BANDAI HILLS BAMBOO REFORESTATION PROJECT, GHANA

Document Prepared by EcoPlanet Bamboo Group, LLC

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CONTENTS

1 PROJECT DETAILS 4

1.1 Summary Description of the Project 4

1.2 Sectoral Scope and Project Type 5

1.3 Project Eligibility 5

1.4 Project Design 6

1.5 Project Proponent 8

1.6 Other Entities Involved in the Project 8

1.7 Ownership 8

1.8 Project Start Date 9

1.9 Project Crediting Period 9

1.10 Project Scale and Estimated GHG Emission Reductions or Removals 9

1.11 Description of the Project Activity 10

1.12 Project Location 16

1.13 Conditions Prior to Project Initiation 17

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks 27

1.15 Participation under Other GHG Programs 30

1.16 Other Forms of Credit 31

1.17 Sustainable Development Contributions 31

1.18 Additional Information Relevant to the Project 33

2 SAFEGUARDS 34

2.1 No Net Harm 34

2.2 Local Stakeholder Consultation 41

2.3 Environmental Impact 45

2.4 Public Comments 46

2.5 AFOLU-Specific Safeguards 46

3 APPLICATION OF METHODOLOGY 49

3.1 Title and Reference of Methodology 49

3.2 Applicability of Methodology 49

3.3 Project Boundary 53
3.4 Baseline Scenario 57
3.5 Additionality 72
3.6 Methodology Deviations 73

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS 74

4.1 Baseline Emissions 74
4.2 Project Emissions 74
4.3 Leakage 93
4.4 Net GHG Emission Reductions and Removals 97

5 MONITORING 101

5.1 Data and Parameters Available at Validation 101
5.2 Data and Parameters Monitored 106
5.3 Monitoring Plan 111

APPENDIX 123

1 PROJECT DETAILS

1.1 Summary Description of the Project

The project is an AFOLU project, located in the Ashanti Region of Ghana, West Africa. The project is located on land that was originally primary forest, that has undergone extreme levels of historical deforestation. Such deforestation occurred more than 10 years before the project start date and has left a landscape of invasive grasses, scrubland with remnant trees and small remaining forest patches. Historical GIS mapping shows that without intervention the lands within the project boundary will transition into a grassland of nonnative, invasive grasses with no chance of reforestation occurring without human intervention.

Specifically, it is a reforestation project targeting the planting and management of select species of giant clumping bamboo. The project is a grouped project, is located within the Bandai Hills Forest Reserve. The total boundary is 7,817.7 ha of which the project area represents 7,372.6 hectares. Remnant patches of standing forest as well as areas where deforestation occurred within the past ten years have been removed from the project area. Within this area 3,500 hectares that underwent deforestation more than 10 years before the project start date will be planted with bamboo, while the remaining areas have been set aside for the restoration of native tree species for conservation and biodiversity purposes and for the creation of a landscape scale restored ecosystem that provides the full suite of ecosystem services.

The project represents the project proponent's proven integrated method of planting, where individual bamboo clumps are inter planted with remaining standing trees, patches of native vegetation and remnant small areas of forest, thereby maximizing biodiversity and overall ecosystem health.

Clumping bamboo species under the right management represent an effective mechanism for biological carbon removals and an associated carbon sink. As the clumps grow and develop they sequester atmospheric carbon, which is stored in the woody culms, auxiliary material (branches and leafy material) as well as within the complex underground root and rhizome system. These carbon removals are long term and permanent with older material being thinned out in order to stimulate the continued growth of new culms on an annual basis.

Planting of the bamboo clumps is targeted to occur over a 3-5 year period, depending on the length of the raining season each year. The project represents an initial total potential GHG emission removals of 3,778,511 tCO_2e represents an average annual GHG emission removal of 188,926 tCO_2e over the 20 year project period.

1.2 Sectoral Scope and Project Type

The project is a grouped project that falls within the sectoral scope of Agriculture, Forestry and Other Land Use (AFOLU), within the Afforestation, Reforestation and Revegetation (ARR) project category. The project meets the VCS definition of reforestation[1] – specifically it is the direct human-induced conversion of non-forested land to forested land through planting on land that was once forested but has been converted to non-forested land.

The project manually interplants species of sympodial (non-invasive, non-spreading) bamboos grown from seed amongst remaining standing trees on land that was once forested but was cleared of primary forest more than 10 years prior to the project start date. The land undergoing such planting activities is currently classified as non-forested land. The proposed project activity includes the selective thinning of the bamboo material, within a sustainable management plan. Such thinning does not represent any loss of the standing biomass and associated carbon, due to the ecological growth pattern of the sympodial bamboo species being grown and the fact that such material is rapidly replaced within the next annual growth cycle. This is described in more detail in Section 1.11 below.

1.3 Project Eligibility

The proposed project activities have been designed to meet the eligibility requirements of the VCS framework, as described in the VCS Standard v4.3. The project activities result in GHG emission removals from project activities in the forestry sector, and under the rules and requirements of the VCS Program. This VCS Program defines eligible activities in the Afforestation, Reforestation and Revegetation category as " activities that increase carbon stocks in woody biomass (and in some cases soils) by establishing, increasing and/or restoring vegetative cover through planting, sowing and/or the human assisted natural regeneration of woody vegetation". The proposed project activities specifically aim to plant select species of woody bamboo with the specific purpose of increasing the carbon stock and associated GHG emission removals.

Furthermore, the VCS defines "reforestation of forest reserves" as a targeted activity for VCS ARR activities. The proposed activity falls specifically into this definition[2], given the targeted land and above-described project activities. The project uses a CDM methodology, as approved under the scope of the VCS for ARR projects and follows the eligibility requirements as specified by this methodology.

The project activities do not result in any clearance or conversion of native ecosystems, nor do they include any draining of native ecosystems or degradation of ecological functions. In contrast, the project

[1] Verified Carbon Standard Program Definitions v4.1, January 2022

[2] Reforestation Plan for the Degraded Bandai Hills Forest Reserve; Government approved reforestation plan, letter received from the Ghana Forestry Commission 21.04.2016

has been designed according to the VCS Program Definitions v4.1 whereby the land on which project activities are occurring was once forested, but whereby deforestation occurred more than ten years prior to the project start date. Evidence for this eligibility requirement is provided in Section 1.13 below.

The project proponent is also the implementation partner, and is responsible for all activities related to implementation, management, monitoring and reporting of the project over the project crediting period.

1.4 Project Design

The project occurs within a single "Forest Reserve" with the legalities of this land tenure defined in Section 1.14, but is separated into 3 areas within the boundaries of this Forest Reserve, each with a distinct boundary. The project area is split into forest management units known as compartments. Compartments are based upon a government delineation, and do not follow a standardized sizing or shape. All planting, monitoring and management activities will be carried out at the compartment level.

The planting of bamboo will occur over a 3-5 year period. The exact timeline of project activity instances will depend upon natural climatic factors that play an influence on any reforestation activity and the length of the planting season.

Bamboo seedlings are planted at a density of 500 clumps per hectare or an approximate 4 meter by 5 meter spacing. It should be noted that 1 hectare of planting relates to a specific number of planted bamboo clumps, rather than an exact 1 hectare area. This is due to the fact that there are remaining standing trees within the reforestation areas, all of which are left untouched. Where a standing tree is found, the planting of bamboo clumps simply avoids this tree and continues on the other side. Patches of bare and exposed rock also occur throughout the project area, representing small areas of unplantable land which are simply excluded from the planting design. In this manner, the actual area within which 500 bamboo clumps are planted differs within each compartment. The project uses a forestry software for the management of such planting activities, and GIS & mapping monitors the actual area covered by the reforestation activities for each year.

Table 1 Estimated Timeline of Reforestation Activities

Year	Number of Hectares Reforested	Number of Planted Bamboo Clumps
2022	500	250,000
2023	1,000	500,000
2024	1,000	500,000
2025	1,000	500,000
Total	**3,500**	**1,750,000**

The grouped project activity includes only a single project activity, which is human assisted reforestation with species of clumping bamboo. All future project activity instances will include only this project activity. The total scale of the project is limited by the size of the Bandai Hills Forest Reserve and the project proponent's securing of land under the same long term land lease as the 7,818.7 hectares under management at the time of validation.

Eligibility Criteria

The Bandai Hills Forest Reserve contains a total of 121 compartments. A 50 year lease is currently held on a total area of 7,818.7 hectares within this Forest Reserve representing 61 of these 121 individual compartments. Any new project instances that may be added will be limited to compartments from within the boundaries of the Bandai Hills Forest Reserve. By their nature, such areas will be identical to those already included, and will adhere to the same eligibility criteria, defined as:

All new project activity instances will meet the applicability conditions as defined by the methodology used by the project, AR-ACM0003 "Afforestation and reforestation of lands except wetlands" version 2.0.

1. No project activities will be implemented on any land designated as a wetland;
2. Soil disturbance as the result of project activities will not cover more than 10% of the area on either of the following types of land:
    a. Lands containing organic soils;
    b. Croplands or grasslands as defined by the methodology.
3. All future project activity instances will follow the same technologies for land preparation, planting, maintenance and monitoring as detailed within this project document.
4. All future project instances will use similar or identical species of sympodial bamboo.
5. The baseline for all future project activity instances will undertake a baseline approach identical to the approach taken in this project document, described as the pre-project scenario of gradual deforestation, forest degradation and conversion to agriculture.
6. All future project activity instances face the identical barriers to implementation as have been detailed within the Tool for the Demonstration and Assessment of Additionality within this project document.

In addition, all new project activity instances will occur only on areas where deforestation occurred more than 10 years prior, as per the VCS eligibility requirements for ARR projects.

Furthermore, prior to the inclusion of any new areas, such compartments will be formally included into the existing land lease documents.

1.5 Project Proponent

Organization name	EcoPlanet Bamboo Group, LLC
Contact person	Camille Rebelo
Title	Chief Operating Officer
Address	4023 Kennett Pike, Wilmington DE 19807, USA
Telephone	+44.7801.999.862
Email	crebelo@ecoplanetbamboo.com

1.6 Other Entities Involved in the Project

Organization name	EcoPlanet Bamboo WA II, LLC
Role in the project	Wholly owned subsidiary of EcoPlanet Bamboo Group, LLC which holds the long term lease to the project area.
Contact person	Camille Rebelo
Title	Chief Operating Officer
Address	4023 Kennett Pike, Wilmington DE 19807, USA
Telephone	+44.7801.999.862
Email	crebelo@ecoplanetbamboo.com

1.7 Ownership

The project proponent meets the ownership requirements of the VCS Program specifications as detailed in section 3.6 of the VCS Standard v4.3 Specifically, the project proponent has the legal right to control and operate all project activities for the duration of the crediting period.

Specifically, ownership is demonstrated according to Clause 4 of the VCS Program Standard:

"Project ownership arising by virtue of a statutory, property or contractual right in the land, vegetation or conservational or management process that generated GHG emission reductions and/or removals (where the project proponent has not been divested of such project ownership)."

The project proponent, EcoPlanet Bamboo, through the subsidiary detailed in Section 1.6 above holds the contractual right to the land within the project boundary, the bamboo to be planted, and the associated GHG emission removals. This contractual right is evidenced by a fifty (50) year Land Lease[3] that is fully executed between EcoPlanet Bamboo and the Government of Ghana, through the Ghana Forestry Commission.

Within the terms of this Land Lease Agreement, EcoPlanet Bamboo holds the legal right to control and operate program activities, as well as to all and any GHG emission removals generated by the project during the crediting period. These contracts are available to auditors as part of validation and subsequent verification events, but have been excluded from this Project Document due to their sensitive commercial nature.

1.8 Project Start Date

June 1st 2022

This date corresponds to the date of first planting.

1.9 Project Crediting Period

The proposed project crediting period is 20 years and is a fixed crediting period.

Start date: June 1st 2022

End date: May 31st 2042

The project's longevity is detailed in the Non Permanence Risk Report and represents a conservative period of 60 years.

1.10 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	x
Large project	

[3] Land Lease Agreement for Public-Private Partnership between Forestry Commission and EcoPlanet Bamboo WA II, LLC, executed April 2016.

Year	Estimated Cumulative GHG emission removals (tCO_2e)
2023	1,655.13
2024	9,557.05
2024	59,672.89
2025	150,192.44
2026	335,879.64
2027	667,227.38
2028	1,270,428.97
2029	2,128,951.70
2030	2,602,485.83
2031	3,298,570.80
2032	3,697,083.43
2033	3,706,130.93
2034	3,715,178.43
2035	3,724,225.93
2036	3,733,273.43
2037	3,742,320.93
2038	3,751,368.43
2039	3,760,415.93
2040	3,769,463.43
2041	3,778,510.93
TOTAL ESTIMATED ERs	**3,778,511**
TOTAL NUMBER OF CREDITING YRS	**20**
AVERAGE ANNUAL ERS	**188,926**

1.11 Description of the Project Activity

Jurisdictional REDD+

The AFOLU project activity is carried out on privately held land and does not fall within a jurisdiction that is covered by a jurisdictional REDD program.

Planting Activities

The project involves the direct planting of 3,500 hectares representing 1.5 million clumps of two species of giant sympodial (clumping) bamboo and includes the following activities all of which are carried out manually:

- Seedlings, grown from seed, are developed in partnership with local nurseries. For each year of planting nursery inventories include the total number of seedlings required for the targeted planting, as well as a minimum of 20% additional inventory to allow for blanking activities.
- Land preparation includes the removal of invasive grasses and herbaceous vegetation from the targeted planting area. All trees are left standing.
- Planting lines are marked with rope at a planting density of approximately 500 bamboo clumps per hectare. Where a standing tree occurs within the direct planting line, that point is missed and the next bamboo is planted at the subsequent planting point. Hence the actual area relating to 1 "planted hectare" or 500 bamboo clumps may be larger in actual area on the ground, depending upon the extent of standing trees.
- Planting pits are dug manually with labor that is employed from the surrounding communities that has been trained and is provided with PPE.
- Planting occurs with the onset of the rainy season (varying between April – May) and can continue through July, depending on scheduling and rainfall patterns.

Post Planting Maintenance Activities

The planted bamboo clumps are actively maintained until the clumps achieve maturity, and the ecosystem achieves a steady state. All activities are carried out manually using trained workers from the surrounding communities that are given the appropriate PPE for the activities being carried out. In the initial 6-8 years after planting maintenance activities are as follows:

- Management of the invasive grasses and herbaceous vegetation through manual slashing of the areas in between the bamboo clumps. This is a required activity to reduce competition and allow the bamboo to become established, but also to reduce flammable material during fire season and therefore reduce the risk of such fire occurring.
- Casing of each bamboo clump, which involves the manual removal of vegetation from a 1m circle around the base of each bamboo clump.
- Due to the degraded nature of the soils fertilization might be necessary to ensure the bamboo can outcompete the invasive grasses and achieve canopy closure. Fertilization occurs on a selective basis, only where plants show signs of nutritional deficiency.

