et al. 2015). This legal reserve was put in place in 1934 to ensure the supply of wood for fuel (Mueller and Alston 2007). Although the original objective has become irrelevant, the regulation has remained in place and has become a valuable tool for promoting biodiversity conservation and restoration.

Brazil's legal reserve indirectly helps to raise finance for restoration by penalizing parties that do not comply with the law. Some banks take this liability into account when lending by deducting the liability from the amount of the collateral (the land value). This reduces the funds available to those who don't comply, thereby indirectly placing a value on natural capital.

Solutions

Elimination of environmentally harmful agricultural subsidies would reduce the incentives to degrade land. Efforts to bolster transparency and enforcement in the timber sector would also shift incentives away from deforestation.

Eliminating or reforming subsidies is difficult, however, because large agricultural enterprises have outsized influence in political spheres (*The Economist* 2015). Agricultural subsidies have been a politically charged topic for decades, in part because they are often seen as a means of ensuring food security or stimulating development (Meléndez-Ortiz et al. 2009).

An argument can be made for increasing subsidies for restoration. Pigouvian subsidies—subsidies that support economic activity with external benefits—can spur restoration projects; such subsidies can improve social welfare by capturing the environmental and social benefits that are not reflected in market prices (Lawn 2016). This approach may be more politically palatable than eliminating agricultural subsidies, because it is framed as stimulating the economy instead of taking benefits away. Another option is to reform existing subsidies rather than trying to create new incentives. This is the approach Costa Rica took (Box 2.6).

Barrier #3: Climate Finance Is Difficult to Access

Problem

In response to the growing urgency of climate change, several multilateral funds have been established to finance climate solutions (Table 2.3). In 2017, funds such as the Amazon Fund ($1.7 billion), the Forest Investment Program ($722 million), and the United Nations Convention to Combat Desertification (UNCCD) Land Degradation Neutrality Fund ($300 million) support countries' efforts to reduce degradation and promote land restoration (CFU 2017; UNCCD 2017). The Amazon Fund and the Forest Investment Program are part of the REDD+ (Reducing Emissions from Deforestation and Forest Degradation) financing mechanism. Nearly 90 percent of REDD+'s funding comes from the public sector, with the Norwegian government being the largest donor (Norman and Nakhooda 2015).

Unfortunately, these funds are the select few that focus on land use and forests. Most climate finance is aimed at renewable energy, energy efficiency, and transportation (Denier et al. 2015). According to a report by the Climate Policy Initiative, public climate finance from development institutions and international finance totaled $128 billion in 2015. Financing for land use projects accounted for just $7 billion of that total (Buchner et al. 2015), and only a fraction of those funds went to restoration. Despite current trends, climate funds are a promising source of financing for restoration projects because of the clear link with land use. Indeed, restoration and avoided forest conversion can provide more than one-third of the climate mitigation needed to keep global warming below 2°C in 2030 (Griscom et al. 2017).

The climate funds listed in table 2.3 have funded several restoration projects. Table 2.4 describes some of them.

BOX 2.6 | REVERSING THE DECLINE IN FOREST COVER IN COSTA RICA

In 1943, 77 percent of Costa Rica's land area was covered with forest; by 1987 the country's forest had declined to just 21 percent (GOCR 2011). The significant reduction in forest land, especially between 1950 and 1985, was driven by a national strategy that looked to agriculture for economic growth, resulting in the expansion of croplands and pastures (World Bank 2000).

The phase-out of subsidies to the beef industry in the 1980s, as well as a drop in the price of beef and dairy in international markets, contributed to a rapid decline in Costa Rica's livestock population (Calvo-Alvarado et al. 2009). Reduced competition for forestland from cattle ranching became the most significant enabler of land restoration in the country (Buckingham and Hanson 2015).

Other factors also contributed to the revival of Costa Rica's forests, including growth in the ecotourism industry and improvements in land tenure. Policy also mattered. In 1997 the government implemented a payment for an ecosystem services scheme, funded by a 3.5% tax on fossil fuels, that encouraged reforestation and the conservation of thousands of hectares of forests (GOCR 1996).

These factors, particularly the elimination of cattle subsidies in 1991, increased the country's forest cover from 29 percent in 1991 to 54 percent in 2015 (GOCR 2011; World Bank 2017b).

Table 2.3 | **Descriptions of Multilateral Climate Funds**

FUND	THEMATIC FOCUS	FINANCIAL INSTRUMENTS USED	ELIGIBILITY FOR FUNDING	CUMULATIVE PLEDGED FUNDING (US$ BILLIONS)	AVERAGE TIME FOR PROJECT APPROVAL
Adaptation Fund	Climate adaptation	Grants	Developing country Parties in the Kyoto Protocol particularly vulnerable to climate change	$0.54	8–13 months
Global Environment Facility - 5 and 6[a]	Climate mitigation; capacity building	Grants; concessional loans; equity; risk mitigation	Developing country Parties and conventions served by the GEF; Parties eligible to receive World Bank funding or UNDP technical assistance	$3.03	18–22 months
Green Climate Fund	Climate mitigation; climate adaptation	Grants; concessional loans; risk mitigation; equity	All developing country Parties to the UNFCCC	$10.3	-
Least Developed Countries Fund	Climate adaptation	Grants	Least developed countries (LDCs)	$1.19	19 months
Pilot Program for Climate Resilience	Climate adaptation; capacity building	Grants; concessional loans; equity; risk mitigation	World's most vulnerable countries and small islands	$1.19	19–45 months
Strategic Climate Fund	Climate mitigation; climate adaptation	Grants; concessional loans; risk mitigation; equity	Official development assistance-eligible developing countries with active multilateral development bank (MDB) country programs	$2.74	18 months

Note: [a] In addition to climate, GEF focuses on biodiversity conservation.
Source: Adapted from Amerasinghe et al. 2017.

Table 2.4 | **Examples of Restoration Projects Funded by Global Climate Funds**

FUND	PROJECT	YEAR FUNDED	DURATION (YEARS)	DESCRIPTION	AMOUNT FUNDED ($ MILLIONS)
Adaptation Fund	Ecosystem-based approaches for reducing the vulnerability of food security to the impacts of climate change in the Chaco region (Paraguay)	2017	3.5	Aims to contribute through the conservation and restoration of forests, agroforestry, agro-ecological farming, etc., to reducing the vulnerability of food security to the impacts of climate change in the El Chaco region of Paraguay	7.12
Green Climate Fund (GCF)	Sustainable landscapes (Madagascar)	2016	10	Sustainable landscape measures (restoration included) to enhance the resilience of smallholders, reducing greenhouse gas emissions and channeling private finance into climate-smart investments in agriculture	69.8 (23 percent cofinanced)
Global Environmental Facility (GEF) – 6	Forest landscape restoration in the Mayaga region (Rwanda)	2017	5	To secure biodiversity and carbon benefits while simultaneously strengthening the resilience of livelihoods through forest and landscape restoration	32.2 (79 percent cofinanced)
Pilot Project for Climate Resilience	Sustainable land and water resources management project (Mozambique	2014	5	Project seeking to strengthen capacity of Mozambique's rural communities to address challenges of climate	35.8 (56 percent cofinanced)

Source: Adapted from AF 2017; GCF 2016a; GEF 2016; and PPCR 2017.

When evaluated for climate funding, restoration proposals may face barriers, including unclear revenue streams, the lack of an investment track record, and the possibility of project failure (Sunding 2011; Godefroid et al. 2011; Wuethrich 2007). In addition, the multitude of funds—each with different rules, requirements, steps, and procedures—has led to high transactions costs.

These inefficiencies are particularly burdensome for least developed countries, which lack the resources and expertise needed to meet the administrative challenges. Well-intentioned efforts to ensure accountability in climate funding have made it difficult to deploy capital. The approval process can take two years or more, increasing costs and bureaucracy and limiting access to funding.

BOX 2.7 | FAST-TRACK PROCESS

The Green Climate Fund (GCF) was founded in 2010 by the United Nations Framework Convention on Climate Change (UNFCCC). It supports developing countries' efforts to implement actions for climate adaptation and mitigation.

To accomplish its goals, the GCF uses a variety of financial instruments, including grants, loans, and equity investments. It has funded a variety of projects based on restoration, including sustainable landscape management in Madagascar and the development of Argan tree plantations in degraded areas of Morocco (GCF 2016b).

The GCF implemented a fast-track process that simplifies the accreditation process for entities already accredited by other funds, such as the Adaptation Fund and the Global Environment Facility (Masullo et al. 2015). Fast-track accreditation has reduced the accreditation process from more than six months to a maximum of three months (GCF 2016c).

Solutions

Structural reform and greater flexibility of funding institutions are key to increasing the number of restoration projects that receive funding (Thomas et al. 2010). The application process for global climate funds can be shortened by coordinating to reduce duplication and inefficiency. In lieu of broad, overlapping areas of investment, funds could agree to target specific, complementary thematic areas, reducing confusion over who funds what. Developing standardized requirements and procedures across different funds would also simplify access, increase speed, and reduce transaction costs for applicants (Amerasinghe et al. 2017). These issues are not unique to climate funds but have been endemic in the development world for decades.

Financing from climate funds often consists of grants or concessional loans that can be layered with other capital sources that have higher hurdle rates for financial return. When structuring deals, climate funds can leverage capital from other sources. Each dollar of climate funding reportedly attracts an average of $2.20–9.70 in cofinancing (Amerasinghe et al. 2017). The Green Climate Fund (Box 2.7) recently announced a commitment of $500 million to absorb risks for low-carbon projects; such funds could help create the risk-return profiles necessary to attract private capital (GCF 2017).

Targeted policies can also help to increase the flow of climate finance toward restoration. Governments should explicitly acknowledge restoration as part of their climate mitigation strategies, known under the Paris Agreement as Nationally Determined Contributions (NDCs); actively track funds that are appropriated for restoration; and set specific targets for restoration finance. When seeking access to global climate funds, governments should be able to channel funds into restoration while providing transparency to funders. While land-use projects, including restoration, only receive a slim fraction of climate funds, these policy actions would signal to global climate funds the importance of restoration and increase the percentage of climate funds directed toward restoration.

Barrier #4: Funding for Restoration Often Comes Only from Small Environmental Budgets

Problem

Many governments have begun to allocate funding to restoration projects. But government officials may treat restoration as a purely environmental concern and confine it to the environmental budget. This is often the case in Africa, based on WRI's experience through AFR100.

The impact of restoration extends well beyond the environmental sphere. Restoring 150 million hectares of degraded agricultural land can provide $30–40 billion a year in extra income for smallholder farmers and additional food for close to 200 million people (GCEC 2014). Lack of awareness and coordination between ministries of agriculture and environment on restoration policies means that restoration projects may fail to be funded.

There are also strong connections between restoration and energy. For example, erosion from deforested and degraded lands near hydroelectric plants can cause sedimentation in reservoirs, affecting electricity production (Sáenz et al. 2014). Restoring land is strongly linked to energy in sub-Saharan Africa, where trees supply about 70 percent of energy needs in the form of fuelwood (DIE 2016). These ties are ignored when restoration is limited to the environmental sphere.

Environmental ministries often have smaller budgets than other government bodies. Table 2.5 compares national budgets for four sectors of the economy in a sample of four countries, chosen on the basis of geographic diversity. In this set of countries, environmental expenditure is on average 40 percent lower than agricultural spending, 45 percent lower than energy spending, and 28 percent lower than spending on economic development. These figures grossly understate the gap in financing for restoration, as restoration usually receives only a small share of the environmental budget.

Table 2.5 | **National Budgets for the Environment, Agriculture, Energy, and Economic Development in Four Countries**

BUDGET ($ MILLIONS)					
Country	Fiscal Year	Environment	Agriculture	Energy	Economic Development
Ecuador	2015	148.2	572.5	1,562.7	144.9
South Africa	2015–16	527.8	313.0	576.1	1,614.0
Nigeria	2017	91.4	433.7	435.4	296.1
Indonesia	2017	507.9	2,069.6	527.0	415.8

Note: The raw data modified to create this table were obtained from sources from a variety of governments with different practices for categorizing fiscal appropriations. Some budget reports specify allocations to ministries and others investments to economic sectors. The authors of this report used their discretion when aggregating expenditures into the sectoral categories environment, agriculture, energy, and economic development. These categories are not drawn directly from the language of government budgets or appropriations reports.
Source: Based on raw data from the Ministry of Finance of Ecuador, the National Treasury of the Republic of South Africa, the Ministry of Budget and National Planning of Nigeria, and the Ministry of Finance of the Republic of Indonesia, modified by WRI.

Solutions

Linking restoration actions to many parts of the government—such as ministries of agriculture, finance, and energy and the treasury—can help increase funding for restoration. Some countries, including Colombia and Guatemala, are already doing so.

Two areas of research would be particularly helpful in making this connection:

- Economic analysis that shows the impact of restoration on employment and income could help mobilize domestic budgets. To date, there has only been one study estimating restoration's economic impact at the national level, and it focused on the United States (BenDor et al. 2015a).
- In countries where agriculture is a big part of the economy, it is important to link restoration to improved livelihoods for farmers and greater food security. Analysis can make the connection between restoring degraded land and improving agricultural productivity at a country or regional level.

In order for governments to treat restoration as a cross-sectoral opportunity with broad benefits for their constituents, experts and advocates should communicate about restoration in terms that are relevant to governments, such as poverty alleviation, job creation, migration, and food and water security. Reframing the issue can go a long way toward convincing governments to consider restoration more broadly than the environment, thus expanding funds (Box 2.8).

BOX 2.8 | HARNESSING MULTIPLE GOVERNMENT AGENCIES IN BRAZIL, ETHIOPIA, AND THE UNITED STATES

Countries that integrate restoration work into multiple governmental entities have a greater capacity for restoration and have made significant pledges toward restoration. Brazil made the largest commitment in Latin America by setting a target of 12 million hectares for restoration and reforestation in its NDC (Biderman et al. 2016). Ethiopia made the largest commitment in Africa of 15 million hectares (WRI 2017). The United States has committed to restoring 15 million hectares by 2020 (Bonn Challenge 2017).

