Afforestation, Reforestation & Restoration methodology

BeZero Carbon Ratings



BeZero

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Glossary

Baseline: A baseline scenario is the amount of emissions that are assumed to occur in the absence of any project intervention.

BeZero Carbon Rating (BCR): The BeZero Carbon Rating is a hybrid analytical framework that fuses financial, scientific, and policy-based analysis. It provides an opinion on the likelihood that a given credit achieves a tonne of CO_2e avoided or removed.

Buffer pool: The buffer pool is an account of non-tradable credits that projects contribute towards and serves as a communal reserve for Nature Based Solutions. Contribution amounts are based on the methodology. If a project loses its carbon stocks, for example to fire or disease, buffer pool credits can be used to compensate for the loss. Alternatively, projects that effectively mitigate the risk of carbon loss can regain the credits they contributed to the buffer pool.

Carbon finance: Financial resources allocated to carbon project activities that reduce or avoid greenhouse gas emissions. It is an additional source of revenue that seeks to make such activities more financially viable.

Carbon pool: Ecosystem components that have the capacity to release, sequester and/or store carbon. These include above- and below-ground biomass, soil organic carbon, soil inorganic carbon, deadwood, litter and harvested wood products.

Commitment period: The duration of time over which a project plans its activities to take place.

Methodology: A framework that sets out a process and parameters for quantifying the carbon benefits of a project. Methodologies enable project developers to quantify baselines, assess key aspects like additionality, and define necessary monitoring practices to ensure the greenhouse gas emission reductions are verifiable, additional and quantified.

Nature Based Solutions (NBS): Nature Based Solutions aim to achieve emission removals or avoidance in the natural environment, these include forestry, soil carbon, and blue carbon.

Project area: The geographical boundaries within which project activities take place.

Rating Committee: A group of members with extensive experience within and across all sectors who discuss and debate the assignment of ratings. The Rating Committee oversees the analytical process and ensures consistency in the application of ratings criteria, methodologies, and comparability of ratings across sectors and countries.

Stakeholders: Individuals and/or groups of people who may be affected by the implementation and activities of a project.

Standards bodies: Organisations that develop and revise methodologies to determine the greenhouse gas benefits of various types of carbon projects, and inform when and how many credits projects can issue.

Vintage: The vintage year refers to the period of time when the emission reduction or removal associated with a credit occurred.

Voluntary Carbon Market (VCM): Carbon markets that exist outside of the regulation and frameworks of international agreements, and are fuelled by commitments of individuals, as well as private and public organisations to reduce greenhouse gas emissions through the trading of carbon credits.

Introduction

BeZero Carbon is a global ratings agency for the carbon market. Our ratings provide a publicly available, risk-based framework for assessing carbon efficacy. We rate qualifying carbon credits in all sectors.

We take a research-first mindset, fusing traditional capital markets research practices with expertise in environmental sciences and technology. We think creatively about climate problems and build solutions the whole market can use.

We have developed extensive analytical frameworks to rate carbon credits on their likelihood of delivering on their promised carbon emissions avoidance or removal. These analytical frameworks are deeply sector nuanced and bring to the fore our extensive experience in rating hundreds of projects across dozens of sub-sectors.

Our Ratings, Geospatial, Data, and Research teams are made up of dozens of climate and data scientists, geospatial experts and financial market analysts. They bring with them the highest academic and industry credentials, a tenacious approach to scientific inquiry and a dedication to climate action through science. They hold PhDs and qualifications in disciplines from remote sensing, forest ecology, ecosystem disturbance, peatlands, and blue carbon to statistics, machine learning, artificial intelligence, financial research, industrial engineering, and public policy. They have published hundreds of academic papers and have been cited tens of thousands of times in peer-reviewed scientific academic literature.

As the market's number one risk metric, our ratings are available on our website and dozens of marketplaces, and alongside extensive analysis and research on our BeZero Carbon Markets platform.

What is ARR?

ARR is the processes of sequestering carbon on terrestrial landscapes by increasing vegetation cover. BeZero Carbon's Afforestation, Reforestation & Restoration methodology is a tool for users of the BeZero Carbon Rating to better understand our multifaceted ratings approach to the sub-sector.

In the Forestry sector, credit issuance can be broadly classified as both avoidance and removal. Afforestation, Reforestation & Restoration (hereafter, ARR) projects are the original carbon removal methods within the Voluntary Carbon Market. Carbon removals are achieved by increasing carbon sequestration by biomass and soil carbon pools above that of a baseline scenario. The key differences between 'afforestation', 'reforestation', and 'restoration' are highlighted in the table below.

Table 1. Basic definitions and differences between the three key activities in the ARR sub-sector.

Project type	Afforestation	Reforestation	Restoration
Definition	Planting trees on land that has not been forested for a long time	Replanting where forests have been lost in recent years	Accelerating the recovery of degraded ecosystems
Previous forest cover	None within the previous 50 years (according to UNFCCC)		Potentially existing degraded forest

In the BeZero Sector Classification system, ARR is one of five Forestry sub-sectors in the Nature Based Solutions (NBS) sector group (Figure 1).

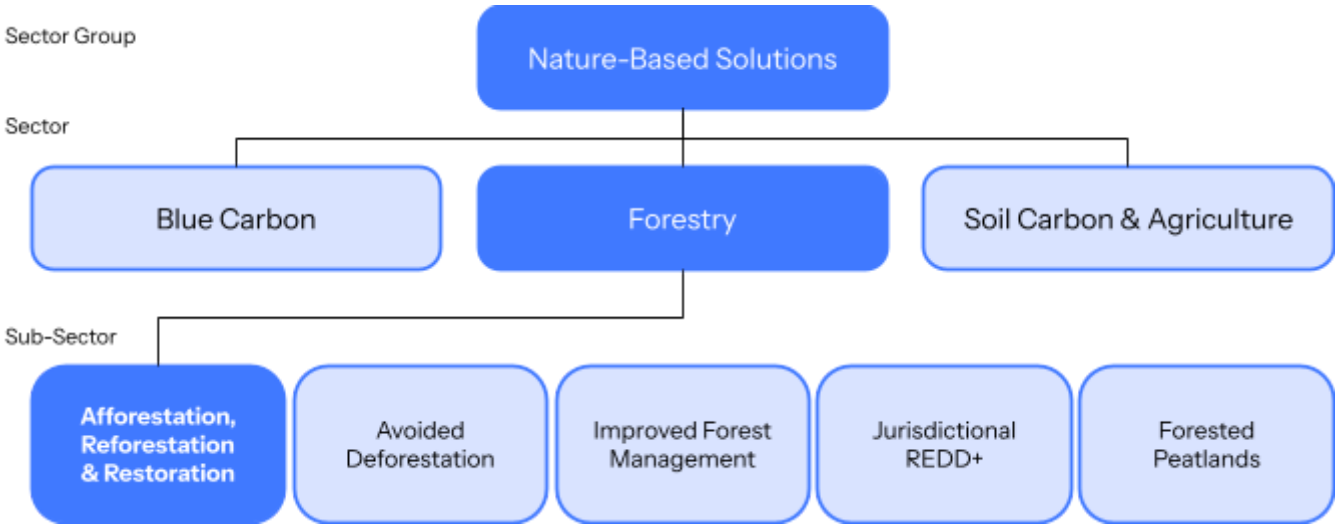


Figure 1. The location of the ARR sub-sector within BeZero's Sector Classification System.

Currently, the majority of projects in the ARR sub-sector conduct afforestation or reforestation activities, with relatively few focused primarily on restoration. There are also projects in other sectors, such as soil and blue carbon, that conduct some ARR activities but are classified differently due to their ecosystems and the proportion of credits from each project activity.

Additional sub-sector qualifiers for ARR

In addition to our sector classification, each sub-sector can have additional unique qualifiers to enable project labelling and grouping. For the ARR sub-sector, one of these qualifiers is based on project activity type: commercial projects, community projects, agroforestry projects, and assisted natural regeneration projects. The second qualifier is based on species choice: native, non-native, and a mix of native and non-native. We describe key features that determine qualifying labels below.

- Commercial plantations: These projects mostly focus on large-scale planting of a monoculture of non-native, commercial tree species. These species may be harvested for timber or produce commercial non-timber forest products such as fruits and nuts. The project proponent receives the benefits of the project's revenue from the sale of forest

products and carbon finance.

- Community-based tree planting: These projects facilitate planting trees on private lands owned by small-scale landowners. They provide financial, technical, or educational support for landowners aiming to overcome barriers to planting. Those barriers can include planting costs, lack of expertise or equipment, or lack of knowledge of the benefits of tree planting.