- Training is an essential part of plantation maintenance activities. All workers undergo annual training across a range of forestry skills.
- Fire protection occurs through a combination of managed fire breaks, and fire patrols during the dry / fire season which occurs between December and the onset of the rains in April.

Mortality Monitoring and Plant Replacement (Blanking) Activities

Newly planted bamboo reforestation areas undergo mortality monitoring approximately 12 months and 24 months after planting, or shortly after the onset of the rains (i.e. for bamboo seedlings planted in June 2022, mortality monitoring occurs in June/July 2023 and again in June/July 2024). This timing allows for clear identification of mortality, as bamboo seedlings may appear to look dead during the dry season but rapidly recover with the onset of the rains. Such mortality in monitored at the compartment level, and subsequent "blanking" activities occur. This is the replanting of individual dead seedlings within a planted compartment. Blanking activities occur twice with the aim of ensuring fully stocked compartments and reforestation areas.

Thinning Activities

Once bamboo clumps are mature, select thinning of each bamboo clump will occur (expected from Year 6-8 of growth, depending on the growth and development of the bamboo as well as the availability of a market for the thinned material). The growth of sympodial bamboo species is such that each year the clump puts out new bamboo shoots which in turn develop into culms. These individual culms achieve their maximum height and therefore associated biomass accumulation within a single growing season. In the project location, such a growing season is 6 months, coinciding with the availability of rainfall. Thereafter the individual culms live for a 3-4 year period before they become over mature and subsequently die over a 1-2 year period. In this manner at any point in time a bamboo clump with have culms that range from 1 to 6 years in age, with this being a continuous cycle throughout the clumps 60+ year life cycle.

Thinning only targets the older mature culms who are reaching the end of their individual life cycle and representing approximately 20% of the standing biomass of the clump. The ecological growth pattern of sympodial bamboos means that the thinning of these removed culms (or poles) serves to stimulate continued growth, and any thinned culms are replaced during the subsequent growing season, resulting in a permanent bamboo forest, with high carbon capture and storage.

This pattern represents the unique nature of bamboo's contribution to long term and permanent carbon removals:

- 20% of the bamboo clump is thinned annually during the dry season (December-April);
- Between April – June with the onset of the rains the clump replaces 100% of these older culms with the next generation of shoots;

- Between June – November these shoots turn into culms, achieving their maximum biomass.

As a result, thinning activities represent no loss of biomass or associated carbon stocks over a 12 month period, and therefore. As a result, under the VCS framework, for bamboo reforestation activities under a sustainable thinning regime no long term average is required, as there is no loss of biomass or associated carbon stocks over a 5 year period for any project instance.

Standard Operating Procedures

EcoPlanet has a comprehensive set of Standard Operating Procedures (SOPs) for all reforestation activities described above. These include the following SOPs: Land preparation; planting plant replacement; fertilization; weed control; thinning. All SOPs have associated data collection and monitoring templates. All SOPs are available to auditors during validation and future verification events.

Forestry Software

The project utilizes MicroForest[4] - a software specifically designed to manage and monitor forestry activities by forest management unit. This software tracks planting and maintenance activities against planned annual operational plans, as well as against annual budgets, to allow for the daily and year to date tracking of achieved activities.

Native Species Planting

The carbon benefits being requested by the project proponent are limited to the bamboo reforestation activities resulting from the activities above. In addition, additional activities within the project boundaries target the planting of native species for biodiversity and conservation purposes. The carbon benefits of these areas are specifically excluded from this project resulting in a conservative valuation of the total carbon removal benefits of the activities within the project boundary.

Bamboo Species

The project is initially focusing on two species of giant sympodial bamboos:

- *Dendrocalamus asper*: a dense-clumping species also known as giant bamboo, or dragon bamboo, native to Southeast Asia and tropical China. Due to its common occurrence across Asia and its attractive features as well as ease of harvesting, this species has been introduced widely across Latin America and Africa. Culms of this species can have lengths of up to 30 m, and culm diameters of up to 20 cm. The culm walls are generally very thick representing a significant biomass and associated carbon stock. *Dendrocalamus asper* is suitability for the climate, elevation, topography and soils of the area. This species is one of the most productive and most

[4] www.microforest.co.za

sought after of all bamboo species for carbon sequestration. Its culms can be easily identified by their greyish hues and the presence of extended hairs around the nodes. It is a tight clumping species with large diameter culms suitable for an array of manufacturing applications. This species is targeted for wetter soil areas within the project area.

- Bambusa textilis spp: a dense-clumping bamboo of southwest China origin. This species is a hardy, drought resistant species that performs well in harsh climates and is suited to the soils, climate and rainfall of the project location. This species has dark green culms with extremely long internode lengths. Culms grow to a maximum known diameter of 12-15 cm but have the unique property of being almost solid at the lower parts making the biomass availability, and thus carbon sequestration is high. This species is targeted for rockier soil areas within the project boundary.

Ghana has only a single species of native bamboo:

- *Oxytenanthera abyssinica* commonly called African lowland bamboo, occurs at low altitude semi-arid areas across sub-Saharan Africa. This species is found only in the drier climates in the Northern Region of the country. It is not found to occur within the targeted project location, which has higher levels of rainfall than the climatic range of this species.

As a result of the lack of suitable native species, the project is utilizing non-native species. Further information regarding the fact that neither species being planted has any potential for invasive properties, or any associated negative environmental impacts, is provided in Section 2.1 below.

Both species had been introduced into Ghana many years before the project start date, including by the International Network of Bamboo and Rattan (INBAR) as being suitable to the West African location. Both species are approved by the Ghana Forestry Commission. However, prior to the proposed project activities, trials of both species were undertaken in the project area, with approximately 60 hectares of planting occurring in 2016. These pilot plantings provided confidence on the suitability of both species to the site-specific conditions, including the long dry season, and their ability to withstand fire.

Photo 1 Targeted Species of Giant Sympodial Bamboo



Entities Involved

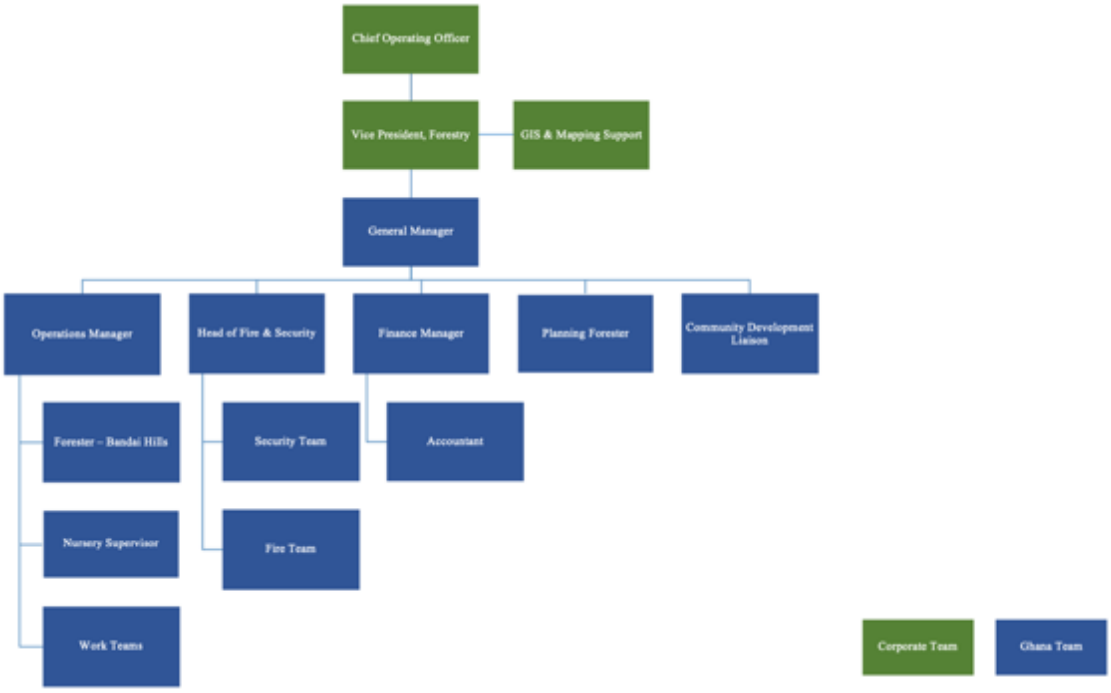
All project activities are carried out by the project proponent by a full operating team that is based within the proximity of the project boundaries. The structure of such involvement is provided in the organizational chart below.

The only external entity involved is the Ghana Forestry Commission, who provide a supporting role to the project. Within the Ghana Forestry Commission there are two facets involved:

- Forest Services Division, Accra – this entity provides high level support, and approves annual reforestation plans.
- Juaso District Office, Juaso – this Forestry Commission office has a manager who has the overall responsibility for overseeing activities across the Forest Reserves in his district which includes the Bandai Hills Forest Reserve. The manager has a team of forest rangers who are responsible for ensuring the integrity of the Forest Reserves and assisting with the reduction in illegal activities.

No communities other than those that are directly employed by the project, either in temporary or permanent positions, are involved in the project or the project activities.

Figure 1 Bandai Hills Reforestation Project Organizational Chart



1.12 Project Location

Figure 2 Project Location in Ghana, West Africa

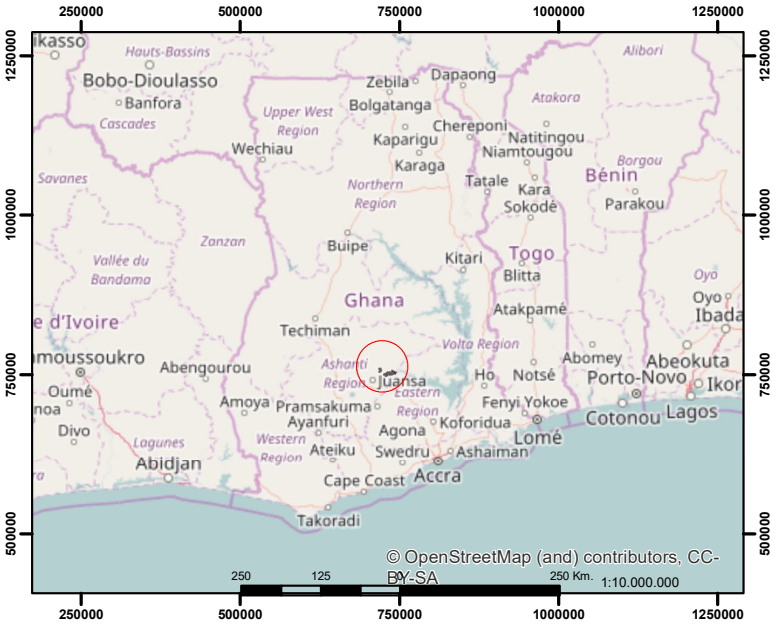


Figure 3 KML Polygon of Project Boundaries



Within the project boundary there are areas where reforestation activities do not occur. These include the 186.6 hectares of forest patches that were present at the project start date, 248.2 hectares of lands where deforestation occurred within the ten years prior to the project start date and 11.3 hectares of roads and / or firebreaks. Such areas have been excluded from the project area. The project area, which represents the area where net emission removals will occur is provided as a separate KML file and shown in the figure below.

Figure 4 KML Polygon of Project Area

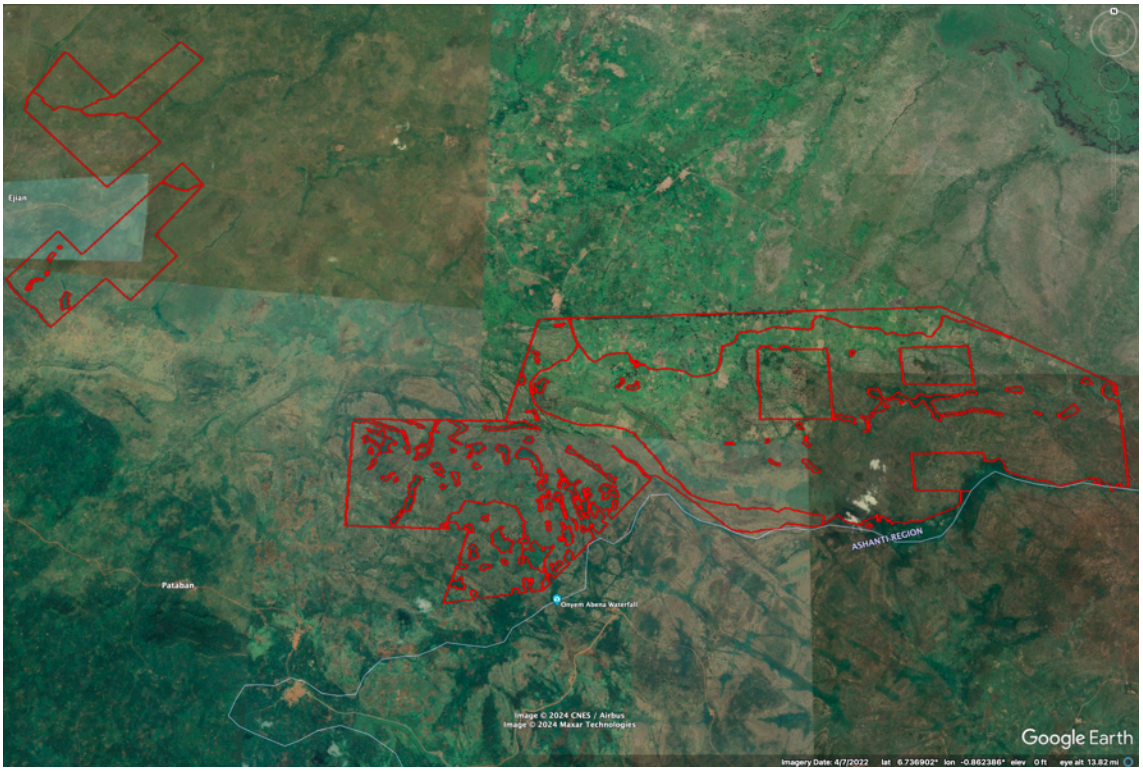
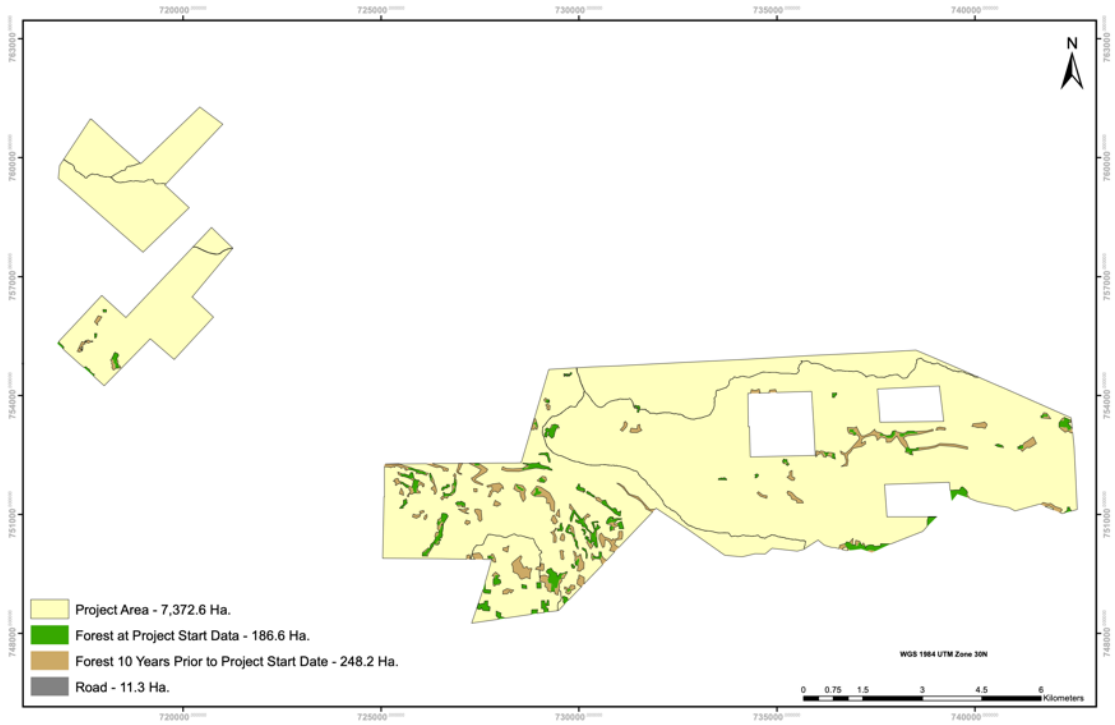


