



Building high-fidelity dynamic baseline for ARR projects under Verra's standard (VM0047)

2026



The carbon market is under pressure to deliver what it promises. Years of scrutiny around inflated credits and overstated additionality have made one thing clear: the credibility of a carbon credit is only as strong as the baseline it is measured against.

The introduction of VM0047* in 2023 marked a turning point - establishing a dynamic baseline as the emerging standard for nature-based carbon projects, particularly in afforestation, reforestation, and revegetation (ARR). Unlike the static baseline, which is fixed at project inception and never updated, the dynamic baseline benchmarks project performance against natural regeneration, ensuring that only genuine, additional carbon sequestration is credited.

Using satellite-derived Stocking Index measurements, the system is designed to match control plots with project plots and validate them at regular checkpoints. We are implementing it in our North Sulawesi project in Indonesia, with 68 project plots and 5 matched control plots per project plot (340 control plots in total), to support genuine additionality, reduce the risk of over-crediting, and provide more transparent and auditable carbon yield estimates.



* See the [VM0047 Standard](#) for additional details

Using dynamic baseline to improve carbon credit estimates

In nature-based carbon projects, particularly ARR projects, the credibility of carbon credits depends on the baseline. This baseline is the reference scenario against which a project's progress is measured, and its carbon credits are estimated.

Traditionally, baselines were static, set once at the start of a project and unchanged for decades. Because landscapes may naturally regenerate over time even without project intervention, relying on a static baseline can misrepresent actual carbon gains by failing to account for this underlying change.

With increasing scrutiny around carbon credit integrity and landscape variability, the dynamic baseline approach is gaining wider adoption in carbon accounting. Unlike the static baseline that may overestimate credits by comparing project outcomes against outdated reference scenarios, the dynamic baseline adjusts carbon credit estimates to reflect natural regeneration and current regional conditions, crediting only genuine, additional carbon sequestration.

Comparison of static vs dynamic baseline

	Static baseline	Dynamic baseline
Reference scenario	Fixed at project start, based on historical assumptions and not updated over time	Periodically updated against natural regeneration in comparable control landscapes
Landscape change	Not reflected; does not account for ongoing natural regeneration	Reflected over time
Carbon estimation	Based on fixed assumptions; can drift from actual conditions, increasing over-crediting risk	Significantly reduced over-crediting risk through periodic recalibration
Comparability	Constrained by fixed reference assumptions with limited ability to benchmark across	Benchmarked against control/ regional reference plots

Dynamic baseline addresses this gap by continuously benchmarking project performance against natural regeneration.

At Thryve, we are implementing the dynamic baseline approach as prescribed by Verra and using our technology to evaluate additionality within this framework. This approach draws on multiple datasets, including satellite-derived stocking index values, jurisdictional boundaries, ecoregion maps, and historical vegetation data to support fair comparisons.

By integrating these data sources, we aim to generate more consistent and auditable credit estimates, strengthen additionality assessments, and reduce key risks such as over-crediting and reputational risk. The goal is to support the development of high-quality, compliant carbon projects that better reflect on-ground conditions.



Our approach

Thryve's Dynamic Baseline Assessment System is being developed to make baselining both scientifically robust and operationally practical. We start with plot-level GIS data to define project boundaries and potential control plots.

Within these areas, we monitor vegetation dynamics using the Stocking Index (SI), a satellite-derived indicator that reflects plant density and biomass changes over time.

