Economics of Forest Landscape Restoration

Estimating impacts, costs and benefits from ecosystem services

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LIST OF ABBREVIATIONS

A/R	Afforestation / Reforestation
AFOLU	Agriculture, Forestry and other Land Uses
AFR100	African Forest Landscape Restoration Initiative
ANR	Assisted Natural Regeneration
CO_2e	Carbon dioxide equivalent
ELD	Economics of Land Degradation
FAO	Food and Agriculture Organization of the United Nations
FCPF	Forest Carbon Partnership Facility
FLR	Forest Landscape Restoration
FRA	Forest Resource Assessment (FAO)
FSC	Forest Stewardship Council
FTE	Full time equivalent
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
GIS	Geographic Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GPFLR	Global Partnership on Forest Landscape Restoration
Ha	hectare
IFC	International Finance Corporation
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IRR	Internal Rate of Return
IUCN	International Union for Conservation of Nature
IUFRO	International Union of Forest Research Organizations
LDD	Land degradation and desertification
LDN	Land Degradation Neutrality
M&E	Monitoring and Evaluation
MDG	Millennium Development Goals
NDC	Nationally Determined Contribution
NGO	Non-Governmental Organization

NPV	Net Present Value
NTFP	Non-Timber Forest Product
NYDF	New York Declaration on Forests
ODA	Official Development Assistance
ROAM	Restoration Opportunities Assessment Methodology
ROE	Return on Equity
ROI	Return on Investment
RUSLE	Revised Universal Soil Loss Equation
SALM	Sustainable Agriculture Land Management
SDG	Sustainable Development Goals
SER	Society for Ecological Restoration
SFM	Sustainable Forest Management
SLM	Sustainable Land Management
TAV	Total Available Water
TEV	Total Economic Value
UNCCD	United Nations Convention to Combat Desertification
UNFCCC	United Nations Framework Convention on Climate Change
USLE	Universal Soil Loss Equation
WACC	Weighted Average Cost of Capital
WRI	World Resources Institute

PREFACE

Imagine you are a cocoa farmer in Ghana, a cattle rancher in Paraguay, or a dairy farmer in the Netherlands. Your family's livelihood – the school fees of your children, your mother's hospital costs, and your food and shelter – all depend on the income that you make from your land. The farm succeeds when the soil has sufficient nutrients, the spring is flowing, the climate is favorable, and you can afford the time and money to manage every aspect of the farm just right. If this balance is off, the farm and your family will be worse off.

Even more than the food and income that the farm provides you, living on the farm is central to your quality of life. You have never been attracted by the hectic life of large cities and the air pollution – you appreciate the clean air and water you have access to in the countryside. Your partner wakes up early every morning to watch the birds and your children play in the farm after school. What's more, you take pride in growing food and preserving the traditional farmer life.

Farm life is not romantic: it is arduous and full of risks. About third of your farm is underperforming. Your parents faced tough times when you were young and cleared a large area of trees, initially to sell the wood and subsequently to plant with a new crop, which did not do well and sucked the nutrients from the soil**.** The spring gives less water than before and there seem to be fewer birds and insects.

You have heard that neighbors are facing similar difficulties and realize you have to change your practices. After saving for a few years, you and your family now have enough money to invest in the land. What should you do? You could buy a tractor, seeds, and fertilizer, allowing you to intensify and expand your farming operations on the land. Your partner prefers to replant native trees there, so that more birds will come to your land. You are also tempted to try a new agroforestry system similar to what your neighbor has started. How do you choose between these different options and the benefits to your family?

These are the choices that farmers, land managers, and policy makers around the world are facing. An estimated 2 billion hectares of the world's forests and natural ecosystems are degraded, hurting agricultural productivity and diminishing the clean air, water, and other vital services these ecosystems provide. If we invest into restoring degraded lands, what ecosystem services do we prioritize? How can we compare the value of producing more agricultural goods, regulating our global climate, creating jobs, or protecting biodiversity? There are some restoration options that provide "win-wins". However, in many cases there are short and long-term tradeoffs between different land management options and decisions.

The aim of the toolbox described in this report is to aid in this decision-making, for the farmer in Ghana, Paraguay, or the Netherlands, as well as large agribusinesses or local and regional governments that envision largescale restoration programs at a landscape scale. It recommends a straightforward, four-step process and provides guidelines and tools for each step. Assessing the costs and benefits of land use investments will allow decision-makers to prioritize restoration investments based on criteria that matter to them: which ecosystem services are prioritized, who should benefit, and when are benefits realized. By projecting the quantities of ecosystem services produced under different investment scenarios – and putting a monetary value on those services when helpful – we can understand the tradeoffs between scenarios and make decisions to optimize land use.

EXECUTIVE SUMMARY

The Bonn Challenge, the New York Declaration on Forests (NYDF, 2014), and regional initiatives have created unprecedented momentum for reversing land and forest degradation. The global area that could be restored is estimated up to 2 billion hectares, and with the unabated pressure on forests, this figure continues to grow. Restoration at scale is thus an imperative to achieving the sustainable development goals (SDGs) and other internationally agreed policy objectives. These initiatives have successfully promoted and triggered massive political commitment for the concept of Forest Landscape Restoration (FLR). Many countries have made ambitious restoration pledges. They often consider restoration as a key strategy under their Nationally Determined Contributions to the UNFCCC Paris Agreement.

Today, FLR is a globally known approach for aligning national "green economy" development agendas and sustainable management of natural resources. Despite the benefits, one barrier to implementing FLR at scale is the significant costs associated with many FLR activities. Consequently, attracting sufficient funding continues to be one of the key challenges: it is estimated that US$36 to 49 billion are needed annually in order to reach Bonn Challenge and NYDF restoration goals, respectively (FAO & UNCCD, 2015). While funds that target FLR investments have been developed, the scale of investment being deployed is nowhere near what is required.

The diverse set of benefits generated by FLR investments – from increased agricultural yields, to global climate change mitigation, to improved soil and water regulation – is an important reason for the interest in FLR. Convincing and comprehensive cost-benefit analyses can be a powerful tool for FLR advocates – policy makers and potential investors – to raise interest and create demand for FLR. The challenge lies in estimating a value of the benefits that is relevant to the stakeholders that are involved in decision-making.

Against these considerations, this report "Economics of Forest and Landscape Restoration" has developed an easily applicable economic framework, helping stakeholders to develop a customized decision-making tool. Consisting of standalone modules and methods, it offers both private and public actors differentiated means of estimating values. Tailored cost-benefit analyses can help a variety of different target groups in their decision-making: from farmers and agribusinesses to local and national level governments.

Assessing the costs and benefits of land use investments will allow decision-makers to demonstrate that investments in FLR are worth the short-term cost for public entities and result in better economic and environmental outcomes. The modeling and its results furthermore allow for prioritizing restoration investments based on different criteria: which ecosystem services are prioritized, who should benefit, and when will benefits be realized? Does the farmer choose to improve agricultural productivity, to protect water resources, to avoid erosion, or some combination? Policy makers need to understand the costs of FLR as well as the multiple benefits: employment effects, tax and Gross Domestic Product (GDP) contribution, and indirect economic values – for example, the value of carbon sequestration and non-marketable ecosystem services as avoided erosion and hydrological services.

The framework at hand consists of a straightforward, four-step process. It provides guidelines and tools for each step: setting the scene, data collection, modeling costs and benefits, and analysis of results. The methodology is applicable for users with different needs and access to resources. Both low- and high-cost assessments are possible, depending on the purpose of the analysis and the level of complexity needed.

The methodology complements ROAM and other restoration opportunity tools, e.g. by providing a cost-benefit analysis of the opportunities identified during a preliminary assessment. It can be applied as part of a restoration opportunity process, once FLR activities have been identified and mapped, but also as a stand-alone decision making tool. The results will allow decision-makers to compare the trade-offs between alternative FLR investment scenarios, and to inform decision processes and land use planning.

1 INTRODUCTION

Unabated deforestation and forest degradation have led to vast areas of degraded lands and forests around the world. Land degradation is the consequence of different land use interventions that are often aggravated by natural responses, e.g. erosion, desertification, or invasive species (Gibbs & Salmon, 2015). Despite many initiatives at different levels, ongoing land and forest degradation remain drivers of food insecurity, climate change, and biodiversity loss (IPCC, 2007b, 2007a; Pan et al., 2011; Pereira et al., 2010; Wreford, Moran, & Adger, 2010). Land degradation occurs when the different ecological processes of ecosystems are disrupted by changes induced directly or indirectly by humans. With the decline in their ecological functions, degradation means that land is not as productive as in its pre-disturbance state: it provides less products and ecosystem services. Globally up to 2 billion hectares (ha) are degraded and could be restored (Bonn Challenge, 2018; WRI, 2011).

Reducing and reversing degradation will help achieve international environmental and development objectives. Restoring degraded lands could be a win for global livelihoods, particularly for people living in rural areas, as it would improve agricultural incomes and other ecosystem services. Since 2010, a number of international policy agreements have established a framework to achieve the promise of land restoration. The most important are the 2010 Aichi Targets of the Convention on Biological Diversity (CBD), the Land Degradation Neutrality Target under the United Nations Framework Convention on Combating Desertification (UNCCD), and the 2015 Paris Agreement under the United Nations Framework Convention on Combating Climate Change (UNFCCC). Besides these processes, the United Nations Declaration on Forests of 2014, high-level policy dialogues as the Bonn Challenge and its related initiatives and the Sustainable Development Goals (SDGs) of 2015 have formulated objectives related to restoring forest landscapes. Moreover, many national-level climate change, forestry, and land use policies and strategies include land restoration targets and objectives.

The Bonn Challenge, the follow-up process on the New York Declaration on Forests (NYDF), AFR100, and the 20*20 initiative – are fostering implementation on the ground. Their explicit rationale is to promote the concept, encourage countries to make voluntary FLR pledges, and to foster and upscale FLR measures. As of August 2019, 59 governments have pledged to restore more than 170 million ha; often the pledges are linked to formal national and international policy targets, such as the Nationally Determined Contributions (NDCs) under the Paris Agreement.

The concept of FLR aligns with national "green economy" agendas and sustainably managing natural resources. FLR has a strong focus on the benefits that restored ecosystems can provide to humans. Following the currently produced Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) thematic assessment on land degradation,[1] this document uses the following definition of restoration: "any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state." This understanding embraces

[1] Report available at: https://www.ipbes.net/system/tdf/ipbes_6_inf_1_rev.1_2.pdf?file=1&type=node&id=16514

the economic monetary and non-monetary values that ecosystems provide for the well-being and livelihoods of mankind.[2]

Attracting sufficient funding for FLR investments is a key challenge for successful implementation. While countries have set restoration goals, achieving these targets will require unprecedented financial and political commitment to FLR; US$36 – 49 billion are needed annually in order to reach Bonn Challenge and NYDF restoration goals, respectively (FAO & UNCCD, 2015). FLR advocates need to make the economic case that investments in FLR are worth the short-term cost for public entities and result in better outcomes. Policy support is needed enable FLR – improving governance, legal frameworks, providing financial incentives, and enhance land use planning. For coping with these challenges policy makers need to understand the costs of FLR as well as the multiple benefits. They include employment effects, tax and Gross Domestic Product (GDP) contribution, and indirect economic values – for example, the value of carbon sequestration or avoided erosion.

The success of the approach will rely on attracting significant private sector engagement and investment. Some financial institutions have made commitments to invest in restoration; for example, investors have earmarked US$ 2 billion for restoration investments in Latin America.[3] However, these funds are insufficient to meet the challenge at hand. Moreover, these funds have not been fully deployed. FLR has not captured the attention of private sector and other large-scale institutional investors in any significant way. One important step to convincing private sector actors to invest in FLR is to demonstrate that FLR business models can generate returns and be financially viable.

Policy makers and private sector actors have different information needs about values generated by single FLR investments, multi-activity programs, and implementation at landscape level. Private sector actors are primarily interested in understanding the financial implications of specific investments: investment needs, expected cash flows, profitability expectations, and risks. In many sectors, particularly agriculture, forestry, and hydropower, the return expectations are directly related to ecosystem function and the flow of ecosystem services. Policy makers may be more interested in the macro-economic impacts of FLR, such as primary and secondary employment, tax generation, GDP contribution, and revenue creation for specific sectors. Credibly estimating, quantifying, and, in some cases, monetizing the multiple impacts of FLR can be an important tool for communicating its value to public and private sector actors.

The main purpose of this study is to develop a practical methodology that enables a rapid, realistic, and robust estimation of the economic impacts of FLR. It will inform investors and policy makers based on their actual information needs, as well as development professionals working in the fields of forestry, agriculture, and climate resilience. Cost-benefit analysis as a decision-making tool is well understood, but the report should help fully account for the benefits of FLR and communicate them to a broader audience.

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[2] In a rigorous academic interpretation the correct term would be ‚rehabilitation'. However, the authors of this report share the broad view that the synonymous use in policy discourses reflects the reality that restoration is a long process with uncertain outcomes.

[3] For more information on investor commitments, see: https://www.wri.org/our-work/project/initiative-20x20/impact-investors#project-tabs

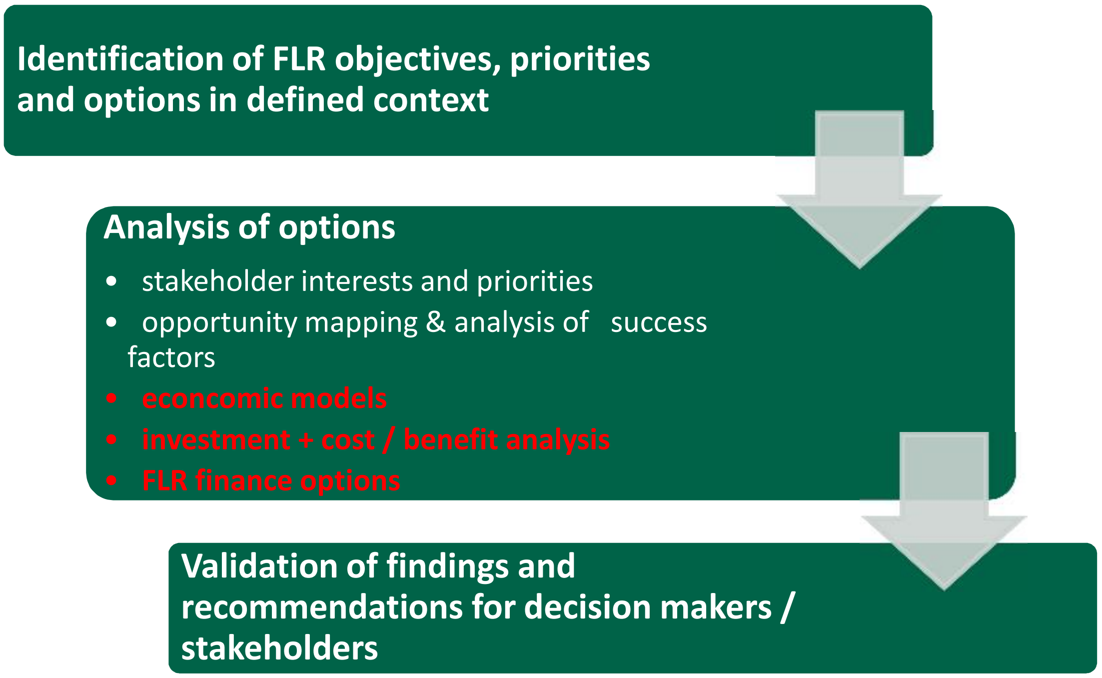
2 OVERVIEW OF METHODOLOGY

This methodology guides its users on how to make credible estimations of the economic impacts of FLR at a landscape level. A cost benefit analysis (CBA) is appropriate when decision-makers have identified concrete policy or investment options and would like to better understand the tradeoffs between options.