Figure 5 Project Area Where Emission Removals Will Occur



1.13 Conditions Prior to Project Initiation

The baseline scenario is the same as the conditions that exist prior to the project initiation and therefore readers should reference Section 3.4 Baseline Scenario. However, the detailed environmental conditions of the project area have been presented below.

Climatic Conditions

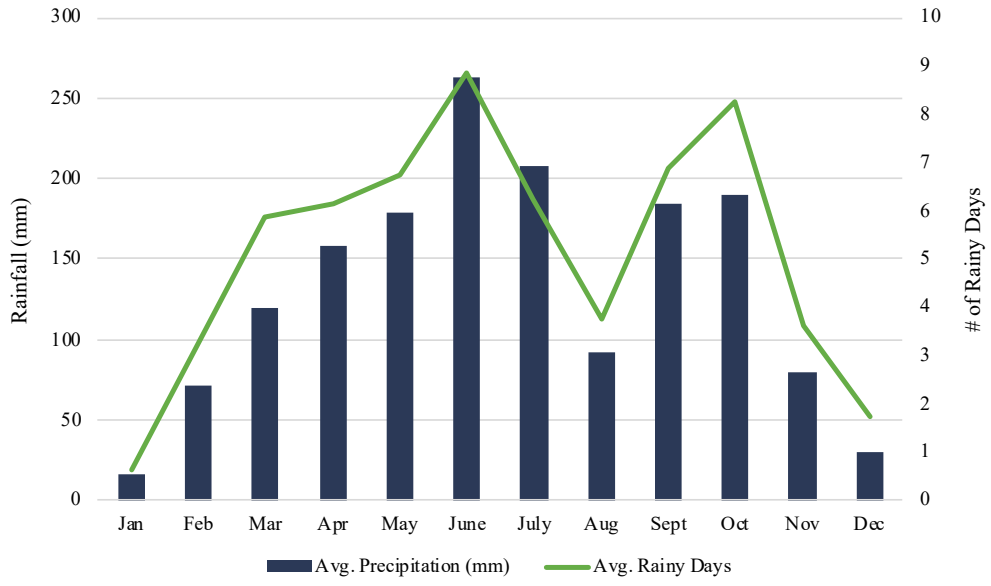
The project area is classified within Ghana's transition forest agro-ecological classification, and is characterized by two distinct rainy seasons:

- The main rainy season runs from late April through July;
- The minor rainy season runs from late September to late October.

Combined the average annual rainfall for the region is in the range of 1,200 – 1,500mm and the combined rainy seasons are followed by an extended dry season that runs from December through March. This dry season is known as the Harmattan season and is characterized by the dry and dusty northeasterly trade wind that blows from the Sahara Desert over West Africa. This season has been accentuated in recent years by climate change.

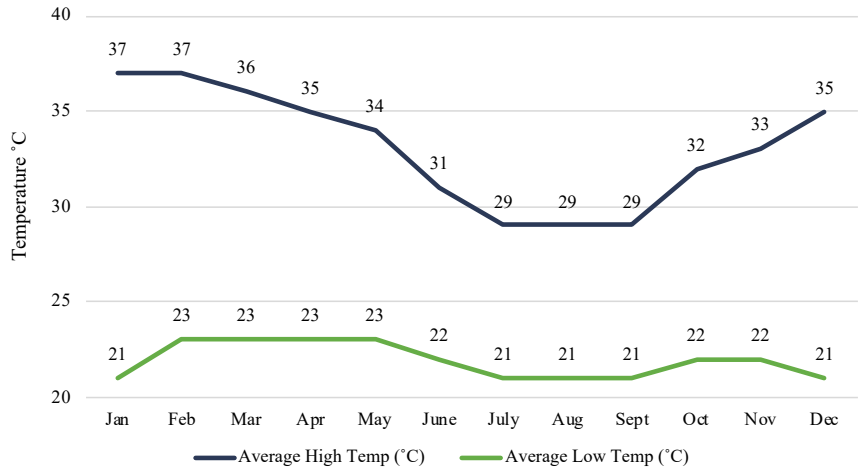
The project area has a uniform temperature distribution throughout the year, with an average daily temperature of 33°C and a minimum daily temperature of 22°C. Relatively humidity is high year around, with an average upwards of 75%.

Figure 6 Mean Monthly Rainfall Data (Juaso)



Source: *Forestry Commission of Ghana*

Figure 7 Mean Monthly Temperature Data (Juaso)

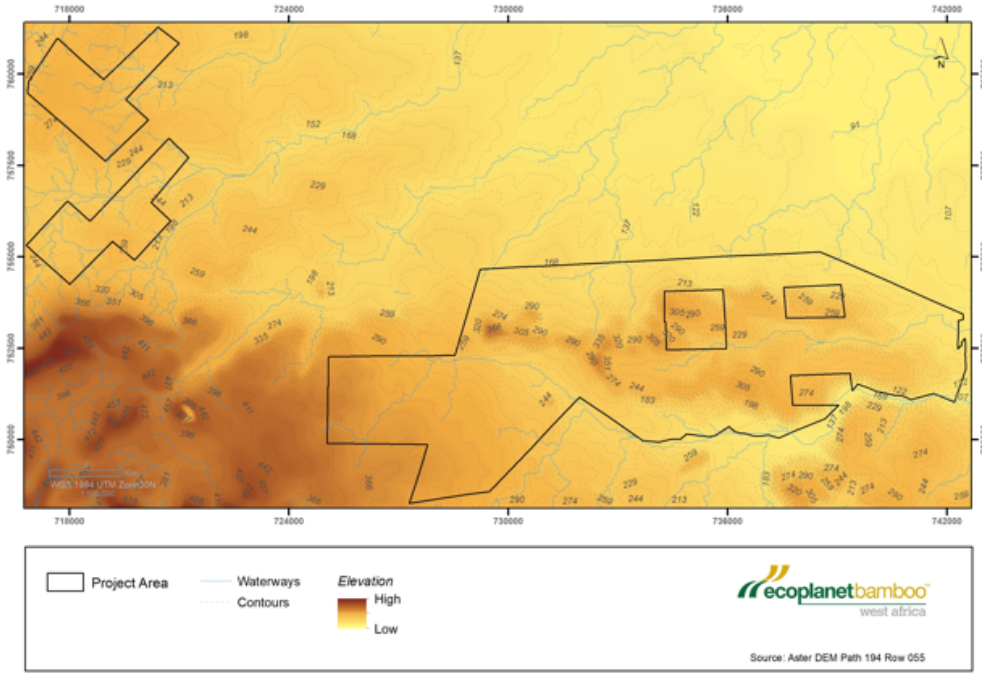


Source: *World Weather Online*

Topography & Geology

The project area is located in the Asante Akim North Municipal, which is characterised by highlands in the south ranging between 305 and 610 meters and lowlands in the north near Lake Volta ranging between 152 and 305 meters. Bandai Hills Bamboo Farm is located in the lowlands area but is characterized by a range of hills in the center of the project area, surrounded by flat and undulating landscape. The project area falls within the Voltain Basin, where the underlying geology is formed of horizontal beds of sandstone, shale, mudstone and conglomerate from the late Precambrian to Paleozoic age.

Figure 8 Topography of Project Area



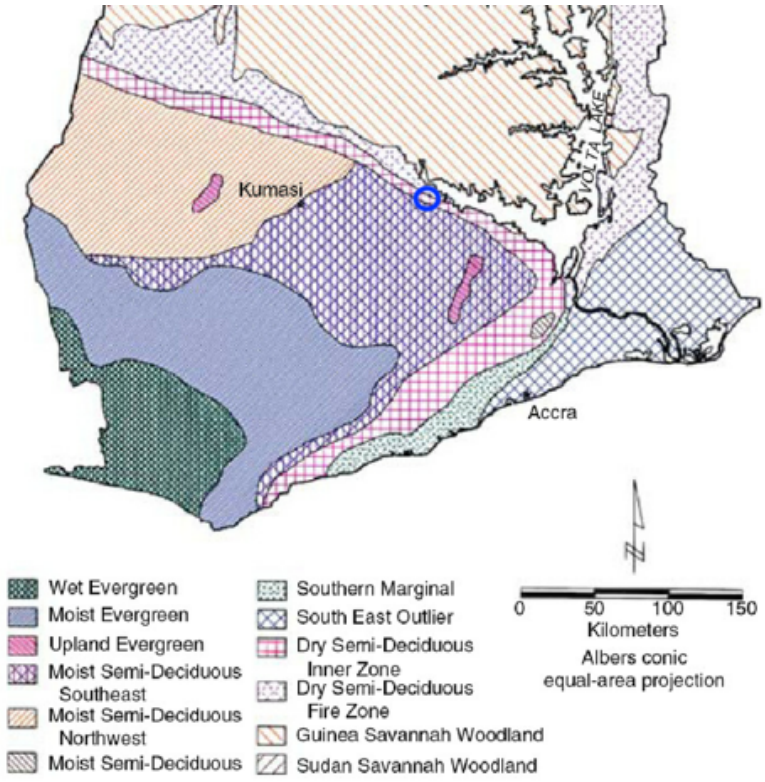
Soils

The soils across the project area can be characterized as Forest Ochrosol. This soil type is red, well-drained, and relatively high in organic content near the surface but leached further down in the profile. It dominates the region but is declining in fertility due to continuous cropping and poor land management. Due to the structure of the soils, soil compaction is not an issue on the farm. There are areas of rocky soils as well as exposed rock, which is primarily found in the western portion of the project site.

Vegetation & Ecosystems

The Bandai Hills Forest Reserve is located in the Ghana's Dry Semi-Deciduous Inner Zone, with the southern parts of the project being within the upper limits of the Moist Semi Deciduous Southeast Zone. Moving north, the ecosystem transitions into the Dry Semi-Deciduous Fire Zone. Climate change, along with the deterioration of the semi-deciduous forests in this region are resulting in changes within the boundaries of these three agro-ecological zones. In the 1990's this ecosystem underwent extreme levels of deforestation, driven by logging of indigenous high value species, such as rosewood and mahogany. The remaining forests came under pressure from charcoal production, illegal agriculture and illegal grazing, where the forests are burned to clear fields or promote the growth of new invasive grasses that suppress any opportunities for the forests to recover.

Figure 9 Agro-Ecological Zones of Ghana, Showing Location of Project Area



This deforestation has resulted in a severely degraded landscape that has been highly modified by human activities, namely clearing of hardwoods and burning for charcoal production, illegal farming and grazing. The flora identified on the farm is consistent with highly degraded lands, as species diversity is low, categorizing the landscape as derelict with scrappy vegetation. Moreover, bird species present in the area are characteristic of species found in open and degraded landscapes as opposed to functioning forest ecosystems.

Photo 2 Remnants of the Original Forests Within the Project Boundaries



Photo 3 Current Landscape Typical of the Bandai Hills Forest Reserve



Photo 4 Table Top Hills Characterized by Dense Grasses & Remnant Standing Trees



Historic Conditions

Ghana has one of the highest deforestation rates in the world, losing approximately 135,000 ha of forest annually and 2.5 million ha lost since the early 1990s. The Ashanti region, where the Bandai Hills Bamboo Farm is located, has suffered from this extreme deforestation, leaving little forest cover remaining. Global Forest Watch[5] reports the Ashanti Region as having the second highest rate of deforestation across the country, and reports that between 2001 – 2020 the region lost over 296,000 hectares of tree cover, representing approximately 19% of the remaining standing forest.

At the same time, Forest Reserves and protected areas harbor the last remaining forest patches across the region. For the land within the project boundaries of the Bandai Hills Forest Reserve, the majority of widespread forest clearance occurred prior to 1998. As seen in figure 6, original forest cover across this area had been reduced to 838.5 ha in 1998. It subsequently continued to be reduced. By 2003, the forest cover had fallen to 574.9 ha. By 2012, it had further decreased to 358.9 ha. At the project start date there was 186.7 ha of forest patches remaining across the total 7,818.7 ha area within the project boundary.

The project is being carried out on land designated as a Forest Reserve that adheres to the VCS requirements and underwent deforestation more than 10 years prior to the project start date. There is an area representing 248.2 hectares of land where forest loss has occurred within the 10 years prior to the project start date. No clearance of forest or any native ecosystems occurs as part of the reforestation activity. There are 186.7 hectares of land classified as forest within the project boundary at the project start date which has been removed from the project area.

This represents a conservative approach, as there is clear evidence that such deforestation and degradation did not occur for the subsequent benefit of receiving carbon removal benefits.