- Assisted natural regeneration: These projects consist of various activities that aim to assist the natural regeneration of forests. This may be achieved through fire suppression, fencing off regenerating areas, applying fertilisers or herbicides and assisting seed dispersion.

- Agroforestry: These projects implement sustainable land management practices that combine forestry and agriculture by integrating trees and shrubs with crops and/or livestock

Table 2. Attributes of commercial, community-based, assisted natural regeneration, and agroforestry ARR projects.

Project type	**Commercial**	**Community**	**Assisted natural regeneration**	**Agroforestry**
Project area characteristics	Centralised or spread over multiple large-scale land parcels	Typically, small land parcels, often many in number and widely distributed	Often afforded some protected status, either by the government or through easements	Typically, small- to medium-sized land parcels and widely distributed
Landowners	Commercial forestry entities	Local small-scale landowners	Governments, related bodies, or project developers	Local small-scale landowners
Project funding streams	Carbon finance, harvested product revenue, commercial investment	Carbon finance, donor funding	Carbon finance, tourism	Carbon finance, harvested product revenue
Community social benefits	• Employment of local people • Education on forestry practices • Improving local infrastructure	• A supply of harvested timber or non-timber forest products • Education on forest benefits and forestry practices • Employment and training • Share of carbon revenue	• Ecosystem services • Employment of local people • Training in alternative livelihoods • Share of carbon revenue	• A supply of harvested timber or non-timber forest products • Education on forest benefits and forestry practices • Share of carbon revenue
Tree species	Commercial species, e.g. pine and eucalyptus	A mix of commercial and native species	Predominantly native species	A mix of native and non-native species

For species choice, we classify projects into Native species, Non-native species, and a mix of the two (referred to as Mixed species).

- Native species: Species that naturally occur and have evolved in a particular geographic region or ecosystem. They are well-adapted to the local environmental conditions and have co-evolved with other native species, playing a crucial role in maintaining ecosystem balance as they have established ecological relationships with other native species over time
- Non-native species: An alien/non-indigenous species living outside its native distributional range which has been introduced by human activity, directly or indirectly, and either deliberately or accidentally
- Mixed species: These projects include both native and non-native species in their planting activity plans

BeZero Carbon Rating analytical framework and process for ARR

We have designed an approach to assessing the carbon efficacy risk for issued carbon credits. This framework is applicable to any project type in any sector accredited by any standards body, and leverages a blend of qualitative and quantitative factors; financial, environmental, policy assessment techniques; and primary and secondary data sources.

Our BeZero Carbon Rating Methodology details our risk based assessment for understanding and interrogating the efficacy of issued carbon credits of any type, in any sector and country.

The BeZero Carbon ex ante Rating Methodology similarly describes our framework for assessing carbon efficacy of credits yet to be issued from projects of any type, in any sector and country. Ex ante ratings will also consider project execution risk.

Sector methodologies are nested within the overarching ex post and ex ante methodologies. The overall rating definitions, risk factors and risk driver categories are common across all projects while the sector methodologies provide more detail on our sector-specific analytical approach.

This document provides an extension to our overarching rating methodologies. It presents BeZero's detailed analytical framework and process for ARR projects. It showcases the various parameters through which we assess risk to the carbon quality of these credits, and how this sub-sector implements our overarching ratings methodologies.

Holistic assessment

The assessment of a carbon credit's efficacy includes a detailed, project-specific, bottom-up and top-down analysis to provide a comprehensive assessment of risk. Further details on the risk factor definitions, the rating process, and the overall risk assessment can be found in our BeZero Carbon Rating Methodology and BeZero Carbon ex ante Rating Methodology.

Important elements of the BeZero Carbon rating process that are applicable to all project types are described in detail in these overarching methodologies and are not repeated here. These include:

- The steps in the rating process
- The project governance assessment
- Project boundary auditing
- Assessing the risks of double counting
- The integrity of reported issuance
- Assessing rating eligibility (whether projects meet our three primary qualifying criteria)
- The rating assignment process
- The role of the BeZero Carbon Rating Committee
- Ongoing monitoring and 'rating watch' process

Geospatial and Earth Observation

For all NBS projects, data and analysis from our Geospatial and Earth Observation team forms a core part of the analytical process. The team draws on a diverse set of data inputs, including but not limited to airborne and spaceborne LiDAR, synthetic-aperture radar, and multispectral measurements, with spatial resolutions ranging from centimetres to kilometres, and temporal frequency and coverage from days to decades.

Other geospatial inputs include data on road and river networks, human demographics, land ownership and governance, soil and climate data, and biodiversity. We also draw on our extensive database of ground-measured carbon, spanning thousands of forest inventory sites globally. These geospatial data are combined in statistical and machine learning frameworks to inform project- and vintage-level risk associated with common practice, over-crediting, leakage and non-permanence.

Some of the core geospatial capabilities for ARR analysis referred to throughout this document are:

1. **Boundary and historical land-use review.** We inspect the project area and a context-appropriate surrounding landscape to verify reported land use, identify pre-existing vegetation, interpret project activities and determine the principal drivers of vegetation change.
2. **Statistically matched dynamic baselines.** We select control locations without a carbon-project intervention that are similar to the project area in observable drivers of carbon-stock change. Land ownership, protection status and other governance constraints are incorporated where they materially affect comparability. Analysts review control locations and covariate-balance diagnostics before relying on the output.
3. **Common practice assessment:** We use satellite imagery and derived spatial datasets to assess regional historic tree-cover gain, distinguish between planted and naturally regenerating vegetation, characterise forest composition, and identify nearby carbon projects that should be excluded from the comparison. GEO analysis also helps define an appropriate comparable landscape by considering factors such as land governance, protected-area status and the environmental drivers of biomass change, allowing observed regional trends to be interpreted in the context of the specific project.

The BeZero Carbon Rating reflects the balance of evidence across all types of information, geospatial or otherwise. Subject to project-specific characteristics and evidence, our geospatial analysis may not be paramount in the final rating view if, for example, financial, policy or other analysis is deemed more decisive. In all cases, non-spatial data - for example buffer pool contributions - provide essential context. Where the quality of matching or of the underlying data is insufficient to support a conclusion, we say so and weigh the evidence accordingly rather than relying on it.

Carbon efficacy assessment

Whilst the foundational questions that underpin a BeZero Carbon Rating converge at the risk factor level, the inputs used to answer these questions show increasing specificity at the sub-sector and project levels.

Additionality

'The likelihood that a project's activities are materially different from the counterfactual or business-as-usual activities.'

Additionality asks whether the project's credited carbon benefit depends on the carbon project and carbon finance. Our assessment is not limited to the project's accredited additionality test. It evaluates actual land-use alternatives, financial incentives, implementation barriers, stakeholder decisions, policy support and observed project outcomes throughout the relevant vintages.

Whilst the foundational questions that underpin a BeZero Carbon Rating converge at the risk factor level, the inputs that are used to answer these questions show increasing specificity at the sub-sector and project levels.

In Table 3, we highlight sub-components of our assessment of additionality for ARR projects. In the sections that follow, we detail the key parameters that factor into each level of risk assessment, and illustrate with case studies where relevant.

Table 3. Sub-components of additionality assessed.

Risk factor	Risk driver category	Risk driver
Additionality	Activity analysis	Common practice
		Alternatives to the proposed project
		Project effectiveness
	Financial analysis	Prior consideration of carbon finance
		Investment analysis
		Barrier analysis
		Benefit sharing
	Legal and policy	Policy support

Activity analysis

Common practice

Common practice is a major driver of our additionality analysis for ARR projects. It explores the extent, setting, and trend of similar activities at landscape, regional and national levels. Our assessments of common practice evaluate the prevalence of similar activities based on the project's scale, timeframe, commercial value, species choice, and forest management approaches.

For example, we use the Spatial Database of Planted Trees and related estimates of planting years, combined with in-house analysis of satellite imagery from NASA, ESA, JAXA, and commercial providers, to understand what has been planted across the wider landscape, patterns of rotation, and how these have changed over time. We also inspect high-resolution imagery inside and outside the registered land parcels where planting is at lower density and spatially dispersed.

We leverage our internal markets and geospatial databases to assess the prevalence of all other voluntary carbon market projects in the area. It is important to identify nearby carbon projects so that carbon-funded activity is not mistaken for common practice without carbon finance.

We further consider how the observed planting patterns could be limited by governance constraints and the suitability of soils, topography and climatic conditions (integrating climate reanalysis data from ECMWF with soil data from ISRIC, and topographic data from ESA).

Our overall view of common practice contextualises these geospatial findings with data on national and regional trends (e.g., from the UN's Food and Agriculture Organisation (FAO) and government datasets), and industry and academic literature on typical species types, rotation lengths, policies, and market trends.