BRAZIL
Embrapa, a Brazilian agricultural research corporation affiliated with the Ministry of Agriculture, is conducting research into the production of native seeds suitable for restoring the Atlantic forest (Embrapa 2016). Brazil's National Bank for Economic and Social Development (associated with the Ministry of Development, Industry, and Trade) has been financing landscape restoration projects for years (BNDES 2011). The Ministry of Agrarian Development aims to tackle issues of sustainable land use and ecological restoration.

ETHIOPIA
Ethiopia has a national blueprint for climate in which all relevant ministries and agencies are involved. A major component of the Climate Resilient Green Economy strategy is restoration. Efforts are led by various ministries, including the Ministry of the Environment, Forest and Climate Change, while the Ministry of Agriculture and Natural Resources and the Ministry of Water, Irrigation, and Electricity lead extensive integrated watershed interventions.

UNITED STATES
In the United States, agroforestry and conservation teams are housed in the agencies and divisions of the Department of Agriculture, the Department of the Interior, and the Environmental Protection Agency.

Barrier #5: Many Restoration Projects Are Too Small to Attract Investors

Problem

Globally, capital is concentrated in large funds that manage billions of dollars. Whether these funds are public or private, deal size matters: A $5 billion fund is not interested in making a $5 million investment, because the transaction costs (expressed as a percentage of the investment) make such an investment unattractive. Large funds look for minimum investment sizes of $50–100 million, as the larger deal size lowers transaction costs. As global markets grow, minimum investment sizes continue to increase, making it increasingly important to aggregate small projects.

Most restoration projects require $1–10 million in capital. Their small size means they are usually of limited interest to institutional investors. Most smallholders and investors in developing countries are not able to make these investments because domestic capital markets in their countries are undeveloped, and banks are unwilling to lend to projects for which transactions costs and risk are high.

Restoration projects with attractive financial returns exist, but there is no standard medium or process to define or identify them, making the search process more time-consuming and costly (Credit Suisse and McKinsey 2016). In contrast, multiple venues exist to pitch business ideas and attract capital for industries like technology and clean energy.[5]

The small size of investments and the lack of a simple method to identify projects means that promising investments are often overlooked and underfinanced. Interviews indicate that restoration is not on the radar of many impact investors, much less mainstream investors. Without a clear signal that financing is available for restoration, entrepreneurs and businesses may be deterred from entering the space, thereby limiting the project pipeline.

Solutions

Financial mechanisms to aggregate assets and bundle projects are an established means of addressing small investments (d'Olier-Lees et al. 2017). These mechanisms have been used to finance small-scale energy efficiency projects (UNIDO

BOX 2.9 | AGGREGATING PROJECTS TO ATTRACT CAPITAL: THE EXPERIENCE OF FORESTFINANCE GROUP

Since 1995, the ForestFinance Group has been investing retail investors' savings in the restoration of degraded forest landscapes in Colombia, Panama, Peru, and Vietnam. On its own, any one of the restoration projects would be too small to attract funding. By aggregating them under one umbrella, ForestFinance is able to raise capital.

The company offers various investment products in developed countries (Table B2.9.1). It manages forest investments of about $100 million for more than 18,000 clients, using the funds to reforest degraded pasturelands and grow mixed-species forests. After 25 years, ForestFinance harvests some of the trees and sells the timber. As of 2016, ForestFinance had 17,500 hectares of forests under management, of which it has restored more than 7,500.

Table B2.9.1 | Investment Products Offered by ForestFinance Group

CONTRACT TERM (YEARS)	INVESTMENT	AREA RESTORED	RETURN FORECAST	PAYOUTS	RESTORATION CONCEPT
25	Twelve monthly payments of €38 or one payment of €396	From 0.0125 hectares	About 6%	About €1,745 after 25 years	Mixed forest
25	One payment of €3,250	From 0.1 hectares	About 6%	Annually from year 6; totaling about €7,735	Cacao cultivation and rain forest protection
12	One payment of €2,625	From 0.25 hectares	About 6%	On years 3, 5, 7, 9, and 12; totaling about €4,990	Mixed forest

Source: ForestFinance Group 2017.

2017) and to convert retail assets (such as cars) into institutional products (such as asset-backed securities). Intermediaries that aggregate restoration projects could help bundle projects to make them more attractive to institutional investors (Kissinger 2014). Since 1995, the ForestFinance Group has been doing just that (Box 2.9).

As a first step, it makes sense to focus on restoration models that have an established proof-of-concept and have demonstrated the ability to deliver financial and environmental returns. For aggregation to be effective, it is important to include comparable and replicable restoration projects (Credit Suisse et al. 2014). Public investors can play an important role in demonstrating proof of concept by supporting emergent businesses with the intention of expanding models that work.

Addressing the high transactions costs of restoration projects can be a chicken-and-egg situation: Investors have limited interest in restoration because of lack of awareness of and inability to find investments, but efforts to develop such a process can be successful only if there is sufficient interest from investors. Efforts therefore need to be made in tandem to establish restoration as a viable investment opportunity and attract investor interest while developing a pipeline of large-scale investable projects and a platform that allows investors to easily identify and evaluate potential investments.

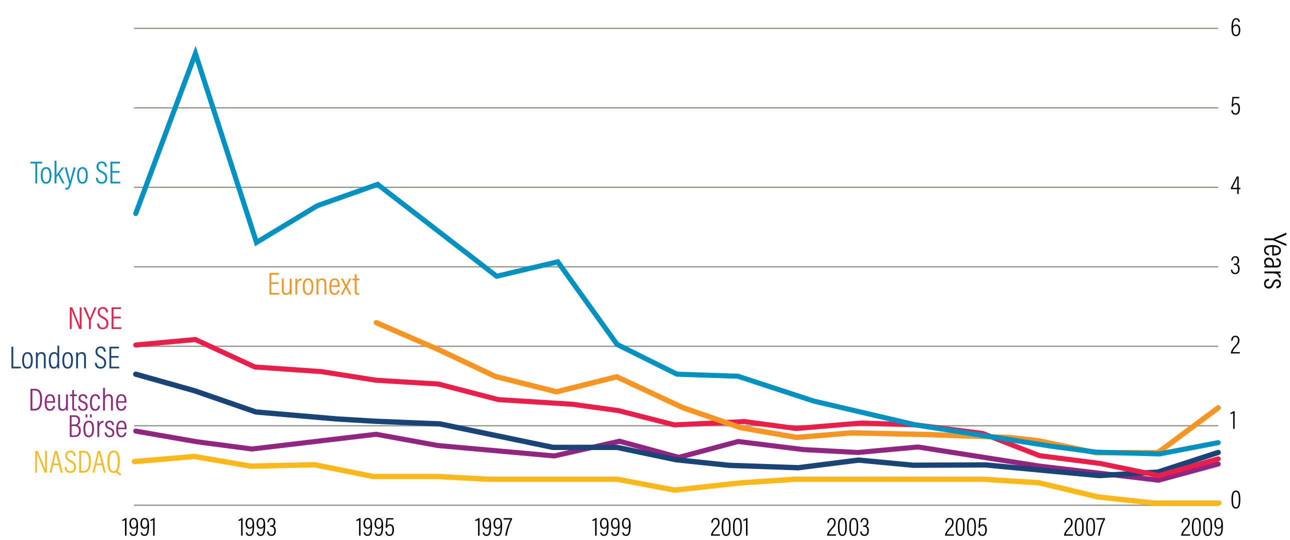
Barrier #6: Many Restoration Projects Have Very Long (10- to 20-Year) Investment Horizons

Problem

Restoration is a multiyear process. Its benefits can span decades, and projects may take a decade or more just to break even. For example, teak plantations require a minimum of 20 to 25 years before the wood is ready for harvest (Ladrach 2009). Obtaining financing that matches the time frame of the restoration project becomes essential to maintain the benefits of restoration because, without sustained financing, there is the risk of reversion to degrading activities, rendering restoration efforts void. This long time frame can significantly limit investor interest because a dollar today is worth more than the same dollar in the future. This means that profits received in the distant future have lower value than those in the near term, and long-term restoration projects are discounted in favor of investments that deliver more immediate returns. (See Box 3.4 in Section 3 for detailed discussions of how discounting may affect investment decisions.)

On a similar note, private investors also consider the liquidity of investments—the ease of trading an asset and converting it to cash without major changes in price. In recent years, institutional investors are increasingly valuing liquidity and shorter-term investments (OECD 2011). Figure 2.6 shows how investment holding periods have declined across major stock markets around the world.

Figure 2.6 | **Average Holding Periods of Various Stock Exchanges**



Source: OECD 2011.

This trend appears to affect even investors who focus on long-term investments: A 2010 study of 900 long-term equity strategies found that more than two-thirds sold their investments more quickly than expected (Mercer LLC 2010).

For conservation and restoration projects, which are often long-term and illiquid, the broader market trend toward short-termism limits the appetite of private investors. The long time horizon required is also a barrier to entrepreneurs and landowners interested in restoration because the costs are incurred up front while the multiple restoration benefits are realized over time.

Solutions

Several approaches could make investing in restoration more attractive to investors. First, projects could focus on business models that mix long-term and short-term cash flows. Agroforestry models, for example, combine high-value, short-term crops with the planting of high-quality, long-term trees. This approach allows for short-term profits as well as long-term, high-value investments, delivering more attractive returns on investment (Gold et al. 2011).

BOX 2.10 | INVESTING IN RESTORATION PROJECTS IN DEVELOPING COUNTRIES: THE MORINGA FUND

The Moringa Fund, founded in 2012, is a private equity fund that invests in restoration projects in Latin America and sub-Saharan Africa. It focuses on agroforestry projects (the incorporation of trees in croplands or pastures) that can potentially deliver attractive investment returns while generating environmental and community benefits (Mercer et al. 2014). The fund's projects provide a diverse range of revenue streams over different time frames, from shorter-term sales of fruits, nuts, and crops to longer-term sales of firewood and timber.

With its strategy of making equity or quasi-equity investments in established agroforestry projects, Moringa aims to generate competitive market returns of 10 to 12 percent a year for its investors. To date, it has financed restoration projects of $3–7 million, with a total investment of $96 million. It is willing to invest in projects of 500 to 10,000 ha, such as Nicafrance, a 1,500-ha coffee farm in Nicaragua in which it invested in 2015 (Moringa 2017).

Second, project developers could seek out investors with longer investment horizons, such as impact investors, family foundations, and pension funds (Rosen and Sappington 2015). These categories of investors are more likely to be comfortable with the patient capital needed for restoration investments, provided that the investments fulfill other requirements in deal size and/or return expectations. Box 2.10 provides an example.

Securitization—aggregating an illiquid group of assets and transforming them into a security—is another option. Securitizing long-term projects can create liquidity for investors with shorter time frames. One example is the bundling of mortgages in the United States into mortgage-backed securities.

Securitization offers many advantages:

- The greater liquidity provided by an aggregated fund (versus individual projects) reduces transaction costs dramatically, making it easier and less expensive to invest in restoration.
- Pooling the risks of different projects reduces investors' exposure to downturns in single ventures, reducing risk.
- Projects of $1–20 million can be aggregated to form much larger funds, allowing a broader range of investors—including pension funds, mutual funds, and retail investors—to participate.

Barrier #7: Restoration Is Considered a Risky Investment

Problem

Investments are based on expectations of future returns and thus carry an element of risk. Risks vary widely, from financial risks (e.g., changes in market conditions) to sociopolitical risks (e.g., political upheaval) to environmental risks (e.g., natural disasters). Also, investors are highly subjective in their consideration of risks, meaning that two investors considering the same opportunity may think about risks differently. When making an investment, investors weigh the trade-off between risk and return, comparing the risk-adjusted returns of various alternatives. For restoration to attract more private capital, it must not only be attractive on an absolute basis, it must also be more attractive than other investments being considered by the investor.

To calculate expected returns from an investment, investors estimate the future stream of revenues of an investment and discount them to estimate their present value. Private investors typically use higher discount rates than public investors when evaluating investments, reflecting the high opportunity costs they face. In addition, the fact that restoration is a relatively new area for most private investors and that it is perceived as risky means that the discount rate is usually high. This bodes poorly for restoration investments—where costs are often loaded up front but cash flows are generated years later, sometimes a decade or more—as high discount rates depress the value of future benefits and assign more weight to present costs. Given a high discount rate and a back-loaded cash flow profile, restoration investments are often viewed by private investors as having poor risk-adjusted returns. (Box 3.4 in Section 3 explains discount rates in more detail.)

This explains why private investment makes up a low share of total investment in restoration. In a survey managed by the GIIN, impact capital allocated toward food/agriculture or forestry/timber (using the two sectors as a proxy for restoration) constituted only 7 percent and 4 percent, respectively, of total assets under management in 2016 (Mudaliar et al. 2017). While impact capital is only a small fraction of available private capital, and figures for the two sectors are imperfect proxies for restoration, the percentages highlight that relatively little private investment is allocated toward restoration.

Solutions

Risk can be mitigated in several ways. Public and philanthropic institutions typically possess lower discount rates, as they place higher value on benefits generated for future generations. As such, they can leverage private investment through financial mechanisms such as first-loss guarantees. Under first-loss guarantees, in the event that an investment loses money, the public investor agrees to bear the initial losses before any remaining losses are spread to the rest of the investors. This gives private investors greater confidence by reducing their potential loss. Over time, as private investors become more familiar with investing in a sector, their perception of risk decreases and they are more willing to invest without continued support. The strategic use of public and philanthropic capital can unlock models for restoration that would not be realized by private investment alone.

Governments can also offer investment tax credits to shoulder part of the initial cost of the investment, thereby mitigating risk. Investment guarantees are also an important tool to mitigate risk. These mechanisms are detailed in Box 2.11.