[5] https://www.globalforestwatch.org/dashboards/country/GHA/ accessed Jan 21 2022

Figure 10 Historical Deforestation, Bandai Hills Forest Reserve, Ghana

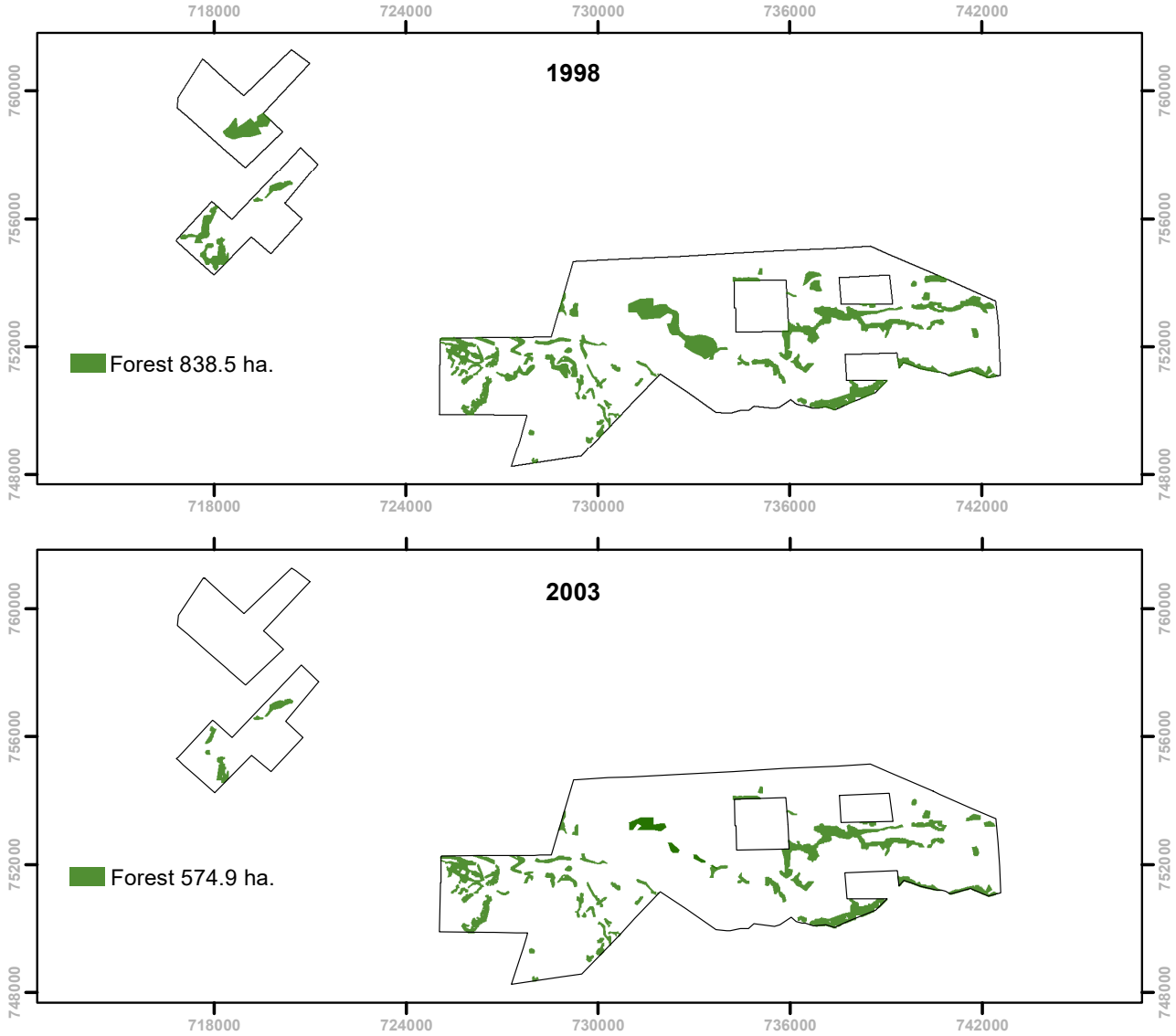


Figure 11 Forest Cover, Bandai Hills Forest Reserve 2012 (10 Years Prior to Project Start Date)

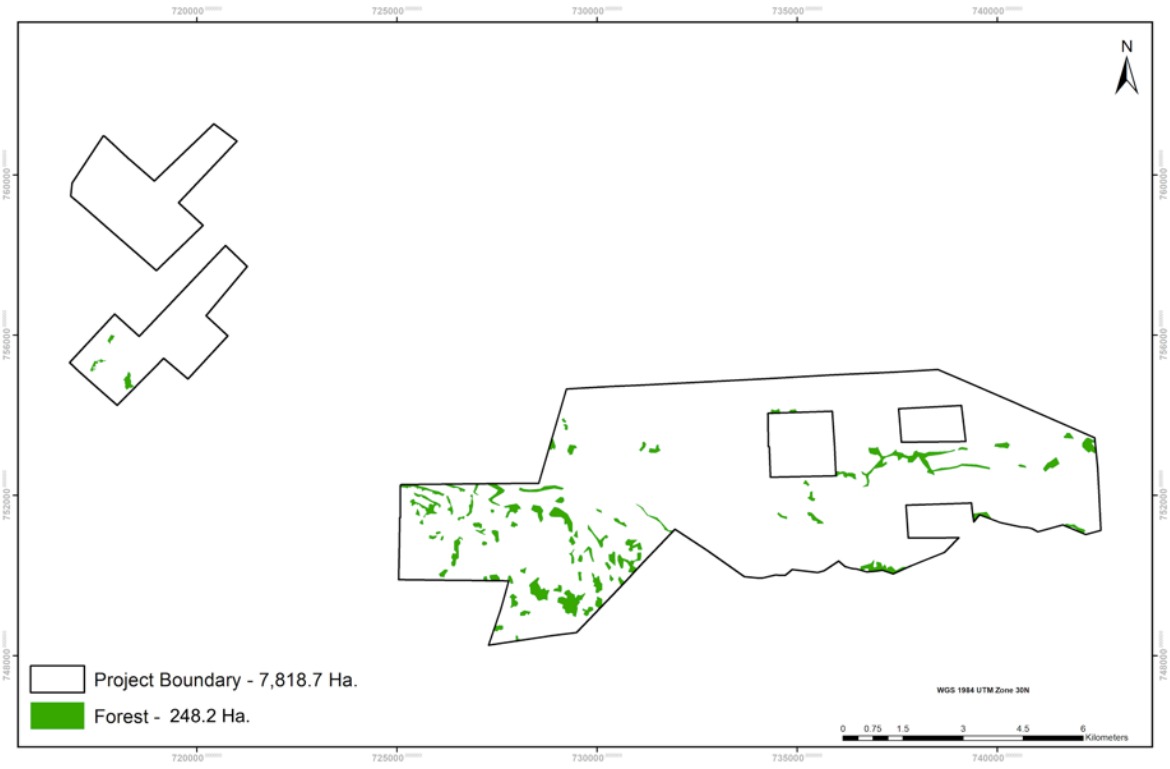


Figure 12 Forest Cover, Bandai Hills Forest Reserve 2020 (Prior to Project Start Date)



The historic conditions clearly show a trend of continued loss of forest combined with forest degradation of remaining forest patches.

While google earth imagery appears to show small patches of new forests in the ten years prior to the project start date, ground truthing, including during the VCS validation audit by the engaged VVB showed that most of these are regrowth which, with the prevalence of fire, are not able to achieve classification as forest under the national definition. This is a direct consequence of the prevalence of fire as the dominating ecological forest within the area,

No clearance of forest, individual trees or any native ecosystems occurs as part of the reforestation activity and in contrast the project is designed specifically to protect and conserve remaining forest resources, and individual standing trees. The monitoring of such standing trees is undertaken as part of the project's monitoring plan, as described in Section 5 below.

1.14 Compliance with Laws, Statutes and Other Regulatory Frameworks

The following laws, statutes and other regulatory frameworks are relevant to the proposed project.

The Forestry Commission Act, 1999 (Act 571)

This Act established the Forestry Commission as a semi-autonomous body responsible for all the forestry sector agencies implementing the functions of protection, development, management and regulation of forest and wildlife resources. Under this Act, EcoPlanet Bamboo is obliged to collaborate with the Forestry Commission on all matters about the establishment of its plantations on lands leased to it by the Forestry Commission.

Article 267 of the Constitution of the Republic of Ghana, 1992

Article 267 of the 1992 Constitution stipulates that "all stool lands in Ghana shall vest inappropriate stool on behalf of and in trust for the subjects of the stool following customary law and usage". In practice, all stool lands belong to paramount chiefs who are the traditional heads of paramount stools. Ownership is often hierarchical with paramount divisional, town or village stools all having an interest in the land according to the mode of acquisition. Under this Act and Article, EcoPlanet Bamboo cannot claim title to stool lands but may lease lands in agreement with the stool landowners and the Forestry Commission, the management and monitoring agency of forest reserves in Ghana.

The Forest Ordinance (Cap 157), 1927

The Forest Ordinance (Cap 157), 1927 section 18(1) states that "the ownership of land is not altered by its declaration as a forest reserve". The stool landowners, therefore, have the right to a share of the benefits from the development of plantations in forest reserves. The Benefit Sharing Agreement signed

by EcoPlanet Bamboo and the Forestry Commission provides provisions for such community benefit sharing.

The Concession's Act (Act 124), 1962

The Concession's Act (Act 124), 1962 indicates that "the timber and land in forest reserves or subject to timber concessions (both within and outside the reserved forests) are vested in the State in trust for the landowning communities". The exploitation of the production forest reserves is administered by the central government through the Ministry of Lands and Natural Resources (MLNR) and the Forestry Commission. Under this arrangement, the landowners have a right to a share of the revenue from both natural timber harvesting and forest plantation development within the forest reserves. EcoPlanet Bamboo has therefore entered benefit sharing agreements with stool landowners and other stakeholders.

The Companies Code (Act 179), 1963

This Act provides for business entities to register their firms with the Registrar-General of Ghana for the issuance of business registration certificates and commencement of business certificates. EcoPlanet Bamboo operates within this Act.

Wildlife Conservation Regulations (L.I. 685), 1971

The Bandai Hill Forest Reserve, where EcoPlanet Bamboo's project is located, contains minimal game and wild animals due to excessive hunting. This legislative instrument places restrictions on the hunting of game, the need to apply for game licenses and permits for the export of game. Through this regulation, EcoPlanet Bamboo has a responsibility to inform the Forestry Commission of any persons that may be in contravention of this regulation.

Ghana Forest and Wildlife Policy, 1994

The Forest and Wildlife Policy 1994 promotes conservation and sustainable development of the nation's forest and wildlife resources. The policy aims to provide for the maintenance of environmental quality and the perpetual flow of optimum benefits to all segments of society. The Policy outlines the enabling conditions under which the Forestry Commission aims to achieve its objectives. It encourages local stakeholder participation in forestry and highlights the need for reforestation of the country's degraded forest reserves. This policy provides EcoPlanet Bamboo with guidelines on how it can contribute to the policy and realization of the Forestry Commission's vision.

The Forest Protection Act (624), 2002

The function of this Act pertains to forest reserves and defines the offenses and corresponding penalties that may be imposed by the Forestry Commission in the event of the unauthorized setting of fires that burn out of control, the obstruction of rivers and waterways, erection of buildings or the moving or destroying a forest reserve boundary marker. This Act, therefore, imposes strict guidelines on how EcoPlanet Bamboo should operate in the Bandai Hills Forest Reserve regarding the management of fires, erection of permanent structures and use of water bodies.

Ghana Forest and Wildlife Policy, 2012

The Forest and Wildlife Policy 2012 promotes the conservation and sustainable development of the nation's forest and wildlife resources. The policy aims to provide for the maintenance of environmental quality and the perpetual flow of optimum benefits to all segments of society. The policy outlines the enabling conditions under which the Forestry Commission hopes to achieve its objectives. It also encourages local stakeholder participation in forestry and highlights the need for reforestation of the country's degraded forest reserves.

Ghana Labour Act (651)

This Act provides a framework for labour relations and employment in Ghana. The Act defines the rights, duties and responsibilities of the employer and employee, the conditions of employment, the protection of remuneration, trade unions and collective bargaining arrangements (for occupational health and safety and the employment of women). EcoPlanet Bamboo is ensuring compliance with all the requirements of the Act.

Table 2 Summary of Applicable Legislation

National Legislation	General Provisions	Provisions Applicable to the Project
The Forestry Commission Act, 1999 (Act 571)	Identifies the Forestry Commission as a semi-autonomous body responsible for all the forestry sector agencies.	EcoPlanet collaborates with the Forestry Commission on matters associated with its plantations on leased land ensuring that all activities adhere to the applicable requirements of this Act.
Article 267 of the Constitution of the Republic of Ghana, 1992	Regulates land tenure.	EcoPlanet Bamboo does not claim title to the properties but leases them under agreements with stool landowners and the Forestry Commission.
The Forest Ordinance (Cap 157), 1927	Enables the stool landowner rights to lands that have been declared as forest reserves.	EcoPlanet and the Forestry Commission have established a benefit sharing agreement that provides benefit sharing to the stool landowner and community.

National Legislation	General Provisions	Provisions Applicable to the Project
The Concession's Act (Act 124), 1962	Provides regulations for timber concessions, including providing benefits to landowning communities.	EcoPlanet and the Forestry Commission have established a benefit sharing agreement that provides benefit sharing to the stool landowner and community.
The Companies Code (Act 179), 1963	Provides for business entities to register their firms with the Registrar-General of Ghana.	EcoPlanet Bamboo operates within this Act and is duly registered and adheres to associated requirements.
Wildlife Conservation Regulations (L.I. 685), 1971	Places restrictions on the hunting of game, the need to apply for game licenses and permits for the export of game.	EcoPlanet Bamboo has a responsibility to inform the Forestry Commission of any persons that may be in contravention of this regulation.
Ghana Forest and Wildlife Policy, 1994	Promotes conservation and sustainable development of the nation's forest and wildlife resources while outlining the objectives for the Forestry Commission.	This policy provides guidelines on how EcoPlanet Bamboo can contribute to the mission of the Forestry Commission.
The Forest Protection Act (624), 2002	Pertains to forest reserves and defines the offenses and corresponding penalties that may be imposed by the Forestry Commission.	This act regulates how EcoPlanet Bamboo manages fires, erects permanent structures and uses water bodies.
Ghana Forest and Wildlife Policy, 2012	Promotes the conservation and sustainable development of the nation's forest and wildlife resources and outlines the enabling conditions under which the Forestry Commission hopes to achieve its objective.	This policy provides guidelines on how EcoPlanet Bamboo can contribute to the mission of the Forestry Commission.
Ghana Labour Act (651)	Provides a framework for labour relations and employment in Ghana.	EcoPlanet Bamboo operates within this Act and adheres to all applicable requirements with regards to the hiring of labour and employment of individuals.