Alternatives to the proposed project

Another key aspect of additionality assessments is understanding the likelihood and extent of the alternative scenarios that may occur in the absence of a project. This analysis identifies the realistic land-use scenarios that could occur without the project and asks whether the proposed ARR intervention is the most carbon-beneficial plausible outcome. The project's stated baseline is one source of evidence, but it does not constrain the alternatives we consider.

We identify alternatives from historical land use, landholder intentions, nearby land-use change, project and regional economics, common-practice findings, policy, land governance and the biophysical characteristics of the project area. Alternatives may include continuation of pre-project use, another productive use, passive or assisted regeneration without carbon finance, or implementation of similar activities to the project through a different funding route. When different parcels face different alternatives, likelihoods are assessed spatially and aggregated by affected area or issuance.

This component of our analysis is interlinked with our assessments of common practices and barriers the project faces. Our common practice assessments inform our analysis of the likelihood of the alternative scenarios proposed by a project or otherwise relevant in the project setting.

Alternatives expected to store as much or more carbon as the project scenario are treated as risks to Additionality. Alternatives that remain below the project scenario but above the credited baseline are

treated as risks in the Baseline scenario assessment in Carbon Accounting. This allocation prevents a single counterfactual concern from contributing risk twice.

Where participation is voluntary or aggregated across many landholders, we also assess adverse selection. Here we ask whether enrolled landholders or parcels are systematically more likely than the wider comparable population to undertake the credited activity without carbon finance. Evidence may include pre-existing planting plans, access to seedlings and labour, low-opportunity-cost land, conservation encumbrances, existing donor or corporate pipelines, the structure of participant outreach and communication, and the selection of particular parcels from a larger holding. Data are often limited, so the analysis establishes whether credible indicators of adverse selection are present rather than claiming to observe every participant's private intentions.

Project effectiveness

Project effectiveness is assessed where sufficient time has elapsed to observe whether project activities have produced the intended additional carbon outcomes. It is principally an ex post risk driver. A project that has not established or maintained vegetation as planned may no longer outperform the most plausible without-project scenario, even if the original intervention was additional in principle.

Where appropriate, we establish a dynamic baseline using matched controls. Control plots are established from a representative sample of land parcels matched on land use, ownership type, and ecological characteristics. They are matched using covariates (e.g. soil, climate, carbon stocks) that machine learning identifies as predictive of baseline outcomes in the relevant geography and over a recent historical period. We then compare carbon density and canopy height trajectories in the project area and controls. The direction, persistence and ecological interpretation of the difference matter more than any isolated annual fluctuation, as remote sensing may not precisely measure gradual biomass accumulation, particularly in young or heterogeneous systems. Inventory evidence, project monitoring and literature are therefore used to corroborate the signal.

The dynamic baseline is supplemented by comparing achieved sequestration with ex ante expectations on a per-hectare basis and by reviewing high-resolution imagery for areas showing limited or no growth. Where underperforming areas can be identified, we estimate the share of expected or issued credits associated with them. We then compare the observed project outcome with the alternative scenarios established above. If a plausible counterfactual now stores more carbon than the observed project, the resulting risk is treated as an Additionality finding under project effectiveness.

Financial analysis

Prior consideration of carbon finance

Some ARR projects apply for carbon finance retroactively, meaning they apply after tree planting is complete or financing is secured. In such cases, there may be a risk that the alternative baseline scenario is not different to project activities, which would indicate a lack of additionality. When this occurs, we assess whether the pre-existing activities were contingent on the anticipated eventual receipt of carbon finance.

We reconstruct the timeline of project planning, land acquisition or leasing, nursery and planting activity, methodology selection, validation, registration, financing and expected issuance. Historical

imagery is used to check whether reported activity dates are consistent with observed land-use change. Where registration or issuance followed implementation after a material delay, we assess the explanation in the context of the standards body's rules and the market conditions that applied at the time.

Potential evidence includes contemporaneous contracts, board or investment approvals, financing conditions, offtakes, pre-purchase agreements, budget commitments or other records. Where carbon finance became necessary only for a later expansion, the conclusion is applied to the relevant area and vintages rather than to the entire project.

Investment analysis

Investment analysis assesses financial viability at project inception and the extent to which implementation depends on carbon revenue. We reconstruct the project's investment case from the perspectives of the proponent and relevant investors, distinguishing the carbon project's economics from those of participating landholders where they differ. Alternative funding is not automatically evidence against additionality. We assess whether grants, equity or debt covered the full cost of implementation, whether they were conditional on future carbon receipts and whether carbon finance changed access to capital or the timing of cash flows. In aggregated projects, the proponent's financial case is addressed here, while the role of payments and other benefits in changing landholder behaviour is considered under Barrier analysis and Benefit sharing.

The analysis identifies capital and operating costs; the timing and value of timber, agricultural and non-timber revenues; grants, subsidies, donor funding and payments for ecosystem services; financing terms; expected issuance; carbon-credit prices and the timing of carbon receipts. We compare project and plausible alternative scenarios with and without carbon finance using the financial measures supported by the available evidence, including net present value, internal rate of return, payback period and any residual funding gap.

Project assumptions are tested against independent evidence on establishment and management costs, yields, product prices, carbon prices, discount rates and comparable investment opportunities. Where project-provided models are sufficiently detailed, we replicate or stress-test them. Where disclosure is inadequate, we reach a directional conclusion based on the funding structure, revenue mix and available comparable evidence.

Barrier analysis

Barrier analysis considers obstacles that can prevent implementation, even when the activity appears desirable in principle, and assesses whether carbon finance is the mechanism to overcome them. For many ARR projects, barriers related to land quality, financial resources, and technical skills can inhibit activities and undermine a project’s additionality. These barriers are often unique to the project’s location and circumstance. To assess the presence and scale of these barriers, our ARR project analysis incorporates geospatial and desk-based approaches.

For example, where prior soil quality and land topography are barriers, we investigate modelled estimates of soil structure and chemistry and remotely sensed measures of elevation, slope, aspect, and terrain ruggedness.

We identify barriers reported by the project and independently reported for comparable activities in the jurisdiction. Each is tested for credibility, project specificity and materiality using project documentation, feasibility studies, geospatial evidence, government or NGO reporting and academic literature. If similar landholders routinely overcome the same barrier without carbon finance, the

barrier provides weaker support for additionality. Where the project is an expansion of pre-existing activity, the relevant question is whether the barrier applies to the expansion rather than to the activity in general.

We then trace how carbon finance is used to address the barrier. Carbon revenue may fund nurseries, planting inputs, technical assistance, infrastructure, early cash flow, training or institutions needed to aggregate landholders. A barrier that remains unresolved does not support additionality merely because it exists; it may instead indicate project-execution or permanence risk.

Benefit-sharing

Benefit sharing is assessed when communities, individual landowners, or other stakeholders control the land or the actions needed for project implementation. The objective is to determine whether the project through carbon finance provides a credible incentive for stakeholders to adopt activities they would otherwise be unlikely to undertake.

We identify formal revenue-sharing or profit-sharing arrangements and non-financial benefits, including planting materials, technical support, training, employment, alternative livelihoods, access to forest products, cooperative structures and community infrastructure. We assess who receives each benefit, when it is delivered, whether it is conditional on vegetation survival or credit issuance, and whether the organisational arrangements allow the intended stakeholders to access it.

The value and timing of benefits are considered against foregone income, labour requirements, maintenance costs and other livelihood impacts introduced by the project. A mechanism supports additionality where it is sufficient and appropriately targeted to change behaviour or sustain participation. The reliability of delivering promised benefits, and the risk that failure causes withdrawal or non-compliance, are assessed separately under Stakeholder engagement in Permanence.

Legal and Policy

Policy support

Our assessment of policy support interrogates whether existing laws, incentives, mandates or protected-area status would enable or require the project activities without carbon finance. We focus on measures that directly affect the project's land, activity, species or target landholders around the project start date and across the rated vintages. For ARR projects, this typically involves investigating forestry regulations aimed at increasing forest cover or improving access to timber resources.

We identify relevant national, subnational and local instruments, including reforestation or conservation mandates, tax treatment, grants, preferential market access, input support and restrictions on land use. For each instrument, we assess legal applicability, implementation and enforcement, uptake, eligibility and whether the project actually receives or is likely to receive the support. Measures targeted to particular landholder groups or land types are assessed at that level rather than assumed to apply uniformly.

Where project activities are required by law or effectively supported by policy, we assess whether they provide regulatory surplus and whether carbon finance remains necessary. Direct financial incentives are incorporated into Investment analysis to avoid duplication.