BOX 2.11 | USING INVESTMENT GUARANTEES AND TAX CREDITS TO SPUR PRIVATE-SECTOR INVESTMENT IN RESTORATION

TAX CREDITS

The Solar Investment Tax Credit (ITC) is a U.S. tax credit first passed in 2005. The tax, which has since been extended to 2021, provides a 30 percent tax credit on residential and commercial installations of solar panels.

The ITC is a very important incentive because, similar to land restoration, the up-front cost of solar energy is high. The ability to claim the tax deduction in the year of installation significantly improves the economics of the solar investment and has helped capital flow to solar energy.

The ITC helped solar installation grow by more than 1,600% since it was passed in 2005 (an annual compound growth rate of 76%). The number of Americans employed in the solar industry is expected to more than double, from 200,000 in 2015 to 420,000 by 2020 while spurring $140 billion in economic activity. Having catalyzed solar investment in the United States, the ITC will be reduced, falling to 26 percent in 2020, 22 percent in 2021, and 10 percent thereafter (SEIA 2017).

INVESTMENT GUARANTEES

The Multilateral Investment Guarantee Agency (MIGA)—part of the World Bank Group—encourages foreign direct investment in developing countries by providing guarantees to investors (MIGA 2015a). Its guarantees cover the noncommercial risks—war, civil disturbance, transfer restrictions, expropriation—of investments in certain sectors of the economy that provide environmental, social, and financial returns.

MIGA issued guarantees to EcoPlanet Bamboo, a U.S. company restoring degraded lands with bamboo plantations, of $27 million (2012) and $22 million (2015) for its investments in Nicaragua. Over a 15-year period, the protection will cover EcoPlanet Bamboo against the risks of expropriation, war, and civil disturbance in Nicaragua (MIGA 2012; MIGA 2015b).

Recommendations

Restoration faces a huge funding gap, as a result of the seven barriers discussed in this section. These barriers are surmountable. National and international efforts are already under way to develop policies and financial mechanisms that facilitate public and private financial flows.

Governments can catalyze investment in restoration in several ways. The suite of policies they implement are not only influential but essential to an industry's success. To accelerate the pace of restoration, governments and practitioners should consider the following actions:

- **Impose carbon prices and use the revenues to fund restoration.** Carbon taxes or auctioned permits are gaining momentum and are being implemented in dozens of nations and states. For countries that are not yet engaged in a carbon emissions trading scheme or have not implemented a carbon tax, we recommend exploring these options as a means of promoting low-carbon development. For nations that have already implemented such policies, we urge them to direct some of the proceeds to restoration and other climate solutions.
- **Redirect incentives.** Governments should reform their current incentive systems, which often make it profitable to degrade land. This can be done by removing existing incentives—such as many agricultural subsidies—that contribute to land degradation, and introducing new mechanisms that incentivize private investment in restoration.
- **Leverage climate finance for restoration.** Climate funds should promote restoration as a means of achieving nations' climate goals by explicitly acknowledging restoration as part of their climate mitigation and adaptation strategies and reducing bureaucracy in the application processes.

- **Take a cross-sector approach.** As restoration generates benefits for multiple areas of the economy, governments should develop an integrated approach that crosses ministries and government bodies. Brazil, Ethiopia, and the United States have demonstrated how integrating restoration into multiple branches of government can bolster the government's capacity for restoration.
- **Mitigate risk.** Governments, multilateral development banks, foundations, and civil society should develop financial mechanisms that mitigate risk and bundle projects in order to attract more private investment. Mechanisms, such as insurance guarantees, tax credits, and first-loss capital structures, can help to bring private investors to the table.
- **Bundle projects.** Aggregating projects is an established financing strategy in multiple sectors, including solar energy and automobiles. Bundling restoration projects would increase investment size and enhance liquidity while reducing project-specific risk through diversification.

These barriers are surmountable. National and international efforts are already under way to develop policies and financial mechanisms that facilitate public and private financial flows.

SECTION 3

ESTIMATING THE FULL SET OF BENEFITS AND COSTS OF FOREST AND LANDSCAPE RESTORATION

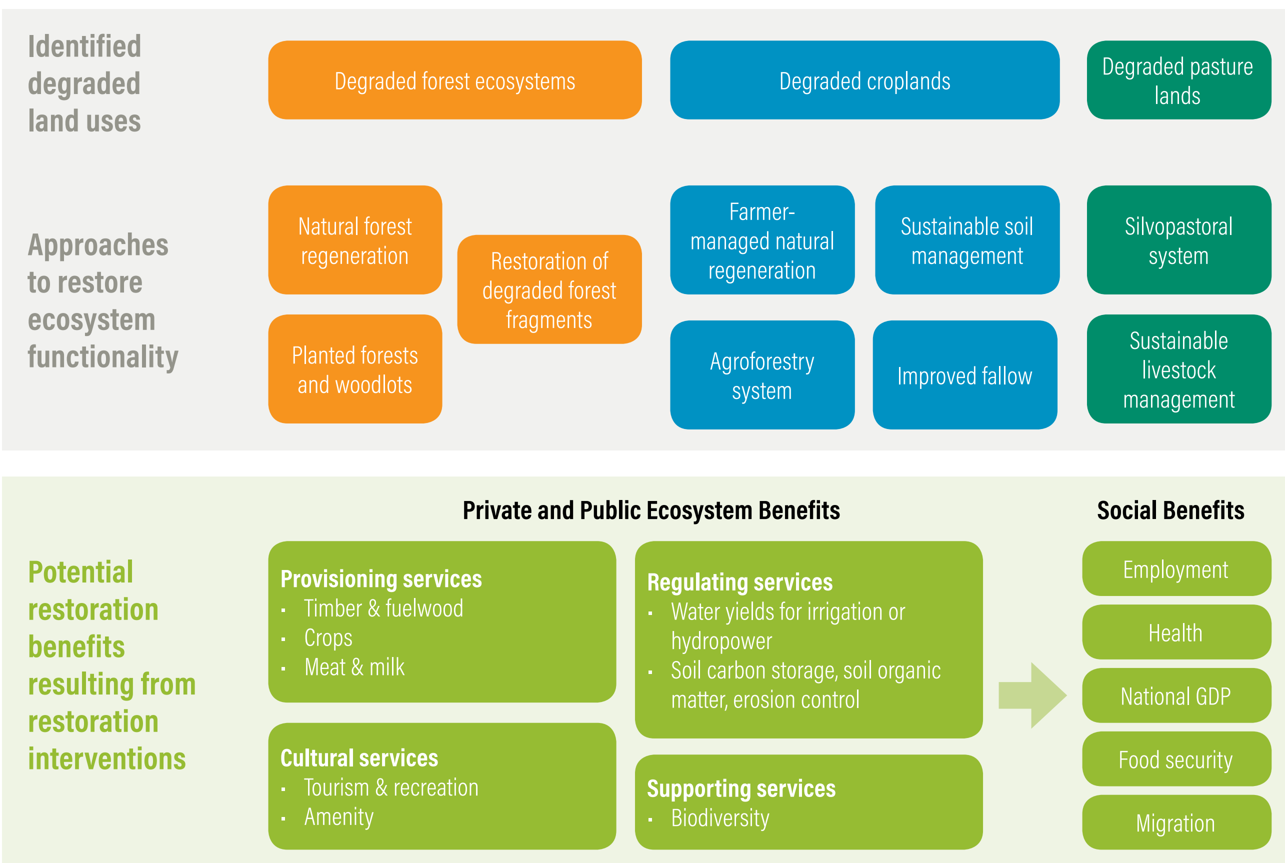
The overwhelming evidence is that restoration, done correctly, creates benefits in excess of its costs at the national, subnational, and community level. Economic analysis has an essential role in making the value of restoration benefits and costs visible to support better-informed policy and investment decisions.

Restoring the productivity of the world's degraded land has become a recognized global priority since the 2011 launch of the Bonn Challenge (see Box 1.1). Restoration increases the supply and quality of ecosystem goods and services for individuals (private benefits) and society (public benefits). Cost-benefit analysis suggests that achieving the objective of restoring 350 million hectares of degraded forest lands globally could create $2–9 trillion in net benefits over a 50-year period (or approximately $170 billion per year) when accounted for the value of public benefits (Verdone and Seidl 2017). Failure to incorporate all the benefits of restoration (see Figure 3.1) leads to a much lower estimate of $0.7 trillion in net benefits (Verdone and Seidl 2017) and reduces the attractiveness of investing in it.

Economic analysis should pay particular attention to identifying who benefits from restoration projects and who pays the costs; what the trade-offs are between different benefits and beneficiaries; and what share of the benefits is public and what share is private. Clear answers to these questions can help direct financial analysis to identify the most appropriate public and private financing means and mechanisms to support restoration at scale.

Despite the unifying vision of restoring degraded landscapes, the ecosystem benefits targeted by restoration projects can be very different across different economies (Aronson et al. 2010; Blignaut et al. 2014; Adams et al. 2016). Table 3.1 provides an overview of the specific restoration benefits that are of most interest to different income country groups.

Figure 3.1 | **Restoration Interventions Create a Wide Variety of Benefits**



Source: WRI authors, based on restoration opportunities defined in IUCN and WRI 2014 and ecosystem service typology defined in Millennium Ecosystem Assessment 2005.

Table 3.1 | **Targeted Ecosystem Benefits of Restoration Efforts in Low-, Middle-, and High-Income Countries**

TARGETED ECOSYSTEM SERVICE BENEFITS THROUGH LANDSCAPE RESTORATION	LEVEL OF EMPHASIS IN ECOSYSTEM SERVICE BENEFITS BY INCOME LEVEL		
	LOW-INCOME COUNTRIES	MIDDLE-INCOME COUNTRIES	HIGH-INCOME COUNTRIES
Soil erosion control	5	5	5
Water yields & runoff	5	5	2
Soil carbon content	3	5	1
Soil organic matter	5	5	3
Timber	3	5	3
Crops for food security	5	3	1
Meat & dairy products for export	2	5	3
Fuelwood	5	3	1
Biodiversity	1	3	5
Recreational value	1	5	5
Aesthetic value	1	3	5

Source: WRI, based on the findings of a meta-analysis of 1,575 peer-reviewed papers on restoration conducted by Blignaut et al. 2013; Table 3 on page 350 in Lele et al. 2013; and consultation with restoration specialists.

Based on the results from a meta-analysis of 1,575 research papers, Table 3.1 shows that the primary focus of restoration in low-income countries tends to be livelihood improvement, mostly through boosting landscape productivity, improving food and water security, and increasing climate change resilience (Benayas et al. 2008; Lawler et al. 2006). For example, in some areas of Africa and the Philippines, restoration has been viewed as a way to improve food security and help local communities build resilience against climate change and natural disasters (Gregorio et al. 2015; Republic of Malawi 2017). Box 3.2 shows an example.

In contrast, the primary focus of restoration in high-income countries is to restore ecological functionality of natural habitats and improve cultural and ecological values such as biodiversity and scenic beauty of the landscape (Blignaut et al. 2013). For instance, some 338 integrated landscape initiatives have been implemented in 33 European countries over the past 30 years (García-Martín et al. 2016). Most of these initiatives have a focus on nature conservation and enhancing local economic activities (such as tourism and the production of organic food).

BOX 3.2 | TRANSFORMING LIVES IN ETHIOPIA THROUGH EROSION CONTROL AND LAND REHABILITATION

In the Tigray region of Ethiopia, local investment supported some four dozen activities intended to reduce dependence on food aid. Most activities focused on erosion control, rehabilitation of degraded soils, tree planting, and water capture and control and rehabilitated 400,000 ha of degraded land, benefiting 125,000 people (40% of them women). Average crop production tripled, and the number of households relying on aid during droughts fell from 90% in 2002 to 10% in 2012 (Denier et al. 2015).

Distinguishing between Private and Public Benefits

Restoration benefits can be classified into two main categories: private and public.

Private Benefits

Private ecosystem benefits refer to the on-site benefits that private landowners or other individuals reap from the direct use or commercial sale of a good or service, such as timber, nontimber forest products (NTFPs), crops, meat, and milk, as a result of restoration interventions on farmland, rangelands, or managed or restored forests.[6] These goods and services can help people meet their survival needs or be sold in the market to generate income. In developing countries, a high proportion of household income comes from subsistence and small-scale agriculture. Acceleration of agricultural productivity can have huge effects on household income among the rural poor in low-income countries (Box 3.3).

Restoration can also improve farmers' incomes by creating on-farm employment opportunities or providing government subsidies or fiscal transfers, such as Payment for Ecosystem Services (PES), which are payments that governments make to farmers if they stop engaging in unsustainable farming practices and land conversions (Adams et al. 2016). Farmers in China and Latin America have also generated off-farm cash incomes through government payments and subsidies provided by restoration projects (Liu et al. 2013; Liang et al. 2012; Pagiola et al. 2005). The payments and subsidies account for about 10 percent of household income for the majority of participants in the PES program in Costa Rica (Ortiz Malavasi et al. 2003). Reinvesting part of the income derived from restoration back in the communities increases villagers' access to health care and education.

Land tenure reform in China and Vietnam that transferred state land to individual households or communities was another important driver of national reforestation programs, which also reduced rural poverty by boosting land productivity on privately owned or managed lands (Clement and Amezaga 2008; Liang et al. 2012; Sandewall et al. 2015).

Restoration projects that yield private benefits are well-suited to attract both private and public investment, as discussed in Section 2.

Public Benefits

Public ecosystem benefits are benefits that affect society as a whole. Direct public benefits of land restoration include cleaner air, increased control of soil erosion, soil and water retention, increased organic matter in soil, carbon sequestration, and biodiversity.

Forest restoration improves crop production by maintaining pollinating insects and supporting bird and bat populations that control insect herbivores. One study of a cacao agroforestry system found a 31 percent reduction in crop yield when both birds and bats were prevented from foraging in cacao trees, leading to an estimated loss of $730 per hectare (Maas et al. 2013). Animal-mediated pollination is required for 75 percent of the world's leading food crops (Klein et al. 2007). A study of more than 40 important crops showed that wild pollinators improved pollination efficiency, doubling the rate of fruit set (Garibaldi et al. 2013).