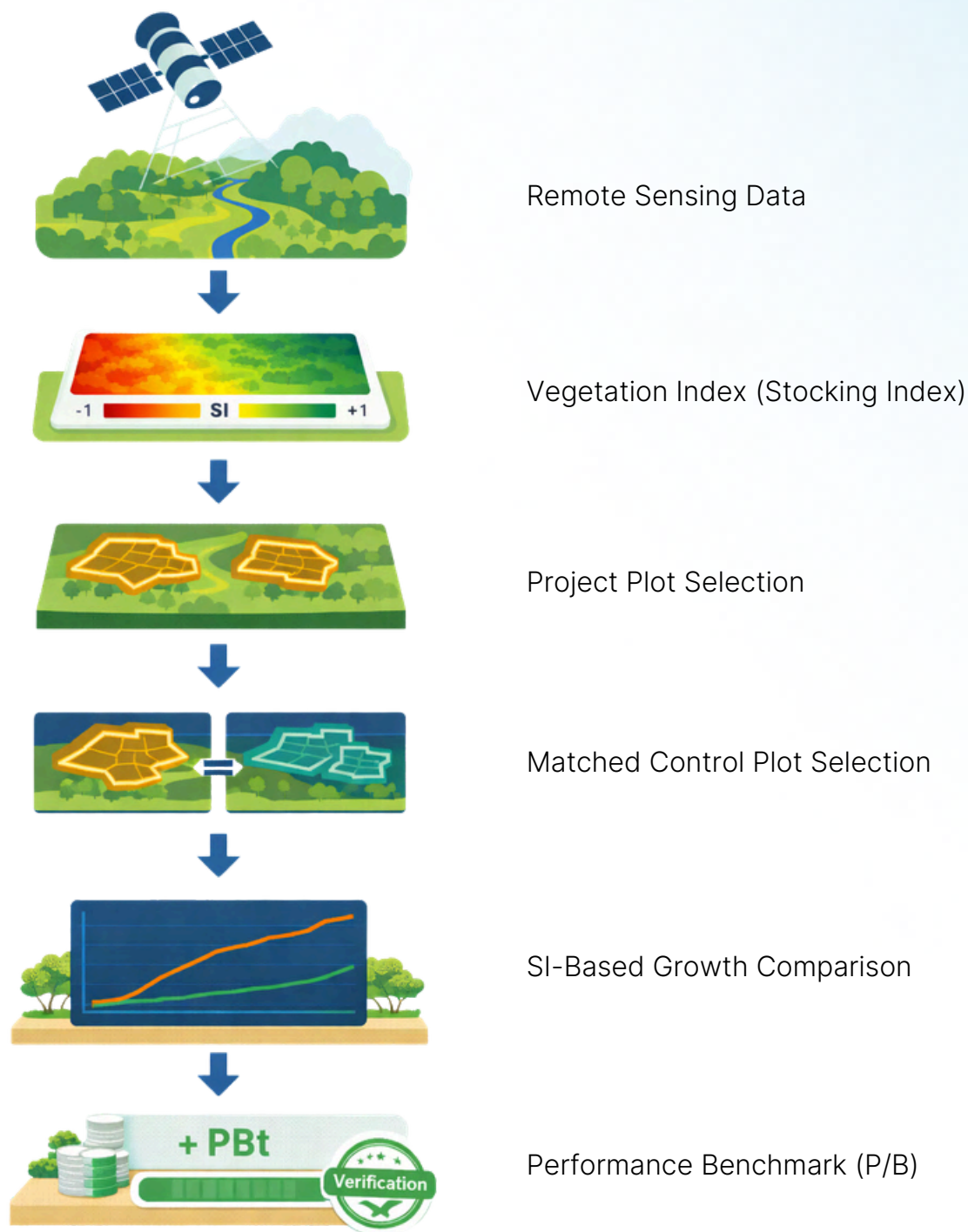
Our system operationalizes VM0047's dynamic baseline approach through a fully automated workflow:

- Project plots are selected via stratified random sampling,
- SI time series are integrated at the plot level,
- Control plots are matched and validated against defined comparability criteria
- Temporal SI differences between project and control plots are analyzed to derive the performance benchmark (P/B) for each monitoring year

Control plot eligibility is continuously monitored, with automatic replacement and re-benchmarking triggered whenever a plot becomes ineligible, ensuring methodological compliance and scalability over the project lifecycle.

The following page (figure 1) provides an overview of the dynamic baseline workflow for performance benchmarking.

Figure 1: Overview of the dynamic baseline workflow for performance benchmarking



The following sub-sections describe the two most technically distinctive components of this system in more detail.

