# Plausible Futures for the Amazon

Modeling deforestation scenarios across the Pan-Amazon and their implications for national conservation policies

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- Integrating cross-border infrastructure in South America (the South American integration routes) tends to reduce transport costs, raise land values, and push deforestation frontiers across the nine territories of the Pan-Amazon.
- The **NewSimAmazonia** — a spatially explicit model developed at CSR-UFMG — projects deforestation through 2050 for the eight ACTO countries and French Guiana, comparing three scenarios: **business-as-usual (BAU)**, **NDC compliance** (Nationally Determined Contribution), and **baseline**.
- Each scenario translates into **$CO_2$ emissions** and **biodiversity loss**, and into the potential to generate **REDD+ carbon credits** under the ART TREES architecture.
- A **public, interactive platform** makes it possible to estimate REDD+ revenues at different carbon prices, supporting evidence-based decision-making.

## The Amazon under new pressure

Amazonian landscapes will undergo major transformations in the coming decades. More decisive than isolated infrastructure projects — highways, railways, waterways, and ports — are the cross-border plans that integrate them. By reducing transport costs, these corridors raise the profitability of agriculture and logging and drive up land values, resulting in the concentration of land tenure and the expansion of deforestation frontiers. Anticipating these effects ex ante is a prerequisite for planning environmentally sustainable development — that is, development that does not compromise the climate, socio-biodiversity, cultural diversity, and ecosystem services of the Amazon *(1, 2)*.

## NewSimAmazonia

NewSimAmazonia is an enhanced version of SimAmazonia that covers the Amazonian territories of the eight ACTO countries plus French Guiana. In annual steps through 2050, it simulates where and how fast deforestation is likely to advance, integrating the effects of transport infrastructure, conservation policies, and land use. It is built on the free platform Dinamica EGO, with open source code and input data — ensuring transparency and replicability.

## Three scenarios to guide decision-making

**Business-as-usual (BAU).** Maintains current trends and the roll-out of planned infrastructure, with no new conservation interventions — the trajectory to be avoided.

**NDC target.** Incorporates each country's climate commitments, translating them into a progressive reduction in deforestation toward emissions neutrality.

**Baseline.** Adopts the 2019–2023 historical average as the reference for measuring deforestation reductions and avoided $CO_2$ emissions.

## From deforestation to climate, biodiversity, and financing

Each scenario is translated into $CO_2$ emissions — derived from biomass maps — and into impacts on biodiversity (species richness, endemism, phylogenetic diversity and endemism). Combining deforestation scenarios with biodiversity maps makes it possible to identify where future territorial pressures coincide with areas of high biological value. Such regions should receive priority attention in protected-area planning, enforcement, and the implementation of land-use policies. The gap between the business-as-usual scenario and the NDC scenario reveals the conservation effort required and the volume of avoidable emissions, which can be converted into REDD+ credits under the ART

TREES architecture *(3)* — a large-scale climate-finance channel for national and subnational governments.

## Online platform

The **online platform** contains interactive maps and charts. It presents deforestation rates and the resulting $CO_2$ emissions, as well as the potential for REDD+ credits, by adjusting the financial-accounting parameters for each scenario modeled in each country. In addition, the platform serves as a public repository of all input and output data of NewSimAmazonia, which can be viewed, queried, and downloaded, together with a set of interactive charts by country and result type.

## Implications and recommendations

The table below presents the cumulative results through 2035 for each country in terms of reduced deforestation and the associated $CO_2$ emissions under the **NDC** scenario, taking the baseline scenario as the starting point.

| | Ha | $CO_2$ |
|---|---|---|
| **Brazil** | 10.6E+6 | 4.6E+9 |
| **Colombia** | 1.6E+6 | 407.8E+6 |
| **Peru** | 900.8E+3 | 345.8E+6 |
| **Venezuela** | 465.3E+3 | 55.6E+6 |
| **Bolivia** | 304.3E+3 | 141.0E+6 |
| **Guyana** | 162.0E+3 | 26.2E+6 |
| **Ecuador** | 156.0E+3 | 82.4E+6 |
| **Suriname** | 62.8E+3 | 22.6E+6 |
| **French Guiana** | 000.0E+0 | 1.2E+6 |

The platform makes it easier to visualize scenarios as policymakers ask "what-if" questions about the impact of forest plans and carbon-emission reduction programs, translating those results into REDD+ fundraising capacity. In doing so, the platform saves policymakers and planners time and effort in a rapidly changing field. It is therefore an important tool for supporting governments in the management of forest areas.

In short, by providing a detailed analysis of the deforestation dynamics and frontiers prevailing in each country, NewSimAmazonia makes it possible to assess ex ante environmental impacts such as habitat fragmentation, biodiversity loss, changes in the hydrological cycle, and emissions of $CO_2$. These projections are therefore a valuable input for policymakers, environmentalists, and land-use planners seeking to develop strategies that balance development with environmental preservation in the Amazon region. Deforestation frontiers follow transnational integration corridors, so the policy response must also be regional — supported by the public platform, which allows testing "what-if" scenarios and estimating REDD+ revenues.