The methodology should be used once FLR objectives have been defined at a high level and potential activities have been identified. An in-depth CBA should be implemented after appropriate restoration opportunities have been identified, e.g. using the ROAM tool that is summarized in

Figure 1 (WRI; IUCN, 2014). The proposed methodology can then be used to analyze and understand FLR options, particularly the items highlighted in red. Aside from ROAM, there are other tools helping to guide decision-makers with FLR strategies, e.g. "The Restoration Diagnostics" tool (Hanson, Craig; Buckingham, Kathleen; Dewitt, Sean; and Laestadius, 2015) or "The Economic Case for Land Restoration in Latin America" (Vergara et al., 2017).

Figure 1: ROAM methodology (WRI; IUCN, 2014)



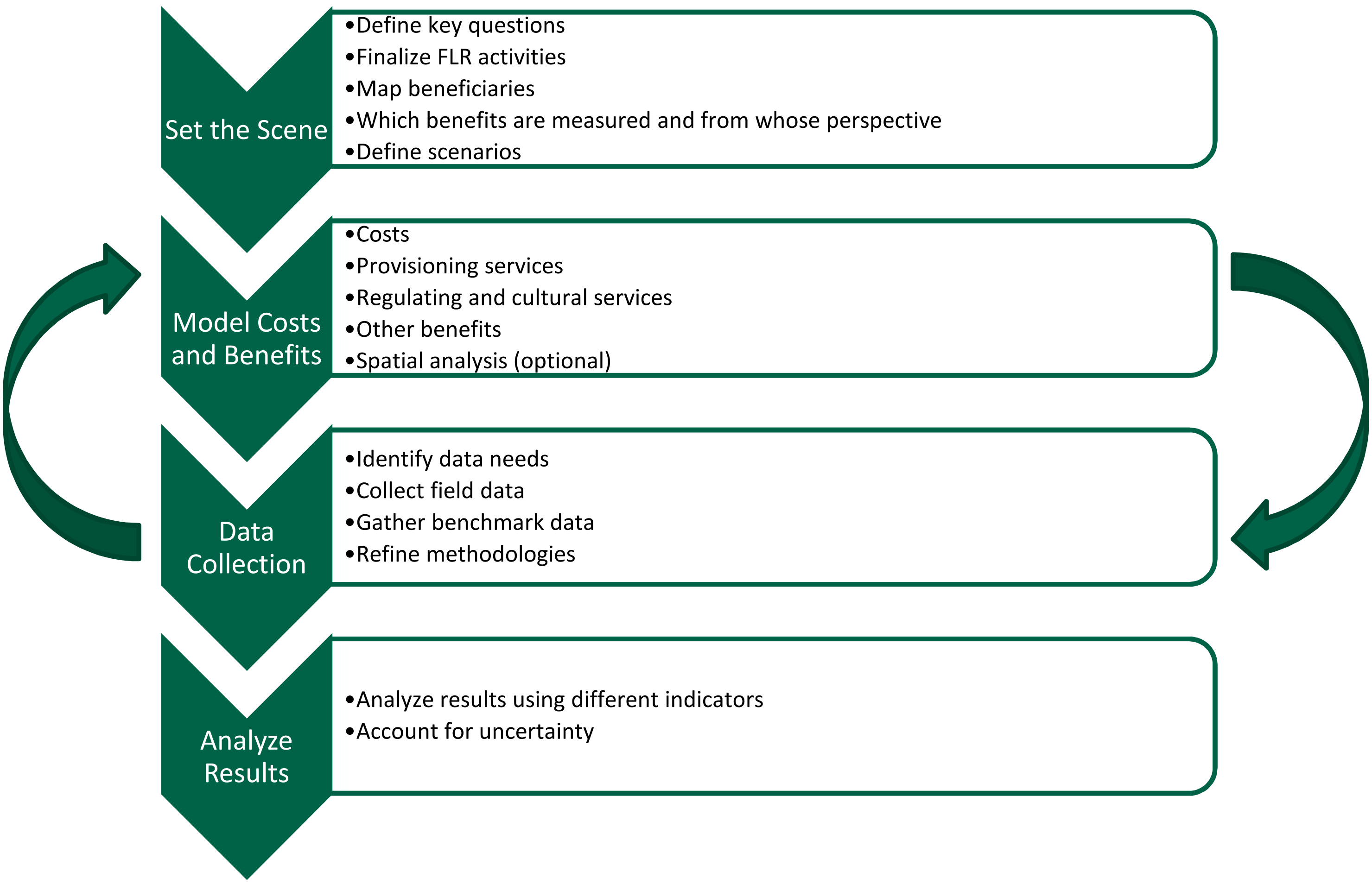
The methodology complements ROAM and other tools, providing a cost-benefit analysis of the opportunities identified during a preliminary assessment. ROAM assessments offer jurisdictional-level assessment of the potential FLR opportunities and help identifying FLR objectives, stakeholder interests, and mapping FLR opportunities. However, they often lack in-depth, targeted, and comprehensive economic assessments, which can be powerful arguments for policy makers and investors. This methodology is a deep dive into an analysis of the identified activities, highlighted in red in Figure 1: the economic modeling of costs and benefits.

The methodology is applicable for users with different needs and access to resources. Both low and high-cost assessments are possible, depending on the purpose of the analysis and the level of complexity needed. The authors distinguish between three tiers:

- A Tier 1 analysis is based on simple methods, proxies, default values and benchmarks. It results in estimations that should be conservative and robust. The assessment requires relatively little time for data collection, but does not deliver results that the user should have high confidence in; Tier 1 analysis is most appropriate at an early scoping stage.
- Tier 2 analysis refines the estimation and uses empirically backed national or even local data and benchmarks. It may incorporate some primary data collection and can be used as a basis for investment decisions.
- Tier 3 analysis incorporates spatially explicit high-resolution activity data and analysis. This level of detail becomes appropriate the impacts of potential activities depend greatly on the spatial distribution in a given landscape. This level of analysis requires significantly greater time and resource input.

Having decided upon the appropriate tier, the user should then follow the step-wise approach summarized in Figure 2.

Figure 2: Overview of methodology



Step 1 helps to set the parameters of the analysis. The user should start by listing the primary questions that should be answered by measuring costs and benefits. FLR activities should be defined, end beneficiaries need to be mapped, and the user should decide which ecosystem services will be included. Based upon all of this, scenarios are developed.

Step 2 (Model Costs and Benefits) and Step 3 (Data Collection) are separate, but will likely require an iterative process of moving back and forth to refine and improve results. The process of monetizing ecosystem services is broken down into a simple equation: Value = Price * Quantity. Values of ecosystem services are modeled over time, estimated at regular time intervals. Both primary data and benchmark data can be collected. It is likely that data gaps may still remain after a first round of data collection, necessitating the user to possibly refine his or her methodologies or seek new sources. The results help stakeholders, policy makers, and investors to understand what investments are required and their expected impacts.

Step 4 finalizes the analysis by interpreting the results. Different financial and economic indicators can help to communicate the impact of results to different stakeholders. Additionally, uncertainty can be high in cost benefit analysis and tools like a sensitivity analysis can help to account for this.

3 PROCESS FOR THE ANALYSIS

3.1 Step 1: Set the scene

Under Step 1 users establish the parameters of their analysis. They have to be clear about the purpose of the analysis, what activities are relevant, who is involved, and what is being measured. Key questions for the analysis should be established at this time in order to ensure that the outputs of the analysis are helpful. Relevant stakeholders should be identified and FLR activities to be evaluated should be finalized. Development of scenarios will allow the user to compare the baseline scenario to alternative investment or policy scenarios. Determining what benefits are measured and which actors are included will have a large impact on the scope and extent of the analysis.

3.1.1 Determine key questions

The first step in setting the scene is to clearly lay out the parameters of the analysis and identify the key questions. See Figure 3 for typical questions that a cost-benefit analysis can help to address.

Figure 3: Example key questions

- What are the costs of inaction? What will happen if we continue under business as usual?
- What investments or policies produce the greatest benefits? What are the costs?
- Which considerations cannot be quantified or monetized, and thus are not included in a cost-benefit analysis?
- What resources are available to conduct an analysis and what level of confidence is needed at this point?
- What are the total environmental / social / financial benefits of different investment scenarios?
- Which investment scenarios are most profitable? Which are most cost-effective?
- By how much do different groups / individuals benefit under different scenarios? How much do different groups / individuals lose under different scenarios?
- Which scenarios are most effective in leveraging public investment?
- What are key risks / threats to a potential FLR investment?
- What are the total costs of different scenarios?

One key question to highlight is the need to determine the appropriate level of complexity. On the one hand, a complex analysis that collects significant primary data will give the user a higher degree of confidence in the results. On the other hand, increasing complexity raises the costs of the analysis itself, and may not be necessary at an early stage of decision-making. The level of complexity of analyses can be broadly categorized into three tiers (Figure 4). It is up to the user to determine the tradeoffs between the desire for accuracy and costs.

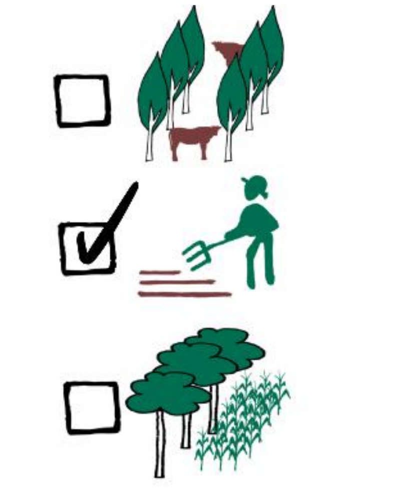
In Tier 1 and 2 analyses, the user will generate a one-hectare model for each activity included in the cost-benefit analysis. These one-hectare models are then scaled-up across the entire area of the proposed project. It is important to note the limitations of using one-hectare models. The ecological functions, the ecosystem services it provides and the overall productivity of one hectare of land is greatly affected by surrounding areas. A one hectare FLR investment will likely not have the same per hectare productivity as a thousand-hectare investment. Tier 3 analyses may develop spatially explicit models, meaning that costs and benefits may vary by geography, and homogenous one-hectare models will not be used.

One option for managing these tradeoffs is to do two stages of analyses. A first stage analysis would rely primarily on readily-available benchmark data and would be less costly. If the results are promising, the user may decide to continue with a second stage analysis, investing more in data collection and following a tier two or three approach.

Figure 4: Three tiers of analysis, based upon quality of input data

Tier 1	Tier 2	Tier 3
• Low cost • Reliant primarily on readily-available, benchmark data; primary sources used • Appropriate at a pre-feasibility stage • Likely not rigourous enough to make investment planning decisions	• Low cost if country-specific data is available • A mix of benchmark data and primary sources; little or no use of spatially-explicit data • Can support investment planning decisions • Appropriate when priority ecosystem servicesare not spatially-dependent	• High cost • Highly reliant on primary data; significant incorporation of spatially-explicit data • Can support investment planning decisions • Appropriate when priority ecosystem services are spatially-dependent

3.1.2 Identify FLR activities



This methodology can be applied on its own, or as a part of a broader decision-making process. ROAM assessments, for instance, have identified potential FLR activities and their suitability within the target country or landscape. Key opportunities identified by a ROAM should be chosen for a full cost and benefit analysis. For example, the Rwanda ROAM identified five potential FLR interventions (Rwanda, 2016):

- agroforestry on steep sloping land combined with soil conservation measures,
- agroforestry on gently sloping land,
- improved management of woodlots and plantations,
- protection and restoration of existing natural forests,
- establishment or improvement of protective areas on important and sensitive sites.

Generally, FLR activities can be categorized as described in Table 1, based on the current use of land; specific FLR actions that may fall in more than one category.

Table 1: Examples of FLR options

Land use	Land sub-type	FLR option	Description
Forest land Land where forest is, or planned to become the dominant land use ➔ Suitable for wide-scale restoration	Forest land is without trees (temporarily unstocked)	Planted forests & woodlots	Planting of trees on formerly forested land. Native species or exotics and for various purposes, fuelwood, timber, poles, fruit production, etc.
		Natural regeneration	Natural regeneration of formerly forested land. If the site is heavily degraded and no longer has seed sources, planting will be required
	Degraded forests	Silviculture / sustainable forest management	Enhancement of existing forests and woodlands of diminished quality and stocking, e.g. by managing pressures (fire, grazing) & silvicultural interventions
Agricultural land Land which is being managed to produce food ➔ Suitable for mosaic restoration	Land is under permanent management:	Agroforestry	Establishment & management of trees on agricultural or pasture land (planting or regeneration), to improve crop productivity, provide dry season fodder, increase soil fertility, enhance water retention, etc.; includes silvopastoral systems
		Integrated soil fertility management	Soil regenerative practices, such as no-till farming, planting of cover crops during fallow periods, planting nitrogen-fixing species, use of fertilizer, etc.
	Land is under intermittent management:	Improved fallow	Establishment and management of trees on fallow agricultural land to improve productivity, e.g. by fire control, extending the fallow period etc.,
Protective land and buffers Land vulnerable or critical in safeguarding ➔ Suitable for mangrove restoration, watershed protection and erosion control	If degraded mangrove:	Mangrove restoration	Establishment or enhancement of mangroves along coastal areas and in estuaries
	If other protective land or buffer:	Watershed protection and erosion control	Establishment and enhancement of forests on very steep sloping land, along water courses, in areas that naturally flood and around critical water bodies

Source: Adapted from IUCN & WRI (2014), page 39

Appropriate FLR activities are always context-specific; an activity that is considered to be restorative in one geography may not be FLR in different contexts. The level of degradation, current economic activities, biophysical factors, and other factors will determine which FLR activities are appropriate. If a ROAM assessment has been completed, it will have analyzed the suitability of different FLR activities in the target geography. If a ROAM assessment has not been completed, the user should ensure that activities are technically feasible in the proposed areas.

