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## Eden Reforestation Projects

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# Quantified Carbon Modeling True Village, Antanamarina



# Madagascar Forest Systems

There are four main classes of forest types in Madagascar: Dry Forest, Humid Forest, Spiny Bush and Transitional Forest due to the unique geography and location on the western edge of the Indian ocean. While coastal areas are dominated by mangrove systems, the inland portions of the island are split between the western side of the island that sees significantly more moisture both in rainfall and humidity, and the eastern side which is dryer and has less rainfall.

The project boundary is located in the Dry Forest area which consists of a subtropical and highly seasonal forest, populated by primarily deciduous tree species. This area has a hot, wet season from November to April and a cooler, drier season from May to October.

While plant diversity is lower in the dry forest than in the moister areas on the west side of the country, it has a higher rate of endemism. While all species are not classified, and estimated 70 percent of the species in this are endemic and home to many endemic species: golden-crowned sifaka, mongoose lemur, western forest rat, the golden-brown mouse lemur, Bernier's teal, Madagascar fish-eagle, Humblot's heron, the Sakalava rail, Namoroka Leaf chameleon and Decary's Leaf chameleon to name a few.



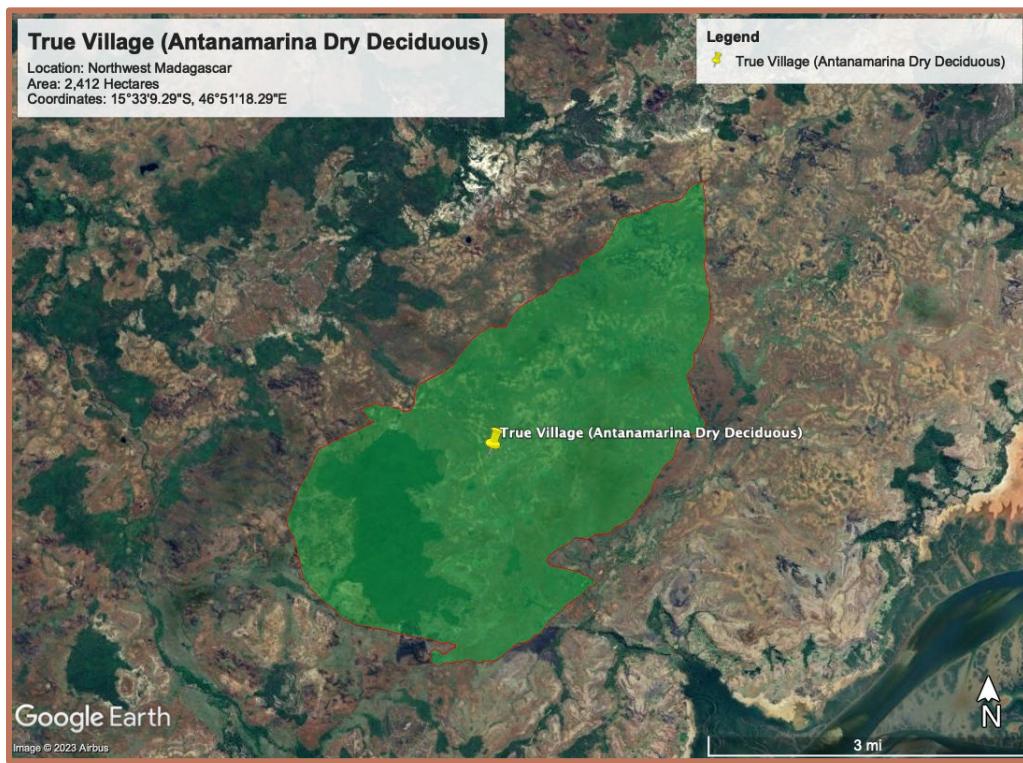
## Quick Stats: True Village, Antanamarina