The project proponent operates in accordance to all applicable laws as described above and maintains due records where required by law.

1.15 Participation under Other GHG Programs

1.15.1 Projects Registered (or seeking registration) under Other GHG Program(s)

The project is not registered or seeking registration under any other GHG program.

1.15.2 Projects Rejected by Other GHG Programs

The project has not been rejected by another GHG program.

1.16 Other Forms of Credit

1.16.1 Emissions Trading Programs and Other Binding Limits

The emission removals resulting from the project are not included in any emissions trading program.

The Government of Ghana includes all LULUCF activities within its Nationally Determined Contributions[6].

To ensure that the GHG emission removals generated by the project will not be otherwise counted or used under any future program or mechanism, the project proponent holds a legally binding commitment from the Government of Ghana to the exclusive ownership and reporting right of such GHG emission removals within a document dated November 11th 2021[7] and executed by the Government of Ghana through the Ghana Forestry Commission, the Agogo Stool, and the project proponent and which states that;

"The Parties hereby agree to forego any claim to the Carbon Benefits and Reporting rights from the Carbon Area…"

Such documentation has been provided to the VVB.

1.16.2 Other Forms of Environmental Credit

The project has not sought nor received another form of GHG-related environmental credit and is not eligible to participate in any such program.

1.17 Sustainable Development Contributions

No long-term restoration project can be successful without a broader focus on the positive and sustainable development of a region and ensuring that people that might be dependent upon an area, whether legally or illegally, benefit in the long run from project activities. In the case of the Bandai Hills Forest Reserve, there are no people living within the boundaries of the Forest Reserve, however there are surrounding "fringe communities" which are the focus of indirect sustainable development activities.

[6] Ministry of Environment, Science, Technology & Innovation; September 2021. Ghana Updated Nationally Determined Contribution under the Paris Agreement (2020 – 2030).

[7] Addendum to the Benefit Sharing Agreement, Bandai Hills Forest Reserve Under a Public Private Partnership;

Ghana has adopted and is implementing a 40-year development plan called The Long-Term National Development Plan of Ghana (LTNDP), with the vision of achieving "a just, free and prosperous society" by 2057. There are 5 main goals of the LTNDP, of which the proposed project activities both directly and indirectly, as described further below, contribute to 3 of the 5:

1. Build an industrialized, inclusive, and resilient economy: the project is designed to be a long term, generational project that provides individuals from the surrounding communities with livelihood improvement opportunities that do not discriminate, thereby creating an inclusive workplace. The project ultimately aims to sustainably manage the bamboo to provide a deforestation free fiber, which will be locally processed, driving green industrialization and contributing to a resilient economy.

2. Create an equitable, healthy, and prosperous society: the project proponent is committed to being an equal opportunity employer, promoting non-discriminatory, fair labor practices as well as safe working environments. The project, its operations, its managers and contractors comply with the strictest labor and health & safety standards, including compliance with the ILO to ensure a healthy working environment. The project framework and activities have been designed and established under a framework of social impact that not only includes income generating opportunities but follows a long-term plan of community engagement and indirect sustainable development activities, aimed at creating a prosperous environment.

3. Build well-planned and safe communities while protecting the national environment: the project has been designed and operates under a framework of strict sustainability standards to protect and enhance the natural environment. It also works to build the capacity of local communities to make them stewards of the environment, ensuring safer and more healthy communities.

Specifically the Bandai Hills Reforestation Project aims to have a positive impact on the following Sustainable Development Goals.

The project activities that result in sustainable development contributions can be categorized as direct and indirect activities.

Direct activities are those that predominantly occur within the project boundary, specifically the planting and long term maintenance of the bamboo seedlings and the protection of the remaining forest patches and individual standing trees within the project boundaries. Direct activities that occur outside of the project boundary are the development of the development and management of large scale seedling nurseries, and the administrative, logistical and management functions that are required to support and run the project. These direct activities contribute to the following Sustainable Development Goals.



Indirect activities relate to those that are carried out within the fringe communities described in Section 2 below, and are outside of the planting of bamboo and associated carbon removals as described in this project document. The project operates a dedicated sustainable development fund managed by a dedicated team. Indirect activities are identified by the communities themselves. In North Bandai, the key thematic areas have been identified by the three target communities as being:

- Access to clean water and sanitation
- Healthcare
- Education, training and lack of employment opportunities
- Poor nutrition and improved farming technology

The project works within the three fringe communities, to address and positively impact these through indirect project activities thereby contributing to the above, as well as the following additional Sustainable Development Goal:



The project proponent monitors Key Performance Indicators (KPIs) associated with each goal on a quarterly basis, and reports annually on these KPIs and its associated contribution to these aspects as part of its United Nation's Global Compact: Communication on Progress. Such annual monitoring reports are available to auditors as part of validation and verification events.

1.18 Additional Information Relevant to the Project

Leakage Management

The project is a reforestation activity carried out on privately held land. No movement of people or communities occurs, and the project is not claiming GHG emission reduction / removals from any activity which might result in leakage as described further in Section 4.3 below. Therefore, no leakage management is necessary.

Commercially Sensitive Information

Commercially sensitive information surrounding the financing arrangements of the project have been excluded from the PD and the associated Non Permanence Risk Assessment, but have been made available to auditors. Such documents are (1) Addendum to the Benefit Sharing Agreement; November 10th 2021 and (2) Reforestation Agreement, Bandai Hills; September 6th 2021.

Further Information

Not applicable, all information is provided elsewhere within this document.

2 SAFEGUARDS

2.1 No Net Harm

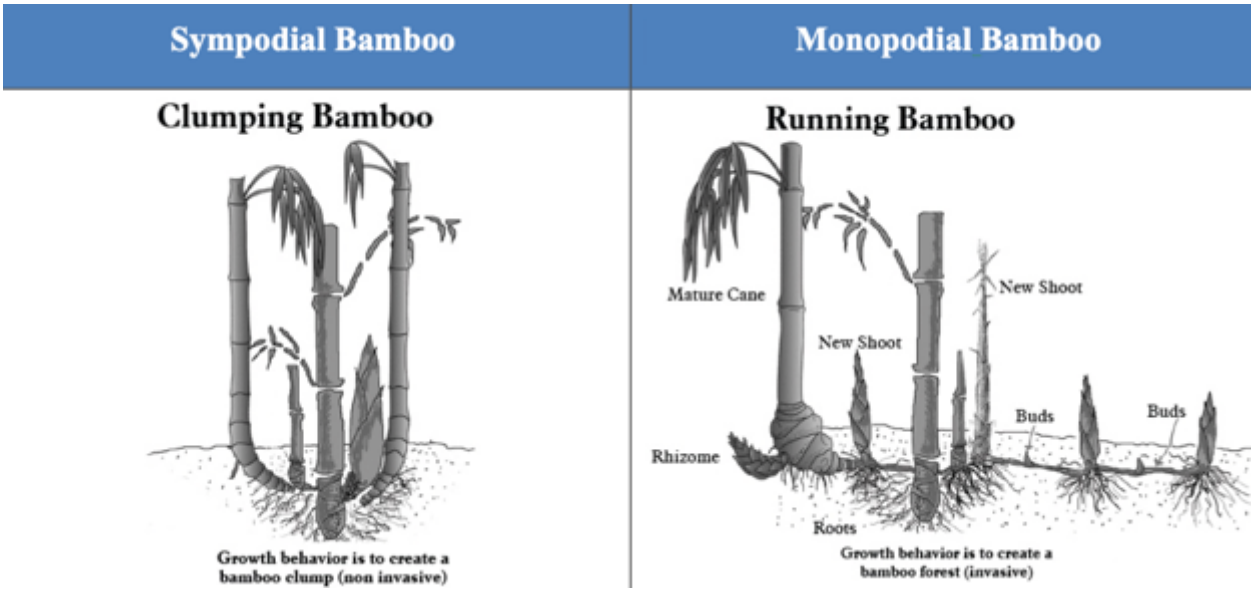
Environmental Impact: The project is utilizing species of clumping (sympodial) bamboo to restore and reconnect remnant forest patches, while conserving all remaining standing trees. The characteristics of the two species being grown are described in Section 1.11 above.

Ghana has only a single endemic species of bamboo, *Oxytenanthera abyssinica* commonly known as African lowland bamboo. This species is not found within the project area but occurs further north, in the semi-arid and arid areas of the country, and occurs in individual clumps. It is not a forest bamboo species – meaning that it does not naturally occur as part of a forest canopy or forest ecosystem. Rather, this native species is a drought resistant bamboo that is low yielding, and does not create the dense canopy or multi-structured ecosystem associated with giant bamboos. Furthermore, it has a short life cycle, with flowering occurring on periods of less than 40 years which makes it unattractive for ensuring longevity and project permanence.

As a result of the above and the conclusion that there not being giant bamboo species that are native to Ghana that are suitable for the project activities, both species to be grown by the project are non-native. As described in Section 1.11 above, both species had been introduced into Ghana many years before the project start date, including by the International Network of Bamboo and Rattan (INBAR) as being suitable to the West African location. Both species are approved by the Ghana Forestry Commission. The project proponent has chosen these particular species due to the following attributes:

Sympodial bamboos: sympodial or clumping bamboo species are typically found across the tropical belt of the world. The growth pattern of these species is to develop as a tight knit clump that stays within a contained area. The rhizomes of clumping bamboo species are very short, emerging as close as possible to the parent plant and forming a dense clump of multiple culms. Each clump remains compact and has no ability to spread horizontally. As a result, these species have no ability for invasiveness that is typically associated with running or monop[odial bamboo species, or associated negative environmental impacts. Both species being grown are giant sympodial / clumping bamboo species.

Figure 13 Comparison of Growth Patterns of Clumping vs Running Bamboo



Availability of seeds: such giant sympodial bamboos undergo a phenomena known as mass or gregarious flowering, whereby all individuals within the species flower at the same time under extremely long time periods. As a result, bamboo seed is hard to secure. Both species being grown are grown from seed of known origin and timing, and reducing any potential for any negative environmental impacts within the project area.

As described in Section 1.11 pilot plantings of both species were undertaken in 2016, in order to ensure that there were no negative effects on the remaining surrounding trees from the planting of both species. The healthy mixed forest ecosystem that results can be seed in Photo 5 below, and these pilot planting are available for auditors to visit as part of validation and future verification events.

Furthermore, not only does the use of these species have no expected negative environmental impacts that require mitigation, but they provide a wide variety of positive environmental impact, as described below.

Historical GIS and remote sensing mapping shows that it is extremely likely that in the without project activities that these remaining native trees and biodiversity would have been cleared and any remaining biodiversity lost. At the same time, in the baseline scenario the increasing occurrence of fire, as these ecosystems are gradually converted from forests to non-native degraded grasslands, which brings with it a suite of negative environmental and social impacts. The project activities are designed to reduce the risk of fire, first through direct fire management activities and later, indirectly as the bamboo restores canopy cover and reduces the likelihood of fire. Bamboo has a high water content and can survive fire, where no management or fire control occurs. The pilot plantings have shown that the presence of the bamboo has protected the remaining surrounding trees – all of which would likely have been removed in

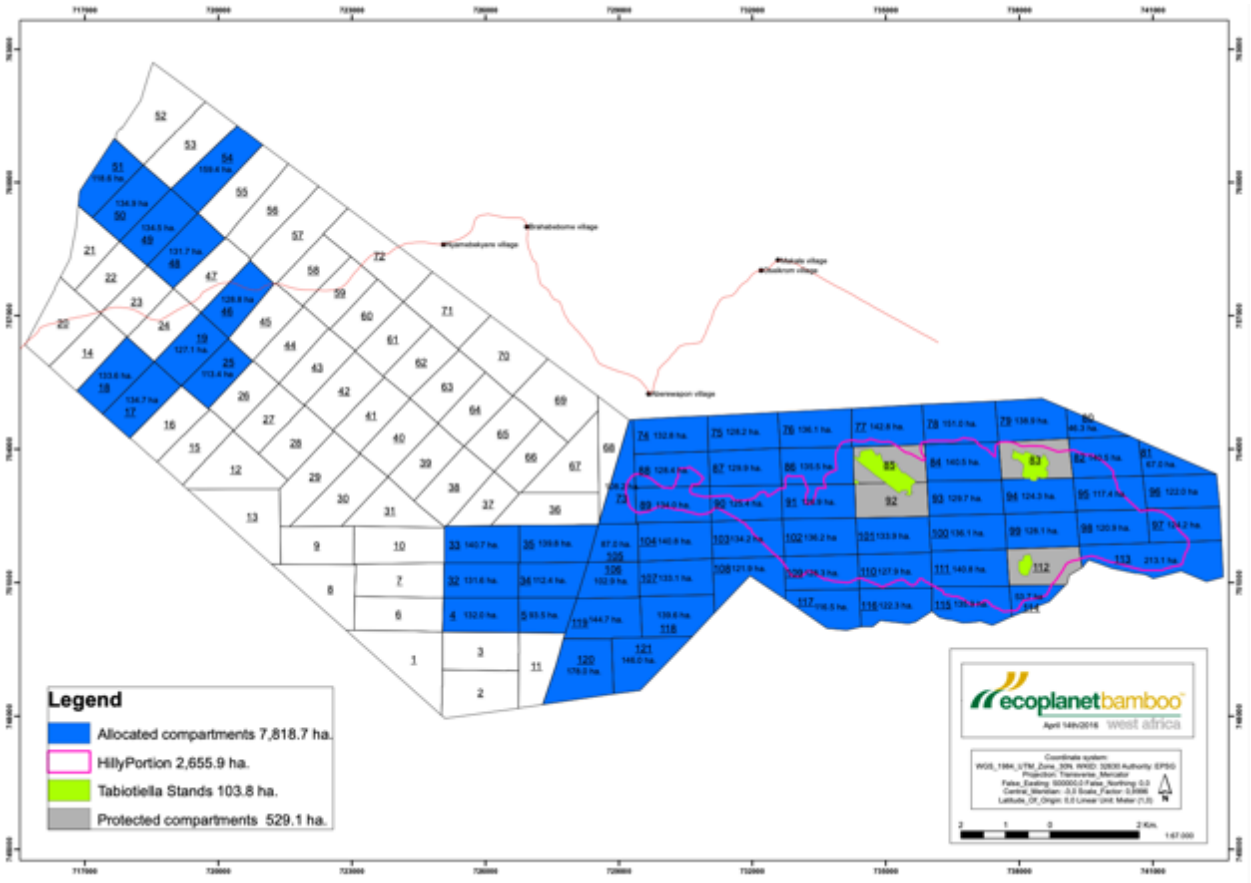
the baseline scenario - and furthermore that there is no negative impact associated with their planting. This is shown in Photo 5 below. The project includes the long term monitoring of these individual trees as part of its monitoring strategy and to ensure that the bamboo has no net harm on these trees. Such monitoring is described in Section 5 below.