1. Proprietary Vegetation Representation

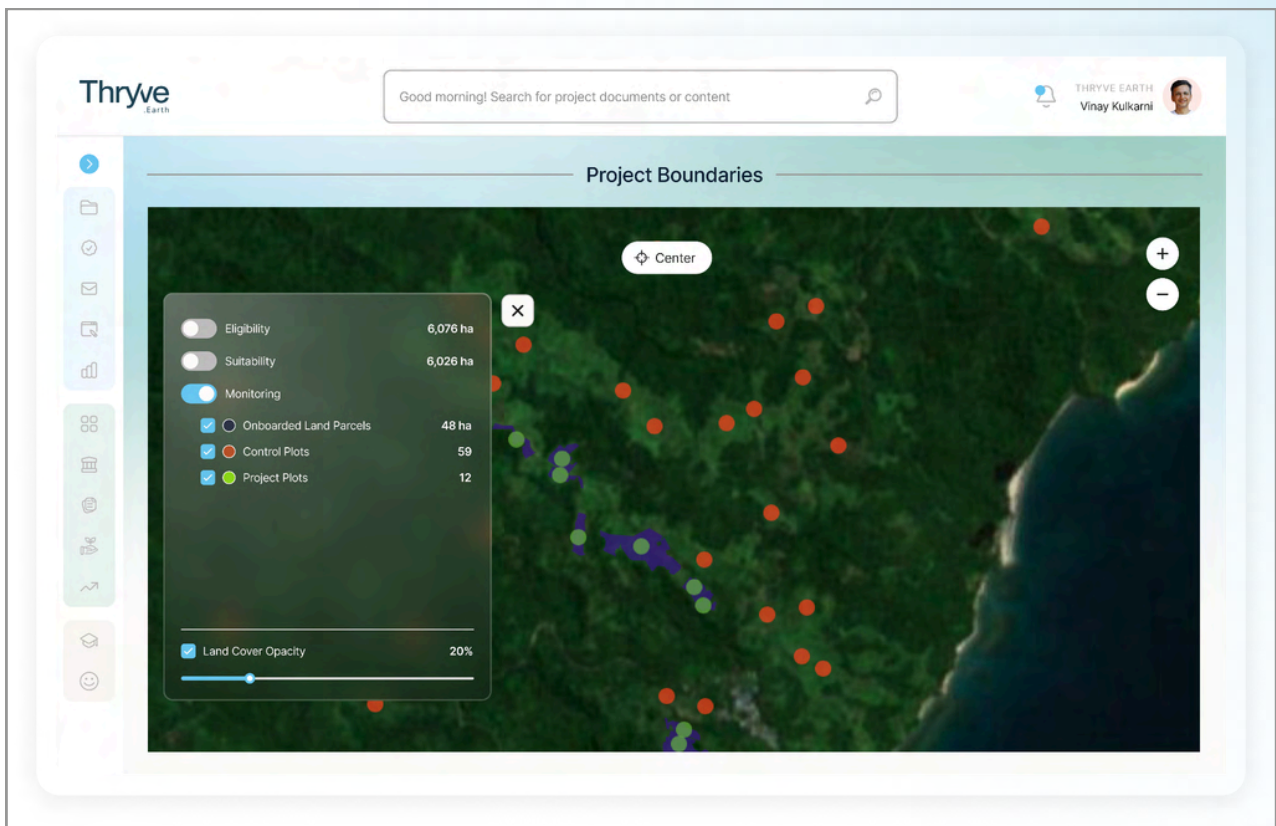
- Rather than relying on a single off-the-shelf index such as NDVI or EVI, we evaluate a suite of optical and SAR-derived indices like RVI, NDFI, and SAVI, etc., to determine which best captures vegetation structure and biomass dynamics within the specific landscape context of each project.
- Each index, or combination of indices, is assessed against statistical performance thresholds ($R^2 > 0.85$) to evaluate its explanatory power relative to biomass.
- The index that best represents vegetation density and structural characteristics for the region is designated as the SI for that project, selected and validated per landscape, not applied as a fixed global default.
- The selected SI is then applied consistently across both project and control areas, ensuring any divergence in biomass trajectories reflects genuine project impact rather than methodological inconsistency.

2. Matched Control Plot Selection

- Control plots are drawn from a donor pool of land parcels sharing comparable ecoregion classification, jurisdictional boundaries, land cover type, soil characteristics, elevation range, and historical SI trajectories - ensuring project plots are benchmarked against environmentally and policy-comparable lands.
- Matching is performed using Euclidean and Mahalanobis distance metrics across these covariates, with match quality validated through a standardised difference-of-means test before any plot is accepted into the baseline.
- At every monitoring event, each control plot is re-evaluated for continued eligibility. If a plot fails to meet checkpoint criteria, it is removed and replaced from the donor pool, triggering a full re-run of the matching and benchmarking process, keeping the performance benchmark methodologically sound as the landscape evolves.

