WORLD RESOURCES INSTITUTE

GUIDEBOOK

Land restoration from planting to proof

A guide to monitoring, reporting, and verification

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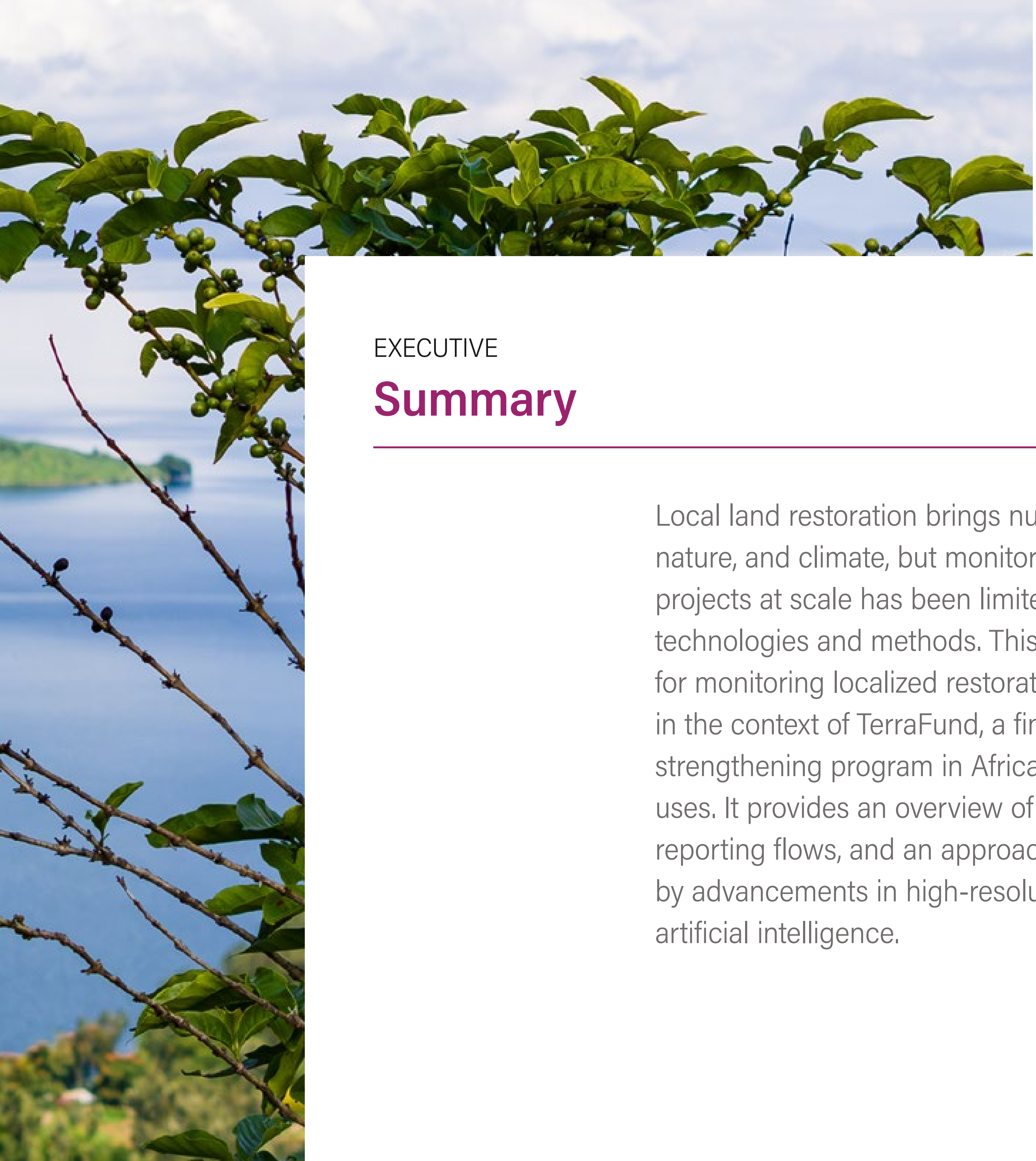


EXECUTIVE

Summary

Local land restoration brings numerous benefits to people, nature, and climate, but monitoring these small-scale projects at scale has been limited by a lack of cost-effective technologies and methods. This guide presents an approach for monitoring localized restoration that has been tested in the context of TerraFund, a financing and capacity strengthening program in Africa, that can be adapted to other uses. It provides an overview of the monitoring indicators, reporting flows, and an approach to verification, enabled by advancements in high-resolution satellite imagery and artificial intelligence.

HIGHLIGHTS

- Monitoring, reporting, and verification (MRV) of restoration projects demonstrates progress, builds credibility with funders, and can help reduce the multibillion-US-dollar finance gap in the sector. Many existing MRV approaches are not suitable for localized, small-scale, or distributed restoration projects due to their costs, capacity requirements, and improperly scaled technologies.
- This guidebook describes one MRV framework for small- and medium-scale localized restoration projects. This approach was created for TerraFund, a program providing finance and capacity strengthening support to medium- and growth-stage tree-based land restoration organizations in Africa.
- The framework was iteratively developed using feedback from restoration practitioners, insights from pilots, project partners, and team reflections.
- This study presents the MRV approach for TerraFund as one replicable model that funders and fund managers, intermediaries, and implementers can adapt to demonstrate project progress and outputs to help deliver and scale restoration.

Context

Forest landscape restoration sector requires field-tested monitoring, reporting, and verification approaches that are practical for the diverse range and scale of restoration projects necessary to address land degradation (Elias et al. 2025; Mansourian and Stephenson 2023; Mansourian and Vallauri 2022; Gatica-Saavedra et al. 2017). World Resources Institute (WRI) and its partners have developed an MRV framework for projects restoring as few as 20 hectares.

This framework was developed and tested in the context of TerraFund, a restoration financing and technical assistance program, and created in partnership with Conservation International, One Tree Planted, and Realize Impact. TerraFund provides grant, debt, and equity funding and capacity-strengthening support to medium- and growth-stage organizations across Africa. Medium-stage organizations are nonprofits or enterprises with operating budgets or annual revenues, respectively, between US$50,000 and $250,000. Growth-stage organizations are those with operating budgets or revenues between $250,000 and $1 million. Small and medium-sized restoration is understood as the projects carried out by the medium- and growth-stage organizations defined here. While strict bounds are not placed on the exact size of restoration projects, project totals can range from 20 hectares (ha) to over 10,000 ha. Individual plots or polygons may be fewer than 10 ha.

The framework captures quantitative and qualitative data about project progress and lessons learned using nine indicator categories, novel technologies including remote sensing methods, and its online platform, TerraMatch. TerraFund MRV brings together this set of tested biophysical, socioeconomic, and financial indicators, program-wide assessments, geospatial data models and analysis, an integrated digital platform for reporting and result sharing, and targeted assistance for project developers. This framework is also designed to be cost-efficient: WRI estimates that for the first 198 projects funded through TerraFund, the remote sensing approach for counting and verifying trees planted will save an estimated $4 million compared to traditional inventories, representing an estimated 98 percent reduction in cost per hectare.[1]

By monitoring, reporting, and verifying restoration's benefits, intermediaries (organizations that distribute funding but are not direct implementers) can help unlock more finance for smaller and local organizations to scale restoration (Faruqi 2016). This guidebook also provides a resource for existing project partners, who can reference this document to understand the purpose and methods behind project monitoring requirements, and address questions they may have about the TerraFund approach. It also provides transparency and awareness of the TerraFund MRV framework for funders and partners.

While these indicators and methods were designed specifically for the TerraFund context, WRI has already started adapting this framework for the Harit Bharat Fund in India and Fundo Flora in Brazil, two WRI-managed restoration financing and technical assistance programs similar to TerraFund. As more organizations and funders recognize the potential of nature-based solutions and restoration to support environmental, social, and climate goals, this guidebook is one resource they can draw on and adapt as needed to their contexts.

Developing the framework

Since TerraFund's inception in 2022, WRI and partners have iteratively refined the MRV framework using established research, field-based trials and pilots, and user-feedback sessions. This approach allowed for iterative refinement of indicators, data collection processes, and verification approaches. This guidebook summarizes the approaches developed and insights gained through this development process.

The Priceless Planet Coalition's *Tree Restoration Monitoring Framework: Field Test Edition* (Sprenkle-Hyppolite et al. 2023), produced in collaboration between Conservation International and WRI, provides the principal basis for the TerraFund MRV framework, as well as the "Restoration Monitoring Tools Guide" (Reytar et al. 2023), the Restoration Project Information Sharing Framework (Gann et al. 2022), "High-Resolution Global Maps of 21st-Century Forest Cover Change" (Hansen et al. 2013), and the Tropical Tree Cover dataset (Brandt et al. 2023).[2]

About MRV for TerraFund

The TerraFund MRV framework measures implementation progress of restoration projects, changes to socioeconomic and environmental conditions, and use of distributed funds. It also measures WRI's effectiveness as the administrator of TerraFund and its equity goals. The framework seeks to balance the breadth and detail of indicators with the resources and capacities of both the implementing organization and WRI as an intermediary party.

The TerraFund model prioritizes the expertise of local restoration organizations that know their region best, while enabling WRI, a large organization with access to financing and high-resolution monitoring technology, to remove some of the barriers that stall medium- and growth-stage restoration organizations. Project developers manage project design, implementation, community engagement, and data collection, while WRI provides financial, technical, and monitoring support through capital provision, targeted trainings on digital applications and data collection, and data management, analysis, and verification through an online platform, TerraMatch.

TerraFund's monitoring system is based on a set of 34 indicators that align with 9 categories. These indicators, listed in Table ES-1, assess both biophysical and socioeconomic dimensions of restoration. Data on these indicators are collected using field-based methods and remote sensing approaches.

Most TerraFund indicators monitor the work that project developers are doing to implement restoration and manage funding, and the outputs of this

Table ES-1 | **TerraFund monitoring indicators**

TYPE	INDICATOR CATEGORY	INDICATORS INCLUDED	
Project implementation	1. Tree restoration	1.1 Seedlings produced 1.2 Trees planted	1.3 Survival rate 1.4 Trees grown*
	2. Land restoration	2.1 Hectares under restoration	2.2 Percentage tree cover change*
	3. Jobs created	3.1 Full-time employees 3.2 Part-time employees	3.3 Volunteers
	4. Livelihood benefits	4.1 Individuals in communities receiving direct benefits 4.2 Individuals in communities receiving indirect benefits	4.3 Trainees 4.4 Income-generating activities
	5. Financial health and performance	5.1 Net profit margin 5.1.1 Change in revenue 5.2 Current ratio 5.3 Enterprise repayment	5.4 Finance repayment 5.5 Budget execution rate 5.6 Change in operating budget 5.7 External finance
	6. Community engagement	6.1 Addressing barriers	6.2 Local input
	7. Carbon sequestration	7.1 Carbon sequestered after 6 years*	
Program administration	8. Inclusive finance	8.1 Women-led projects 8.2 Women-led finance 8.3 Youth-led projects 8.4 Youth-led finance	8.5 Local projects 8.6 Local finance 8.7 Locally led projects 8.8 Locally led finance
	9. Market access	9.1 Percentage of projects accessing market-based finance	9.2 Percentage of total finance allocated as debt or equity

Note: * Indicator measured using remote sensing methodologies.
Source: WRI authors.

work. The TerraFund MRV framework also includes indicators that monitor WRI and its partners' roles as the administrators of TerraFund, specifically their efforts to support inclusive finance and market access for project developers. The set of indicators draws on quantitative and qualitative approaches typically found in both MRV and monitoring, evaluation, and learning (MEL) systems to understand the range of inputs, outputs, and benefits of restoration. Elements typical of MRV systems include strictly quantitative indicators directly related to tree growth, such as the number of trees planted. Those typical of MEL frameworks are centered on project assessment rather than verification of outputs, such as the number of people trained, the amount of budget spent, or projects addressing harmful barriers. By bringing different assessment methods together, the TerraFund MRV framework aims to understand a range of environmental, climate, socioeconomic, and organizational development activities and outputs for a holistic sense of a project.

TerraFund's reporting system includes the processes, methods, and tools used to collect and communicate data from project developers. Reporting continues for six years after the project start date. Over the lifetime of a project, developers submit project, site, nursery, and financial and expense reports through 12 biannual reporting cycles. These reports are submitted through TerraMatch, a digital data management platform. The reporting system also includes the communication channels between WRI, stakeholders, and donors, particularly through the TerraMatch dashboard.

TerraFund verification is the process of ensuring data quality, accuracy, and reliability. While the use of traditional independent verification is the highest standard, TerraFund also employs validation processes using nonaudited secondary sources and quality assurance assessments. Assessments of data quality, in all its forms, are performed by TerraFund staff and entail detailed reviews of reported information and supporting documentation, remote sensing and field-based tree verification techniques, and site visits.

By combining geospatial approaches with validation practices from the social sciences, TerraFund can confidently assess the range of project activities, from biophysical outputs to socioeconomic benefits. All indicators, whether verified, validated, or quality assured, still serve an important part in quantifying project and program progress and in communicating the work of project developers.

Further research and iteration

This guidebook can serve as a starting point for other intermediary organizations, funders, or implementers seeking to monitor restoration projects. TerraFund recommends that this framework and its associated lessons learned be adapted to other contexts to support this scale of restoration work.

There is an opportunity for TerraFund to modify and improve its MRV approach to evaluate the outcomes to which restoration projects aim to contribute, such as improved ecosystem services like biodiversity, soil health, water quality, and additional social and socioeconomic benefits. The version of the MRV framework presented in this guidebook focuses on monitoring the outputs that restoration projects control, such as the number of trees they plant or the number of people they employ. Understanding delivery of these outputs can provide a limited sense of progress toward the longer-term outcomes to which projects seek to contribute. By expanding the framework to include additional indicators and more robust monitoring approaches in the future, TerraFund could better understand the ultimate environmental and social outcomes of interest to projects, and support learning from progress to enhance restoration outcomes.


Introduction

Land restoration has the potential to bring life back to degraded land, improving biodiversity, food security, agricultural productivity, and climate resilience, as well as provide livelihood opportunities and socio-economic benefits. Without the tools to monitor, report, and verify implementation and outputs, however, land restoration remains underfunded.

The MRV approach described here aims to enable small and medium-size restoration organizations to demonstrate the environmental, socio-economic, and financial benefits of their projects.

Forest landscape restoration: Benefits and barriers

In the decade between 2010 and 2020, African countries experienced the highest rate of net forest area loss of any region in the world (FAO 2020a). Since the turn of the 21st century, over 66 million hectares of tree cover have been lost on the continent, largely driven by shifting cultivation and permanent agriculture (Global Forest Review 2025). An estimated 65 percent of arable land is degraded (UNCCD 2013). On a continent where agricultural production is defined by smallholder farming (Nyambo et al. 2022; Gollin 2014; FAO 2013), this degradation threatens food security, economic opportunities, biodiversity, and climate resilience (UNCCD 2020; UNEP 2015).

Land restoration, even on small plots, can mitigate both the environmental and socioeconomic costs of degradation (Mansourian et al. 2021; Skole et al. 2021b; FAO 2020b; IPCC 2019; Lung and Schaab 2010). By bringing together many of these smallholder plots, which are often using agroforestry techniques and planting trees outside forests, restoration can reduce deforestation pressures from agriculture and provide the co-benefits of enhanced ecosystem services, climate change adaptation, poverty reduction, and food security (Seymour et al. 2022; FAO 2022; Sacande et al. 2021; Skole et al. 2021a; Adhikari et al. 2020; IPCC 2019; Berrahmouni et al. 2021).

A growing body of research further highlights the role of these smaller-scale, more-local projects in reducing land degradation and desertification. When local organizations and communities have a meaningful role in the management of initiatives, they can shape restoration approaches to align with local priorities and take context-specific environmental and social factors into consideration, supporting longer-term sustainability. Natural resource management approaches that are community-based or co-developed with local communities can lead to greater longevity and social and environmental benefits compared with top-down approaches (Schubert et al. 2024; Stolton et al. 2024; Zhang et al. 2023).

Despite the benefits local organizations stand to provide, their ability to scale restoration is stalled. Enabling restoration of any kind is not an easy task, but two compounding barriers particularly impact local practitioners: funding and monitoring.

Restoration finance's "missing middle"

Restoration at large is underfunded by an estimated $278 billion (UNCCD 2024). Perceived risks, low return on investments, and unclear measurements of benefits deter investors (UNCCD 2024; Löfqvist et al. 2023; UNEP et al. 2021; Faruqi 2016; Credit Suisse et al. 2014).

Financing gaps disproportionately affect local actors. When funding is available, it rarely caters to the scale or needs of local organizations (Faruqi 2016). Local restoration organizations, with operating budgets ranging from $50,000 to $1 million, have outgrown microfinance and require more than the small, limited-term grants that some governments can provide. This level of funding often does not cover monitoring costs, and grant cycles do not align with the time frame needed for the benefits of restoration to be realized. Conversely, institutional investors tend to favor larger projects, closer to the range of $50 million to $100 million, which minimize transaction costs and are seen as more likely to generate returns and have impact (Ding et al. 2017).

Too big for microfinance or public grants and too small for private finance, medium- and growth-stage restoration organizations face barriers to scaling and delivering on their potential.

Monitoring small-scale restoration, at scale

One way to address the financing gap is to inspire confidence and trust among funders by measuring and validating the outcomes of restoration (Löfqvist et al. 2023; Faruqi 2016). However, few existing monitoring frameworks cater to the approaches and needs of local restoration organizations, often operating on many distributed plots, rather than in contiguous forest areas. These distributed models pose additional monitoring challenges. Even with advances in remote sensing technologies, most satellite imagery has difficulty detecting individual trees outside forests (TOFs) on small plots, especially in the early stages of planting. The high-resolution imagery (0.3 m) that *can* detect trees outside forests is prohibitively expensive for local restoration organizations and, when purchased, often unnecessarily includes the area between the many small plots (Thomas et al. 2021).

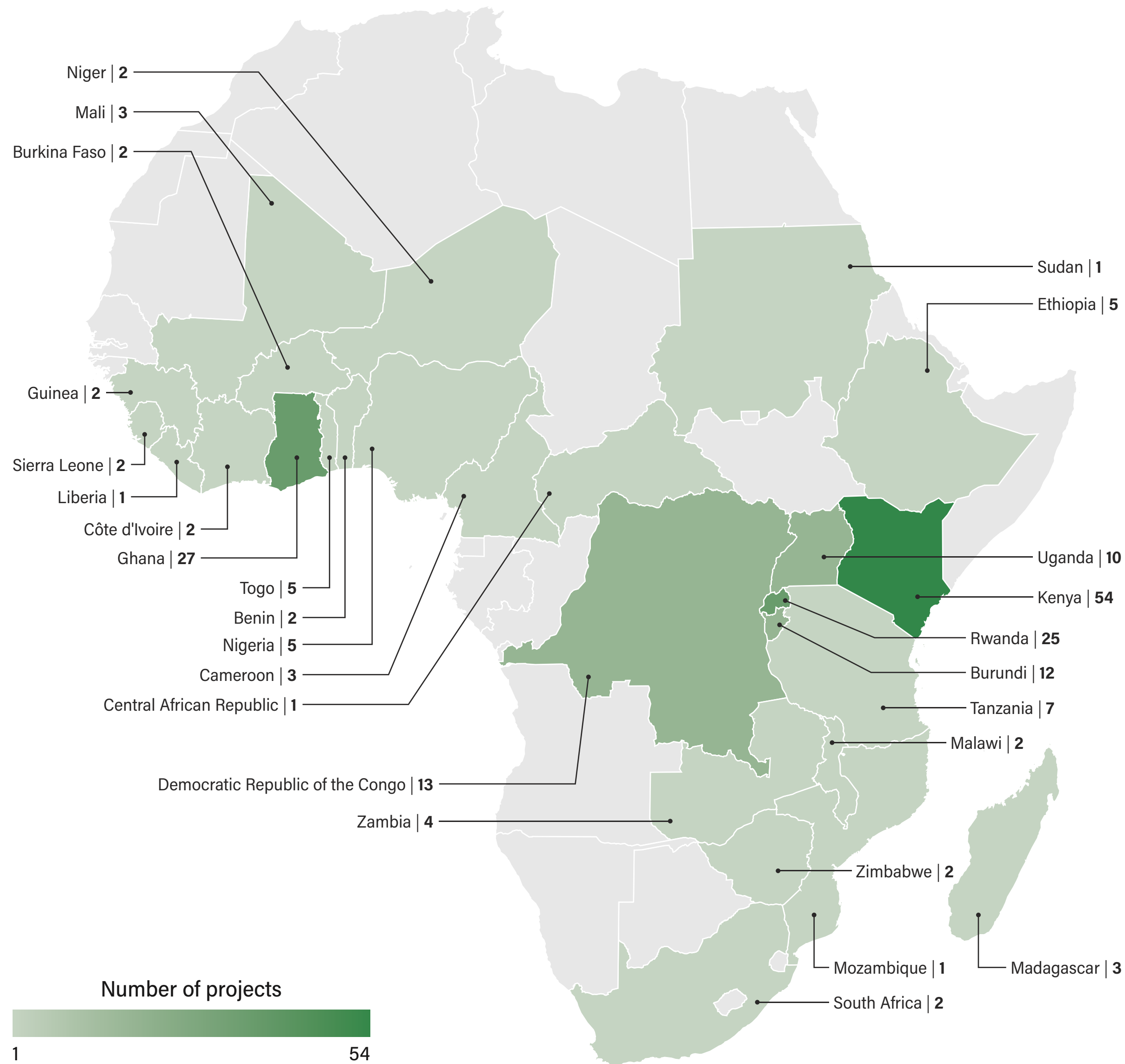
Without appropriate monitoring methodologies, local restoration organizations cannot prove the benefits of their projects and therefore often struggle to address the uncertainty and risk that discourage funders from investing.

About TerraFund

TerraFund was developed to address the lack of financing and access to monitoring technologies for local restoration organizations. In 2021, WRI and founding partners One Tree Planted and Realize Impact established TerraFund to support this under-funded but high-potential group of local projects. TerraFund provides technical assistance and debt-, equity-, and grant-based capital to medium- and growth-stage nonprofits and for-profit enterprises that design, coordinate, or implement tree-based land restoration initiatives in Africa. WRI and partners developed TerraFund as a contribution to the African Forest Landscape Restoration Initiative (AFR100), a multicountry initiative to restore 100 million hectares of land across 34 African countries. Figure 1 shows which countries have TerraFund projects. To meet the goals of AFR100, TerraFund attempts to bring together this multicountry vision of forest and landscape restoration with the local approaches of smaller organizations operating on as few as 20 hectares.

TerraFund projects typically employ one or more of three restoration practices: tree planting, direct seeding, or assisted natural regeneration. Projects operate on various target land use systems, but agroforestry accounts for 78 percent of the first two groups of projects—or "cohorts"—financed through TerraFund. More information on each TerraFund

Figure 1 | **Map of TerraFund project countries**



Note: Darker green indicates more projects per country, while a lighter green indicates fewer projects. There are no projects in gray countries. Number of projects range from 1 to 50 as of 2025.

Sources: WRI 2025. Illustrative administrative boundaries provided by geoBoundaries 2024.

restoration practice and target land use system can be found in Appendix B.

TerraFund acts as an early funder, providing capital to promising organizations that would traditionally face barriers to financing, whether these are high borrowing costs, prohibitive requirements, or inflexible funding. TerraFund's grants, equity investments, and concessional loans range from $50,000 to $500,000. This investment level is intended for medium- and growth-stage organizations that are more likely to face challenges accessing traditional capital but established enough to be able to effectively deliver restoration projects. Ninety-nine percent of recuperated funds from loans or equity investments are reinvested in enterprises. TerraFund management is continually learning and refining this financing scope to better suit the needs of local organizations.

Alongside financial capital, TerraFund provides restoration implementers, or "project developers," with training and resources, including dedicated budget to monitor, report, and verify the progress of their projects. This curated technical support aims to provide access to MRV approaches and high-quality data on projects for smaller organizations.

This guidebook describes one MRV approach for these smaller, localized restoration organizations. While developed under TerraFund for projects in Africa, the framework can be adapted to different contexts and can be a resource for organizations interested in monitoring restoration projects, including project developers, intermediary organizations, and funders.

Monitoring, reporting, and verification

Definitions of monitoring, reporting, and verification (MRV) vary across contexts. Here, MRV is defined as the data collection and analysis protocols that support measurement, communication, and validation of a project's progress and outputs.

MRV is often understood in the context of greenhouse gas (GHG) mitigation and carbon sequestration projects (Singh et al. 2016; UNFCCC 2014). The goal of MRV for carbon sequestration projects is to prove that a particular activity has in fact reduced or avoided the emission of GHGs and to convert those activities into monetized credits for the international carbon market (IBRD and World Bank 2021; Singh et al. 2016). These MRV protocols typically align with a particular standard, like Verra's Verified Carbon Standard (VCS Association 2017).

The MRV approach presented here serves a purpose distinct from that of carbon MRVs. This MRV framework supports assessment of project progress against a set of indicators using a digital platform. It does not calculate an independent carbon measurement to support any credit issuance.

MRV is a useful tool to understand whether interventions need to be adapted to achieve the desired outcomes. An effective MRV framework includes accountability mechanisms, adaptive management strategies, and cross-project comparisons. These components help ensure that restoration initiatives are meeting compliance standards, making progress toward their biophysical and socioeconomic goals, and, eventually, demonstrating outcomes in the target landscape.

MRV can also demonstrate environmental and social return on investments. Many benefits of restoration, such as biodiversity and other ecosystem services, are not currently monetized in traditional markets and are realized over long time frames. MRV approaches provide intermediary indicators of progress by documenting the short-term outputs of restoration (Ding et al. 2017). By observing and communicating the benefits of restoration in a target landscape, funders can understand the connection between a dollar invested and a tree grown or job created, giving them confidence to invest (Löfqvist et al 2023; Ding 2017; Faruqi 2016).

Figure 2 depicts some of restoration's benefits in a landscape.

Figure 2 | **Direct and indirect benefits of restoration**

Source: Faruqi and Wu 2016.

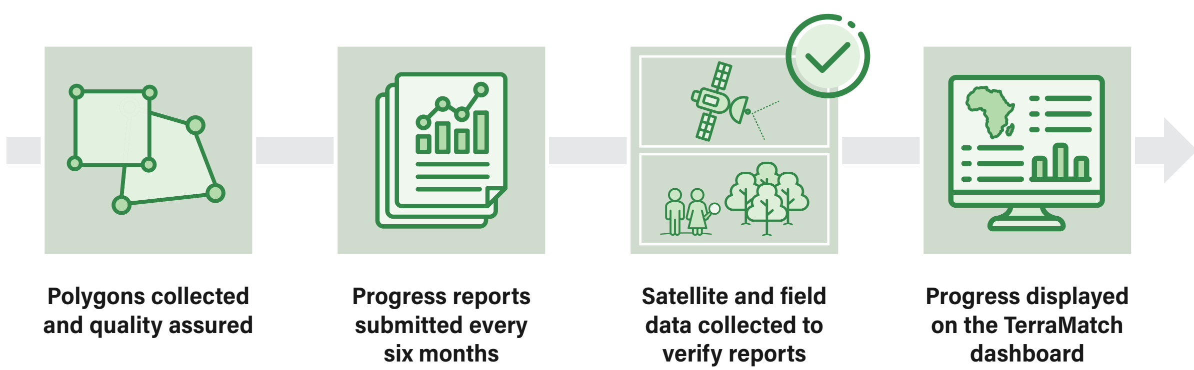
MRV for local restoration

This MRV framework aims to support medium and growth-stage restoration organizations to track project progress and monitor their outputs. Figure 3 summarizes this process, from the early stages of monitoring to the final verified data. It was designed to provide an MRV approach that meets the due diligence and reporting requirements of funders while also catering to the capacities and resources of local project developers. It is also intended to be cost-efficient and replicable; for the 198 projects supported through the first two rounds of TerraFund, WRI estimates that the remote sensing approach to counting and verifying trees planted described below will save an estimated $4 million compared to traditional inventories.[3]

In designing the MRV approach for TerraFund, WRI adapted an MRV framework created in partnership with Conservation International for the Priceless Planet Coalition (PPC) to monitor projects on medium to large scales (a few thousand hectares) (Sprenkle-Hyppolite et al. 2023).[4] TerraFund consulted other indicator frameworks, described in more detail in the "Methods" section and Appendix A. However, at the time of TerraFund's inception, no other framework met the need to monitor small and mid-sized restoration projects at scale and was co-created with practitioners.

Monitoring grounds the TerraFund MRV framework in 34 indicators across 9 categories. These indicators represent biophysical and socioeconomic outputs and serve as proxies for the various dimensions of project and program progress.

Figure 3 | **Phases of TerraFund MRV**



Note: MRV = monitoring, reporting, and verification.
Source: WRI authors.

Reporting is the sharing of data collected by project developers through project, nursery, and site reports, which are submitted on the TerraMatch platform in a standardized format every six months. TerraMatch is a two-way online platform that integrates the application process, reporting cycles, and technical support into a single interface. After submission on TerraMatch, portfolio managers conduct quality assessments and necessary analyses. Once reported data on trees, hectares, and jobs are verified, they are automatically transferred to the TerraMatch dashboard, where they can be viewed by internal and external stakeholders.

Verification is the assessment of data to confirm their accuracy, completeness, and reliability (Singh et al. 2016; Umemiya et al. 2015). Verification with an independent or audited secondary source of data is used to confirm indicators such as the number of trees grown or an organization's financial data. For data that are not independently verified, TerraFund uses two other practices to ensure data quality: validation and quality assurance (QA). Validation and QA provide confidence in reported data without the stringent requirements of traditional verification. Together, these three processes offer external stakeholders and funders credible data and provide project developers with an extra seal of approval for the quality of their work. See the "Verification" section or Table 1 for more detailed information on the three methods TerraFund uses to ensure data quality.

The MRV timeline

TerraFund operates on a six-year timeline for implementation, maintenance, and monitoring of restoration projects. While TerraFund ideally would monitor beyond year 6, the realities of funding mean the direct financing agreement between TerraFund and project developers is limited to six years. The first one to two years of a project are dedicated to tree planting and implementation, followed by three years of maintenance and monitoring by the project developers, and an additional year for the monitoring team to assess tree survival one year following project completion.

Despite the hope to monitor for longer, this time frame extends beyond what is normally allocated for monitoring in conventional tree-growing initiatives and provides time for the establishment of root systems, increased survival rates, the provision of ecosystem services, and sustained community engagement (Duguma et al. 2020; Brancalion et al. 2019).


Methods: Developing the framework

Since TerraFund's inception in 2022, WRI and partners have continuously refined the MRV approach through research, field-based trials and pilots, and user-feedback sessions. This guide builds upon the Priceless Planet Coalition's monitoring framework co-developed by Conservation International and WRI and has been tested on the ground with the help of 198 projects across Africa. It is now being adapted for use in programs in India and Brazil.

This MRV guide was developed by building on prior frameworks in the restoration monitoring space, primarily the Priceless Planet Coalition's *Tree Restoration Monitoring Framework: Field Test Edition* (Sprenkle-Hyppolite 2023).[5] See Box 1 for a description of the Priceless Planet Coalition. The guide is also the result of developments in the sector, including the "Restoration Monitoring Tools Guide" (Reytar et al. 2023), the Restoration Project Information Sharing Framework (Gann et al. 2022), *The Road to Restoration* (Buckingham et al. 2019), and the AURORA monitoring tool (FAO and WRI 2022). Progress in geospatial monitoring, as described in publications such as "High-Resolution Global Maps of 21st-Century Forest Cover Change" (Hansen et al. 2013) and the Tropical Tree Cover dataset (Brandt et al. 2023), is also fundamental to the TerraFund framework.

The creation of the TerraFund MRV approach began in 2020 with the development of the PPC framework, and it has been continually refined since. The process that WRI undertook to develop the TerraFund MRV framework entailed desktop research and a literature review of existing MRV frameworks to identify compatible models and indicators, subject expert consultation, consultation with local implementing project leads, and particular adaptation of the PPC MRV framework. The desk research and literature reviews helped the team understand how other frameworks converted their top-level goals into discrete, measurable metrics. Consultation with local project leads of the organizations selected for TerraFund has helped to ensure that the MRV framework captures the elements that are most relevant to restoration projects and stakeholders and are also practical to monitor given the time and resource constraints many local organizations navigate. The framework has since been tested with 198 restoration projects across Africa. For a map of countries with TerraFund projects, see Figure 1 above.

In preparing to launch TerraFund, the WRI team explored existing methods and frameworks best aligned with the types of TerraFund projects that were being funded to ensure a balance between the need for quality, verifiable data and the realities of implementation that can make monitoring more challenging, such as internet connectivity challenges, hard-to-reach restoration sites, and limited monitoring resources. Initial exploration with partner organizations on their existing restoration MRV frameworks yielded a list of over 200 indicators that are used to monitor restoration efforts. The Society for Ecological Restoration (SER) monitoring framework is one example of frameworks WRI reviewed. This comprehensive framework offers nearly 70 suggested indicators (Gann et al. 2022). Reviewing frameworks like these underscored the importance of monitoring frameworks being fit for purpose, and the need for the TerraFund framework to select a limited set of indicators in the interest of feasibility (Elias et al. 2025).

After surveying the landscape of options, WRI decided to adapt the PPC framework to develop the TerraFund framework, adjusting some indicators, disaggregations, and data collection approaches and tailoring reporting and verification to TerraFund. To match the capacity and resource constraints of both project developers and WRI, not all PPC indicators were included in the resulting TerraFund framework.

Compared with those of PPC, TerraFund-supported projects are often smaller in scale and aggregate many individual plots that may be 10 or fewer hectares. These smaller organizations also often have fewer resources to dedicate to monitoring. Therefore, the WRI monitoring team sought to create a simplified reporting process that matched the size and capabilities of small-scale, localized restoration projects.

After potential indicators were compiled through consultations, literature reviews, and adaptations of the PPC framework, TerraFund applied three core criteria to select indicators to include in the first iteration of its MRV framework. These criteria were feasibility for local partners to monitor, alignment with TerraFund's theory of change, and alignment

Box 1 | **The Priceless Planet Coalition monitoring framework**

Funded by Mastercard and managed by Conservation International and WRI, the Priceless Planet Coalition (PPC) is a global initiative that brings together a network of partners to restore 100 million trees across the world in locations where tree-based restoration has great potential to positively impact climate, communities, and biodiversity. WRI and Conservation International worked together to co-develop the MRV framework for PPC, which now serves as a model for the TerraFund MRV framework. The PPC monitoring framework provides guidance on monitoring mid- and large-scale restoration projects, in the range of 500–5,000 contiguous hectares.

with the SMART (specific, measurable, attainable, relevant, and timebound) indicator framework.

The TerraFund team approached the first year of implementation as one of learning and adapting and made iterative improvements to the MRV framework based on ad hoc and structured feedback from project developers, including through MRV workshops that WRI and One Tree Planted hosted as part of onboarding project developers. The TerraFund team also learned lessons through the reporting process, such as what questions were not consistently understood across respondents and should be rephrased, or what data were not as relevant as expected. The areas of learning that drove the most updates to the MRV framework related to mapping polygon boundaries, verifying tree count, MRV for assisted natural regeneration (ANR), and socioeconomic indicators.

TerraFund views its MRV framework as a living document and allows a limited degree of flexibility to continue to integrate feedback from partners and refine methods to improve accuracy of data and reduce burden on project developers, while also maintaining the consistency required to monitor progress over time. The following section describes the development and revision of four notable framework components as examples: collection of geospatial polygons, collection and validation of tree growth data, monitoring of assisted natural regeneration approaches, and monitoring of restoration's socioeconomic contributions.

Polygons

Polygons are a key component of geospatial monitoring, described in greater detail in the "Monitoring" section. TerraFund relies on precise location data in the form of geospatial polygons to understand where interventions are occurring. Polygons also allow the team to monitor and verify indicators of biophysical progress that can be connected to an exact set of points on Earth's surface, such as the change in tree cover. During the first year of implementation, the WRI team learned that the process for demarcating restoration areas, converting to geospatial data, and aggregating polygons into sites was a time-intensive and inefficient approach for many project developers. WRI initially requested that project developers provide polygons using the platform of their choice, and recommended Google Earth as an open-source option. However, this method required project developers to draw their site boundaries by hand, and without easily identifiable geographic features such as roads or rivers. It was difficult for project developers to orient polygons, specifically on rural sites. Project developers provided feedback that mobile applications that collect Global Positioning System (GPS) points in the field, especially offline-capable mobile apps, would be more efficient to map polygons. These field apps are essentially cameras that, along with photos of the site, capture GPS data and record characteristics about the restoration location in the attribute table and metadata. The geospatial data collected are then used to map a boundary of the restoration location. Mobile apps are particularly effective at mapping agroforestry projects, which have restoration locations that are scattered through an entire village or community.

With this understanding, the WRI team worked closely with partner and TerraFund recipient Wells for Zoë (2025a), which had developed a mobile application to overcome geospatial data collection challenges. WRI and Wells for Zoë collaborated to refine their two applications, Flority and Greenhouse, to give project developers a more user-friendly interface to collect geospatial polygons along with its attribute data (Wells for Zoë n.d., 2025a, 2025b). WRI geospatial data quality analysts (DQAs) work closely with project developers to train (and hire when necessary) a dedicated geospatial lead in Flority and Greenhouse and act as the point person for the individual restoration organization. After being trained, geospatial leads may then train other field enumerators in polygon collection and submission, depending on the size and needs of the project. If the project developer's staff has limited technical experience with mapping tools or has requested assistance, TerraFund may assign a field coordinator to help collect polygons directly in the field. Flority is used by projects' geospatial leads and enumerators to collect geotagged photos along the perimeter of the restoration plot. The location data collected in the photos are automatically converted to a geospatial polygon on a map on the back-end application, Greenhouse. Geospatial leads also collect attribute information such as restoration practice, planting dates, and number of trees planted, which along with these geotagged photos are then also uploaded to Greenhouse. This method requires no technical expertise, automatically uploads a mass amount of data points in real time, and does not allow data capture if an accuracy threshold of 5 meters is not met, making it more reliable than other geolocation camera applications (Wells for Zoë n.d.).