Improving the regulation of ecosystem services can safeguard living conditions, stabilize crop production, and buffer environmental impacts on health and food security. These benefits are particularly important in developing countries where people have little resilience when it comes to climate change and other disasters.

BOX 3.3 | INCREASING INCOMES THROUGH FARMER-MANAGED NATURAL REGENERATION AND OTHER PRACTICES

Adopting farmer-managed natural regeneration helped increase annual gross income of the Maradi region of Niger by between $17 million and $21 million and has contributed an additional 900,000 to 1,000,000 trees to the local environment (Haglund et al. 2011). This natural regeneration resulted in at least 500,000 additional tons of grain produced a year—equivalent to the consumption needs of 2.5 million people (Reij et al. 2009).

In East Africa, new agroforestry systems for feeding livestock have increased smallholder production and income from cattle and small ruminants, such as sheep and goats (Franzel et al. 2014). In China, Ethiopia, Sweden, and Vietnam, increasing forest plantations has increased incomes for many households, contributing some 10 to 25% of household cash income (Sandewall et al. 2015). However, direct income benefits in the form of NTFPs—fruits and nuts, vegetables, medicinal plants, resins, essences, a range of barks and fibers like bamboo and rattan, and a host of other palms and grasses—to forest communities or landowners from restoration activities are poorly documented. Many of the NTFPs may take years to materialize because it takes time for ecosystem functionality to recover after being restored.

Forest ecosystems are also essential to the spiritual and cultural value of local communities. In many regions, forest and landscape restoration is creating opportunities for ecotourism, which can become an important source of income for landowners and others in the community. The increasing demand for public benefits provided by forest landscapes in Costa Rica has created demand for restoration in the region (Broadbent et al. 2012; Zambrano et al. 2010).

Although public benefits have value for society, it is often hard to monetize them, which reduces the incentives for private actors to invest in restoration. For example, pollinators like bees can fly from one field to another, making it difficult for individual farmers who invest in beehives to capture the full benefits of their investment. As a result, restoration projects that consist largely of public benefits find it hard to attract private financing. These projects are better suited to public funding from governments and civil society.

Using Economic Analysis to Inform Decision-Making on Restoration

Figure 3.2 illustrates the steps involved in conducting economic analysis. It indicates the kind of restoration-related decisions that can be informed by different types of economic analytical tools.

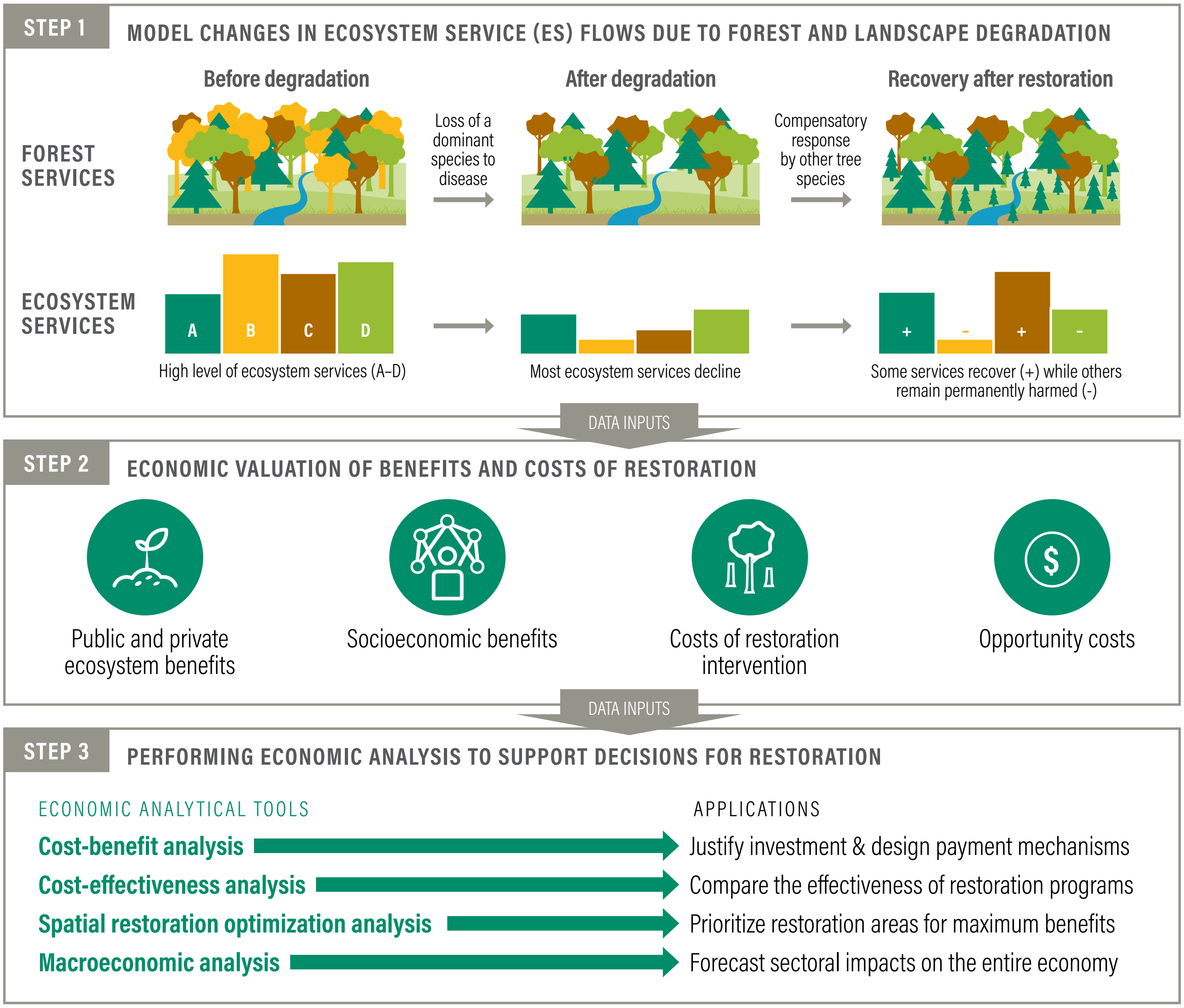
Step 1: Model the Changes in Ecosystem Service Flows Resulting from Restoration Interventions

Various ecosystem modeling tools have been developed and applied to assessing the impacts of land management practices (Christin et al. 2016). De Groot et al. (2017) find 80 ecosystem modeling tools that quantify changes in ecosystem services. They include InVEST,[7] ARIES,[8] Co$ting Nature,[9] and many others. Some tools incorporate the uncertainty inherent in biological systems. For example, Monte Carlo simulations are often used to determine the tipping points and thresholds in the system (Blignaut et al. 2014).[10] A few guiding documents have been developed to help users compare and select the appropriate models (Bagstad et al. 2013; Christin et al. 2016; Bullock and Ding forthcoming).

There is also a growing demand that ecosystem services modeling should incorporate landscape spatial patterns and temporal dynamics, coupled with consideration of political scale (jurisdictional and administrative); the socio-cultural characteristics of stakeholders (knowledge systems, value pluralism); governance and institutional settings; and the decision objectives and scope (IPBES 2016).

Modeling of ecosystem service flows under Step 1 should be performed for at least two scenarios: a restoration scenario and a status quo (baseline) scenario. Comparison of the two describes the effect of action. Changes in ecosystem service flows will eventually have an impact on human well-being via constraints on consumption and production. Figure 3.3 illustrates how the biophysical changes of ecosystem services are linked with socioeconomic systems. Clearly, any postponed action or inaction to restore degraded forest and landscape will result in high costs in the form of reduced ecosystem service flows and thus jeopardize long-term economic prosperity.

Figure 3.2 | **Economic Analysis Can Improve Decision-Making for Restoration**



Source: WRI authors, adapted from Boyd et al. 2013.

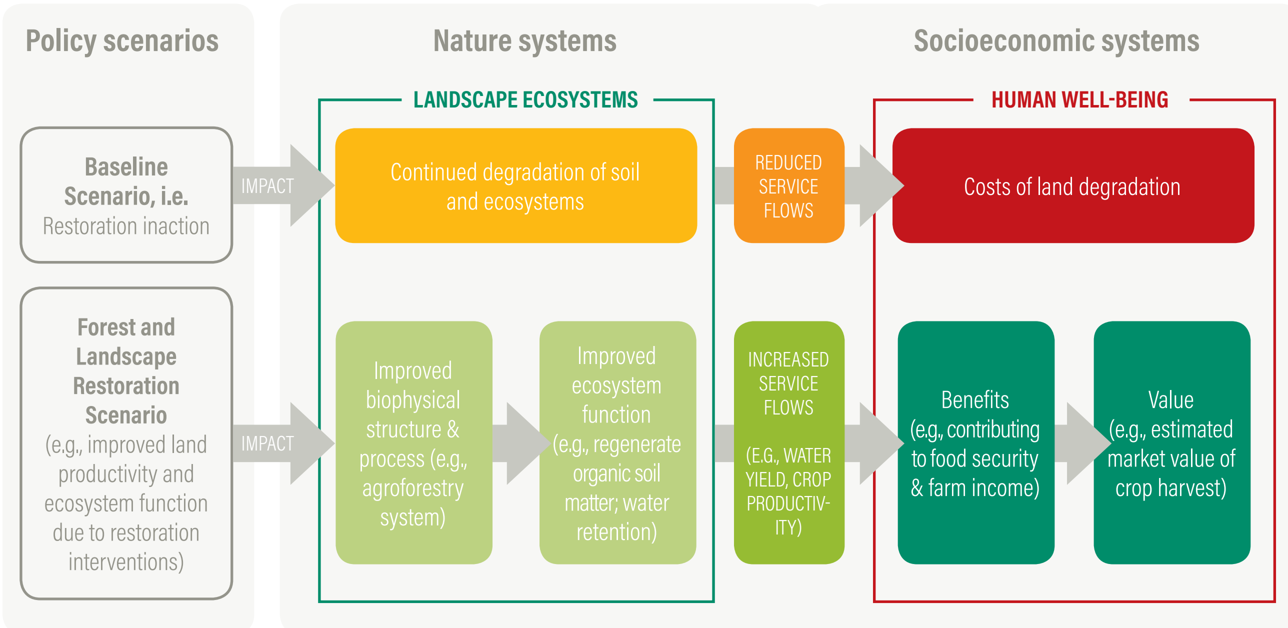
Step 2: Quantify the Benefits and Costs of Restoration Interventions

The estimated biophysical changes of ecosystem services generated in Step 1 are translated into monetary terms using market and nonmarket valuation methods.

Several methods have been developed to assess and capture the contributions of ecosystems to the public and private spheres. The foundation for valuing natural capital and ecosystem services in monetary terms is the total economic value (TEV) framework, which distinguishes between use and non-use values that contribute to well-being in a direct or indirect manner. Figure 3.4 classifies restoration ecosystem benefits using the TEV framework and shows the corresponding economic valuation methods used to assess these benefits.

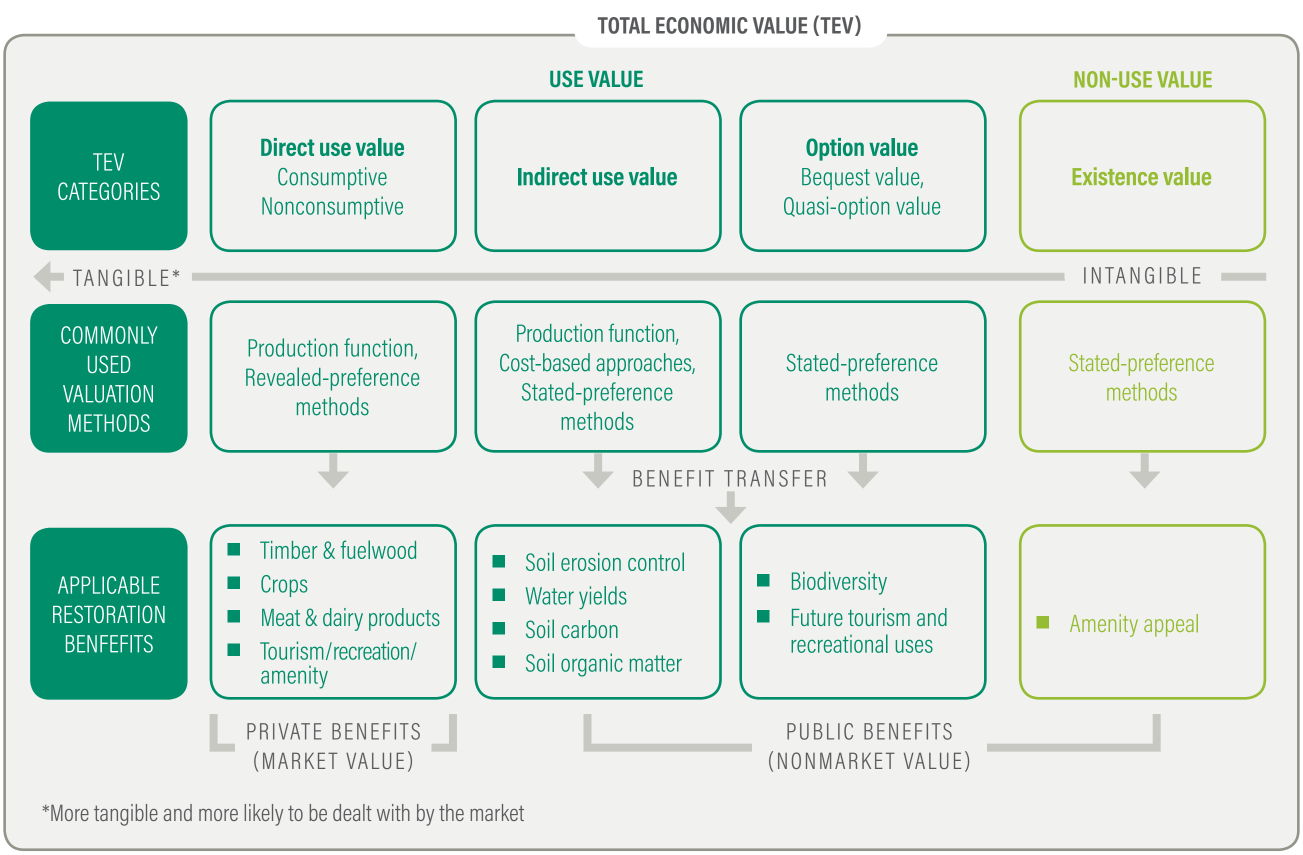
Direct use value includes private benefits derived from consumptive use of ecosystem goods and services, such as food, timber, and fuelwood, as well as from nonconsumptive uses, such as recreational use of a forest or natural reserve. The valuation of the direct use is straightforward. It is based on production function and market-price-based valuation approaches to assess the change in ecosystem goods and services through the change in value of output (Table 3.2).