We assess the presence of protected areas that overlap with the project area or fall within a 50-km buffer zone around it. In ARR projects, the presence of effective protected areas may reduce pressures on forest resources and allow for natural regeneration. Alternatively, where projects are within protected areas, there may be incentives for the body responsible for their protection to increase forest cover without carbon finance. Such incentives may include increased tourism revenue or the achievement of mandated forest cover requirements. The coverage of protected areas is assessed using the World Database on Protected Areas. Where the project overlaps a protected area, we examine the designation, timing and practical effectiveness of protection, and whether protection alone has led or is likely to lead to vegetation establishment without the project. Policy changes over time are reflected in the vintages and areas they affect.

Carbon Accounting

'The likelihood that or degree to which climate benefits are accurately or conservatively quantified.'

In Table 4, we highlight sub-components of our assessment of carbon accounting for ARR projects. In the sections that follow, we detail the key parameters that factor into each level of risk assessment and illustrate with relevant case studies.

Table 4. Sub-components of our carbon accounting assessment.Direct accounting.

Risk factor	Risk driver category	Risk driver
Carbon Accounting	Direct accounting	Baseline scenario
		Project scenario
		GHG conversions
	Leakage accounting	Activity displacement
		Market leakage

Reconstructing the project's crediting structure

Our carbon accounting assessment begins by reconstructing how a project arrived at its net issuance across the rated vintage period, so we can locate the effect of each subsequent finding within that structure.

Using project-reported values, we establish the project's total gross emissions reductions as the difference between project-area carbon stocks under the baseline and project scenarios. From gross emissions reductions, we then deduct the project's leakage and add its buffer pool contribution to arrive at claimed net emissions reductions.

Separately, we construct equivalent quantities based on our own assumptions to obtain our best-estimate range for comparison. Where our analysis of the risk drivers below leads us to a different view of the counterfactual, reported project emissions, growth rates, or the appropriate leakage deduction, we quantify the emissions reductions that our own assumptions would imply, and arrive at a BeZero view of net emissions reductions for the rated vintages. The proportion of the project's claimed net issuance that our analysis does not support is the central output of our carbon accounting assessment, and the primary determinant of the risk factor score.

Three methodological points follow from this. First, quantification is attempted wherever the evidence permits it, including where we conclude that a project's accounting is conservative rather than aggressive. Second, where available evidence does not support a single definitive estimate, we make analytical assumptions based on the best available evidence and scientific judgement. Third, in many cases we also need to consider the range and shape of uncertainty, strength of the scientific consensus that underpins the estimations, the likelihood of other unknowns, and other more qualitative considerations. Where the evidence supports a range rather than a point estimate, we present a range, and in conditions of material uncertainty we prefer to do so.

Baseline scenario

Our objective is to determine the range of plausible without-project carbon-stock trajectories, to determine whether the project's selected baseline is conservative with respect to this range, and if not conservative, to quantify the effect on issuance. The analysis has two connected components: treatment of pre-existing vegetation and changes in carbon stocks under plausible alternative land

uses. If the project scenario remains above the independent counterfactual but the project's baseline is lower than that counterfactual, the project may be additional while still over-crediting due to the baseline.

For pre-existing vegetation, we first establish whether carbon stocks existed before project implementation and how the project treated them. Historical imagery, land-cover data, vegetation indices, canopy height, forest cover, and carbon density products are used to identify unreported stocks or clearance associated with site preparation. Where pre-existing vegetation is retained, we verify that the project credits only subsequent growth; where it is cleared, we estimate the resulting emissions and compare them with the project's deductions.

To assess changes in carbon stocks under plausible alternative land uses, we compare the baseline against two independent references.

The first is our statistically matched dynamic baseline, which shows the change in carbon stock density implied by the project's asserted baseline, compared with that observed in matched control pixels over the rated vintages.

The output is then interpreted alongside imagery, inventory and literature evidence rather than used as a stand-alone estimate. Specifically, we also consider the alternative scenarios we identified that are expected to store less carbon than the project scenario. Their likelihood, spatial distribution and long-term carbon stocks are used to form an independent baseline. Where several alternatives are credible, the baseline is weighted. Historical land use, landholder intent, regional trends, carbon-stock evidence and project economics are considered together.

Where the project's baseline implies greater carbon stock loss than our counterfactuals, the project is likely over-crediting, and we characterise the extent of that overestimation based on the difference between the project's issuance and the issuance that would result from replacing the project baseline with our counterfactuals. Where the project's baseline is consistent with our counterfactual and dynamic baselines, we state that the baseline is appropriate and that quantification of an alternative is unnecessary.

Several limitations bear on this analysis and are disclosed where they apply. Our ability to construct a robust counterfactual depends on data availability and varies by project. There are land governance contexts in which the dynamic baseline is uninformative, or requires heavy contextualisation. We therefore generally use these data as a coarse approximation of potential over-crediting, rather than a precise measure of it.

Project scenario

The project-scenario assessment tests whether emissions caused by implementation and management are complete and accurately calculated. We identify the full set of relevant sources, including nursery operations and transport, site and soil preparation, equipment use, fertiliser application, hydrological change, expected mortality, thinning, coppicing and harvesting. The applicable boundary depends on the project activities and the significance of each source.

Reported activity data and emission factors are checked against project records, methodology requirements and independent evidence. Where harvesting occurs and a long-term average is applied, we examine whether accounting represents the management cycle through an appropriate long-term average, includes the final harvest, reflects staggered planting and replanting, and uses a plausible growth trajectory. Geospatial evidence of forest loss and canopy change is used to test whether reported harvest and disturbance align with observed outcomes.

We recalculate omitted or underestimated project emissions where feasible and compare them to total issuance to determine potential over-crediting risk.

GHG conversions

GHG conversions address the equations, factors, carbon pools and monitoring design used to translate field observations and project activities into tonnes of CO_2e. It asks whether reported carbon stocks are plausible, whether the calculation approach is appropriate for the vegetation and geography, and whether monitoring can reliably detect change over time.

Carbon pools are ecosystem components that can sequester, store, and release carbon. These include above- and below-ground live biomass, soil organic carbon, deadwood, litter, and harvested wood products. We identify which pools are included in the baseline and project scenarios and whether their treatment is conservative given the expected direction of change. Aboveground biomass, belowground biomass, soil organic carbon, deadwood, litter and harvested wood products are assessed where material. For harvested wood products, product mix, durability, decay and interaction with the long-term average are considered. An excluded pool is not automatically a risk; the question is whether exclusion omits a loss, or whether inclusion credits a gain that is not adequately supported.

We identify how aboveground and belowground biomass are calculated. We review taper or form factors, wood density, biomass expansion factors, and allometric approaches. For belowground biomass we determine and review the separate allometric relationship or a root-to-shoot ratio employed. Carbon fractions and all other conversion factors are traced through the calculation. The appropriateness of each equation or factor is assessed against species, forest or ecosystem type, geography, age and size range, sample design and sample size. Where a project uses several equations, the assessment is weighted to account for the contribution of each species or stratum to issuance.

We search for independent equations or factors of equal or greater contextual relevance and compare outputs across representative diameter, height and wood-density inputs. Any resulting difference is translated into over-crediting relative to issuance.

We review whether the project area is stratified according to material drivers of sequestration, including species, activity start year, soil, topography, ecological zone and previous land use. Plot distribution is examined for spatial bias, and random, systematic, or census-based designs are assessed by how well they represent each stratum. We review remeasurement frequency relative to issuance, treatment of dead or missing trees, restratification, strata-level sample sufficiency and any uncertainty deduction.

Reported growth rates are compared with project monitoring, geospatial observations, BeZero's plot database, national inventories and published evidence. Soil-carbon claims are assessed according to the sampling or modelling method, depth, bulk density, spatial representation, temporal design and uncertainty treatment. Where monitoring or equations do not support the claimed stock change, we estimate a more appropriate value or range and quantify the effect on issuance.

Leakage accounting

Activity displacement

Activity displacement occurs when the same stakeholders move pre-project activities outside the project boundary because implementation restricts their previous use of the land. We identify the project area's recent land uses and the stakeholders responsible for them, including grazing, cropping, fuelwood or charcoal production, timber harvesting and collection of non-timber products. We assess which activities cease or contract within the project area because of the project, whether participants retain a need or incentive to continue them elsewhere, and whether the project provides a credible substitute for lost income or subsistence resources.

For activities expected to move, we identify likely receiving land from project plans, stakeholder evidence and regional land-use trends. The scale of displacement is estimated from the most relevant activity data, and the carbon-stock change on receiving land is estimated from geospatial, inventory and literature evidence.

We then assess project mitigation and accounting. Alternative livelihoods and agricultural intensification are viewed as mitigants only to the extent that they are likely to be implemented, additional, capable of delivering the claimed production uplift, and sustained for the commitment period. Estimated net displacement is compared with the project's leakage deduction and carried into net issuance.