Tree data collection and verification

Knowing the number of trees going into the ground and surviving is crucial for understanding the success of TerraFund. However, tracking and verifying the growth of millions of individual trees across hundreds of projects is not an easy task. Since 2022, the team has explored numerous approaches to solving the question of how to monitor and verify trees at scale and at a lower cost than traditional inventories. The current approach is described in the "Monitoring" and "Verification" sections, but the original TerraFund MRV framework planned to use the Collect Earth Online system to verify trees (Reytar et al. 2021). This would have entailed individuals manually reviewing geospatial imagery and estimating the number of trees based on common geospatial image indicators. In testing the framework, the team quickly learned that this approach was not fit for TerraFund's purposes, in part due to the inherent subjectivity and limited accuracy of relying on individuals to assess whether geospatial images contain trees or not. Also, seedlings are typically not visible in satellite imagery before three years. The team sought alternative methods for monitoring tree growth within two years of planting in order to support effective and adaptive project management. Given that mortality rates are high in the first year and planting usually takes place up to year 2, identifying early insights after this two-year mark helps pinpoint areas where seedlings are struggling to survive and the project developer may need to adjust the site or maintenance practices. Early insights also signal to TerraFund that projects are making progress toward their targets relative to their budget spending, a crucial metric for the project management team and donors.

WRI tested a drone mapping approach to count young trees with various types of consumer drones (including DJI Mavic Air 2S, Mavic Mini, and Phantom 4 Pro), attempting to observe planting at a 1 centimeter (cm) ground sample distance. These drones on average used a 1-inch complementary metal oxide semiconductor sensor and had 12–20 megapixel resolutions. The team found, however, that this method was not cost-effective at the scale required to monitor all TerraFund projects. Drones are often considered an affordable alternative for mapping smaller plots compared to satellite technology because of their finer spatial resolution. However, monitoring using drones requires significant data storage to save all the images, as well as trained drone pilots and access to drones, both of which come with a high per-project cost. Given the dispersed model of TerraFund projects, many individuals would need to have access to and trainings on drones. Projects that have access to drones and pilots may find this a useful monitoring approach, but TerraFund determined that the cost of drones and associated staff training required was not cost-effective or scalable. The monitoring team pivoted and developed a new approach for detecting trees using remote sensing imagery and computer vision, a form of artificial intelligence that uses machine learning to train a computer to interpret digital images (Brandt and Stolle 2020). Through this approach, described in more detail in the "Verification" section of this guidebook and in a forthcoming journal article, WRI uses a computer vision technique to identify tree crowns in high-resolution imagery from Vantor, a satellite imagery provider, using the least amount of high-resolution imagery possible.

Assisted natural regeneration

Assisted natural regeneration (ANR) is a cost-effective method for land restoration and a crucial component of the TerraFund portfolio. Often paired with tree planting, ANR encourages restoration by removing threats, like grazing, fires, and invasive species, that hinder natural regrowth. Despite its importance, it is notoriously undermonitored across the sector, since MRV efforts tend to focus on the number of trees planted, which are easier to count (Chazdon et al. 2023). Without ANR-relevant metrics, projects using the approach can find it difficult to demonstrate progress, since they cannot report the number of trees planted. When the MRV framework was first tested with the inaugural cohort of projects in 2021, it similarly did not include ANR. However, over the years, the TerraFund team has worked to develop a monitoring approach that sheds light on the importance of the practice and demonstrates the impact of practitioners' implementing it.

To incorporate ANR into the framework, project developers were asked how commonly they applied ANR techniques in the field. Along with desk research of other ANR monitoring methods, the TerraFund team surveyed restoration project developers that implement ANR on the practices they employ. The TerraFund team held interviews with a sample of these developers to understand the metrics of progress they would find useful and the approaches they have used in the past to track and account for their restoration progress. After this research and testing period, the TerraFund team created an ANR reporting process that allows project developers to describe their approaches and markers of progress and report on defined metrics. ANR projects primarily report on the number of hectares under restoration and the number of self-regenerating trees, an indicator currently being piloted. This approach allows TerraFund to efficiently track progress on ANR interventions more effectively but leaves room for developers to describe their activities more holistically. Appendix C describes TerraFund's approach to MRV of ANR in greater depth.

Socioeconomic indicator definitions

Central to TerraFund MRV is the objective to understand project contributions to local livelihoods. To do this, TerraFund measures resulting employment, skills, and other restoration benefits such as provision of tree seedlings or nontree crops, which can provide a source of income and food security. After testing approaches to tracking information about livelihood contributions, the TerraFund team learned that some of the terminology used was interpreted differently by different partners. For example, the original reporting framework asked developers to report the "number of jobs created." Some developers interpreted this as the number of jobs directly on the project, while others understood it as the number of jobs potentially created across the supply chain, such as jobs for individuals working in the nurseries that supplied seedlings, individuals transporting inputs and equipment, or those employed by processing plants that TerraFund companies sell to. This led to a wide range of reported figures. To remedy this problem, the TerraFund team worked closely with project developers to formulate and clarify the definitions of socioeconomic terms. In biannual project reports, the terminology "number of people employed" is used, rather than "jobs created." However, in WRI's external reporting, it is "jobs created," as this is more easily understood by nonpractitioners such as donors.

Another component of socioeconomic benefits to which many TerraFund projects contribute is skills-building. The original MRV framework asked developers to report the number of people with increased skills or knowledge. Project developers reported that measuring increases in skills or knowledge would require follow-up tests or surveys to the trainings they provide, and that a more precise metric would be "number of people trained." This feedback and analysis of reported socioeconomic data has informed adjustments that have improved the data quality and user-friendliness of MRV of socioeconomic objectives.

Monitoring

TerraFund's monitoring system is based on a set of 34 indicators across 9 categories. These indicators assess both the biophysical and socioeconomic dimensions of restoration. Indicators are carefully chosen to capture key insights on restoration progress while aiming to minimize the burden of data collection on project developers. Indicator data are collected using field-based methods and remote sensing approaches. Most indicators assess the progress and outputs of restoration projects. Some indicators are used to monitor the success of WRI and its partners in their efforts as fund managers to support inclusive finance and market access.

Monitoring is a fundamental process for understanding the progress of restoration projects. The Organisation for Economic Co-operation and Development defines monitoring as a "continuing process that involves the systematic collection or collation of data on specified indicators or other types of information" (OECD 2024). The function of monitoring is to show progress and achievements, signal when adjustments to programs and approaches are required, and demonstrate use of funds (OECD 2024). This section describes the components of TerraFund's monitoring approach and the indicators it measures.

TerraFund's monitoring approach

The TerraFund monitoring framework is comprised of 34 indicators related to the objectives of TerraFund restoration investments, including the biophysical restoration of land and socioeconomic benefits created by restoration. There are nine categories of indicators: tree restoration, landscape restoration, jobs created, livelihood benefits, financial health and performance, community engagement, carbon sequestration, inclusive finance, and market access. TerraFund indicators measure project-level progress and portfolio-level progress. The sources of monitoring data are remote sensing approaches, field monitoring, project proposal and applications, and project data sources such as physical or digital records and registries or expense reports. TerraFund indicators measure outputs, or intended results that the TerraFund program directly influences. Many of these indicators also serve as proxies for the longer-term outcomes to which TerraFund aims to contribute, such as landscape-level restoration.

TerraFund categorizes its indicators in two ways based on their distinct functions, as project implementation indicators or program administration indicators.

Project implementation indicators focus on evaluating individual restoration projects and their progress. These indicators capture metrics such as the number of seedlings produced, the survival rates of planted trees, and the number of employment opportunities. They can also be aggregated to provide a comprehensive view of progress across all TerraFund-supported projects. These indicators primarily use the numbers of outputs as their metric (number of trees, jobs, hectares, etc.).

Program administration indicators assess the effectiveness of WRI and its partners as the administrator of TerraFund. Particularly, these indicators assess efforts to support inclusive finance and market access for project developers and include the number of women-led and youth-led organizations supported, as well as the percentage of projects accessing market-based finance. Program administration indicators primarily use the number of projects as their metric. Measuring number of projects, rather than outputs, is one way to leverage self-reported data to accurately quantify harder-to-measure activities that are based on qualitative data, such as those around livelihoods and community engagement.

The set of TerraFund indicators draws on quantitative and qualitative approaches typically found in both monitoring, reporting, and verification (MRV) and monitoring, evaluation, and learning (MEL) systems in an effort to understand the range of inputs, outputs, and benefits of restoration. Understanding the different purposes for each indicator and the different data collection methods to monitor indicators helps inform how to interpret and use monitoring data. Table 1 provides a grouping of TerraFund indicators. More details about the indicators can be found in the "Indicator overview" subsection and in Appendix F.

Table 1 | **Indicator groupings**

TYPE	INDICATOR CATEGORY	VERIFICATION, VALIDATION, OR QA	TRACKING CHANGE OVER LIFETIME OF PROJECT	INDICATORS INCLUDED	
Project implementation	1. Tree restoration	▪ Quality assurance of reports ▪ Validation through site visits ▪ Verification using remote sensing and AI model	Yes	1.1 Seedlings produced 1.2 Trees planted	1.3 Survival rate 1.4 Trees grown
	2. Land restoration	▪ Quality assurance of polygons ▪ Validation through site visits ▪ Verification with remote sensing	Yes	2.1 Hectares under restoration	2.2 Percentage tree cover change
	3. Jobs created	▪ Quality assurance of reports ▪ Validation through site visits and additional documentation	Yes	3.1 Full-time employees 3.2 Part-time employees	3.3 Volunteers
	4. Livelihood benefits	▪ Quality assurance of reports ▪ Validation through site visits	Yes	4.1 Individuals in communities receiving direct benefits 4.2 Individuals in communities receiving indirect benefits	4.3 Trainees 4.4 Income-generating activities
	5. Financial health and performance	▪ Quality assurance of reports ▪ Verification using audited supporting documentation	Yes	5.1 Net profit margin 5.1.1 Change in revenue 5.2 Current ratio 5.3 Enterprise repayment	5.4 Finance repayment 5.5 Budget execution rate 5.6 Change in operating budget 5.7 External finance
	6. Community engagement	▪ Quality assurance of reports ▪ Validation through site visits	Yes	6.1 Addressing barriers 6.2 Local input	
	7. Carbon sequestration	▪ N/A; field collected, calculated using an allometric carbon model with remotely sensed data	Yes	7.1 Carbon sequestered after 6 years	
Program administration	8. Inclusive finance	▪ N/A; supporting documentation collected during project selection	No	8.1 Women-led projects 8.2 Women-led finance 8.3 Youth-led projects 8.4 Youth-led finance	8.5 Local projects 8.6 Local finance 8.7 Locally led projects 8.8 Locally led finance
	9. Market access	▪ N/A; supporting documentation collected during project selection	No	9.1 Percentage of projects accessing market-based finance 9.2 Percentage of total finance allocated as debt or equity	

Notes: AI = artificial intelligence; QA = quality assurance. Verification is the use of independent or audited secondary supporting documentation to confirm the accuracy of reported data, such as audited financial statements or the AI tree count model; Validation is the use of nonaudited, supporting documentation or field visits to assess the accuracy of reported information; Quality assurance is the manual or automated review and cleaning of reported information to assess its completeness and reasonableness. It does not use any supplemental documentation.

Source: WRI authors.

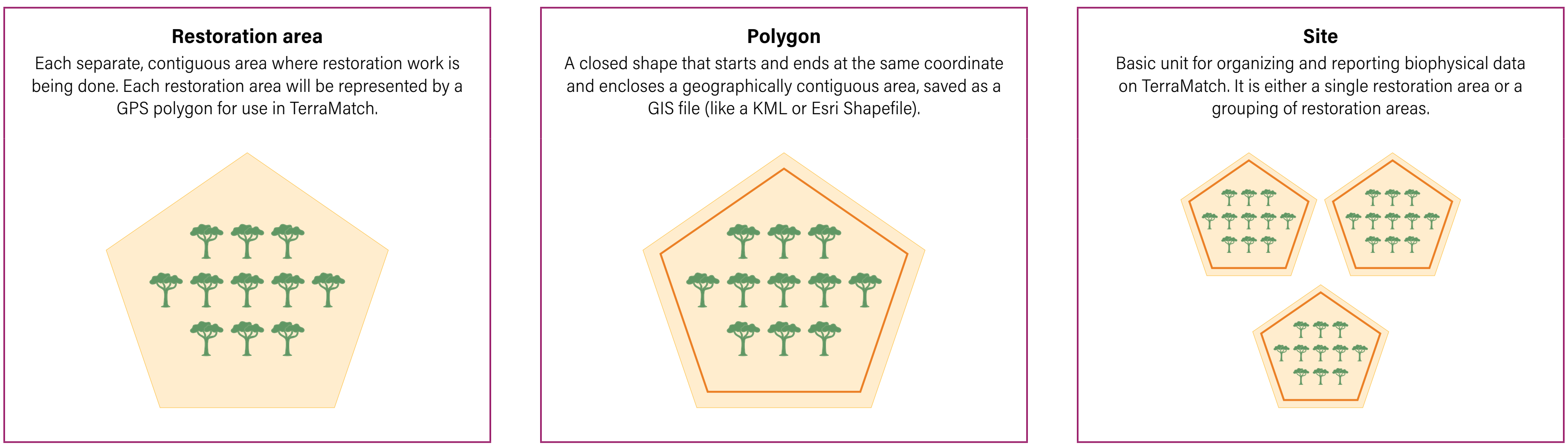
Geospatial monitoring

Monitoring biophysical progress is rooted in a demarcated geospatial boundary called a *polygon*. A polygon is a closed shape that starts and ends at the same GPS coordinate (Esri n.d.). Each polygon represents the exact location of a geographically contiguous area where a restoration practice is occurring. Practices include active tree planting, direct seeding, or assisted natural regeneration activities and can occur on a variety of target land use systems. Multiple restoration practices can be used on a single polygon and across a site (defined below). However, each polygon has a single target system. See Appendix B for more information. Target land use system and intervention type are included in each polygon's associated attribute table, which also contains identifying information, GPS data, distribution type, planting start dates, tree count, and area in hectares.

Polygons are grouped into *sites*, a larger collection of restoration locations that can include a single polygon or multiple polygons that may not be contiguous. Unless a site has a single polygon, sites do *not* have a demarcated boundary. A single *project* may have multiple sites. One project can have multiple polygons corresponding to where they are implementing restoration. Figure 4 describes the difference between restoration areas, polygons, and sites.

Polygons demarcate where project activities are occurring, enabling more effective project management. Confirming whether restoration is happening is much easier if progress is tied to specific GPS points. When visiting project sites, for example, TerraFund staff know exactly where to go to determine if planting has occurred. Polygons also allow TerraFund staff to conduct more precise analyses on project areas. For example, TerraFund's geospatial monitoring team can use high-resolution imagery to identify the individual number of trees planted (at 30 cm spatial resolution with Vantor imagery) or the change in tree cover on just the project area under restoration and nowhere else. This not only eliminates the cost of purchasing unnecessary satellite imagery but also means analyses will be more accurate, only including the trees planted and the area restored by the project. Figure 5 shows how polygons

Figure 4 | **Definitions of restoration area, polygons, and sites**



Notes: Esri = Environmental Systems Research Institute; GIS = geographic information system; KML = keyhole markup language.
Source: WRI authors.

capture the precise area where a project is restoring across a given tract of land and avoid counting areas where restoration is not occurring.

By clearly outlining the restoration location with geospatial polygons, TerraFund staff can analyze biophysical change at multiple levels—for example, the number of hectares under restoration across a landscape—as well as the number of individual trees grown. While socioeconomic benefits extend beyond a single geographic boundary, polygons help to contextualize where some of the project's socioeconomic contributions may be centered.

The number and size of these polygons, as well as the target land use system, determine the restoration model of the project. For TerraFund projects, the techniques used to restore land (such as agroforestry, ANR, enrichment planning, and mangrove restoration) and whether restoration is happening in a concentrated, distributed, or hybrid manner (see below) are the main characteristics that determine the restoration model. This model helps determine which geospatial data collection approach is most appropriate. For example, an agroforestry project might involve planting trees along a farm's perimeter to function as a windbreak. In this case, the entire farm area could be considered under restoration due to the positive impact of the windbreak on the farm.

TerraFund employs three distinct models for geospatial data collection (shown in Figure 6), tailored to different types of land use systems:

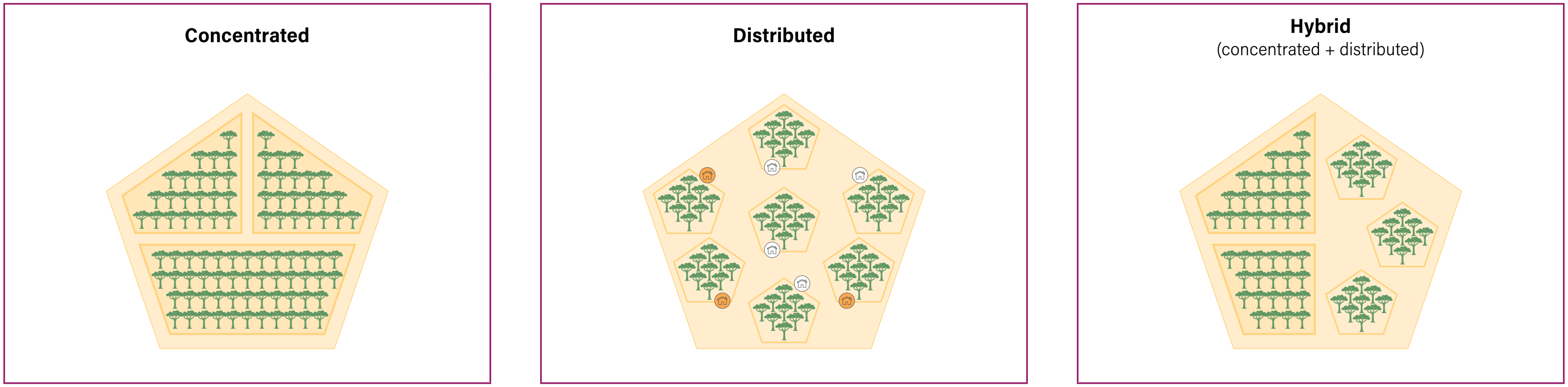
- Concentrated model: This model applies to projects with fewer, larger restoration areas. The average size of each restoration area exceeds three hectares, with fewer than 50 total restoration areas. Polygon data are collected by walking the boundary of each restoration area.
- Distributed model: This model is for projects with a larger number of smaller restoration areas. The average size of each restoration area is less than three hectares, with more than 50 total restoration areas. Polygon data are also created by walking the boundary of the restoration area.
- Hybrid model: This model is used when a restoration project includes areas aligning with a distributed model and one or more areas aligning with a concentrated model. For example, a hybrid model would be a project that is mostly distributing seedlings to individual farmers in five villages but is also working with the community to restore twenty hectares of a degraded community forest. If the project is a hybrid project, separate sites must be created for concentrated and distributed restoration areas. Project developers may create one or multiple concentrated and distributed sites, based on how many locations they are working in.

These models provide both the monitoring team and project developers with a clear framework for understanding project distribution. Once the appropriate model is identified, geospatial data are gathered directly by project developers. TerraFund partnered with Wells for Zoë (2025b), one of the organizations funded through TerraFund, to develop the approach to geospatial polygon collection. The approach

Figure 5 | **Single agroforestry polygon (left) and site (right) in Ghana**

Sources: Authors and anonymous project partner. Satellite imagery © Mapbox, © OpenStreetMap.

Figure 6 | **Concentrated versus distributed sites**

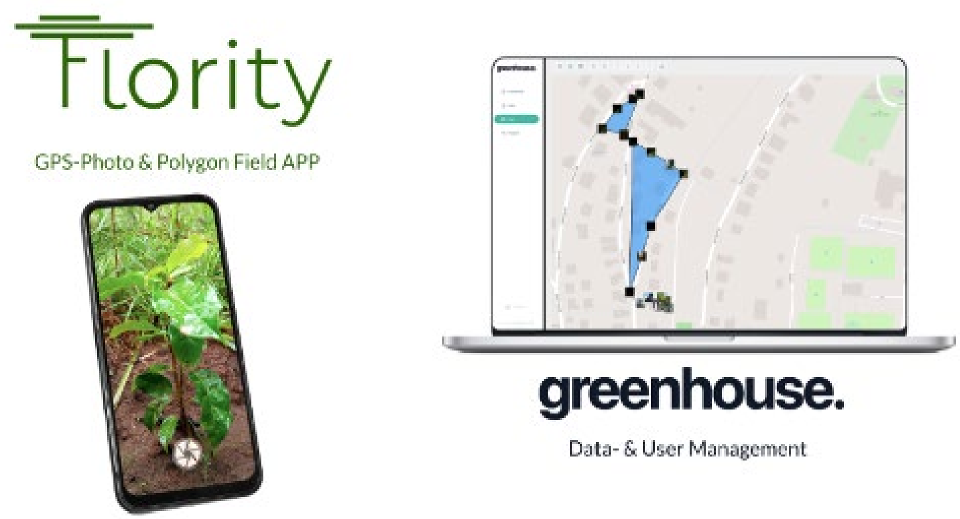


Source: WRI authors.

uses a "point-and-shoot" mobile application called Flority and its associated back-end web system, Greenhouse, to take geotagged photos around the perimeter of a restoration area and upload them to the web system, where they can be transformed into polygons using the coordinate information in the photos' metadata (Wells for Zoë n.d.) (see Figure 7). Flority enables users to easily collect polygon data, even in areas without cellular service, and to output standard geospatial data formats and metadata. See Figure 8 for an in-app view of Flority's point-and-shoot interface.

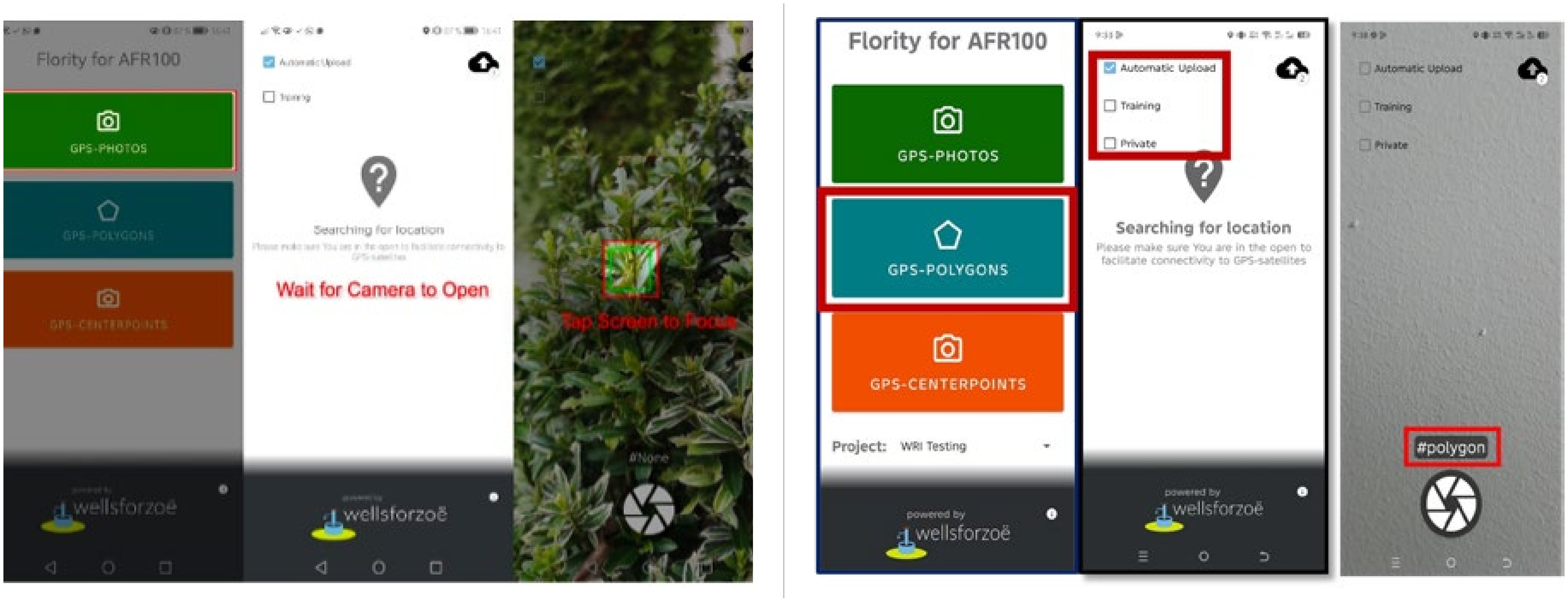
Once collected, these geospatial data serve as the foundational component for subsequent monitoring and remote sensing activities, supporting the assessment of key indicators in the restoration process.

Figure 7 | **Views of the Flority and Greenhouse applications**



Source: Wells for Zoë n.d.

Figure 8 | **In-app view of Flority**



Source: Wells for Zoë n.d.

Report-based monitoring

TerraFund employs remote sensing approaches to monitor as many indicators as possible (trees grown, tree cover, and carbon sequestration), but many indicators are not suitable for remote sensing (jobs, beneficiaries, survival rate, budget expenditures, etc.). In these cases, TerraFund does not prescribe monitoring protocols for project developers but rather provides support and resources to inform monitoring approaches. Project developers employ the monitoring techniques they find most suitable and that allow them to report progress on a biannual basis. WRI and partner support includes the survival rate guidance in Appendix D and the employee registry in Appendix E, as well as a selection of resources through a dedicated help desk (TerraFund n.d.).

Indicator overview

This subsection describes TerraFund indicators and the functions they serve for understanding the progress of individual projects and the overarching portfolio. Appendix F provides details on data sources and data collection methods, the way data for each indicator are disaggregated, and additional considerations specific to each indicator.

Project implementation indicators

1. TREE RESTORATION

1.1. Number of seedlings or saplings produced: The total number of seedlings grown in nurseries for planting across sites and projects. The indicator tracks intermediary progress toward indicator 1.2, "Number of trees planted." Data on seedlings and saplings are disaggregated by species, providing insight on contributions to biodiversity and native tree count.

1.2. **Number of trees planted**: The total number of trees planted over the duration of a project. These data are self-reported, and, like data on seedlings and saplings, disaggregated by species type. This indicator is one of the earliest signifiers of project progress and provides a baseline metric used in assessments of survival rates, species diversity and composition, and progress toward contract goals. To confirm planting that has occurred and enable adaptive project management, this indicator is subject to early insights review via remote sensing two years following planting. Trees grown through direct seeding and enrichment planting are included here. For projects using exclusively ANR, this indicator is not considered.

1.3. **Survival rate of planted trees**: An assessment of the continued existence and growth of planted trees, evaluated by project developers once a year in the three months preceding a site report. Because they submit site reports twice a year, projects choose in which reporting cycle it is most appropriate to report survival rates. Trees replaced within the reporting cycle when planting also occurred do not count against survival rate. Survival assessments are required once a year; however, project developers are encouraged to calculate survival rate twice in the first year of planting. Estimating survival rate early and often in the project life cycle can help project developers and the TerraFund team determine if the project is on track to meet expected restoration targets and decide if an intervention is necessary to achieve the desired size, density, and quality of planted seedlings. ANR-only projects are not required to conduct a survival rate assessment. See Appendix D for more information on survival rate calculation and guidance on replacement and replanting.

1.4. **Number of trees grown by project conclusion**: The total number of trees planted that survive six years after the project's start, adjusted by their survival rate and verified using TerraFund's remote sensing–based and artificial intelligence tree count model. Long-term tree establishment is one of the main goals of tree-based restoration. By focusing on sustained growth, not just planting, this indicator provides insight into the durability of tree-planting efforts. This metric does not include trees naturally regenerated through ANR.

2. LAND RESTORATION

2.1. **Total number of hectares under restoration**: The total hectarage of polygons submitted by projects with active restoration practices. Hectares under restoration provides information on the project's target area and the number of hectares being restored across the portfolio. This indicator is relevant for both ANR and tree-planting projects and is the primary indicator for ANR interventions.[6]

2.2. **Percentage of tree cover change**: The change in tree cover over six years, providing another lens for understanding contributions to land restoration over the lifetime of the project. Measured using the Tropical Tree Cover dataset, this indicator provides an independent metric of restoration progress (Brandt et al. 2023). Tree cover change is measured completely using remote sensing at a spatial resolution of 10 m. It does not currently apply to projects using exclusively ANR.

3. JOBS CREATED

3.1. **Number of full-time employees of TerraFund projects**: The number of people working 35 or more hours per week on TerraFund projects with a consistent role that involves daily or almost daily engagement for at least three out of the six months of the reporting period. This indicator provides insight into the project's contribution to socioeconomic outcomes in the local area.

3.2. **Number of part-time employees of TerraFund projects**: The number of people working part-time on TerraFund projects, broken down into two categories: part-time employees, those working less than 35 hours per week on projects, and short-term, seasonal, or casual employees. This is an inclusive definition of the various types of part-time employment, an important contribution to restoration projects, and critical to understanding socioeconomic contributions. Part-time employees work less than 35 hours on the project per week with a consistent role that involves frequent engagement for at least three months of the last six-month reporting period. Short-term, seasonal, and casual employees are people working periodically on the project, typically involved in tasks that take a few days, or during high-engagement seasons such as planting seasons. These include jobs that involve recurring engagement at the same time in different months but for a short duration ranging from a few days to a few weeks (e.g., people engaged to plant for three days).

3.3. **Number of volunteers contributing to the project**: The number of unpaid volunteers assisting with TerraFund projects, used to assess the contributions of unpaid labor in restoration work. Volunteer arrangements may be one form of community engagement for some projects. Project developers provide qualitative data on the nature of volunteer work, which provides additional insight into the labor and community engagement supporting a project.

4. LIVELIHOOD BENEFITS

4.1. **Number of local community members directly receiving benefits from restoration**: The estimated number of local community members who are direct recipients of tangible benefits from TerraFund projects, such as seedlings, access to savings and loan services, or support for income-generating activities such as beekeeping. While quantitative data related to this indicator are challenging to verify, project developers also provide qualitative data on the types of benefits, providing a more holistic view of restoration projects beyond tree growth.

4.2. **Number of local community members indirectly receiving benefits from restoration**: The estimated number of people indirectly receiving benefits from the project. A benefit received indirectly refers to the downstream value realized as a peripheral result of a project, such as improved water or soil quality, or the knock-on benefits provided to community members who did not directly receive a benefit. This indicator provides an opportunity for project developers to capture the full range of benefits they believe their projects are contributing.

4.3. **Number of people who received training from the project**: The number of people who received training, including other capacity-strengthening or skill-building opportunities, on topics related to restoration or other livelihood sources. Providing training is one way many restoration projects aim to contribute to improved livelihoods for community members.

4.4. **Number of projects supporting income-generating activities**: The number of projects in the portfolio that support activities such as apiculture, nursery establishment, or livestock-keeping to supplement the income of farmers and community members. This indicator provides data on how many projects are contributing to community livelihoods, while project developers also provide supplementary qualitative information on how projects are supporting income-generating activities.

5. FINANCIAL HEALTH AND PERFORMANCE

The financial reporting processes for nonprofits and for-profits vary slightly, with the indicators reflecting these differences. Nonprofits follow industry standards and report on budget expenditure to understand how much has been spent in relation to project progress. For enterprises, for whom it is difficult and not an industry-wide practice to assess each investment's impact as a separate "project," TerraFund takes a holistic view of an enterprise's finances to understand its performance. For-profits report on standard, organization-level financials to track business growth, solvency, and debt repayments.

Enterprise-specific

5.1. **Net profit margin**: The percentage of revenue that remains as profit after all operating expenses, interest, taxes, and other costs have been deducted.

5.1.1. **Gross and percentage change in revenue**: The gross and percentage change in annual revenue (in US$) of the enterprise over the tenure of the investment. Change in revenue is used to calculate project margin and is therefore a constituent part of the net profit indicator but also an important standalone subindicator of business-level health.

5.2. **Current ratio**: The liquidity of an enterprise, calculated by comparing current assets to current liabilities.

5.3. **Percentage of enterprises repaying loans on time**: The percentage of enterprises that have paid the amount due on their loan balance each week.

5.4. **Percentage of finance repaid by borrowers**: The amount of total capital of each loan repaid in US dollars to date.

Nonprofit-specific

5.5. **Budget execution rate**: The annual percentage of the budget spent out of the total approved amount. An example nonprofit expense report is included as Appendix G. The reports are designed to help organizations understand the percentage of funds they can allocate to project activities, income-generating initiatives, and other nontree-based interventions that support restoration permanence. Both enterprises and nonprofits may use up to 30 percent of the total budget for complementary, nontree-planting activities as part of the overall restoration effort. For portfolio managers, tracking budget spend-down allows early detection of under- or overspending, particularly in relation to project progress. A low execution rate may indicate delays in project implementation, while a very high rate early in the project may raise concerns about burn rate or financial planning.

5.6. **Change in organization operating budget**: The percentage change in the total annual operating budget of a nonprofit organization over the course of its TerraFund project.

All organizations

5.7. **Level of external finance catalyzed for projects**: The number and US dollar amount of additional or "follow on" grant, loan, or equity investments that organizations have accessed since receiving TerraFund funding. This indicator assesses TerraFund's progress toward its goal of unlocking additional finance for funded organizations but is not considered in the total amount invested by TerraFund.

6. COMMUNITY ENGAGEMENT

6.1. **Percentage of projects demonstrating efforts to address barriers to equity for women and youth**: The proportion of projects that demonstrate they are addressing financial, economic, and social barriers, or inequitable land and resource rights that women and youth face that limit their participation in decision-making regarding restoration benefits. TerraFund defines youth in line with the African Union's (2006) definition as individuals between 18 and 35 years of age. This may include activities such as providing access to credit or savings groups or conducting educational trainings. More information on this indicator and eligible project activities is included in Annex F.

6.2. **Percentage of projects seeking local community input in project decisions**: The proportion of projects actively involving local communities and their priorities in project decision-making, planning, and implementation, demonstrated through projects' descriptions of the specific mechanisms used to gather local community input in project decisions, the decisions this input informs, and the frequency at which they seek this input. This is an indicator of how localized projects' approaches are.

7. CARBON SEQUESTRATION

7.1. **Metric tons of carbon sequestered after six years**: An evaluation of change in the tons of carbon stored in restoration areas between baseline and six years after project implementation. The indicator is measured with high-resolution imagery (30 cm) via an allometric relationship between diameter at breast height (DBH) and crown projected area (CPA). This information is collected either through a remote sensing mapping approach or a field inventory approach. A machine learning model is trained using high-resolution imagery and run across the landscape at no less than 1 m resolution to map tree crowns and then uses the CPA-to-DBH allometry developed by Mbow et al. (2014), Kachamba et al. (2016), and Kuyah et al. (2012) to assign carbon stocks. Appendix H explains TerraFund's approach to monitoring carbon benefits in detail.

Program administration indicators

8. INCLUSIVE FINANCE

8.1. **Percentage of projects allocated to women-led organizations**: The proportion of projects managed by women-led organizations over the total number of active TerraFund projects. "Women-led" is defined as over 50 percent women in leadership positions, understood as ownership for enterprises or decision-making authority in nonprofits. This portfolio-level indicator tracks WRI and partners' progress distributing finance to women-led organizations.

8.2. **Percentage of finance allocated to women-led organizations**: The percentage of TerraFund financing allocated to organizations with over 50 percent women leadership. This indicator is used to monitor whether women-led organizations are receiving equitable levels of financing per organization.

8.3. **Percentage of projects allocated to youth-led organizations**: The proportion of projects managed by youth-led organizations over the total number of active TerraFund projects. "Youth-led" is defined as over 50 percent youth in leadership, represented either as ownership for enterprises or decision-making authority in nonprofits. This portfolio-level indicator tracks WRI and partners' progress distributing finance to youth-led organizations. As stated above, TerraFund defines youth as those between 18 and 35 years of age (African Union 2006).

8.4. Percentage of finance allocated to youth-led organizations: The percentage of TerraFund finance allocated to organizations with over 50 percent youth leadership. This indicator is used to monitor whether youth-led organizations are receiving equitable levels of financing per organization.

8.5. Percentage of projects allocated to local organizations: The proportion of projects managed by local organizations over the total number of active TerraFund projects. This indicator helps TerraFund differentiate between local organizations that have local management and represent local interests and international organizations that have a locally registered branch. Appendix F provides more details on TerraFund's definition of "local."

8.6. Percentage of finance allocated to local organizations: The percentage of TerraFund finance allocated to local organizations.

8.7. Percentage of organizations aligned with a locally led approach: The percentage of projects that demonstrate efforts to take an increasingly localized approach. Table 2 illustrates how TerraFund defines different levels of localization.

8.8. Percentage of finance allocated to organizations aligned with a locally led approach: The percentage of TerraFund finance allocated to organizations that demonstrate efforts to take an increasingly localized approach.

9. MARKET ACCESS

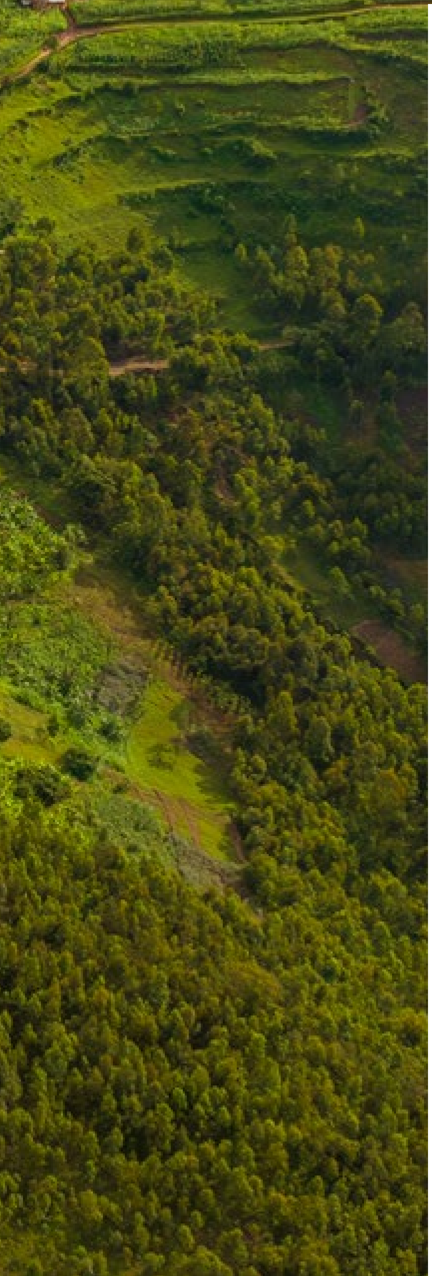
9.1. Percentage of projects accessing market-based finance: The percentage of projects receiving debt or equity investments compared to the total number of projects. This indicator helps assess sustainability of projects to continue receiving finance beyond TerraFund.