3.1.3 Map beneficiaries and other stakeholders

As a next step, beneficiaries and other stakeholders should be mapped. Stakeholder mapping is an important part of any decision-making process, but it has a specific purpose in determining the costs and benefits of an FLR investment: it is critical to define stakeholders by the costs that they assume and the benefits that accrue to them.

Table 2 describes potential stakeholders, and the relevant costs and benefits.

Table 2: Stakeholder types

Stakeholder type	Potential costs	Potential benefits
Public sector	▪ Directly purchase, lease, or subsidize land, materials, equipment, and labor ▪ Fiscal incentives for improved land use or commodity produced	▪ Increased tax collection ▪ Political support
Land owners or private sector companies	▪ Purchase or lease land, materials, equipment, and labor ▪ Opportunity cost of current land use	▪ Increased production and/or prices ▪ Improved local ecosystem services unrelated to production ▪ Reputational benefits
Community members not owning land	▪ Opportunity cost of current land use ▪ Labor	▪ Employment opportunities ▪ Higher supply of forest or agricultural products ▪ Improved local ecosystem services unrelated to production
Commodity offtakers	▪ Price premium or other subsidy for commodities produced under FLR system	▪ Improved access to supply ▪ Price premium from own customers ▪ Reputational benefits
Global / regional community	▪ Taxes contributing to FLR investment	▪ Climate change mitigation ▪ Improved water management, reduced soil erosion, or ES that benefit people outside of the project area ▪ Biodiversity benefits

3.1.4 Which benefits are measured and from whose perspective

Next, the user should decide on the perspective of the analysis and the costs and benefits to be measured, and the benefits that should be included. A cost-benefit analysis can be done from the perspective of any number of actors: a private investor, a community, a political jurisdiction, a country, or even the global community.

A financial analysis takes a narrow perspective than an economic analysis, i.e. typically a private sector entity implementing the investment.

Table 3 summarizes the differences between financial and economic analysis. Costs and benefits are restricted to the financial flows that actually materialize, such as upfront and management costs, increased revenues from products sold, and any fiscal incentives from the public sector.

Benefits from ecosystem services can be included in a financial analysis, but only those that will affect the cash flows of the business, e.g. reduction in soil erosion that lead to improved agricultural productivity and higher revenues from agriculture. Many ecosystem services benefits will be excluded. Carbon benefits, for example, should only be included insofar as carbon credits could be sold to a buyer.

Economic analysis, on the other hand, is much broader. Such an analysis is more appropriate when a public sector entity is making an investment, as they have an interest in understanding the diverse costs and benefits of a particular FLR activity. The scope of stakeholders can be adjusted depending on the purpose of the analysis, often set at a communal, jurisdictional, or global level. Ecosystem services need not be commercialized in order to be included; benefits from climate change mitigation relate to the social good of mitigating climate change rather than the private benefit of selling carbon credits.

Another important distinction is that an economic analysis should carefully account for transfers between stakeholders. For instance, a fiscal incentive provided to a private company by a government entity is included in a financial analysis, but is a “net zero” in an economic analysis since the company benefits as much as the government entity has increased costs.

Table 3: Differences between financial and economic analyses

Financial analysis	Economic analysis
▪ Perspective of single actor ▪ Costs and benefits with commercial value to that actor ▪ Cash flows in and out of an entity ▪ A tool for private investment decision-making	▪ Perspective of multiple actors ▪ Costs and benefits with benefits to any actor included in analysis, measuring total economic value ▪ Economic (i.e. not only cash flows) benefits ▪ A tool for public investment decision-making; can aid private decision-making as well

Having decided on the perspective of the analysis, the user must next determine the types of benefits that will be measured. The Millennium Ecosystem Assessment (MEA, 2005) places ecosystem services into four broad categories: supporting, provisioning, regulating, and cultural (Table 4). This framework is critical for integrating ecosystem services into cost-benefit analyses as it takes an anthropocentric perspective on the goods and services provided by ecosystems. Monetizing benefits from an FLR investment is inherently an anthropocentric activity. There are values and benefits, especially from biodiversity and but also some ecosystem services, beyond what benefits humans and cannot be monetized.

Table 4: Overview of different ecosystem services categories

<u>**Supporting services, e.g.:**</u> ▪ Nutrient cycling ▪ Soil formation ▪ Primary production	<u>**Regulating services, e.g.:**</u> ▪ Climate regulation ▪ Flood regulation ▪ Disease regulation ▪ Water purification
<u>**Provisioning services, e.g.:**</u> ▪ Food ▪ Fresh water ▪ Wood and fiber ▪ Fuel	<u>**Cultural services, e.g.:**</u> ▪ Aesthetic ▪ Spiritual ▪ Educational ▪ Recreational

Any analysis that measures the total economic value (TEV) of an investment attempts to estimate and monetize *all economic impacts* of an investment. TEV recognizes that benefits and costs radiate far beyond the landowner or investor – from neighboring properties all the way to global impacts.

The private level measures financial benefits to the investor or landowner where the investment is being made. Estimating financial benefits should consider the effect of ecosystem services on cash flows. For instance, expected changes in water flows will have a large impact on a business that is highly dependent on water. There may be other private benefits, such as status or prestige, which are difficult to monetize.

The community or national levels imply a wider range of costs and benefits. Most easy to monetize are direct financial benefits, such as changes in tax collection by local or national governments and changes in local incomes. Reduction in soil erosion, increase in pollination services, increase in tourism revenues, and others are the result of biophysical changes on the affected land that spill over onto neighboring land. These benefits are more difficult to estimate because of challenges in modelling biophysical changes, but are still important to attempt to monetize in many projects.

At the global level, the primary benefits are from climate change mitigation and from promoting biodiversity, which underpins all other ecosystem services. Climate benefits are relatively easy to monetize; the end beneficiary is all humans that are impacted by climate change.

Another consideration in determining relevant indicators is that the methodologies for monetizing ecosystem services can be time-consuming and expensive to implement. Certain ecosystem services are difficult to monetize. Supporting services typically have no direct monetary benefit; rather they contribute to a healthy ecosystem that enables the supply of other ecosystem services. Provisioning services tend to be the simplest to monetize because they are associated with commodities that often have a market value. Regulating services are more difficult to monetize, but depending on the FLR investment, can also have an important contribution to the project. Finally, cultural services are typically the most difficult to monetize as their value would need to be derived from a number of indirect methods, and the results may not adequately reflect their importance.

The cost of measuring a particular ecosystem service should be weighed against the importance of that service to the FLR investment. Water purification services, for example, can be quite difficult to model and monetize. However, if water purification is a primary objective of the FLR investment, then this ecosystem service should likely be included, despite the cost.

Not all benefits can be monetized; however, they can still be tracked and included in the cost-benefit analysis. For instance, benefits such as increased political support, employment generation, or improved biodiversity are difficult or impossible to monetize, but should be factored into decision-making.

3.1.5 Define scenarios

Finally, based upon the above steps, scenarios should be defined. Scenarios may already have been developed under a ROAM assessment. These scenarios should be revisited to ensure that they are realistic as cost-benefit analyses are time-consuming and expensive. A scenario should define the following: activities, stakeholders, time horizon, area of intervention, type of analysis (whether financial and/or economic), and whether the analysis should be spatially-explicit or not.

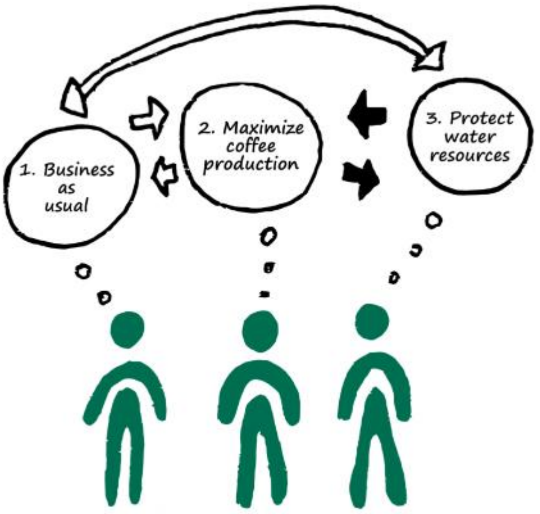


Figure 5 describes an example of simple scenarios for a hypothetical FLR investment.

This methodology constructs scenarios based on one-hectare models. If, for example, establishment of coffee agroforestry systems is identified as an activity, the user should build a one-hectare model for coffee agroforestry systems that defines benefits and costs. A scenario will define the area on which each activity will be implemented, with costs and benefits then scaled up to the entire project area based on the one-hectare model. If a spatially-explicit analysis is required, spatial differences will then be accounted for.

Figure 5: Scenario example

Example project: private investment of combined timber and coffee agroforestry systems on 1,000 ha of degraded cattle pastures in Guatemala:

- Financial analysis from perspective of company purchasing land and implementing activities
- Economic analysis including local community, government, downstream water users, and global community as stakeholders
- 25-year time horizon chosen to reflect life of coffee plantation
- Spatially explicit in order to account for water and soil erosion reduction benefits

Baseline scenario:

- 500 ha of currently degraded land used for extensive cattle grazing
- 250 ha of secondary forests converted to pasture for extensive cattle grazing
- 250 ha secondary forests further degraded from fuelwood collection activities

Coffee producing maximizing scenario:

- 500 ha of currently degraded land converted from cattle grazing to combined timber and coffee agroforestry systems
- 250 ha of highly degraded secondary forests planted with low density coffee plants
- 250 ha of less degraded secondary forests protected and regeneration facilitated

Soil erosion reduction maximizing scenario:

- 250 ha of currently degraded land converted from cattle grazing to combined timber and coffee agroforestry systems
- 250 ha of currently degraded land with high potential for reducing soil erosion converted from cattle grazing to protection and planting with native species
- 500 ha of degraded secondary forests protected and regeneration facilitated

An important scenario to include is the baseline scenario, or the expected land use given no intervention. Establishing a baseline creates a reference point to which to compare the alternative investment scenarios; the difference between the baseline scenario and alternative scenario can be seen as the costs and benefits of inaction. The baseline scenario should be as dynamic as possible and project how land use would change without the FLR activity.

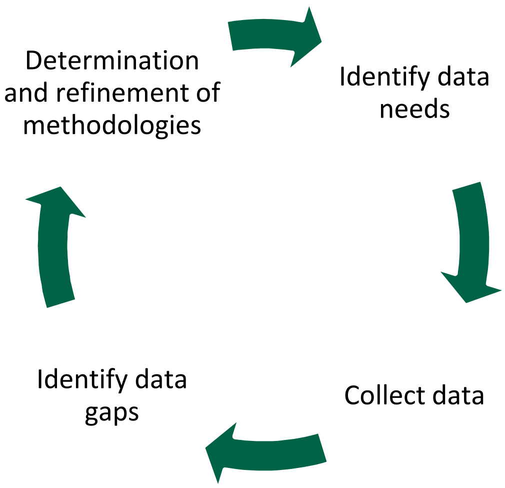
Finally, scenarios should elaborate the amount of time that the costs and benefits are modeled – the time horizon. On the one hand, FLR investments generate benefits over a long period and extending the time horizon of the analysis will enable the user to capture all benefits of the investment. Long time horizons are especially appropriate for economic analysis that consider the public benefits of global public goods that take a long time to materialize, e.g. carbon sequestration. On the other hand, a long time horizon increases the uncertainty of the analysis, as the user will have less confidence about the flows of costs and benefits far in the future (WRI; IUCN, 2014). These two factors should be balanced.

Foto: Multiple use landscape.

3.2 Step 2: Model costs and benefits

Steps 2 and 3 are laid out as distinctive steps, but, in practice, moving between Steps 2 and 3 is likely to be an iterative process (Figure 6). The user must first determine appropriate methods for estimating costs and benefits. Data needs can then be determined and collected. It is likely that not all data are available from primary sources. In this case, the user will need to determine whether benchmark data can be used to fill in these gaps. If not, monetization methodologies may have to be refined and data recollected.

Figure 6: Moving between modeling and data collection



This methodology proposes to use 1-hectare models that can be scaled up according to the identified scenarios. In the case of the hypothetical FLR case in Guatemala (Table 5), for example, 1-hectare models need to be developed for the following land use types:

- extensive cattle grazing on degraded land,
- extensive cattle grazing on converted secondary forests,
- fuelwood collection from secondary forests, establishment of timber and coffee agroforestry systems on degraded land,
- establishment of low density coffee in secondary forests,
- protection and ANR of secondary forests, and
- active restoration of degraded cattle land.

A critical aspect of modeling costs and benefits is to carefully track *from which actors* costs are being invested and *to which actors* benefits are flowing. The cost benefit model should delineate costs and benefits individually for each group of stakeholders involved in the analysis. A TEV to estimate costs and benefits for all groups may also be calculated, and distinguishing between stakeholders will also be critical for an analysis of distribution of benefits.

Table 5: Example summary of costs and benefits by beneficiary type (US$, per ha)

	Investment costs	Revenues from coffee, cattle, timber, and fuelwood (minus taxes)	Tax revenues	Climate change mitigation	Soil erosion reduction benefits
Land owners in project area	(1,000)	4,000	0	0	200
Downstream land owners (e.g. hydroelectric provider)	(200)	0	0	0	500
Guatemalan government	(1,000)	0	500	0	0
Global community	0	0	0	500	0
Total	**(2,200)**	**4,000**	**500**	**500**	**700**

At its core, determining economic value for any particular time period is a function of "price * quantity." Each cost will be calculated by estimating the amount of an input that is needed and the price of one input. Conversely, benefits will be estimated by determining the quantity of outputs that is produced and the value of one output. The following sub-sections give guidance on how price and quantity can be determined for different ecosystem service types.

The user should take care not to double count costs or benefits from ecosystem services, in particular when adding costs and benefits across different actors to calculate TEV. In the example above, there is risk of double counting benefits from revenues from coffee, cattle, timber, and fuelwood production and tax revenues going to the Guatemalan government. The user can track costs and benefits for multiple users, but they should not be added together if there is double counting. Double counting is a risk when monetizing ecosystem services because one can count both ecosystem service processes and end benefits, which are connected to one another (Balmford et al., 2008). Under the MEA framework, for instance, one can count benefits from both pollination itself and the resulting increase in food production.