Market leakage

Market leakage occurs when a project’s activities alter the equilibrium of supply and demand for a commodity that might be produced in the without-project counterfactual scenario. Shifting market dynamics may increase emissions from activities elsewhere. Market leakage is distinguished from activity displacement by the market mechanism and by the involvement of different producers or suppliers.

We identify market-linked production under the pre-project and most plausible counterfactual land uses and determine whether the project materially reduces supply. The relevant markets may be local, regional, national, or international. We assess whether demand is likely to persist and how it is most likely to be met: expansion into new land, intensification on existing land, alternative domestic suppliers, imports, substitution or reduced consumption.

Where evidence supports a land-expansion pathway, displaced production is converted into an affected area based on relevant yield data, and the carbon-stock consequences are estimated for the likely receiving land. Where intensification, substitution, or alternative supply is more plausible, we assess the corresponding carbon effects and uncertainties without assuming that all forgone production results in land-use change. Beneficial leakage is considered where replacement production has a lower emissions intensity.

The project's leakage deduction is assessed against the most plausible market response. We identify pathways that the project has omitted and quantify residual leakage where possible. Activity displacement and market leakage are separated so that the same risk is not counted twice.

Ecological leakage

Ecological leakage is assessed where project activities may alter ecological processes outside the project boundary and thereby change carbon stocks. Relevant pathways may include changes to water tables or hydrological flows, altered fire spread, or other connected ecosystem effects.

An example of ecological leakage is the initiation of an afforestation or reforestation project on wetland soils, such as peat. In these cases, the planting of a project results in modification of the local groundwater table. This, in turn, can cause the deterioration and oxidation of wetland soils outside the project area, ultimately resulting in carbon loss.

Beneficial ecological leakage can also occur where a project's environmental benefits spread beyond the project area. This may occur where plantations increase soil water retention or slope stability within the surrounding region, or if planted trees may propagate outside of the project area.

This driver is assessed on a case-by-case basis when a credible pathway is identified. We define the mechanism, identify the affected area and carbon pools, review project and independent evidence, and estimate the direction and potential magnitude of carbon-stock change. The project's accounting and mitigation are then assessed against that pathway. Where the evidence does not support quantification, the uncertainty and likely materiality are stated explicitly.

Permanence

'The likelihood that the climate benefits of the project will persist for the time committed.''

Our analysis of this risk factor considers the permanence of climate benefit as it relates specifically to the contractual commitment of a given project and its credits. We distinguish the contractual commitment embodied in a carbon credit from the durability of carbon avoided or removed over 100 to 1,000 years or longer; the latter concept as applied in the carbon market is beset by inconsistencies and contradictions. To avoid confusion between contractual reality and theoretical debate, our assessment focuses on how long is actually committed to ensuring the carbon avoided or removed remains so, the mechanisms in place to guard against losses, and the strength and accuracy of the claims made.

Our assessment addresses four questions:

- How likely is it that the project's claimed carbon benefit will reverse before the end of its commitment period?
- What is the severity of any carbon stock losses, and how does this compare to the project's credit issuance?
- How likely is it that carbon losses are transient - that is, recovered through future project activity such as regrowth or replanting?
- Is the project properly mitigating this risk through a risk buffer and/or other mechanisms, so as to limit the risk to its issued credits?

Identifying the commitment period

All identified risks to permanence are then considered in relation to the identified commitment period. Because we assess reversal risk over the period actually committed, the first step in any permanence analysis is to identify that period. Commitment periods are labelled differently by different standards bodies - as commitment period, project longevity, or minimum project term, among others. In some cases, the commitment period coincides with the crediting period. In some cases, the commitment period is implicitly specified in the choice of 100-year global warming potentials for short-lived greenhouse gas species.

Assessing risk within the committed period allows comparability between credits based on what has actually been promised.

For each permanence risk driver, we estimate the likelihood that a reversal occurs before the end of the commitment period, and the proportion of the project area, carbon stock, and/or carbon benefit expected to be affected. Together, these give an expected reversal, which we then translate into an impact on the project's carbon stocks per hectare and compare against the project's issuance. We then consider the effect of the risk buffer and of any other mitigation, such as replanting or committed future deductions, to arrive at a residual, unmitigated risk to the carbon stocks over the commitment period.

Framing the assessment as an expectation rather than a binary outcome matters, because the same expected reversal can be constructed in different ways: a high likelihood of a small reversal and a low likelihood of a total reversal may imply comparable expected losses, and both are captured. Individual risk drivers are assessed on this common basis, which allows risks of very different character - fire, drought, pests, encroachment, loss of rights - to be compared and aggregated coherently.

Table 5 highlights the sub-components of our assessment of permanence for ARR projects. In the following sections, we detail the key parameters that factor into each level of risk assessment, and illustrate with case studies as relevant.

Table 5. Sub-components of permanence assessed.

Risk factor	Risk driver category	Risk driver
Permanence	Natural risks	Fire
		Extreme weather
		Pests and diseases
		Sea level change
	Anthropogenic risks	Project management and carbon rights
		Encroachment risk
	Risk mitigation instruments	Risk buffer and mitigation
		Stakeholder engagement

Natural risks

Fire risk

Our objective is to determine the extent to which project carbon stocks are at risk from fire over the commitment period. If fires are likely to occur within the project area during that period and the tree species present are not generally fire-adapted, reversals are likely and permanence risk increases.

We establish the fire history of the project area and the surrounding landscape from Earth observation records of burned area and active fire detections, comparing periods before and after the project start date. Burned area captures the spatial extent of burning; active fire detections reflect the count of hot pixels at satellite overpass. Combining a historical perspective on fire activity within the project area with a broader view of fires across the landscape allows us to distinguish project-specific risk from regional background risk.

Where the project has reported a loss event within the rated vintage period, we assess whether its reported magnitude is consistent with our observations of burned area, and where there is notable inconsistency, we estimate the potential impact on claimed emissions reductions. Where we observe significant fire activity within the project area since the project start but no loss event has been reported, and fire is otherwise unaccounted for, we estimate the emissions associated with those events and their effect on the project's claimed emissions reductions.

Interpretation is heavily context-dependent. Fire plays a natural role in many dryland and grassland ecosystems, and can be a fundamental ecological process in some forest systems, while causing tree mortality and long-term carbon loss in others. We therefore assess whether the project sits within a fire-adapted ecosystem and what proportion of the species composition within the project area is fire-tolerant. Fire activity across the wider landscape does not necessarily indicate high risk to the project. Conversely, where fire activity in the region is closely related to climate extremes or is increasing over time, this may indicate a rising risk of degradation, and we use climate projections and regional literature to form a view of fire risk over the remainder of the commitment period. We also assess whether fire coincides with drought and whether young vegetation faces an elevated risk of establishment.

Historical fire is interpreted in the context of previous land use and the new vegetation system. Fire formerly used to maintain pasture may decline after project implementation, while establishment of woody biomass may create a new fuel load.

Mitigation is assessed according to design and implementation. Mitigatory activities may include fire-resistant species, fuel or understorey management, fire breaks, spatial separation of parcels, patrols, early-warning systems, lookout infrastructure and training. Incentives to protect commercially valuable trees or other products are also considered. The expected area and stock loss after mitigation are estimated from observed activity, project carbon density and evidence on fire impacts in comparable ecosystems.

Extreme weather

Extreme weather events such as droughts or tropical cyclones can pose an evolving permanence risk to ARR projects and may result in reversal events and carbon losses over time.

We characterise drought history for the project area using the Standardised Precipitation Index (SPI) and the Standardised Precipitation Evapotranspiration Index (SPEI). Values are calibrated to the project's own location and to typical climatic conditions there. We interpret the frequency, magnitude and trend of drought events, and consider whether decadal conditions are stable, deteriorating, or improving.

Future drought is assessed using climate-model projections across multiple emissions scenarios over the commitment period. We compare projected rainfall and moisture stress with the tolerances of dominant species and the adaptation of the target ecosystem.

Key factors we consider to drive or mitigate risk are multi-year events, repeated establishment failures, young-tree vulnerability, irrigation, and intercropping. Where the project produces commercial products, we also assess whether drought-related yield or quality losses could lead to project abandonment or early harvest. We place these metrics in a wider context using academic and industry sources. Such context includes ecosystem type, topography, hydrological regime, regional land use, predominant species, and oceanic oscillations such as El Niño.

For cyclone risk, we review historical storm tracks, intensity and proximity and assess the probability and severity of future damaging events under current and projected climate. Topography and expected dissipation before reaching the project area are considered. Species susceptibility to windthrow, stand structure, carbon density and documented impacts in comparable systems are used to estimate potential losses. Observed storm-related forest change is reconciled with project-reported loss events and deductions.