<b>Forest type:</b> Dry Deciduous Forest	<b>Coordinates:</b> 15°33'09.29"S, 46°51'18.29"E
<b>Area:</b> 2,412 hectares	<b>Trees Planted:</b> 252,600 <sup>1</sup>
<b>Total Projected Sequestration of <a href="https://www.tree.com.au">tree.com.au</a>'s sponsored 3,554 Ha over 30 years:</b> 375,636+/-31,553 tonnes of CO <sub>2</sub> e (+/-8.4% at a 90% confidence level)	<b>Average Projected Sequestration amortized per year:</b> 12,521+/-1052 tonnes of CO <sub>2</sub> e per year
<i><sup>1</sup>Note: Total projected carbon sequestration is based on the carrying capacity of the forest as mature forest conditions are established and not on every tree planted becoming fully mature. Some of the planting will be reduced through grazing/browsing animals, natural selection, and eventual conversion to DOM in the soil.</i>	

## True Village, Site Description

The True Village (Antanamarina) site consists of dry deciduous forest in northwestern Madagascar, between the rural settlements of Andranoboka and Mariarano in the Boeny region. The project includes extensive remaining forest remnants as well as degraded areas that need to be restored. The remaining forest areas form the beginning of a broader greenbelt program that will extend seven miles east of the project site to the Mariarano Reserve.

The region around the location boasts amazing waterfalls with primary forests in its gorges, as well as an enormous cave system with subterranean rivers and lovely sunken woods not far away. Deforestation of the area's dry deciduous forest endangers the habitat of numerous Madagascar-endemic species. Coquerel's sifaka (*Propithecus coquereli*), a diurnal, medium-sized lemur unique to this region, is severely endangered according to the IUCN (International Union for the Conservation of Nature) Red List. The Van Dam's Vanga (*Xenopirostris damii*) is an endemic bird that inhabits primary dry deciduous forests and adjacent vegetation up to 200 meters above sea level. The Malagasy gigantic chameleon, also known as Oustalet's chameleon, seeks refuge in this dry deciduous environment. The spectacular *Adansonia madagascariensis* (Madagascar Baobab), listed as threatened by the IUCN, flourishes in this region's dry deciduous ecosystem. Eden Reforestation Projects (Eden) safeguards a lake in this region that is the unique home for a micro-endemic wolf spider (*Hippasosa ghost*), of which just 30 individuals are known to exist.



# Introduction to Forest Carbon

## Clarification of terms:

Tonnes of biomass, tonnes of carbon, and tonnes of carbon dioxide equivalent are often used to describe forest sequestration. Distinguishing the subtle differences in meaning of the terms when reading the FREL, IPCC documents, and this report is essential to ensure clear understanding.

- **Biomass** (tonne m) – the total dry mass of the plant –some reports abbreviate this to *t.d.m.* which is tonnes of dry matter.
- **Carbon** (tonne C) – the amount of carbon in the biomass—this is usually around 45% to 50% and varies with species.
- **Carbon dioxide equivalent** (tonne of CO<sub>2</sub>e) – Calculated from the carbon using the ratio of the molar weights of Carbon and Carbon Dioxide (44/12). All the values for sequestration used in this document are in CO<sub>2</sub>e since that best represents the actual greenhouse gas (GHG) reductions.

This means that 100 tonnes of biomass (m) are equivalent to about 47 tonnes of carbon (tC) which is equivalent to about 172 tonnes of carbon dioxide equivalent (tCO<sub>2</sub>e).

It is important to note that the calculated (projected) carbon for this report serves as an estimated amount of carbon that may be sequestered over the course of 30 years, assuming the forest grows in a predictable way. However, this is an unfixed figure, and the actual carbon sequestered at the site can only be measured by in-person field tests after the forest has reached maturity. Likewise, even though the carbon is calculated using a linear function (as is common practice), yearly amounts of carbon accumulation is not a linear process with different amounts of CO<sub>2</sub>e sequestered based on the growth stage of the tree as well as a variety of other variables.

## Projected Carbon Sequestration Calculations

To calculate the total Biomass (m), Carbon (tC), and Carbon Dioxide Equivalent (CO<sub>2</sub>e), Eden Reforestation Projects used data from [Forest Reference Emission Level of Madagascar for reducing emissions from deforestation and forest degradation](#) and from [2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 4: Forest Land](#). The following data was used to calculate the eventual mature condition of the forest.