9.2. Percentage of total finance allocated as debt or equity: The percentage of debt and equity investments over all distributed funding to understand how much market-based investments versus nonpayment grants make up the total TerraFund portfolio.

Table 2 | **Localization continuum**

	LEAST LOCAL LEADERSHIP		→ MOST LOCAL LEADERSHIP		
Level of engagement	**Conventional**	**Consultative**	**Participatory**	**In partnership**	**Locally led**
Description	Local actors informed but do not shape project design. One-way extraction of data and information.	Local actors provide feedback through one-way communication mechanisms.	Local actors invited to plan a project or inform decisions. Process to identify local actors and promote their participation. No formal process for local actors to inform decisions.	Decisions are made jointly between local partners and nonlocal actors.	Local actors make technical and programmatic decisions.

Source: WRI authors.



Reporting

The reporting system is the flow of indicator data from project implementers on the ground, to TerraFund project management staff via the online platform TerraMatch, and eventually onto the public dashboard for other stakeholders. Over the lifetime of the project, developers will submit project, site, nursery, financial, and expense reports over 12 biannual reporting periods.

In TerraFund, all funded projects report on progress biannually through TerraMatch, in January and July of each year. Reporting entails all projects responding to the same set of general and indicator-specific questions pertaining to project activities and results in the six months preceding the reporting period. In addition to indicator data, reports collect information that builds a narrative understanding of a project for the TerraFund team, such as information about the challenges projects face and the most significant changes organizations observe. The team uses this information to provide targeted assistance to developers and signal the need for intervention if needed. While not every dimension of project delivery can be represented with an indicator, the entirety of reported information creates a holistic picture of project successes and risks.

Reporting serves the following purposes for TerraFund:

1. **Assess progress**: Understand project-level performance against indicators and track the overall progress of the portfolio of projects.
2. **Facilitate adaptive management**: Learn and adjust strategies, timelines, and processes in response to challenges faced by projects. This may include altering planting schedules, modifying operations, or recommending new approaches.
3. **Define and celebrate success**: Identify success stories and provide an opportunity for projects to share their achievements.
4. **Provide portfolio transparency and accountability**: Offer insights for partners, project developers, and donors to understand the scope and progress of TerraFund projects.
5. **Manage risk**: Identify potential risks that may hinder project performance and develop strategies to mitigate them, ensuring the success and sustainability of projects.

TerraMatch

All reported information is communicated through TerraMatch, a digital monitoring, reporting, and verification interface developed by WRI with input from Conservation International. TerraMatch is an online, two-way platform that integrates the application process, reporting cycles, and technical support into a single platform, allowing project developers and the WRI staff to communicate progress, challenges, and questions. Figure 9 provides a view of TerraMatch's homepage. After submission on TerraMatch, TerraFund's portfolio managers conduct quality assessments of reported data. Once reported data on trees, hectares under restoration, and people employed (jobs created) undergo the relevant verification processes, they are automatically transferred to the TerraMatch dashboard and can be viewed by internal and external stakeholders (TerraMatch 2025).

Each project developer creates an organization profile on TerraMatch, which is linked to the relevant project, nursery, and site records, and then quality-assured by portfolio managers. The profile QA process aligns project workplans, contractual agreements, and goals, as mentioned above, on the reporting platform. In case of inconsistencies or errors, TerraFund staff follow up with project developers for clarity and consistency. This phase establishes a baseline against which future progress will be measured.

On the platform, biannual project reports are hosted under the project record, nursery reports are connected to each nursery record, and site reports and associated polygons are attached to each site record. Developers upload their reports directly to Terra-

Match, where their submitted data are reviewed and stored. Report data are compared to original project targets, also recorded in TerraMatch. The platform then serves as the central repository where a variety of stakeholders can access the needed data. The TerraMatch dashboard similarly shares summary results of overall progress back to project developers and showcases their successes to external audiences.

Data protection, privacy, and informed consent

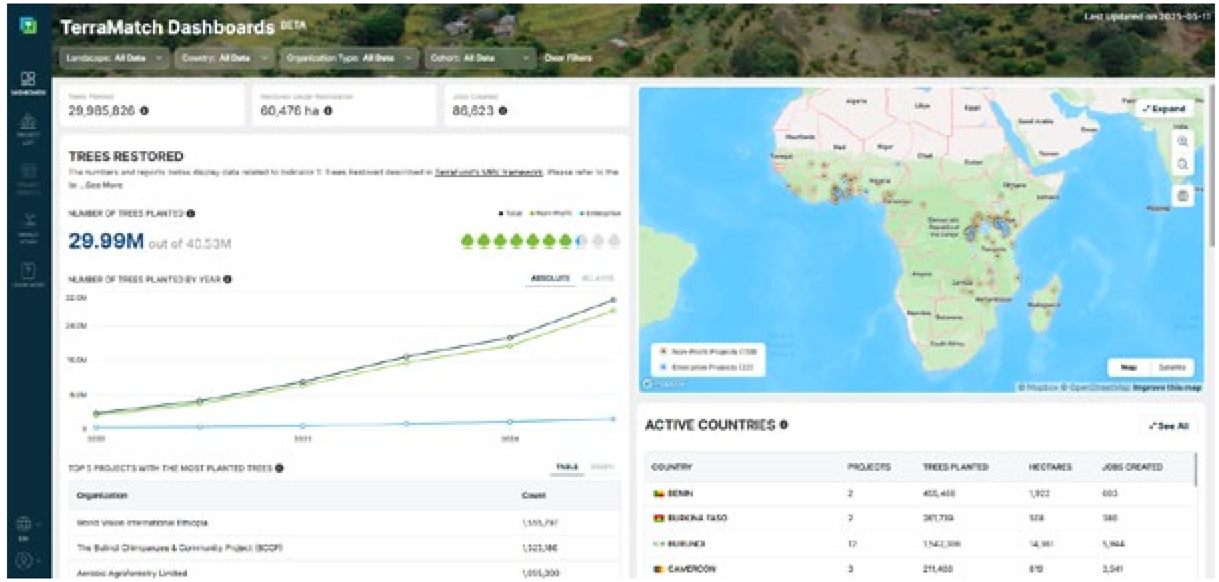
TerraMatch data governance protocols seek to ensure responsible, secure, and transparent handling of MRV data from ecosystem restoration projects around the world. Appendix I outlines how TerraMatch governs data access, sharing, quality, security, and retention within its platform.

Report types

TerraFund uses four distinct types of reports to assess progress: project reports, site reports, nursery reports, and financial and expense reports.

Biannual **project reports** describe overall progress toward environmental, socioeconomic, and equity goals. These reports ask project developers to provide quantitative data on progress toward indicators, as well as qualitative data on successes and challenges, and supplementary narrative descriptions to contextualize quantitative data on indicators. These supplementary questions ask project developers to provide examples and additional information, such as types of benefits provided to local communities or the nature of volunteer work.

Figure 9 | **TerraMatch dashboard**



Source: WRI authors.

Biannual **site reports** provide details on site-level activities, including the number and species of trees planted and details about any disturbances that have occurred at their sites. For the projects practicing assisted natural regeneration (ANR), developers also provide details on these activities in site reports. For more information on ANR, see Appendix C.

Disturbance reporting through site reports is a crucial project management tool enabling the TerraFund staff to evaluate and address risks. Disturbances are categorized into climatic events, such as floods, droughts, or wildfires, manmade disruptions, like vandalism or illegal grazing, and ecological events, such as pests or diseases. Disturbances are required to be reported if at least 25 percent of the restored trees or site area have been killed or severely impaired. Disturbance reporting is one aspect of the TerraFund risk mitigation approach that includes, but is not limited to, security and ecological risk assessments in the project sourcing phase and site visits. In extreme cases, where disturbances or external conditions severely impact a project, projects are eligible for a change in the project scope or contract termination.

Biannual **nursery reports** provide information on the number of seedlings grown or managed in project nurseries. Project developers provide the number of tree seedlings per species, their seed source, native status, readiness for transplanting, and potential commodity value. Developers also list any species-specific challenges, describe the contribution of each cultivated species to the landscape restoration goals, and submit photos of the nursery. Given that many developers maintain nurseries to supply their tree-planting interventions, nursery reports ensure that they have a reliable supply of germplasm for their restoration activities.

Financial reporting combines multiple reporting flows to create robust and reliable picture of an organization's financial health. Reports are designed specifically for the needs of either a nonprofit or an enterprise.

By tracking project-specific expense data in conjunction with progress toward indicators like tree restoration, TerraFund portfolio managers will know to check in with a nonprofit project developer if the project has spent an outsized portion of its funding relative to its planting progress, maintenance or monitoring activities, or community engagement initiatives.

By collecting information at the organizational level, portfolio managers can understand how an organization is growing or contracting—for example, if a nonprofit experiences a major change in its organizational budget or an enterprise in its revenue or profitability. Responsible financial management also signals to the team to deliver another tranche of payments or potentially to make a follow-on investment.

For organizations that are unable to submit quality financial information, WRI and its partners may provide training or additional reporting requirements until the project developer can submit accurate financial reports. If accurate financial information cannot be submitted, future payments may be terminated.

Narrative descriptions in reports and regular touch points between project developers and portfolio managers provide auxiliary information on business growth and health. This information remains private to the TerraFund consortium, its donors, and the individual enterprise. In aggregate, it is reported publicly in TerraFund impact reports and in communication materials.

Over the course of a project, TerraFund employs the following six methods for financial reporting:

PROJECT BUDGETS

Organizations submit one proposed project budget during their application process. These are reviewed, revised, and approved by TerraMatch staff during the contracting phase. These budgets serve as the basis for monitoring future years' spending in expense reports. Budgets are uploaded as Excel files to TerraMatch and are required for both nonprofits and enterprises, with fields specific to each organization type.

EXPENSE REPORTS

Nonprofits submit expense reports annually alongside the January project report. Expense reports are uploaded as Excel files and are based on the spending allocations proposed in the original project budget. They detail spending on each approved line item for a TerraMatch project during the past calendar year. Expense reports are not required for enterprises.

ORGANIZATION FINANCIAL REPORTS

Financial reports are submitted directly on TerraMatch and collect data on the organization's financial performance in the last year. Both nonprofits and enterprises are required to submit financial reports once a year, but project developers have the choice to submit them during either the January or July reporting cycles, depending on the organization's fiscal year. Reports are due 30 days after project, nursery, and site reports and are specific to the organization type. Enterprises detail their revenue and profit, new investments, their assets and liabilities, and so on, while nonprofits describe any changes to their operating budgets. In both types of reports, organizations provide information about any new external investments they may have received.

AUDITED FINANCIAL STATEMENTS

TerraFund uses audited financial statements to verify the information submitted in financial reports. These are official financial documents reviewed and certified by an external auditor, providing a verified account of an organization's financial position and performance. Once a year, statements are uploaded as pdf files with the financial report to TerraMatch. While only required for all eligible enterprises, nonprofits are strongly encouraged to submit their statements as well to validate the information in their financial and expense reports.

MANAGEMENT ACCOUNTS OR UNAUDITED FINANCIAL STATEMENTS

Management accounts and unaudited financial statements are internally prepared financial statements reflecting the organization's income and expenditure over the past six months without third-party verification. These are required for enterprises and uploaded to TerraMatch in the interim reporting period when audited financial statements are not collected. For example, if an enterprise submits its official statements in January, it could submit this documentation in July to demonstrate the health of its business before full-year audited information is available.

LOAN REPAYMENT TRACKING

Loan repayments by enterprises are recorded monthly with an online tracker managed by TerraFund's partner financial institution, Realize Impact. These additional financial data on loan balance and repayments signal to TerraFund portfolio managers if the enterprise can accept future investments and if it is a viable candidate for future TerraFund or external funding.

Details on budget categories are included in the sample expense report in Appendix G.

Report data analysis

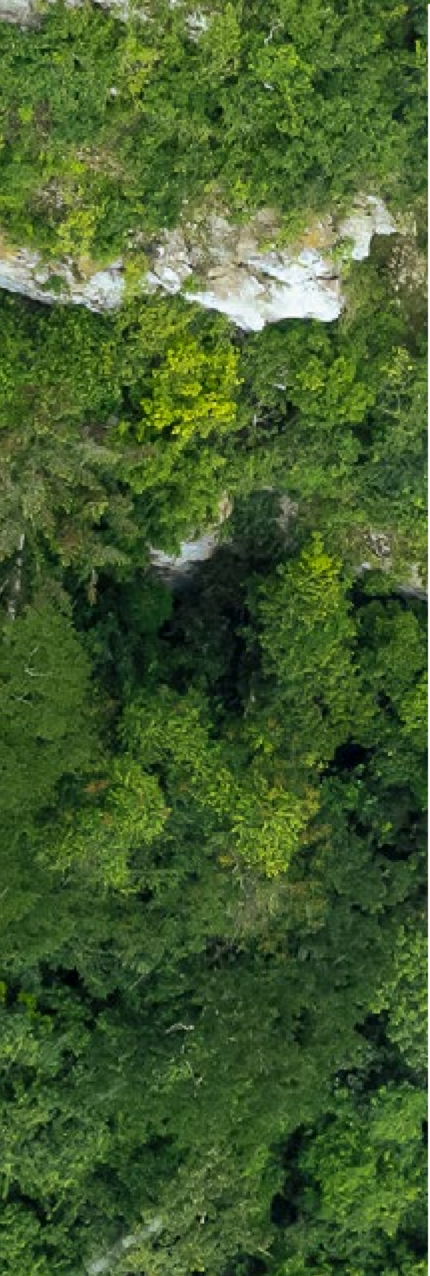
After project reports are quality assured, data are organized and analyzed using qualitative and quantitative analytical software (NVivo, and R or Stata). This analysis is used to aggregate the indicators to the portfolio level, understand the type of jobs created, the challenges faced, and highlight projects' successes and progress.

To derive indicators from the quantitative information included in reports, numerical data are cleaned and analyzed using the statistical computing software R. These data points include the numbers of jobs created, volunteers engaged, community members directly and indirectly benefiting from project activities, and community members who received training. The number of trees planted is also aggregated each reporting period.

Qualitative data included in narrative reports are analyzed using NVivo, a qualitative data analysis software that enables analysis of multiple narrative responses. TerraFund data analysts conduct a thematic analysis, which involves inductive coding of the responses to each narrative question into different themes. These themes can then be visualized and summarized into insights to support project management.

Data analysts begin the thematic analysis by familiarizing themselves with report responses to identify and note potential code ideas. They then generate initial codes, to which they tag segments of text data. As patterns emerge, these codes are iteratively refined. Following this step, related codes are grouped by theme into broader categories that act as "parent codes." These are reviewed in context to merge or remove any irrelevant or redundant codes to ensure coherence. Upon completion of this thematic coding process, each code is queried to identify the exact number of projects whose responses were tagged to it. The totals are then used to generate insight reports.

These insights, trends between periods, and lessons learned from report data are then shared with the TerraFund team to be used for decision-making and improve indicators and reporting questions. Insights are also shared back to project developers for their knowledge, validation, feedback, and motivation. Sharing back insights and lessons to project developers has resulted in improved reporting as developers are able to see the work of their peers and examples of how to better highlight their own individual progress. The recognition of their contributions has also motivated improved reporting. Projects are excited to share not only their progress relative to their TerraFund goals but also their stories of impact on the people and communities they work with.

Verification

Verification is the process of ensuring the quality, accuracy, and reliability of reported data. Three processes fall under the umbrella of verification: independent verification, validation, and quality assurance. Methods include detailed reviews of reported information and supporting documentation, remote sensing and field-based tree verification techniques, and site visits.

While independent verification is the highest standard, the two additional approaches—validation and quality assurance assessments—provide options to balance data quality requirements and the resources and capacity of project implementers, WRI, and its partners.

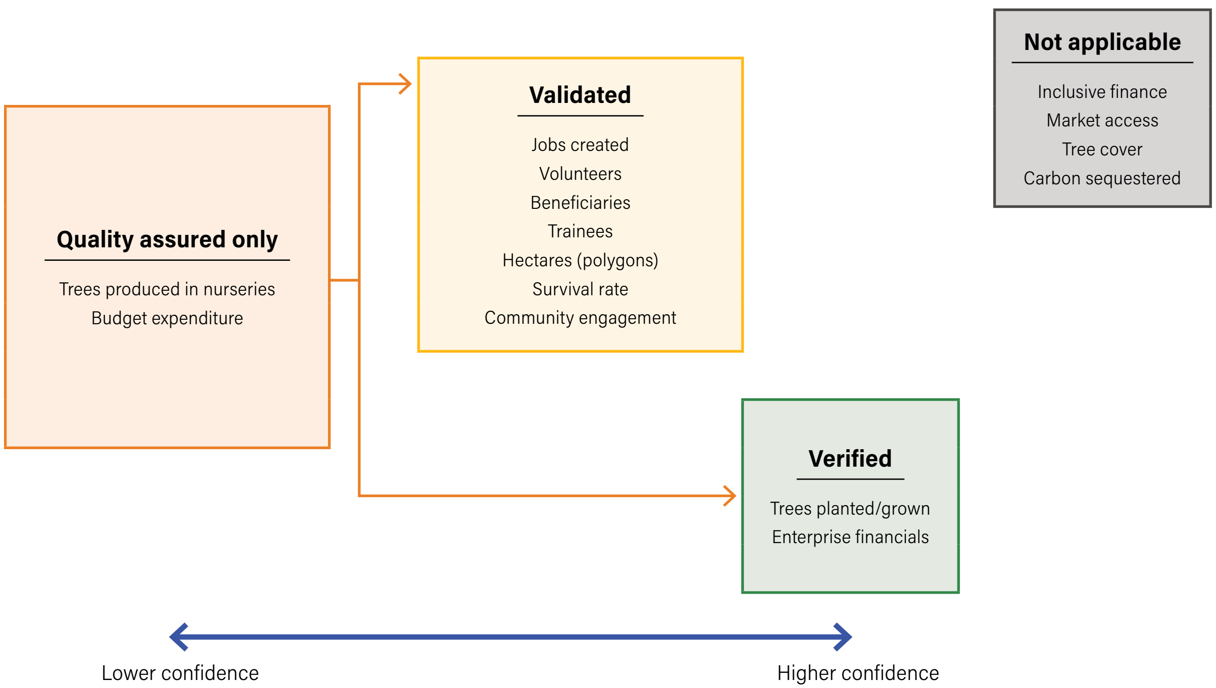
Verification encompasses the various processes used to ensure the quality of the data TerraFund receives and reports back to stakeholders.

To create and display data that are complete, reliable, and accurate, TerraFund uses three types of processes: independent verification, validation, and quality assurance. All reported data are quality-assured, with some indicators subject to further validation and verification, depending on feasibility and necessity (Table 3). Figure 10 illustrates the relationship between these three processes.

Validation and quality assurance processes are included alongside traditional independent verification approaches because they can provide greater confidence in reported data without the stringent requirements of formal verification. While it would be ideal to verify all collected data, independent verification is not feasible for many indicators. These three processes—verification, validation, and quality assurance—reflect the time and capacity constraints faced by TerraFund staff and project developers, as well as the diverse nature of TerraFund indicators covering biophysical and social components. The level of data quality checks for indicators depends on the feasibility of assessment, project developer and TerraFund team capacity, the accuracy needed for proper project management, and donor requirements.

Verification, validation, and quality assurance are essential, given that most TerraFund data are self-reported and come with inherent limitations such as possible bias or human error. Verification, validation, and quality assurance processes enhance trust with funders and partners, align with WRI's goal of robust assessment of project outcomes, and provide restoration project developers with an endorsement of their data quality.

Figure 10 | **Verification, validation, and quality assurance**



Source: WRI authors.

The components of TerraFund verification processes

Verification is the highest standard and most rigorous assessment of data quality. A "verified" indicator means that the data's accuracy has been confirmed by an independent external source, often a third party or reviewer. Verification may involve remote sensing models (e.g., artificial intelligence–based tree counts), field verification surveys, or audited supplemental documentation.

Examples: TerraFund's AI model is used on satellite imagery, or field visits are conducted to confirm reported tree counts. This also includes using audited financial statements to verify an enterprise's revenues.

Validation is the second level of data quality review, focused on assessing accuracy, consistency, and reliability. Validation goes beyond quality assurance (described below) by determining whether the data can be trusted across the portfolio. It is defined as the use of supporting documentation (e.g., nonaudited records, such as employee registries or management financial reports) or field validation site visits, to confirm the accuracy and credibility of reported or observed information. Because the secondary supporting documentation is *not* audited, validation is considered to be a step below independent verification.

Examples: Field visits are conducted to validate reported data, or employee registries are used to ensure that the number of employees matches what was submitted to TerraMatch.

Quality assurance is the first level of ensuring data quality, involving basic review and cleaning to provide an initial stamp of approval for reported data. All TerraFund *self-reported* data undergo a QA process. QA is defined as the manual and automated review of all submitted information to ensure its completeness and reasonableness (WHO 2017). WRI reviewers follow a set of guidelines to detect and correct errors, inconsistencies, or discrepancies in the self-reported information. QA ensures that data are prepared for visualization on the TerraMatch dashboard. This process usually does not require additional documentation unless it is requested from the project developer.

Examples: Confirming polygons are correctly submitted, progress reports are complete with sufficient information, or the number of jobs created aligns with the project implementation plan.

How it differs from validation: QA verifies completeness and basic compliance (Are the data present and aligned with project objectives?), while validation tests integrity (Are the data accurate, consistent with supporting documentation, and usable?).

What gets verified, validated, or quality-assured?

TerraFund prioritizes verifying the number of trees grown because these indicators can often be a proxy for the other, more difficult-to-measure benefits of restoration, like changes in ecosystem services. If the team is highly confident that the number of appropriate trees reported has in fact been planted and that they still stand after six years, it follows that the allocated budget has been well spent, and that those trees are more likely to be providing their intended benefits, like increased soil quality or erosion control.

These assumptions are then validated by the information collected through reports, site visits, and ad hoc field studies, an approach that avoids placing an undue reporting burden on project developers.

Complementing the verification approach described in this section is a commitment to due diligence at the application stage, and a foundation of trust-based relationships with project developers. At the application stage, extensive vetting and interviews between the project developer, WRI staff, and technical partners allow WRI to understand a project's scope, have confidence in its alignment with TerraFund objectives, and assess the project developer's ability to deliver. Interviews and vetting criteria center on the company's or organization's history of tree growing and community engagement, its financials, and its approach or business plan if it were to receive TerraFund financing. More information about vetting can be found in Appendix K. Figure K-1 depicts the vetting process and Table K-2 lists the vetting criteria. Dedicated project management and support staff, regular trainings and convenings, an online help desk, and field visits provide regular touch points and opportunities to cultivate trusting relationships with partners and support them in their restoration work.

Table 3 | **Indicator evaluation methods**

VERIFIED	VALIDATED	QUALITY ASSURED ONLY	NOT APPLICABLE
Trees planted / Trees grown*	Jobs (All)	Nursery saplings produced	Market access
Enterprise financials: Profit/revenue, ratio, external finance catalyzed	Beneficiaries, volunteers, trainees	Nonprofit budget execution rate	Inclusive finance
	Community engagement		Carbon sequestered*
	Hectares (polygons)		Tree cover change*
	Survival rate		
	Operating budget, external finance		

Note: *Indicator measured using remote sensing methodologies.
Source: WRI authors.

Independent verification

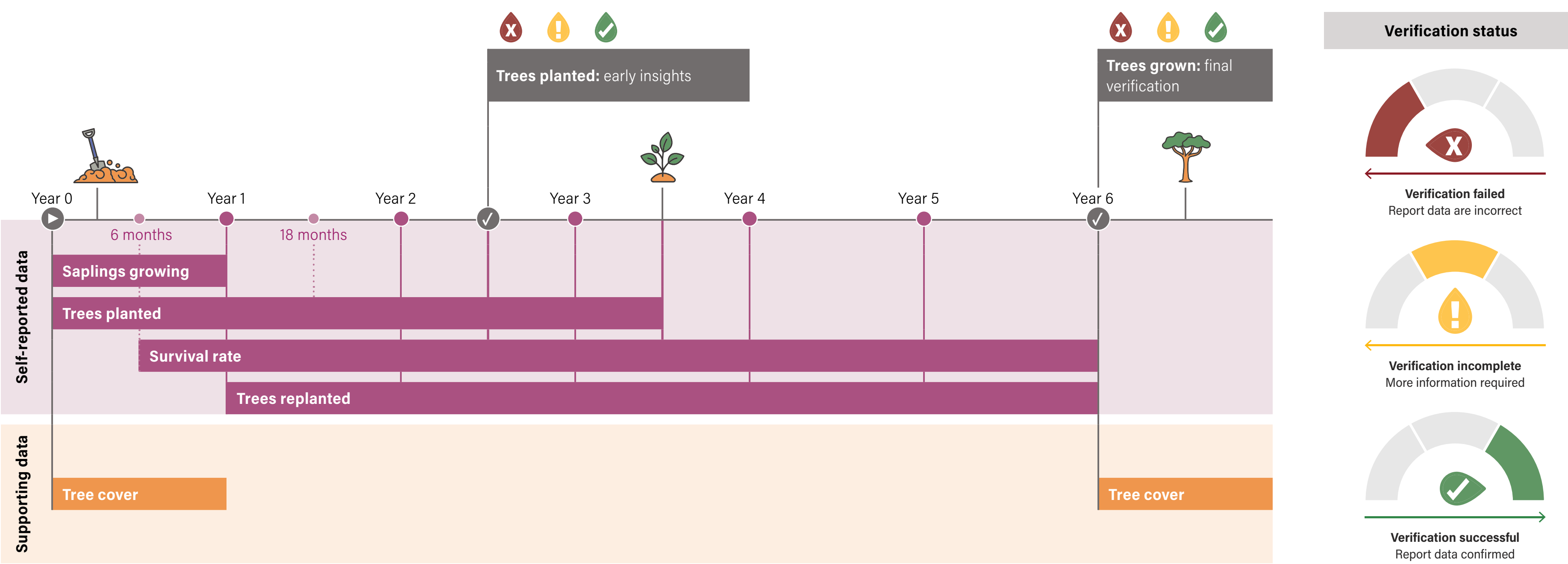
Trees restored

TerraFund's approach to verifying tree count uses high-resolution remote sensing imagery in as many contexts as possible to optimize resources and provide accurate tree counts. WRI has developed a remote sensing approach that uses a foundational vision transformer model and object detection methods to identify tree crowns in high-resolution imagery. This model is used at three stages:

- Baseline: to verify the tree count before tree-planting activities begin.
- Early Insights: to check projects' progress towards their tree count goals two to three years after planting.
- Endline: to verify the final count of surviving trees at project conclusion.

Over the long term, not all trees are likely to reach maturity, even in perfect conditions. Because of this attrition (tree loss), the number of trees planted does not always equate to trees grown. The application of both the intermediary (trees planted) and final (trees grown) indicators take this attrition into account by multiplying the reported tree counts by their survival rates. The figure produced by remote sensing and object detection models then acts as an independent verification mechanism, further confirming the number of surviving trees. See Figure 11 for a visual of the tree verification timeline.

Figure 11 | **Tree verification process**



Source: WRI authors.

Remote sensing approach

Remote sensing–based verification is performed using state-of-the-art artificial intelligence applied to high-resolution (0.3 m) Vantor satellite imagery. Satellite imagery is acquired through WRI's contractual license with Vantor.

The approach uses a foundational vision transformer and an object detection model to associate input satellite images with the locations of trees. Trees are labeled in each image using bounding boxes. The object detection model consists of a backbone, a neck, and a detection head. The backbone (DiNOv2 ViT-H/16 (Tolan et al. [2024]) takes the input image and generates high-dimensional-feature embeddings at various resolutions. The backbone model was trained on 18 million high-resolution images across 65,000 graphics processing unit (GPU) hours. The neck takes the embeddings and casts them to match the resolution of the input image. The detection head takes the high-resolution, high-dimension features and translates them to bounding boxes.

This method allows us to detect and count early growth trees across restoration sites to derive an independent "observed tree count." The observed tree count is compared to the reported "Number of trees planted" indicator and adjusted by the "Survival rate of planted trees" indicator. If the reported tree count falls within a reasonable range of the observed tree count, the tree count is considered verified. Where the self-reported count deviates significantly from the observed tree count, additional field verification is required.

Figure 12 shows an example monitoring result for a project polygon, where the remote sensing model has been applied to high-resolution images acquired before and after project implementation. Within the project polygon, the baseline trees are color coded in blue, while the trees planted as a result of the project activities are color coded in red. Detecting individual trees early in the project's life cycle facilitates adaptive management by providing early insight into projects' progress towards their tree growing goals. At the end of the project, the same tree detection approach enables verification of the final number of trees grown.

Through this assessment, the team can simultaneously confirm that the number of hectares is correct so long as newly planted trees can be validated within the polygon boundaries.

Field verification approach

In some instances, remote sensing cannot be used. This may occur in areas where high-resolution satellite imagery is not available or in areas within closed canopy systems, where canopies of full-grown trees are so dense that they enclose the vegetation below, making it impossible for satellites to determine baselines or detect new tree growth. In these cases, a field-based approach is implemented for verification, whereby technicians visit a random sample of project sites to manually count and extrapolate the number of trees planted.

Figure 12 | **Remote-sensing and AI identification of trees before and after project implementation**

Sources: Authors; satellite imagery © 2025 Vantor.

Early insights: trees planted

The WRI team measures the number of trees planted two to three years after planting begins. These "early insights" numbers are used for adaptive management purposes such as requesting additional information from the projects or confirming planting densities. The team applies a model to high-resolution satellite imagery to count trees on project polygons at baseline (before planting has begun) and during the early insights observation window. The baseline tree count is subtracted from the early insights tree count to determine the number of trees the project planted in project polygon areas. For projects where remote sensing cannot be used, a field protocol is implemented for early insights. The field protocol is provided in Appendix J. This observed tree count is compared to the self-reported trees planted, adjusted by the self-reported survival rate. Where the adjusted trees planted indicator deviates significantly from the observed tree count, additional project or field information is required. The reasonable tolerance range is defined based on preliminary evaluations of model performance. The exact range will be confirmed with additional testing and described in a forthcoming paper focused on verification.

Final verification of trees grown

A similar process takes place approximately four to five years after planting to verify the total number of trees planted and create a final number of "Trees grown." The number of trees grown is calculated as the difference between the number of trees measured after six years and the number of trees measured at baseline. This *observed* trees grown number is compared to the *self-reported* trees planted (adjusted by survival rate). The self-reported tree count is considered verified when it falls within the confidence interval of the observed trees grown number. If it does not, it is subject to additional verification.

Financial reports

To verify the information included in the financial reports for eligible enterprises and nonprofits, TerraFund analysts compare the submitted data to organizations' third party–audited financial statements or interim management reports submitted on TerraMatch. In case of any discrepancies, portfolio managers will reach out directly to project developers to correct the reported information in alignment with what is included in the financial documentation.

Remotely sensed indicators

Some indicators do not fit perfectly into the three categories of verification, as evidenced by the "Not applicable" category in Figure 10. However, two of these indicators can be considered verified because they were generated using remote sensing and artificial intelligence models and not from reported information. These models act as an independent third party. For change in tree cover and carbon sequestered, these indicators come from remotely sensed data and analysis, rather than human-reported or collected information.

Validation

Jobs created

The process for validating jobs data aims to confirm self-reported employment figures and understand employment outcomes accurately. This approach was developed following a consultation process with project developers and a test pilot.

In the project reports on TerraMatch, project developers record the number of new employees hired in the last six months. Developers also submit an employee registry, where they track each employee's name, gender identity, age range, full- or part-time status, job function, and start date, as well as their employment status in each reporting period.

Next, TerraFund portfolio managers review both the report numbers and the employee registry. They check that reported jobs information aligns with the size and scope of the project and look for red flags, such as sharp increases in the number of full-time employees or part-time employees outside the planting season or repetition of reported figures across reporting periods. The MRV team then compares the figures in the approved employee registries with those reported on TerraMatch to identify discrepancies. If the difference between the two sets of data is less than 10 percent, TerraMatch numbers are updated to align with the employee registry. If the discrepancy between report numbers and registry numbers exceeds 10 percent, projects receive follow-up to correct the figures. This follow-up may entail meetings or site visits to understand the source of discrepancies and correct the reported figures.

While the registry serves as an additional layer of verification for WRI, it also serves as a tool for project developers to organize their own employee data in a unified format and facilitate reporting. During the development of TerraFund's job verification approach, developers were surveyed to understand if and how employment data are collected. Given the variance in responses, the registry template aims to provide a consistent approach to monitoring employment data without overly burdening project developers. The employee registry template is included as Appendix E.

The registry collects personal information, so these data are stored securely on the TerraMatch platform and are only accessible to TerraMatch staff for verification purposes. Before downloading the template, a data consent statement is provided, and users are asked to acknowledge that they have been informed about the purpose and use of data and consent to its collection and secure handling as described.

Site visits

Site visits serve to ground-truth multiple indicators simultaneously, while building closer relationships between TerraFund staff and project developers. Each project is visited at least once throughout its lifetime, but this could be more frequent depending on project needs. Through these visits, TerraFund and partners validate reported information such as community engagement indicators, volunteers, and beneficiaries by triangulating data, requesting additional documentation, and speaking with local community members.

Quality assurance

Polygons (hectares)

The QA process begins by assigning TerraFund data quality analysts (DQAs) as polygon reviewers responsible for tracking the progress for each project. A polygon reviewer looks at data as they come into Greenhouse from Flority and helps geospatial leads (GIS staff) from the project developer side correct bugs or systematic data collection errors. The polygon reviewer then pushes data from Greenhouse to TerraMatch or uploads them directly for non-Flority projects.

The reviewer then runs scripts on TerraMatch to check for errors or flags. These include geometric errors (overlapping or duplicated polygons, self-intersections, ring self-intersections, and spikes), missing attributes, incorrect file format or coordinate system, or total project polygon areas that are 25 percent larger or smaller than the proposed hectarage to be restored. Here, the reviewer confirms that each polygon attribute table contains a site ID, site name, target land use system, restoration practice (or practices), and planting dates.

The script automatically fixes minor errors, such as small edge overlaps, during this step. For larger errors that require manual edits, the reviewer downloads projects' polygons, corrects them in GIS software, and reuploads them to TerraMatch. Once all the errors and flags are resolved, the DQA publishes the site's data and marks the status as approved on TerraMatch.

As mentioned above, the tree verification process, which starts approximately two years after planting is complete, serves as way to also validate the number of hectares submitted. By confirming that trees have been newly planted in the polygon area, the team is able to validate the total number of hectares under restoration.

Project reports

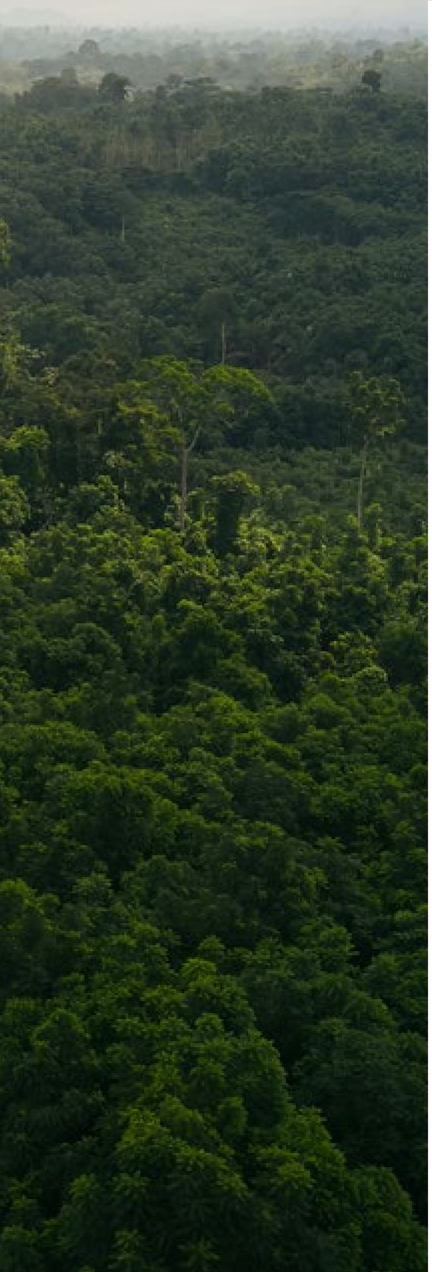
All data collected through reports are subjected to a quality assurance (QA) process to ensure the accuracy, consistency, and reliability of data from restoration projects.

QA reviewers follow prepared guidelines that define the information that should be included in each report and provide examples of common errors. Reviewers check for clarity, consistency, and reasonableness. Particularly for trees planted, people employed (jobs created), and project narratives, reviewers use the guidelines in Appendix L to evaluate report quality. The QA guidelines and more information about the process also can be found in Appendix L.

During this QA process, TerraFund portfolio management staff check individual project reports for errors, any misinterpretations of questions, duplications between questions or reporting periods, and any unclear explanations for set questions. The portfolio managers then follow up with project developers for clarification or explanations of any of their findings. Reports are approved by portfolio managers once they have been reviewed and accepted by TerraFund staff completing QA. After the report QA for individual reports, the monitoring team also undertakes a second step, quality checks for the whole portfolio. This stage involves data cleaning, reviewing outliers, errors, and duplications between reporting periods. If there are great inaccuracies and extreme variations in the data, data analysts seek clarifications with portfolio managers and make corrections. This effort provides an additional check and reduces the number of errors input, stored, and communicated through TerraMatch.

Expense reports

For nonprofits, the budget execution rate undergoes a quality assurance process. The spending in each budget category in the expense reports is compared to the spending outlined in the project budget. If there are significant differences between what has been budgeted and what has been spent, or the amount spent is misaligned relative to project progress, portfolio managers will follow up with projects to understand the figures, course-correct spending, if needed, or suspend funding disbursements in serious cases. TerraFund opts for a quality assurance process for project spending and, to avoid unduly burdening project developers, does not formally verify this metric. However, TerraFund reserves the right to collect receipts to confirm budget spend-down if necessary.

