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Core Document

Protocol for Carbon Curve Modelling

Summary

This document outlines the methodology used by Equitable Earth to model carbon sequestration through project-specific carbon curves. It defines the purpose and scope of the approach, which involves pixel-level projections of above-ground biomass (AGB) accumulation over time. The protocol incorporates stratified modelling principles and applies biome-specific growth parameters. The approach uses scientific best practices to ensure conservative estimation of Verified Restoration Units (VRUs).

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1 Introduction

1.1 Normative References

1.1.1 This document must be read in conjunction with the following documents:

- M001 - Methodology for Terrestrial Forest Restoration
- Terms & Definitions

2 Protocol for Carbon Curve Modelling

2.1 Scope of Applicability

2.1.1 **Boundaries.** The carbon curve is established within the same geographical and physical boundaries delineated in the project's zonation.

2.1.2 **Temporal framework.** Carbon curves must be aligned with the crediting period defined in the Equitable Earth Standard.

2.1.3 **Exclusions.** Projects located in non-tropical/non-subtropical regions, or in African subtropical humid forest and American subtropical steppe, as defined by IPCC[1], are excluded from this carbon curve protocol unless the developer is able to provide the necessary data supported by relevant peer-reviewed literature.

2.2 Methodology

Principles

2.2.1 Carbon curve modelling is conducted at the pixel level for each pixel within the restoration site.

2.2.2 Each pixel's sequestration potential evolution is independently estimated and subsequently aggregated to produce the overall project-level carbon curve.

2.2.3 The carbon curve is included in the Project Design Document, publicly available on the Equitable Earth Registry.

Methods

2.2.4 **General equation.** Equitable Earth's methods are based on a sigmoid approach to model the curves, represented by equation (1):

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[1] For more details, refer to the Food and Agriculture Organization of the United Nations (FAO). (2012). *Global ecological zones for FAO forest reporting: 2010 update*. FAO

$$f(x) = \mathbf{C}_{net-capacity} \times (1 - exp(-(x/\lambda)^{k})) \quad (1)$$

Where:

- **k** is the shape parameter, controlling the initial acceleration of AGB growth and its asymptotic behaviour;
- $\mathbf{C}_{\text{net-capacity}}$ represents the maximum net GHG removal capacity achievable by the project;
- **λ** is the scale parameter, specific to the studied biome, it governs the growth rate.

2.2.5 **Parameter determination.** Equitable Earth selects parameters based on a combination of empirical studies and established IPCC guidelines to ensure that the generated curves are both scientifically robust and aligned with Equitable Earth GHG removal quantification procedures.

2.2.5.1 The value of **k** has been set between 1.5 and 2.5, based on empirical observations of forest growth patterns.

2.2.5.2 $\mathbf{C}_{\text{net-capacity}}$ represents the maximum net GHG removal capacity achievable by the project. It corresponds to the theoretical upper limit of net removals the project could generate over its lifetime. Refer to the *GHG Removal Capacity and Carbon Potential* section of the M001 for more details.

2.2.5.3 **λ** is calculated by deriving the general equation, ensuring that the inflexion point of the curve corresponds to the IPCC growth rates from the pixel's location and biome, as provided in the most recent IPCC Guidelines, "Table 4.10". Missing values are estimated by averaging existing values within the same biome.

2.2.6 **Uncertainty.** To account for uncertainties in growth rates and model parameters, Equitable Earth generates three distinct carbon sequestration curves:

2.2.6.1 The **default curve**, which represents the expected carbon sequestration using a baseline k value of 2 and the standard IPCC growth rate.