A final issue to take into account is the high level of uncertainty that is often associated with estimating costs and benefits in an FLR investment. There are methods of analyzing the impacts of uncertainty, described during Step 4, but uncertainty also needs to be considered during data collection through two means. First, when collecting data, the user should estimate the level of confidence in a particular data point and, if confidence is low, describe a possible range that the data could fall under. Second, the authors recommend to use a principle of conservativeness in selecting data: cost estimates should err toward the high side, while yield and price estimates should err toward the low end.

3.2.1 Calculation of costs

Broadly speaking, costs can be split into capital expenditures (CAPEX), operational expenditures (OPEX), and working capital. CAPEX items are typically durable goods that a company will use for more than one year. CAPEX includes, for example, the purchase of land, perennial seedlings, equipment, or infrastructure. OPEX, on the other hand, is expenses for goods or services that are used during one year and are often related to the management and maintenance of the investment. This could include, for example, hiring labor to prune a restored area. Working capital is directly related to short-term expenses for the purchase and sale of goods and is most relevant for companies that buy an unfinished product, add value, and then sell the product. Regardless of CAPEX, OPEX, or working capital, expenses should be delineated according to the time in which they are purchased, with initial investments starting in year 0.

Costs need not only include financial contributions. In kind contributions, particularly labor and land, should be incorporated into the cost benefit analysis even if they do not result in direct expenses.

3.2.2 Provisioning services

Provisioning services are goods from agricultural, forestry, and other sectors that can be produced for subsistence or for commercial sale. The value of goods can be incorporated into cost-benefit analysis even if they are used for subsistence and not sold at markets. Value is determined by estimating the quantity of a product produced and multiplying by the expected price.

3.2.2.1 Quantity

Quantity is determined by modeling the productivity of an FLR activity. In many conventional agricultural and forestry production systems, only one product needs to be modeled (e.g. tons of wheat). However, in particular in landscapes with multiple production models, all relevant products should be modeled (e.g. timber and coffee in agroforestry systems).

Productivity per hectare can be based on experience with production systems in similar agro-ecological zones and other conditions, ideally from nearby the proposed site. The production models should be tightly linked to the cost model. The density of planting is closely tied to both productivity and costs. For instance, 100 coffee plants per hectare is likely to be cheaper, but less productive than planting 1,000 coffee plants per hectare. As much as possible, productivity assumptions should take into account changes that are expected to occur through other activities supported in the FLR investment. If, for example, one FLR activity will increase pollination services the productivity of other FLR activities may increase.

3.2.2.2 Price

Provisioning services are typically the easiest services to value. There are two different prices that can be used for a given commodity, depending on whether the user is conducting a financial analysis or an economic analysis. In the case of a financial analysis, the user is interested in the revenues that will accrue to a specific actor, and therefore market prices should be used for goods sold to customers. If goods are commodities that are sold on international markets, these market prices should be used. If goods are expected to be sold in local markets or via negotiated purchase prices, more research will be needed to properly estimate selling prices by, for example, speaking with potential customers. Prices for some commodities fluctuate predictably during the course of a year due to regular changes in supply and demand. In this case, the user should select prices that best reflect the expected time of sale; i.e. if the product is likely to be sold during a time of oversupply, when prices are low, the historical prices from times of oversupply should be used. Uncertainty about selling price should be accounted for in sensitivity modeling, as discussed in Section 3.4.2. Incorporating an inflation factor for prices (and for costs) is appropriate when historical market trends make estimating an increase in prices reasonable.

Under an economic analysis, using market prices may or may not be appropriate. Government interventions – e.g. taxes, subsidies, tariffs – may distort market prices so that their economic value (the contribution of the good to society's welfare) is different from their financial value (the contribution of the good to one actor's welfare). If markets are significantly distorted, the user should develop "shadow prices" that distinguish between the two. Shadow prices remove government distortion of prices so they reflect a commodity's economic value (Beeli, Anderson, Barnum, Dixon, & Tan, 2001).

Two other methods are primarily used for determining the value of goods that are produced for subsistence or otherwise not sold to customers. First are replacement cost methods, which estimate the price of a produced good based upon the cost of purchasing it in markets. This is most appropriate if the produced good is similar to a good available in markets. Other appropriate methods are based upon stated preferences, which are determined by surveys of consumers on how much they value the good.

3.2.3 Valuation of selected ecosystem services

While the value of other ecosystem services is also calculated through the "price * quantity" equation as provisioning services, the methodologies used to determine price for regulating and cultural ecosystem services can be more complicated. There is often not a market price being paid for the service, so the user needs another way to estimate the price. Valuation methods for climate change mitigation and water services are provided below; Table 6 offers an overview of valuation methodologies. For a more detailed discussion on valuation methodologies, see (Defra, 2007; Pascal & Muradian, 2010; TEEB, 2010; Verdone, 2015).

Table 6: Valuation methodologies adapted from (Verdone, 2015)

Revealed preferences methods rely on determining prices from available data that demonstrate the economic value of a service. Market prices are an example of how prices can be revealed – the price paid for a consumer demonstrates the value of a good or service. Revealed prices can also be determined via indirect means. Travel costs incurred for a visit to a national park, for instance, show how much tourists value the cultural/recreational services provided by the park.	**Stated preferences** methods ask consumers of services, directly or indirectly, how much they value the service. This can be done through surveys, otherwise known as a contingent valuation technique.	**Benefit transfer** methods assume that a value estimated in one location is transferrable to another location. The user simply applies the valuation to the ecosystem service at question in their geography. Benefit transfer is much less costly, but can also be less accurate depending on how transferrable the value is.

3.2.3.1 Climate mitigation

Quantity

This methodology follows the approach of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Rypdal et al., 2006) and quantifies mitigation benefits from FLR activities in line with IPCC guidance, as follows:

$$E_{FLR,i} = EF_{FLR,i} * AD_{FLR,i}$$

Where E_{FLR} represents net emissions[4] from an FLR activity type i, $EF_{FLR,\,i}$ is an emission or carbon stock change[5] factor expressed in metric tons of carbon dioxide equivalent per unit of FLR activity i, and $AD_{FLR,i}$ is the quantity of the relevant activity performed, i.e. ha planted.

This equation should be separately estimated for the baseline scenario and a FLR project scenario. The baseline scenario represents the land use activities and net GHG emissions that would most likely have occurred in the absence of any intervention under FLR. The difference between GHG emissions in the two scenarios is the GHG mitigation benefit due to FLR implementation.

[4] Gross emissions (including all industrial activities, mostly fossil fuel combustion) minus carbon sinks from forestry activities and agricultural soils.
[5] Emissions or sinks of CO_2.

Table 7 summarizes the main direct GHG effects of common FLR options. The global benchmark column provides the reference level emissions per hectare per year for the activity. The area significance threshold describes the number of hectares needed to achieve 25,000 tCO_2.

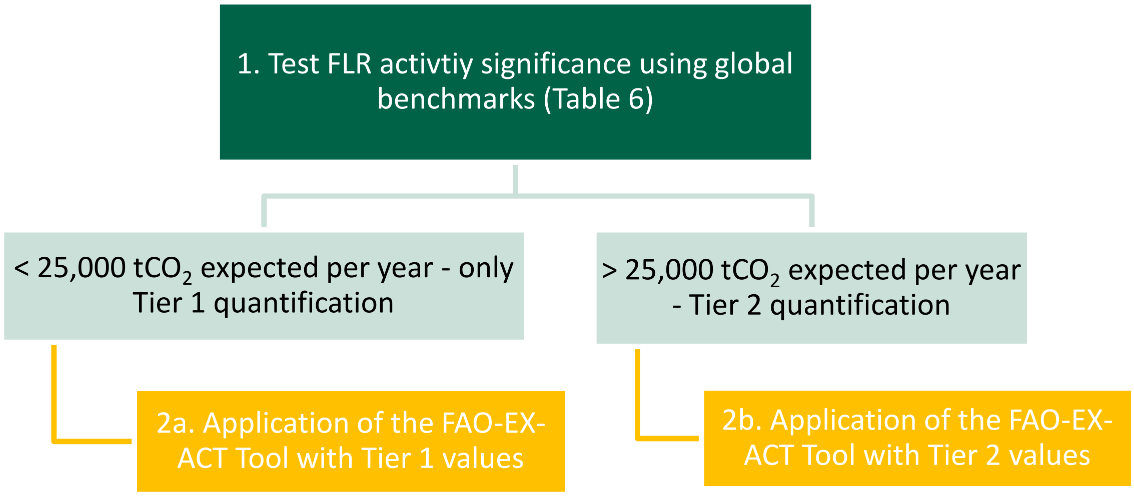
Table 7: GHG effects of common types of FLR activities

	Types of carbon mitigation activity promoted by FLR option	Main carbon pools and GHG sources	Global benchmark of $tCO_2\ ha^{-1}\ year^{-1}$ ($EF_{FLR,\ i}$)	Area significance threshold (25,000 tCO_2) in ha[6]
Planted forests & woodlots	Reduction in rate of deforestation	Above & belowground woody biomass (CO_2)	2.6	9,615
	Afforestation/ Reforestation	Above and belowground woody biomass (CO_2)	10.0	2,500
Natural regeneration	Reduction in rate of deforestation	Above and belowground woody biomass (CO_2)	2.6	9,615
	Assisted natural regeneration	Above and belowground woody biomass (CO_2)	9.0	2,778
Silviculture / SFM	Reduction in forest degradation	Above and belowground woody biomass (CO_2)	1.5	16,667
	Improved forest management	Above and belowground woody biomass (CO_2)	3.0	8,333
Agroforestry systems	Agroforestry with increased tree biomass	Above and belowground woody biomass (CO_2)	3.0 (complex system) – 7.0 (simple)	8,333 – 3,571
Improved fallow	Restoration of degraded land	Soil carbon (CO_2)	2.0	12,500
Soil restoration and management	Adoption of improved cropland management	Soil carbon (CO_2)	1.2	20,833
	Conservation farming practices	Soil carbon (CO_2)	1.2	20,833
	Improved nutrient management	Nitrogen in fertilizer (N_2O) & soil carbon (CO_2)	1.2	20,833
	Improved grassland management	Soil carbon (CO_2)	2.0	12,500
Mangrove restoration	Reduction in forest degradation	Above and belowground woody biomass (CO_2)	1.5	16,667
	Afforestation/ Reforestation	Above and belowground woody biomass (CO_2)	10.0	2,500
Watershed protection and erosion control	Agroforestry with increased tree biomass	Above and belowground woody biomass (CO_2)	3.0 (complex system) – 7.0 (simple)	8,333 - 3,571
	Reduction in forest degradation	Above and belowground woody biomass (CO_2)	1.5	16,667
	Adoption of improved cropland management	Soil carbon (CO_2)	1.2	20,833
	Assisted natural regeneration	Above and belowground woody biomass (CO_2)	9	2,778

[6] Area below which the activity will result in less than 25,000 tCO_2e sequestered / avoided.

The authors propose a step by step approach for quantifying GHG emission reductions. The 2006 IPCC Guidelines provide estimated emission factors at global or regional level, known as Tier 1 emission factors. Because these are general estimates, the values are associated with large uncertainty. If more precise estimates are needed, Tier 2 values can be used (Figure 7).

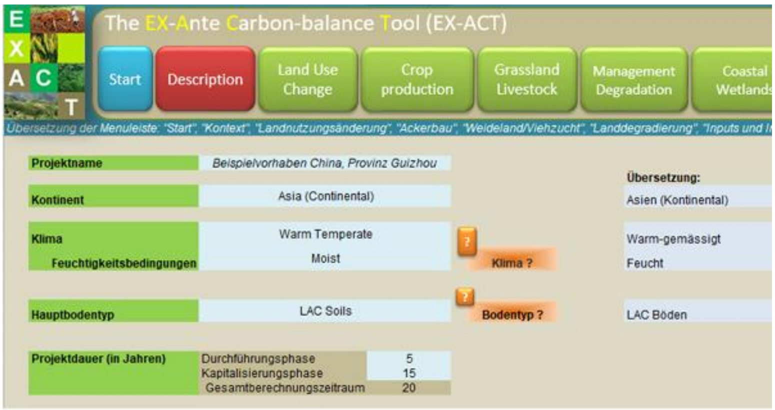
Figure 7: Step by step approach for quantifying GHG emission reductions



The first step is to get a sense of the potential scale for reducing emissions using global benchmarks. Multiply the hectare-specific emission factors from Table 7 above by the expected area with an FLR activity. Below an annual threshold of 25,000 tCO_2 per year, a simplified methodology is sufficient (Step 2a). Above 25,000 tCO_2 per year, there may be a need to follow a higher tier approach (Step 2b). For simplification, the minimum total ha of each FLR activity is also given in the last column of the same table, if the areas under any specific activity are expected to be higher than 25,000 tCO_2.

The FAO Ex-Ante Carbon-balance Tool (EX-ACT) is proposed to estimate FLR mitigation benefits. EX-ACT is a land-based accounting system in Excel, estimating CO_2 stock changes as well as GHG emissions per unit of land, expressed in equivalent tons of CO_2 per hectare and year. The strength of this tool is that it provides estimates for almost all possible FLR activities in one system, allowing the user to assess the impacts of all the different FLR activities. Further, this tool allows for ex-ante estimation (before FLR activity implementation) as well as for ex-post estimation (during or after FLR activity implementation). The Ex-Act Tool is built in different modules with the first modules (context modules) required for calibrating the tool to the specific locations and environmental conditions of the FLR activity subject to assessment (Figure 8).

Figure 8: Context modules to calibrate the tool to location conditions of the FLR activity



Then, the tool is divided into different land use modules, from which those that represent the different FLR activities need to be selected and operated. Figure 9 summarizes the different land use modules.