Photo 5 Visualization of the Ecosystem Restoration Generated by Interplanting of Bamboo



During initial due diligence activities, the presence of an IUCN red list, critically endangered plant *Talbotiella gentii,* was identified by the Forestry Commission. This ever green small tree is endemic to Ghana and the project area, and is endangered primarily due to habitat loss. Subsequently, prior to the signing of the land lease the Forestry Commission identified and located any occurrences of this species. Three small stands were identified, specifically in compartments 83, 85/92 and 112. These areas were demarcated as "protected compartments" and removed from the project boundary and project area. However, the compartments around them were included in the project boundary with the target of reducing risks of illegal harvesting and / or fire that might result in the continued loss of this endangered species.

Figure 14 Location of *Tabiotella gentii* Stands & Associated Protected Compartments



Therefore, not only does the project not represent any net harm, but in contrast the reforestation activity and the permanent canopy that will be developed by the bamboo brings a suite of environmental benefits, in addition to the carbon removals and associated climate change benefits. These include:

- Protection of any remaining trees and forest patches at the start of the project activity;
- Restoration of degraded soils;
- Regeneration of additional ecosystem services, including healthy soils, water and biodiversity;
- Reduced risk of fire;

All activities included within the project are carried out in a low intensity manner, relying almost entirely on manual work, and with all activities working hand in hand with the full ecosystem.

Furthermore, the planting of the bamboo and its future potential to generate revenue if barriers can be successfully overcome, allows for the allocation of 45% of the total area of the project boundary to be set aside purely for the planting of native trees and associated regeneration of biodiversity. The carbon removals from these plantings are specifically excluded from the Bandai Hills Reforestation Project, however they would not be possible without the bamboo reforestation activity.

The project therefore does not have any potential negative environmental impacts that require risk mitigation activities.

Socio-Economic Impact: The project is being carried out on land that is under long term state controlled tenure and utilizes private financing. There are no communities directly involved in the project as stakeholders other than those that are actively employed by the project.

The project aims to positive impact the communities closest to its boundaries. These will also represent the source of employment for the reforestation activities, and therefore the project has been designed to maximize positive impact, while mitigating any potential negative impacts that arise from the reduction in illegal activities that such communities currently undertake within the boundaries of the Forest Reserve. Such activities are a direct factor of how close a community is located to the Forest Reserve, and the size of the community.

There are four fringe communities that are within the vicinity of the project boundaries. The most important and closest of these communities is the village of Aberewepon. Three additional communities are within the radius of impact, although are located at a considerable distance from the project boundaries. These represent the villages of Mankala-Oeikrom[8], Brahabebome and Nyambekere.

Increased economic activity in the project area is expected to result in significantly improved standards of living for these fringe communities through the following avenues:

- Creation of livelihood opportunities - bamboo is a manually intensive plant. As a result the bamboo reforestation activities will generate significant amounts of employment, both temporary and longer term. Secure employment and livelihood opportunities is one of the priority needs highlighted by fringe communities. Secure employment allows for additional funds to flow into communities where previously few opportunities existed;

- Empowerment of women – the project works to empower women, which in turn results in an increase in community spending on critical development aspects such as health and education;

- Sustainable development – the project implements an annual community development plan that adheres to international best practices, and targets key priority sectors identified by communities themselves as priority. These priorities were identified through community engagement meetings carried out before the start of project activities as being:

    - Employment: There are very limited employment opportunities available in the communities and most are not year round, resulting in economic vulnerabilities. The

[8] *The village of Mankala-Oeikrom is the closest community for the adjacent project, the North Bandai Reforestation Project with all sustainable development activities of this sister project targeting this community. As a result it is not included in the activities specifically related to the Bandai Hills Reforestation Project.*

provisions of attractive, long-term employment will be a main factor driving project impact.

- Access to Clean Water and Sanitation: Potable water scarcity is a major concern for local communities as is improved sanitation. Projects to improve access to clean water such as the development of boreholes or water catchment systems as well as toilet facilities were key priorities.
- Healthcare: Local healthcare is virtually non-existent. Support for programs that enable access to health care such as engaging a traveling clinic are priorities for the communities.
- Education: Quality of education and access to education are concerns due to poor funding of rural schools and long distances that children have to travel to school.
- Nutrition: Malnutrition from lack of access to nutritious foods is a major concern in the area. Capacity building on sustainable agriculture, selection of nutritious varieties of foods and improved farming methods can tackle this challenge.

Interviews with community members prior to the start of project activities have indicated that these communities currently carry out periodic illegal farming activities within the boundaries of the Forest Reserve, to differing extents. Farming land is not in short supply within the project area, however farming within the Forest Reserve represents a "free" resource, with farmers not having to make any payments for land use. In contrast, farmers traditionally pay up to 30% of the proceeds from their farming activities to local chiefs.

Despite such activities being illegal in nature illegal farming can take two forms of benefit to communities:

a) Where the activity is being undertaken on a larger scale, individuals are employed to provide manual labor of the crops, typically plantain. This potential loss of income is directly mitigated through the provision of more secure, legal and attractive employment opportunities, which have the following additional employment benefits which such workers would not currently benefit from:

    i. Enrolment into social security services
    ii. Daily meal
    iii. Provision of transportation & PPE
    iv. Training & education

    Therefore loss of employment from the reduction in illegal farming activities is not expected to have a negative impact on these communities.

b) Where the activity being undertaken is on a subsistence level, this has the potential to have negative impacts on the well being of the involved individuals and therefore this must be mitigated. All farming activities within the area are carried out as shifting cultivation, and rely on a very narrow selection of crops with a heavy reliance on plantain. Provision of land for farming within the project boundaries is strictly prohibited by the Forestry Commission. As a result, and given the shortage of land, mitigation measures must focus on improved productivity and agricultural intensification outside of the project boundaries.

The project proponent is working on a multi-generational (50+ year project) and therefore has a desire to ensure the long term positive impact on the surrounding communities. A five year program into the development of improved agriculture, with a focus on the initiation of agroforestry and syntropic farming based systems for fringe communities have been integrated into the project design. These activities are targeted to begin shortly after the project start date through the design of an initial pilot regenerative farm, with the integration of poultry, with additional technology transfer to farmers across the region.

As an additional mitigation measure the planting activities associated with the project have been designed to provide a 2-3 year timeframe before reaching the areas directly adjacent to this village (compartments 73, 74, 75, 87 and 88) to provide a sufficient timeframe for sustainable farming initiatives to be implemented and ensure no net harm.

The opportunity for the project to positively transform such communities through the combined provision of long term livelihood opportunities, training, and a financial contribution towards priority development projects as identified by such communities themselves, while mitigating any potential net harm associated with the reduction in illegal activities, is high.

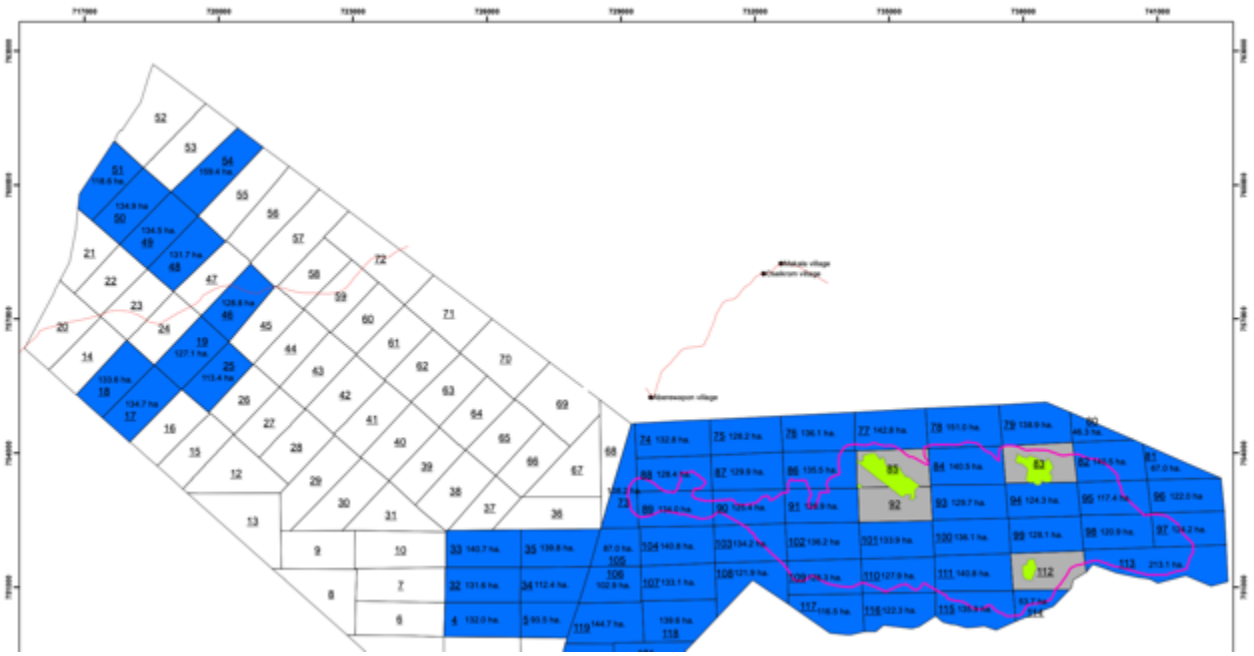
2.2 Local Stakeholder Consultation

Stakeholder Identification: there are four main groups of stakeholder involved in the project, in addition to the project proponent. These are defined as:

1. The Ghana Forestry Commission (GFC). The GFC are involved and consulted at all stages of its design and implementation of the project. The GFC benefits from an annual Ground Rent payment. Within this government body there are two following levels of management:
    a. Forestry Commission Head Office, Forest Services Division, Accra – responsible for the partnership with the project proponent;
    b. Forestry Commission District Office, Jusao – responsible for oversight and management of the North Bandai Forest Reserve, and providing support to the project proponent where needed.

2. The Agogo Stool. The Agogo Stool is the traditional leadership body for the region. Nana Sarpong is the Paramount Chief of the Agogo Area and the associated Agogo Stool. Under the terms of the Land Lease the Agogo Stool is represented through the Ghana Forestry Commission, who is responsible for all formal communications with this external stakeholder.
3. Fringe Communities: there are no communities living within the boundaries of the project. However those within the vicinity are termed "fringe communities", and defined as those adjacent to and considered to be within the area of influence of the Forest Reserve, were identified. There are three communities within the vicinity (Aberewepon, Makala and Oseikrom), as shown in the map below, that are identified as stakeholders and with whom the project proponent engages in continuous communication and engagement. Such communities are represented by a village Chief.
4. Employees: the project employs large numbers of unskilled workers, mostly from surrounding communities and the nearest town of Agogo.

Figure 15 Location of Aberewepong, Makala and Oseikrom Fringe Communities



The design of the project was carried out through on-going in person meetings and associated consultation between the project proponent and the sole local stakeholder, the Ghana Forestry Commission. Agreement on the key elements of the reforestation project design was a requirement prior to the securing of the relevant land lease for the North Bandai Forest Reserve. These consultations resulted in the "Reforestation Plan" being approved in May 2016. A copy of this document stamped with the Ghana Forestry Commission approval is available in project offices and to auditors.

Procedures for Engaging Stakeholders: in advance of the start of project activities in 2022, a number of meetings were undertaken. These meetings, the procedures for engagement and the form of documentation undertaken provided in Table 3 below.

Table 3 Summary of Stakeholder Meetings[9]

Stakeholder & Meeting Date	Method of Engagement	Documentation	On-Going Communication
Forestry Commission District Office 01 April 2021	Phone call for arrangement of in person meeting.	Minutes	Annual stakeholder meeting held in April each year in order to agree on the specific area to undergo reforestation activities, and any changes to the project design.
Forestry Commission Regional Office 21 July 2021	Phone call for arrangement of in person meeting.	Minutes	Participants agreed that all future communication will be directed to the District Office who will communicate as required to other offices.
The Agogo Stool 22 July 2021	Meeting arranged in Formal letter sent to request meeting 1 week in advance.	Minutes	Participants agreed that as the Agogo Stool is represented through the Forestry Commission, that there is no future requirements for formal engagement between the project proponent and this entity, and on-going communication and engagement will be done through the Forestry Commission.
Aberewepon Community Leaders* 27 July 2021	In person meeting with the Community Chief to arrange this engagement, 2 weeks in advance.	Minutes	Future community engagement follows EcoPlanet's Community Engagement Plan.

Following the above meetings, field visits with key stakeholders was carried out during the 2021 planting season in order to gain feedback and any recommendations for incorporation into the project design in advance of the 2022 project start date.

August 23 – 26th 2021 the project had a stakeholder field visit to the areas targeted for undergoing reforestation activities in 2022 including:

[9] Minute meetings and attendance registers are available for viewing by auditors in the project's Agogo offices.

- The Head of Plantations, Forest Services Division, Ghana Forestry Commission along with a technical team.
- District Manager, Ghana Forestry Commission, along with a team of forest rangers from this department.
- Management and technical team from EcoPlanet Bamboo.

On a continued basis stakeholders are engaged through a variety of means, including emails, phone calls, group WhatsApp messages, and in person meetings. EcoPlanet's corporate team holds monthly phone calls with the Ghana Forestry Commission Head Office, while the project General Manager in Ghana holds monthly meetings with the District Manager of the Forestry Commission, who is based in proximity to the project area.

Documentation Procedures: as described in Table 3 above, minutes and attendance registers are taken for all formal stakeholder engagement meetings.

Project Design Consultations: given that the project was designed in close co-operation with the Ghana Forestry Commission, no further input or any requested updates to the project design was given during these stakeholder engagements. However, a number of risks were raised during these meetings, which are detailed in section 2.5 below, along with details as to actions undertaken as a result of the received input.