2.2.6.2 The **max boundary curve**, generated with a k value of 1.5 and the maximum growth rate.

2.2.6.3 The **min boundary curve**, generated with a k value of 2.5 and the minimum growth rate.

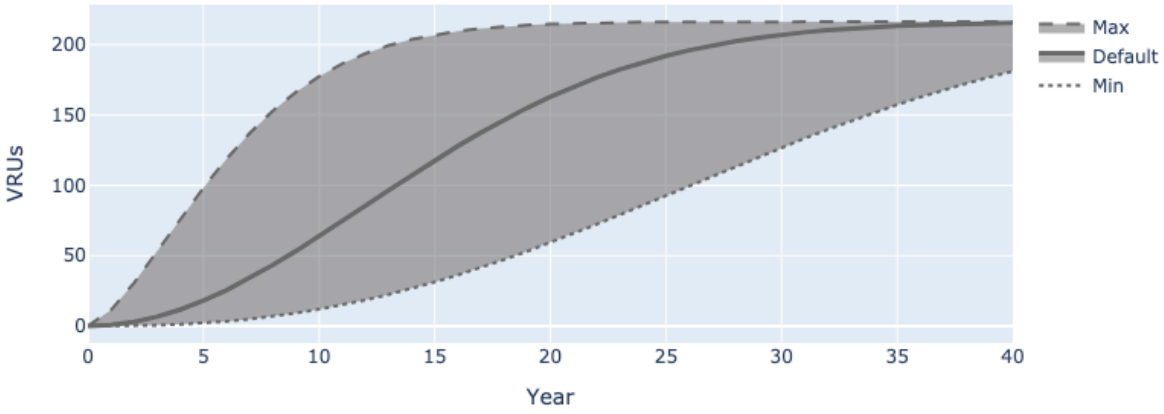

Figure 1. Example of a carbon curve

2.3 Adjustment factors

2.3.1 **Baseline carbon stock.** Equitable Earth adjusts the curves based on the baseline carbon stock of each specific land conversion. This adjustment involves shifting the curves along the x-axis (years) to ensure alignment with the baseline carbon stock at year 0. This transformation minimises overall uncertainty, shifting the uncertainty curves closer to the default curve. Finally, the curve is adjusted along the y-axis to ensure it starts at 0 VRUs.

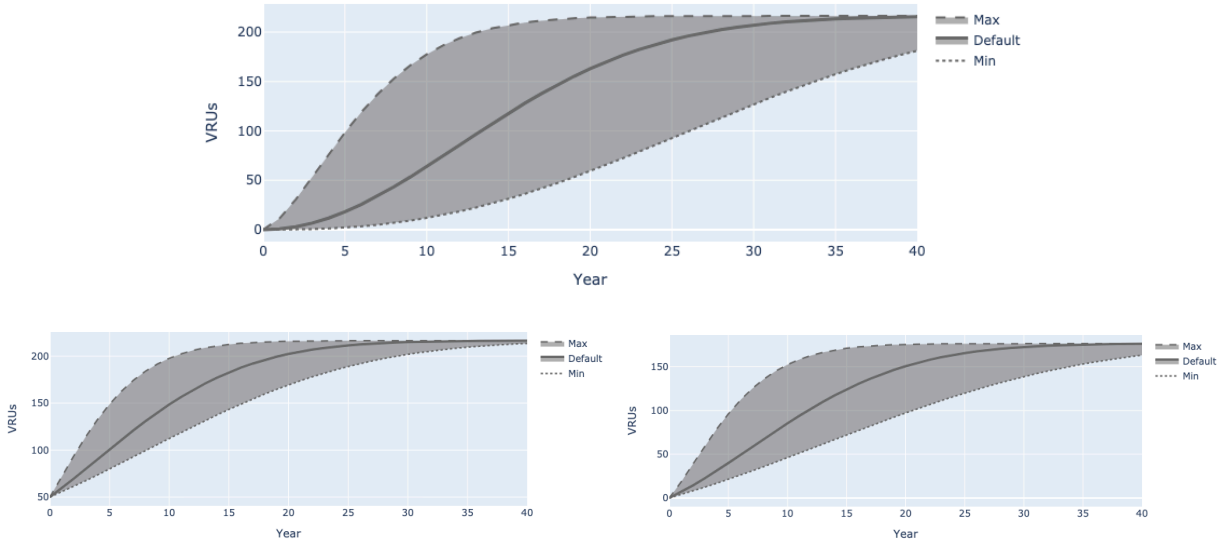

Figure 2. An original curve compared to its shifted version, starting at 50 tCO2e

2.3.2 **Timing.** Carbon curves must start at the project start date.

2.3.3 **Growth rate.** If developers provide substantiated evidence of an ecosystem-specific growth rate for the project area, supported by robust data and literature, Equitable Earth may adjust the carbon curves. In such cases, rather than using the IPCC's default growth rate, the curve will be matched with the newly provided growth rate, as detailed in the *Parameter Determination* section.