Figure 9: Selection chart of EX-ACT land use modules based on the specific FLR activity types

First question to answer: what is the type of project?		Modules to be used
IF... Sustainable intensification project	*Go to* →	Crop Production & Inputs
IF... Livestock project	→	Grassland & Livestock
IF... Watershed project	→	Afforestation/ Reforestation
IF... Forest Management / Forest conservation	→	Land Use Change
IF... Irrigation project	→	Inputs & Crop production
IF... Land use change project	→	Land Use Change
IF... other Multi-objective projects	→	See next
Second question: Which other modules are needed based on project actions?		**Modules to be used:**
All project types	**Specific positive or negative effects occurring with or without project?**	
	IF deforestation/afforestation with or without project ○ For expanding agriculture area or pastures ○ Additional land areas planted with forest → *Go to*	Land Use Change
	IF degraded land transformed in annual crops or pasture land **IF** annual crops switched to perennials, pastures **IF** agriculture land transformed in other land →	Land Use Change
	IF Inputs used and energy consumed →	Inputs & Investment
	IF Drainage of organic soils →	Land Degradation
	IF Investment in buildings, roads, storages →	Inputs & Investment
	IF Irrigated areas rehabilitated with improved systems →	Inputs & Investment
	IF Degradation or improvement of existing pastures →	Grassland & Livestock
	IF Increased annual crop areas with manure – compost use →	Crop Production & Inputs
	IF Degradation or improvement of forestry areas →	Land Degradation
	IF Improved techniques in annual crops ○ stop burning residue, compost, terracing… →	Crop Production
	IF Inputs consumed in value chain processing, transport →	Carbon Footprint functionality (see annex)

Source: (Bockel, Louis; Grewer, Uwe; Fernandez, 2013)

To use and run the EX-ACT tool, the following references should be downloaded and used:

- Guidance for standardized GHG Assessment of Agriculture, Forestry and Oher Land Use (AFOLU) Projects.[7] This guidance document provides a comprehensive overview of GHG accounting best practices (ex-ante as well as ex-post) in the land use sector on a level of detail which represents a Tier 2 approach. Therefore, this document should be seen as an overall methodological guidance framework for assessing mitigation impacts in particular for FLR activities under the Tier 2 approach.
- Excel FAO EX-ACT Tool.[8]
- Quick user guidance (multi-lingual).[9] The Quick Guidance provides a well-founded and concise overview of methodology, data needs, application and final use of EX-ACT.

Price

Having determined the number of tons of GHGs that will be removed or added to the atmosphere, the user must decide on how to value climate change mitigation. There are three separate ways to incorporate the benefits of climate change mitigation in a cost-benefit analysis.

- Consider the number of tons to be reduced and not place a monetary value on the climate change mitigation contribution. This approach is more relevant for a country that is trying to meet its Nationally Determined Contribution (NDC) commitments, or a firm that would like to understand its CO_2 impact for corporate social responsibility purposes.
- If an FLR activity is going to generate significant amounts of verifiable carbon credits for sale, a market assessment should be used to estimate a reasonable sale price. It is important to note that many carbon developers are not able to find buyers for their credits. In 2016, credits equivalent to 63 Mt of CO_2 were traded in carbon markets; a full 56 Mt of credits were not sold (Hamrick & Gallant, 2017). Carbon prices are historically difficult to predict. Thus, any valuation should take a conservative approach and optimally – until carbon markets have stabilized – investments should be viable without depending on income from carbon credits.
- Another approach is to value mitigation benefits based on the social good provided by the avoidance or sequestration of GHG emissions. Climate change is causing economic damage and is expected to continue doing so. The UNDP estimates, for example, that 2.5 degree Celsius warming will result in global losses of US$ 21 trillion by 2050 (UNDP, 2016). Based on this estimated damage, a social cost of carbon – or the economic losses caused by each ton of CO_2e – can be calculated. Estimates of the social cost of carbon vary significantly depending on the severity of damage predicted. The World Bank Group uses a range between US$ 40-80 in 2020 and a range of US$ 50-100 by 2030 (World Bank, 2017). Valuing the social cost of carbon is necessary if a user would like to calculate the TEV of a project, but this is not necessary for many decision-making cases.

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[7] http://www.fao.org/fileadmin/templates/ex_act/doc/EX-ACT_MRV_Guidelines-lb-20_1_2016.pdf
[8] http://www.fao.org/tc/exact/carbon-balance-tool-ex-act/en/
[9] http://www.fao.org/tc/exact/user-guidelines/en/

3.2.3.2 Water and avoided erosion

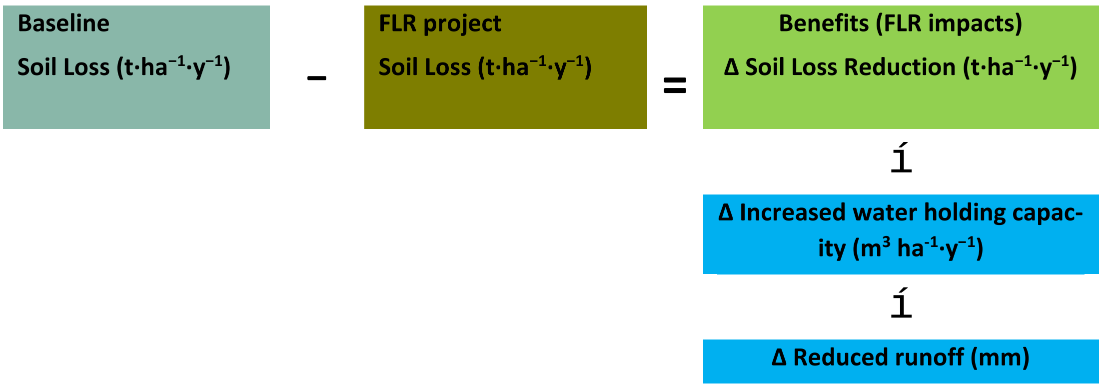
Quantity

To estimate the reduction of top soil erosion, increased water availability, and the reduction of water runoff from FLR interventions, a proxy based method is proposed. This method was developed to assess water impacts based on land use level activities, with soil loss used as a proxy to estimate changes in water storage and average available soil water. The methodology can be applied on a per hectare level; the assessment can be spatially up-scaled by considering the aggregated areas within the total landscape. The assessment is comparing the baseline scenario with the project scenario when FLR land use activities and practices are adopted.

Top soil erosion

The project minus the baseline are the erosion impacts, as shown in Figure 10.

Figure 10: Overview of calculation to measure soil loss change



In the methodology, soil loss is calculated using the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE). The USLE model incorporates the main components of soil loss from erosion, which can predict the changes in water storage i.e. the per cubic meter water content within a given area soil. The USLE model has become the most widely used empirical soil erosion model globally. The RUSLE 2015 model introduces some improvements to each of the soil loss factors. The equation is represented as

$$A = R \times K \times LS \times C \times P:$$

Where A is represented as the long term average annual soil loss in tons per hectare per year ($t \cdot ha^{-1} \cdot y^{-1}$), R is the rainfall and runoff factor, K is the soil erodibility factor, LS is the slope length factor, C is the crop management and vegetation factor, and P is support practice factor.

Soil water availability

Aside from erosion, one can also measure the change in water availability. The increase in water storage capacity in the soil is linked to increase or stabilization of topsoil (i.e. reductions in soil loss as a result of SALM implementation), which affects the soil water[10] availability. Soil classification is used to estimate the percentage of water holding capacity.

In order to estimate the total available water (TAW), one converts the metric for soil loss into water availability (i.e. $t \cdot ha^{-1} \cdot y^{-1}$ to $m^3 \cdot ha^{-1}$ soil water). The change in soil water storage is not directly measurable because it can change quickly depending on the climatic conditions. Therefore, the authors use a conservative approach that gives us an estimation of the TAW within a given soil classification.

In order to convert $t \cdot ha^{-1} \cdot y^{-1}$ soil to $m^3 \cdot ha^{-1}$ water availability, simple factors can be used:

-1 m^3 of top soil = 1.5 tons of top soil (taken as average from major soil textures)

-1 ton of top soil = 0.7 m^3

Given this conversion, as well as knowing the total available water percentage based on the soil classification,[11] (i.e. 20% volumetric soil moisture content for clay soils), the user can calculate the average amount of available top soil (saturated zone) water in m^3.

Runoff

The runoff coefficient provides an estimation of watershed level runoff and runoff reductions as a percentage based on land use changes. The runoff coefficient is best suited to larger regional areas based on average annual precipitation and runoff data. The user can predict overall reductions in sedimentation and siltation as a percentage within a project boundary. To apply the runoff coefficient expressed as a change in land use, the user calculates runoff as a separate factor with the formula. In table 8 below, a stepwise procedure is shown, explaining how to calculate runoff (K) using the Curve Number Method.12 In the formula, runoff is arbitrarily expressed as Q, however once the value is determined using the curve number method, we consider Q = K for consistency within the use of this manual and succeeding formulas. Once the value for runoff has been determined, the user can determine the runoff coefficient as a percentage, based on shifts in land-use and cultivation.

[10] Soil water refers to the water found in soil, i.e. the level of soil moisture.
[11] https://nrcca.cals.cornell.edu/soil/CA2/CA0212.1-3.php
[12] http://www.esf.edu/ere/endreny/GICalculator/TR55.pdf

Table 8: Runoff curve number method

Factor	Q as an expression of runoff
Data Unit	Inches (in)
Description	The runoff curve number method is used to calculate runoff at the watershed level based primarily on factors related to soil and cover. The curve number method is expressed in the formula below: $Q = \frac{(P - 0.2S)^2}{P + 0.8S}$ Where: Q = Runoff in (in) P = Rainfall in (in) S = Potential maximum retention after rainfall begins (in) Through many studies on agricultural watersheds, initial abstraction (I_a) gives approximate values for the empirical equation above (i.e. 0.2S and 0.8S) S is related to soil and cover conditions within the watershed through a curve model CN; CN is a value ranging between 0-100. S is expressed in the formula below in inches: $S = \frac{1000}{CN} - 10$ Once a value is determined for S, it can be used to determine the total amount of runoff at the watershed level. The values for CN are empirically derived based on soil and cover and have been listed within a table format for long list of CN values and how to calculate them based on area of watershed).
Source of Data	Soil Conservation Service Curve Number (SCS-CN) Methodology Handbook
Comments	Once a value has been determined in inches, simply convert to metric; *inches to mm (1 inch = 25.4 mm)*

Table 9: Runoff Coefficient

Factor	K as an expression of total runoff
Data Unit	Millimeters and total percentage (%)
Description	To assess either the annual (for perennial crops) or the seasonal runoff coefficient. This is defined as the total runoff observed in a year (or season) divided by the total rainfall in the same year (or season). The runoff coefficient is expressed in the formula below: $K = \frac{Yearly(seasonal)TotalRunoff[mm]}{Yearly(seasonal)TotalRainfall[mm]}$ Where: K = Total annual runoff expressed as the ratio (percentage) of catchment to cultivated area.
Source of Data	Local meteorological databases

Price

The costs and benefits of reduced soil erosion, increased soil water availability, and reduction in runoff can be measured through their impact on economic activities. Soil quality is related to agricultural productivity, for example; soil water availability and runoff impact agricultural productivity and sectors that use large quantities of water, such as hydroelectric power generation, municipal and private water providers, and others. Valuing soil erosion and increased water availability is typically centered on the change in economic output in those activities.

The "replacement cost" method estimates the cost of obtaining the same result through another means. For instance, hydroelectric dams often have reservoirs, which are impacted by soil erosion through the collection of sedimentation in the reservoir. If sedimentation is too high, it affects water flow and the hydroelectric operator is forced to pay for dredging services to remove the excess soil. A replacement cost method would value the reduction in soil erosion from FLR activities at the cost of dredging the same quantity of sedimentation from the reservoir.

An alternative is to estimate the increased value that the service brings to an economic activity. For instance, it is reasonable to expect that reduction in erosion will boost agricultural output. The value of reduced soil erosion is tied to the increase of agricultural provisioning services.

3.2.4 Employment

Assessing employment impacts in the cost-benefit analysis adds a special focus on people's lives. From a societal point of view, earnings from employment are often the most important driver of poverty reduction, addressing the SDGs. For groups of individuals affected by the investment, positive or negative employment impacts can be significant. The heterogeneity of employment types (e.g. direct/indirect, self/dependent, formal/informal, permanent/temporary, etc.) and job attributes (e.g. hours, skill-level, payment, provision of benefits, target population, etc.) lead to complex and data intensive assessment methods. In order to be time and cost-effective, the proposed methodology is a stepwise approach that incorporates quantitative data drawn from other measures of the CBA and adds an additional qualitative assessment.

Step 1: Quantify employment effects

The total costs of labor should be known from an economic feasibility study and included as a line item in an investment proposal's use of funds. The total amount of paid for labor during the project period can be divided by the average wage for the project to derive an estimate of employment impact.[13] For more thorough investigation of employment impacts the actual working hours for restoration, maintenance and harvesting have to be derived from empirical studies suitable for area and type of FLR investment (Kluve & Stoterau, 2014).

To estimate indirect employment effects that are related to the value addition of raw materials produced, the basic product value chains have to be described. The value chains can either be product specific (e.g. milk for local dairy industry, round wood for electricity poles) or sector specific (e.g. sawn wood, fuelwood, pulpwood/industrial wood for boards and panels).

[13] For more information see: https://data.oecd.org/earnwage/average-wages.htm

Once the product value chains are described, specific data collection needs should be identified. The goal of data collection is to estimate the number of jobs related to product values (i.e. how many jobs are created per an amount of product). For product related value chains, data are based on existing business cases (e.g. collect data on number of employees in dairy and amount of milk processed in dairy per year). When the user derives data from businesses, he or she should relate to a comparable level of technology used in the processing. For sector specific value chains, statistical data may be available. For instance, in the Ethiopia Forest Sector Review, employment is covered as full-time-equivalent per 1,000 m^3 intake of wood in different sectors: 8 full time employment (FTE) in wood industry (sawmilling and panels), 20 FTE in furniture, 6 FTE in pulp and paper (Ministry of Environment Forest and Climate Change, 2017). If information is not available, national statistics have to be analyzed to calculate value creation within a sector, the intake of raw material and the sector (or national) average FTE per GDP contribution.

Step 2: Evaluate qualitative impacts on sectors and stakeholders

Investments in FLR may have both positive and negative employment impacts. Especially in countries transitioning from middle to high income, investments may replace labor with capital (Basnett & Sen, 2013). Social values of jobs like safety, social identity, and gender equality should be considered (International Labor Organization (ILO), 2017).

In an ex-ante evaluation, positive and negative potential impacts on selected target groups can be assessed qualitatively:

- Define the boundaries of qualitative assessment along the value chain (e.g. sourcing of plants, establishing site and maintenance, harvesting, transport, first processing).
- Assess potential positive and negative impacts compared to base scenario (e.g. investments including technical equipment like a harvester will reduce labor demand significantly, but also determine a safer and healthier working environment).The next step is to define special target groups. Beneficiaries and stakeholders are identified in the first step of the cost-benefit analysis. Assess potential positive and negative impacts related to the FLR investment, compared to base scenario.

A qualitative assessment of employment impacts can be collected in a simple matrix. Table 10 illustrates how to map positive and negative impacts along the investment value chain and for target groups.