Pests and disease

The presence of pests and diseases can damage vegetation in ARR projects and lead to a reversal event directly by killing trees or indirectly by triggering aggressive control strategies and early harvest. To assess the risk from pests and diseases, we first apply a top-down approach and assess the prevalence and likelihood of this risk within the region and for the planted species. We use a range of national datasets, such as forest inventories and pest and disease maps, in combination with academic and industrial literature to assess these parameters. Presence alone is not treated as a carbon loss; the analysis establishes the mechanism and likely effect on growth, mortality, product quality and long-term management. Project records, forest-health reporting, academic literature and geospatial observations are used to identify current or emerging outbreaks.

Next, we assess the project specifically with respect to its mitigation activities and the resilience of the planted stand. For example, in ARR commercial projects with monoculture stands or

high-density planting, exposure to pests and diseases is more likely to result in reversals due to the ease of spread. In comparison, community-based projects tend to face lower risks of natural permanence, as they are often distributed across a larger area and comprise tens to thousands of small land parcels. Hence, pests and diseases are less likely to spread or may be more easily controlled. Other mitigation measures may include resistant species, mixed stands, monitoring, biological or chemical treatments, and fencing. For productive or rotational systems, we also assess whether pest or disease impacts could cause early harvest, abandonment or failure to replant and thereby reduce the long-term average carbon stock. Our bottom-up approach also assesses whether the project area has historically been exposed to pests or diseases and whether it has adequately accounted for pest and disease risk in its risk buffer assessment.

Sea level rise

Sea level change is applicable to ARR projects in low-lying coastal settings. Where relevant, we assess exposure to permanent inundation, saltwater intrusion and storm surge over the commitment period using elevation, hydrology and published projections under multiple climate scenarios. To assess this risk, we predict the extent of sea-level rise within the project area for the project's commitment period relative to a baseline from 1995 to 2014, using data from NASA and the IPCC 6th Assessment Report. Our analysis includes two scenarios, a 2°C and 3°C increase in global mean surface temperatures towards the end of the century, to predict sea level change and associated uncertainty based on an ensemble of global climate models. Using academic literature, we then apply our top-down approach to situate these predictions within the local context (including topography, hydrological regimes, planted species, land use, sediment transport, and tectonic and isostatic uplift in relevant areas). If available, the project's risk assessment of sea-level rise is also reviewed to evaluate whether it has adequately accounted for and mitigated these risks through its buffer pool contributions.

Geological hazards

This risk driver is typically not applicable for ARR projects. Where salient geological hazards - such as earthquakes, volcanic eruptions, landslides or tsunamis - are identified during analysis, they are assessed and reflected here.

Other natural risks

This risk driver is typically not applicable for ARR projects. Where salient natural risks not captured by the drivers above (such as flooding unrelated to extreme weather or sea level rise) are identified during analysis, they are assessed and reflected here.

Anthropogenic risks

Project management and carbon rights

Carbon rights are property rights that enable the ownership and trading of accredited carbon units. Our assessment determines ownership of these rights and potential permanence risks. Details are found in project documents or literature.

Failure to secure land/carbon ownership, or reliance on traditional land rights, can pose permanence risks, as the project may occur on land to which it does not have legal title. This can result in legal conflict over the project, potentially leading to its discontinuation or the reallocation of carbon rights/credits. Our analysis identifies the owners and users of the project land, including customary and overlapping claims, and verifies land titles, registry information, concessions, leases, easements and other evidence where it is available.

Where the developer does not own the land, we review the contractual transfer of land-use and carbon rights, the duration and renewal provisions, restrictions on withdrawal or transfer, remedies for breach and the relationship between the contract term and the commitment period. Free, prior and informed consent and equivalent consent principles are considered when communities or customary rights holders are affected. Claims are tested against national and subnational law and independent evidence on tenure security and land conflict. Clear land ownership by the project developer or local stakeholders reduces risks by decreasing the likelihood that projects will be discontinued due to legal conflicts.

Finally, we assess the technical capability of the proponent and landowner, including the number of forest carbon projects they have previously been involved in and whether there is a precedent for them to carry out the specific activities the project requires.

Encroachment risk

Encroachment risk addresses human intrusion that may remove or degrade vegetation within the project boundary. We identify the principal regional drivers of land-use change and the communities, companies or other agents that could access the project area. Historical and current deforestation, mining, infrastructure and settlement pressure are reviewed using geospatial and third-party evidence.

Project-specific exposure is assessed based on prior and planned land use, the value of project resources, road and river access, land availability elsewhere, nearby land-cover loss, protected-area effectiveness, tenure strength and whether local communities previously relied on the project land or access through it. Where use is restricted, we assess whether project benefits or alternatives replace the lost resources.

Our assessment uses a range of national and international datasets, including those pertaining to concessions for natural resource extraction, to assess the project's anthropogenic threat. For example, risk may be introduced if a high proportion of the project area overlaps with concessions. Risk is generally tempered if there is no evidence of concessions or other anthropogenic risks (such as conflict).

Here, we also assess the risk to the project’s carbon stocks from changes in policy and protected status during the project's crediting period. For example, lands placed under permanent easements may be more likely to retain GHG benefits outside a project’s commitment period.

Risk mitigation instruments

Stakeholder engagement

Stakeholder engagement is assessed for projects where communities, landholders, or other affected parties can materially influence the continuation of project activities or the maintenance of carbon stocks. The analysis considers both the risk of withdrawal or non-compliance and the project's ability to deliver promised benefits.

We identify relevant stakeholders from project documentation and independent sources and assess whether free, prior and informed consent or equivalent informed agreement was obtained. We review the accessibility and independence of grievance and dispute-resolution mechanisms, the identification of affected groups, communication in appropriate languages and formats, reported disputes and the project's plans for resolution. Landholder contracts are reviewed for withdrawal provisions, penalties and whether the project could recoup the carbon impact of exit.

For benefit delivery, we compare promised mechanisms with project records, stakeholder reporting, relevant media and the performance of comparable projects. We consider administrative, legal and market barriers that may delay or prevent payments or non-financial benefits, and the measures used to bridge those failures. The conclusion reflects whether engagement and benefit delivery are likely to sustain participation for the commitment period.

We then determine how withdrawal or dissatisfaction could affect land management and carbon stocks. The absence of effective engagement may cause risks to materialise, including local communities encroaching on project areas, damaging carbon stocks, or, ultimately, withdrawing from carbon projects. Replacement enrolment is not automatically treated as mitigation because replacement landholders may face the same reasons for withdrawal, and prior investment or credited carbon may already have been lost.

To evaluate this risk, we apply a bottom-up approach that evaluates the presence and success of stakeholder consultations, grievance channels, benefit-sharing structures, and alternative livelihood activities through project-specific case studies, academic literature and project documents. Risks can be countered through strong evidence of community support and integration with project activities.

Risk buffer and mitigation

Our objective is to compare residual expected reversal across the individual risk drivers with the project's buffer contribution and other mechanisms. We verify the buffer allocation from project and registry records and compare it with both the project's own risk assessment and BeZero's independent view. Other mitigatory activities targeting individual drivers of loss are assessed within the individual risk drivers to which they relate.

Additional mitigation may include committed replanting, incentives to replant, natural regeneration after partial loss, insurance, and mechanisms to make deductions from future issuance. Each mechanism is recognised only where it is funded (or clear plans and commitments to fund it exist), operationally feasible, required or otherwise assured to be implemented, and capable of restoring or compensating for carbon loss within the commitment period. The analysis accounts for the greater recovery potential of young stands, avoids double counting mitigation already applied within individual drivers, and carries any unmitigated difference into the permanence conclusion.

Our assessment comprises two parts. Firstly, we extract the project’s own permanence risk buffer contribution, and compare the materiality of the risks the project has identified against those identified through our own analysis. A buffer contribution consistent with our assessment of residual

risk indicates adequate mitigation; a contribution that falls short of it indicates that reversal risk is unaccounted for.

The second concerns the provenance of the buffer credits themselves. Under some standards, it is permissible to transfer credits to the buffer pool from a separate project, rather than to issue credits from the project being rated. Where credits have been transferred, we establish the proportion of the total this represents and, where the source project is identifiable, compare its risk profile against that of the project being rated. Where the source cannot be identified, the unknown risk profile of those credits is itself a source of risk - a buffer contribution is only as protective as the credits standing behind it. Risk is elevated where a substantial share of the buffer has been transferred rather than issued, and the project also faces acute permanence risks in its own right.