Figure 3.3 | **Economic Modeling Demonstrates How Restoration Can Improve Natural and Socioeconomic Systems**



Source: Adapted from Liquete et al. 2013 and based on Farber et al. 2006.

Figure 3.4 | **The Total Economic Value (TEV) Framework Provides a Way to Classify and Value Restoration Benefits**



Source: WRI authors, based on chapter 5 of Kumar 2010; Ding et al. 2016a; Barbier 2007; and Farber et al. 2006.

Table 3.2 | **Tools Used to Estimate the Value of Ecosystems**

APPROACH/TOOL	DESCRIPTION
Production Function Approach	
Production function method	Estimates how much an ecosystem service contributes to the delivery of another service or commodity that is traded on an existing market
Market-price-based method	Estimates the economic value of ecosystem products or services that are bought and sold in commercial markets
Travel cost method	Estimates economic-use values associated with ecosystems (and biodiversity) or sites that are used for recreation. The values of recreational sites are assumed to be associated with a cost (direct expenses and opportunity costs of time). The value of a change in the quality or quantity of a recreational site (resulting from changes in biodiversity and ecosystem) can be inferred from estimating the demand function for visiting the site being studied.
Revealed-Preferences Approach	
Hedonic pricing	Evaluates the attributes of a nonmarket characteristic (e.g., scenic beauty) on market prices of a relevant commodity (e.g., real estate) using information about the implicit demand for an environmental attribute of marketed commodities. It has been widely applied to assess how changes in environment quality may have impacts on people's willingness to pay for a property.
Stated-Preferences Approaches	
Contingent valuation	Uses questionnaires to ask people how much they would be willing to pay for increasing or enhancing the provision of an ecosystem service or, alternatively, how much they would be willing to accept for its loss or degradation.
Conjoint analysis/ choice experiment	Questionnaire-based technique that presents respondents with two or more alternatives of a service in order to estimate people's willingness to pay for improved attributes of the ecosystem services to be valued.
Cost-Based Approaches	
Replacement costs	Estimates costs incurred by replacing ecosystem services with artificial technologies.
Avoided damage costs	Estimates expenditures on infrastructure or measures to protect ecosystems from further damage.

The value of tourism and recreational use of the restored landscape can be assessed through the travel-cost method, which measures the consumptive value of the environmental attributes. It assumes that the price an individual places on the environmental good is equal to the opportunity cost of time and travel incurred in traveling to the recreational site. The scenic value of a healthy landscape could also be assessed using the hedonic pricing method. This method is often used to assess, for example, how the improved amenity of a landscape can affect the price of nearby properties, through constructed econometric models.

Indirect use value refers to the functional benefits of ecosystems, such as soil erosion control, water and nutrient regulation, and soil carbon storage, that support the delivery of ecosystem goods and services indirectly. Ideally, these values would be assessed using a production function method that assesses how ecosystem changes affect the delivery of goods or services sold in the market. These links are often hard to model, and information for such analysis is often unavailable.

Alternative approaches to valuing the indirect use value of ecosystem services are cost-based methods, such as avoided damage or replacement cost methods. These methods use conventional market information, such as environmental defensive expenditures (e.g., flood insurance) to minimize environmental damages, soil replacement costs, and relocation costs, to estimate the cost savings (or benefits) of avoided damages. If cost data are not available, a contingent valuation can be performed by estimating how much farmers would be willing to pay to adopt climate-smart agriculture practices that would avoid further resource degradation or improve land productivity.

Table 3.3 | **Estimates of Net Benefits of Large-Scale Restoration Initiatives**

STUDY	RESEARCH QUESTION	METRIC	AREA	ESTIMATED BENEFIT	GOODS AND SERVICES CONSIDERED
Costanza et al. (2014)	What is the global value of ecosystem services provided by different biomes?	Change in ecosystem value from forest degradation between 1997 and 2011	Global	$3.3 trillion a year	17 ecosystem services[a]
Chiabai et al. (2011)	What is the cost of policy inaction that leads to the loss of forest area?	Change in ecosystem value from forest degradation between 2000 and 2050	Africa	$858 billion a year	Timber products, NTFPs, carbon sequestration, recreation, and passive use
Verdone and Seidl (2017)	What are the net economic gains of achieving the Bonn Challenge of restoring 350 million ha of degraded lands?	Change in ecosystem value from forest restoration between 2015 and 2065	Global	$2–9 trillion in net benefits over a 50-year period (or approximately $170 billion a year)	Timber products; NTFPs; carbon sequestration, recreation, and passive use
	What are the net economic gains of restoring 40 million ha of degradated lands in Africa?	Change in ecosystem value from forest restoration between 2015 and 2065	Africa	$65.5–339.9 billion in net present value, (approximately $1.3–6.7 billion a year)	Timber forest products, NTFPs, carbon sequestration, recreation, and passive use
Vergara et al. (2016)	What is the average gain in value of restoring 20 million ha of degraded lands in Latin America?	Change in ecosystem value from restored forests, savannas, and agricultural landscapes over 50-year period	Latin America and the Caribbean	$23 billion in net present value (approximately $460 million a year)	Timber forest products, NTFPs, ecotourism income, agricultural products, avoided food premium, carbon sequestration

Note: [a] Costanza et al. (2014) considered 17 services in their benefit calculation: gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refugia, food production, genetic resources, recreation, and cultural services.

Option value refers to the value individuals are willing to pay for the option of preserving natural resources for future use by themselves or future generations. *Existence value* is the value individuals attach to the mere existence of a natural resource or environmental asset, unrelated to current or optional use. These values are usually assessed using contingent valuation or conjoint analysis and choice experiment methods.

If primary data are not available at a particular location, estimates from other studies of similar situations can be used. Using estimates from other studies (known as *benefit transfer*) can involve the simple *unit value transfer method* or the more complex *function transfer method* (Navrud and Ready 2010). Benefit transfer has been used in several large-scale ecosystem value studies (Costanza et al. 2014; Chiabai et al. 2011).

A Review of Estimated Ecosystem Benefits of Large-Scale Restoration Efforts

Estimates of the annual net benefits of restoring degraded forests range from $23 billion in the Latin America and Caribbean to $3.3 trillion a year globally (Table 3.3).

Using a simple benefit transfer method, Costanza et al. (2014) show that the conversion of forest landscapes to other land uses between 1997 and 2011 resulted in a loss of ecosystem services worth an estimated $3.3 trillion a year. Chiabai et al. (2011) use a range of methodologies (listed in Figure 3.4) to estimate the economic loss of forest ecosystem degradation by 2050 that stems from the lack of enforceable conservation policies in 10 world regions plus Brazil, China, and Russia. They report that the total economic losses derived from timber and NTFPs, carbon stocks, and recreation and cultural values in Africa are in the order of $858 billion as a result of land-use change over a period of 50 years. These cost estimates of land conversions and degradations can be used as approximations to ecosystem benefit gains, if world or land conversion and degradation were avoided. However, their study do not consider the costs of policy actions for averting land conversion or degradation.

Several large-scale land restoration benefits assessments are built upon Chiabai et al. (2011), but some also extend to cover lands other than forests. Vergara et al. (2016) estimate that restoring 20 million hectares of degraded forests, savannas, and agricultural landscapes in Latin America would yield net economic benefits of $23 billion ($1,140 per hectare) over a 50-year period. Three-quarters of these benefits come from the sales of timber and agricultural products. Another quarter are non-market benefits, achieved through carbon benefits and reduced food insecurity. Verdone and Seidl (2017) report that restoring 350 million hectares of world degraded forest landscapes can generate $2–9 trillion in net benefits over a 50-year period. Among others, 40 million hectares of degraded forest landscapes will be restored in Africa, creating $65.5–340 billion of net public and private benefits over a 50-year period. These studies used social discount rates of 1.3 to 4.3 percent to reflect different social discounting philosophies.

The estimates of large-scale economic valuation studies are not consistent across regions, partly because they use different ecosystem service models, valuation methods, and discount rates and are based on data of varying quality. The quality of the data used has an impact on the accuracy of the model results. Ecosystem services that are included in the economic valuation also affect the estimates of total economic benefits. The failure of capturing the cobenefits (especially the nonmarket benefits) of restoration interventions will lead to a lower benefit-cost ratio, and make restoration projects generating public benefits that are greater than private benefits less favorable from the perspective of private investors and landowners.

The methods used to value entire ecosystems are also limited by their ability to account for changing values driven by changes in demands and supplies. As the area (i.e., supply) of an ecosystem and its associated services is reduced, the demand for the services provided by the remaining area will

increase, pushing up the value. Current methods do not account for this dynamic, leaving global benefit estimates open to criticism. To better understand the dynamics of ecosystem value changes, economic analysis must take a broader scope that goes beyond the valuation of individual ecosystem services. It requires the analysis of trade-offs of restoration impacts at a landscape level or within a macroeconomic framework.

A Review of Estimated Ecosystem Benefits of Local and National Restoration Efforts

At the national and subnational levels, a handful of studies were found focusing on benefit assessments for specific landscape restoration interventions. A summary of the major restoration benefits studies for Africa and Latin America and the Caribbean is provided below.

As shown in Table 3.4, most of the restoration benefit analysis in Africa focused on agricultural activities, including agroforestry, fodder shrubs, improved woodlot management, natural regeneration, and improved fallows. The most important ecosystem benefits included in these studies are timber, fuelwood, food, carbon sequestration, and watershed protection. Most economic studies focus on a small subset of benefits or a small group of beneficiaries, based on the primary objectives of a given restoration initiative or activity. Few, if any, studies have documented all the benefits that restoration can yield. As a result, the societal economic gains that restoration provides—in particular, nonmarket benefits, such as water regulation and biodiversity—are underestimated and underappreciated.

Land restoration efforts in Latin America include reforestation, silvopasture, forest conservation, agroforestry, and soil conservation. In addition to timber and carbon sequestration benefits, countries restore degraded land to increase the productivity of cash crops, meat, and dairy products. In Costa Rica, the benefits of ecotourism and recreational value of improved landscapes were assessed.

Comparison of results across countries makes little sense because of the inconsistent use of units of measurement and time frame. But for the same ecosystem service, it seems that the net benefits are higher in countries in Latin America and the Caribbean. Two factors affect the estimated benefits: the per-unit price of the ecosystem services under consideration and the quantity of the same service

The most important ecosystem benefits included in these studies are timber, fuelwood, food, carbon sequestration, and watershed protection. Most economic studies focus on a small subset of benefits or a small group of beneficiaries, based on the primary objectives of a given restoration initiative or activity.

provided by the ecosystem. For instance, the use of different carbon prices leads to very different estimates of the economic values of carbon sequestration. Brancalion et al. (2012) report that reforestation in Brazil leads to annual carbon sequestration benefits of $3,959 per hectare, using a carbon price of $11 per ton of carbon. Using a much lower carbon price ($1.2–3.7 per ton of carbon), Carriazo et al. (2003) estimate that forest conservation in Colombia would generate annual carbon sequestration benefits on the order of $411–1,236 per hectare.

Frequently used carbon prices range from a few dollars per ton of carbon (reflecting current rates in voluntary carbon markets) to more than a hundred dollars per ton, to account for the marginal cost of global damage because of climate change. The latter price is known as the social cost of carbon. It incorporates a low probability of high-damage events. The former price is often used to pay large private owners for carbon credits generated through forest conservation or avoided forestland conversion (for example, through the REDD+ program).