* NDVI (Normalized Difference Vegetation Index), EVI (Enhanced Vegetation Index), RVI (Radar Vegetation Index), NDFI (Normalized Difference Fraction Index), and SAVI (Soil Adjusted Vegetation Index)

Figure 2: Illustrative example of a matched control plot distribution around project plots - structured to enable spatially grounded, like-for-like performance comparisons across the landscape.



Spatial distribution of control plots (red) and their corresponding connected project plots (green) across the study landscape.

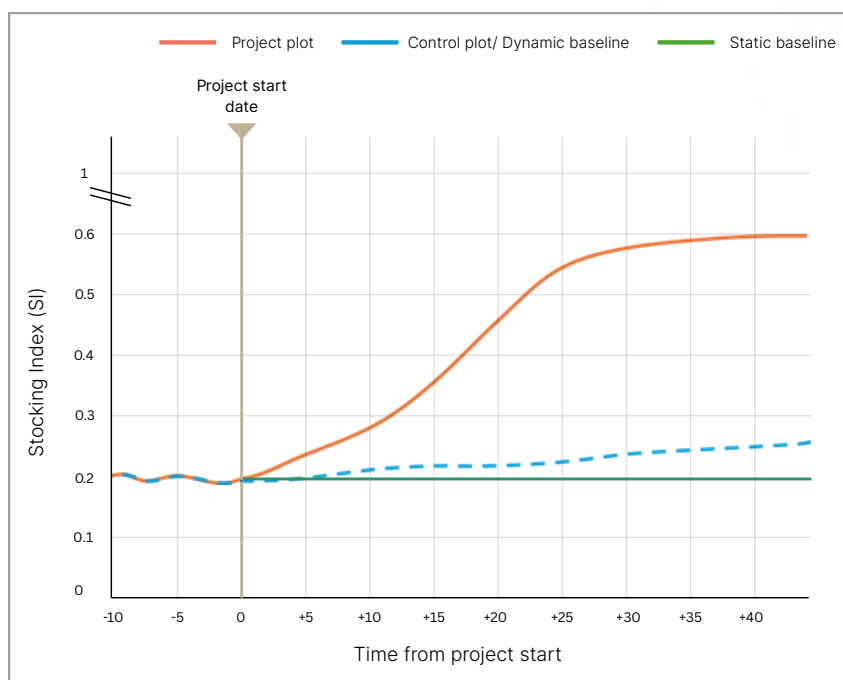


Our approach in practice: North Sulawesi, Indonesia

Our ARR project in North Sulawesi, Indonesia, demonstrates how dynamic baseline work in practice. We are currently implementing a dynamic baseline across 68 project plots, each paired with 5 matched control plots drawn from a rigorously screened donor pool - totalling 340 control plots across the project area. Plots were selected using stratified random sampling to ensure representative coverage of the broader landscape, and each pairing was validated at baseline before monitoring began.