Limitations and areas for further research

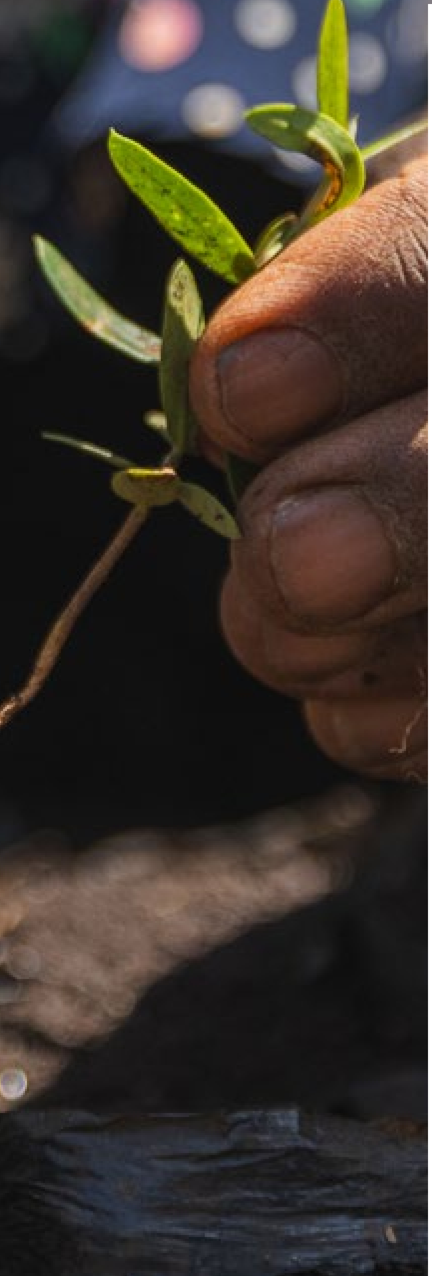
WRI and partners have refined the TerraFund MRV framework over time and have sought to improve monitoring, reporting, and verification approaches to promote accuracy, relevance, efficiency, and user-friendliness. Opportunities to further strengthen the framework remain, specifically to enhance MRV of ecosystem services, social equity and socioeconomic objectives, contributions of enterprises, and assisted natural regeneration.

The MRV framework presented in this guidebook is the result of multiple iterations of learning and adapting. Additional areas remain for learning to improve the current MRV framework, and WRI expects that the framework will be further adapted. The following are areas where WRI and partners can conduct additional research to update and strengthen the framework.

- **Ecosystems services** such as climate resilience, biodiversity, soil quality, or food or water security are among the objectives of many TerraFund projects. The TerraFund MRV framework currently includes an approach to monitoring carbon sequestration as well as proxy indicators for biodiversity through monitoring of tree species type. Additional research could build on the current framework and integrate approaches to monitoring additional ecosystem services more systematically. TerraFund may be able to capitalize on the rapid improvements in monitoring technologies to support this. New methods for monitoring biodiversity benefits are currently being scoped and developed.
- **Social equity and socioeconomic objectives** tend to be complex to monitor, report, and verify. TerraFund will continue to explore opportunities to strengthen the rigor of methodologies to assess social equity and socioeconomic benefits while minimizing burdens on project developers. The TerraFund team hopes to explore ways to more accurately monitor localization and better

understand decision-making dynamics within the leadership of TerraFund organizations.

- **Contributions of enterprises** to the restoration economy often differ from their nonprofit counterparts' role, and their monitoring and reporting frameworks vary as well. Further iterations of TerraFund should continue to iterate its approaches to MRV that are enterprise-specific, such as updated monitoring techniques and contribution analysis methodologies.
- **Assisted natural regeneration** is an effective and widely used restoration technique, estimated to be relevant to at least 40 percent of the TerraFund portfolio. However, trees grown under ANR are not directly planted, grow on variable time frames, and are not easily identifiable by remote sensing technologies until they mature (5–10 years). Given these limitations, creating monitoring schemes that can work across landscapes is difficult. TerraFund is continually refining its current ANR monitoring approach to more accurately assess the value of ANR interventions. It is currently exploring ways to expand remote sensing approaches to monitor ANR more at scale and provide expanded guidance for project developers on how to effectively identify and record the number of naturally regenerating trees.

Conclusion

Restoration is central to revitalizing degraded land and supporting healthy ecosystems for the communities that depend on them. MRV is necessary for restoration, providing the tools and systems to measure progress and results, and in turn support credibility and effectiveness.

This guide to MRV provides one model for measuring the results of restoration efforts. It was designed to be practical and tailored for localized, small and medium-sized restoration efforts. Fund managers, project developers, and funders can use this guidebook to learn from and adapt the approach to support their MRV needs and support localized restoration.

Comprehensive efforts to restore degraded lands and forests have been ongoing around the world for decades. Renewed global interest in restoration has placed additional scrutiny on projects and raised the global standard for reporting on results. But without continued innovation and new monitoring approaches—for all scales of restoration—opportunities to prove restoration's benefits, attract funding, and expand interventions will stall.

TerraFund as an initiative sought to bring restoration financing to localized small and medium-scale restoration organizations, an underresourced but high-potential group of implementers. Its monitoring, reporting, and verification framework now seeks to demonstrate that monitoring these restoration projects can be cost-effective, practical, and possible at scale.

When the TerraFund team began developing an MRV system, it hoped to address many of the gaps limiting the effectiveness of existing approaches, particularly for localized restoration projects (Elias et al. 2025).

As a fund manager, TerraFund uses a refined number of indicators that reflect the various dimensions of restoration, including its socioeconomic benefits and funding use, in addition to its biophysical outputs. This is a limited but intentional set of indicators that are easier and practical to measure at local scales. When there are gaps, TerraFund provides capacity-strengthening trainings and resources.

These indicators, their collection methods, and monitoring instruments are informed by local stakeholders, allowing project developers to appropriately adapt them to their context. The flexibility around indirect beneficiaries, for example, encourages developers to use the collection method they deem most accurate. For polygon creation, while the use of Flority is suggested, projects are welcome to use another collection technology approved by the TerraFund team. Where more standardized guidance is helpful—for assessing jobs created, for example—indicators, definitions, and methodologies are more prescriptive. TerraFund has also invested in technological advances wherever possible, using cutting-edge AI and remote sensing technology to dramatically reduce the burden of tree-counting and its integrated online platform, TerraMatch, to simplify reporting.

TerraFund draws on many of the lessons learned from the development of other frameworks, working

to incorporate those insights directly into its MRV approach. Now, after multiple years of iteration, the TerraFund MRV framework is a comprehensive but realistic monitoring approach that caters to the needs, capacities, and strengths of local organizations and WRI as an intermediary. By integrating reported information with remote sensing technologies, TerraFund's approach has the potential to save millions of dollars in field monitoring costs. While it is continuously evolving and improving, the framework strikes a balance between reliability and manageability, offering verified outputs without putting an undue burden on project developers.

This guidebook provides the TerraFund MRV framework and the lessons learned from developing it so that other fund managers, project developers, and funders can learn from and adapt this approach to support and promote localized, smaller-scale restoration initiatives around the world.

Appendices

Appendix A. Comparison of monitoring frameworks

Table A-1 compares other notable restoration monitoring approaches, particularly large-scale indicator frameworks, to demonstrate the use case for TerraFund MRV.

Table A-1 | **Comparing restoration monitoring frameworks and standards**

	TerraFund MRV (WRI)	Tree Restoration Monitoring Framework: Field Test Edition (CI, WRI)	Restoration Project Information Sharing Framework (SER)	Framework for Ecosystem Restoration Monitoring (FAO)	Ecosystem Restoration Field Verification Standard (Preferred by Nature)	Verified Carbon Standard + Climate, Community, and Biodiversity Standards (Verra)
Implemented and field-tested	✓	✓	X	N/A	N/A	✓
Targeted set of indicators aligned with needs of implementing and intermediary organizations	✓	✓	N/A	N/A	N/A	X

Table A-1 | **Comparing restoration monitoring frameworks and standards (cont.)**

	TerraFund MRV (WRI)	Tree Restoration Monitoring Framework: Field Test Edition (CI, WRI)	Restoration Project Information Sharing Framework (SER)	Framework for Ecosystem Restoration Monitoring (FAO)	Ecosystem Restoration Field Verification Standard (Preferred by Nature)	Verified Carbon Standard + Climate, Community, and Biodiversity Standards (Verra)
Scalable geospatial monitoring and verification approach	✓	X	X	X	X	X (in development with Pachama)
Specific project management guidance	✓	✓	X	X	X	X
Catered to medium- and growth-stage implementing organizations, focus on local organizations	✓	X	X	X	X	✓
Socioeconomic indicators	✓	✓	✓	✓	✓	✓
Integrated monitoring platform	✓	✓	X	✓	X	✓

Notes: CI = Conservation International; FAO = Food and Agriculture Organization of the United Nations; SER = Society for Ecological Restoration; WRI = World Resources Institute.

Sources: Priceless Planet Coalition: Tree Restoration Monitoring Framework: Field Test Edition (Sprenkle-Hyppolite et al. 2023); "Restoration Project Information Sharing Network" (Gann et al. 2022); "Framework for Ecosystem Restoration Monitoring" (FAO and UNEP 2024); "Ecosystem Restoration: Field Verification Standard" (Fraisse and Donovan 2021); "Climate, Community, and Biodiversity Standards" (VCS Association 2017; see also Verra and Pachama 2022).

Appendix B. Target land use systems and restoration intervention typology

Target land use systems

The following target land use system definitions were originally drafted by the authors of the *Tree Restoration Monitoring Framework* (Sprenkle-Hyppolite et al. 2023). Note that most text is directly quoted, with minor adjustments or additions made to some definitions.

- **Agroforest**: An agroforest is productive, managed land containing a mix of woody perennial species (trees, shrubs, bamboos) and agricultural crops in a way that improves the agricultural productivity and ecological function of a site. This category includes agroforestry for shade grown crops (cacao, coffee), as well as planting trees at a low density to allow for continued full-sun agriculture, also known as intercropping or row cropping. Please note that silvopasture is its own separate land use system.
- **Open natural ecosystem**: Open natural ecosystems mainly comprise naturally open (low percentage tree cover) and often treeless habitats, ranging from savannas and scrublands to grasslands, ravines, and dunes. Grasslands are generally open and continuous, fairly flat areas of grass. They are often located between temperate forests at high latitudes and deserts at subtropical latitudes. Note that TerraFund is specifically focused on tree-based restoration. However, its related programs, such as the Harit Bharat Fund, do include projects that restore open habitats with nontree restoration practices. WRI does not advocate for the conversion of open habitats with tree planting but includes this definition to account for the projects in other programs focusing on this target land use system.

- **Natural forest**: A natural forest ecosystem is a rural landscape where the majority of trees are native species and features biologically integrated communities of plants, animals, and microbes, together with the local soils (substrates) and atmospheres (climates) with which they interact.
- **Peatland**: Peatlands are terrestrial wetland ecosystems in which waterlogged conditions prevent plant material from fully decomposing.
- **Riparian area or wetland**: Riparian ecosystems encompass a suite of ecosystem types, including riverbanks, floodplains, and wetlands, that are characterized primarily by being transitional zones between terrestrial and aquatic realms. Wetlands are areas where the soil is covered with water or can be present near the ground throughout the year, including marshes, swamps, bogs, and fens. They support both terrestrial and aquatic species.
- **Silvopasture**: A silvopasture system is productive, managed land containing a mix of woody perennial species (trees, shrubs, bamboos) and animal forage or pastureland to improve the agricultural productivity and ecological function of a site for continued use as pasture.
- **Urban forest**: An urban forest encompasses the trees and shrubs in an urban area, including trees in yards, along streets and utility corridors, in protected areas, and in watersheds. This includes individual trees, street trees, green spaces with trees, and even the associated vegetation and the soil beneath the trees.
- **Woodlot or plantation**: A woodlot is a type of plantation, predominantly managed by a single landholder or a community, to supply wood for construction and fuel to the landholder or community. A plantation is a forest predominantly composed of intensively managed trees that are established through planting and/or deliberate seeding, with the explicit goal of harvesting and processing those trees for wood once they reach maturity.

Restoration practices

- **Tree planting**: Tree planting is defined as the planting of seedlings or saplings over an area to meet specific goals. This includes all planting, including in areas with no forest canopy and in areas with partial canopy coverage.
- **Assisted natural regeneration**: Assisted natural regeneration is the exclusion of threats (i.e., grazing, fire, invasive plants) that prevent natural regrowth from seeds and roots already present in the soil or from natural seed dispersal from nearby trees. This does not include any tree planting (Sprenkle-Hyppolite 2023).[7]
- **Direct seeding**: Direct seeding is the active dispersal of seeds (preferably ecologically diverse, native seed mixes) that accelerate natural regrowth, provided the area is protected from disturbances. It includes only active collection and dispersal of seeds and excludes any natural dispersal that would occur without human intervention. This does not include any tree planting.

Appendix C. Assisted natural regeneration monitoring, reporting, and verification approach

Background

Many TerraFund partners may include assisted natural regeneration (ANR) in their land restoration work. This appendix provides additional reporting guidance for projects that use ANR techniques. To understand the impact of this work, partners will be asked to provide additional information about the activities that do not involve direct tree planting, in addition to the standard reporting requirements.

Defining ANR

TerraFund invests in projects focused on tree planting and other cost-effective restoration interventions, such as assisted natural regeneration (ANR). ANR promotes land restoration and vegetation recovery by removing threats like grazing, fires, and invasive species, which hinder natural regrowth from existing seeds, roots, or natural seed dispersal from nearby trees. ANR is often integrated with other restoration techniques, including tree planting. While many tree-planting projects engage in some ANR to complement their tree-planting activities, the portfolio of TerraFund projects also includes some projects that are restoring trees using ANR almost exclusively and are not planting trees directly.

Assisted natural regeneration includes but is not limited to the following interventions within the landscape:

- Physical fencing
- Social fencing (including patrols and surveillance agreed among community members)
- Cattle management (including removing cattle and controlling access to pastures)

- Invasive and/or exotic species control (including the removal of grasses and selective weeding)
- Pest control
- Maintenance of regenerating individuals (including thinning, pruning, and other forms of protection for regenerating plants)
- Fire protection (including creating firebreaks)
- Removal of invasive or other undesirable species
- Farmer-managed natural regeneration

Monitoring ANR

ANR progress is first monitored through a site visit in year 1 to collect baseline information and confirm ANR activities. To help quantify projects' efforts, TerraFund is testing the ANR-specific indicator below:

Number of naturally self-regenerating trees

- *Description*: Assisted natural regeneration is an approach to restoring land and supporting the recovery of vegetation by eliminating threats (i.e., grazing, fire, invasive species) that prevent natural regrowth from seeds and roots already present in the soil or from natural seed dispersal from nearby trees. Many projects will use ANR and plant trees directly. This indicator intends to capture tree growth that does not directly result from planting activities. Implementing agencies will provide an estimated target for the total number of trees to be naturally regenerated over the course of the project at project initiation, with guidance from the TerraFund team and based on tree cover ranges that are appropriate for the intervention and region.
- *Disaggregation*: Site, species.
- *Data source*: A target is provided at project initiation. Biannual site reports, narrative descriptions, and geotagged photos are used to collect data on progress of the ANR intervention.

There are specific reporting guidelines for this indicator depending on whether the project is doing a mixture of tree planting and ANR or ANR exclusively.

- Projects that **use ANR exclusively** do not report any numbers under the Number of trees planted indicator.
- Projects that use **ANR alongside tree planting** through enrichment planting or direct seeding report on both the Number of trees planted and the Number of trees naturally regenerated indicators. The Number of trees naturally regenerated only includes the newly regenerating trees for each site with ANR intervention.
- Projects that are **not implementing ANR** do not report under this indicator.
- All projects employing ANR, exclusively or partially, must answer these questions:
  - What assisted natural regeneration practices are you implementing on this site?
  - What ANR activities or practices have been implemented in the ANR site within the reporting period (for example, fencing has been effective at preventing encroachment; reduced presence of invasive species has been observed in intervention areas). Please be as specific as possible.
  - How many hectares of land are under ANR implementation since the last reporting period?
  - How many self-regenerating trees are observed in the areas under ANR?

Submit at least five geotagged photos with each relevant site report, including at least one photo of each ANR practice being implemented as evidence of the "assistance" conducted on the site in the past six months, such as new fences constructed, pollarding, or construction of fire breaks.

Reporting on ANR

The following is the TerraFund reporting guidance for projects using ANR.

Projects that use ANR exclusively to restore a TerraFund site and do not do any tree planting or direct seeding:

- Answer "0" to the number of trees that they have grown in the past six months on that site.

Projects that use ANR partially to restore a TerraFund site but are also planting trees or applying direct seeding:

- Indicate only the number of trees that they have planted on the site, broken down approximately by species. That number will not include trees newly regenerating through ANR.

All projects employing ANR, exclusively or partially:

- Answer the following questions:
  - What assisted natural regeneration practices are you implementing on this site? *Choose from a drop-down menu from the ANR taxonomy*, with associated subcomponents:
    - Fire protection and fighting
    - Livestock management
    - Physical protection and isolation
    - Enrichment with native species
    - Control of invasive or native species
    - Farmer-managed natural regeneration
    - Maintenance of regenerating individuals
    - Ant or pest control

- Please describe activities undertaken for each of the ANR practices and interventions shared above. *Describe activities undertaken by project as well as quantify activities undertaken such as number of invasive species removed, size of land fenced, number of beehives mounted, and so on.*

- On how many hectares of land has the project implemented ANR in the last reporting period?
- Are any new trees or self-regenerating trees observed in the areas under ANR? (Y/N)
- How many new trees are regenerating on this site following the ANR activities? (May only be possible at year 1, 3, 6)
- Please provide geotagged photos to document ANR activities. This includes before-and-after photos of ANR interventions such as active fences, fire tracing, removal of invasive species, and other relevant activities.

Report quality assurance

When portfolio managers review project reports for ANR projects, they will have the option to mark whether a project is on track or not.

- If a project has satisfactorily followed the reporting requirements outlined above, specifically by reporting on the ANR practices it is implementing and by providing required photos, the portfolio manager marks the project as "on track."
- This approach ensures that the progress of projects is captured regardless of whether they are using tree planting or ANR as their primary approach to restoring trees, and that ANR projects are not considered off track solely based on low tree-planting numbers or the absence of tree planting.
- A project will be considered "off track," however, if its report does not provide the information required.

Guidance for assessing tree density

1. Assess your site by sampling several 1 hectare (ha) plots: count wildlings or sapling clumps **15–200 centimeters tall.**
2. Compare densities to the ranges above to decide your approach.
3. For enrichment planting, use a layout like 2 × 3 meter spacing (~1,670 trees/ha) and subtract the existing natural seedlings to determine how many additional seedlings are needed—for example, if there are 600 wildlings/ha, you would need about 1,070 planted seedlings to hit that target.

Appendix D. Survival rate guidance

To fulfill TerraFund's goal of catalyzing successful restoration projects across Africa, proper forest management practices must be applied to ensure the growth and sustainability of planted seedlings. Funded projects must adhere to and use the following guidelines to assess or evaluate and record the survival of planted seedlings.

The goal of this guidance is to provide project developers with simplified technical methods of assessing or evaluating the survival rate of planted tree seedlings to increase transparency and consistency across the portfolio.

Note that this guidance applies to planted seedlings, not naturally regenerated trees. The guidance covers the following areas:

- Purpose of tree survival assessment
- Survival rate thresholds
- Survival assessment procedure
- Calculating the survival count ratio
- Reporting tree replacement numbers for TerraFund projects
- Time frame when dead seedlings would count against survival rates

Purpose of tree survival assessment

- Survival count is assessing the existence and growth performance of planted seedlings in the field. Trees are planted for numerous reasons (soil protection, restoration of degraded lands, climate regulation, logging for construction material, home usage as firewood, etc.). Whatever the reason for planting, site managers expect high survival rates to compensate for the significant investment made in planting.

- If survival is low, assessing or measuring survival rate early in the project life cycle can help a restoration project developer intervene to achieve the desired size, density, and quality of planted seedlings. Trees can die because of the inferior quality of seedlings planted, poor seedling handling, lack of favorable weather and soil conditions, damage to seedlings during transport, and lack of technical capacity.
- Assessing the survival of seedlings helps to identify factors that led to the death of seedlings and inform plans to either "beat up" failing areas or replace dead seedlings.
- Different organizations or people carry out survival assessments for different purposes. The purpose for TerraFund survival count is as follows:
  - To track the health and well-being of seedlings in a specific area over time and determine whether planting was successful
  - To help TerraFund restoration project developers determine whether replacement planting or "beating up" is necessary, which is recommended to be completed immediately after planting, no more than two to four weeks, depending on the species
  - To give the TerraFund portfolio manager the opportunity to take a closer look at on-the-ground accomplishments to improve the quality of planting material and other factors contributing to the survival of trees
  - To provide feedback to the project developers on what and how to plant, including seedling quality, time of planting, and planting technique
  - To identify problems with different tree species or other factors related to tree planting to improve planting success and survival
  - To inform decisions on whether further disbursement of financial installments can proceed

Survival rate thresholds

- A survival rate of **80 percent indicates healthy performance** of planted seedlings. This allows the project to focus on protection and other management operations to improve growth.
- A survival rate below 80 percent indicates that there is likely a need to beat up or replace dead seedlings (Taylor 1943).
- For TerraFund projects, **the minimum acceptable survival count is 70 percent**, due to severe climatic conditions in some of the countries under the program.
- A survival rate below 70 percent requires approval from the restoration project developer's assigned portfolio manager.

Note: Survival and tree growth vary depending on tree species' response to environment, light, rain, shade, and other factors. A thorough assessment should therefore be conducted to determine which species to plant and where to maximize survival.

Survival assessment procedure

When to conduct tree survival assessment

- Because TerraFund finances project developers in different countries and regions that experience seasons differently, all projects must conduct a survival assessment before submitting either their July or January progress reports on TerraMatch.
- If submitting in the July report, they should conduct the assessment between April and June.
- If submitting in the January report, they should conduct the assessment between October and December.

While project developers are required to conduct survival assessment once a year, they are strongly encouraged to assess the survival twice during the project's first year, preferably at three months and then six months after planting seedlings. Even more frequent assessment, while not required for reporting, is advisable throughout the project's lifetime.

What to prepare

A project developer's staff member who is assigned to conduct a survival assessment must prepare the following:

- A recording tool: a recording form, a pen, or an electronic tool (phone, tablet, computer). Choose the appropriate tool according to the nature of the terrain.
- A rope or tape measure.
- Tree tags or markers (optional for individual tree identification).
- Compass (optional for orientation).
- Pruning shears or hatchet (for removing competing vegetation, if necessary).

How to conduct survival assessment

Survival is difficult to measure by simply looking at the planting site. It can be impossible or time-consuming to see, assess, and count every single seedling on a planting site. There are different methodologies for survival count. Only visibly planted seedlings should be included in the survival assessment; mature trees on the site should not be counted.

- **Census**: For an area **smaller than 0.5 hectares**, the best way is a census count, where you assess whether every planted seedling has survived or not.

- **Sampling**: If your project area is too large to count all the planted seedlings individually (**more than 0.5 hectares**), use a systematic sampling methodology to select the areas to conduct the count.
- Divide the area into smaller plots or transects and sample representative sections of the site. Ensure that the sampling design is random or stratified to minimize bias, especially when the planting site has greater inhomogeneity in various aspects.
- Mark every sample plot with a visible marker, such as with a colored metal bar, to denote the area where you will assess survival rate.
    - Ensure that sample plots selected are an accurate representation of the project's target land use systems (separation of restoration intervention types), such as agroforest or natural forest, and planting arrangement such as planting with rows and without rows. For example, if the project is 80 percent agroforest and 20 percent natural forest, 80 percent of the sample plots should be in agroforest zones.
    - For example, if 80 percent of a project's area is planted in rows and 20 percent not planted in rows, 80 percent of the sample plots should be in areas planted in rows.
- Read TerraFund's recommendations for creating simple sample plots in each scenario below.

Method for natural forest, riparian area, woodlot or plantation, urban forest

Survival assessment for plantation with rows

1. For areas under 0.5 hectares, count all trees in the area (census).
2. For areas more than 0.5 hectares, sample every 10th row. Randomly select an edge to start from and count until the end of the row and repeat every 10th row until you have covered the area.
3. Count each seedling, record the species, and note whether the seedling is alive, dead, or missing. Identify possible causes for death or damage.

Survival assessment for plantation without rows (no defined layout)

1. For areas under 0.5 hectares, count all planted seedlings in the area (census).
2. For areas more than 0.5 hectares, count all the planted seedlings within randomly distributed circular sample plots.
3. If advice is needed to create sample plots, consult the TerraFund portfolio manager.
4. In total, these plots must contain at least 10 percent of planted seedlings in the area.
5. TerraFund recommends plots of 10 square meters with a 3.14 meter radius (but variation is possible).
6. Count each tree, record the species, and note whether the seedling is alive, dead, or missing. Identify possible causes of death or damage.

Method for agroforest and silvopasture

TerraFund project developers implement agroforestry work with hundreds to thousands of farmers, making it impractical to visit every farmer and measure the survival of every tree.

In this case, the project developer conducts survival assessment on the land of a random sample of at least 30 percent of the beneficiaries where the project's seedlings were planted. For example, if a project developer engaged 100 farmers for this project, he or she counts seedlings on 30 farmers' land. Project developers are highly encouraged to sample the land of more than 30 percent of farmers, if possible. The project developer can select farmers using any randomization technique that he or she sees fit.

By individual farmer:

1. The project developer can use a spreadsheet or paper record and list the name of each farmer in alphabetical order, regardless of the number of trees the farmer planted or the hectares.
2. Then the project developer randomly selects every third farmer regardless of the number of seedlings the farmer planted or the hectares.
3. On each farmer's land, count each tree, record the species, and note whether the seedling is alive, dead, or missing. Identify possible causes of death or damage.
4. For all further survival assessments, the project developer should revisit the same farmers to ensure that the data collected are comparable over time.

Calculating the survival count ratio

Survival rate is the percentage of living seedlings at the time of data collection, divided by the total number of seedlings planted.

$$SR = NLS / NTS * 100$$

Where: *SR* = survival rate; *NLS* = number of living seedlings; and *NTS* = number of total planted seedlings (Regreening Africa 2020; Londo and Dicke 2006).

This figure is uploaded to TerraMatch as part of the six-month progress report, in addition to any supporting documentation that the project developer used to arrive at this figure. Project developers are highly encouraged to submit as much supporting documentation as possible.

Note: The tree survival evaluation should be done and reported at each site in all TerraFund projects.

Reporting tree replacement numbers for TerraFund projects

What is tree seedling replacement?

Seedling "replacement" can be defined as a process of replacing newly planted seedlings that have died or failed to survive due to factors such as disease, poor soil conditions, drought or other natural disaster, pests, poor seedling stock, or seedling damage during transportation and planting. Replacement ensures that the initial targeted planting stock is regained. There are two types of replacement:

- The process of filling the spaces occupied by trees or seedlings that have died is commonly known as "**beating up**" the plantation (Taylor 1943). This is a standard practice and typically occurs within the first months after planting.
- "**Replanting,**" also referred to as reforestation, involves planting seedlings over an area of land where a major disturbance has led to the death of a majority of seedlings and trees, such as a fire, disease, natural disaster, or human activity like tree harvesting (Gyde Lund 1999).

Time frame when dead seedlings would count against survival rates

Replacement within the reporting cycle

When a seedling is planted, dies, and is replaced within the six-month reporting period on TerraMatch, project developers should report the original number of seedlings planted in their site report. Project developers should not count replacement seedlings as additional trees planted to avoid double-counting.

Here is an example:

- During the first season of planting on Site A, the project developer planted 100,000 seedlings, and within three weeks, 100 seedlings died.
- The team replaced the 100 dead seedlings with an additional 100 seedlings within the TerraMatch reporting cycle and after planting.
- The project developer should then report in its six-month report for Site A on TerraMatch that it has planted 100,000 seedlings, not 100,100 seedlings.

Replacement after the reporting cycle

If seedlings are replaced after the reporting cycle in which they were originally planted, project developers should report the seedling replacement in the next six-month TerraMatch site report following these steps:

- Trees that are replaced must be reported on the correct site where they were replaced.
- In that section of the site report form, project developers should do the following:
  - Report the number and species of trees replaced in the relevant field on TerraMatch. The species remains the same as previously planted unless the change has been approved by the portfolio manager.
  - Include only the replaced trees there. If 100 were dead, and 100 seedlings were planted as replacements, "100" should be reported.
  - Report the date when seedlings were replaced in DD/MM/YYYY format.

What is the window where dead seedlings would count against survival count?

On each site, TerraFund requires restoration project developers to report the numbers of trees planted every six months and the survival rate of those trees. This information is used to complement remotely sensed monitoring of tree growth. Project developers follow the survival calculation guidelines in this document when implementing a survival count and fill out the recording sheet.

If replaced within the reporting cycle where planting also occurred, the replaced trees should not count as "dead trees" when reporting on TerraMatch. In all subsequent reports, replaced trees that die should be included in the survival rate calculation, and they should be marked as "replacement" trees in the recording sheet. It is strongly recommended that project developers conduct several survival rate tallies throughout the project lifespan, starting as early as one month after planting.

Tree planting involves considerable investments in money and time, and meeting land restoration goals will only be possible if planting targets are achieved. To reach those targets, practitioners must return to planting sites, assess tree establishment and survival rates, and make early adjustments to improve the performance of restoration work.

Appendix E. Employee registry

Figure E-1 | **Example of employee registry template**

(Please Do not edit this original template. Make a copy first)

Organization name:

PLEASE DOWNLOAD THE REGISTRY/EXCEL, SAVE IT ON PC AND FILL IT OFFLINE AND UPLOAD IT ON TERRAMATCH

All personal information collected will be treated with the highest standards of confidentiality and data protection. This information is collected solely for the purpose of verifying employment status and supporting project monitoring, reporting, verification and learning (MRV) objectives, and will be stored in the TerraMatch database with access limited to only TerraMatch admins and Project Managers. No personal identifiers will be shared publicly or with third parties outside the project team without the participant's explicit, written consent and the data will not be used or shared for any other purpose without prior consultation and consent. All data will be retained only for the duration necessary to fulfill the stated purpose and will be deleted or anonymized thereafter, in accordance with applicable data protection laws and institutional policies. By providing your information, you acknowledge that you have been informed about the purpose and use of your data and consent to its collection and secure handling as described.

GUIDANCE:
Employee Name: Legal name of the employee (2 names)
Gender identity: Whether employee is male or female or unknown (to be selected from the drop down menu)
Age Range: Select employee age range from the drop down menu to indicate whether employees are youth(18 - 35 years) or non-youth(36+)
Employment Type: identify the type of employment, whether full-time, part-time/temporary or short-term/seasonal/casual
*Full-time jobs refers to all people working 35+ hours per week on a project, with a consistent role that involves daily or almost daily engagement for at least 3 months of the reporting period
*Part-time jobs refers to all people working <35 hours per week on a project, with a consistent role that involves frequent engagement for at least 3 months of the reporting period
*Short-term/Seasonal/Casual jobs refers to all people working <35 hours per week periodically on a project for less than 3 months within the reporting period
*Short-term/Seasonal/Casual jobs are a sub-category of Part-time jobs and the sum of them and the reported part-time jobs should add up to the total Part-time jobs reported on TM
Contact Info: Provide the employee's contact (a phone number or email address) - OPTIONAL for short-term/seasonal/casual workers
Personal ID: Provide the employee's personal identification number
Job Function: Description of the actual job done(eg. nursery worker, data collector, etc)
Employment Start Date: Input the date when the employee was first employed
Duration of Employment: Input the duration the employee was employed for within the specified reporting period (specify i.e. 3 days, 3 months etc, if not engaged put 0)

Employee Name	Gender Identity	Age Range	Employment Type	Contact Info	Personal ID	Job Function	Employment Start Date	Duration of Employment													
								1st Jan-31st June 2024	1st July-31 st Dec 2024	1st Jan-31st June 2025	1st July-31 st Dec 2025	1st Jan-31st June 2026	1st July-31 st Dec 2026	1st Jan-31st June 2027	1st July-31 st Dec 2027	1st Jan-31st June 2028	1st July-31 st Dec 2028	1st Jan-31st June 2029	1st July-31 st Dec 2029	1st Jan-31st June 2030	1st July-31 st Dec 2030
Jane Doe	*Female*	*18-35*	*Full time*	*254700123456*	*78801234*	*Data Entry Clerk*	*7/5/2024*	*6 months*	*6 months*	*3 months*											
John Doe	*Female*	*36+*	*Part-time/Tempx.*	*254717238540*	*13579135*	*Consultant*	*1/18/2025*	*3 months*	*6 months*	*3 months*											
June Doe	*Female*	*18-35*	*Short-term/Seas*	*254719673280*	*38507386*	*Seed Planter*	*8/23/2024*	*3 weeks*	*7 days*	*0*											

Source: WRI authors.

Appendix F. Indicator descriptions

Project implementation indicators

1. Tree restoration

Indicator 1.1: Number of seedlings or saplings produced

- *Description*: Nursery tree count is the total number of seedlings grown in nurseries for planting across sites and projects and acts as an intermediary progress indicator for project developers. Although it does not directly count toward the top-line number of trees planted, in the early stages of project implementation, when seedlings or saplings have not been planted, projects can still report progress on their seedlings, showing partners and funders that they are on track toward their tree target. Particularly if a TerraFund recipient is planning to source their own young trees and seedlings, an accurate count ensures that the project will have sufficient planting material and that it will be able to meet project goals. If not, this indicator allows for timely interventions by WRI. Project developers conduct this count prior to tree planting for each site and submit evidence of seedlings and young trees to TerraMatch.
- *Disaggregation*: Species, percent native species.
- *Species*: Disaggregating by species type and count allows for a more nuanced understanding of the diversity of species being cultivated and planted, which is vital for assessing ecological impacts and success rates of different species in various environments (Roman et al. 2013; Bourgeois et al. 2016).
- *Percent native species*: This disaggregation emphasizes the focus on restoring indigenous tree species, which are crucial for maintaining local biodiversity, ecosystem resilience, and cultural significance. It also helps assess the restoration's alignment with local environmental goals. See *Considerations* of indicator 1.2 for more information on calculating nativity.
- *Purpose and use*: This intermediary indicator helps to gauge progress toward the trees grown count and monitors contributions to biodiversity and native tree counts. By maintaining accurate records, organizations can assess the efficacy of their nursery practices, inform future planting strategies, and contribute to broader ecological restoration goals. Understanding the species composition can also aid in identifying potential challenges related to species-specific growth and survival rates in different environments (James et al. 2011). Furthermore, data on productive species can be a proxy for their contribution to livelihood or income opportunities.
- *Data source*: Biannual nursery reports include detailed logs of seedling production, species type, and growth conditions. See the "Reporting" section of this guidebook for more information on nursery reports.

Seed cultivation and plant development can take from a few days to over a year, depending on whether they are planted as seedlings or as saplings. Projects managing nurseries report the number of viable seedlings by species for each site. "Viable seedling" means that from seeds filled in sockets, at least one seedling was formed with two to three adult leaves. Seedlings are counted as soon as they reach the viable stage, disaggregated by species, and each seedling is only counted once.

Indicator 1.2: Number of trees planted

- *Description*: This indicator represents the total self-reported number of trees planted by TerraFund organizations, over the duration of the entire project. It encompasses various planting strategies, including planting and seeding (direct seeding, seedling transplantation, applied nucleation), and ecosystem engineering (riparian restoration, windbreaks). This indicator not only reflects the direct output of restoration activities but also serves as a foundational element for evaluating ecological recovery and biodiversity enhancement in grown areas.
- *Disaggregation*: Project, site, polygon, species type, percent native species.
    - *Site*: Project developers report the number and species of trees across an entire site, which may include multiple polygons. The site-level number accounts for geographic and ecological variations that may exist across multiple potential project locations.
    - *Polygons*: For verification purposes, the number of trees planted is counted at the polygon-level by the remote sensing tree count model. Project developers may also submit tree counts in polygon attribute tables. Polygon-level tree counts are integers with no species information included.
    - *Species type*: Project developers record planted trees' scientific, local, and common name and the number of individual species offering ecological benefits. Disaggregating by species type helps monitor biodiversity, livelihood, and income opportunities; understand species survival rates; and assess ecosystem functionality. This metric also provides a snapshot of the species composition and diversity of the restored areas.

- *Percent native species*: This disaggregation emphasizes the focus on restoring indigenous tree species, which are crucial for maintaining local biodiversity, ecosystem resilience, and cultural significance. It also helps assess the restoration's alignment with local environmental goals.
- *Purpose and use*:
  - The number of trees planted is the initial source of data on trees grown, additional biophysical outcomes, and project progress. Project developers report the number and species of trees planted biannually in site reports. These numbers are the baseline metric used in assessments of survival rates, biodiversity and native species contributions, ecosystem functionality, livelihood and income opportunities created, species diversity and species composition, and progress toward contract goals. Using the Trees planted indicator, the WRI team can identify trends in site management practices, assess the success of different species in various environments, and pinpoint areas that may require additional support or intervention (Osman et al. 2022).
  - Being one of the first signifiers of project progress, this metric provides insight into management practices, potential issues, and support needs. Understanding the dynamics of tree planting can inform adaptive management practices, ensuring that restoration efforts align with ecological and community goals (Bourgeois et al. 2016; Matys 2022).
- *Indicator data source*: Biannual site reports provide data on trees planted. These reports include detailed accounts of planting activities, species diversity, and any relevant notes on site conditions or challenges encountered during the planting process, which are crucial for evaluating the success of restoration initiatives (Viani et al. 2017). The Trees planted indicator is verified once during the project lifespan, between two to three years after planting begins, using either a remote sensing approach or a field validation protocol. See "Trees restored" in the "Verification" section for more information on verification approaches.
- *Considerations*:
  - **Calculating the percentage of native species**: Calculating native species is critical for understanding the ecological benefits projects bring to the target landscapes. While the TerraFund approach to native species calculation is still in development, the current pilot process relies on species data from site reports, comparing the number of native species trees to the total number of trees planted. To organize and classify individual species, the reported tree species are matched to a taxonomic background provided by World Flora Online (WFO 2025), with additional information on distribution, uses, climate and life-form description, and conservation status provided by the Global Useful Trees Database (GlobUNT) (Kindt et al. 2022), the Botanic Garden's Conservation International GlobalTreeSearch (GTS) (BGCI 2024), the World Checklist of Useful Plant Species (Diazgranados et al. 2020), the World Checklist of Vascular Plants (Govaerts 2022), and the IUCN (2025) Red List of Threatened Species.
  - The accuracy of the matched reported species is confirmed in consultation with portfolio managers and local experts. Project species data are then matched with the GlobUNT database of tree species that support restoration and GTS, determining nativity by comparing the project country to the list of countries where that species is distributed. The percentage of native tree species will be determined by calculating the number of trees planted for tree species considered native to the project country out of the overall number of trees planted by a project.