Interpreting and comparing the results of different studies requires a careful review of the assumptions and data used for ecosystem and economic modeling and the market information used to calculate benefits. It would be useful if all studies adopted a

Table 3.4 | **Estimated Net Benefits from National-Level Restoration Assessments in Africa and Latin America and the Caribbean**

RESTORATION ACTIVITY	COUNTRY	ECOSYSTEM GOODS AND SERVICES CONSIDERED	NET BENEFIT	STUDY
AFRICA				
Agroforestry	Kenya	Food production	$111–175 per household year	Franzel (2005)
	Kenya	Fuelwood and food production	$94 per hectare over 2 years	Swinkels and Franzel (1997)
	Rwanda	Food and timber production; carbon seq.; erosion control	Ranging between $701–$1,100 per hectare in net present value depending on beans and maize prod. over 30 years	RNRA and IUCN (2015)
	Malawi	Crop and timber yields; carbon seq; watershed protection	$1,904 per hectare in net present value over 30 years	Republic of Malawi (2017)
Fodder shrubs	Mali	Reduced input costs	$145–273 in net present value per community over 4 years	Franzel (2007)
Improved woodlot management	Rwanda	Food and timber yield; carbon seq.; erosion control	$487 per hectare in net present value over 30 years	RNRA and IUCN (2015)
	Tanzania	Timber and fuelwood production	$543 per hectare in net present value over 5 years	Franzel (2005)
	Uganda	Timber yields; carbon seq.; watershed protection	$754 per hectare in net present value over 30 years	MWE and IUCN (2016)
Community woodlots	Malawi	Timber yields, carbon seq.; watershed protection	$180 per hectare in net present value over 30 years	Republic of Malawi (2017)
Natural regeneration	Uganda	Timber yields; carbon seq.; watershed protection	$828 per hectare in net present value over 30 years	MWE and IUCN (2016)
Improved fallows	Zimbabwe	Food production and reduced inputs costs	$9–41 per household per year	Mudhara and Hildebrand (2005)
	Zambia	Fuelwood and food production	$296 per hectare in net present value over 5 years	Franzel (2005)
	Kenya	Fuelwood and food production and reduced input costs	$208 per hectare over 2 years	Swinkels and Franzel (1997)
LATIN AMERICA AND CARIBBEAN				
Reforestation	Brazil	Carbon sequestration	$3,959 per hectare/year ($11/tC)	Brancalion et al. (2012)
	Chile	Wood forest products from native species	$1,897 to $2,539 per hectare in net present value over 52 years	Rojas et al. (2012)
	Guatemala	Carbon offsets and flood control	$457 per hectare (C) & $16,934 per hectare (FC) in net present value over 30 years	Zamora-Cristales et al. (In preparation)
Silvopasture	Costa Rica	Meat production	$1091 per hectare in net present value over 10 years	Jansen et al. (1997)
	Mexico	Milk production	$3,285 in net present value over 10 years	Gonzalez (2013)
Forest conservation	Costa Rica	Ecotourism	$700 per hectare/year	Menkaus and Lober (1996)
	Costa Rica	Recreational use value	$59.7 per hectare/year	De Sena (1997)
	Colombia	Carbon sequestration	$411–1,236 per hectare/year ($1.2/tC to $3.7/tC)	Carriazo et al. (2003)
Agroforestry	El Salvador	coffee productivity (>1200m above sea level)	$2,275 per hectare in net present value over 20 years	Raes et al. (in preparation)
	Mexico	Increases in agricultural productivity	$5,533 in net present value over 18 years	Lopez-Sanchez and Musalem (2007)
Soil conservation practices	Mexico	Soil erosion and agricultural productivity	$19.40–$38.80 per hectare for each cm of soil loss	Cotler et al. (2011)

standard valuation framework that provides clear guidance on which ecosystem services, valuation methods, discount rates, time frames, and socioeconomic contexts have been considered in assessing the benefits of specific restoration interventions, so that valuation results could be compared across locations. It would be helpful to create a central database similar to The Economics of Ecosystems and Biodiversity—Valuation Database.[11] The database would serve as an inventory of original economic valuation studies and provide detailed information on each study in terms of the assessed restoration benefits, valuation techniques used, years of the study, geographic areas covered, and other factors.

Estimating the Economy-wide Benefits of Restoration

The degradation of natural resources and the accompanying loss in biodiversity affects the rural poor by reducing household consumption and employment tied directly to natural resource use (Ghermandi et al. 2013). When restoration activities are successful, the benefits are transmitted across the economy, as the sale of agricultural and forestry products produced by restored landscapes increases employment and rural incomes, leading to additional spending in other sectors of the economy.

The effects of restoration activities can be transmitted throughout the economy in a variety of ways (Bellu and Vega, 2009), including:

- increasing the production of agricultural and forestry goods and services;
- fostering demand for inputs from other sectors to support augmented production;
- changing the availability of production factors in the agricultural and other sectors (e.g., capital, labor, and land used for other purposes);
- increasing revenues for the government (e.g., via an increase in tax revenues from restoration-related economic sectors) and private institutions and trade (e.g., exports of agricultural products);
- capturing revenues from ecosystem service markets (e.g., carbon markets); and
- fostering reinvestment from public and private sectors in maintaining or extending restoration activities.

The economic impacts of restoration can be evaluated *ex ante* or *ex post*. An *ex ante* evaluation assesses and compares the simulated effects of a range of restoration activities in order to

identify the best intervention to implement. This type of evaluation provides information about the likely impacts of exogenous changes in the national or international context (such as changes in agricultural commodities' prices or climatic conditions that may affect land productivity) and formulates appropriate responses. Examples of these kinds of evaluations include computable general equilibrium (CGE) models, input-output (I-O) models, and system dynamics models. Table 3.5 describes the advantages and disadvantages of each of these methods.

Table 3.5 | **Advantages and Disadvantages of Computable General Equilibrium, Input-Output, and Systems Dynamics Modeling**

APPROACH	DESCRIPTION	SOCIOECONOMIC VARIABLES REPORTED	REQUIREMENTS	ADVANTAGES	DISADVANTAGES
Computable general equilibrium (CGE) modeling	Model reproduces structure of the economy and transactions among its agents (economic sectors, households, government, trade) as a system of interdependent components; external shocks create ripple effects throughout the economic system.	Government surplus, wage rate, labor supply and demand, income, tax revenues, consumption, poverty reduction, income distribution.	Significant amount of data (e.g., transactions among economic agents, productive sectors). Special software to run the model. Significant amount of time to construct and run the model. High level of analytical capacity of user.	Ability to capture economy-wide effects of policies (e.g., distributive effects of restoration). Reflects gains or losses in aggregated variables (e.g., welfare, income, employment, taxes). Analyzes medium- or long-term effects of policies.	Significant data and time requirements. Results are not precise measures of effects but rather represent their directions and distributive patterns. Not appropriate for short-term analysis. Not adequate to analyze small sectors or regions.
Input-output (I-O) modeling	Model based on I-O tables; i.e., matrixes describe quantitative transactions between the economic sectors, the sales to meet the final demand, and the value added of each sector. Following an exogenous demand, change (e.g., increase in restoration investment), the model shows the resulting direct and indirect economic effects.	Output, employment, and income multipliers (i.e., proportion of employment and output increased by a change in demand).	Significant amount of data to construct the I-O table. Resources to find data either through surveys (to households and businesses) or nonsurvey methods (e.g., scaling down national or state level I-O models). Capacity to construct the I-O tables.	Provide key information for analyzing linkages between activities as well as sectoral and regional disaggregation. Often suited for estimating distributional and short-term transitional impacts. Relatively transparent and easy to interpret.	Not appropriate for dealing with long-term analysis. Not well-suited for assessing changes that are likely to have large effects on prices. Fixed technical coefficients (i.e., no technological progress). I-O tables are not regularly updated (costly).
System dynamics modeling	System dynamics is a computer-aided method to assess complex social, managerial, economic, or ecological systems to assist policy analysis. It is appropriate for any dynamic system characterized by interdependence, mutual interaction, information feedbacks, and circular causality.	Land productivity, social and economic indicators, such as poverty, unemployment, and nutrition.	Variable input data amounts (could function in data-poor environments). Expert's time and resources to elucidate links among systems. Documentation that backs systems' feedbacks and relations.	Ability to understand changes over time on systems that may have complex interactions; does not need huge amount of data.	Time consuming if experts do not agree on system relations; can only run one version of the model at a time.

Ex post evaluations assess the site-scale socioeconomic impacts of restoration projects after they have been implemented. These evaluations are often based on household surveys and can assess the financial and social benefits received directly by smallholders. *Ex post* evaluation surveys may cover a range of socioeconomic indicators including income, job creation, poverty reduction, food security, and new opportunities for women. For example, in Wuqi County, Shaanxi Province, China, the sloping land conservation program increased local incomes by 164 percent and off-farm income by 20 times between 1998 and 2011 (Li et al. 2015).

Better understanding of how restoring land may affect GDP and job creation is important for informing macroeconomic policies. Macroeconomic analysis is very important for demonstrating the impacts of restoration to high-level decision-makers, such as finance ministers and multinational development agencies. This analysis needs to show how forest and landscape restoration in developing countries affects consumption, employment, imports, and exports. Effects should be documented with evidence from household surveys and statistical analysis.

Despite limited research in the literature (Wagner and Shropshire, 2009; Nielsen-Pincus and Moseley, 2013), BenDor et al. (2015a) examined the impacts of ecological restoration in the United States. They report that the sector directly employs about 126,000 workers and generates about $9.5 billion in annual GDP; indirectly, it supports another 95,000 jobs and $15 billion in GDP.

Estimating the Actual Costs of Restoration

Restoration projects involve four types of costs:

- Establishment costs are the up-front capital investment in restoration. Depending on the project, they can include costs of engineering works, site preparation, planting or seeding, and fencing.
- Maintenance costs include ongoing management, administration, and monitoring.
- Transactions costs include the costs of searching for suitable sites, sourcing and researching potential investments, negotiating and signing contracts, conducting due diligence, paying legal fees, and incurring governance-related institutional costs. For many projects, these costs can be substantial.
- Opportunity costs refer to the income private landowners would have received had the land set aside for restoration been used for something else, such as cropland or rangeland.

Estimates of restoration costs for different categories of degradation are lacking because a single standard of reporting does not exist (Blignaut et al. 2014). These costs vary by location and over time. The Economics of Ecosystems and Biodiversity (TEEB) study assumed average costs of restoring forests of $2,390–3,450 per hectare (TEEB 2009). Other studies assume the cost of restoring forest ecosystems is equal to 75–100 percent of the maximum restoration costs (De Groot et al. 2013).

The perceived high costs of many restoration projects may preclude restoration from even being considered.

The costs of restoration are based on various factors, including the degradation level, the type of ecosystem, the climate, the ease of access to the restoration site, the type of restoration intervention, the status of land tenure, the number of stakeholders involved, and other factors. The perceived high costs of many restoration projects may preclude restoration from even being considered. Clearly estimated up-front costs of restoration, as well as the short- and long-term benefits, are therefore essential for making the case for investing in restoration.

Not all approaches to restoration require large sums of money. Costs vary widely from site to site, depending on whether passive (e.g., natural regeneration) or active (e.g., establishing agroforestry or silvopastoral systems on agricultural lands) approaches are adopted (Ghazoul and Chazdon, 2017). Passive restoration may require that the land not be used for other activities, making it a difficult approach in heavily populated areas.

Active restoration approaches cost more than passive restoration practices. The cost of preventing land degradation is much lower than the cost of rehabilitating already severely degraded lands or replacing lost soil and nutrients (Shiferaw et al. 2015; Chazdon and Uriarte 2016). Farmer-managed natural regeneration—halting the cause of degradation and allowing trees to regrow naturally—is considered one of the least expensive interventions (Haglund et al. 2011; Chazdon and Guariguata 2016). Selective removal of pioneer species is another potential restoration intervention that is relatively inexpensive (Swinfield et al. 2016).

Tables 3.6 and 3.7 provide estimates of restoration costs in several African and Latin American countries. The reported costs in Africa range from $14 to $1,505 per hectare (Table 3.6). The average across the sample was $440, which is significantly lower than the global average of $1,276 found by Verdone and Seidl (2017).

Table 3.6 | **Estimated Costs of Implementing Restoration Activities in Selected Countries in Africa**

RESTORATION ACTIVITY	COUNTRY	COST PER HECTARE (DOLLARS)	STUDY
Community management of forest resources, sustainable fuelwood production	Benin	1,362	World Bank Project Database
Fodder shrubs	Kenya	14	Franzel (2005)
Improved fallows	Zambia	266	Franzel (2005)
	Kenya	22	Swinkels and Franzel (1997)
Agroforestry	Kenya	590	Swinkels and Franzel (1997)
	Malawi	425	Republic of Malawi (2017)
	Uganda	357	MWE and IUCN (2016)
Plantation establishment in Masoala corridors	Madagascar	279	Halloway et al. (2009)
Plantation forestry	Malawi	334	Republic of Malawi (2017)
Restoration of rain forest corridors by sourcing and planting trees	Madagascar	938	Halloway and Tingle (2009)
Conservation agriculture	Malawi	215	Republic of Malawi (2017)
Community woodlots	Malawi	166	Republic of Malawi (2017)
Improved woodlot management	Tanzania	385	Franzel (2005)
Improved woodlot management	Uganda	1,505	MWE and IUCN (2016)
Farmer-managed natural regeneration	Malawi	153	Republic of Malawi (2017)
Natural regeneration	Uganda	26	MWE and IUCN (2016)
Average		440	

The lowest-cost restoration activities tend to be ones that involve few inputs. Adopting improved farm fallow, planting fodder shrubs, allowing degraded forests to regenerate naturally, and farmer-managed natural regeneration cost as little as $14–153 per hectare. More labor- and input-intensive restoration activities, such as agroforestry ($590 per hectare) and woodlot management ($1,505 per hectare) cost much more.

Costs in Latin America and the Caribbean—at least $900 per hectare—are considerably higher than in Africa (Table 3.7), mainly because landscape restoration has focused on high-input restoration interventions, such as establishing agroforestry and silvopastoral systems, and labor costs are higher. Sometimes higher-cost interventions are warranted because of the higher revenues they generate.

Estimating the Opportunity Costs of Restoration

The allocation of public land to ecological restoration or protection may impose a cost on society in the form of the forgone economic gains from commercial development. The opportunity costs of restoring private lands can be estimated based on data on agricultural productivity, land rental costs, and land prices (Stefanes et al. 2016; Budiharta et al. 2016). This analysis can be used to estimate the compensation that needs to be offered to landowners when land conservation or restoration activities are undertaken on their lands (Mewes et al. 2015). Opportunity cost has been widely applied to estimating the level of compensation paid to Costa Rican farmers who adopted agroforestry or silvopastoral systems. This cost has also been used to determine the price paid per unit of carbon stocks saved via the REDD+ program.