- Forest Aboveground Biomass (AGB): 69.82 Tonnes of Dry Biomass per hectare
- Forest Belowground Biomass (BGB): 19.85 Tonnes of Dry Biomass per hectare
- Dead Organic Matter (DOM): 0.7 Tonnes of Dry Biomass per hectare (IPCC)
- Total number of hectares under reforestation: 2,412 ha.

See Table 1 for an overview of all the data and their sources used to calculate the total amount of Carbon Dioxide Equivalent

Table 1. Overview of data used and their sources to calculate the total amount of Carbon Dioxide Equivalent.

Description	Value	Source
AGB (T.d.m /ha)	69.82	Government of Madagascar, FREL (Dry Forest)
BGB (T.d.m /ha)	19.85	Government of Madagascar, FREL (Dry Forest)
DOM (biomass tonnes/ha)	0.7	IPCC (not included in FREL)
Area (ha)	2412	Eden GIS (Updated 12/1)
Biomass to Carbon conversion	0.47	Government of Madagascar, FREL (Dry Forest)

Table 2 provides an overview of the carbon calculations for each component. The estimated (projected) total carbon sequestration for the **2,412 hectares** at the True Village, Antanamarina Project Site is projected to be **375,636+/-31,553 (8.4% at a 90% confidence level) tonnes of CO<sub>2</sub>e** over the project lifetime (30 years). This includes both Above Ground and Below Ground calculations as well as accumulated dead organic matter(DOM).

Table 2. Overview of calculations of amount of carbon sequestered in 2,412 hectares over a 30-year period.

	Biomass	Carbon	CO <sub>2</sub> e
AGB	69.82 Tdm/ha * 2412 ha <b>168,405 T.d.m.</b>	168,405 Tdm * 0.47 tC/tdm <b>79,150 Tc</b>	(44/12) * 79,150 Tc <b>290,218 T CO<sub>2</sub>e</b>
BGB	19.85 Tdm/ha * 2412 ha <b>47,878 T.d.m.</b>	47,878 Tdm * 0.47 tC/tdm <b>22,502 Tc</b>	(44/12) * 22,502 Tc <b>82,509 T CO<sub>2</sub>e</b>
DOM	0.7 Tdm/ha * 2412 ha <b>1,688 T.d.m.</b>	1,688 tdm * 0.47 tC/tdm <b>793 TC</b>	(44/12) * 244 Tc <b>2,909 T CO<sub>2</sub>e</b>
Total ABG+BGB+DOM			<b>375,636 T CO<sub>2</sub>e</b>

One thing to note is the absence of a soil carbon calculation. While carbon will be sequestered in the soil for this project, no reliable models currently exist at the time of this report and need to be directly measured over the lifetime of a project. Some estimates show this could be anywhere from 3% to 20% of the total listed above, but with such a wide possible range, it has been conservatively excluded from this report.

With a projected 375,636+/-31,553 (8.4% at a 90% confidence level) tonnes of CO<sub>2</sub>e over 30 years, the yearly average conversion of GHG is **12,521+/-1052 tonnes of CO<sub>2</sub>e per year** when amortized at a linear rate. Note: Trees do not grow at a uniform rate, therefore any particular year may have a rate above or below the average and the rate presented is calculated from the condition of a mature forest

Eden Reforestation Projects hopes these estimated projected carbon calculations help [tree.com.au](http://tree.com.au) communicate its commitment to the environment to its stakeholders. However, these calculations are not to be used as verified carbon tonnes (aka carbon credits), as these require a Monitoring, Reporting, and Verification (MRV) approach with vigorous field data collection and third-party verification instead of predictive modeling and calculations contained herein.

Thank you for supporting Eden Reforestation Projects and sharing our commitment and values towards restoring our natural environment and the importance of these ecosystems to the communities who live and depend on these forests.

## References:

Hending, D., Holderied, M., McCabe, G., & Cotton, S. (2022). "Effects of Future Climate Change on the Forests of Madagascar." *Ecosphere* 13(4): e4017. <https://doi.org/10.1002/ecs2.4017>

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IPCC, 2006: "2006 IPCC Guidelines for National Greenhouse Gas Inventories"



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