In future reporting cycles, TerraFund organizations' species data will be automatically matched to the World Flora Online taxonomic background through TerraMatch, with additional resources on local and common names for reference (WFO 2025).

Indicator 1.3: Survival rate of planted trees

- *Description*: Survival rate is an assessment of the continued existence and growth after seedlings have been planted. In any restoration effort, some level of attrition of planted seedlings is expected. Young trees may not survive due to factors such as low-quality seeds, damage to seedlings during transportation or planting, or events such as flooding or drought (Regreening Africa 2020).
- *Disaggregation*: Site, project.
- *Purpose and use*: Estimating survival rate early in the project life cycle can help a project developer or the TerraFund team assess if the project is on track to meet expected restoration targets and determine if intervention is necessary to achieve the desired size, density, and quality of planted seedlings.
- *Data source*: Developers are required to calculate and report survival rates at least once a year in site reports but are encouraged to conduct this assessment more frequently throughout the project's lifetime. It is advised that survival rate be estimated twice during the first year, three and six months after planting. See Appendix D for TerraFund's survival rate guidance for project developers.
- *Considerations*: A survival count above 80 percent indicates healthy performance of planted seedlings, enabling the project to focus on protection and other management operations to improve growth (Regreening Africa 2020). A survival rate below

80 percent shows that dead seedlings need to be beat up or replaced (Regreening Africa 2020; Taylor 1943). For TerraFund projects, the minimum acceptable survival count is 70 percent, due to the severe climatic conditions in some of the countries under the program.

- Note that at this time, species specific survival rates are not calculated due to the current capacity of the TerraFund team and project developers.

Indicator 1.4: Number of trees grown

- *Description*: The number of trees grown is the number of planted trees that survive six years after the start of the project. The number of trees grown is calculated as the aggregated self-reported number of trees planted over the total lifespan of the project, adjusted by the self-reported survival rate across the lifespan of the project.
- *Disaggregation*: Project, site, polygon.
- *Purpose and use*: This indicator is an overall metric of a project's success in reaching its target of trees grown. The indicator demonstrates the project's ability to not only plant trees but maintain them in a sustainable way within the landscape.
- *Indicator data source*: Project developers report the number of trees planted and assess survival rates in biannual site reports. The Number of trees grown indicator is calculated by multiplying the total number of trees planted after 72 months by the reported survival rate.
- To verify this indicator, the reported number is compared to an observed count. The observed count is the tree count generated either by remote sensing data or by field visits at the end of the project (minus the baseline count and adjusted by survival rate). The number of trees grown is verified when the reported number falls within the confidence interval of the observed count. See the "Verification" section of this guidebook for more information.
- *Reporting accuracy*:
    - The calculation of the independently verified count of trees grown is adjusted based on an uncertainty assessment of the tree count model's predictions compared to a predetermined number of field plots that are located within the same biome or ecoregion.

2. Land restoration

Indicator 2.1: Total number of hectares under restoration

- *Description*: "Hectares under restoration" refers to the total area where active restoration interventions are being implemented, categorized by target land use and restoration strategies (see Appendix B). Monitoring hectares under restoration involves a combination of field-based data collection and geographic information system analysis to track progress over time. The data collected are crucial for assessing vegetation cover and tree growth indicators, which are essential for evaluating the success of restoration efforts. These geospatial data, combined with the project's self-reported data, provide an accurate measurement of the progress of ecological restoration, thereby contributing to the resilience and sustainability of the restored landscapes. The number of hectares under restoration are disaggregated by site, as well as the number of hectares and projects under each target land use and restoration practice.
- *Purpose and use*: Hectares restored is a primary way to evaluate the restorative value of a restoration organization's work. In addition to asking about hectares in the biannual report, the TerraFund team reviews the polygons submitted by each organization. While an aggregate of all the hectares restored by each organization creates this top-line metric, it also provides insight into the effectiveness of each intervention strategy and the impact of individual organizations.
- *Data source*: Biannual project reports, field-reported polygon data.
- *Considerations*: It is important to note the pattern in which trees are restored in each site (restoration distribution), especially for long-term monitoring. TerraFund defines three types of spatial distribution across a restored area—in lines, patches, or across the whole area—as follows:
    - Single line: Trees are grown in a single line within a portion of the restoration areas.
    - Partial coverage: Trees are grown across the restoration areas but only cover a portion of the restoration areas or are grown evenly but with an open canopy.
    - Full coverage: Trees are grown evenly across the site, and the canopy is closed.

Indicator 2.2: Percentage tree cover change

- *Description*: This indicator evaluates tree cover change over time. The Tropical Tree Cover dataset is used to derive the tree cover percentage for all sites in a project. Change is determined by comparing tree cover at two points in time. To calculate tree cover change for a given project, tree cover at month 72 (year 6) is subtracted from tree cover at baseline. This indicator sheds light on larger, landscape-scale tree cover trends over the lifetime of the project.
- *Disaggregation*: Polygons, sites.
- *Purpose and use*: The method is used as an independent data source to support baseline planning and suitability assessment of restoration interventions. It can be used in combination with indicator 2.1, and data on restoration intervention and

land use type help landscape managers evaluate the accuracy of the reported area under restoration.

- *Data source*: Data for this indicator come from the Tropical Tree Cover dataset, a 10-meter tree cover extent dataset that uses Sentinel-2 and Sentinel-1 optical and radar satellite data with a time-series convolutional neural network to perform image segmentation on monthly composite images. The dataset maps the probability that at least one tree canopy intersects each pixel's center (Brandt et al. 2023).

3. Jobs created (people employed)

TerraFund defines a job as a set of tasks and duties performed by one person aged 18 or over in exchange for monetary pay in line with living wage standards. All indicators in the Jobs created category are disaggregated by number of women, number of men, and number of youths.

Individuals counted toward indicators 3.1 and 3.2 must be directly employed by the project, as reflected on employment records. TerraFund does not monitor or verify the number of jobs that may have been created indirectly along the restoration supply chain, only the number of people employed directly on the project. People employed indirectly—for example, through partners, subcontractors, or contracted service providers—are not counted toward this indicator and are instead reflected under livelihood indicators. Projects may estimate the number of jobs that they expect to have indirectly helped to create in their estimates of indicator 4.2, Number of local community members indirectly receiving benefits from restoration, for example, by supporting nurseries or other actors along the supply chain.

In addition to reporting quantitative data on the number of people employed or volunteering on the project, TerraFund projects also provide qualitative data on the type of work they are hiring employees to do, and on the nature of volunteer engagements.

Job creation data are self-reported and then verified through the process described in the "Verification" section of this guidebook. TerraFund provides guidance to projects to support the quality of data reported and to mitigate inaccuracies due to human error or misinterpretation of definitions.

Indicator 3.1: Number of full-time employees of TerraFund projects

- *Description*: This indicator measures the number of people working 35 or more hours per week on projects funded by TerraFund. Full-time employees are people regularly paid for their work on the project and working 35 or more hours per week throughout the year, with a consistent role that involves daily or almost daily engagement for at least three months of the reporting period.
- *Purpose and use*: This indicator provides insight into the project's contribution to socioeconomic outcomes in the local area, with particular focus on women and youth engagement. The TerraFund MRV team uses these data to assess progress toward job creation goals at the individual project and at the portfolio levels. The TerraFund MRV team also assesses the qualitative data projects provide to understand trends and highlights from the types of jobs created through TerraFund restoration projects.
- *Disaggregation*: Gender, youth.[8]
- *Data source*: Biannual project reports and TerraFund employee registry (see Appendix E).

Indicator 3.2: Number of part-time employees of TerraFund projects

- *Description*: This indicator measures the number of part-time employees working on projects funded by TerraFund. The definition of part-time employees includes two categories: part-time employees and short-term, seasonal, and casual employees. Part-time employees are people regularly paid for their work on the project and working less than 35 hours per week with a consistent role that involves frequent engagement for at least three months of the six-month reporting period. Short-term, seasonal, and casual workers are people working periodically on the project, typically involved in tasks that take a few days, or during high-engagement seasons such as planting seasons. These include jobs that involve recurring engagement at the same time in different months but for a short duration ranging from a few days to a few weeks.
- *Purpose and use*: The purpose and use of this indicator are the same as for indicator 3.1. Monitoring part-time jobs is especially important to understanding contributions to job creation goals, as most employees of TerraFund projects are part-time employees. Monitoring these data is necessary to provide a complete picture of job creation through TerraFund. This way of disaggregating part-time employees has been shown to provide more accurate data and minimize double-counting.
- *Disaggregation*: Gender, youth, part-time, short-term.
- *Data source*: Biannual project reports and TerraFund employee registry (see Appendix E).

Indicator 3.3: Number of volunteers contributing to the project

- *Description*: A volunteer is an individual who freely dedicates their time to the project because they see value in doing so but who does not receive payment for their work. For example, they may volunteer their time because of a personal interest in environmental causes, or because they believe restoration efforts will benefit their community, or as part of their educational pursuits. Paid employees or beneficiaries who do not dedicate their time to the project are not considered volunteers.

- *Purpose and use*: This indicator provides insight into how much unpaid labor contributes to ongoing restoration efforts. This is why it is included in the category of "employment opportunities" indicators, even though TerraFund does not consider volunteer positions to be jobs. The TerraFund MRV team uses quantitative and qualitative data on volunteers to understand trends and highlights from the types of contributions volunteers are making, and the types of volunteers projects are engaging, providing insight into the organizational models supporting restoration.
- *Data source*: Biannual project reports.

4. Livelihood benefits

Restoration has the potential to provide livelihood co-benefits in addition to the direct benefits of tree growth. The organizations that TerraFund supports have social as well as environmental goals. These goals are often based on the role that restoration can play in supporting the livelihoods and well-being of local community members, for example through improved productivity on farms or increased access to clean water (Ullah 2024). Some TerraFund project developers implement supplementary activities to tree planting, such as training farmers and supporting community members to take on additional income-generating activities, such as beekeeping, or support community savings groups, so that local farmers and community members have access to other sources of income.

This section describes the TerraFund indicators that help us understand the livelihood benefits projects provide to local community members. These co-benefits of restoration activities are often difficult to capture accurately and consistently, because understanding the full extent of if and how community members benefit from restoration requires in-depth, resource-intensive studies, and because of the long time frames over which certain benefits are realized.

The TerraFund team acknowledges the limitations of using self-reported data to monitor livelihood benefits. Limitations include the subjective nature of the data, leading to inadvertent overestimations and difficulty in verifying the data. With these limitations in mind, monitoring livelihood benefits using the indicators described in this section provides insight into the ways restoration can support livelihoods, and the priorities and perceptions of TerraFund restoration organizations regarding livelihood benefits.

Indicator 4.1: Number of local community members directly receiving benefits from restoration

- *Description*: Project developers are asked to report on the estimated number of local community members who have directly received benefits from TerraFund projects. TerraFund defines a direct benefit as an immediate and tangible value a project provides to target groups and local communities. In most cases these benefits support the livelihoods and well-being of recipients—as do food and agricultural products, seedlings, or access to savings and loans—and the number of recipients of benefits is straightforward to estimate. Projects need to identify their direct beneficiaries and target them during project implementation. Direct benefits are different from jobs and increased skills and knowledge, which are tracked separately from benefits.
- *Disaggregation*: Gender, youth, and number of smallholder farmers.
- *Purpose*: Supports understanding of TerraFund project contributions to socioeconomic outcomes and contributes to understanding of how restoration can support livelihoods and well-being.
- *Data source*: Biannual project reports.
- *Considerations*: In addition to the quantitative data on the estimated number of local community members receiving benefits, project developers provide qualitative information describing the nature of these benefits. The TerraFund team provides additional guidance to developers to clarify whom they should include in the estimated total, and whom they should not include. This helps mitigate double-counting of individuals with other indicators, such as People employed and Number of volunteers contributing to the project. According to TerraFund's definitions, this indicator only includes the direct recipients of benefits and not, for example, members of their household, as this could lead to overestimations.

Indicator 4.2: Number of local community members indirectly receiving benefits from restoration

- *Description*: Project developers also can report the estimated number of people indirectly receiving benefits from the project. An indirect benefit can be intentional or unintentional and refers to the downstream value realized as a peripheral result of a project's restoration efforts. This includes community members who benefit, for example, through improved soil or water quality, or members of the households or communities of the individuals included in indicator 4.1.
- Disaggregation: Gender.
- *Purpose*: These estimates offer another avenue for organizations to capture the broader benefits of their project. Additionally, from a project management perspective, by clearly delineating between "direct" and "indirect," the estimations of direct beneficiaries are often more accurate and better reflect the tangible benefits a project provides.
- *Data source*: Biannual project reports.
- *Considerations*: The number of people indirectly receiving benefits may be complicated to estimate,

but developers provide additional information explaining how they calculated these estimates in their reports.

Indicator 4.3: Number of people who received training from the project

- *Description*: Many organizations offer training, capacity-strengthening, and skill-building opportunities to local community members. Trainings are expected to highlight the value of restoration and equip people with the tools and knowledge necessary to bolster their livelihoods. Example topics include restoration or agriculture techniques, business development, or other income-generating activities.
- *Purpose*: Supports understanding of TerraFund project contributions to socioeconomic outcomes.
- *Data source*: Biannual project reports. In addition to the quantitative data on the estimated number of people who received training, project developers provide qualitative information describing these trainings and the skills or capacities they expect the trainings to support.

Indicator 4.4: Number of projects supporting income-generating activities

- *Description*: Many organizations support income-generating activities to help local farmers and community members supplement their incomes. Supplemental income-generating activities can offer a dual advantage of supporting farmer livelihoods and increasing reception and adoption of restoration by helping to offset the long time frames required for the income-generating benefits of trees to materialize (Ding et al. 2017).
- *Purpose and use*: Supports understanding of TerraFund project contributions to socioeconomic outcomes, the prevalence of supplementary income-generating activities, and the types of income-generating activities supported.
- *Data source*: Biannual project reports.
- *Considerations*: All organizations that support income-generating activities are asked to provide additional information about the types of income-generating activities they support. Analysis of this qualitative data may support future disaggregation of this indicator by activity type, such as livestock-keeping, aquaculture, crop production, apiculture, or nursery establishment in homesteads. The type and value created through the income-generating activity greatly varies by project.

5. Financial health and performance

This set of indicators tracks financial performance and demonstrates the ability for both nonprofits and enterprises to manage investments and grow as institutions. Also included under this set of indicators are metrics that help the management team assess risk across the portfolio.

TerraFund's financial reporting approach is designed to help project developers build stronger fiscal stewardship and demonstrate their growth over time. Many TerraFund project developers struggle to produce high-quality financial documentation, which is the backbone of the health of an organization. TerraFund provides financial and expense reports in a standard format to help organizations learn industry best practices for submitting reliable financial data, which improves chances of receiving future funding.

Enterprise-specific indicators

For-profits

The approach for evaluating financial health differs slightly between enterprises and nonprofits. After funding is distributed, for-profits report on their financial health in three ways: annual financial reports submitted on TerraMatch, audited financial statements for most organizations, and nonaudited statement or management accounts. These sources, as described in the "Reporting" section of this guidebook, contribute to the understanding of the three enterprise-specific financial indicators and subindicators.

Indicator 5.1: Net profit margin

- *Description*: This indicator measures the percentage of revenue that remains as profit after all operating expenses, interest, taxes, and other costs have been deducted.
- *Disaggregation*:
  - Per enterprise
  - Per enterprise type (medium stage, growth stage)
  - Per geographic region or landscape
  - Per cohort
- *Purpose and use*: Net margins are the primary way to assess an enterprise's profitability. This metric helps identify enterprises that are financially sustainable and can scale, supporting investment decisions and financial risk assessments by potential co-investors.
- *Data source*: Yearly profit is collected through the annual TerraMatch financial report and verified using audited financial statements. It is calculated automatically in TerraMatch based on the reported net profit and total revenue using the following formula:

  Net profit margin = (net profit / total revenue) × 100

Calculated values, organized into the ranges shown in Table F-1, guide project management interventions.

Indicator 5.1.1: Gross and percentage change in revenue

- *Description*: This indicator measures the gross and percentage change in the enterprise's annual revenue

Table F-1 | **Net profit margin ranges**

NET PROFIT MARGIN (%)	STATUS	INTERPRETATION	RECOMMENDED ACTION
< 0	Red	Operating at a loss; low or negative margins may reflect preprofit stage, early losses, or high overheads.	Ask project developer how they intend to improve profit margins; consider reschedule of debt finance.
0–10	Yellow	Low profit margin	Ask project developer how they intend to improve profit margins.
10–20	Green	Healthy margin	No action required.
> 20	Green	Strong profitability; high margins may suggest efficiency but could also reflect underinvestment in scale or impact.	Consider for follow-on or co-investment.

Source: WRI authors.

(in US$) over the tenure of the investment. It is a subindicator under indicator 5.1, Net profit margin, because while it is an important standalone metric of business-level health, it is primarily a constituent part of net profit and a part of its calculation.

- *Disaggregation*:
  - Per enterprise
  - Per enterprise type (medium stage, growth stage)
  - Per geographic region or landscape
  - Per cohort
- *Purpose and use*: Change in revenue is an important standalone indicator of business-level health and a constituent part of the Net profit margin indicator. Tracking revenue at multiple stages—using lookback data from prior years' revenue in applications and recurring annual reports—allows TerraFund portfolio managers and businesses themselves to judge the financial success of their enterprise, visualize causes for concern, and demonstrate potential for additional investment.
- *Data source*: Financial data are collected annually in the TerraMatch financial report and are verified using audited financial statements. Once the self-reported data are verified, they are uploaded to a database for analysis, where gross and percent change in revenue values are calculated.

Indicator 5.2: Current ratio

- *Description*: The current ratio evaluates an enterprise's short-term liquidity by comparing current assets to current liabilities. It shows the ability of the enterprise to meet short-term obligations, providing insights into its financial health.
- *Disaggregation*:
  - Per enterprise
  - Per enterprise type (medium stage, growth stage)
  - Per geographic region or landscape
  - Per cohort
- *Purpose and use*: This indicator gauges the short-term solvency of restoration businesses and supports decisions on working capital, operational financing, and risk management. This metric serves as an early warning to engage with the enterprise, restructure terms if needed, or prepare for risk mitigation.
- *Data source*: Data for this indicator are collected annually in an organization's TerraMatch financial report and verified through submitted audited financial documentation. Using the following formula, ratios are categorized into four categories for assessment:

  Current ratio = current assets / current liabilities

The calculated ratio will fall into one of the ranges shown in Table F-2 and will guide project management interventions.

Indicator 5.3: Percentage of enterprises repaying loans on time

- *Description*: This indicator shows the percentage of enterprises that have paid the amount due on their loan balance, updated weekly.
- *Disaggregation*:
  - Per enterprise
  - Per cohort
- *Purpose and use*: This indicator tracks to what extent each borrower is on track toward repaying their loans, flags enterprises that are falling behind for corrective action, and—if they have on-time repayment—helps determine which enterprises are eligible for reinvestment and reductions in their effective interest rate.
- *Data source*: Repayment tracker, a live spreadsheet managed and updated weekly by the relevant fund manager, populated with bank transaction data. If an enterprise has two loans, it must be fully up to date on both loans.

Table F-2 | **Ranges for current ratios**

CURRENT RATIO	STATUS	INTERPRETATION	RECOMMENDED ACTION
< 1.0	Red	Risk of short-term insolvency	Ask project developer for action plan for boosting revenues for reducing liabilities. Pause future investments.
1.0–1.5	Yellow	Tight liquidity	Ask project developer for action plan for boosting revenues for reducing liabilities. Pause future investments.
1.5–2.0	Green	Good liquidity	Consider enterprise or follow-on investment for co-investment.
> 2.0	Yellow	Excessive liquidity or underused assets	Consider enterprise for follow-on or co-investment.

Source: WRI authors.

Indicator 5.4: Percentage of finance repaid by borrowers

- *Description*: Amount of total capital of each loan repaid to date (in US$), updated weekly.
- *Disaggregation*:
  - Per enterprise
  - Per cohort
- *Purpose and use*: This indicator tracks the financial health of each investment by comparing the amount borrowed to the amount repaid to the relevant fund manager. It also aids the team in determining if and how much finance can be recycled for additional lending to the most-qualified borrowers.
- *Data source*: Repayment tracker, a live spreadsheet managed and updated weekly by the relevant fund manager, populated with bank transaction data. If an enterprise has two loans, it must be fully up to date on both loans.

Nonprofit-only indicators

Indicator 5.5: Budget execution rate

- *Description*: This indicator tracks the annual percentage of the total allocated project budget that has been spent within the reporting period.
- *Disaggregation*:
  - Per nonprofit project
  - Per geographic region or landscape
  - Per cohort
- *Purpose and use*: This indicator tracks financial discipline, absorption capacity (readiness to receive additional funding), implementation progress, as well as operational gaps. It is critical for understanding the financial health and responsibility of nonprofit organizations. Both enterprises and nonprofits may use up to 30 percent of the total budget for complementary, nontree-planting activities as part of the overall restoration effort. Tracking budget execution ensures that project developers are using funds in a timely and appropriate manner, enabling portfolio managers to compare project spend-down with progress toward key impact indicators, particularly tree restoration, land restoration, and jobs created. Consistent tracking allows early detection of under- or overspending. A low execution rate may indicate delays in project implementation, while a very high rate early in the project may raise concerns about burn rate or financial planning. For TerraFund and its financial partners in their role as fund managers, this indicator supports risk management and adaptive project support.
- *Data source*: Data on budget execution are collected from nonprofits through annual project expense reports. These reports are uploaded as Excel files to TerraMatch with the January project report. The data are calculated using the following formula:

Budget execution rate = (actual expenditure/ approved budget) × 100

TerraFund uses ranges shown in Table F-3 to understand the calculated spend-down and guide project management interventions.

Indicator 5.6: Change in organization operating budget

- *Description*: This indicator measures the percentage change in the total annual operating budget of a nonprofit organization over the course of its TerraFund project.
- *Disaggregation*:
  - Per nonprofit organization
  - Per geographic region or landscape
  - Per cohort
- *Purpose and use*: By collecting operational budget information, TerraFund can track trends in fundraising by project developers and assess the organization's scale-up or contraction potential. This metric assists project developers with long-term planning and sustainability, while allowing TerraFund portfolio managers to better evaluate risk of failure for funded projects.

Table F-3 | **Budget execution rate ranges**

EXECUTION RATE (%)	STATUS	INTERPRETATION	RECOMMENDED ACTION
< 70	Red	Underspending; possible delays or underperformance	Request explanation from project developer; block payment until justification is appropriate.
70–80	Yellow	Moderate execution; may require minor adjustments	Request explanation from project developer.
80–110	Green	On target; healthy financial implementation	Continue implementation, no explanation required.
> 110	Red	Overspending; potential overrun or budget misalignment	Request explanation from project developer; block payment until justification is appropriate.

Source: WRI authors.

Table F-4 | **Operating budget ranges**

(%) CHANGE IN OPERATIONS	STATUS	INTERPRETATION	RECOMMENDED ACTION
< -20	Red	Significant annual budget cut	Request explanation from project developer to understand roadblocks.
-20–0	Yellow	Minor reduction in budget	Request explanation from project developer to understand rationale, e.g., stagnation, phase out of revenue source, efficiency gains.
0–20	Green	Stable or slight increase, positive continuity	No action needed.
> 20	Green	Significant scale-up or expansion	Request explanation from project developer to understand positive trend.

Source: WRI authors.

- *Data source*: Information on operating budgets is collected annually in financial reports, submitted directly on TerraMatch, and verified using audited financial documentation. It is calculated using the following formula and categorized into one of three ranges:

Change in operating budget = (annual operating budget at baseline – current annual operating budget / annual operating budget at baseline) × 100

The change in operating budget will fall into one of the ranges shown in Table F-4 and will be used to guide project management interventions.

All-organization indicators (enterprises and nonprofits)

Indicator 5.7: Level of external finance catalyzed for projects

- *Description*: This indicator measures the total amount (in US$) of additional non-TerraFund financial resources leveraged since the signature of the organization's TerraFund contract, as well as the total number of additional individual investments. Additional financing can be directly or indirectly associated with an organization's TerraFund contract and includes external grants, loans, equity, and co-financing from public or private actors but excludes internal revenue. TerraFund hopes the financing that organizations receive is catalytic and generates additional opportunities for financial growth outside of the initial investment. To show the impact of TerraFund funding, project developers report any additional finance unlocked after joining the cohort. They describe how the additional capital enabled the organization to grow, as well as if and how its relationship with TerraFund contributed to the investment.
- *Disaggregation*:
  - Per organization
  - Per financing type (private grant from foundation, private grant from government, loan or credit finance from private bank or investor, equity from private investor, product offtake contract, carbon credits contract, public-private payments for ecosystem service)
  - Per cohort
- *Purpose and use*: TerraFund hopes the financing that organizations receive is catalytic and generates additional opportunities for growth outside of the initial investment. This indicator demonstrates project success in attracting additional capital, a

helpful metric for organizations themselves and for TerraFund as it seeks to understand its role in catalyzing finance for medium- and growth-stage organizations. It also supports impact storytelling to donors and partners and encourages resource mobilization and replication.

- *Data source*: Project developers record new investments in the annual financial report on TerraMatch. These figures are then verified using transaction documentation such as investment agreements, donor letters, partnership memorandums of understanding, or audited financials. TerraFund categorizes external investments using the ranges shown in Table F-5.

6. Community engagement

TerraFund centers community engagement on two principles, gathering input and addressing barriers, with an indicator representing each. This approach looks beyond just leadership data to understand the inclusion of the local community, as well as the benefits for women and youth from a systemic perspective.

Measuring community engagement is complex, and TerraFund recognizes there are limitations to its current approach. These include challenges with verifying reported information, and that the context-specific nature of community engagement makes it difficult to compare across projects. Collecting input alone, for example, does not guarantee that every community member was consulted, or that project developers will prioritize this feedback in their project. TerraFund has refined its approach to monitoring community engagement to improve the quality of information reported on these indicators. However, this approach is still being iterated upon and TerraFund recognizes its imperfect nature.

Understanding the progress of TerraFund's projects toward these goals is therefore not calculated at one discrete moment in a reporting cycle; it is combination of intentional project sourcing, diligent vetting, and open and honest communication between TerraFund staff and project developers, where the value of equitable community engagement can be shared.

Indicator 6.1: Percentage of projects demonstrating efforts to address barriers to equity for women and youth

- *Description*: This indicator tracks the proportion of projects that can demonstrate the specific actions they are taking to address the relevant systemic barriers that women and youth face to accessing benefits of restoration.
- *Disaggregation*: Projects targeting women, projects targeting youth.
- *Purpose and use*: Disaggregating other socioeconomic data by age and sex is important to understand the number of women and youth accessing opportunities such as employment and training, but additional data on specific project approaches are needed to understand progress toward reducing systemic barriers. Addressing barriers faced by marginalized populations, such as women and youth, is essential to promoting gender and social equity. This indicator provides information about the direct, targeted actions and innovations projects are taking to contribute to equity.
- *Data source*: Biannual reports. Project developers are asked to select which of the following three types of gender and social equity barriers their work addresses. They then describe associated activities and provide evidence.
  - Removing **financial and economic barriers** (e.g., making inclusive decisions, establishing guidelines, loan systems that provide alternative forms of collateral, credit for women and youth).
  - Addressing **harmful cultural norms** (e.g., activities that challenge or improve harmful practices and make restoration spaces more inclusive for women and youth. Activities can include evidence of gender sensitization training AND mobilization activities with local leaders and chiefs to make favorable space for women and youth in restoration projects).
  - Addressing **land and resource rights inequities** (e.g., creating legal or collective agreements that secure land and tenure rights for women and youth through cultural or legal strategies—such as allocating verbal collective rights for women and youth to lease lands, retain women's traditional rights to homesteads while engaging with the

Table F-5 | **External investment ranges**

INVESTMENT AMOUNT	STATUS	INTERPRETATION	RECOMMENDED ACTION
$0–$10,000	Red	Minimal external interest	Ask project developer to revisit fundraising strategy and advise on shifts.
$10,000 to < 100% of TerraFund investment amount	Yellow	Moderate catalytic effect	No action required.
> 100% of TerraFund investment amount	Green	Strong leverage and potential for scale	Discuss with champion their successful strategy and consider for engagement with other financial partners.

Source: WRI authors.

market economy, develop a new legal strategy or intervention to improve land and tenure rights of women and youth).

Indicator 6.2: Percentage of projects seeking local community input in project decisions

- *Description*: Ensuring that local communities are actively and continuously involved in decisions surrounding the implementation of restoration initiatives in their communities and the priorities of these restoration initiatives is a primary concern of TerraFund.
- *Disaggregation*: Cohort (group of implementing organizations).
- *Purpose and use*: As project developers and the TerraFund program explore innovative ways to engage local communities, this indicator provides insight into which approaches have been successful and should be scaled. It further helps the team that mechanisms for community engagement are continuous and meaningful.
- *Data source*: In biannual project reports, project developers describe their engagement of local communities by providing information on the mechanisms used to gather local community input in project decisions, the decisions this input informs, and the frequency at which they seek this input.
- *Considerations*: The TerraFund approach to community engagement has adapted over the cohorts. Because of updates to indicator language and reporting questions, analysis differs slightly between cohorts.

7. Carbon sequestration

Indicator 7.1: Metric tons of carbon sequestered after six years

- *Description*: This indicator evaluates baseline carbon stocks and evaluation of change in tons of carbon stored in restoration areas between baseline and six years after project implementation. Data for this indicator are developed in partnership with Michigan State University. The indicator is measured with high-resolution imagery via an allometric relationship between diameter at breast height (DBH) and crown projected area (CPA).
- *Disaggregation*: Polygon, site, landscape.
  - Landscape: Carbon stocks will be calculated across polygons within the three TerraFund priority landscapes: the Great Rift Valley, the Ghana Cocoa Belt, and the Lake Kivu and Rusizi River Basin.
- *Purpose and use*: This indicator shows climate change mitigation impact at both the project and landscape level, as well as the growth of trees. The results of these analyses can be used for adaptive management. For example, if a project used the same methods in two sites but has different amounts of carbon storage across the project's lifetime, this insight can be used to understand the contributing factors of carbon storage in the landscape.
- *Data source*: Data are currently in development in partnership with Michigan State University. They are derived from field data collections and high-resolution satellite imagery. See Appendix H for more information regarding the Carbon for TerraFund protocol.
  - This pilot protocol contains two possible methods for calculating carbon sequestration. Generally, method 1 (mapping) is the primary method for estimating carbon on project sites and in landscapes, and method 2 (inventory) is used to add additional detail, as for project sites with seedlings, saplings, or continuous tree cover that cannot be measured in the mapping approach. The mapping method is based on remote sensing and is used to measure carbon stocks in individual trees with detectable tree canopies (greater than 5 m^2) for the entire landscape using a "wall-to-wall" approach, which measures and reports continuously across the entire landscape (not based on a sample frame). The mapping method also reports for trees within sites where trees are present in the baseline and at months 72 and 120. The mapping method does require field sampling to collect data for its crown-based allometric scaling of remote sensing measurement and delineation of tree crowns.
  - The inventory method is supplementally used when measurements of seedlings and saplings are required; when small trees below the mapping detection limit are found, or for other important layers such as shrubs; and when closed canopy forests or woodlands are measured. The inventory method is sample-based. The sample frame for the inventory method is a statistical sampling of carbon stocks directly, and as such needs to be extrapolated across a land unit represented by the sample. It may require considerable field time and effort, for instance in cases of large areas or dense forest cover.

Program administration indicators

8. Inclusive finance

TerraFund intentionally targets investment toward groups that traditionally face significant barriers to finance, such as local and women- and youth-led organizations. The inclusive finance indicator assesses the extent to which TerraFund investment supports these organizations.

As the closest proxy for progress on financial inclusion, the eight indicators below measure both the percentage of projects and proportion of total funding allocated to organizations that are local and led by women and youth. Taking a project and funding approach to analysis ensures broader dispersion and a deeper impact in target organizations, while preventing the concentration of investment in a select few projects.

An organization qualifies as women-led or youth-led if over 50 percent of its leadership is held by women or youth. For enterprises, leadership is determined by company ownership; women or youth must represent over 50 percent of the top one to five people with the largest ownership stake in the organization. For nonprofits, leadership is determined by decision-making authority; women or youth must represent more than half of the top five key decision-makers in the organization.

Leadership information is self-reported by project developers during the application process. For enterprises, applicants must list the name, gender, nationality, and age of the top one to five people with the largest ownership stake in the organization, while nonprofit applicants must list the name, title, gender, nationality, and age of the top five key decision-makers in the organization. To verify this self-reported information, applicants submit their organization's organogram, or other documentation that outlines the organization's structure. Because gender and youth are not mutually exclusive categories, the youth- and women-led indicators are further disaggregated by gender and youth status, respectively. TerraFund defines youth in line with the African Union (2006) definition as individuals between 18 and 35 years of age.

Indicator 8.1: Percentage of projects allocated to women-led organizations

- *Description*: The number of projects managed by women-led organizations compared to the total number of active TerraFund projects.
- *Disaggregation*: Cohort, youth-led organizations.
- *Purpose and use*: By requesting this information during the vetting process, the selection committee can better distribute funding equitably across the restoration sector.
- *Data source*: Application data. See above for information on determining the gender breakdown of the leadership team.

Indicator 8.2: Percentage of finance allocated to women-led organizations

- *Description*: The percentage of project budgets allocated to organizations with over 50 percent women leadership.
- *Disaggregation*: Cohort, youth-led organizations.
- *Purpose and use*: Used to evaluate TerraFund's progress on gender equity and supporting women-led organizations.
- *Data source*: Application data. The percentage of total finance allocated to women-led organizations is determined by using the total project budget (in US$) allocated to organizations with over 50 percent of top leadership roles or ownership held by women, divided by the total project budget allocation to all projects in the cohort.

Indicator 8.3: Percentage of projects allocated to youth-led organizations

- *Description*: The number of projects managed by youth-led organizations compared to the total number of active TerraFund projects.
- *Disaggregation*: Cohort, women-led organizations.
- *Purpose and use*: This indicator is a primary way to understand TerraFund's progress toward supporting youth-led organizations.
- *Data source*: Application data. See above for information on determining the youth breakdown of the leadership team.

Indicator 8.4: Percentage of finance allocated to youth-led organizations

- *Description*: The percentage of overall project budgets allocated to organizations with at least 50 percent representation of youth (18–35 years old) on their leadership teams.
- *Disaggregation*: Cohort, women-led organizations.
- *Purpose and use*: Understand TerraFund's progress in supporting youth.
- *Data source*: Application data. The percentage of total finance allocated to youth-led organizations is determined by using the total project budget (in US$) allocated to organizations with over 50 percent representation of youth on their leadership team, divided by the total project budget allocation to all TerraFund landscape projects.

Localization

The following indicators (8.5–8.8) relate to WRI's attempt to make restoration more localized. A locally led approach to restoration is characterized by local people (nationals and residents of the area or representatives of local communities) and their communities having individual and collective agency over their restoration priorities and how restoration takes place. A locally led approach ensures equitable access to resources and decision-making power for the people, communities, and groups at the lowest appropriate governance level (household, village, city, district, etc.). In other words, decision-making and resources should reach the most local level where a decision will have direct impacts and should focus on those who experience marginalization or disproportionate socioeconomic and climate vulnerabilities.

Localization additionally requires that

- local actors be equal partners, not just beneficiaries;
- local community and Indigenous rights and knowledge be respected;
- restoration approaches be appropriate to the local context and local social, economic, and ecological values;
- local communities define their role in restoration; and
- developers aim to address power imbalances between local communities and power-holding actors (funders), as well as local social imbalances (gender and class differentials).

It is also critical to recognize that shifting the existing power structures present in the restoration sector is a process. It takes time to establish the governance and decision-making processes, organizational cultures, operational systems, and trust-based partnerships that locally led restoration requires. Given the timescale, localization for TerraFund is understood on a spectrum, shown in Table F-6.

Indicator 8.5: Percentage of projects allocated to local organizations

- *Description*: TerraFund defines a local organization as one that is run by local people in their own contexts and based in the landscape where restoration is taking place. Local organizations represent the interests and priorities of local communities and the landscape. Restore Local adopts criteria for a local organization from *Publish What You Fund*, as described in a 2023 Oxfam report (Adomako and Cohen 2023). An organization is local if it is
  - headquartered and incorporated in the recipient country, excluding subsidiaries or brands of international organizations;
  - managed and governed by nationals of the recipient countries or by nonnationals from a specific beneficiary group (e.g., refugees), or there is a succession plan in place to transition organizational leadership; and
  - only working subnationally or nationally; a substantial percentage of the organization's budget is spent in the landscape.
- *Purpose and use*: As part of the Restore Local initiative, it is vital to TerraFund to focus efforts and support toward organizations that meet TerraFund definitions of "local."
- *Data source*: Self-reported data from project proposals (applications for funding).

Indicator 8.6: Percentage of finance allocated to local organizations

- *Description*: The percentage of total project budgets allocated to local organizations. See indicator 8.5 for a definition of "local."
- *Disaggregation*: Cohort.
- *Purpose and use*: Understand TerraFund's financial progress toward supporting local restoration organizations.
- *Data source*: Self-reported data from project proposals (applications for funding).