Table 10: Example of qualitative employment impacts

Target groups	Positive impacts	Negative impacts
Women	Increase in work in nurseries	Gender discrimination means that women may be excluded from work from other activities
Untrained	Significant work opportunities in forest plantations	Work is challenging and not highly-paid
Highly educated	Increase in technical, management positions	Compared to untrained labor opportunities, few new opportunities for highly-educated
Youth	Small increase in jobs for youth	

3.2.5 GDP and tax contributions

The macroeconomic implications of an FLR investment can also be included, particularly their impact on GDP and tax revenues. It is important to note that neither GDP nor tax revenues should be included in the net value calculation of a project that are used to estimate the project's total economic value. Taxes represent flow of resources from one party to another and are thus a net zero in terms of total economic value created.

GDP is the total economic output of a given jurisdiction, most often calculated at the country level. The contribution of a specific investment to a country's GDP can be estimated; this is only a helpful calculation to make in the case of large investments. In addition to the GDP contribution of the investment itself, an investment is likely to have significant indirect contributions to GDP, for instance through increasing consumer spending or encouraging growth in downstream sectors. In order to estimate indirect impact on GDP, a multiplier can be used; e.g. for every US$ 1 of investment, GDP increases by US$ 5. The multiplier is equal to: 1 / (1 – the marginal propensity to consume). The marginal propensity to consume should be drawn from country economic data. If more accuracy is needed, a marginal propensity to consume can be estimated on a regional or other jurisdictional basis.

Most investments will also increase a jurisdiction's tax revenues. To estimate change in revenues, a thorough analysis of the relevant tax policies (at national, state, and local levels) must be completed in order to understand all relevant taxes. All tax policies, including capital gains tax, income tax, foreign investment tax, payroll tax, and sales tax, should be accounted for.

3.2.6 Opportunity costs

Opportunity costs represent the costs and benefits of activities that would have taken place if the FLR investment did not take place. For example, if a degraded pasture land was not reforested, it would have continued to provide grazing area to cattle and therefore income to the cattle owner. Opportunity costs are important to include as it allows the user to compare different investments and understand the full costs and benefits of an investment.

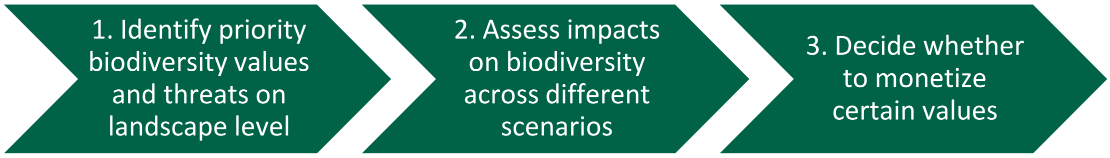
Under this framework, opportunity cost is accounted for by developing a business as usual scenario. The business as usual scenario should estimate all of the costs and benefits that would accrue without the proposed investment, as well as can be predicted. If an FLR investment restricts economic activities in a particular area, then the business as usual scenario should include the forgone revenues or other benefits that actors would have received.

3.2.7 Biodiversity

Biodiversity is defined by the Convention on Biological Diversity as "the variability among living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD 1992). Biodiversity is the underpinning for ecosystem services. Attempts have been made to translate global biodiversity and associated ecosystem services into economic values, e.g. (Costanza et al., 1998). Attempts at monetization typically result in values that underestimate the importance of biodiversity or result in values that are not convincing to decision-makers. However, that does not mean that the importance of biodiversity should be removed from decision-making processes. Instead of valuing biodiversity in economic terms, the authors propose that impacts on biodiversity be considered through a risk and opportunity approach. In specific cases where certain biodiversity values are easily linked to specific ecosystem services (e.g. tourism values) there may be scope for some valuation.

Figure 11 provides an overview of the approach proposed to assess biodiversity values in the landscape, identify opportunities, and mitigate threats to biodiversity. A full methodology for assessing biodiversity values can be found in Annex 3.

Figure 11: Step-wise approach for biodiversity assessment



3.2.8 Tier 3 analysis: Incorporating spatially-explicit data

Tier 1 and Tier 2 analysis rely on one-hectare models that do not vary according to specific conditions within that hectare. For many purposes, this level of detail is sufficient to provide the user with an adequate level of confidence about the results. However, in other cases, it may be necessary to increase the accuracy of the results by adjusting the one-hectare models depending on local conditions. Within a large project area, conditions can vary substantially, with significant effect on the ecosystem function.

In order to incorporate precise local conditions and modify the outputs of the one-hectare model, users should divide or stratify the project areas into smaller units with shared characteristics. Stratification is a tool for minimizing sampling errors and increasing precision. The principle behind stratification is to group project implementation areas into relatively homogenous units. This reduces the sample size required to meet defined precision levels. There is no rule for ideal number of strata to have in project, but it is recommended to have minimum possible (4 to 6) with more effective criteria. Strata should be developed based on criteria that will have the greatest impact on the costs or benefits in the project area.

The most important physical attributes in FLR projects typically are: land cover type, elevation zone, slope, agro ecological zone, annual average precipitation, temperature, and soil type. Additionally, variables like current land use, presence of particular groups of people, and distance from human settlements or roads can be also used as criteria for stratification.

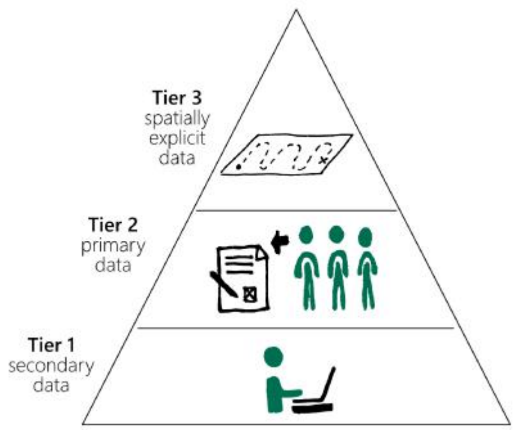
Drawing the boundaries of every strata is most effective using a GIS program. In case project specific data are not available, the following variables can be downloaded freely and used for the stratification:[14]

- Aspect and position of hill slopes - Sites differing in aspect and position on a hill slope are also stratified as tree growth varies in relation to these factors. For example, a stand on the south side may have greater productivity than one on the north aspect.
- Altitude - Forest blocks are selected within altitudinal ranges above mean sea level as vegetation types differ according to altitudinal variation. It is sensible to design elevation strata that represent forests within certain range in altitude.
- Physical and administrative boundaries – it is useful to consider if policy are different in this admin units that affect the survival or growth of trees.
- Soil texture / composition – Soil plays important role in agriculture, forest or any land based project. Thus, it is important to categorize it on their effect on growth.
- Precipitation – Average annual Precipitation classes categories that are relevant to growth of trees or crop productivity.

The user should then determine how characteristics of the separate strata affect outputs of the economic models, and incorporate these effects.

3.3 Step 3: Data collection

If input data come from reliable, local, and up-to-date sources, the level of confidence in the cost-benefit analysis will increase. On the other hand, data collection can be expensive and time-consuming. The costs of data collection should be weighed against the need for accuracy, depending on the purpose of the analysis.



3.3.1 Identify data needs and sources

The user must first identify all data needs based upon calculations to be made under Step 2. Methodologies for estimating prices and quantities should be elaborated at this stage in order to ensure that all needed data are collected. Necessary inputs for each calculation are determined. Potential sources and means of collection for every data input should be identified. This step should distinguish between primary data that will be collected "from the field" and areas where benchmark data will be used.

[14] Physical and administrative boundaries can be found at: https://gadm.org/data.html; soil texture and composition can be found at : http://www.fao.org/soils-portal/soil-survey/soil-maps-and-databases/harmonized-world-soil-database-v12/en/; precipitation can be found at : http://www.worldclim.org/; and altitude and aspect can be found at http://www.diva-gis.org/Data or https://asterweb.jpl.nasa.gov/gdem.asp

3.3.2 Collect field data

Having determined data needs and sources, the user should collect primary data. Differences between predicted and actual data sources should be carefully documented. The data collector should also document any potential sources of uncertainty and estimate an "error range," or the percentage by which the collected data could be incorrect. Upon finishing data collection, remaining data gaps must be carefully noted.

3.3.3 Benchmark data

In terms of costs and expected revenues, it is difficult to generalize across countries and FLR activity types, as there is wide variance.

Table 11 provides an overview of expected financial costs and revenues for FLR activity types on a per hectare basis. Project-specific circumstances (e.g. country, exact project activities) vary from case to case, meaning that some FLR projects may fall outside of the ranges provided. The estimates offer users a sense of the scale of potential costs and revenues and the timing and frequency of revenues. Aside from provisioning services, this table does not include ecosystem service values.

Table 11: Generalized costs and benefits for FLR activity types per hectare (US$)

	Initial investment	Annual maintenance	Harvest cost	Total revenues	Timing of revenues	IRR
Planted forests and woodlands	1,000 – 2,000	200 – 500	2,000 – 4,000	8,000 – 15,000	Thinnings from year 3; final harvest yr 7-20	5-15%
Natural regeneration / ANR / active regeneration	0 – 2,000	0 – 100	N/A	N/A	N/A	N/A
Sustainable forest management	50 – 200	50 – 100	200 – 1,000	500 – 3,000	Annual	15-50+%
Agroforestry	1,000 – 5,000	200 – 1,500	500 – 1,500	5,000 – 20,000	Variable; many tree-based crops from yr 3	10-25%
Soil restoration*	10 – 100	5 – 100	0	200 – 3,000	Annual or more frequent	10-50+%

Source: Authors' calculations; soil restoration amounts are additional to existing agricultural activities

Planting forests and establishing woodlands requires significant upfront investments, primarily for seedlings, labor, infrastructure, and planting equipment. Annual maintenance – pruning, weeding, pest management, fire prevention – is crucial to ensure future returns. Depending on the tree species rotation length of the plantation, thinnings may happen one to three times, usually starting during year three or four; this generates some revenues in early years. However, the majority of the revenues occur at final harvest, anywhere between years seven and twenty (or even longer, depending on the tree species). The combination of upfront investment and back loaded revenues creates liquidity gaps and financing challenges for such investments.

Natural regeneration, assisted natural regeneration, and active regeneration vary in the intensity of planting and management of the planted species. The primary financial cost of natural regeneration is simply in fencing off the protected area. However, there may be a significant opportunity cost from natural regeneration from foregone economic activities. ANR and active regeneration imply a higher number of planted individuals per hectare, and thus higher costs.

SFM can be a highly profitable activity, with relatively low upfront investment costs – typically for equipment and labor. Depending on the forest management regime, revenues can begin immediately.

Agroforestry has the highest variability as the chosen crop combinations imply significantly different investment volumes. Expenses include seedlings, labor, equipment, and infrastructure. A silvopastoral system, for example, has relatively low upfront investment. Establishment of a cocoa system, on the other hand has much higher costs. Maintenance costs are also high, typically for fertilizer (if relevant) and labor. With annual crops, revenues may start from year one, in systems involving tree crops (e.g. coffee or cocoa) harvest may begin later. The high investment associated with agroforestry can result in high returns.

Soil restoration activities also vary significantly (e.g. use of organic fertilizer, no-till farming), but tend to have relatively low costs: labor, inputs, and equipment. Most activities result in revenues during the first year at the time of harvest; depending on the country and commodity, harvest may occur more than one time per year.

3.3.4 Refine methodologies, recollect data

It may be the case that a user is unable to collect all necessary data from either primary or benchmark data sources. In this case, the user should return to Step 2 in order to refine methodologies. Data need identification and collection should then be restarted.

3.4 Step 4: Analysis of costs and benefits

Having determined costs and benefits over time, the user should construct a model, estimating the flow of economic and/or financial value over time. In simple terms, this will look similar to Table 12. Models can be constructed for the project as a whole – the total economic value of the project – and for individuals or groups of stakeholders. It may be desirable to understand the costs and benefits for a specific stakeholder, for example, a private investor.

Table 12: Simplified net values model (US$)

Year	0	1	2	3	4	5	6	7
Costs	(1,000)	(300)	(300)	(300)	(300)	(300)	(300)	(300)
Benefits	100	300	300	600	600	600	600	600
Total	(900)	0	0	300	300	300	300	300

Determining the timing of costs and benefits is central to the analysis in order to account for the time value of money. The idea that costs and benefits have different values depending on time is a central concept in economics. With a few rare exceptions, benefits received today have more value than benefits received in the future. Future values are discounted using a **discount rate** so that values at different times can be easily compared. This is done by assigning a weight to future events based on society's preference for events that occur at different points in time. This allows a decision-maker to determine tradeoffs between different investments under consideration. Determining the discount rate is a difficult and potentially controversial element of a cost-benefit analysis because it has a large impact on the perceived value of a project.

A discount rate can be calculated through a few different methodologies, depending on the user. A private company or investor typically uses its **weighted average cost of capital** (WACC) as its discount rate. WACC represents the cost that a company pays to finance an investment, including both equity and debt contributions to the investment.

Public actors will use a different means of determining the appropriate discount rate. The most straightforward way to choose the discount rate is to set it to the nominal rate of government return on bonds minus expectations of inflation.

However, in many cases, a public sector entity will calculate a discount rate through other means in order to incorporate the preferences of its members. National governments use vastly different discount rates, ranging from 3 to 15%, while other bodies use even lower rates, or apply a lower rate for values far in the future (Harrison, 2010). Choosing a discount rate that includes subjective preferences is as much of an art as a science, and there is significant debate about the methodology to choose an appropriate rate. The rate depends on the preferences of relevant stakeholders. A young community may, for example, prefer future benefits over current benefits. An older community may prefer the opposite. Smallholders, especially if they are not wealthy, will likely have immediate cash needs and therefore a high discount rate. If the user wants to take inter-generational preferences into account – the relative value of the preferences of people who have not been born yet – then a discount rate of close to zero or one that declines with time is necessary (Cropper, 2013).

In the context of FLR investments, it is important to note that environmental benefits typically accrue relatively far in the future. Using a high discount rate will decrease the relative monetary value of environmental benefits in FLR investments. However, the desire to include the monetary of value environmental benefits should be weighed against the immediate needs of a country or community. It may be appropriate to test how different discount rates affect the project's value via a sensitivity analysis (cf. Section 3.4.2).

3.4.1 Relevance of different indicators

Once a model is constructed, the user can conduct a variety of calculations for different types of analysis. Definitions and equations for these indicators can be found in Annex 1. The relevance of different indicators is described below.

Net present value (NPV) describes the value of an investment discounted to present terms. Any positive NPV value means that the discounted benefits from the project are greater than the discounted costs – i.e. it is a worthwhile investment. NPVs of similar investments can be compared to determine which is more profitable. The downside of using NPV is that it is difficult to compare the profitability of investments of different sizes. For instance, the NPV of a US$ 1 million investment may be greater than the NPV of a US$ 1 investment, but the effectiveness of each dollar invested is not apparent from NPV.