Project Communication of Key Aspects

i. Project design, implementation and results of monitoring: In July 2021, meetings were held with the Forestry Commission regional office in Kumasi, the district office in Juaso and the local office in Agogo to provide updates on the project activities to date, provide details on the project design and plan of reforestation activities and to inform these entities on mechanisms for on-going engagement and grievance reporting. Further meetings were held with the Chief of Agogo and local community leaders of the fringe communities to get their input on the project. These meetings all had a component of providing an overview of the project, a discussion forum for participants to ask questions and share their feedback on the potential impacts of the project as well as be informed of procedures for reporting grievances or sharing further feedback. All meeting logs and minutes are available in the project officers for viewing by auditors.

ii. Risks, costs and benefits of the project to local stakeholders: a due diligence analysis was carried out prior to the signing of the land lease agreement between the project proponent and the Ghana Forestry Commission. This assessment provided an analysis to both sides of the risks, costs and benefits, and formed the basis of the executed agreements. These legal documents are available to auditors.

iii. Relevant laws and regulations covering workers' rights: the project proponent has a strict set of environmental health and safety procedures against which all operations occur. During the

initiation and training period of new workers, all details surrounding workers' rights are provided. Such rights are also discussed during monthly meetings where workers have the chance to ask questions. Printed and laminated copies detailing key aspects are available within strategic locations in the project area. Furthermore, the project is committed to undertaking Forest Stewardship Council (FSC) certification within 2 years after the completion of planting activities. FSC has strict procedures on workers' rights.

iv. Community engagement plans: following the July meetings the Community Liasion Officer worked with community committees from the three fringe communities to develop an annual engagement plan for 2022, targeting in-direct project activities to occur outside of the project boundaries.

v. The process of VCS program validation and site visit: prior to validation the project proponent has been in continuous communication with the key local stakeholder – the Forest Services Division of the Ghana Forestry Commission – located at the Forestry Commission headquarters in Accra. At the project site, a formal introduction of the carbon validation project was conducted with the district office of the Forestry Commission in April 2021. The meeting was held between the project acting General Manager, and the Forestry Commission District Manager and included the provision of information on the carbon benefits of the project, the up-coming validation process, to inform the district office of the project's mechanisms to report on grievances. During the first week of March 2022 all workers and employees were provided information regarding the upcoming VCS validation and the scheduled site visit of the auditor.

Use of Non Native Species: With regards to the use of non-native species, the Verra Standard v4.3 states that "To reduce damage to the ecosystems on which the local stakeholders rely:" "The project shall justify the use of non-native species over native species, explaining the possible adverse effects of non-native species". The project is using non native species that are not expected to have any adverse effects on local ecosystems and instead has been designed specifically to enhance and restore the functions of such ecosystems. A description of the choice of species has been provided in Section 1.11 and Section 2.1 above.

The use of such species has been approved by the Ghana Forestry Commission. However, there are no stakeholders that rely on the project area, due to its status as a Forest Reserve. As such there is no potential for negative impact from the choice of non-native species.

2.3 Environmental Impact

An EIA is not a requirement for the project activities, given the tenure of land, and the approval of activities by a government body, the Ghana Forestry Commission. However, the project proponent carried out an

extensive internal environmental impact assessment for the project area as part of its feasibility and due diligence process, which is available in the project's Agogo offices.

2.4 Public Comments

The public comment period for the project ran from 04/04/2022 to 04/05/2022. No public comments were received during this period.

2.5 AFOLU-Specific Safeguards

Respect for Local Stakeholder Resources: There are no communities or individuals living within these forest reserves and due to this structure of land tenure, none that have any access or resource rights. The Ghana Forestry Commission is the sole local stakeholder that holds any rights to the land or resources within the project area, within the North Bandai Forest Reserve. Given that this entity has approved the project activities as being aligned with national development strategies and the desired restoration of these degraded forest reserves. There are no other stakeholders that hold any property rights and therefore there is no likelihood of the project impacting local stakeholder property rights, and therefore no associated stakeholder mitigation measures are required. Mitigation measures for any negative impacts that might occur as the result of the project reducing the occurrence of illegal activities has been detailed in Section 2.1 above.

The project activities are related only to the active planting and restoration activities, and subsequent maintenance and protection of the planted bamboo within the project boundaries. With the exception of employment opportunities, the project has no direct impact on areas outside of the project boundary, although the project engages in indirect sustainable development activities as described in Section 2.1 and 2.2 above.

The project is not introducing any invasive species, and ensures that no invasive project be allowed to thrive through project implementation. Justification as to the choice of species is provided in Section 2.1 above.

The project does not utilize any chemical pesticides or biological control agents. Use of fertilizers is limited and managed under strict forest management plans, that are designed and implemented by qualified personnel.

Risks, Costs and Benefits to Stakeholders:

Benefits: The project aims to create long term job opportunities and associated positive socio-economic change in the project region. As such, employees have an interest in the success of the project to the extent that they are able to maintain employment and their livelihoods, and as employees they have the

potential to affect and be affected by the project. Strong and positive relationships are therefore a key aspect to ensure long term success of the reforestation activities.

Risks: There are no communities or individuals with any property, customary or resource rights to the project area. In contrast the Ghana Forestry Commission is the sole local stakeholder that holds any rights to the land or resources within the project area, within the Bandai Hills Forest Reserve. Given that this entity has approved the project activities as being aligned with national development strategies and the desired restoration of these degraded forest reserves

The sole identified potential risk to stakeholders relates to enforcement of no farming to occur within the project boundaries and the potential negative impact on fringe communities. Opportunistic illegal farming is sometimes found within the project boundaries. During pre-project implementation meetings with fringe communities, it was conveyed that strategies that reduce the impact on these farmers should be considered as part of the planting strategy such as allowing crops to initially stand until they can be harvested and offering jobs to illegal farmers as alternative livelihoods. These aspects have been included in the project's design. Furthermore a long term community engagement program that targets the transfer of technology for improved farming techniques will be implemented beginning in Q3 2021.

Sexual Harassment: neither the project proponent nor any other entity involved in the project design or implementation has been involved in any form of discrimination nor sexual harassment. The project proponent operates a zero tolerance policy for such discrimination and / or harassment.

Management Teams: the project proponent comprises of experienced management teams that have expertise and prior experience working within the project area, and within similar contexts and at the same project scale. This experience includes both the operational experience necessary to implement such a project at the targeted scale, as well as the carbon aspects of project management. The project management team includes qualified individuals across all necessary skills, including a dedicated community liaison manager and community engagement teams.

Procedures for On-Going Stakeholder Communication: the project proponent has a set of Environmental Health & Safety Standard Operating Procedures (EH&S SOPs) that guide all operations, including stakeholder communication and consultations. These procedures include EH&S Standard Operating Procedure #7 "Communication Procedure", which specifically deals with stakeholder consultations:

- Annual Meetings: formal stakeholder meetings are held annually with external and internal stakeholders, which cover: An update on project activities;
    - Results of any monitoring or changes to the project in the last year;
    - Discussion on project impacts, including risks costs and benefits the project may bring;
    - Review of relevant laws and regulations covering workers' rights;

- Annual Reforestation Plan: in Q4 of each year the project proponent provides the Forest Services Division of the Ghana Forestry Commission the plan for the following year's reforestation activities. This includes the specific areas to be targeted for reforestation activities, as well as the proposed location of fire breaks and other key operational aspects.
- Bi-Annual Meetings: once a quarter the General Manager of the project meets with the full team to discuss any concerns, issues, complaints or grievances.
- Monthly Meetings: on the first working day of each month the General Manager meets with the full team to discuss updates, priorities and work plans for the month.
- Weekly Meetings: each Monday the General Manager meets with the Foresters to discuss the achievements of the previous week, challenges, and the schedule for the week ahead.
- World Bamboo Day: September 18th is World Bamboo Day. The project proponent uses this annual opportunity to provide environmental education and detailed understanding surrounding the project's reforestation activities to Forestry Commission teams, employees and surrounding communities.
- The General Manager is in daily contact with EcoPlanet's corporate team which provides comprehensive support functions.
- The General Manager and project team is in daily contact with the District Manager of the Ghana Forestry Commission.

Communication with Fringe Communities: quarterly community meetings is carried out with each of the key fringe communities, under a structured and on-going manner. During these meetings general updates on the project are provided, communities are engaged in an open discussion during which questions are answered, and are given an opportunity for complaints to be raised. The project has also employed a full time Community Engagement Liaison Officer who is responsible for continuous engagement.

In addition to the team meetings detailed in Section 2.4 above, the project has in place a Complaints, Grievances, Disputes & Conflict Resolution Mechanism, which has been made available to the validation body.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

The project is utilizing the below approved CDM methodology:

AR-ACM0003 A/R Large-scale Consolidated Methodology: Afforestation and reforestation of lands except wetlands Version 02.0

The methodology requires the use of a number of tools. The following A/R methodological tools are applicable to the project activity and the carbon sinks under development:

- "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities";
- Tool for the "Estimation of Carbon Stocks and Change in Carbon Stocks of Trees and Shrubs in A/R CDM Project Activities" UNFCC/CCNUCC 2011a
- Tool for "Estimation of Change in Soil Organic Carbon Stocks due to the Implementation of Project Activities" UNFCC/CCNUCC 2010a;
- Tool for the "Estimation of Carbon Stocks and Changes in Carbon Stocks of Dead Wood and Litter in A/R CDM Project Activities" UNFCC/CCNUCC 2010;
- Tool for the "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity" UNFCC/CCNUCC 2011;
- Tool for the "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in the A/R project activity" UNFCC/CCNUCC 2011;
- Tool for "Demonstrating Appropriateness of Allometric Equations for Estimation of Aboveground Tree Biomass in A/R CDM Project Activities" UNFCC/CCNUCC 2011;
- Tool for the "Calculation of the Number of Sample Plots for Measurements within A/R CDM Project Activities" (UNFCC/CCNUCC 2009)

3.2 Applicability of Methodology

The VCS allows for the use of accepted CDM methodologies.

The project activities meet the following required eligibility requirements, as described in Section 2.2 of the methodology:

Applicability Condition: The land subject to the project activity does not fall in wetland category.

Project Justification: As per the IPCC GPG LULUCF 2003, wetlands are defined as lands that are covered or saturated by water for all or part of the year (e.g., peatland) and that does not fall into the forest land, crop land, grass land or settlements categories including reservoirs, natural rivers and lakes. The project site consists of forest land and does not cover any wetlands. Hence, this criterion is applicable.

Applicability Condition: Soil disturbance attributable to the project activity does not cover more than 10 per cent of the area in each of the following types of land, when these lands are included within the project boundary":

- "Land containing organic soils"
- "Land which, in the baseline, is subjected to land-use and management practices and receives inputs listed in appendices 1 and 2 to this methodology" - the baseline prior to the project start date was degraded transitional forest lands, which had no active management or inputs, as described in section 3.4.

Project Justifications

i. The soils in the project area are classified as sandy loam soils, as described in Section 1.13.
ii. The lands of Appendix 1 refer to cropland in which soil disturbance is restricted. The project activities are not occurring on cropland. Therefore, the project area does not classify as land listed in Appendix 1.

    The lands of Appendix 2 refer to grassland in which soil disturbance is restricted. There are no grasslands in the project area with the use of any inputs. Therefore, the project area does not classify as land listed in Appendix 2.

The methodology requires the use of a number of tools, as detailed in Section 3.1 above. The applicability conditions and associated project justifications of each tool is detailed in the table below.

Table 4 Tool Applicability Conditions and Associated Justifications

Tool: Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities	
Applicability Condition	**Justification**
a) Forestation of the land within the proposed project boundary performed with or without being registered as the A/R CDM project activity shall not lead to violation of any applicable law even if the law is not enforced.	a) The project is in compliance with applicable legal and regulatory requirements. (See section 1.14)
b) This tool is not applicable to small - scale afforestation and reforestation project activities	b) This project is not a small-scale afforestation and reforestation project, as it does not fulfil the small-scale conditions as defined by VCS (VCS Program Definition Booklet).
Tool: Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities.	
Applicability Condition	**Justification**
No applicability conditions	No justifications required
Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities	
Applicability Condition	**Justification**
This tool is applicable when the areas of land, the baseline scenario, and the project activity meet the following conditions: a) The areas of land to which this tool is applied: i. Do not fall into wetland category; or ii. Do not contain organic soils as defined in "Annex A: glossary" of the IPCC GPG LULUCF 2003. iii. iii. Are not subject to any of the land management practices and application of inputs as listed in the Tables 1 and 2.	a) Project lands are not wetlands or peatlands. The project area is characterized as agricultural land. The type of soil in the project area are clay, loamy, sandy and sandy loam soils as described in section 1.13. Such croplands under tropical conditions have less carbon compared to plantations and forest cover. The lands of Table 1 refer to cropland in which soil disturbance is restricted. The project area is not cropland. Therefore, the project area does not classify as land listed in Table 1. The lands of Table 2 refer to grassland in which soil disturbance is restricted. There are no grasslands in the project area with the use of any inputs. Therefore, the project area does not classify as land listed in Table 2.

b) The A/R CDM project activity meets the following conditions: i. Litter remains on site and is not removed in the A/R CDM project activity; and ii. Soil disturbance attributable to the A/R CDM project activity, if any, is: • In accordance with appropriate conservation practices, e.g., follows the land contours. • Limited to soil disturbance for site preparation before planting and such disturbance is not repeated in less than twenty years.	b) Soil disturbance associated with the project activities are limited to those during site preparation (digging of holes to plant seedlings).

Tool for the estimation of carbon stocks and changes in carbon stocks of dead wood and litter in A/R CDM project activities	
Applicability Condition	**Justification**
This tool is not applicable if the displacement of agricultural activities is expected to cause, directly or indirectly, any drainage of wetlands or peat lands.	The project is carried out in an area of the dry transitional forest zone of Ghana. There are no wetlands or peatlands within the project area or surroundings.
Applicable to all occurrence of fire within the project boundary.	The project is located in an area where uncontrolled fires occur in the baseline scenario.
Applicable when an area greater than the minimum threshold area reported by the host Party for the purpose of defining forest, provided that the accumulated area affected by such fires in a given year is ≥5% of the project area.	No justifications required, measured ex ante.

Tool for the estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity	
Applicability Condition	**Justification**
No applicability conditions	The project activities do not include the burning of woody biomass for the purpose of site preparation, or as part of forest management.

Tool for the estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R CDM project activities	
Applicability Condition	**Justification**
This tool is not applicable if the displacement of agricultural activities is expected to cause, directly or indirectly, any drainage of wetlands or peat lands.	The project is carried out in an area of the dry transitional forest zone of Ghana. There are no wetlands or peatlands within the project area or surroundings.

Tool for demonstrating appropriateness of allometric equations for estimation of aboveground tree biomass in A/R CDM project activities

Applicability Condition	Justification
No applicability conditions	No justifications required
Tool for the calculation of the number of sample plots for measurements within in A/R CDM project activities	
Applicability Condition	**Justification**
No applicability conditions	No justifications required
Tool for the identification of degraded or degrading lands for consideration in implementing CDM A/R project activities	
Applicability Condition	**Justification**
No applicability conditions	No justifications required

3.3 Project Boundary

The carbon pools and GHG included in the baseline and project scenarios are described in the table below.

Table 5 Project Carbon Pools & Included GHG in the Baseline (Top) and Project (Bottom) Scenario

Source		Gas	Included?	Justification/Explanation
Baseline	Above and Below Ground Biomass	CO_2	Yes	These are the major carbon pools for both the baseline and project scenario.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.
	Soil Organic Carbon (SOC)	CO_2	No	The increase in SOC over the 20 year project period is estimated as an annual increase, following the applicable tool. Therefore, this carbon pool is not included in the baseline, but is included within the project scenario.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.