Appendix I: Sources as of October 2026

Geospatial data sources

Our Geospatial and Earth Observation team uses data from, but not limited to, the following:

Aboveground carbon in mangroves (Caltech / Simard et al. 2018), Aboveground carbon northern Africa (NASA / Tucker et al. 2023), Administrative districts (OpenStreetMap), Amazon indigenous territories (RAISG), American Indian, Alaska Native, and Native Hawaiian Areas (U.S. Census Bureau), BeZero Carbon Boundaries Database (curated in-house from registry data and other public sources), BeZero Carbon Plots Database (curated in-house from private collections, national inventories, international plot networks, academic studies, research partnerships, and other sources), Brazil indigenous lands (Terrabrasilis), Brazil mining concessions (Brazil National Departament of Mineral Production), Brazil protected areas (National Registry of Conservation Units - CNUC), Brazilian Cadastro Ambiental Rural (Brazilian government), Brazilian Sistema de Gestão Fundiária (Brazilian government), California timber harvesting plans (California Department of Forestry & Fire Protection), Cambodia mining concessions (Open Development Cambodia), Cameroon community forest (Ministère des Forêts et de la Faune), Cameroon Forest Management Units (Global Forest Watch), Cameroon mining permits (Cameroon Ministry of Mines and Technological Development), Cameroon production forests (Ministère des Forêts et de la Faune), Canada mining permits (various open sources), Chloris Above-ground biomass stock (Chloris Geospatial), Colombia agricultural frontier (El Sistema de Información para la Planificación Rural Agropecuaria (SIPRA)), Colombia mining titles (Tierra Minada), Colombia national parks (Parques Nacionales Naturales de Colombia), Congo peat maps (University of Leeds), Consejo Comunitario Titulado (Datos Abiertos Agencia Nacional de Tierras Colombia), CORINE landcover (Copernicus), Cost maps for ARR (Busch et al. 2024), Crop Sequence Boundaries (USDA), Cropland extent and change (GLAD/UMD), Decadal Land Use and Land Cover Classifications across India (Roy et al. 2016), Democratic Republic of the Congo mining permits (DRC Cadastre Minier), Dynamic World (Brown et al (2022)), EBA Brazil aboveground carbon (INPE), Ecoregion map (Resolve), Ejido territories (Registro Agrario Nacional - Catastro Rural), ERA5 Land climate variables (ECMWF), ESA Biomass Climate Change Initiative (Santoro, M.; Cartus, O. (2026)), ESRI Sentinel-2 10m land use land change time-series (ESRI), EU Farm Structure Survey (European Commission), European Union Tropical Moist Forests (IFORCE), Florida conservation lands (FLMA) (Florida Natural Areas Inventory), Forest Extent and Height Change, 2000-2020 (GLAD/UMD), Forest/Non-Forest (JAXA), Forest Type Groups of the United States (USDA Forest Service - Forest Inventory and Analysis (FIA) Program & Geospatial Technology and Applications Center (GTAC)), Forest ownership in the conterminous United States circa 2022 (Harris et al. (2025)), Forest Planning Open Data (Hokkaido Forest Planning Division, Forestry Bureau), Forisk North American Mill Capacity Database (Forisk), Gabon mining permits (Gabon Ministry of Mines, Petroleum, and Hydrocarbons & WRI), GEDI L2B canopy cover (NASA/UMD), GEDI L4A Footprint aboveground carbon (NASA/UMD), GEDI L4B Gridded aboveground carbon (NASA/UMD), GEDI Level-2A vegetation height (NASA/UMD), Global Canopy Height (ETH Zürich), Global Distribution of Mangroves (UNEP-WCMC), Global Forest Change (GLAD/UMD), Global Human Settlement Layer (GHS-SMOD) (Schiavina M., Melchiorri M., Pesaresi M. (2023)), Global Mangrove Watch (JAXA), Global mining extent polygons (Maus et al. 2022), Global mining extent polygons (Tang & Werner 2023), Global naturally regenerating forests (UN FAO), Global peatlands (CIFOR, Wetlands International, Indonesian Ministry of Agriculture, Indonesian Ministry of Transmigration and Land Resources), Global planted forest (UN FAO), GlobBiomass above and below ground carbon (ESA), HURDAT2 hurricanes (NOAA), IBTrACS hurricanes (NOAA), Integrated Deforestation Alerts (Global Nature Watch), IPCC AR6 Sea level rise (NASA/IPCC), IUCN Red List of Threatened Species (IBAT), Key Biodiversity Areas (IBAT), Köppen-Geiger climate classification (Beck et al. (2023)), Landsat 5, 7, 8 and 9 L2 Surface Reflectance (NASA/USGS), Land cover (JAXA), Malaysia logging concessions (Global Forest Watch), MapBiomas Brazil land cover (MapBiomas Brazil), MapBiomas Colombia land cover (MapBiomas Colombia), MapBiomas Paraguay land cover (MapBiomas

Paraguay), MapBiomas Peru land cover (MapBiomas Peru), Mapbox visual basemap (Mapbox), Maxar Imagery Surface Reflectance (Maxar Technologies), MCD12Q1 Land Cover Type (NASA), MCD64A1 Burned area (NASA/UMD), Mexico mining concessions (Secretaria de Economia), Mineral Resources Data System (USGS), Minnesota DNR Management Units (Minnesota Department of Natural Resources), MOD44B Vegetation Continuous Fields (NASA), MYD10A2 Snow cover (NASA), MYD13Q1 Vegetation Indices (NASA), National Cropland Data Layer (USDA), National Flood Hazard Layer (FEMA), Navigable water (OpenStreetMap), New York Protected Area Database (NYPAD) (New York Natural Heritage Program), New York state (DEC) lands (New York State Department of Environmental Conservation), NEX-GDDP-CMIP6 (NASA/NCCS), Northern Forest land ownership map (Northern Forest Center), Oil and gas concessions (various government sources), Peru cadastral and concessions (Digital Government Secretariat Peru), Peru mining concessions (Ingemmet), Peru native community boundaries (Peru Ministry of Culture), Planet Forest Carbon Diligence (Planet Labs), Planet Quarterly visual basemaps (Planet Labs), PlanetScope Imagery Surface Reflectance (Planet Labs), Population density (WorldPop), Primary designated management objectives of forest (UN FAO), Primary humid tropical forests (GLAD/UMD), PRODES Amazon deforestation (INPE), Regrid US land parcel data (Regrid), Republic of the Congo mining permits (Republic of the Congo Ministry of Mines and Geology), Roads (OpenStreetMap), Root-shoot ratios (Huang et al. 2021), SDPT plantations, planting year and planted species (WRI / Du et al. 2022), Sentinel-2 L2A Surface Reflectance (ESA Copernicus), SkySat Imagery Surface Reflectance (Planet Labs), Soil cation exchange capacity (ISRIC), Soil nitrogen (ISRIC), Soil organic carbon (ISRIC), Soil type classification (ISRIC), Soil water pH (ISRIC), Species Rarity-weighted Richness (IBAT), SRTM Digital Elevation Model (NASA), STAR Species Threat Abatement and Restoration Metric (IBAT), STORM Cyclone historical baseline (Bloemendaal et al. (2020)), STORM Cyclone future projections (Bloemendaal et al. (2022)), US Forest Type Groups of the United States (U.S. Department of Agriculture - Forest Inventory and Analysis (FIA) Program & Remote Sensing Applications Center (RSAC)), US National Conservation Easement Database (U.S. Endowment for Forestry and Communities), US Native lands (U.S Department of the Interior Bureau of Land Management), US Protected Areas Database (United States Geological Service (USGS)), US stand age (2005) (United States Geological Service (USGS)), US state boundaries (United States Census Bureau), USA Census of Agriculture (USDA), VARDA Global FieldID (VARDA), VNP14IMGML Active fire detections (NASA/UMD), World Database on Protected Areas (IBAT), Worldclim climatology (SEI), Global Population Data (unconstrained 100m) (WorldPop).

Other third-party datasets

In addition to our geospatial sources, we also incorporate many other third-party or industry datasets and sources into our assessments of individual risk factors. These include but are not limited to:

National and regional government information on climate change, GHG emissions, forestry and food production, domestic and international trade, pricing and distribution statistics; national forestry inventories, protected areas and easements; national and regional natural risk maps; policy trackers for impact, legislation, governance and action; land registration and titling databases including regional cadasters, mining concessions and indigenous territories; NDC registry; carbon credit pricing databases.

Literature sources

Our curated database of literature sources spans all types of peer-reviewed literature and industry research, with hundreds of entries for every sector, region or risk factor.

The number of relevant literature-based sources specific to the ARR and Avoided Deforestation sub-sectors exceeds 2,100 as of January 2025. In Figure 25, we show how these sources are split by carbon risk factor.