Table 3.7 | **Costs of Restoration Activities in Selected Countries in Latin America and the Caribbean**

ACTIVITY	COUNTRY	ESTABLISHMENT COST (DOLLARS)	ANNUAL MAINTENANCE COST (DOLLARS)	STUDY
Agroforestry: Brazil nut, perennial shrubs, black pepper, banana, cupuassu tree	Brazil	2,086 per hectare	1,569 per hectare	Gama (2003)
Agroforestry: trees in borders of agricultural farms	Costa Rica	530 per kilometer	158 per kilometer	Gómez and Reiche (1996)
Agroforestry: windbreak trees	Costa Rica	815 per kilometer	N/A	Gómez and Reiche (1996)
Agroforestry: coffee with trees	Costa Rica	2,138 per hectare	N/A	Gómez and Reiche (1996)
	Ecuador	1,072 per hectare	165 per hectare	Ramírez (2005)
Agroforestry: beans with trees	Costa Rica	944 per hectare	N/A	Gómez and Reiche (1996)
Silvopasture: cows with trees for milk production	Mexico	2,894 per hectare	262 per hectare	Gonzalez (2013)
Silvopasture: cows with trees for meat production	Brazil	2,805 per hectare	N/A	Vinholis et al. (2010)
	Brazil	1,712 per hectare	702 per hectare	Dos Santos and Grzebieluckas (2014)
	Costa Rica	1,315 per kilometer	152 per kilometer	Villanueva et al. (2008)
Silvopasture: cows with sauco and kukuyo trees for meat production	Colombia	1,107 per hectare	N/A	Rocha et al. (2013)
Silvopasture: cows with leucaena trees for meat production	Colombia	2,553 per hectare	230 per hectare	Montagnini et al. (2015)
Reforestation: assisted natural regeneration	Brazil	639 per hectare	N/A	Nunes et al. (2017)
Reforestation: eucalyptus and native species	Brazil	2900 per hectare	775 per hectare	Brancalion et al. (2012)
Reforestation native species	Chile	1156 per hectare	138 per hectare	CONAF (2011)
	Colombia	1060 per hectare	176 per hectare	CONIF, (2012)
Reforestation	Costa Rica	910 per hectare	243 per hectare	Gómez and Reiche (1996)
Reforestation riparian zones	Guatemala	1343 per hectare	446 per hectare	Zamora-Cristales et al. (In preparation)

Note: N/A indicates that the costs of maintenance were either not available or not reported because of the insignificant amount involved.

On severely degraded forest and agriculture lands that are no longer suitable for cultivation and are abandoned, opportunity costs may equal zero. This is the case in some parts of African countries, such as Malawi.

Opportunity costs do not need to be considered when institutional arrangements make it legally impossible to pursue other uses (e.g., commercial), other than in the case of subsistence uses by indigenous communities (Ding et al. 2016b).

Step 3: Conduct Economic Analysis to Improve Decisions and Design Better Policy and Financial Instruments

The benefits and costs of restoration activities are inputs for economic analytical tools such as cost-benefit analysis, cost-effectiveness analysis, spatial restoration optimization analysis, and macroeconomic analysis. Results of these economic analyses will provide important economic evidence to justify investment in restoration projects. For example, cost-benefit analysis can help prioritize investment by comparing the expected net benefits of two different restoration projects.

Economic analysis can also be used to develop policy instruments that will improve the economic efficiency of the provision of public environmental goods. For instance, macroeconomic analysis can estimate the welfare impacts of policies that aim to redirect subsidies from sectors or economic activities with harmful impacts on lands and deforestation (e.g., agricultural input subsidies) to activities that favor sustainable land use and management.

In turn, public policies can make markets work better (correct market failures), by integrating ecosystem service values where possible into price signals and by putting adequate institutions, regulations, and financing in place. Some of the policy instruments include payments for ecosystem services (PES) schemes, subsidy reforms and fiscal transfers. PES can be local (e.g., water yields) or global (e.g., carbon credits generated from reduced emissions from avoided deforestation and forest degradation through REDD+ programs). These policy instruments may serve as important financing instruments to cover the up-front costs of restoration activities.

Cost-Benefit Analysis

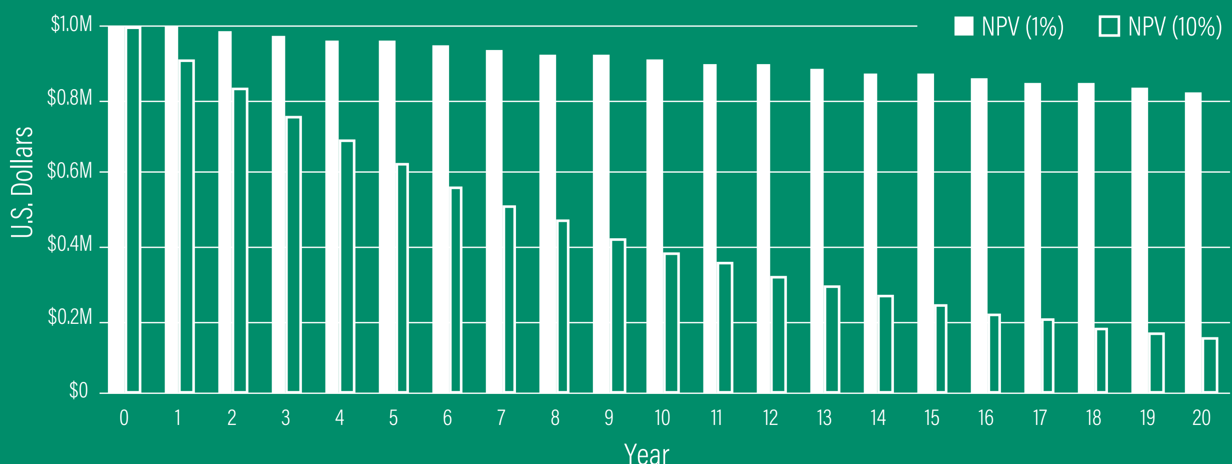
Cost-benefit analysis of restoration projects extends the discounted future cash-flow approach used in financial analysis to public benefits of restoration projects (Harrison and Herbohn 2016). It is widely used to justify investment decisions, perform trade-off analysis of public and private benefits perceived by different beneficiaries, and determine the appropriate economic incentives for engaging private landowners in restoration. Results of cost-benefit analysis can be presented in terms of net present value, the benefit/cost ratio, or the internal rate of return. An investment in restoration can be justified if the net present value is greater than zero (or the benefit/cost ratio exceeds 1). The choice of the discount rate used to calculate the net present value has a huge effect on the attractiveness of a potential investment (Box 3.4).

Verdone and Seidl (2017) estimate a benefit-cost ratio of restoring 350 million hectares of degraded forest land ranging between $7.5 and $30.9 (i.e., every dollar invested would yield approximately $7–30 in benefits for restoring 350 million hectares of forest lands, or an estimated $2–9 trillion NPV for a 50-year period). Their results are consistent with the estimates made by De Groot et al. (2013), who found that the benefit-cost ratio of restoring temperate and tropical forests and woodlands over a 20-year time horizon ranged from a low of about $2 to a high of about $32, depending on the biome and scenario. It should be noted that failure to capture all of the cobenefits (especially the nonmarket benefits) of restoration interventions can lead to lower benefit-cost ratios. For example, Verdone and Seidl (2017) reported a much lower estimate of $0.7 trillion NPV under a 4.3 percent discount rate without accounting for the value of public goods.

BOX 3.4 | HOW DISCOUNT RATES AFFECT INVESTMENT DECISIONS

The choice of discount rate has a profound impact on the net present value of a project. The present value of a $1 million payment received 20 years from now is $819,544 at a 1 percent discount rate—and just $148,644 at a discount rate of 10 percent (Figure B3.5).

Figure B3.5 | Net Present Value of Capital



The discount rate has a particularly large effect on restoration decisions because projects tend to generate revenue streams over a long period. The discount rate reflects the uncertainty and risk associated with projected cash flows as well as the opportunity cost of capital. In particular, when a restoration project is considered less profitable or more risky from the perspective of private investors, governments or public investors should step in for the sake of public interest and long-term benefits.

The discount rates used by private and public investors vary greatly. Private investors usually use a high discount rate that is greater than market interest rates, which are generally high in developing countries and higher in countries with unstable social and economic situations. For example, the annualized interest rates that central banks charged to commercial banks is 0.5 percent in the United States, and 25.5 percent, 24 percent, and 13.75 percent in Ghana, Malawi, and Brazil, respectively. [a]

However, ethical public investors often want to account for the ethical considerations of intergenerational justice by applying a social discount rate that is lower than the private discount rate (Young and MacDonald 2006). WRI-UNEP DTU (forthcoming) suggested average social discount rates between 0 and 10 percent, depending on how one wishes to address equity concerns with respect to future generations. However, a lower rate is usually suggested for time horizons that cross generations. Empirical evidence of investor behavior suggests that the value of the social rate ranges between 2 and 5 percent (Pindyck 2013), whereas the consensus among 197 economists suggests the use of an average 2.25% long-term social discount rate (Drupp et al. 2015). In addition to a constant social discount rate, a few countries such as the United States, the UK, and France have incorporated declining discount rates (DDRs) in government-body recommendations when looking at very long-term cash flows (Freeman and Groom 2013).

Note: [a] https://www.cia.gov/library/publications/the-world-factbook/rankorder/2207rank.html

Cost-Benefit Analysis

Cost-effectiveness analysis is an alternative to cost-benefit analysis. It selects interventions that achieve a specified objective at the least cost. Different from cost-benefit analysis's emphases on the profitability of restoration projects, cost-effectiveness analysis focuses on the balance between economic cost-efficiency and the environmental interest of ecological restoration of degraded land and ecosystems. Cost-effectiveness analysis might be used to assess how to restore a degraded forest to increase carbon storage at the lowest cost per ton sequestered. This form of analysis is found in studies that compare project costs for achieving specified ecological restoration objectives (Adame et al. 2015).

Financial incentives for restoration should focus on locations where restoration is likely to be cost-effective; that is, achieving the highest ecological objective with lowest costs. Birch et al. (2010) compared the cost-effectiveness of forest restoration across four dryland areas in Latin America and found that forest restoration is highly sensitive to the carbon price.

Cost-effectiveness analysis can also help justify public and private investment in green infrastructure. Using this technique, WRI found that investing in green infrastructure options such as riparian buffers and reforestation could generate cost savings of up to 67 percent over constructing a new filtration plant in Portland, Maine (Talberth et al. 2013). Nevertheless, very few studies have evaluated the cost-effectiveness of restoration interventions (Birch et al. 2010).

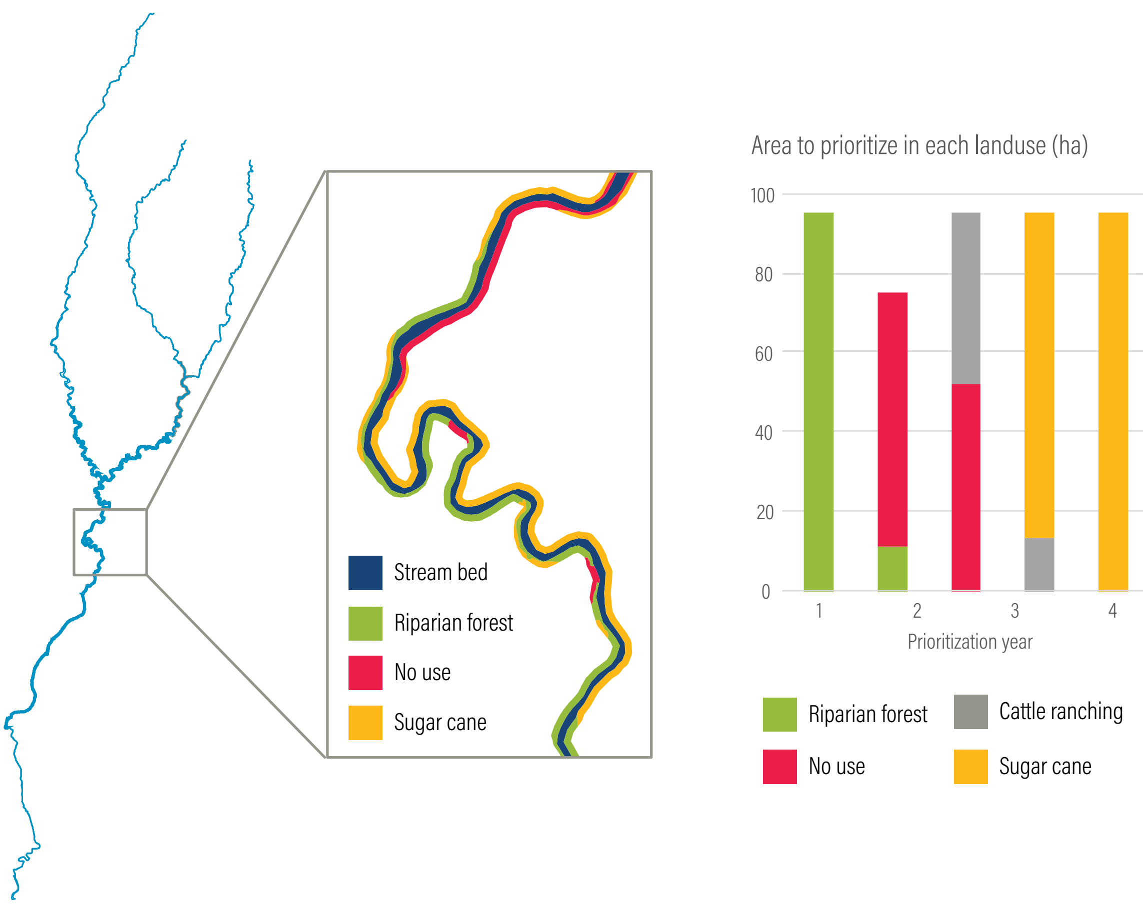
Spatial Restoration Optimization Analysis

The collective benefits of forest and landscape restoration are more than the sum of the individual benefits of each land-use intervention. Spatial optimization models can be used to take into account the total benefits and potential trade-offs generated at the landscape scale. Focusing on the landscape level helps policymakers better understand the optimal combination of restoration interventions that enable the long-term recovery of functionality and sustainability and improve livelihoods and well-being. These models build on geographical information systems (GIS) and economic optimization modeling to spatially estimate and simulate future potential land-use allocations and calculate optimal mosaic restoration options that generate the highest multiple economic and environmental benefits.