Indicator 8.7: Percentage of organizations aligned with a locally led approach

- *Description*: A locally led approach to restoration is characterized by local people (nationals and residents of the area or representatives of local communities) and their communities having individual and collective agency over their restoration

Table F-6 | **Localization continuum**

	LEAST LOCAL LEADERSHIP		→ MOST LOCAL LEADERSHIP		
Level of engagement	**Conventional**	**Consultative**	**Participatory**	**In partnership**	**Locally led**
Description	Local actors informed but do not shape project design. One-way extraction of data and information. *RL does not fund projects at this level*	Local actors provide feedback through one-way communication mechanisms.	Local actors invited to plan a project or inform a decision. Process to identify local actors and promote their participation. No formal process for local actors to inform decisions.	Decisions are made jointly between local partners and nonlocal actors.	Local actors make technical and programmatic decisions.

Note: RL = Restore Local.
Source: WRI authors.

priorities and how restoration takes place. A locally led approach ensures equitable access to resources and decision-making power for the people, communities, and groups at the lowest appropriate governance level (household, village, city, district, etc.). In other words, decision-making and resources should reach the most local level where a decision will have direct impacts and should focus on those who experience marginalization or disproportionate socioeconomic and climate vulnerabilities. Projects count toward this indicator if they are aligned with the standards of localization outlined in the locally led continuum or are making active progress toward localization.

- *Data source*: Self-reported application data collected during the first year and biannual project reports.
- *Purpose and use*: Except for organizations following a conventional approach to project implementation, TerraFund finances projects along the locally led spectrum. Because of this, tracking where on that continuum projects fall is crucial for understanding how WRI is supporting locally led restoration. Also recognizing the longer-term horizon of shifting to locally led restoration, as mentioned above, TerraFund needs to know the current distribution of locally led projects in the portfolio to track progress across years.
- *Considerations*: Should organization leadership change hands, it is expected that these changes will be explained in the biannual progress reports and that the recipient organization will maintain a locally led structure.

Indicator 8.8: Percentage of finance allocated to organizations aligned with a locally led approach

- *Description*: The percentage of overall projects budgets allocated to organizations with local leadership and prioritizing local needs. See Table F-6 and the description of indicator 8.7 for more information about what constitutes "locally led."
- *Disaggregation*: Cohort.
- *Purpose and use*: Understand TerraFund's progress on supporting locally led organizations.
- *Data source*: Application data.

9. Market access

Long-term, equitable market access is of primary concern in WRI's effort to develop a just restoration economy. A critical part of building a restoration economy is developing nonphilanthropic funding pipelines (Credit Suisse et al. 2014). "Market-based finance" refers to investments that seek returns. For the purposes of TerraFund, it is understood as the debt and equity investments. Project developers' access to market-based finance helps evaluate the financial sustainability of the restoration project and organization outside of grant funding.

Indicator 9.1: Percentage of projects accessing market-based finance

- *Description*: A portfolio-wide statistic examining the percentage of organizations receiving debt or equity investments compared to the entire portfolio.
- *Disaggregation*: By cohort.
- *Purpose and use*: Because many current restoration efforts are almost entirely supported by philanthropic funding, they are not self-sustaining without external grant-based funding. Measuring the ratio of projects with access to debt or equity investments helps determine the long-term financial sustainability of the funded organizations. Furthermore, by knowing how much funding is market-based and/or repayable, funders and team management can calculate returns on investment and the potential amount of recyclable funding.
- *Data source*: This metric is a categorization indicator and is calculated after the most recent onboarding cycle has been completed.

Indicator 9.2: Percentage of total finance allocated as debt or equity

- *Description*: Similar to 8.1, this indicator looks at the amount of finance mobilized across both cohorts to evaluate how much funding is market-based compared to non-repayment grants.
- *Disaggregation*: By cohort.
- *Purpose and use*: Access to market-based finance is used as a measure of financial sustainability for restoration organizations and a proxy metric for the sustainability of the larger restoration economy.
- *Data source*: Organizations are categorized as grant recipients or for-profit recipients (debt or equity investments) during the sourcing and application period. The final breakdown is calculated following the completion of the most recent onboarding cycle.

Appendix G. Nonprofit expense report

Nonprofit expense report template.

Appendix H. Carbon for TerraFund protocol

Authors: Created by David Skole, Michigan State University, Forestry Department, Global Observatory for Ecosystem Services; Justine Spore, WRI; Edward Saenz, WRI.

Guidance for users

This indicator and associated guidance establish a baseline carbon stock, the change in carbon stocks over 72 months, and a 30-year projection. This process was piloted for several projects and is under continued development. Data collected during the pilot phase will be used to inform additional research around carbon sequestration on restoration sites. The protocol describes how carbon will be estimated and monitored

- on all sites in a project, and
- at the landscape level for tree-based restoration projects.

Year 0, referred to as the baseline, is the year when the first field data collection for carbon estimate occurred. Year 6 is 72 months after the baseline was measured, when the second field data collection activity for carbon estimation occurs. Refer to Table H-1 for a timeline of the carbon protocol.

Definitions

Forest: Land with tree crown cover (or equivalent stocking level) of more than 10 percent and area of more than 0.5 hectares (ha). Trees should be able to reach a minimum height of 5 m at maturity in situ.

Landscape: A large area surrounding the specific restoration intervention areas greater than 40,000 ha. While there is not one universal definition, it can be defined in several ways:

1. By obtaining input from the project developers on the region in which they are working and would normally have activities, contact with farmers, and general outreach and engagement influence.
2. As the area that surrounds specific intervention sites for projects, whether or not they are funded by TerraFund.
3. As the area bounded by the remote sensing images used for analysis.
4. As an area bounded by a jurisdictional boundary such as a municipality, land management unit, or rural investment area.
5. As a watershed, river basin, or other bio-geophysical unit.

Table H-1 | **Timeline of carbon data collection and projection**

YEAR	YEAR 0	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 30
Months since baseline	**0**	12	24	36	48	60	**72**	**360**
Assessment type	**Baseline: first data collection**						**Reassessment: second data collection**	**Projection**

Note: Data collection: blue; ex-ante calculation: orange.
Source: WRI authors.

Project: The entire geographic area where an organization has received funding to restore land. A project can consist of a single restoration area or multiple restoration areas.

Restoration area: Each separate, contiguous area on the ground where restoration work is being done. Each restoration area will be represented by a polygon for use in TerraMatch's monitoring system, depending on the context.

Site: The basic unit for organizing and reporting biophysical data on TerraMatch. It can be a single restoration area or a grouping of restoration areas based on proximity and/or common characteristics. A site may contain multiple target land use systems, restoration practices, and target tree distributions but is always specific to a single planting year.

Target land use system: The land use system (or systems) that will exist after six years of project implementation, not the current state of the land or the state of the land as it transitions to its final use, a group comprising agroforest, mangrove, natural forest, open natural ecosystem, silvopasture, riparian area or wetland, urban forest, and woodlot or plantation. See Appendix B for definitions of each system.

Target tree distribution: How trees will be spread throughout the site after restoration work has concluded. These consist of single line, partial coverage, and full coverage. See Appendix F for definitions of each distribution.

Trees outside of forests (TOFs): Often referred to as trees on farms, a more specific definition includes landscapes of trees not formally included in the forest zone, which is often defined officially as recorded forest area, gazetted forest (an officially demarcated forest area under special protection or management), forestlands, or by other designations. TOFs may include occurrences of sparse woodlands and savannas with canopy cover less than the forest definition; agricultural landscapes with individual remnant or planted trees on farms; agroforestry systems that combine perennial trees with annual crops; smallholder plantations; orchards; or woodlots and other widely spaced or individually grown tree-based systems. A default definition and classification can be found in Skole et al. (2021a) or Foresta et al. (2013).

Importance

The carbon estimation methods establish year 0 baseline carbon stocks on sites and in landscapes, a 72-month reassessment of carbon stocks on sites and in landscapes, change in carbon stocks between year 0 and month 72 (year 6) on sites and in landscapes, and a year 30 projection of carbon stocks through an ex ante calculation on sites and in landscapes. The amount of carbon sequestered is estimated as the change in stocks, which adopts an approach closely related to the stock change method of the Intergovernmental Panel on Climate Change (IPCC 2003). For purposes of reporting, carbon stocks will be reported both at the finest level possible (nominally to be the tree level consistent with standard allometric inventory), as well as on a summary basis as carbon per hectare. The latter, averaged across a land unit (landscape, restoration area, or site), provides a carbon density, which is useful for comparing across projects, land use systems, and places.

In partnership with Global Observatory for Ecosystem Services at Michigan State University (MSU), a small group of restoration project developers from Cohort 1 of TerraFund were invited to participate in a carbon field data collection activity to pilot the methods in 2023 and 2024. These 23 projects (10 in Kenya, 7 in Ghana, 4 in Rwanda, and 2 in Malawi) were selected based on location, relationship with One Tree Planted partners, restoration strategy, and geospatial boundary submission. Data collected at and around these projects will be used to develop models specific to each landscape that can estimate carbon at and around Cohort 2 projects and beyond.

This indicator shows climate change mitigation impact at both the project and landscape level, as well as the growth of trees. The results of these analyses can be used for adaptive management. For example, if a project used the same methods in two sites but has different amounts of carbon storage across the project's lifetime, this insight can be used to understand which factors contribute to carbon storage in the landscape. Additionally, the result of the year 30 projection can be used to identify projects and project types that result in high carbon storage and could potentially pursue a carbon crediting scheme.

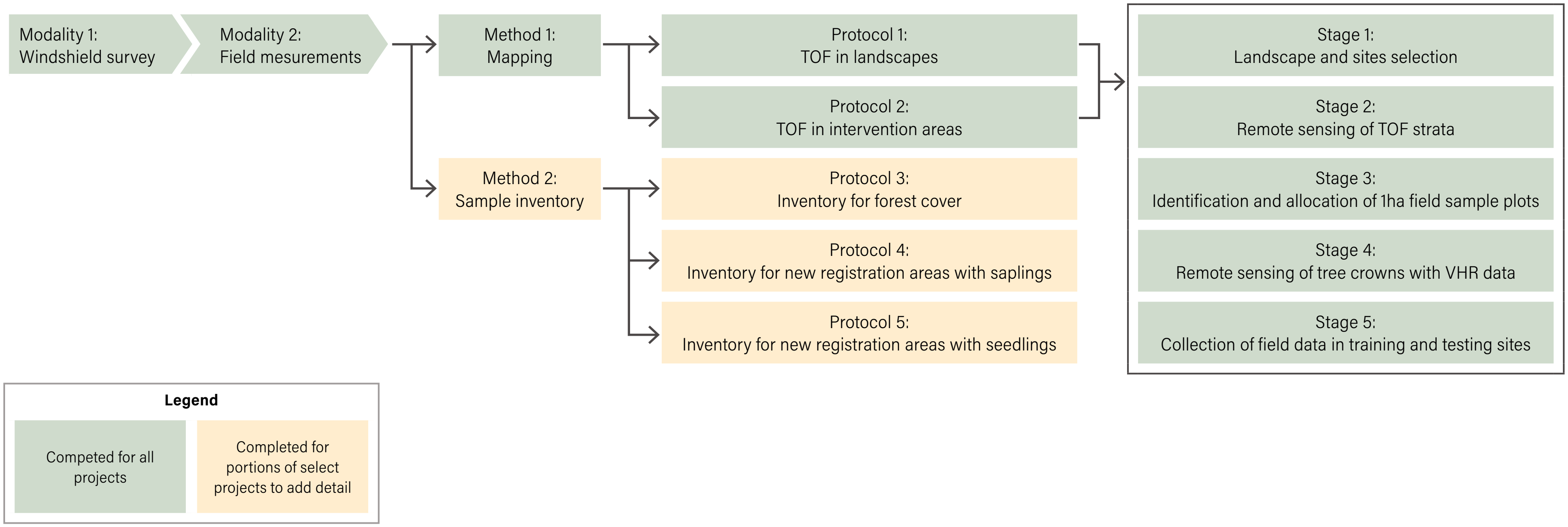
Methodology

The methods for baseline and month 72 carbon estimation on project sites and landscapes are derived from the methods presented in Skole et al. (2021a) and Mugabowindekwe et al. (2023). Fieldwork conducted to complete baseline and year 6 carbon sequestered will be completed using the methods in Skole and Samek (2023a, 2023b, 2023c, 2023d). This work is structured into two modalities, one for field reconnaissance and the second for field deployment. Field measurement deployment protocols are further organized into two general methods and five associated protocols. See Figure H-1.

Modality 1: "Windshield survey" for field reconnaissance

The first modality for field reconnaissance is the "windshield survey," where the team inspects the landscape and gathers observations that inform the analysis and field measurement itself. Field reconnaissance is meant to gather information to develop a broad measurement plan or framework for

Figure H-1 | **Flowchart of methods and protocols completed to calculate carbon sequestered**



Notes: TOF = tree outside of forest; VHR = very high resolution.
Sources: Authors, David Skole (Michigan State University).

the projects in a portfolio. As such, it is done on a small cross-sectional sample of projects in the portfolio. To do this, an initial assessment of the project portfolio is made through a formal process to inventory and define various characteristics of projects in the portfolio, following the down-select approach used by MSU.

During the field reconnaissance effort, detailed photographic and documentary information is compiled about the site where restoration is taking place, the ecological context, and what types of interventions are occurring. It defines the context and uses very high resolution (VHR) satellite data as the map base for notation and commentary.

Modality 2: Field measurements for field deployment

The second modality for field deployment is actual measurements using sample plots in which parameters that relate tree characteristics, usually allometric scaling parameters, to tree and stand biomass are measured. These characteristics can then be transformed into tree or tree-cover carbon stocks using one of two methods. Across the two methods are five protocols for field data collection. See the differences between the mapping and inventory approaches in Table H-2.

Generally, method 1 (mapping) will be the primary method for estimating carbon on project sites and in landscapes, and method 2 (inventory) will be used to add additional detail at the discretion of the MSU team for project sites with seedlings, saplings, or continuous tree cover that cannot be measured in the mapping approach (Table H-2). Soil carbon and litter will not be included in carbon estimations. Belowground live biomass will not be measured directly; instead, a standard root-to-shoot ratio of 0.26 is used for both methods. Shrubs and standing and lying deadwood will only be measured and included in method 2 carbon estimates.

Table H-2 | **Comparison of mapping versus inventory methods**

METHOD	MAPPING	INVENTORY
Priority of use	Primary	Supplementary
Mechanism	Field data and remote sensing	Statistical sampling and extrapolation
Target	Individual trees with detectable tree canopies	Sites where individual tree canopies are not detectable
Protocols	1. Landscapes 2. Intervention areas	1. Continuous tree cover 2. Sites with saplings 3. Sites with seedlings

Source: Authors, David Skole (Michigan State University).

1. Mapping: The first type of method is based on mapping, in which field measurements are gathered as input for a model that interrelates allometric parameters from the field with remote sensing. Crown projected area (CPA) (meters) and diameter at breast height (DBH) (centimeters) are collected in the field in random 1 hectare circular plots, and a relationship between the two characteristics is calculated. In parallel, VHR imagery of the sample plot area is acquired, and individual tree crowns are mapped using machine learning image segmentation analysis. Measures of DBH obtained from field measurements are then specifically associated with individual trees and their mapped CPAs. This, in turn, allows the use of a standard allometric equation based on DBH to compute individual tree carbon stocks from CPA. This mapping is then applied to VHR remote sensing data to map carbon in large landscapes at the tree level.

   The mapping method is based on remote sensing and is used to measure carbon stocks in individual trees with detectable tree canopies (greater than 5 square meters) for the entire landscape using a "wall-to-wall" approach, which measures and reports continuously across the entire landscape (not based on a sample frame). The mapping method also reports for trees within sites where trees are present in the baseline and at months 72 and 120 (years 6 and 10, respectively). *The mapping method does require field sampling to collect data for its crown-based allometric scaling of remote sensing measurement and delineation of tree crowns*.

   Under the mapping method are two detailed protocols for how to collect data for trees outside of forests (TOFs) in landscapes (protocol 1) and intervention areas (protocol 2), including planted trees, isolated trees, plantations and agroforestry, and other individual tree-based activities. Protocols 1 and 2 have five associated stages of field data collection.

2. Inventory: The second method is based on a sample inventory, in which measurements are used to directly estimate the carbon stock of tree cover in sites with seedlings, saplings, or continuous tree cover that cannot be delineated in the mapping approach. This method uses standard forest inventory methods to sample a limited area or whole forest stand. Depending on the nature of the sample plot arrangements (clustered or nonclustered plots), the plot estimates are averaged and then extrapolated using an expansion factor to the entire project or stand area, either in total or by strata. This biomass is converted to carbon stocks using a standard conversion factor: C = 0.5 * Biomass (kg/ha).

   Under the inventory method there are three protocols depending on what type of site or intervention is being measured. These are whole stands of forest or continuous tree cover, new restoration areas as sites or projects with saplings, and new restoration areas as sites or projects with seedlings.

   The inventory method is supplementally used when measurements of seedlings and saplings are required; when small trees below the mapping detection limit are found, or for other important layers such as shrubs; and when closed canopy forests or woodlands are measured. The inventory method is sample-based. The sample frame for the inventory method is a statistical sampling of carbon stocks directly, and as such needs to be extrapolated across a land unit represented by the sample. It may require considerable field time and effort, as in cases of large areas or dense forest cover.

Baseline carbon analysis for project landscapes

Modality 1: Windshield survey

The first objective of a field deployment will be to document the local tree and vegetation cover context by making observations of field conditions. This will be a driving or on-foot survey of the project, taking note of the overall landscape features and how the project is implementing tree-based activities. Using the camera or phone for photos, locations are marked using the Global Positioning System (GPS), and a log of photos is kept and organized by number or order.

First, the field team goes to the project general areas to write notes and take photos. Imagery is also consulted and annotated with notes on trees and other objects (e.g., shrubs). This is a ground-truthing effort, which will be used later to interpret the landscape. Then the field team goes to project sites and takes notes and photos. It is not necessary to identify species, but the general type of trees is noted. The objective is to build a map of the area where landscape features can be filtered into those that are natural objects not directly associated with the restoration work and those that are directly a result of the interventions.

Modality 2: Field measurements

Method 1, protocols 1 and 2: Mapping landscape and site TOFs

The fieldwork objective for method 1 is to collect a dataset of tree parameters, chiefly diameter at breast height (DBH), crown projected area (CPA), and crown diameter, for developing an allometric model. The data collection protocol involves five stages:

- Conducting a selection exercise to identify sampling locations for developing the allometric relationship between field measured DBH (cm) and CPA or crown diameter (m).
- Remote sensing mapping of areas (strata) of TOFs at a broad scale and resolution using Landsat or Sentinel-2 data (predominantly Sentinel-2).
- Identification of a large sample of 1 ha plots for measurement of tree allometric parameters in areas of high-density TOFs, using the spatial characteristics and crown size characteristics from the remote sensing to guide sample locations and sample allocation.
- Remote sensing of training sites and testing sites using VHR remote sensing data from Worldview/Vantor (30 cm resolution) to create a machine learning model. At this stage of the effort, a generalized model has been developed to be used in several countries.
- Running the machine learning model across the landscape at no less than 1 m resolution to map tree crowns and then using the CPA-to-DBH allometry to assign carbon stocks.

The reporting product is a map of carbon estimates predicted for individual trees delineated in VHR imagery, resulting in a per-tree carbon map for project sites and landscapes.

Stage 1: Landscape and site selection

Ten training sites and 10 testing sites, each about four square kilometers (km^2) in area, are identified randomly within each project's landscape. Inside the training and testing sites, a set number of 1 ha plots for ground data collection is deployed, as described in stage 3.

Stage 2: Remote sensing of TOF strata

Using Sentinel data, the MSU team shall lead the deployment of a map of TOF cover at the 10 m resolution. These data shall be used to define the TOF strata, if needed. The TOF strata is the estimated cover area of trees outside forests. It is used for locating additional training and test sites, each being 4 km^2 in area.

Stage 3: Identification and allocation of 1 ha field sample plots

For this stage two options are identified, depending on scope and available resources. The first uses the machine learning training and testing sites. The second uses only a purposeful selection of sample plots in the landscape. Within each training and testing site, the team identifies the centroid of 10 random 1 ha circular plots. For the selection of purposeful sample plots, the team selects enough sample plots to obtain approximately 100–200 trees per landscape. A portion of the 1 ha plots is located inside the TerraFund project sites.

A follow-up step in plot allocation is related to "modulating" the sample allocation to accommodate the VHR remote sensing analysis. This is discussed below in stage 4 and is an adjustment to the plot allocation to ensure that there is a representative distribution of tree sizes and other factors important to the model's development. This reduces statistical outliers and in principle makes the model more tailored to the mapping feature object (crown area), further discussed in Skole et al. (2021a).

Stage 4: Remote sensing of tree crowns with VHR data

Individual tree crowns are mapped on VHR imagery within each training and testing site, as well as in the larger landscape. This is the first deployment of one of the output products and will also provide the basis for field data collection.

Using maps of CPAs from VHR remote sensing data, the field team will ensure that there is a direct matching between the trees in the sample plots and the same trees identified in the VHR data. This is important because the variables in the regression model are the tree stem DBH in the field and their precise counterpart CPA from remote sensing. Similarly for consistency checking later, field measurements of CPA will be collected to be associated with the same tree in the VHR data map of CPA.

The remote sensing adds important information in the sample plots allocation—in particular, information on the size class distribution of CPAs. To ensure that the plot allocation captures a robust distribution of CPAs across all size classes, a modulation of the allocation is made to ensure that the CPA distribution is proportional to the landscape distribution. Thus some plots are either removed or added.

Stage 5: Collection of field data in training and testing sites

The purpose of field data collection differs in the mapping and inventory methods. The purpose of this stage of the mapping method is to collect data for building the machine learning crown mapping model and the crown-based allometric scaling model. In the inventory method, field data collection is to conduct an area-representative sampling of actual biomass by tree carbon measurements. Therefore, although it is useful to have 1 ha plots delineated precisely in the field, it does not actually impact the model development if there are minor imprecisions in the delineation of the plot boundaries. All reasonable effort should be made to work within a 1 ha plot, but where boundaries are uncertain, this will be recorded in field notes.

Each allocated sample plot is located in the field using the plot centroid and GPS, and a fixed radius of 56.42 m for a 1 ha circular plot is measured. The following measurements are taken and identified precisely in the VHR remote sensing map:

- Plot number and plot features notes
- Date
- Tree locations, GPS and as identified on VHR map
- Tree identification number, which includes tree number and plot number, and identified on the VHR map
- Tree species name
- DBH (cm)
- CPA (m): This is measured using the long axis crown diameter and its perpendicular diameter tree height

At each 1 ha plot, start with the tree nearest to due north and begin a clockwise sampling of individual trees, marking the GPS location and marking on a paper or digital map the tree identification. Take photos in cardinal directions, starting due north and rotating clockwise. Copious field notes are taken at each plot, including a labeling of all measured trees on paper and on the corresponding VHR imagery.

These field data are the basis for developing an allometric scaling model using crown dimensions instead of stem or other tree dimensions. This is because remote sensing detects only objects it can image from the satellite instrument in orbit. In this case, the dimension is the crown projected area, crown diameter, or related crown measures. This allometric scaling model is a regression between field collected crown data and field collected stem diameters. The crown measurements are made using the remote sensing machine learning model. They are represented in spatial format in a geographic information system as polygons of crown areas. The crown-based allometric scaling model predicts a tree's diameter from its crown dimensions. Thus, for each mapped tree the predicted stem diameter is used with a standard allometric equation for the region, landscape, or vegetation cover type. The approach thus allows for use of a variety of local equations and for new equations to be used later.

To calculate carbon from the predicted stem diameters, the team uses the allometric equations developed by Mbow et al. (2014), Kachamba et al. (2016), and Kuyah et al. (2012).

Baseline carbon analysis for project sites

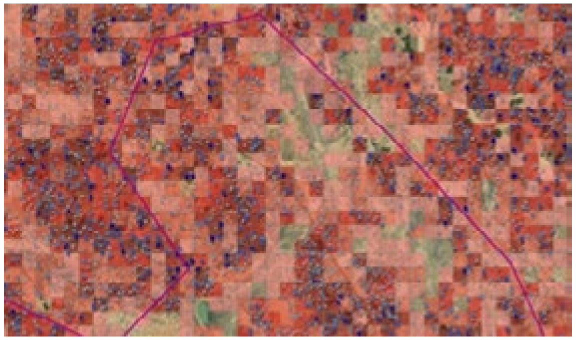
After the baseline measurements are mapped at the landscape level, the full spatial dataset (the map) of individual trees is overlaid with the boundaries or polygons of the project sites. Those trees within site polygons are selected and measured as a subset of the landscape-wide dataset. Sometimes this process is loosely called "cookie-cutting" the project sites from the landscape map. The sum of the individual tree carbon estimates for the site is reported (Figures H-2 and H-3).

Figure H-2 | **TerraFund project in Kenya, outlined in red**

Notes: Blue polygons represent tree crowns identified via remote sensing. Darker blue indicates higher carbon stock.

Sources: WRI and Michigan State University authors; satellite imagery © 2025 Vantor.

Figure H-3 | **TerraFund project in Kenya, outlined in purple**



Notes: Blue polygons represent tree crowns identified via remote sensing. Darker blue indicates more carbon stock. Each red ¼ hectare grid represents carbon stocks, with darker red indicating more carbon stock.

Sources: WRI and Michigan State University authors; satellite imagery © 2025 Vantor.

Method 2

For sites with continuous forest cover, recently planted saplings, or seedlings, an additional sample inventory will be conducted. This method uses standard forest inventory methods to sample a limited area or forest stand, which is then used to estimate select carbon pools in the project site (see Table H-3 for definitions of the types of carbon pools). Carbon estimates from this inventory will be added to the carbon map created with method 1. Field data collection will follow standard forest inventory procedures, including MSU Standard Operating Procedures (*Standard Operating Procedures: Forest Carbon Inventory, Data Collection and Reporting*, vols. 1 and 2).

Plot design for tree inventory

The selection of sample trees will be done in fixed size circular plots, which are easy to establish in the field and can be demarcated with simple tools and procedures.

The sampling point design applied in the field inventory follows this scheme for a nest plot design to capture both large and small trees (Figure H-4):

- 6 m radius circular plot: small trees 5–15 cm DBH
- 12 m radius circular plot: medium trees 15–30 cm DBH
- 20 m radius circular plot: big trees > 30 cm DBH

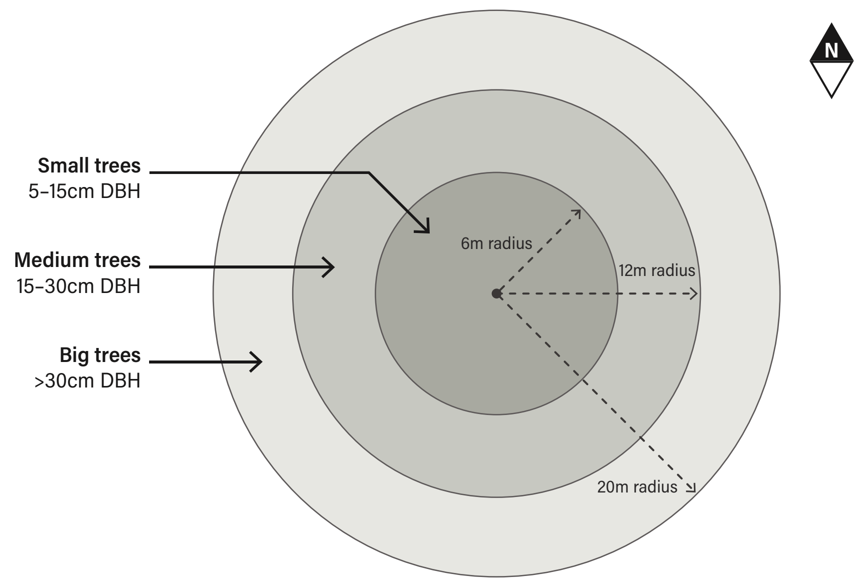
We recommend a cluster sample using three points as the most suitable design in terms of access and ease of implementation (Figure H-5). This scheme is to be established at each of the plot locations defined.

Table H-3 | **Carbon pools, their definitions and inclusion in method 2 carbon estimates**

CARBON POOL	DESCRIPTION	INCLUSION IN CARBON ESTIMATE
Aboveground biomass	Woody and herbaceous biomass of living vegetation above the soil surface that includes trees, shrubs, palms, bamboo, vines, and other living plants. (kg/ha)	Directly measured at each inventory site
Belowground biomass	The biomass of live roots > 2 mm diameter that includes the coarse roots of trees, shrubs and other living plants. (kg/ha)	Default value used in estimate
Deadwood	Nonliving woody biomass that is larger than the litter pool. Deadwood includes both standing deadwood and down deadwood lying on the surface ≥ 15 cm diameter. (kg/ha)	Directly measured at each inventory site
Litter	Nonliving biomass on the soil surface that is larger than soil organic matter (> 2 mm) and smaller than the deadwood (< 15 cm). (kg/ha)	Not measured and excluded from estimate
Soil organic carbon	The organic carbon in mineral or organic soils to a specified depth (30 cm is the default depth but sometimes measured up to 1 m deep). (kg/ha)	Not measured and excluded from estimate

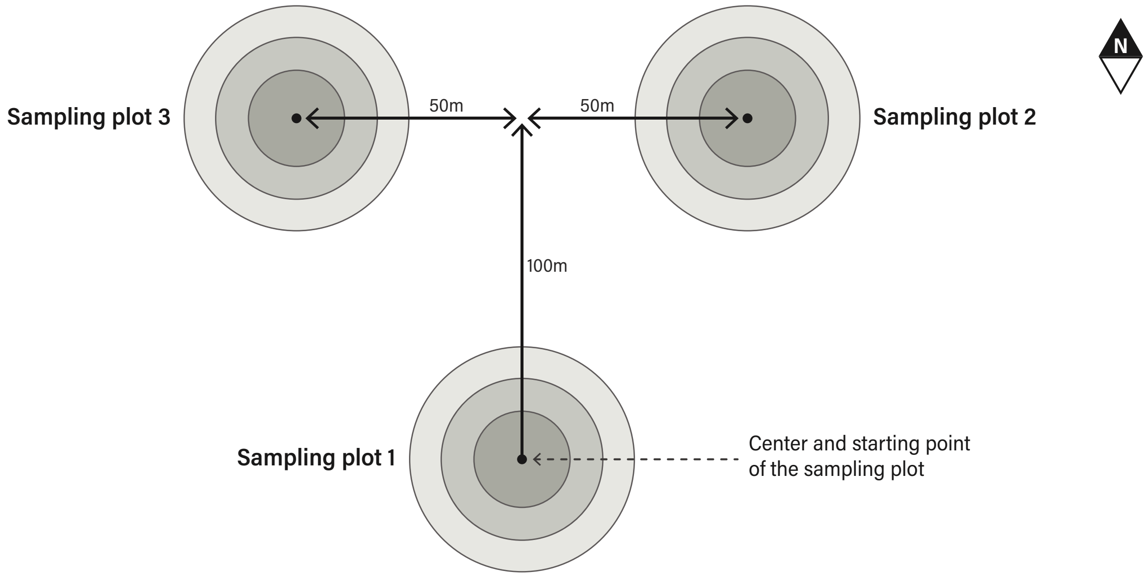
Notes: cm = centimeter; ha = hectare; kg = kilograms; m = meter; mm = millimeter.
Sources: Skole and Samek 2023c, 2023d.

Figure H-4 | **Sample plot for use in method 2, inventory sampling**



Notes: cm = centimeters; DBH = diameter at breast height; m = meters.
Sources: Authors; Skole and Samek 2023c.

Figure H-5 | **Cluster of three sampling plots used in method 2, inventory sampling**



Sources: Authors; Skole and Samek 2023c.

Tree measurement

The following tree characteristics will be measured and assessed in each sampling plot to estimate forest biomass (and timber volume):

- Genus: all trees
- Species: all trees
- Diameter at breast height (DBH) (cm): all trees
- Canopy height (m): all trees of greater than 15 cm DBH (only at the primary plot)
- Canopy projected area (CPA) (m): all trees of greater than 15 cm DBH (only at the primary plot)

Standing deadwood is estimated by assigning dead trees into two classes based on their decomposition: dead trees with branches still attached to stem or dead trees without any branches remaining on the stem. For standing dead trees without branches attached to the trunk, estimate stem volume and calculate biomass by weight (kg/ha) by multiplying with the correct density class for deadwood (sound, intermediate, rotten). The stem volume is calculated by measuring the DHB.

Lying deadwood measured inside the largest nested plot using the scheme shown in Figure H-6. Measure the diameter (cm) of all lying deadwood more than 15 cm in diameter and calculate the volume using the appropriate formula. Record the decay class for each piece of lying deadwood. Determine biomass by applying the wood density class for each piece of lying deadwood.

Additional technical details about the field measurement protocol can be found in the MSU Standard Operating Procedures (*Standard Operating Procedures: Forest Carbon Inventory, Data Collection and Reporting*, vols. 1 and 2).

Biomass estimate

Aboveground biomass (AGB) (kg/ha) estimates generated by the sample inventory will focus on trees as the dominant component of the AGB pool. Most of the components of AGB are not directly measured through destructive sampling but are typically estimated by genus- or species-specific volume equations (converted to mass by means of density) or by allometric equations that directly predict the AGB. Although many allometric equations are available for temperate zone species, many tropical tree species do not have a species-specific allometric equation. Field teams can select among several general equations for the appropriate landscape, target land use type, or ecosystem type, but these equations should be verified as accurate for the project location.

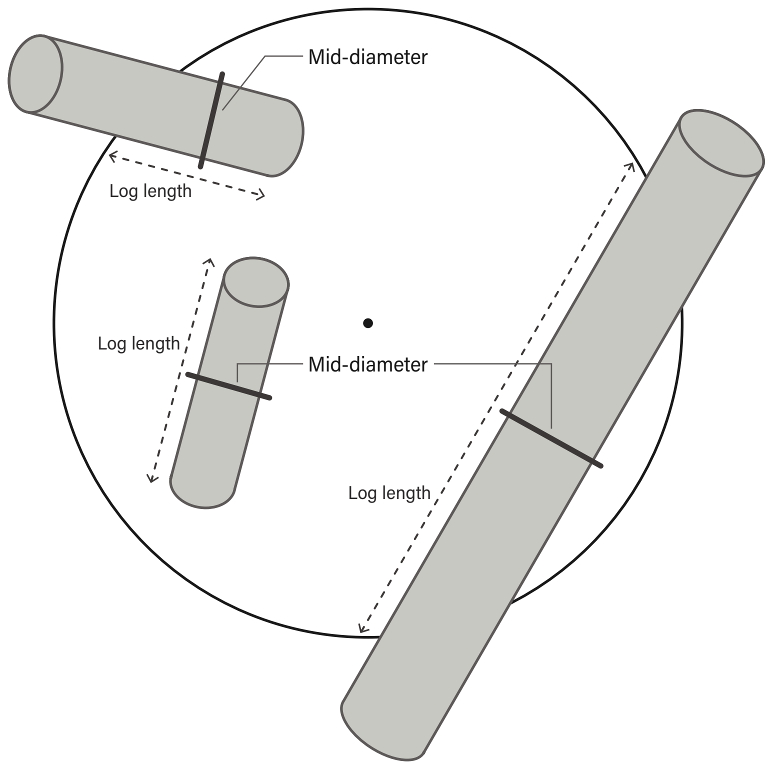
Method 2, protocol 3: Inventory for forest cover

For forested parts of the project site's landscape (area greater than a half hectare that has at least 10 percent canopy cover and is not being utilized for any other land use), an additional sample inventory will be completed when it is part of the target land use. Carbon estimates from this inventory will be added to the carbon map created with method 1 for areas with continuous tree cover that could not be delineated with the mapping method.

Method 2, protocol 4: Inventory of new restoration areas with saplings

For parts of the project site where sapling planting has been completed, an additional sample inventory will be performed. Carbon estimates from this inventory will be added to the carbon map created with method 1 for areas

Figure H-6 | **Measurement scheme for lying deadwood in sample plots**



Sources: Authors; Skole and Samek 2023c.

with continuous tree cover that could not be delineated with the mapping method.

The same methods as protocol 3 will be used but substituting a fixed radius plot of smaller size of 2–10 m as appropriate for the size of the site. Here, first count all tree saplings in the plot with a height less than 35 cm. For trees with DBH between 5–10 cm make measurements of the DBH and height. Do not measure deadwood or shrubs or seedlings. The number of plots for this survey is minimal and should be determined based on available time.

An alternative approach is to use a transect method. Here a 6 m wide transect is established in restoration areas with saplings. For saplings greater than 30 cm in height, the height and individual count is made and reported. The area of the transect is estimated and the estimates are extrapolated to the size of the site. If a standard measure of biomass and height is available, the height estimates can be directly translated to biomass per sapling, averaged per hectare, and then extrapolated. If there are no standard values of sapling height–based biomass, then either assign a logical estimate or take a destructive sample by harvesting a sample of 30 or more and getting an estimated biomass per sapling.

Method 2, protocol 5: Inventory of new restoration areas with seedlings

Sites with seedlings should be assessed only for planting rates by counting all the individuals in a fixed radius plot of 2–10 m as appropriate. The number of plots sampled should take into account time and effort availability. An alternative is to use a transect method as for saplings, but only providing counts.

Year 6 carbon analysis for project sites

The pilot is based on the following approaches:

Method 1: No additional fieldwork required. Tree crown delineation and allometric carbon modeling will be run on VHR imagery for year 6. This will produce a new landscape map of carbon stocks. As for the baseline, the site polygons are used to subset their trees and carbon stocks and reported for the site. Carbon sequestered can be estimated by stock difference.

Method 2: Fieldwork required. Inventory sites from baseline analyses are not permanent, so new inventory sites will be identified and the above inventory protocols will be followed.

Change in carbon analysis for project sites

The pilot is based on a stock change method to compute the change in stocks and the sequestered amount of carbon. The reanalysis of target land use systems in restoration areas provides new estimates of stocks, which can be compared by subtraction with the baseline measurements to estimate the change.