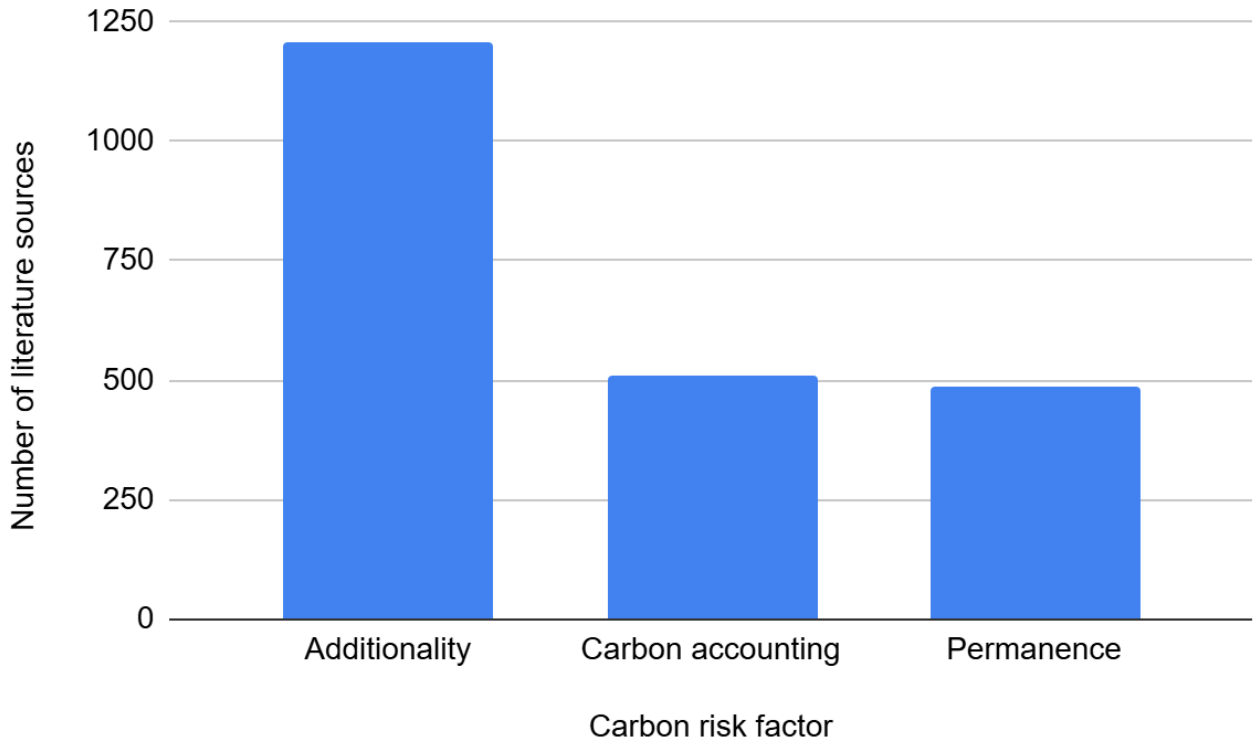


Figure 25. Number of literature sources relevant to the ARR and Avoided Deforestation sub-sectors used by BeZero Carbon Ratings as of January 2025.

Sample of academic literature sources

1. Al-Karaki, G. (2013). The Role of Mycorrhiza in the Reclamation of Degraded Lands in Arid Environments (pp. 823–836). https://doi.org/10.1007/978-94-007-5332-7_48

2. Andreetta, A., Huertas, A. D., Lotti, M., & Cerise, S. (2016). Land use changes affecting soil organic carbon storage along a mangrove swamp rice chronosequence in the Cacheu and Oio regions (northern Guinea-Bissau). Agriculture, Ecosystems & Environment, 216, 314–321. https://doi.org/10.1016/j.agee.2015.10.017

3. ATALA, C., MUÑOZ-CAPPONI, E., PEREIRA, G., NAVARRETE, E., OSES, R., & MOLINA-MONTENEGRO, M. (2012). Impact of mycorrhizae and irrigation in the survival of seedlings of Pinus radiata D. Don subject to drought. Gayana. Botánica, 69, 296–304.

4. Baumann, Esther A., "Assessment of the Environmental Sector and Climate Change in Malawi: Relationships between Environmental Policy, Scientific Literature, and Development Projects" (2016). International Development, Community and Environment (IDCE). 46.

5. Berenguer, E., Lennox, G., Ferreira, J., Malhi, Y., Aragão, L., Barreto, J., Espírito-Santo, F., Figueiredo, A., França, F., Gardner, T., Joly, C., Palmeira, A., Quesada, C., Chesini-Rossi, L., Seixas, M. M., Smith, C., Withey, K., & Barlow, J. (2021). Tracking the impacts of El Niño drought and fire in human-modified Amazonian forests. Proceedings

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Appendix II: Additional reading

Check out the ratings resources page on our website to find links to all of our published methodologies, in addition to our series of risk factor assessment frameworks, our frameworks for assessing project methodologies and country-level risks, deep dives on factors influencing the carbon efficacy of projects in various sectors, and more.

Appendix III: Methodology review policy

All BeZero methodologies are live and current, with versioning logs at the end of each document. The ex post rating methodology is comprehensive and holistic and is not knowingly subject to major or structural shortcomings.

The methodology is subject to periodic review, and at least once annually. The need for revisions will consider a range of factors including:

- Methodology review and evaluation. BeZero continuously reviews emerging data and research on the carbon market. BeZero will assess any evidence indicative of structural weaknesses in the framework or systemic risks that are not appropriately captured.
- Evolution in the market dynamics and scientific best practice. Evolutions in the scientific consensus and market infrastructure that underpin carbon markets may warrant methodological revisions (e.g. the definitions or conventions used for vintages).
- External regulatory and asset framework shifts where relevant. Shifts in the legal basis, regulatory architecture or accounting conventions that underpin carbon markets may warrant methodological revisions (e.g. the definitions or conventions used for risk concepts such as additionality, durability or permanence).
- Periodic review. All active frameworks are reviewed periodically (at least annually) to ensure continued robustness and effectiveness and to make analytical refinements.

Revisions to the methodology will be deemed material or non-material.

Non-material changes typically refer to minor updates such as administrative fixes, editorial clarifications that do not alter the underlying analysis. Other potential non-material changes may reflect an elaboration or expansion of the risk assessment framework. Non-material revisions are published routinely as needed.

Material changes typically refer to a fundamental shift in the analytical framework, scoring models, rating scope and definitions, or key rating assumptions that could reasonably alter an existing credit rating outcome. BeZero will undertake an impact assessment when material revisions are proposed. Impact assessments will evaluate the expected portfolio-wide impact, estimating the proportion of ratings that might migrate (upgrade or downgrade) as a result of the revised criteria.

Any change to the rating methodologies are led by our Lead Analytical Officer and approved by a formal Analytical Committee composed of senior personnel from the analytical team. We also consult with our external advisory board on such matters as required.

Changes to methodologies are tracked and logged. The version history of this methodology is available at the end of this document.

Stakeholder consultation

BeZero engages regularly with a wide range of market stakeholders. Feedback is welcome and will be considered as part of the periodic review process. BeZero in some cases may consult with stakeholders via ‘request for comment’ or equivalent processes when considering material methodology revisions.

Updates and reviews

Version number	Date	Description
1.00	07/07/23	Initial release
1.01	31/01/24	Formatting updates
1.02	03/10/24	Formatting updates, updated example, clarification on additionality as a limiting factor
2.0	01/04/25	Updated risk factor framework
3.0	27/10/26	Formatting updates, edits and revisions to align with ESMA regulatory requirements.

Disclaimer

The BeZero Carbon Rating of voluntary carbon credits represents BeZero Carbon's current opinion on the likelihood that carbon credits issued by a project achieve a tonne of CO_2e avoided or removed. The BeZero Carbon Rating and other information made publicly available or available through the BeZero Carbon Markets platform ("Content") is made available for information purposes only. The Content and in particular the BeZero Carbon Rating sets out BeZero Carbon's opinion on a particular carbon credit or project based on publicly available information as at the date expressed and BeZero Carbon shall have no liability to anyone in respect of the Content, opinion and BeZero Carbon Rating. The Content is made available for information purposes only and you should not construe such Content as legal, tax, financial or investment advice. The Content is a statement of opinion as at the date expressed and does not constitute a solicitation, recommendation or endorsement by BeZero Carbon or any third party to invest, buy, hold or sell a carbon credit. The Content is not a statement of fact and should not be relied upon in isolation. The Content is one of many inputs used by stakeholders to understand the overall quality of any given carbon credit. BeZero Carbon shall have no liability to you for any decisions you make in respect of the Content. If you have any questions about BeZero Carbon, the BeZero Carbon Rating, the BeZero Carbon Rating methodology, qualifying criteria, rating process, any element of Content, the BeZero Carbon Markets platform or otherwise please contact us at: commercial@bezerocarbon.com.