Initiative 20x20, coordinated by WRI, developed and applied a spatial optimization model in Guatemala to identify the optimal resource allocation for public investments in restoration interventions to achieve different government objectives, taking opportunity costs into account.[12]

Zamora-Cristales et al. (In preparation) present model results for a five-year strategic plan for a Pacific Coast river, where the government has set

Figure 3.5 | **An Example of a Five-Year Strategic Plan for Restoration Investment**



Source: Zamora-Cristales et al. In preparation.

a goal of restoring at least 70 hectares of forest per year (Figure 3.5). According to the model, during the first year, restoration should focus on conserving the existing forest areas along the river. In years two and three, areas with no current use (low opportunity cost) are a priority. In years four and five, restoration should focus on areas currently used for sugar cane and cattle ranching.

The spatial component of this analysis allows decision-makers to visualize potential impacts of certain policies across different locations. Spatially explicit models of restoration benefits can be combined with temporal data to develop multiple restoration scenarios that explore how benefits change over space and time. This analysis can be combined with multi-objective optimization functions to account for different desired impacts for restoration and identify trade-offs between different objectives.[13]

The results from spatial optimization models may be particularly helpful for guiding public investment decisions. In particular, they provide information that can help investors, including impact investors, identify investments that will support a combination of diverse restoration interventions on different land mosaics to maximize the socioeconomic gains while achieving decent restoration outcomes at the landscape level.

However, the use of spatial optimization models is often constrained by the poor quality of biophysical information. Model application is often limited to modeling correlations between restoration activities and their environmental impacts.

Macroeconomic Analysis of Socioeconomic Impacts

Unlike economic benefit analysis, macroeconomic analysis focuses on the contributions of changes of a particular policy to changes in gross output and employment (BenDor et al. 2015b), as well as the income distribution effects of the policy. For instance, Go et al. (2010) examine the impacts of wage subsidies on employment in South Africa. Using a CGE model paired with information on occupational choice and employment, they estimate that a 10 percent wage subsidy would increase employment by 2 to 7 percent, depending on the rigidity of the labor market. The results helped South Africa's finance minister redraft the original wage subsidy policy proposal (Devarajan and Robinson 2013).

Macroeconomic models have not yet been used to assess restoration benefits more broadly. To help extend their application, the International Food Policy Research Institute (IFPRI) recently partnered with WRI. The two institutions will jointly explore the potential of incorporating restoration policies into a CGE model for agriculture and pilot it in selected countries that have committed to Initiative 20x20. The modeling results are expected to help international donors and governments better understand the potential economy-wide impacts of achieving national restoration objectives under different scenarios.

Recommendations

Economic analysis plays an important role in motivating restoration interventions. It makes the value of ecosystem services and costs of degradation visible, and it identifies who bears the costs and who reaps the benefits.

Despite this, the potential of economic analysis to inform policymaking in support of restoration is still largely unrealized. This is because most environmental economic analyses are still an academic exercise, still almost exclusively *ex ante* with very few analyses assessing the actual costs and benefits after a successful restoration activity, and because the theoretical valuations of expected future benefits are clearly not persuading investors. To enhance the science-based decision-making for restoration in developing countries, scientists and organizations that work in the field of assessing the benefits of forest and landscape restoration around the world could be better coordinated through a formally established international body, such as the UNCCD or Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Moreover, a work stream focusing on the economics of land restoration, similar to TEEB, could be created to monitor and document the progress and outcomes of restoration implementation around the world, to promote research and communication on the science-policy and science-business interface to better inform decision-making, and to host a central database of research findings and economic evidence on restoration around the world. The following specific actions could be undertaken within the work stream:

Spatially explicit models of restoration benefits can be combined with temporal data to develop multiple restoration scenarios that explore how benefits change over space and time.

1. Report disaggregated benefits in addition to the total net present value of projects. Such reporting would help stakeholders see who gains, who loses, and who may need to be compensated for undertaking restoration activities.
2. Analyze the benefits of restoration activities beyond the restored sites, taking into account broader economic benefits, including nonmarket benefits, where possible.
3. Broaden the scope of farm-level analyses to a landscape scale, in order to achieve buy-in for interventions. Broad analyses can engage a wide range of stakeholders, including water utilities, electricity providers, and government agencies, by demonstrating how they would benefit from smallholder-led efforts coordinated at a landscape scale.
4. Use macroeconomic modeling to show how changes in land productivity may affect the national or global economy.
5. Following project implementation, conduct studies on the effects of restoration to help policymakers track how landscape restoration improves livelihoods; monitor and document actual restoration projects to provide concrete ex post evidence of benefits delivered.

6. Improve the quality and delivery of information provided to practitioners and policymakers. For example, with recent advancements in technology and computer science, economic modeling tools can better incorporate spatial information in the analysis. Information presentation can be significantly improved by visualizing restoration benefits on GIS maps.

7. Create a database of findings. Although many ecosystem service values, especially values relating to local benefits, are context-specific, the results of studies in one area can be useful for decision-makers in others. Creating a database would provide policymakers or others who lack the time or money to have custom studies performed with access to state-of-the art knowledge. It would reduce the duplication of effort, allowing scarce research funds to be devoted to other areas.

8. Adopt a standardized valuation framework for assessing restoration benefits at both the national and community levels, in order to enhance the comparability and robustness of different studies. A high-level panel of social scientists, similar to the blue ribbon panel that the National Oceanic and Atmospheric Administration created to evaluate the robustness of nonmarket valuation methods in the context of landscape restoration, could be established to provide this type of guidance (Arrow et al. 1993).

All these efforts would help bring together governments, research organizations, international development agencies, business, and civil society to act on improving restoration economic analysis and on better using economic analysis to inform policy and investment decisions.

SECTION 4

CONCLUSIONS

Improved understanding of the economics of restoration and mechanisms for financing restoration actions will unlock current opportunities to transform landscapes and achieve multiple beneficial outcomes.

Degradation of land and forests has greatly reduced the productivity of some forest and agricultural ecosystems (Turner et al. 2016). For instance, degradation led to declining yields of maize, rice, and wheat that caused an estimated $244 million annual economic loss (6.8 percent of GDP) in Malawi and $2.3 billion (13.6 percent of GDP) in Tanzania (Kirui 2015). At a global level, degradation costs an estimated $6.3 trillion a year (8.3 percent of global GDP in 2016) in lost ecosystem service value, which includes agricultural products, clean air, freshwater, climate regulation, recreational opportunities, and fertile soils (Sutton et al. 2016).

Recognition of the importance of restoring degraded land and forests has grown, as commitments to the Bonn Challenge indicate. But restoration is not attracting the necessary investment, for the seven reasons identified in Section 2:

- Environmental and social benefits usually have no market value.
- Incentives to degrade land outweigh incentives to restore it.
- Climate finance is difficult to access.
- Funding for restoration is sometimes limited to small environmental budgets.
- Many restoration projects are too small to be attractive.
- Many restoration projects have very long (10- to 20-year) investment time frames.
- Restoration is considered a risky investment.

Much of the problem could be overcome if decision-makers widened their concept of return on investment in restoration to include a broader set of benefits, including both market benefits (such as greater crop yields and timber and nontimber forest products) and nonmarket benefits (such as biodiversity and improved water and soil retention). The reason they do not is that these nonmonetized benefits cannot easily be incorporated into financing decisions.

Economic analysis (see Section 3) can reveal all of the costs and benefits associated with restoration—not just the short-term gains on a particular piece of land but the long-term gains for productivity, employment, income, health, the environment, and the avoided costs of migration, civil conflict, and war. Such analysis makes the value of ecosystem services and the costs of degradation visible. Economic valuation can also help build support for new financing mechanisms funded through subsidies and fiscal transfers, and it can help spur the reallocation of capital by analyzing who bears the costs for implementing a project and who benefits.

In contrast to ecosystem restoration projects at local, site-based scales, forest and land restoration takes a landscape approach. To implement it, governments need to integrate restoration across ministries and government bodies, rather than relegate it to a single agency, and they need to incorporate it into their green growth strategies. Quantifying the myriad public benefits of restoration can help scale investment in landscape restoration by blending different sources of capital, including climate and development finance.

As the restoration economy continues to develop, we expect that developing voluntary international standards for restoration projects would help improve communication and reduce uncertainty for all stakeholders, including governments and investors. Steps are under way to begin developing standards based on an extensive consultative process. The intent is to develop standards that sharpen and clarify the understanding of what constitutes forest and landscape restoration, outline the technical knowledge on how to execute restoration, and develop monitoring frameworks to report on progress.

Given the strong political impetus for restoration, the time is right to accelerate implementation on the ground. To do this, landscape restoration must be considered an integral part of any sustainable development strategy. This report is expected to help develop the groundwork for a thriving restoration economy.

ABBREVIATIONS

ARIES	Artificial Intelligence for Ecosystem Services
BNDES	National Bank for Economic and Social Development
CGE	Computable general equilibrium
CIF	Climate Investment Funds
DDR	Declining Discount Rates
ES	Ecosystem services
ETS	Emissions trading systems
FLR	Forest and landscape restoration
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
GIIN	Global Impact Investing Network
GIS	Geographic information system
IFPRI	International Food Policy Research Institute
InVEST	Integrated Valuation of Environmental Services and Trade-offs
I-O	Input-output
ITC	Investment tax credit
IUCN	International Union for Conservation of Nature
MIGA	Multilateral Investment Guarantee Agency
NDC	Nationally Determined Contribution
NOAA	National Oceanic and Atmospheric Administration
NPV	Net present value
NTFPs	Nontimber forest products
OECD	Organisation for Economic Co-operation and Development
PES	Payments for ecosystem services
REDD+	Reducing Emissions from Deforestation and Forest Degradation in developing countries
TEEB	The Economics of Ecosystems and Biodiversity
TEV	Total economic value
TIMOs	Timber Investment Management Organizations
TNC	The Nature Conservancy
UNCCD	United Nations Convention to Combat Desertification
UNEP DTU	UN Environment Programme (UNEP) Risø Centre
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute

ENDNOTES

1. Information on the Bonn Challenge can be found at http://www.bonnchallenge.org/content/challenge.

2. http://www.bonnchallenge.org/commitments.

3. http://www.afr100.org/.

4. http://www.wri.org/our-work/project/initiative-20x20.

5. For an example of a venue in which technology entrepreneurs can pitch ideas and attract capital investment, see Silicon Valley Open Doors (http://www.svod.org).

6. Private benefits may also include the nonconsumptive use of natural resources by individuals through recreational or educational activities.

7. Developed at Stanford University, InVEST is a suite of free, open-source software models used to map and value the goods and services from nature that sustain and fulfill human life. It has been applied to developing nature-based solutions to targeting investments in forest restoration for the International Union for Conservation of Nature (IUCN) and national governments in Africa. See https://www.naturalcapitalproject.org/invest/.

8. Launched in 2007, ARIES is a networked software technology that redefines ecosystem service assessment and valuation for decision-making. The ARIES approach to mapping natural capital, natural processes, human beneficiaries, and service flows to society is a powerful new way to visualize, value, and manage the ecosystems on which the economy and well-being depend. See http://aries.integratedmodelling.org/.

9. A web-based policy-support tool for natural capital accounting and analysis of ecosystem services provided by natural environments: http://www.policysupport.org/costingnature.

10. Monte Carlo simulation is a computerized mathematical technique that allows people to account for risk in quantitative analysis and decision-making.

11. For more information on TEEB's database see http://www.teebweb.org/publication/tthe-economics-ofecosystems-and-biodiversity-valuation-database-manual/.

12. Initiative 20x20 is a country-led effort to bring 20 million hectares of land in Latin America and the Caribbean into restoration by 2020. For detailed information about the initiative, see http://www.wri.org/our-work/project/initiative-20x20.

13. Gourevitch et al. (2016) used an optimization framework to optimize investments in national-scale forest landscape restoration in Uganda for different strategic objectives.

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ACKNOWLEDGMENTS

This report benefited greatly from spirited discussions with all participants at the Expert Workshop on the Economics and Financing of Restoration Opportunities, organized by World Resources Institute in Washington, DC, on March 31, 2017.

The authors are grateful for the comments and suggestions on an early report outline provided by Amy W. Ando (University of Illinois and Resources for the Future), Christopher Delgado (World Bank and Johns Hopkins School of Advanced International Studies), Barbara Wagner (Montana Dept. of Labor and Industry), Edward Barbier (Colorado State University), and Stefanie Tye (WRI).

The authors also wish to express their particular thanks to the following individuals for their valuable guidance, critical reviews, and research support: Ana Ríos (Inter-America Development Bank), Anil Markandya (BC3), Caroline van Leenders (Dutch Ministry of Foreign Affairs), David Mayer (UNDP BIOFIN), Dolf de Groot (Wageningen University), Edward Davey (the Prince of Wales's Charitable Foundation), John Herbohn (University of the Sunshine Coast), Jon Strand (University of Oslo), Robert Beach (RTI International), Sara Scherr (Ecoagriculture), and Todd Bendor (UNC).

Many World Resources Institute colleagues provided comments on drafts of this report, including Fred Stolle, James Mulligan, Katie Reytar, Maria Franco Chuaire, Helen Mountford, Sean DeWitt, Laura Malaguzzi Valeri, Daryl Ditz, and Michelle Manion. The authors would also like to acknowledge those involved with graphic design, editing, and layout as well as communications and outreach: Carni Klirs, Julie Moretti, Emily Matthews, Barbara Karni, Caroline Gagne, James Anderson, Natasha Ferrari, John-Rob Pool, Deborah Zabarenko, Lauren Zelin and Ally Friedman.

We are pleased to acknowledge our institutional strategic partners, who provide core funding to WRI: Netherlands Ministry of Foreign Affairs, Royal Danish Ministry of Foreign Affairs, and Swedish International Development Cooperation Agency. This report also received financial support from Doris Duke Charitable Foundation.

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ABOUT WRI

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Our Challenge
Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies where the future of sustainability will be determined.

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ISBN 978-1-56973-925-9