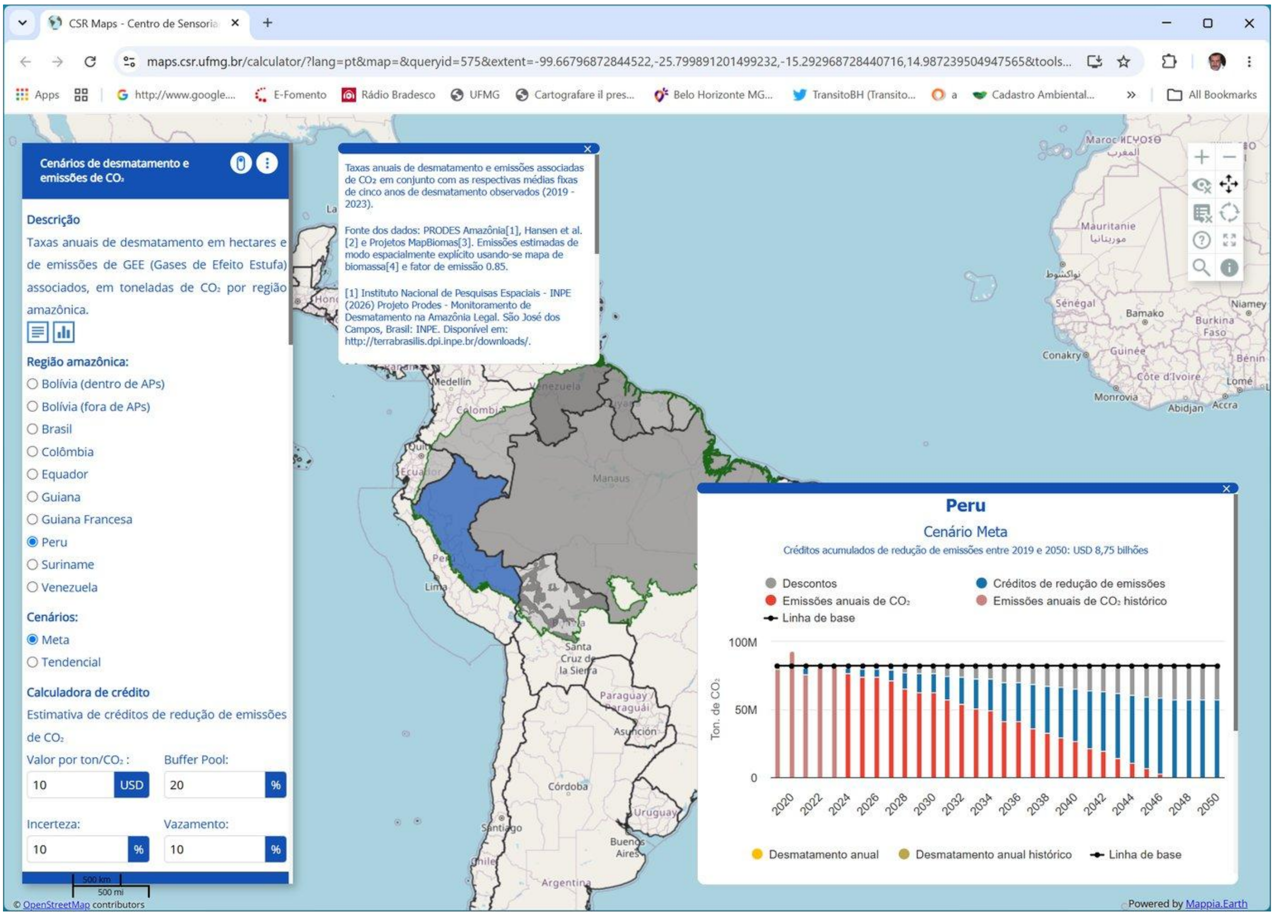


**Figura 1.** *Platform interface for the REDD+ component, featuring a credit calculator based on the ART-TREES methodology.*

# Methodology

**Model architecture.** Coupled models at two levels — socioeconomic sub-regions and 500 m raster cells (a grid of 6,167 × 8,007 cells). An upper-level model allocates deforestation rates to the sub-regions; within each, map algebra and cellular automata generate the spatially explicit simulation. It runs on the free platform Dinamica EGO, whose parallel processing makes continental-scale simulation feasible. A dedicated module simulates road-network expansion, the main driver of new frontier openings *(9)*.

**Data and calibration.** Annual deforestation maps for 2009–2023 — PRODES/INPE in Brazil *(12)* and the global mapping by Hansen et al. for the remaining countries *(13)* — and above-ground biomass density *(10, 14)*. The models are calibrated over 2009–2015, validated over 2016–2023, and projected in annual steps through 2050.

**$CO_2$ emissions.** Calculated from the cleared forest biomass, adding 20% for below-ground biomass and assuming that 85% of the carbon is released during and after deforestation *(11)*.

**Scenario construction.** The business-as-usual scenario projects 2019–2023 by linear regression (least squares); the baseline fixes the 2019–2023 average; the NDC scenario converts each country's climate targets *(15–27)* into linear deforestation-reduction trajectories through 2030–2050, aligned with the emissions neutrality of the Paris Agreement.

**Biodiversity.** 8.6 million occurrence records (GBIF and GABI) were cleaned and georeferenced with BioDinamica *(28)*. Sampling-effort bias was corrected using the USSE method *(29)*, and predictive surfaces were generated using deep neural networks *(30)*, with predictors including climate (WorldClim *(31)*), topography, and a Composite Vegetation Index (canopy height from LiDAR + NDVI/MODIS variance). Metrics: species richness; weighted endemism (WEIc); phylogenetic diversity *(32)*; phylogenetic endemism *(33, 34)*; and biogeographic regions derived from beta diversity (Sørensen index *(36)* modeled by GDM *(37)* and clustered by k-means *(38)*. The 2050 projection replaces only the vegetation index with the simulated deforestation maps.

**REDD+ credits (ART TREES).** A credit level is defined by the five-year historical average of emissions; credits equal the difference between that level and observed emissions, after discounting shares for a buffer reserve, uncertainties, and leakage, and are priced by the value of a ton of $CO_2$ *(3)*.

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