The internal rate of return (IRR), on the other hand, describes the effectiveness of each dollar spent and allows the user to compare profitability of investments of different sizes. Any IRR with a positive value means that the discounted benefits of the project are greater than the discounted costs. What a public or private investor determines to be an acceptable IRR depends on their other investment options and their perception of risk.

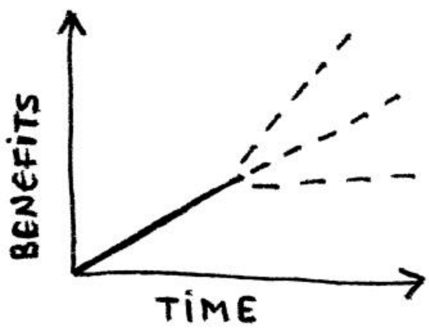
Benefit/cost ratio is another effective indicator for analyzing the effectiveness of invested resources. A benefit/cost ratio that is greater than one implies that total benefits are greater than total costs.

Return on investment (ROI) and return on equity (ROE) are indicators that also measure the efficiency of resources invested. ROI tells the user the profitability return for every dollar invested. ROE is similar to ROI, with one important difference, except that it measures only the return on equity invested.

The initial investment amount is the amount of financial resources that are needed in the first stage of the investment. For smallholders and other actors in the forestry and agricultural sectors, borrowing money or otherwise attracting investors can be a key challenge. Therefore, this is often a key indicator.

Breakeven point is the time at which the cumulative cash flows of the project shift from negative to positive. In addition to indicating the payback period, this is a helpful indicator as it is linked to the amount of time needed to repay an external investment.

3.4.2 Dealing with uncertainty



Cost benefit analyses inevitably involve a degree of uncertainty as they are an attempt to estimate or model the future. There are a few strategies to account for uncertainty. Any cost-benefit analysis should be clear about key assumptions that it makes in order to make its calculations. An external party reading the analysis should be able to easily identify input variables and on what basis the author of the report chose the value.

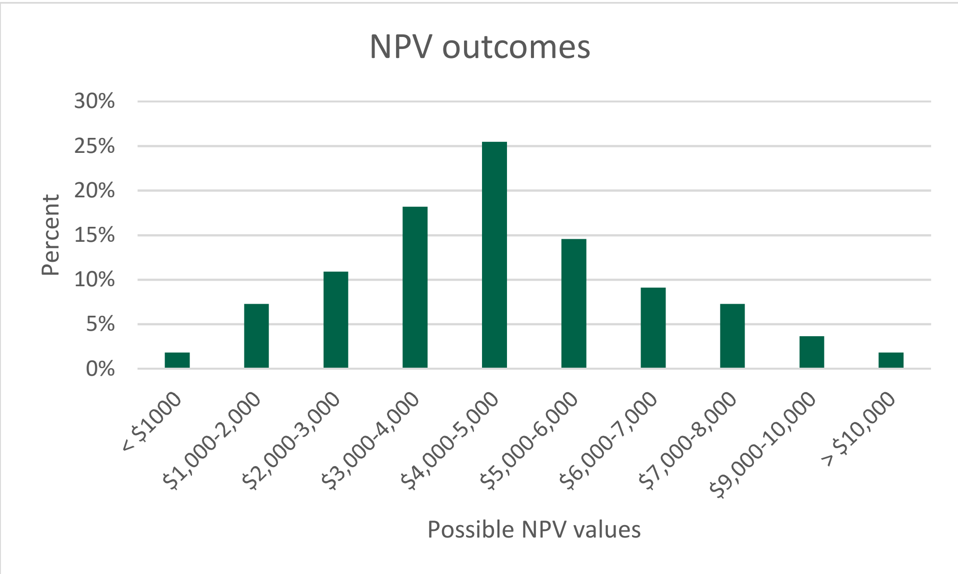
A cost-benefit analysis should account for uncertainty by conducting a sensitivity analysis. Sensitivity analyses test how the calculations of the model change if key input data changes. This allows the user to understand under which conditions their investment is feasible or not and the variables that have the greatest impact on a project's success. A handful of input variables that have a large impact on the costs and benefits of the investment should be chosen. For each selected variable, reasonable alternatives should be chosen and the model re-run with the new inputs. Table 13 provides the results from a hypothetical project that tests the sensitivity of the IRR of the investment to change in productivity, or mean annual increment.

Table 13: Example sensitivity table (IRR)

	Mean annual increment: 20m³	Mean annual increment: 25m³	Mean annual increment: 30m³
Scenario 1	12%	17%	20%
Scenario 2	15%	17%	19%
Scenario 3	17%	17%	17%

A Monte Carlo simulation is similar to a sensitivity analysis in that it demonstrates how a project's profitability varies. However, instead of altering one input variable and analyzing how that variable affects the project, a Monte Carlo simulation attempts to model uncertainty across multiple input assumptions. The model is run thousands of times in order to understand different possible outcomes and the likelihood of them occurring. The results of a Monte Carlo simulation are typically visualized in histogram, depicting the likelihood of different outcomes (Figure 12).

Figure 12: Example Monte Carlo analysis



In this example, the x-axis depicts different possible project NPVs and the y-axis depicts the likelihood of those values occurring. The user can understand the minimum, maximum, median, and mean results. In this case, project NPVs between US$ 4,000 – US$ 5,000 are mostly likely. Probabilities within a given range can be added together to estimate the likelihood of the outcome falling within that range. In the given example there is a 62% chance that the project NPV is greater than US$ 4,000.

4 CONCLUSIONS

Economically sound business models for sustainable land use activities can provide strong arguments for both, investors and policy makers. These arguments will help advancing from discussions to implementation. The outputs of a cost-benefit analysis seem clear: one scenario will be more profitable than others. However, taking a decision is not as simple as selecting the scenario with the greatest total net benefits. Cost-benefit analyses are only one tool amongst many in decision-making.

A cost benefit analysis can help designing specific investments, programs and supporting policies. For example, financial incentives for different stakeholder groups can be based on a cost benefit analysis: it will elucidate how different stakeholders bear the costs and benefits of an investment. It may also reveal, for instance, that landowners implementing a watershed protection scheme have higher costs than benefits to the landowners. In this case, the analysis can help identifying potential financial incentives for these landowners. If quality input data were available, the analysis should provide a comprehensive understanding of the tradeoffs under different scenarios. To inform decision-making key inputs and outputs should be presented in an easy to understand manner.

The user should be prepared that the results of a cost benefit analysis can be controversial and may be met with disbelief and questioning the validity of the results. For this reason, one hast to be aware of the limitations. Once the analysis has been completed, it should be validated through consultations with different stakeholders. In addition to confirming the accuracy or improving accuracy, validation is an important step to encourage stakeholder buy-in. The analysis will also make clear the scale of investment needed, so considering possible sources of investment is another important next step.

Limitations of cost-benefit analyses as a decision-making tool

First, the analysis is based on a number of assumptions that have a varying degree of confidence. Ideally, key stakeholders are consulted during the data collection process to improve the accuracy and increase their buy-in. Climate change and other unforeseen events may affect productivity in difficult to predict ways, which should be noted. Stated assumptions should go beyond cost, price, and productivity assumptions to include social and/or political assumptions.

Second, monetizing environmental and social benefits is a difficult and, at times, controversial topic. Stakeholders may value environmental benefits differently and therefore dispute the findings of the analysis. For example, some prioritize global ecosystem services like GHG mitigation while another prioritizes local benefits as reducing soil erosion. Selecting a discount rate – and thus prioritizing near-term versus long-term benefits – is an inherently subjective decision. Lastly, the value of some environmental benefits, such as supporting biodiversity, are often intentionally excluded because they cannot be monetized. However, although biodiversity may not be valued in a cost benefit analysis, it can still be included in decision-making.

Third, there may be political or social considerations that are difficult to monetize and include in the analysis. As much as stakeholders would expect that policy makers select the option that produces the greatest benefits for all, this does not occur in the real world. Benefits to one group may be valued more than benefits to another group because of political reasons, although this is not included in the cost benefit analysis.

Last, a common misperception of cost benefit analysis is that it is *the* important decision-making tool for private investors. While the expected profitability of an investment is of course important for investors, it is one of many criteria. Investors are not just investing into an Excel model; they are investing in people and companies, who are operating in complex and sometimes risky environments. The creditworthiness of an investee – their credit history, the collateral they can provide, the size of their business, their experience – is typically more important than the expected IRR of a business model. Macroeconomic conditions, especially political risk and foreign currency volatility, will also be investigated by investors.

The level of detail of analysis should inform immediate next steps. If a Tier 1 analysis was completed, relying primarily on benchmark data, the user may not be very confident of the final results. If such a high level analysis suggests that investment scenarios could be profitable, then a Tier 2 or Tier 3 analysis should be completed in order to ensure confidence in the results.

Outlook

Successful implementation of FLR activities at a landscape level has significant potential for different kinds of economic benefits, which accrue to different stakeholders. A full economic analysis tries to capture not only monetary, but also non-monetary values from different ecosystem services. Simply adding up these figures would result mislead, but ignoring such impacts and values would create an incomplete picture of the benefits. The compromise should be a differentiated assessment, based on the purpose of the assessment and the needs of those requesting it. Independent of beneficiary, purpose and level of detail, any assessment of costs and benefits should be robust and guided by the principles of conservativeness and credibility.

Robust and credible estimations of the economic impacts and the costs of inaction can be powerful instruments to stimulate the implementation of FLR on the ground. In many cases, policy makers still need to be convinced of the various benefits of such investments and their dimension. It can help translate country pledges into action on the ground and weigh alternative scenarios, e.g. in the context of bi- and multilateral development cooperation programs. It can also refine the results of FLR opportunity assessments, structure and inform discussions among stakeholders and help identifying trade-offs between different options (including inaction).

Public and private investors considering FLR need quick, but reliable information on the financial dimension and other impacts. Financial analyses are straightforward and provide basic information such as investment needs, returns on investment, internal rates of return, and cash flow profiles. However, particularly impact investors are increasingly interested in also having estimations of the expected environmental and social impacts of their activities.

Economic analyses can help identifying trade-offs between different FLR options for identified landscapes. At landscape level there will be different options for starting restoration processes, with significant impacts on investment needs and impacts. In light of uncertainties, assumptions and different benefits accruing at different points of time, its results are not sufficient to determine the most appropriate FLR strategy for a given landscape. Ideally, the proposed methodology builds on and complements an opportunity assessment with a stakeholder process.

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ANNEX 1: GLOSSARY OF TERMS

Benefit/cost ratio

This is an effective indicator for analyzing the effectiveness of invested resources. It is calculated by dividing total discounted benefits by total discounted costs. A benefit/cost ratio that is greater than one implies that total benefits are greater than total costs.

Bonn Challenge

A voluntary high-level policy approach which encourages countries to pledge degraded lands for the global FLR movement. The Bonn Challenge was initiated by the German government as an implementation-focused approach complementary to the various formal negotiation processes under the UN – in particular the UNFCCC, the UNDCCD and the CBD. It aimed at having by 2020 more than 150 million hectares of the world's degraded and deforested lands in processes of restoration. Two associated regional initiatives have evolved out of the Bonn Challenge: the AFR100 initiative for Africa and the 20*20 initiative for Latin America.

Breakeven point

The break-even point is the time at which the cumulative cash flows of the project shift from negative to positive.

Capital Expenditure (CAPEX)

CAPEX items are durable goods that a company will use for more than one year. CAPEX includes, for example, the purchase of land, perennial seedlings, equipment, or infrastructure.

Carbon stock change

Carbon stock is the quantity of carbon contained in a "pool", meaning a reservoir or system which has the capacity to accumulate ("sink") or release carbon ("source"). For forests, it refers to changes in its different pools, mainly in living biomass and soil, but also in dead wood and litter (Watson et al., 2000).

Cost-benefit analysis (CBA)

CBA is a decision-making tool that provides a systematic approach for quantifying and monetizing the strengths (benefits) and weaknesses (costs) that helps decision makers decide between alternative investment options.

Discount rate

The interest rate used in discounted net value analysis to determine the present value of future values. The higher the discount rate, the lower the present value of the future values.

Financial analysis

A financial analysis takes the perspective of a single actor, often a private sector entity aiming at engaging into a FLR investment. It takes into account costs and benefits that are restricted to cash flows that can be directly monetized, such as upfront and management costs, increased revenues from products sold, and any fiscal incentives from the public sector. It helps in the process of deciding on investments and comparing the potential returns from the proposed FLR investment with alternative investment options.

Economic analysis

Economic analyses are carried out when a public sector entity is making an investment. They are used for calculating the diverse costs and benefits of a particular FLR activity. While financial analyses compare benefits and costs to an enterprise, economic analyses compare the benefits and costs to the whole economy, or to various actors.

Forest Landscape Restoration (FLR)

FLR is defined as a long-term process of regaining ecological functionality and enhancing human well-being across deforested or degraded forest landscapes. It aims to restore a whole landscape 'forward' to meet the present and future needs and to offer multiple benefits and land uses over time (IUCN, n.d.). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) defined restoration as "any intentional activity that initiates or accelerates the recovery of an ecosystem from a degraded state."

Forest / land degradation

The FAO defines degradation as "changes within the forest which negatively affect the structure or function of the stand onsite, and thereby lower the capacity to supply products and/or services." (FAO 2006). Degradation can simply be described as any process which lowers the quality of land, and as a consequence, impairs ecological functions and provision of ecosystem services.

Initial investment amount

The initial investment is the amount of financial resources that are needed in the first stage of the investment. Given that many large projects are financed in part from external sources, it demonstrates the scale of resources that need to be raised from outside investors.

Internal rate of return (IRR)

IRR is calculated using the NPV formula (see NPV definition below) and setting the NPV equal to zero, then solving for the discount rate. IRR describes the effectiveness of each dollar spent and allows the user to compare profitability of investments of different sizes. A positive value for IRR means that the discounted benefits of the project are greater than the discounted costs

Net present value (NPV)

NPV describes the total value of the investment, discounted to present day terms. It is calculated by modeling the net values into the future, discounted by the chosen discount rate:

$NPV = (\text{Net values}) / (1 + r)^n$

Where R is equal to the discount rate and N is equal to the period in years.

Operational expenditure (OPEX)

OPEX refers to expenses for goods or services that are used during one year and are often related to the management and maintenance of the investment. This could include, for example, hiring labor to prune a restored area or fire prevention activities.