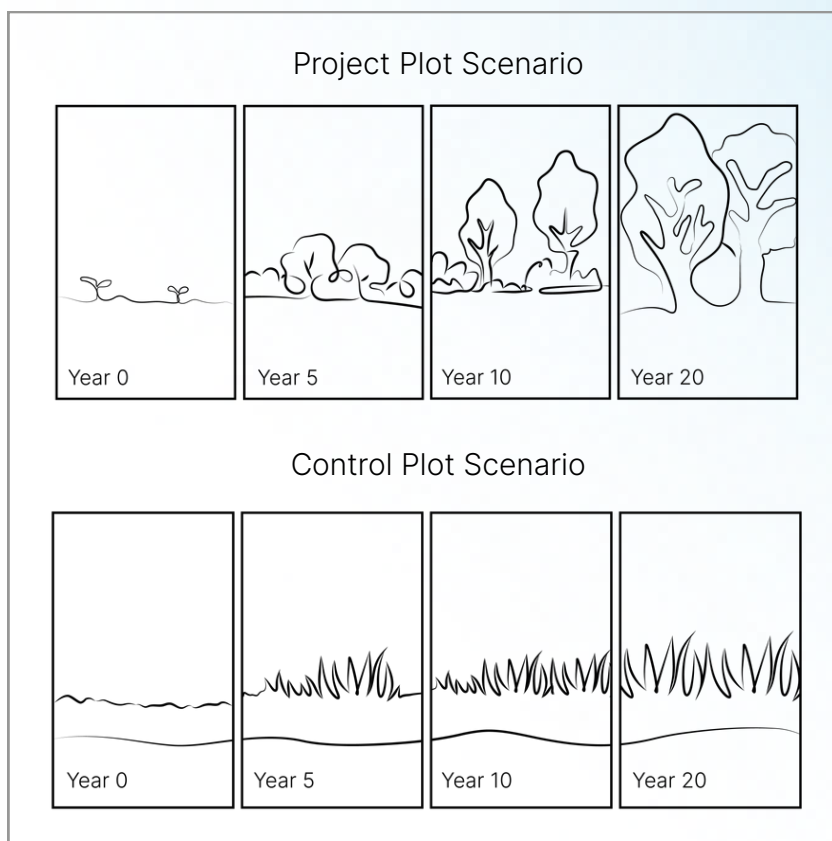
Vegetation dynamics are being tracked continuously using the Stocking Index. As the chart (figure 3) illustrates, project plots exhibit a clear upward divergence in SI relative to matched control plots following intervention - a trajectory that reflects the impact of active restoration against the background of natural regeneration. The widening gap between the two is what the methodology translates into credible carbon sequestration, with the dynamic baseline ensuring that only project-attributable gains are counted.

Figure 3:
Stocking Index (SI)
comparison showing
divergence between
project and control
plots over time



To illustrate this divergence on the ground, the following visual (figure 4) shows the contrast in vegetation progression between project plots (top) and control plots (bottom) over a 20-year horizon. Project plots show staged forest growth through active restoration, while control plots follow the slower, unmanaged regeneration trajectory that forms the baseline.

Figure 4: Illustrative comparison of vegetation growth in project vs control plots over time



The SI chart (figure 3) is the primary quantitative output of the dynamic baseline system - the widening gap between project and control plots over time is what drives the performance benchmark and, ultimately, net carbon credit yield. The illustration (figure 4) complements this by showing what that divergence represents on the ground: project plots undergoing active restoration see a sharp increase in vegetation density and biomass, while control plots follow the slower, marginal growth typical of unmanaged natural regeneration.

Together, they show both the measurement and the reality behind it - giving implementation partners and capital partners confidence that credited sequestration reflects genuine, project-attributable impact rather than ambient landscape change.

Benefits for stakeholders

For capital partners:

- Ensures crediting reflects only genuine improvements beyond the business-as-usual scenario, not fixed assumptions from project inception.
- Frequent natural growth comparisons strengthen additionality assessments and improve confidence in projected carbon yields.
- More accurate, continuously maintained baseline protect long-term revenue by improving the integrity of issued credits.
- Transparent, benchmarked baseline provide clearer, auditable credit estimates that hold up to registry, verifications, and due diligence reviews.
- Consistent regional metrics make it easier to compare performance across a project portfolio.

For implementation partners:

- Enables continuous comparison of project performance against natural regeneration, encouraging management practices that consistently outperform the baseline.
- Provides early-stage insight into plantation effectiveness, informing site selection, species choice, and management decisions before issues compound.

Our vision and future direction

The dynamic baseline is a core part of how Thryve develops credible, investable carbon projects. By embedding Stocking Index measurements and plot selection algorithms into our geospatial workflow, we aim to benchmark ARR projects against relevant regional conditions. This approach supports greater transparency for landowners, capital partners, and registries.

At Thryve, we are building the infrastructure to make this standard operational at scale. Our roadmap includes full automation of baseline re-benchmarking within our platform, so that control plot replacement and performance benchmark updates happen without manual intervention. Beyond ARR, we intend to extend the dynamic baseline framework to REDD+ and IFM project types as the methodology evolves.





Thryve develops high-quality Nature-based Solutions (NbS) carbon projects that regenerate ecology.

By combining a locally grounded and tech-enabled approach with rigorous project management and strong governance, we create resilient returns and lasting value for capital partners, landowners, and communities.

Interested in learning more?



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