Appendix I. Data governance and management in TerraMatch

TerraMatch is designed with robust data governance protocols to ensure responsible, secure, and transparent handling of monitoring, reporting, and verification (MRV) data from ecosystem restoration projects around the world. This appendix outlines how TerraMatch governs data access, sharing, quality, security, and retention within its platform.

Role-based access and permissions

TerraMatch uses a granular role-based access control system that defines what data users can view, edit, or export. There are two primary user categories:

- **Project users** (e.g., project developers and monitoring partners), who create and manage their own project and site data.
- **Platform admins**, with permissions varying by role—such as super admins, framework admins, or project managers—who can oversee data across multiple projects and ensure data compliance.

Permissions are enforced at the record level and defined in configuration policies within the application's codebase. Every data model has specific create, read, update, and delete policies, as well as extended actions like approval or export, which are implemented programmatically and stored in the back end.

User onboarding and identity verification

To access TerraMatch, users must register, confirm their identity via email, agree to the platform's terms of use (wriorg.s3.amazonaws.com/s3fs-public/terra-match-terms-and-conditions.pdf), and be affiliated with an approved organization. Access to specific programs is restricted via invitation or program-specific access codes. Unauthorized access attempts are denied with appropriate http error codes (e.g., 403 errors).

Monitoring partners gain visibility into a project's data only if explicitly added. This ensures that data confidentiality is preserved and that access is traceable and revocable.

Data ownership and intellectual property

Project developers retain ownership of the data they submit to TerraMatch. By participating, they grant rights to the platform administrators (e.g., WRI, Conservation International) to use submitted data for reporting, verification, and programmatic impact analysis, as agreed upon in the platform's terms of use.

Derived datasets and indicators codeveloped by platform administrators follow collaborative agreements governing intellectual property, citation requirements, and responsible data-sharing.

Data editing and deletion protocols

Only authorized admins can edit or delete data. Edits and deletions must be approved by relevant data owners and logged thoroughly. Deletion is only permitted under strict conditions and is accompanied by a backup and audit trail containing

- who made the change;
- when it occurred;
- what was modified or deleted; and
- a link to the backup data version.

These practices ensure transparency, auditability, and data integrity over time.

Privacy and ethics

Personal information collected by TerraMatch is limited to essential account-level details (e.g., name, email, phone number). Data are handled in compliance with the platform's privacy policy, and usage of identifiable data (e.g., photographs of individuals or sensitive field notes) is governed by prior informed consent and usage agreements.

Any sensitive ecological or social information shared during the project life cycle is anonymized and handled with a "do no harm" commitment.

Data organization and storage

Data are organized by projects and sites, with relational access permissions defining visibility. TerraMatch uses Amazon Web Services (AWS) for cloud storage and backup. Files, including shapefiles and images, are stored in Amazon S3 and inherit access rules from their parent entities. Version control is managed using Git to track changes and maintain data integrity across development environments.

Data security and backup

TerraMatch applies modern security protocols:

- **Access control**: Admins and developers are authenticated through whitelisted internet protocols and secure shell keys.
- **Encryption**: Data are encrypted at rest (AES-256) and in transit (https).
- **Backups**: AWS Relational Database Service databases are backed up daily, with a 14-day rolling backup window.

- **Monitoring**: Access attempts are logged, and unauthorized access is blocked at the infrastructure and application levels.

Data quality assurance

Each project's data are reviewed and quality-checked by designated regional or technical leads before use for analysis or reporting. Verification includes cross-checks between field data and remote sensing inputs and validation of shapefiles, tree counts, and other key metrics. Quality assurance responsibilities are distributed across partner organizations, with clear designation of reviewers and sign-off protocols for each data stream.

Data retention and archiving

Data submitted to TerraMatch are retained in perpetuity unless the data creator requests their deletion. However, during active project periods, data deletion is restricted due to reporting obligations. After project closure, access and archiving timelines (e.g., up to 12 years) align with monitoring and compliance requirements.

Responsible data-sharing and licensing

Nonsensitive datasets may be made publicly available under open access terms that require

- proper attribution and citation;
- clear marking of modified versions;
- notification of data use in publications; and
- adherence to disclaimer terms.

These conditions promote transparency, replicability, and collaborative knowledge generation while protecting sensitive content.

Appendix J. Field verification protocol

WRI has developed a tree count model, which is a remote sensing–based product derived from state-of-the-art artificial intelligence applied to high resolution (0.3 m) Vantor satellite imagery. The approach uses a foundational vision transformer and an object detection model to associate input satellite images with the locations of trees. Trees are labeled in each image using points. While this model can be used to verify planted trees on project sites, some projects have characteristics that make it more challenging to count trees from satellites, such as a closed canopy or lack of available cloud-free imagery. For these projects, we will implement a field verification approach to sample and extrapolate the number of planted trees on a TerraFund project site on the ground. The field verification protocol will also be used to count the number of trees existing on a TerraFund site at baseline.

Approach for concentrated sites

This protocol is adapted from the Priceless Planet Coalition MRV approach for indicators 1.2 and 1.5.

Plot distribution and quantity

Place a 1 ha grid over the site. This can be done using the ArcGIS "Fishnet" tool or geemap "fishnet" tool (ArcGIS n.d.; geemap n.d.). Next, generate random points within each grid cell (see Figure J-1). Each point will be used as the centroid for the sampling plot. Regenerate or limit the points so that none overlap when buffered to a plot or include area outside the polygons. Lastly, randomly limit the number of plots to the quantity required to cover no less than 5 percent of the total project area.

Download the filtered point centroids with at least five decimal places to ensure accuracy in the field. Assign a PlotID to each centroid using the following scheme: "ProjectName_SiteNameOrNumber_PlotNumber"

- For example: The first centroid in the first polygon in a project named "Tree Growing" multipolygon = "TreeGrowing_1_1"
- For example: The 12th centroid in a site called "Green Hills" site in a project called "Landscape Restoration" = "LandscapeRestoration_GreenHills_12"

When field technicians arrive in the field, they should use their best judgment to ensure that sample plots selected accurately represent the project's target land use systems (agroforest, natural forest, etc.) and planting arrangement (planting with rows and without rows, etc.). Use your best judgment to approximate the types of land represented in the sample plots.

- For example, if the project is about 80 percent agroforest and 20 percent natural forest, 80 percent of the sample plots should be in agroforest zones.
- For example, if 80 percent of a project's area is planted in rows and 20 percent is not planted in rows, 80 percent of the sample plots should be in areas planted in rows.
- Random points inside the grid can be manually readjusted to follow the above scheme but primarily must remain inside the original 1 hectare (ha) grid.

Figure J-1 | **Example of a 1 hectare grid placed over a restoration project site, and points randomly generated within each grid square**

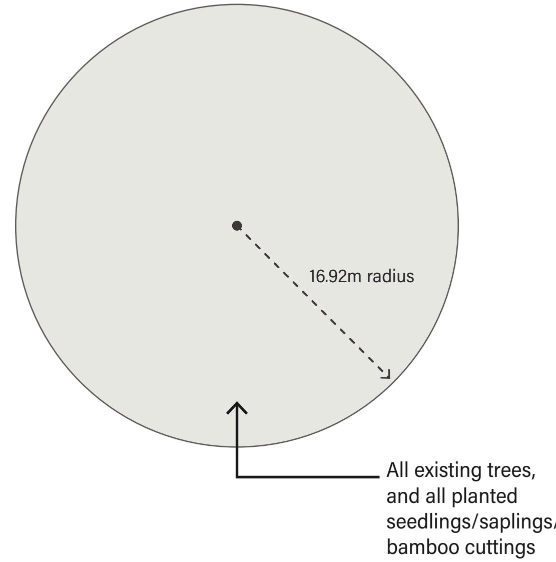
Note: The point will be the centroid of the sample plot.
Sources: Conservation International; satellite imagery © 2025 Vantor.

Plot description

Sampling plots are 900 square meters (m^2), where all baseline trees, planted saplings, and bamboo cuttings are recorded.

Field crews have the option to choose between using a circular plot with a radius of 16.92 m (Figure J-2) or a square plot where each side measures 30 m. It is recommended to use the circular plot for open canopy plots where there are not very many trees, and the square plot in densely vegetated plots. The total area of each measured plot equals 900 m^2.

Figure J-2 | **Circular plot with a 16.92 radius (900 m^2)**



Notes: m^2 = square meters. For densely forested areas, a square plot can be used. Each side of the square plot is 30 m for a total area of 900 m^2.
Source: WRI authors.

Data collection and tools

In each sample inventory plot, counts of all the baseline trees, saplings, and bamboo cuttings must be recorded. If a tree straddles the boundary of the circular plot, include and record it. Count baseline trees separately from saplings and bamboo cuttings planted for TerraFund.

Planted bamboo is counted in terms of “cuttings” or “clumps,” which aligns with how they are grown in nurseries and then planted. Field technicians can use their best judgment to determine where one planted clump ends and another begins. Additional guidance for counting mature bamboo at year 6 is in development.

Differentiating between planted saplings and existing short vegetation

Field technicians should use all potential indicators and contextual information to decide if a sapling has naturally regenerated, existed at baseline, or was part of TerraFund planting activities. Generally, planted trees must be within polygon boundaries. Field technicians can ask developers for additional planting records or check with landowners for more information. Planted saplings are typically 3 m in height or shorter.

Guidance for commonly planted species

- *Grevillea robusta*: When climate and soil are suitable and weed competition is not severe, annual height and diameter increments of at least 2 m and 2 cm, respectively, are usually achieved for the first few years in row planting on farms. Annual height increments of 3 m have been observed at the most favorable sites.
- *Calliandra calothyrsus*: Grows really fast.
- *Markamia lutea*: Grows fast in good forest soil, and plants can attain growth rates of more than 2 m per year.
- *Manguifera indica*: Moderate growth.
- *Cedrella serrata*: Fast growth when young.
- *Persea americana*: Fast growing, 1–2 m in first year.
- *Erythrina abyssinica*: Growth is slow.
- *Spathodea campanulata*: Fast growing, can reach up to 1.5–2 m in first two years.
- *Maesopsis eminii*: Medium growth, can reach up to 2–3 m in the first two to three years.

Data should be recorded following the template in Table J-1.

Table J-1 | **Data collection template**

DATA COLLECTED	OPTIONS	DATA TYPE	NOTES
Site information			
Date		Date	
Organization name		Text	
Site ID		Text	
Sampling time frame	Baseline / early insights, year 6	Select from list	
Plot information			
Plot ID		Text	
Plot shape	Circle, square	Select from list	
Description of tree-planting pattern within plot		Text	Grid spacing, clumping, etc.
Coordinate system used		Text	
Centroid of plot		GPS coordinate	
Device margin of error			
Notes		Text	
Trees in circular plot (all existing trees)			
Count of existing trees		Integer	
Notes		Text	
Saplings or bamboo cuttings in circular plot			
Count of planted saplings and bamboo cuttings		Integer	
Notes		Text	

Note: Early insights and baseline evaluation occur concurrently.
Source: Adapted from Form 1 in Sub-protocol 4, Annex 1, of the PPC Monitoring Framework.

Extrapolation to site

- Calculate sampling ratio = Total area monitored / total restored area.
- Extrapolations to the site:
  - The numbers of total existing trees and saplings for each monitoring plot are summed and multiplied by (1/sampling ratio).

Approach for distributed sites

First, union and dissolve intersecting tiny polygons into one polygon (Figure J-3) and define two categories of polygons:

Category 1: Unioned polygons greater than 10 ha in area

- Treat the same as concentrated project polygons: Use 1 ha grid approach to identify plots, where the quantity of plots is enough to cover 5 percent of the unioned area, rounding up.
- Perform field verification protocol on identified plots. (For fieldwork planning, distributed project polygons can be split geographically into groups.)
- Total number of trees in unioned polygon is split proportionally by number of original polygons based on the proportion of each original polygon's area to get tree count per polygon.
- If no plots are randomly identified on the unioned polygon, it is skipped.

Category 2: Individual tiny polygons less than 3 ha in area

These polygons will remain as individuals (Figure J-4). Additional guidance for completing field verification on category 2 dispersed projects is currently under development. The approach will likely involve using contextual project information such as previously submitted reports and project management site visits to characterize the project as low, medium, or high risk. The amount of inventorying that occurs on dispersed sites will be related to the risk level of the project—low-risk projects with strong reports and visible signs of progress may require less field verification than high-risk projects with missing reports and limited signs of progress.

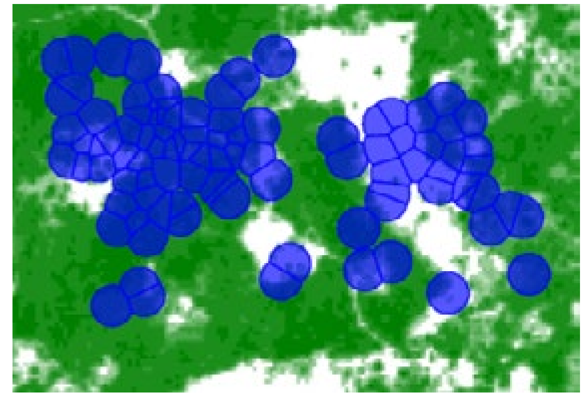
Additional information

Plot quantity (species accumulation curve approach)

The quantity of plots for concentrated projects will be the number of plots required to sample no less than 5 percent of the total project area. The 5 percent threshold was determined using a species accumulation curve approach on tree count model results for 14 test projects across Africa. These 14 test projects had sufficient high-quality satellite image coverage and open canopies at baseline to assess tree count via remote sensing and to inform a field approach. The species accumulation curve is a relationship between the number of observations recorded and the effort expended searching for them. It is typically a logarithmic curve, where at a certain point the number of observations levels out no matter how much more effort is spent searching for the target, and can be used to indicate the sufficiency of sampling to represent a population. While typically used in ecology settings, for this application, the relationship between total trees counted and extrapolated out to the project area and the number of sampling plots inventoried was considered. This approach was applied to the remotely sensed tree count results to predict at what point the number of plots employed on the ground would not affect the number of trees extrapolated to the project site.

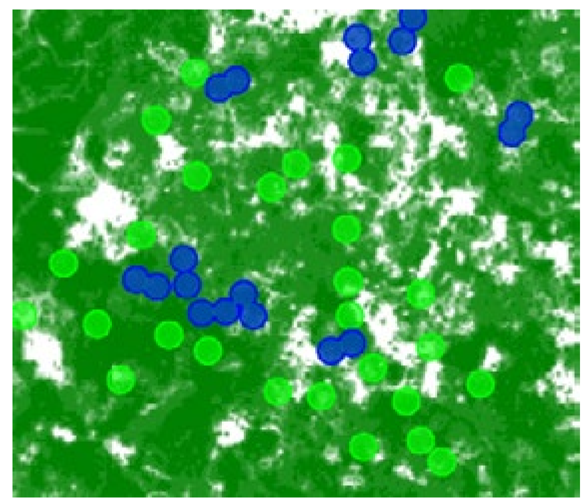
1. Calculate tree count results from the remote sensing tree count model to predict the total number of trees on the test project site.

Figure J-3 | **Example of overlapping tiny polygons that can be unioned into one polygon**



Sources: Authors; data from the Tropical Tree Cover Dataset (Brandt et al. 2023).

Figure J-4 | **Nonunioned points in green as individual polygons (category 2)**



Sources: WRI authors; data from the Tropical Tree Cover Dataset (Brandt et al. 2023).

2. Used the 1 ha grid approach described above (Figure J-1) to randomly place 1 plot per hectare on the site.
3. Count the number of trees in each plot predicted by the remote sensing model.
4. For each project, extrapolate the number of trees from each plot to the total site area, repeatedly for each number of sample plots from 1 to the maximum number of plots (equal to project area in ha).
5. Calculate at what number of plots the number of trees predicted on the project site changes by less than 1 percent.

Based on the results of applying the species accumulation curve approach to the 14 test projects, we found a sampling rate of 5 percent was sufficient for all projects.

Appendix K. Sourcing and vetting guidance

The process for project selection is composed of two phases: sourcing and vetting.

After learning from the first two rounds of open calls for applications, TerraFund shifted to a closed-call application or sourcing approach. This method allows the TerraFund team to use their strong in-landscape connections, reduces the time and capacity costs associated with vetting, and better enables co-creation between project developers and TerraFund.

During the initial step of sourcing, TerraFund staff identify and scope potential organizations and projects. Approved organizations are then invited to submit a full application on TerraMatch. Vetting is the process following application submission in which the project proposal is assessed against a set of criteria by TerraFund staff. Only after being approved through the vetting process do projects formally join the portfolio and receive funding.

Sourcing: Assessment form

This assessment form (Table K-1) provides baseline information about each organization and a justification for why it would be a suitable partner. This information enables reviewers to decide if an organization will be invited to submit a full application on TerraMatch. Figure K-1 displays the process for vetting.

For each organization, reviewers work with the contact point at the organization to populate the fields. At this stage, many of these fields will be based on initial impressions and may change with further engagement.

Table K-1 | **Fields for sourcing and vetting**

FIELD NAME	FIELD TYPE / OPTIONS	DESCRIPTION
Organization name	Short text	Name of organization
Assigned sourcing team member	Person field	Which member of the sourcing team is responsible for this organization?
Form submitter	Short text	Name of the person submitting this form and flagging the organization.
How did you hear about this organization?	Short text	Please explain how you heard about this organization. If the organization was recommended by a partner, please list their name and organization.
Notes from the sourcing team member or other staff	Long text	Include all notes of past engagement with this organization throughout the sourcing process.
Date of last contact	Date	Date of last contact
Contact name	Short text	Our point of contact at the organization
Contact title	Short text	Organization contact point title
Contact email	Short text	Organization contact point email

Table K-1 | **Fields for sourcing and vetting (cont.)**

FIELD NAME	FIELD TYPE / OPTIONS	DESCRIPTION
Contact phone number (WhatsApp enabled)	Number	Organization contact point phone number, must be WhatsApp enabled
Organization type	Single select	Type of organization
Is the organization a cooperative?	Yes/no/unsure	Cooperatives are businesses owned and operated by those who work there.
Is this organization a subsidiary of a larger international organization?	Yes/no/unsure	For example, WRI Africa is a regional office of a larger international organization.
Headquarters country	Single select	In which country is the organization headquartered?
Application cohort and year (applied)	Lookup field	Notes if the organization has applied to any TerraFund or Land Accelerator cycle
Application cohort and year (selected)	Lookup field	Notes if the organization has been selected for any TerraFund or Land Accelerator cycle
If they have a funded TerraFund project, are they 100% compliant?	Lookup field	Compliance definition = polygons and reports are submitted and approved. If relevant, loan repayments are up to date and approved. Updated quarterly.
Partnerships	Lookup field	Tracks if the organization is working with any established WRI partners. Includes active, planned, inactive, and prospective partnerships.
Is the organization officially registered?	Yes/no	Please indicate if the organization is legally registered in the countries in which it operates.
Organization leadership	Multiple select: ▪ Women-led ▪ Youth-led ▪ Neither	To the best of your knowledge, is the organization's leadership equal to or more than 50% women, 50% youth, or both? The definition of youth is between 18 and 35 years of age.
Which project segmentation model does the organization fall under?	Single select: ▪ FP community-centric ▪ FP partner and community-centric ▪ FP project-centric ▪ FP project-centric with partners ▪ NP community-centric ▪ NP partner and community-centric ▪ NP project-centric ▪ NP project-centric with partners ▪ Uncertain	FP indicates a for-profit organization. NP indicates a nonprofit organization. Further segmentation is determined by who is responsible for decision-making and implementation at 4 key stages in a project life cycle: ▪ Project planning and identification ▪ Seedling/nurseries ▪ Planting ▪ Maintenance

Table K-1 | **Fields for sourcing and vetting (cont.)**

FIELD NAME	FIELD TYPE / OPTIONS	DESCRIPTION
In which countries does the organization operate?	Multiselect: ▪ Burundi ▪ DRC ▪ Ghana ▪ Kenya ▪ Rwanda	Please select any of the following countries in which the organization operates. You may select multiple countries.
What is this organization's past experience with restoration?	Long text	Please provide details on this organization's relevant experience. Include details on location, how this organization works to restore land, methods used to monitor success, and anything else you feel would be useful.
What does this organization do and why is it a good fit for this opportunity?	Long text	Please describe what this organization does and why it should be considered.
What is the organization's source of income or revenue?	Long text	Please explain the existing source of income or revenue drivers of the organization.
Does the organization operate within the target landscape boundaries?	Yes/no	Please indicate if the organization operates within the target boundaries. View the landscape boundaries here (insert link).
If the organization operates within the target boundaries, select the subnational jurisdictions in which it has worked.	Multiselect: Dropdown of all the relevant admin 3 boundaries for the 5 countries	To the best of your knowledge, select which jurisdictions the champion has worked in in the past.
How much funding could this organization absorb?	Currency (US$)	Please provide your best estimate on how much money this organization could absorb in US$. This figure cannot be more than $500,000 or less than $50,000.
How much funding would you recommend for this organization's proposed project?	Currency (US$)	Note that TerraFund does not provide finance in excess of the organization's largest annual budget in one of the past three years. If the recommended budget is less than $50,000, the organization may be asked to join a consortium. An individual organization cannot itself receive more than $500,000. Do not inflate the recommended budget.
Briefly summarize the organization's project idea.	Long text	Please provide details on the organization's proposed project.
Which investment window is most relevant for this champion?	Multiselect: ▪ Improve biodiversity ▪ Improve food security ▪ Channel private investment to enterprises ▪ Pilot outcome-based finance	Select one or several investment windows.

Table K-1 | **Fields for sourcing and vetting (cont.)**

FIELD NAME	FIELD TYPE / OPTIONS	DESCRIPTION
Where would the proposed project fall on the locally led spectrum?	Single select: ▪ Conventional / locally implemented / informed ▪ Consultative ▪ Participatory ▪ In partnership ▪ Locally led	The locally led spectrum can be found in Appendix F as Table F-6. Note that project developers are provided with WRI's locally led spectrum, an adapted version of which can be found in Coger et al. (2025). Note that project developers are provided with the locally led spectrum included in Snyder et al. (2025), an adapted version of which can also be found in Coger et al. (2025).
What support or training would be helpful to help grow this organization throughout the TerraFund program?	Multiselect	Based on your understanding of the organization, please indicate what kind of capacity-building support the organization would need to grow.
Details on organization's technical assistance needs.	Long text	Please elaborate on the organization's technical assistance needs that you selected previously.
Will this organization be invited to submit a full application on TerraMatch?	Yes/no	Those marked as "yes" will be invited to submit a full application.

Notes: Green = prepopulated if the organization already exists in the internal database; orange = information carried over from the request for consideration form (auto-filled for self-recommended or staff-recommended organizations); pink = no population necessary; background information for existing Unified Database organizations; blue: to be filled in by applicant.

Source: WRI authors.

Vetting scorecard

The vetting scorecard provides an overview of the criteria reviewers use when assessing applications to TerraFund. It is designed to ensure consistency across reviewers and can be adapted for use in other restoration finance programs.

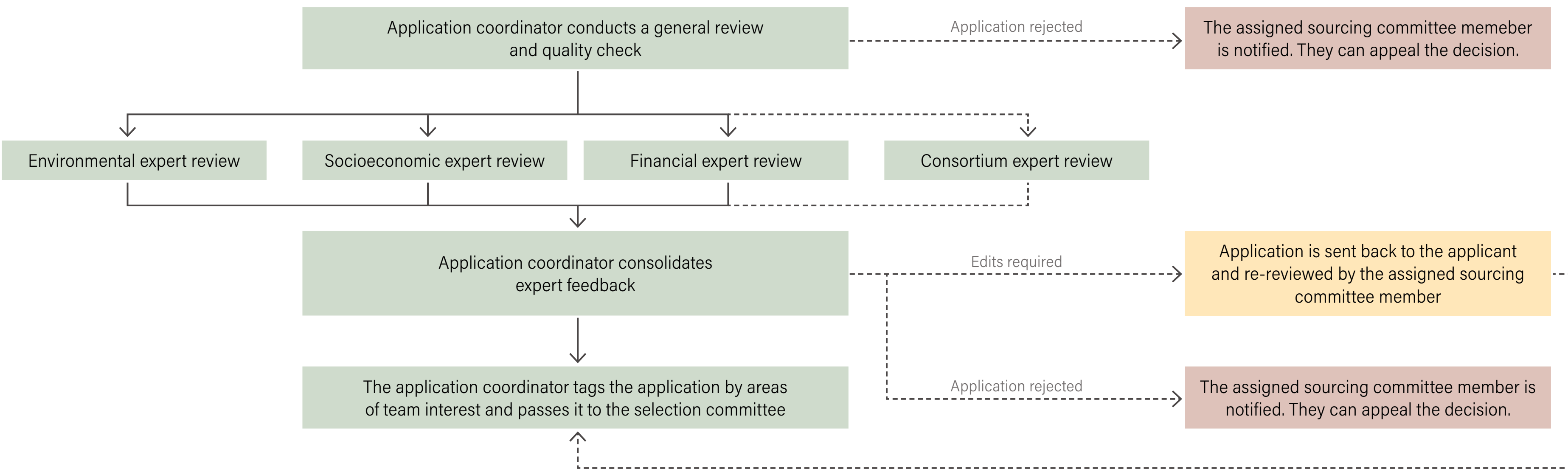
Process overview

Applications undergo review by multiple experts (Figure K-1). Each reviewer assesses specific categories and provides both a score and written feedback. These simplified categories and questions can be seen in Table K-2.

Scoring options:

1. Fail
2. Tentatively pass, but needs revision
3. Pass

Figure K-1 | **Vetting process flow**



Source: WRI authors.

Table K-2 | **Vetting criteria**

Application coordinator		
CATEGORY	**CHECK**	**REVIEWER ACTION**
Automatic disqualification checks	Is the organization legally registered?	Yes/no
	Is it proposing a project in the landscape?	Yes/no
	Is it proposing a tree-based land restoration project or complementary restoration business case enabling activities?	Yes/no
General completion with quality responses	Review entire application for completion and quality.	1–3
High-quality assessment	Includes a system for monitoring and adaptive management.	1–3
Recommendation	Will the application be sent to expert reviewers?	Single-select: ▪ Reject with justification. ▪ Send back with edits. ▪ Send to expert reviewers.
	Written feedback	Long text

Table K-2 | **Vetting criteria (cont.)**

Environmental expert		
CATEGORY	**CHECK**	**REVIEWER ACTION**
Capacity assessment	Does the past restoration work align with the proposed project?	1–3
High-quality assessment	Provides ecosystem services	1–3
	Avoids ecosystem conversion	1–3
	Enhances recolonization and performance of native/suitable species	1–3
	Considers drivers of degradation	1–3
	Project resilience to climate change and other hazards	1–3
	Targets and concentrates interventions in a defined and limited geographic area	1–3
Recommendation	Environmental expert recommendation	Single-select: ▪ Reject with justification. ▪ Return with major edits. ▪ Return with minor edits. ▪ Recommend with no edits.
	Written feedback	Long text

Socioeconomic expert		
CATEGORY	**CHECK**	**REVIEWER ACTION**
Capacity assessment	Does the past socioeconomic work align with the proposed project?	1–3
High-quality assessment	Improvements to social equity	1–3
	Improvements to economic prosperity	1–3
	Respects land tenure and other rights, and provides safeguards against risks to disproportionately vulnerable populations	1–3
	Aligns with local priorities	1–3
Locally led assessment	Where does this project's engagement approach with local actors (include landowners/farmers and communities) fall on the locally led continuum?	Single-select: ▪ Conventional / locally implemented / informed ▪ Consultative ▪ Participatory ▪ In partnership ▪ Locally led

Table K-2 | **Vetting criteria (cont.)**

Socioeconomic expert

CATEGORY	CHECK	REVIEWER ACTION
Recommendation	Socioeconomic expert recommendation	Single-select: ▪ Reject with justification. ▪ Return with major edits. ▪ Return with minor edits. ▪ Recommend with no edits.
	Written feedback	Long text

Financial expert

CATEGORY	CHECK	REVIEWER ACTION
Capacity assessment	Is the applicant equipped to implement the proposed project based on its past finances?	1–3
Budget strength	Is the budget well-composed?	1–3
High-quality assessment	Is the organization financially sustainable?	1–3
Recommendation	Financial expert recommendation	Single-select: ▪ Reject with justification. ▪ Return with major edits. ▪ Return with minor edits. ▪ Recommend with no edits.
	Written feedback	Long text

Consortium expert

CATEGORY	CHECK	REVIEWER ACTION
Automatic disqualification checks	Is the consortium made up of four or fewer organizations that are all legally registered?	Yes/no
	Is the applicant recommended for participating in or leading a consortium by the approval committee?	Yes/no
	Are the established partnerships supported by existing MoUs or letters of support from all partners?	Yes/no

Table K-2 | **Vetting criteria (cont.)**

Consortium expert		
CATEGORY	**CHECK**	**REVIEWER ACTION**
Consortium budget checks	Is there a shared and approved budget that is agreed upon by all partners?	Yes/no
	Total funding request not exceeding $1 million	Yes/no
	The lead organization, if not an implementer, must limit its own share to 20%.	Yes/no
Consortium effectiveness review	Rate effectiveness based on criteria present in consortium section of the guiding principles document.	1–3
Recommendation	Consortium expert recommendation	Single-select: ▪ Reject with justification. ▪ Return with major edits. ▪ Return with minor edits. ▪ Recommend with no edits.
	Written feedback	Long text

Note: MoU = memorandum of understanding.
Source: WRI authors.

Appendix L. Quality assurance explainer

Reviewers follow a set of guidelines developed to aid the quality assurance (QA) process. This guidance provides reviewers with a set of information that should be included in each report and examples of common errors.

Reviewers check for clarity, consistency, and reasonableness. They use the guidelines below to evaluate report quality, particularly for trees planted, people employed, and project narratives.

Trees planted

Reviewers confirm that the following are present in reported tree data:

- Feasible numbers of trees planted within implementation period
  - For instance, if a project developer reports having planted 1 million trees in a 2-month period, portfolio managers would flag this and follow up with the project developer.
- Reasonable variation in tree-planting numbers across multiple reporting periods
  - Because some variance in tree-planting activities is expected across report cycles, project developers who report identical numbers across multiple, six-month periods are flagged.
- Correctly listed and enumerated tree species

Jobs created (people employed)

When reviewing report data and employee registries, the quality assurance team looks for the following:

- Numerical data recorded matches the descriptions of work completed and project progress
- Jobs categorized correctly, and the full-time, part-time, and volunteer figures align with the reviewer's understanding of project employment types
- All jobs listed in subsequent reports are "new employees"
  - Each report should only include people who have joined the organization in the past reporting period or people who were not accounted for in the prior reporting periods.
- Correct classification of beneficiaries rather than employees
  - If an individual qualifies as an employee and a beneficiary, then the person should only be recorded under people employed.
- Alignment between number of jobs and scale of work
  - For instance, does the number of trees planted align with the number of people engaged, either as employees or volunteers?
- Reasonable variation in jobs across reporting periods
  - If the same number of full-time employees is reported in sequential reports, there could be double-counting across reporting periods.

Narrative reports

Narrative reports are expected to contain the following information:

- Specificity and high-level of detail where possible regarding project or enterprise progress.
- Comprehensive assessments of progress over the last six months. Written responses are expected to be of the same quality as in a traditional grant report.

Quality assurance terminology and definitions

Polygon quality assurance

Definition: The automated and manual review and cleaning of TerraFund projects' polygon data in TerraMatch to ensure accuracy and to avoid, eliminate, and rectify errors (Shen 2023).

Purpose: To confirm that geospatial data and their associated attribute table entered into TerraMatch do not contain errors, to verify that the submitted polygon matches the proposed area under restoration, and to enable later analyses, such as the change in tree count and tropical tree cover.

Who: WRI—data quality analysts (DQAs)

How: Following data collection and polygon creation through Flority and Greenhouse, DQAs do the following:

- Perform visual checks on polygons as they come into the Greenhouse platform and help projects' geographic information system (GIS) staff correct bugs or systematic data collection errors.
- Push polygons to TerraMatch for quality assurance.
- Run 14 automated quality checks built into the TerraMatch interface. These checks identify errors in polygons and red flags that require further investigation by a DQA but may not need to be edited (for example, large discrepancies in area between area of polygons and the projected area under restoration).

- For errors that cannot be fixed automatically, edit the polygons manually directly in TerraMatch. DQAs leave a comment on the changes made and save a version of that polygon (the original version of the polygon can be reviewed by tapping on Version History).
- Investigate any "flags" (issues that may or may not require intervention) raised by the automated QA checks. If the flag reveals a legitimate error, the DQA sends the polygon back to the geospatial lead by changing its status to "more information requested," leaves a comment on the status change for the project developer to address, and contacts the geospatial lead for that project developer via alternative means. They can communicate by WhatsApp message, email, video call, or in-person meetings to acquire the information and make the changes that are necessary.
- Rerun the automated QA checks on edited and re-uploaded polygons until no errors remain.
- Once all errors have been identified and corrected for all polygons submitted by a project developer during the current polygon QA cycle, update the site's polygon status in Airtable (field "Cycle X Polygon Status") and to "Approved" on TerraMatch (this will notify the restoration project developer).

Report quality assurance (first phase)

Definition: The system of checks, quality controls, assessments, and improvements used by portfolio managers to ensure accurate, complete, and consistent self-reported data from project developers (EPA 2019, 2000; ISO 2015). Report QA includes the review of individual reports by portfolio managers to both identify and correct errors, inconsistencies, or discrepancies in the self-reported information.

Purpose: To ensure that the data collected through TerraMatch are accurate and a true representation of the real-world accounts of project developers' work. Individual report QA also minimizes the number of errors entered into the TerraFund datasets.

Who: WRI and partners—portfolio managers (PMs)

How: Portfolio managers look at a single project at a time, assessing that reports are complete and accurate. Right after report submission, PMs

- check the completeness of the information provided for each project, confirm numbers, and request more information on sections with limited or no information;
- ensure that reports reflect their contract and agreements;
- communicate feedback with project developers and work with them to address any questions or inconsistencies in self-reported figures; and
- recompile the figures and update them on TerraMatch. The figures are then approved following a final check from the portfolio manager.

Data quality checks (QA second phase)

Definition: The review of the portfolio-wide dataset to rectify errors, inconsistencies, and outliers. This process determines if the reported values fall within acceptable conditions (Zio et al. n.d.).

Purpose: An additional check that no errors were entered into the database, crucial to maintaining data accuracy and coherence. This is an indicator-focused view.

Who: WRI—data analysts

How: The monitoring, reporting, and verification (MRV) team also validates and checks the quality of the indicator data as a whole, across the portfolio. The data validation enables data analysts to

- resolve issues with indicator data in reports such as duplicate reports, filter and check for outliers and seek clarifications with PMs, check for missing data, fix errors, and validate data; as well as
- identify discrepancies or anomalies that may require further investigation, ensuring data integrity.

This step ensures, for example, that data are up-to-date, project reports have not been accidentally deleted from the database, duplicate reports are eliminated, and missing information is updated. Any identified inconsistency prompts discussions with PMs for clarification; if necessary, a further discussion is escalated to project developers. Projects exhibiting persistent inconsistencies or minimal progress over time are escalated to the WRI / One Tree Planted team to discuss next steps, remediation, and, if needed, project termination. Once data are corrected and approved, aggregate numbers are pushed to the TerraMatch dashboard, the public database for TerraFund project data.

Data analysis and insights

Definition: Analysis of reported data to transform raw data into actionable insights.

Purpose: To report on progress on indicators as well as lessons learned from the implementing organizations, with findings used to improve project management processes and decision-making.

Who: WRI—data analysts

How: In addition to the data shared on the TerraMatch dashboard, the MRV team also aggregates, assesses, and conducts analyses on the other indicators across the portfolio (e.g., change in tree count every six months), change in jobs, livelihood beneficiaries, successes, and challenges. Analysis is done using statistical tools such as R, STATA for quantitative data, and NVIVO for qualitative data. The insights are shared with the restoration teams for feedback and lessons learned, adaptive management, and any donor reporting. The insights also provide an opportunity to understand if projects are facing any challenges and for risk assessment. Analysis also helps highlight project successes during the reporting period.

Indicator review

Definition: Similar to the report quality assurance process, aims to identify if the set of indicator questions in each report sufficiently collects correct, reliable, and accurate responses from project developers.

Purpose: To ensure that reports sufficiently gather the information of interest to the TerraFund team and that project developers hope to share.

Who: WRI—MRV team

How: Every six months after the processes detailed above, the TerraFund team reevaluates the report questions project developers are asked. This process ensures that the TerraFund team is getting accurate data for each indicator and enables them to make clarifying changes to the indicator questions or indicator definitions and improve data collected through additional questions. This process is managed by the MRV team and takes contributions from all pillars.

Indicator verification

Definition: The periodic independent assessment of the reported information by a third party or comparison using audited secondary documentation to establish accuracy. Verification helps to ensure reliability and conformance with any established procedures and can provide meaningful feedback for future improvement (Singh et al. 2016; Umemiya et al. 2015).

Purpose: To provide additional verification for tree indicators and financial information.

Who: WRI—MRV team and geospatial data team

How: Indicator verification follows methods in the MRV publication. Some indicators undergo validation rather than formal verification.

Abbreviations

AGB aboveground biomass

ANR assisted natural regeneration

CPA crown projected area

DBH diameter at breast height

DQA data quality analyst

FLR forest and landscape restoration

GHG greenhouse gas

GTS GlobalTreeSearch

MEL monitoring, evaluation, and learning

MRV monitoring, reporting, and verification

PD project developer; implementing organization

PM portfolio manager; WRI or partner staff liaising with and managing implementing projects

PPC Priceless Planet Coalition

QA quality assurance

REDD+ reducing emissions from deforestation and forest degradation in developing countries

TOF tree outside of forest

VHR very high resolution

Glossary

Attribute table: A set of nonspatial information describing a specific piece of geospatial data that includes its associated target land use system, restoration practice (or practices), tree distribution, and dates of planting.

Benefits and beneficiaries:

- **Direct:** The immediate and tangible value a project provides to target groups and local communities. In most cases these benefits support the livelihoods and well-being of recipients, such as food and agricultural products, seedlings, or access to savings and loans. For the purposes of project reporting, direct recipients of benefits include only the direct individual recipients, so the number of local community members directly receiving benefits should be straightforward to estimate. This differs from jobs and those with increased skills and knowledge, which are tracked separately from benefits.
- **Indirect:** The downstream value realized as an indirect result of a project's restoration efforts, unintentionally or intentionally. This could include community members who benefit indirectly from restoration efforts—for example through improved soil or water quality—or members of the households or communities of the individuals included in the above tally of local community members who directly received benefits. The number of people indirectly receiving indirect benefits may be less straightforward to estimate.