Return on investment (RoI)

ROI tells the user the profitability return for every dollar invested. It is calculated using the following formula:

ROI = (benefits – costs) / total investment

Return on equity (RoE)

ROE is another indicator that measures the efficiency of resources invested. ROE is similar to ROI, with one important difference, as seen in the following formula:

ROE = (benefits – costs) / total equity invested

Therefore, ROE demonstrates the profitability return on equity invested into the project. This takes the perspective of a shareholder in the company and their expected return. The difference between ROI and ROE is determined by the amount of debt that is used to finance a project.

Total economic value (TEV)

A measure to estimate and monetize all economic impacts of an investment. TEV recognizes that benefits and costs radiate far beyond the landowner or investor – from neighboring properties all the way to global impacts.

Weighted average cost of capital (WACC)

WACC is one of the ways to calculate a discount rate, and is typically used by a private company or investor. WACC represents the cost that a company pays to finance an investment, including both equity and debt contributions to the investment. WACC is calculated as follows:

WACC = (E/V * Ke) + (D/V) * Kd * (1 – T)

Where E = the market value of the firm's equity; V= the market value of the firm's equity and debt; Ke = the cost of equity; D = the market value of the firm's debt; Kd = the cost of debt; and T = the tax rate.

Working capital

Working capital is related to short-term expenses for the purchase and sale of goods and is most relevant for companies that buy an unfinished product, add value, and then sell the product.

ANNEX 2: ECOSYSTEM SERVICE MODELING TOOLS

Table 14: Ecosystem service modeling tools; table is largely taken from (WRI; IUCN, 2014), with some additions and alterations

Abbreviation	Model Name / Developer	Tool Description
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs (Natural Capital Project)	Spatial mapping and modeling of multiple ecosystem services. The 17 models of ecosystem services range from wave energy and off shore wind energy, to recreation value and scenic quality. The models provide spatially explicit results in either biophysical or economic terms.
ARIES	Artificial Intelligence for Ecosystem Services (BC3)	Links multi-scale variability (Spatial, Temporal and Structural) and spatially explicit ecosystem services directly to beneficiaries. Models map services as a flow from ecosystem, to service, to those that receive the benefit in an attempt to reduce double-counting. This tool also uses a "Probabilistic Bayesian approach to [adjust for] data uncertainty and scarcity."
MIMES	Multiscale Integrated Models of Ecosystem Services (Affordable Futures)	Open Source Modeling Platform which attempts to model the cause-effect relationship/link between ecosystems and the economy. MIMES allows for an individual to map decisions/policies and illustrate how those choices with ripple through economy and ecosystems.
EcoMetrix	EcoMetrix (EcoMetrix Solutions Group and Parametrix)	Field based tool, designed for use at relatively fine spatial scales. Primary use is to illustrate the effects of human activities on natural capital/ES. This software could aid in deciding how to sustain ecosystem services over the long run through human action.
NAIS	Natural Assets Information System (Spatial Informatics Group)	NAIS is an integrated database of valuation literature and reporting engine. The database is integrated with proprietary spatial modeling tools to characterize ecosystems and flow of services on the landscape.
EVT	Ecosystem Valuation Toolkit (Earth Economics)	EVT provides monetary values for natural assets under multiple modules: Researcher's Library: Researchable database of ecosystem service values, SERVES, a web-based tool for calculating ecosystem service values and performing natural capital appraisal. Resources: General materials on ecosystem services and valuation as well as links to further resources around the web.
SolVES	Social Values for Ecosystem Services (USGS)	Spatial mapping and modeling of cultural ecosystem services. A GIS application that estimates the social values of ecosystem services such as recreation, culture and scenic quality.
ESR for IA	Ecosystem Services Review for Impact Assessment (WRI)	The model provides a six step method to address project impacts and dependencies on ecosystem services as part of the environmental and social impact assessment process. First, it identifies measures to mitigate

Abbreviation	Model Name / Developer	Tool Description
		project impacts on the benefits provided by ecosystems. Second, it identifies measures to manage operational dependencies on ecosystems.
MESP	Marine Ecosystem Services Partnership (Duke)	Database of publications that report economic outputs of ecosystem services. Provides an interactive map (through filters) to show publications by region. The tool specifically targets oceanic and coastal (marine) ecosystem services and provides databases specified by region/ecosystem.
Tessa	Tessa (Bird Life International)	A site-specific look at ecosystem services. The tool allows for an “alternate state” which can be directly compared to with the current state of an ecosystem. Uses flow charts to map where the ecosystem services are benefiting society.
Co$ting Nature	Co$ting Nature (King’s College London and AmbioTEK)	Spatial mapping and modeling of multiple ecosystem services using global coarse-resolution datasets. Understands ecosystem services as opportunity cost. This tool emphasizes the importance of conservation measures.
EnSym	Environmental Systems Modelling Platform (State of Victoria, Australia)	EnSym is an environmental systems modeling platform and framework for scientists and researchers to test and apply empirical and process-based scientific models. EnSym provides users with an evidence-based framework to support decision-makers on how and where to invest to maximize environmental outcomes.
LUCI	Land Utilization and Capability Indicator (Victoria University of Wellington)	Formerly known as PolyScape. ”LUCI explores the capability of a landscape to provide a variety of ecosystem services. It compares the services provided by the current utilization of the landscape to estimates of its potential capability, and uses this information to identify areas where change might be beneficial, and where maintenance of the status quo might be desirable” (quoted from website)
Wildlife Habitat Benefits Estimation Toolkit	WHBET (Specific Paper) (Defenders of Wildlife & Colorado State University)	Spreadsheet for monetary valuation (function transfer). Models include: residential property values and open space, wildlife recreation, and total value of habitat/wetland services.
Envision	Envision (Oregon State University)	Open Source GIS-based tool for scenario based planning and environmental assessment. Able to complete “multiagent modeling” to represent human decisions on landscape simulations.
iTree	ITree (US$A)	Provides urban forest analysis and benefit assessment tools. This tool specifically identifies ecosystem services from tree (be it a single tree or forested park, neighborhood, city or state). The tool aids in urban forest management activities.

Abbreviation	Model Name / Developer	Tool Description
Madrona	Madrona (Eco-Trust)	Open source software used for a decision support and area-based planning that can be used by a broad audience. Madrona creates a framework for modeling a specific goal, audience, geography and culture in decision making process.
EcoSET	ES Evaluation Tool (Biodiversity Institute Oxford)	The model's aim is to generate a user-friendly automatic ecosystem service evaluation tool to calculate on-demand maps of ecosystem services provision anywhere globally.
RIOS	Resource Investment Optimization System (Natural Capital Project)	Spatial mapping and modeling of multiple ES. The tool combines biophysical, social, and economic data to help users identify the best locations for protection and restoration activities in order to maximize the ecological RoI, within what is socially and politically feasible.
SWAT	Soil and Water Assessment Tool (Texas A&M University, US$A)	SWAT is a small watershed to river basin-scale model to simulate the quality and quantity of surface and ground water and predict the environmental impact of land use, land management practices, and climate change.
PA-BAT	Protected Area Benefit Assessment Tool (WWF)	The PA-BAT aims to help collate information on the full range of current and potential benefits of individual protected areas. This toolkit provides the necessary data to assess the benefits of protected areas as well as the beneficiaries (how/where benefits are transferred).
Open NSPECT	Open NSPECT (NOAA)	Open-source version of the Nonpoint Source Pollution and Erosion Comparison Tool (more), to investigate potential water quality impacts from development, other land uses, and climate change. The tool specifically simulates erosion, pollution and their movement/accumulation from overland flow including elevation data.
CFT	Cool Farm Tool (Cool Farm Alliance)	The open-source tool allows farmers to measure the carbon footprint of their crop and livestock products through three areas: carbon (field level assessment including nutrients, energy and land use), biodiversity (quantitative scoring of whole farm management) and water (crop irrigation requirements and blue/green water footprints). Based on this, it allows for exploration of non-crop specific mitigation options.
EX-ACT	Ex-Ante Carbon balance Tool (FAO)	This land-based accounting system provides estimates of the impact of agriculture and forestry development projects, programmes and policies on the carbon-balance (C stock changes and GHG emissions/unit of land). The tool helps project designers to estimate and prioritize project activities with high benefits in economic and climate change mitigation terms. It is cost effective, requires a comparatively small amount of data and has in-built resources.

Source: Adapted from IUCN 2015

ANNEX 3: APPROACH FOR ESTIMATING BIODIVERSITY VALUES

Identifying priority biodiversity value and threats on landscape level

To assess biodiversity values, the target landscape should be screened in order to understand its biodiversity value. First and foremost, this would include the existence of protected areas (including biosphere reserves and Ramsar[15] sites), as these often include sites protected specifically to protect biodiversity values. If protected areas exist within the target landscape, general information should be reviewed, as follows:

- Conservation category (National park, landscape reserve, etc.)
- Existence of buffer zones
- Land uses allowed within these areas and/or buffer zones and whether they are considered to be aligned with conservation goals
- Current threats to conservation goals

In addition, the target landscape should be screened against previous assessments or studies that provide information on particular biodiversity values, such as:

- HCV Resource Network: https://www.hcvnetwork.org/resources/global-hcv-toolkits
- Intact Forest Landscapes: https://glad.umd.edu/dataset
- Key Biodiversity Areas (KBAs) and Important Bird Areas (IBAs): https://www.birdlife.org/worldwide/programmes/sites-habitats-ibas-and-kbas

Protected areas and sites classified as important for biodiversity should be clearly mapped. Additionally, the threats to these areas should be identified for each site.

Assess impacts on biodiversity across different scenarios

The different scenarios proposed should be applied to the biodiversity values identified in the landscape. After this, possible impacts on biodiversity should be assessed. When applying the scenarios planned to biodiversity values, the following first considerations should be made:

- Protected areas and forests: Are business models compatible with the legal regime and protection category?
- Compatibility of business model with biodiversity protection in high value sites: Are proposed business models compatible with the conservation of these sites? Do they require an intensive change in the landscape that would affect the habitat value and species survival?
- Threats: Do proposed business models deepen current threats to biodiversity in any way? Or on the contrary, can they provide incentives to halt or reverse such trends? For example, sustainable forest management could offer economic incentives to protect the forest instead of deforesting for conversion into agriculture.

[15] A *Ramsar Site* is a wetland site designated of international importance under the *Ramsar Convention*. Please refer to https://www.ramsar.org/sites-countries/the-ramsar-sites for more information.

As a general guide, the matrix presented below can be used to understand the logic of such an assessment (Figure 13). Risks and opportunities for biodiversity will mainly depend upon the baseline condition of the site and the level of intervention on the landscape required for the implementation of a business model.

Figure 13: Matrix for biodiversity risk assessment when implementing business models

Level of intervention in landscape		
	Risk for biodiversity: Medium *Opportunities for biodiversity: Medium* E.g.: Mechanized agriculture on areas previously dedicated to extensive livestock production.	*Risk for biodiversity: High* *Opportunities for biodiversity: Low* E.g.: Interventions requiring drainage of wetlands, conversion of natural forests to agriculture.
	Risk for biodiversity: Low *Opportunities for biodiversity: Medium* E.g.: Agroforestry schemes in areas previously dedicated to agriculture or livestock production.	*Risk for biodiversity: High* *Opportunities for biodiversity: High* E.g.: Sustainable natural forest management in forests with high biodiversity value, game parks in savannahs.
	Anthropogenic landscape — *Natural areas*	*Pristine or semi-pristine areas incl. HCV, KBA, etc.*

Level of "naturalness"

As can be seen in the matrix, a high level of naturalness of an environment when matched with a low-intervention activity may entail opportunities for biodiversity. This means the business model is adapted to the site, and relies upon the natural processes of a functioning ecosystem. They entail, for example, sustainable natural forest management models which incentivize conservation through business. In such a context, forestry and agroforestry models that are compatible with the conservation of natural ecosystems may provide the necessary incentives for conservation. While these are interesting business models from an impact-point of view, one should be aware of the risks they entail.

To ensure the minimization of risks, the following aspects should be considered:

- Proof of concept/Environmental Impact Assessment: If the proposed land use is already applied in the region or similar regions, with proven benefits for biodiversity, the risk is lower when compared to a new model. In the case of a new model, a comprehensive baseline analysis and environmental impact assessment should be completed.
- Assessment of capacities: Particularly when implementing models that are not well known by the local population, and when they require technical skill, capacities for sound implementation should be carefully assessed. Technical assistance may be crucial for the implementation of sustainable practices.
- Continuous monitoring: A monitoring and verification system should be in place that ensures risks are recognized early and mitigated.
- Governance: In the context of weak environmental and/or forest governance structures, parallel structures to ensure sustainable project implementation are even more crucial. To reduce risks of unsustainable management, a good reference for sustainable project implementation are the Performance Standards on Environmental and Social Sustainability of the International Finance Corporation (IFC, 2012). In addition, the FSC principles and criteria provide widely legitimated standards for sustainable forest management.

The value of biodiversity to specific ecosystem services

In some cases, when biodiversity is clearly linked to a particular ecosystem service, monetizing the value of that service may be a helpful way to support biodiversity. Examples for this may be game reserves and protected areas in which the main attraction is wildlife. Hunting licenses in game reserves and tourism in safaris are obviously related to the presence of wildlife, especially large, iconic mammals, such as elephants and tigers. Establishing the link between habitat protection, the provision of this service and the associated revenue flows may provide the necessary incentives for biodiversity conservation. Monetization methodologies will vary case to case; a simple way to make this valuation is to estimate the revenues generated from the service. For an example, see
Figure 14 below.

Figure 14: Tourism case study

Case Study for Monetizing Biodiversity-related Tourism

Region	Ecosystem	Reference
Amani Nature Reserve (ANR), Tanzania	*Eastern Arc forests, biodiversity hotspot*	*Rehema Abeli Shoo and Alexander N. Songorwa, 2013*

Context

The ANR was established in May 1997. It covers an area of about 8,380 hectares of pristine forest including some 1,065 hectares of forest from Usambara tea company, managed as part of the reserve. It is considered one of the 25– biodiversity hotspots in the world.

The reserve supports large numbers of poor local communities who depend upon natural resources. The income for these communities has increased through employment offered by Amani Nature Reserve, guiding fees, selling of handcrafts and contribution of 20 % revenue accruing from the uses of natural resources and services offered by Amani Nature Reserve.

Socio-economic importance

- Over 12 million Tanzanian Shillings (TAS) (≈ US$10,000; US$ 1 = TAS 1300 in November 2007) are generated by ANR annually as revenue from eco-tourism. About 20 % of this is distributed equally to the 18 villages that surround the reserve.
- On average, eco-tourism contributes 9.6 % of total annual household income but only 22.7 % of the households earn income from eco-tourism.

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