2.3.4 **Curve implementation.** After generating individual pixel-level carbon curves, Equitable Earth aggregates them across the entire restoration site, weighting each pixel's contribution based on its area and sequestration capacity. The final carbon curve represents the total projected removals over the crediting period.

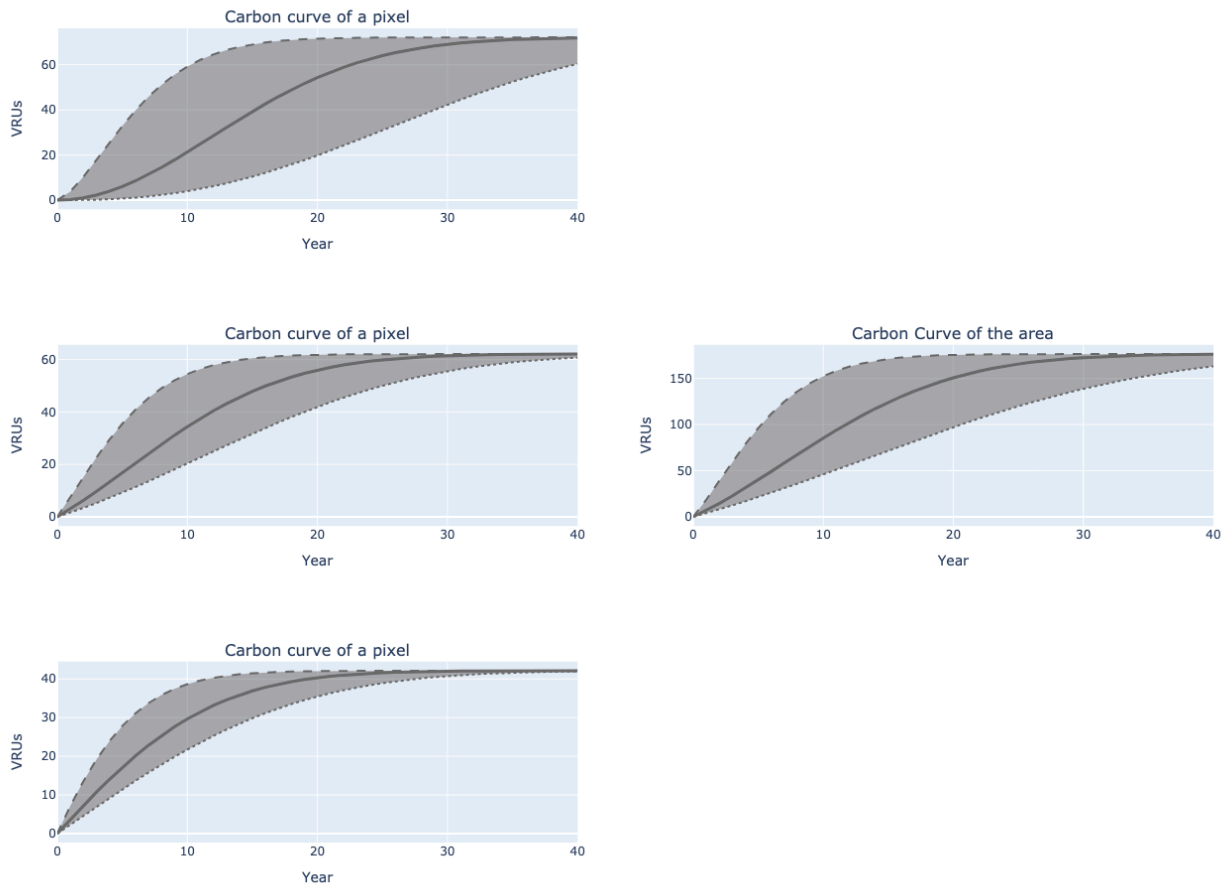

Figure 3. Example of a 3-pixel area

2.4 Ex-Post Treatment

2.4.1 **Periodic updates.** Carbon curves must be updated prior to every verification to incorporate actual net GHG removals verified by validation and verification bodies (VVBs). These updates ensure that the project's credit issuance is aligned with the actual project performance rather than relying solely on projections made at earlier stages.

2.5 Limitations

For comprehensive details about the specific limitations and areas for potential improvement, please refer to the Future Improvements and Limitations documentation.

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