Boundary: The outline of the site or the overall project area.

Cohort: A group of organizations in the TerraFund portfolio; refers to the funding wave (and year) in which they were accepted into the portfolio (e.g., Top 100, 2022).

Employee:

- **Full-time:** People who are regularly paid for their work on the project and work 35 or more hours per week throughout the year.
- **Part-time:** People who are regularly paid for their work on the project and are working fewer than 35 hours per week throughout the year. This includes seasonal, temporary, and casual workers who work less than 35 hours per week.

Expense report: A report specifically for nonprofits to detail their expenses and budget spend-down.

Financial report: An annual report submitted by developers to provide information on an organization's operating budget, revenue, liquidity, audited financial statements, and other financial information. Financial reports differ slightly between nonprofits and for-profits.

Flority: An app through which project developers collect geospatial location data of each restoration area. Once restoration work has begun, preferably on the same day as planting, restoration project developers use the app to collect polygons or Global Positioning System (GPS) points representing the locations where trees have been planted. All collected data will be automatically uploaded to the Greenhouse cloud-based platform where project developers can visualize, edit, and download collected data. Then the polygons are taken off Greenhouse, quality assured, and uploaded by the TerraFund team to a project developer's TerraMatch profile.

Geospatial location data: Highly accurate data TerraFund project developers collect for each area where they are restoring land with TerraFund. The data take the form of GPS points, lines, or polygons denoting the areas covered by project efforts.

GPS point: A dimensionless, discrete location on Earth's surface, represented by a pair of x and y coordinates.

Hectares under restoration: The total land area where active restoration interventions are being applied, including agroforestry, silvopasture, riparian restoration, direct seeding, mangrove restoration, assisted natural regeneration, and reforestation. "Land area under restoration" does not exclusively mean areas with active tree planting but counts efforts that enable natural regeneration as hectares under restoration.

Impact: "The extent to which the intervention has generated or is expected to generate significant positive or negative, intended or unintended, higher-level effects" (OECD 2024).

Income-generating activity: Activity undertaken for the purpose of increasing the income of an individual or household, such as through the sale of a product or service. Examples include but are not limited to beekeeping, livestock rearing, and production and sale of fruits, vegetables, or other crops.

Indicator: "A quantitative or qualitative factor or variable that provides a . . . means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development actor" (Parsons et al. 2013).

Job: Defined as a person aged 15 years or older who has worked for pay, profit, or benefit for at least one hour during a given week, as defined by the International Labor Organization (ILO).

Livelihood: Activity or activities pursued to make a living using one's capabilities and assets (physical, natural, human, social, financial).

Local community: People and households living in the surrounding areas of a restoration project who will be affected by restoration activities, and/or who are affected by the challenges restoration activities aim to address.

Localized interventions: The spectrum of organizations and projects that are intended to be concentrated at the local level and relevant to local actors. "Localization" describes the process by which decision-making power and access to resources are increasingly shifted toward the people and institutions in the locality where interventions occur and who are directly affected by the intervention.

Locally led: An approach to restoration characterized by local people (nationals and residents of the area or representatives of local communities) and their communities having individual and collective agency over their restoration priorities and how restoration takes place. These approaches concentrate decision-making and resources at the most local level where a decision will have direct impacts and is more likely to benefit those who experience marginalization or disproportionate socioeconomic and climate vulnerabilities.

Local organization: An organization run by local people in their own contexts and based in the landscape where restoration is taking place. Local organizations represent the interests and priorities of local communities and the landscape. TerraFund adopts criteria for what constitutes a local organization from Publish What You Fund, as described in a 2023 Oxfam report (Adomako and Cohen 2023).

- An organization is local if it is
  - headquartered and incorporated in the recipient country, excluding subsidiaries and brands of international organizations;
  - managed and governed by nationals of the recipient countries or by nonnationals from a specific beneficiary group (e.g., refugees), or there is a succession plan in place to transition organizational leadership; and
  - only working subnationally or nationally, with a substantial percentage of its budget spent in the landscape.

Nursery profile: A profile representing a nursery that the restoration project developer operates as part of its TerraFund project. On TerraMatch, each project profile has one or more nursery profiles associated with it. The number of nursery profiles required for each project will depend on its characteristics; project developers do not have to create a nursery profile if they do not operate their own nurseries or if their project design sources trees from existing or available nurseries instead.

Nursery report: A report containing information about the number of seedlings in the nursery at a given time, broken down by species, along with any written narratives and photos of progress. Restoration project developers must submit a report every six months for each of their nursery profiles. Organizations can indicate if they have nothing to report about a nursery when submitting a report.

Outcome: "The short-term and medium-term effects of an intervention's outputs. Outcomes are often changes in the institutional and behavioral capacities for development conditions that occur between the completion of outputs and the achievement of impacts" (OECD 2024).

Output: "The products, capital goods and services that result from an intervention. Outputs may also include changes resulting from the intervention that contribute to the achievement of outcomes and are within the control of the implementing team and attributable to it. Outputs include changes in knowledge, skills, or abilities produced by the activities" (OECD 2024).

Polygon: A closed shape that starts and ends at the same coordinate and encloses a geographically contiguous area, saved as a geographic information system (GIS) file (like a KML or Esri shapefile), to describe the data representing a site's boundary. It is NOT a point or a line and must be a shape that demarcates an enclosed area.

Portfolio: One or more cohorts tied to a single geography (TerraFund, Harit Bharat Fund, Fundo Flora).

Portfolio manager: A One Tree Planted, World Resources Institute, or other TerraFund partner employee assigned to oversee progress and keep constant contact with TerraFund grantees.

Project developer: A TerraFund grantee that is a nonprofit or medium- and growth-stage enterprise.

Project location definitions:

- **Concentrated project:** A project comprised of fewer than 50 restoration areas, with the average size of each area being greater than three hectares.
- **Distributed project:** A project comprised of more than 50 restoration areas, with the average size of each area being less than three hectares.

Project profile: A TerraMatch profile that restoration project developers have for each of their TerraFund projects. It includes narrative information about the entire project, a summary dashboard of numerical targets and progress toward them, and access to photos and past reports.

Project report: An overview report of project progress that restoration project developers submit biannually, by January 31 and July 31 of each year, including narrative questions about the challenges faced and overcome and numerical information about the number of jobs created and people benefited.

Project site or area: The single site or multiple noncontiguous sites for a project. Noncontiguous sites may have different interventions (e.g., tree planting, agroforestry) or the same interventions in separate locations of the same locality, such as a village.

Quality assurance (QA): The review of individual reports by portfolio managers to both identify and correct errors, inconsistencies, and discrepancies in the self-reported information.

Quality assurance (polygon): The automated and manual validation and cleaning of TerraFund projects' polygon in TerraMatch to ensure accuracy and to avoid, eliminate, and rectify errors (Shen 2023). Polygon QA is synonymous with the land verification process.

Quality assurance (report): The system of checks, quality controls, assessments, and improvements used by portfolio managers to ensure accurate, complete, and consistent self-reported data from project developers (EPA 2019, 2000; ISO 2015).

Restoration intervention: The specific combination of a restoration practice, target land use, and distribution type used on a site to restore land.

Restoration practice: The direct techniques for growing and restoring trees. The approved options for restoration practices are tree planting, assisted natural regeneration, and direct seeding.

Shapefile: A commonly used term in GIS for a representation of vector data as opposed to raster data. It refers to the polygon (or polygons) that are a site's boundary outlines, anchoring the shape of the boundaries in a coordinate system and allowing a researcher to map the site on the globe.

Site: The precise location where intervention activities are happening, demarcated with an appropriate shapefile, with one or many sites combining to form an overall project area that shares common characteristics, like proximity or target land use. A site may contain several different interventions stratified by intervention types or a single intervention type.

Site profiles: The one or more profiles that comprise a TerraMatch project profile, with the number depending on the project design. Sites are the base unit for reporting, with each site profile needing reports generated to fill its profile.

Smallholder farmer: As defined by the Food and Agriculture Organization of the United Nations, farmers who operate on fewer than 10 hectares of land, often only for subsistence and characterized by limited resources and frequent reliance on family labor (FAO 2013).

Target land use system: The intended use for project land after the six-year project term, distinct from land use at the start. The approved options for target land use are agroforest, open natural ecosystem, natural forest, peatland, riparian area or wetland, silvopasture, urban forest, and woodlot or plantation.

TerraFund staff: Employees of WRI who assist with the various aspects of the TerraFund program, including project management, monitoring, or evaluation.

TerraMatch: TerraFund's integrated online, two-way platform used for data management, project application, technical support, reporting, analysis, verification, and visualization through the TerraMatch dashboard.

Tree: A woody vegetation either greater than five meters in height regardless of canopy diameter or between three and five meters in height with a canopy diameter of at least five meters. This definition excludes tall herbaceous vegetation like sugarcane, bananas, and cacti as well as short woody crops like tea and coffee.

Tree count: The total number of trees growing on the landscape area, measured at the baseline prior to the beginning of the intervention effort as well as throughout the duration of the project as the trees mature.

Tree cover: The percentage of tree canopy cover in a project polygon, as determined by the Tropical Tree Cover dataset.

Tree distribution: The way trees will be spread throughout the site after restoration work has concluded. Trees can cover either an entire restoration area (full coverage) or part of the area (partial coverage), or they can be planted in single row (single line).

Tree planted: The number of seedlings or saplings directly planted by the agents of a TerraFund project.

Tree restored: The number of trees that survive six years after the start of the project. TerraFund derives this number of "trees restored" by comparing the reported number of trees planted or naturally regenerated to the number of trees that independent satellite data can verify.

Very high resolution (VHR): A general term used in reference to the quality of remote sensing satellite imagery data; in this guidebook this is Worldview/Vantor (30 cm resolution).

Volunteer: An individual who freely dedicates their time to the project because they see value in doing so but who does not receive payment for their work. Volunteers must work directly on the project. Paid workers or beneficiaries who do not dedicate their time to the project are not considered volunteers.

Women-led organization: One whose senior leadership is comprised of more than 50 percent women, measured by the number or roles held as opposed to a definition based on the name of the leadership role.

Youth: A person between the ages of 18 and 35.

Youth-led organization: One whose senior leadership is comprised of more than 50 percent youth, or people aged 35 and under. Similar to women-led organizations, youth-led ones are defined by the number of senior leadership roles held by youth, not the specific title of these roles.

Endnotes

1. This figure is based on estimated field costs of $40 per hectare across 130,000 hectares, compared to remote sensing costs, excluding research and development. Given varying intervention types, land use types, and locations, estimating costs is difficult. However, WRI estimates that field verification costs approximately $40 per hectare, whereas verification with remote sensing would cost approximately $0.96 per hectare, representing a reduction in cost of about 98 percent.

2. Components of the TerraFund framework were specifically modeled on the Tree Restoration Monitoring Framework. Conservation International, 2023, Tree Restoration Monitoring Framework: Field Test Edition, Version 3.1. Lead author: S. Sprenkle-Hyppolite.

3. This figure is based on estimated field costs of $40 per hectare across 130,000 hectares, compared to remote sensing costs, excluding research and development. Given varying intervention types, land use types, and locations, estimating costs is difficult. However, WRI estimates that field verification costs approximately $40 per hectare, whereas verification with remote sensing would cost approximately $0.96 per hectare, representing a ~98 percent reduction in cost.

4. Components of the TerraFund framework were specifically modeled off the Tree Restoration Monitoring Framework. Conservation International, 2023, Tree Restoration Monitoring Framework: Field Test Edition, Version 3.1. Lead author: S. Sprenkle-Hyppolite.

5. Components of the TerraFund framework were specifically modeled off the Tree Restoration Monitoring Framework. Conservation International, 2023, Tree Restoration Monitoring Framework: Field Test Edition, Version 3.1. Lead author: S. Sprenkle-Hyppolite.

6. Indicator 2.1 is the primary indicator for assessing progress of ANR projects, rather than indicators under Tree Restoration. For projects using exclusively ANR, the indicators under Tree restoration, 1.2 Number of trees planted, 1.3 Survival rate, and 1.4 Number of trees grown, are not applicable. In other words, for ANR-only projects, the number of trees planted is not counted. Under the ANR protocol currently being piloted, ANR projects will also report the number of trees naturally regenerating if they are using the approach exclusively or to complement tree-planting efforts. Any projects using both approaches will report the number of trees planted and the number of trees naturally regenerated. More information can be found in Appendix C.

7. TerraFund uses the definition of ANR included in the PPC monitoring framework (Sprenkle-Hyppolite 2023).

8. Gender categories in applications and reports include male, female, and nonbinary.

References

Adhikari, B., N. Lodhiyal, and L.S. Lodhiyal. 2020. "Assessment of Crop Yield, Productivity and Carbon Sequestration in Agroforestry Systems in Central Himalaya, India." *Agroforestry Systems* 94 (1): 281–96. doi:10.1007/s10457-019-00388-2.

Adomako, M., and M.J. Cohen. 2023. *Funding the Localization Agenda: Measuring Progress of United States Development and Humanitarian Assistance to Local Organizations*. London: Oxfam and Publish What You Fund. www.oxfamamerica.org/explore/research-publications/funding-the-localization-agenda/.

African Union. 2006. "African Youth Charter." Banjul, The Gambia. https://au.int/sites/default/files/treaties/7789-treaty-0033_-_african_youth_charter_e.pdf.

ArcGIS. n.d. "Create Fishnet." ArcMap 10.8. https://desktop.arcgis.com/en/arcmap/latest/tools/data-management-toolbox/create-fishnet.htm.

Berrahmouni, N., and S. Mansourian. 2021. "Review of Forest and Landscape Restoration in Africa 2021." Accra: Food and Agriculture Organization of the United Nations and African Union Development Agency—New Partnership for Africa's Development. doi:10.4060/cb6111en.

BGCI (Botanic Gardens Conservation International). 2024. "GlobalTreeSearch Online Database (Version 1.9)." doi:10.13140/RG.2.2.27733.23522.

Bourgeois, B., A. Vanasse, E. González, R. Andersen, and M. Poulin. 2016. "Threshold Dynamics in Plant Succession after Tree Planting in Agricultural Riparian Zones." *Journal of Applied Ecology* 53 (6): 1704–13. doi:10.1111/1365-2664.12675.

Brancalion, P.H.S., P. Meli, J.R.C. Tymus, F.E.B. Lenti, R. M. Benini, A.P.M. Silva, I. Isernhagen, and K.D. Holl. 2019. "What Makes Ecosystem Restoration Expensive? A Systematic Cost Assessment of Projects in Brazil." *Biological Conservation* 240 (December): 108274. doi:10.1016/j.biocon.2019.108274.

Brandt, J., and F. Stolle. 2020. "A Global Method to Identify Trees Outside of Closed-Canopy Forests with Medium-Resolution Satellite Imagery." *International Journal of Remote Sensing* 42 (5): 1713–37. doi:10.1080/01431161.2020.1841324.

Brandt, J., J. Ertel, J. Spore, and F. Stolle. 2023. "Wall-to-Wall Mapping of Tree Extent in the Tropics with Sentinel-1 and Sentinel-2." *Remote Sensing of Environment* 292 (July): 113574. doi:10.1016/j.rse.2023.113574.

Buckingham, K., S. Ray, C.G. Granizo, L. Toh, F. Stolle, F. Zoveda, K. Reytar, et al. 2019. *The Road to Restoration*. Washington, DC: World Resources Institute. www.wri.org/research/road-restoration.

Buzzard, B. 2024. "From Pledges to Practice." Maliasili and Synchronicity Earth. https://static1.squarespace.com/static/5a816a14e5dd5be8941a4448/t/66f51a6a35b1571ff9ef3.

Chazdon, R., D. Celentano, P. Durst, M. Karambiri, J. Ferreira, R. Soriaga, D. Dayamba, and M. Oliveira. 2023. "A Status Report on Assisted Natural Regeneration: What, Why, Who, Where, and How? ANR Alliance." Accessed June 10, 2025. www.researchgate.net/publication/382879773_A_status_report_on_Assisted_Natural_Regeneration_What_why_who_where_and_how_ANR_Alliance.

Coger, T., Y.S. Lemma, M. Orengo, M. Mulanga, S. Okoth, H. Ding, B. Arakwiye, et al. 2025. "The Challenge with Tree-Planting Initiatives—and How to Get Them Right." World Resources Institute, July 29. www.wri.org/insights/right-way-plant-trees-restore-land.

Credit Suisse, WWF, and McKinsey & Company. 2014. "Conservation Finance: Moving beyond Donor Funding toward an Investor-Driven Approach." www.cbd.int/financial/privatesector/g-private-wwf.pdf.

Diazgranados, M., B. Allkin, N. Black, R. Cámara-Leret, C. Canteiro, J. Carretero, R. Eastwood, et al. 2020. "World Checklist of Useful Plant Species." Text/xml. KNB Data Repository. doi:10.5063/F1CV4G34.

Ding, H., S. Faruqi, A. Wu, J.-C. Altamirano, A.A. Ortega, R.Z. Cristales, R. Chazdon, et al. 2017. *Roots of Prosperity: The Economics and Finance of Restoring Land*. Washington, DC: World Resources Institute. www.wri.org/research/roots-prosperity-economics-and-finance-restoring-land.

Duguma, L., P. Minang, E. Aynekulu, S. Carsan, J. Nzyoka, A. Bah, and R. Jamnadass. 2020. "From Tree Planting to Tree Growing: Rethinking Ecosystem Restoration through Trees." World Agroforestry Centre. doi:10.5716/WP20001.PDF.

Elias, F., I.N.S. Djenontin, J.F.M. Kamoto, and S. Mansourian. 2025. "Accelerating Forest Landscape Restoration Monitoring in Africa: Informing Tangible Actions from a Practical Perspective." *Restoration Ecology* 33 (3): e14366. doi:10.1111/rec.14366.

EPA (US Environmental Protection Agency). 2000. "Guidance for Data Quality Assessment Practical Methods for Data Analysis." EPA QA/G-9 QA00 UPDATE. www.epa.gov/sites/default/files/2015-06/documents/g9-final.pdf.

EPA. 2019. *Application of Quality Assurance and Quality Control Principles to Ecological Restoration Project Monitoring*. Chicago: Great Lakes National Program Office.

Esri (Environmental Systems Research Institute). n.d. "Polygon Definition: GIS Dictionary." Accessed February 24, 2025. https://support.esri.com/en-us/gis-dictionary/polygon.

FAO (Food and Agriculture Organization of the United Nations). 2013. "Smallholders and Family Farmers. Factsheet." Office of Assistant Director-General (Natural Resources Management and Environment Department). https://openknowledge.fao.org/handle/20.500.14283/ar588e.

FAO. 2020a. *Global Forest Resources Assessment 2020: Main Report*. 1st ed. Rome: FAO. doi:10.4060/ca9825en.

FAO. 2020b. *The State of the World's Forests 2020*. Rome: FAO and UN Environment Programme. doi:10.4060/ca8642en.

FAO. 2022. *The State of the World's Forests 2022: Forest Pathways for Green Recovery and Building Inclusive, Resilient and Sustainable Economies.* https://openknowledge.fao.org/handle/20.500.14283/cb9360en.

FAO and UNEP (UN Environment Programme). 2024. "Framework for Ecosystem Restoration Monitoring (FERM) User Guide." https://ferm.fao.org/docs/ferm_user_guide_draft.pdf.

FAO and WRI. 2022. "AURORA Assessment, Understanding and Reporting Of Restoration Actions." Decision Support Tool for Restoration Monitoring. www.aurora-monitoring.org/#/.

Faruqi, S. 2016. "Forest Restoration Gets a Tiny Fraction of the Money It Needs: How to Fill the Gap?" Washington, DC: World Resources Institute. www.wri.org/insights/forest-restoration-gets-tiny-fraction-money-it-needs-how-fill-gap.

Foresta, H. de, E. Somarriba, A. Temu, D. Boulanger, H. Feuilly, and M. Gauthier. 2013. "Towards the Assessment of Trees outside Forests." Resources Assessment Working Paper 13. Rome: Food and Agriculture Organization of the United Nations. https://openknowledge.fao.org/handle/20.500.14283/aq071e.

Fraisse, M.C., and R.Z. Donovan. 2021. "Ecosystem Restoration: Field Verification Standard." Preferred by Nature. www.preferredbynature.org/sites/default/files/Preferred%20by%20Nature-Ecosystem-Restoration-Field-Verification-Standard-v%202.0.pdf.

Gann, G.D., B. Walder, S.M. Manirajah, and S. Roe. 2022. "Restoration Project Information Sharing Framework." Washington, DC: Society for Ecological Restoration, Climate Focus.

Gatica-Saavedra, P., C. Echeverría, and C.R. Nelson. 2017. "Ecological Indicators for Assessing Ecological Success of Forest Restoration: A World Review." *Restoration Ecology* 25 (6): 850–57. doi:10.1111/rec.12586.

geemap. n.d. "117 fishnet." GitHub v0.36.6. https://geemap.org/notebooks/117_fishnet/.

Global Forest Review. 2025. "Forest Loss Indicator." World Resources Institute, May 21. https://research.wri.org/gfr/forest-extent-indicators/forest-loss.

Gyde Lund, H. 1999. "Definitions of Forest, Deforestation, Afforestation, and Reforestation." Forest Information Services. www.researchgate.net/doi/10.13140/RG.2.2.31426.48323.

Gollin, D. 2014. *Smallholder Agriculture in Africa: An Overview and Implications for Policy*. Working Paper. London: International Institute for Environment and Development.

Govaerts, R. 2022. "World Checklist of Vascular Plants (WCVP), Version 10." Board of Trustees of the Royal Botanic Gardens, Kew. doi:10.34885/NSWV-8994.

Hansen, M.C., P.V. Potapov, R. Moore, M. Hancher, S.A. Turubanova, A. Tyukavina, D. Thau, et al. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." *Science* 342 (6160): 850–53. doi:10.1126/science.1244693.

IBRD (International Bank for Reconstruction and Development) and World Bank. 2021. "The Partnership for Market Readiness: From the Ground Up: A Decade of Lessons on Carbon Pricing." https://documents1.worldbank.org/curated/en/416741627365320014/pdf/The-Partnership-for-Market-Readiness-From-the-Ground-Up-A-Decade-of-Lessons-on-Carbon-Pricing.pdf.

IPCC (Intergovernmental Panel on Climate Change). 2003. "Good Practice Guidance for Land Use, Land-Use Change and Forestry." www.ipcc.ch/site/assets/uploads/2018/03/GPG_LULUCF_FULLEN.pdf.

IPCC. 2019. *Climate Change and Land: IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. Cambridge: Cambridge University Press. doi:10.1017/9781009157988.

ISO (International Organization for Standardization). 2015. "Quality Management Systems: Fundamentals and Vocabulary." ISO 9000:2015. www.iso.org/standard/45481.html.

IUCN (International Union for Conservation of Nature and Natural Resources). 2025. "The IUCN Red List of Threatened Species." www.iucnredlist.org/en.

James, J.J., T.J. Svejcar, and M.J. Rinella. 2011. "Demographic Processes Limiting Seedling Recruitment in Arid Grassland Restoration." *Journal of Applied Ecology* 48 (4): 961–69. doi:10.1111/j.1365-2664.2011.02009.x.

Kachamba, D.J., T. Eid, and T. Gobakken. 2016. "Above- and Belowground Biomass Models for Trees in the Miombo Woodlands of Malawi." *Forests* 7 (2): 38. doi:10.3390/f7020038.

Kindt, R., L. Graudal, J.-P.B. Lillesø, F. Pedercini, P. Smith, and R. Jamnadass. 2022. "GlobalUsefulNativeTrees: Country-Specific Selections of Native Tree Species for Forest Landscape Restoration and Biodiverse Plantings." (Database). https://worldagroforestry.org/output/globalusefulnativetrees. Accessed on January 3, 2025.

Kuyah, S., J. Dietz, C. Muthuri, R. Jamnadass, P. Mwangi, R. Coe, and H. Neufeldt. 2012. "Allometric Equations for Estimating Biomass in Agricultural Landscapes: I. Aboveground Biomass." *Agriculture, Ecosystems and Environment* 158 (September): 216–24. doi:10.1016/j.agee.2012.05.011.

Löfqvist, S., R.D. Garrett, and J. Ghazoul. 2023. "Incentives and Barriers to Private Finance for Forest and Landscape Restoration." *Nature Ecology and Evolution* 7 (5): 707–15. doi:10.1038/s41559-023-02037-5.

Londo, A., and S. Dicke. 2006. "Measuring Survival and Planting Quality in New Pine Plantations." *Southern Regional Extension Forestry*, January. www.researchgate.net/publication/242194744_Measuring_Survival_and_Planting_Quality_in_New_Pine_Plantations.

Lung, T., and G. Schaab. 2010. "A Comparative Assessment of Land Cover Dynamics of Three Protected Forest Areas in Tropical Eastern Africa." *Environmental Monitoring and Assessment* 161 (1): 531–48. doi:10.1007/s10661-009-0766-3.

Mansourian, S., and P.J. Stephenson. 2023. "Exploring Challenges and Lessons for Monitoring Forest Landscape Restoration." *Current Landscape Ecology Reports* 8 (4): 159–70. doi:10.1007/s40823-023-00092-z.

Mansourian, S., and D. Vallauri. 2022. "Challenges in Measuring Multiple Impacts Hinder Performance Recognition in Forest Landscape Restoration: Experience from Seven Field Projects." *Restoration Ecology* 30 (1): e13504. doi:10.1111/rec.13504.

Mansourian, S., N. Berrahmouni, J. Blaser, N. Dudley, S. Maginnis, M. Mumba, and D. Vallauri. 2021. "Reflecting on Twenty Years of Forest Landscape Restoration." *Restoration Ecology* 29 (7): e13441. doi:10.1111/rec.13441.

Matys, A. 2022. "Long Term Monitoring of Actions and Outcomes: Improving and Streamlining Learning from Longleaf Pine Restorations at Morningside Nature Center." *UF Journal of Undergraduate Research* 24 (December). doi:10.32473/ufjur.24.130799.

Mbow, C., M.M. Verstraete, B. Sambou, A.T. Diaw, and H. Neufeldt. 2014. "Allometric Models for Aboveground Biomass in Dry Savanna Trees of the Sudan and Sudan–Guinean Ecosystems of Southern Senegal." *Journal of Forest Research* 19 (3): 340–47. doi:10.1007/s10310-013-0414-1.

Mugabowindekwe, M., M. Brandt, J. Chave, F. Reiner, D.L. Skole, A. Kariryaa, C. Igel, et al. 2023. "Nation-Wide Mapping of Tree-Level Aboveground Carbon Stocks in Rwanda." *Nature Climate Change* 13 (1): 91–97. doi:10.1038/s41558-022-01544-w.

Nyambo, P., P. Nyambo, Z. Mavunganidze, and V. Nyambo. 2022. "Sub-Saharan Africa Smallholder Farmers Agricultural Productivity: Risks and Challenges." In *Food Security for African Smallholder Farmers*, edited by H.A. Mupambwa, A.D. Nciizah, P. Nyambo, B. Muchara, and N.N. Gabriel, 47–58. Singapore: Springer Nature. doi:10.1007/978-981-16-6771-8_3.

OECD (Organisation for Economic Co-operation and Development). 2024. *Glossary of Key Terms in Evaluation and Results-Based Management for Sustainable Development*. 2nd ed. Paris: OECD Publishing.

Osman, A., K. Adu-Boahen, B. Arko, and E.Y. Okyere. 2022. "Analysis of Planting Practices and Post-planting Stewardship Intention of Participants of Arbor Day." *Restoration Ecology* 31 (8): e13838. doi:10.1111/rec.13838.

Parsons, J., C. Gokey, and M. Thornton. 2013. "Indicators of Inputs, Activities, Outputs, Outcomes and Impacts in Security and Justice Programming." Vera Institute of Justice. www.vera.org/publications/indicators-of-inputs-activities-outputs-outcomes-and-impacts-in-security-and-justice-programming.

Regreening Africa. 2020. "Seedling Survival Count Guideline." https://regreeningafrica.org/wp-content/uploads/2020/08/Guideline-for-survival-count-final.pdf.

Reytar, K., O. Martin, F. Landsberg, S. Ray, C.G. Granizo, and R.Z. Cristales. 2021. "Mapping Together: A Guide to Monitoring Forest and Landscape Restoration Using Collect Earth Mapathons." Food and Agriculture Organization of the United Nations and World Resources Institute. https://library.unccd.int/Details/fullCatalogue/1665.

Reytar, K., D. Levin, J. Gladstone, and M. Dyck. 2023. "Restoration Monitoring Tools Guide." World Resources Institute and Climate Focus. https://restorationmonitoringtools.org/about-guide.

Roman, L.A., E.G. McPherson, B.C. Scharenbroch, and J. Bartens. 2013. "Identifying Common Practices and Challenges for Local Urban Tree Monitoring Programs across the United States." *Arboriculture and Urban Forestry (AUF)* 39 (6): 292–99. doi:10.48044/jauf.2013.038.

Sacande, M., M. Parfondry, C. Cicatiello, G. Scarascia-Mugnozza, A. Garba, P.S. Olorunfemi, M. Diagne, and A. Martucci. 2021. "Socio-economic Impacts Derived from Large Scale Restoration in Three Great Green Wall Countries." *Journal of Rural Studies* 87 (October): 160–68. doi:10.1016/j.jrurstud.2021.09.021.

Schubert, S.C., K.E. Battaglia, C.N. Blebea, C.J.P. Seither, H.L. Wehr, and K.D. Holl. 2024. "Advances and Shortfalls in Applying Best Practices to Global Tree-Growing Efforts." *Conservation Letters* 17 (2): e13002. doi:10.1111/conl.13002.

Seymour, F., M. Wolosin, and E. Gray. 2022. *Not Just Carbon: Capturing All the Benefits of Forests for Stabilizing the Climate from Local to Global Scales*. Washington, DC: World Resources Institute. www.wri.org/research/not-just-carbon-capturing-benefits-forests-climate.

Shen, J. 2023. "Data Quality in GIS: The Key to Accurate and Reliable Information." July 27. https://gis.technology/data-quality-gis-ensure-accuracy/.

Singh, N., J. Finnegan, and K. Levin. 2016. "MRV 101: Understanding Measurement, Reporting, and Verification of Climate Change Mitigation." World Resources Institute, August 26. www.wri.org/research/mrv-101-understanding-measurement-reporting-and-verification-climate-change-mitigation.

Skole, D.L., and J.H. Samek. 2023a. "Field Measurements Protocol: Carbon Stock Estimation in Landscapes and Sites. Initial Scoping Deployment in Kenya and Ghana." Unpublished report. Rev. 1.0. Michigan State University.

Skole, D.L., and J.H. Samek. 2023b. "Specific TOF CPA Field Sampling and Measure Protocol: Measuring Trees Outside of Forests." Unpublished report. Rev 3.0. Michigan State University.

Skole, D.L., and J.H. Samek. 2023c. "Standard Operating Procedures Forest Carbon Inventory, Data Collection and Reporting, vol. 1, "Establishing the Inventory and Sample Plots." Unpublished report. Rev. 3.0. Global Observatory for Ecosystem Services, Department of Forestry, Michigan State University.

Skole, D.L., and J.H. Samek. 2023d. *Standard Operating Procedures Forest Carbon Inventory, Data Collection and Reporting*, vol. 2, *Field Measurements at Sample Plots*. Rev. 3.0. Global Observatory for Ecosystem Services, Department of Forestry, Michigan State University.

Skole, D.L., J.H. Samek, M. Dieng, and C. Mbow. 2021a. "The Contribution of Trees Outside of Forests to Landscape Carbon and Climate Change Mitigation in West Africa." *Forests* 12 (12): 1652. doi:10.3390/f12121652.

Skole, D.L., C. Mbow, M. Mugabowindekwe, M.S. Brandt, and J.H. Samek. 2021b. "Trees Outside of Forests as Natural Climate Solutions." *Nature Climate Change* 11 (12): 1013–16. doi:10.1038/s41558-021-01230-3.

Sprenkle-Hyppolite, S., N. Alexandre, S. Begeladze, J. Brandt, J. Cross, S. DeWitt, I. Hillman, et al. 2023. *Tree Restoration Monitoring Framework: Field Test Edition*. Conservation International.

Stolton, S., N. Dudley, and H.L. Timmins. 2024. "Making the Global Local; Should the Drive to 30x30 Be Locally Led?" *Fauna and Flora*, October. www.fauna-flora.org/wp-content/uploads/2024/10/fauna-flora-making-the-global-local-report.pdf.

Taylor, W.L. 1943. "Beating Up Blanks in New Plantations." *Forestry: An International Journal of Forest Research* 17 (1): 47–51. doi:10.1093/forestry/17.1.47.

TerraFund. n.d. "TerraFund Cohort Member Hub: TerraMatch Help Center." Accessed February 25, 2025. https://terramatchsupport.zendesk.com/hc/en-us/categories/12512083927579-TerraFund-for-AFR100-Cohort-Member-Hub.

TerraMatch. 2025. "TerraMatch Dashboard." www.terramatch.org/dashboard.

Thomas, N., P. Baltezar, D. Lagomasino, A. Stovall, Z. Iqbal, and L. Fatoyinbo. 2021. "Trees Outside Forests Are an Underestimated Resource in a Country with Low Forest Cover." *Scientific Reports* 11 (1): 7919. doi:10.1038/s41598-021-86944-2.

Tolan, J., H.-I. Yang, B. Nosarzewski, G. Couairon, H.V. Vo, J. Brandt, J. Spore, et al. 2024. "Very High Resolution Canopy Height Maps from RGB Imagery Using Self-Supervised Vision Transformer and Convolutional Decoder Trained on Aerial Lidar." *Remote Sensing of Environment* 300 (January): 113888. doi:10.1016/j.rse.2023.113888.

Ullah, A. 2024. "Forest Landscape Restoration and Its Impact on Social Cohesion, Ecosystems, and Rural Livelihoods: Lessons Learned from Pakistan." *Regional Environmental Change* 24 (1): 26. doi:10.1007/s10113-024-02198-4.

Umemiya, C., K. Koakutsu, A. Amellina, T. Ono, O. Bannai, W.K. Fong, and T. Morimoto. 2015. "One Hundred Questions and Answers about MRV in Developing Countries." www.iges.or.jp/en/pub/one-hundred-questions-answers-about-mrv-0/en.

UNCCD (UN Convention to Combat Desertification). 2013. *The Economics of Desertification, Land Degradation and Drought: Methodologies and Analysis for Decision-Making: Background Document—UNCCD Second Scientific Conference*. Secretariat of the Convention to Combat Desertification and Global Risk Forum. Bonn, Germany: UNCCD. https://digitallibrary.un.org/record/749587.

UNCCD. 2020. *The Great Green Wall Implementation Status and Way Ahead to 2030*. Bonn, Germany: UNCCD. www.unccd.int/sites/default/files/2024-08/1551_GGW_Report_ENG_Final_040920.pdf.

UNCCD. 2024. *Investing in Land's Future: Financial Needs Assessment for UNCCD*. Bonn, Germany: UNCCD.

UNEP (UN Environment Programme). 2015. *The Economics of Land Degradation in Africa: Benefits of Action Outweigh the Costs—A Complementary Report to the ELD Initiative*. Bonn, Germany: ELD Secretariat. www.unep.org/resources/report/economics-land-degradation-africa-benefits-action-outweigh-costsa-complementary.

UNEP, World Economic Forum, Economics of Land Degradation, and Vivid Economics. 2021. *State of Finance for Nature 2021*. Nairobi: UNEP. www.unep.org/resources/state-finance-nature-2021.

UNFCCC (UN Framework Convention on Climate Change). 2014. *Handbook on Measurement, Reporting, and Verification for Developing Country Parties*. Bonn, Germany: UNFCCC. https://unfccc.int/files/national_reports/annex_i_natcom_/application/pdf/non-annex_i_mrv_handbook.pdf.

VCS (Verified Carbon Standard) Association. 2017. "Climate, Community, Biodiversity Standards." https://verra.org/wp-content/uploads/CCB-Standards-v3.1_ENG.pdf.

Verra and Pachama. 2022. "World's Largest Carbon Program Pilots Digital Measuring of Forest Carbon." November 16. https://verra.org/worlds-largest-carbon-program-pilots-digital-measuring-of-forest-carbon/.

Viani, R.A.G., K.D. Holl, A. Padovezi, B.B.N. Strassburg, F.T. Farah, L.C. Garcia, R.B. Chaves, et al. 2017. "Protocol for Monitoring Tropical Forest Restoration: Perspectives from the Atlantic Forest Restoration Pact in Brazil." *Tropical Conservation Science* 10 (January). doi:10.1177/1940082917697265.

Wells for Zoë. 2025a. "Flority." Flority. https://flority.app/.

Wells for Zoë. 2025b. "Wells for Zoë." https://wellsforzoe.org/.

Wells for Zoë. n.d. "Flority and Greenhouse: Documentation." Accessed January 28, 2025. https://wells-for-zoe.github.io/book/greenhouse/Introduction.html.

WFO (World Flora Online). 2025. "World Flora Online." www.worldfloraonline.org.

WHO (World Health Organization). 2017. *Data Quality Review: Module 3—Data Verification and System Assessment*. Geneva: WHO. https://iris.who.int/handle/10665/259226.

WRI (World Resources Institute). 2025. "New AI Model Maps Every Tree on Earth." March 13. www.wri.org/outcomes/new-ai-model-maps-every-tree-earth.

Zhang, Y., P. West, L. Thakholi, K. Suryawanshi, M. Supuma, D. Straub, S.S. Sithole, et al. 2023. "Governance and Conservation Effectiveness in Protected Areas and Indigenous and Locally Managed Areas." *Annual Review of Environment and Resources* 48 (2023): 559–88. doi:10.1146/annurev-environ-112321-081348.

Zio, M.D., N. Fursova, T. Gelsema, S. Gießing, U. Guarnera, J. Petrauskienė, L.Q. Kalben, and M. Scanu. n.d. "Methodology for Data Validation."

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