Source		Gas	Included?	Justification/Explanation
	Dead Wood	CO_2	No	Given the trend of deforestation and degradation within the project boundary, the project activities are expected to result in an increase in dead wood in comparison to the baseline scenario. Excluding this carbon pool from the baseline scenario is therefore considered to be conservative.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.
	Litter	CO_2	No	Given the trend of deforestation and degradation within the project boundary, the project activities are expected to result in an increase in litter in comparison to the baseline scenario. Excluding this carbon pool from the baseline scenario is therefore considered to be conservative.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.

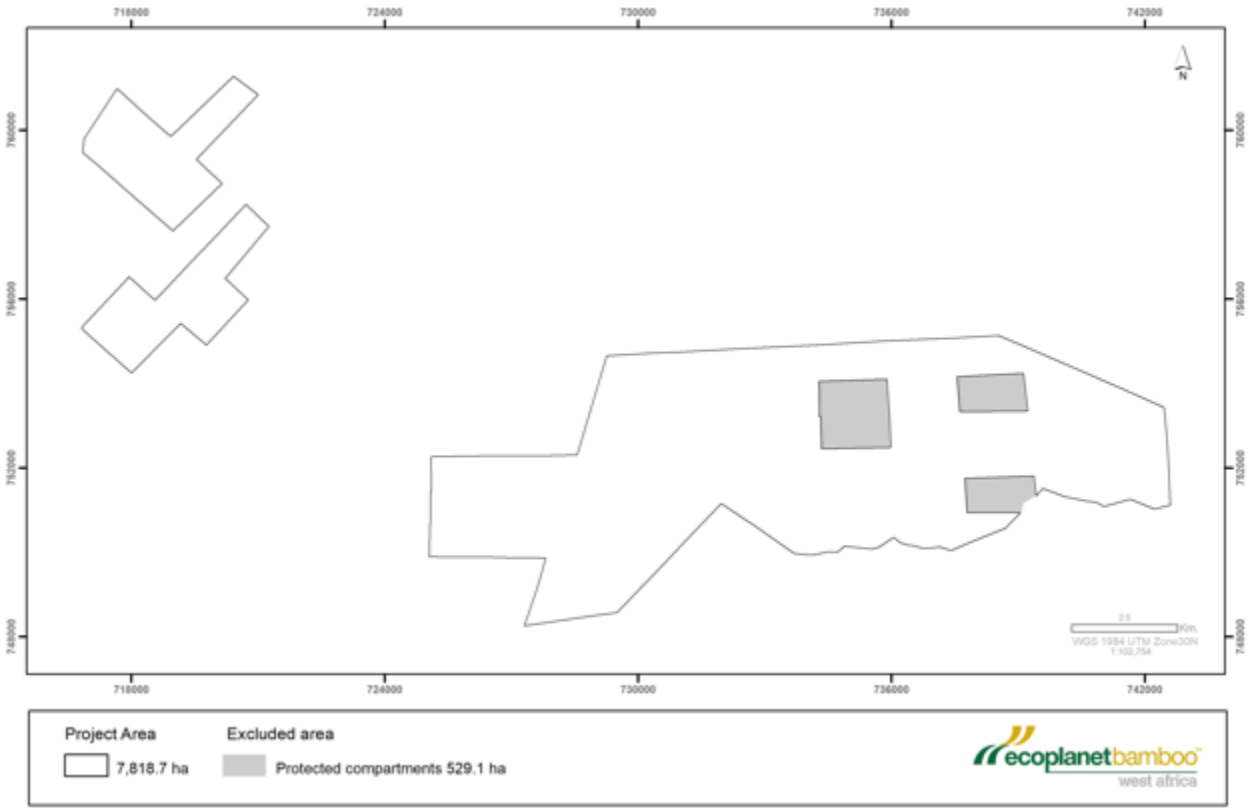
Source		Gas	Included?	Justification/Explanation
Project	Above and Below Ground Biomass	CO_2	Yes	These are the major carbon pools for both the baseline and project scenario.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.
	Soil Organic Carbon (SOC)	CO_2	Yes	The project activities are expected to trigger an increase in SOC over time as assessed using the applicable tool.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.
	Dead Wood	CO_2	No	The ecological growth patterns of clumping bamboo means that there is a constant number of culms that die, as new culms emerge during each annual growing season. These are

Source		Gas	Included?	Justification/Explanation
				thinned but are not left on site and therefore this pool is not included within the project scenario.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.
	Litter	CO_2	Yes	The bamboo clumps drop significant volumes of leafy material each year, resulting in an increase in this carbon pool.
		CH_4	No	Excluded as per the requirements of the methodology
		N_2O	No	Excluded as per the requirements of the methodology
		Other	No	There are no other GHG sources relevant for the chosen baseline scenario.

Table 6 Emission Sources and GHGs Selected for Accounting

Source		Gas	Included?	Justification/Explanation
	Burning of Woody Biomass	CO_2	No	As per the terms of the methodology, CO_2 emissions due to burning of biomass are accounted as a change in carbon stock.
	Burning of Woody Biomass	CH_4	No	The project activities do not include the burning of woody biomass for the purpose of site preparation, or as part of forest management.
	Burning of Woody Biomass	N_2O	No	The project activities do not include the burning of woody biomass for the purpose of site preparation, or as part of forest management.

Figure 16 Project Boundary



The project boundaries of the 7,818.7 ha land under the project proponent's management at the time of validation are shown above. The KMZ image of the project area on which GHG emission removals will be generated is available in Section 1.12, Figure 5 above.

The project boundary covers 3 unique areas with a total project area of 7,372.6 hectares. The GFC delineates Forest Reserves into "compartments" which are areas of varying size. Within the project boundary are 4 compartments that, during initial feasibility studies, were found to contain an IUCN red list species, *Tabiotella gentii* and were set aside as protected compartments for conservation purposes. This combined area of 529.1 is excluded from the land lease held by EcoPlanet and therefore excluded from the project boundary and total available area for the bamboo reforestation activities.

Within the project area of 7,818.7ha the project proponent intends to plant approximately 3,500 net ha of bamboo, totaling 1.5M individual bamboo clumps. The actual area covered by the planting of this 1.5M individual bamboo clumps will be larger, due to the presence of scattered standing trees, all of which are left untouched and protected. At the time of validation, the project area, where net emission removals will occur is a total area of 7,372.6 ha. A KML file of the project area has been provided.

The remainder of the area within the project boundary includes 186.6 ha classified as forest at the project start date, and 248.2 ha of lands where deforestation has occurred in the 10 years prior to the project start date, as well as 11.3 hectares of roads and firebreaks.

However given the size of the project area, ground truthing at the time of planting will refine the project area. Therefore updating of the project area has been included within the monitoring plan described in Section 5.

3.4 Baseline Scenario

The chosen methodology requires the use of the following tool for the demonstration of the baseline scenario: *"A/R Methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" (Version 01").*

This tool provides a step-wise approach to identify the baseline scenario and simultaneously demonstrating additionality for A/R project activities. The project meets the applicability conditions of the tool:

- The reforestation activities do not lead to any violation of any applicable laws;
- The project is not a small-scale activity.

The project has followed the five steps of the tool as described below.

STEP 0: Preliminary screening based on the starting date of the A/R project activity

The project is not a CDM project, but utilizes a CDM methodology due to the unavailability of a suitable VCS methodology at the time of validation. The project starting date is June 1st 2022 and the validation audit occurred in April 2022, prior to the project start date. The date of project registration is pending. The project was designed from the start as a carbon financed reforestation activity, as evidenced from relevant documentation[10],[11] provided to auditors during the validation process and as demonstrated through the Additionality Assessment below.

STEP 1. Identification of alternative land use scenarios to the proposed A/R CDM project activity

Sub-step 1a. Identify credible alternative land use scenarios to the proposed A/R CDM project activity

The proposed project activities are occurring within a single Forest Reserve, the Bandai Hills Forest Reserve, located within the Ashanti Region of Ghana. As such, all land included within the project boundary falls under the legislative framework of "Forest Reserves", which significantly limits the type of activities that could realistically occur in the absence of the project. These areas, which were officially

[10] Bandai Hills Benefit Sharing Agreement 2016;

[11] Interviews with the Government of Ghana, through the Ghana Forestry Commission

designated between 1922 and 1948 and are distributed across the major ecological zones of the country to were set aside for four main purposes:

a) Watershed and ecosystem management;

b) Protection from rapidly expanding agricultural operations, in particular cocoa;

c) To provide representative samples of the ecological and genetic diversity of species found across the country;

d) To provide micro climates for surrounding cocoa and other agricultural plantations;

Since this time the land areas included within the designated boundaries of such Forest Reserves has been under the management of the Government of Ghana, through the Ghana Forestry Commission, maintained and managed for the above purposes. No human occupation or settlements have occurred in the period since. As a result, the activities that could legally occur within this categorization of land are limited to either pure conservation activities, or commercial plantation forestry activities with a focus on the production of timber species for subsequent harvesting while maintaining the above unique attributes of these Forest Reserves.

This legal classification has unfortunately not resulted in the protection of Ghana's remaining forest resources. Across Ghana as a nation, deforestation continues. A 2016 study by Tappan et. al.[12] reported a 24% decrease in forest cover between 1975 and 2013, citing unsustainable agricultural practices as the dominant driver of such deforestation. Another peer reviewed study in the International Journal of Environmental Monitoring & Analysis[13] states that Ghana's rate of deforestation accelerated in the period from 1990 – 2010, representing an area of more than 2.5 million hectares of forest loss during this period.

Within the context of the project boundaries the same trend has occurred. The majority of deforestation of the original forest ecosystem occurred prior to 1998 and the land use trend since then has continued to be one of forest loss.

The Ghana Forestry Commission describes the project area as a "Degraded Forest Reserve"[14] within the official Public Private Partnership legal documentation.

The following alternative land use scenarios have therefore been identified:

i. Alternative Scenario 1: Continuation of the pre-project land use;

[12] https://eros.usgs.gov/westafrica/data-downloads

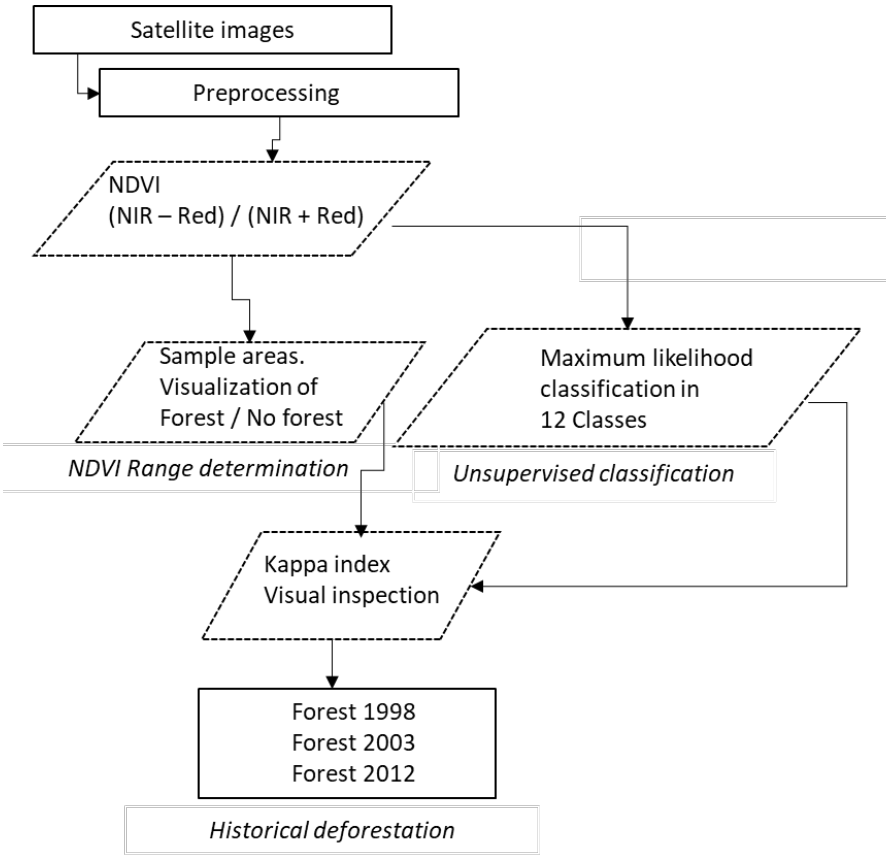
[13] Ikpe Emmanuel Quacou. Unsustainable Management of Forests in Ghana from 1900-2010. International Journal of Environmental Monitoring and Analysis. Vol. 4, No. 6, 2016, pp. 160-166. doi: 10.11648/j.ijema.20160406.14

[14] Land Lease Agreement for the Degraded Bandai Hills Forest Reserve.

The pre-project land use is one in which continued degradation of the remaining forest resources occurs, resulting in a conversion of the ecosystem to one of invasive grasses[15].

Within the project boundaries, a GIS and remote sensing analysis of the period between 1998 to 2012, representing 10 years before the project start date, shows that the pre-project scenario reflected this national trend. The following steps were undertaken:

Figure 17 Workflow of Remote Sensing Analysis of Historical Deforestation



The following satellite images were analyzed:

Figure 18 Temporal Analysis of Available Satellite Data

Sensor/Mission Date	Spectral Resolution (µm)	Spatial Resolution Pixel Size	Radiometric Resolution
Thematic Mapper ™/ Landsat 5 **1998-03-01**	Visible: Blue (0.45-0.52), Green (0.52-0.60) Red (0.63-0.69)		

	NIR Near Infrared (0.76-0.90), MIR Medium Infrared (1.55-1.75)	30 m	8 bits
Enhanced Thematic Mapper Plus (ETM+) /Landsat 7 **2003-07-26**	Visible: Blue (0.45-0.52), Green (0.52-0.60), Red (0.63-0.69) NIR Near Infrared (0.77-0.90)	30 m.	
Sentinel 2 **2012-02-09**	Visible: Blue (0.45-0.52), Green (0.54-0.57), Red (0.65-0.68) NIR 1 (0.78-0.90)	10 m.	12 bits.

The project area is under the jurisdiction of the Ghana Forestry Commission which uses the following definition of forest:

Forest: A community of trees on land with a minimum area of 1 hectare, minimum tree crown cover of 15%, or with existing tree species having the potential of attaining at least 15% crown cover, with trees that have a minimum height, or the potential to achieve a height of 5.0 meters at maturity in situ[16].

The image processing involves the establishment of a common scale of analysis to allow its comparison, the computation of index that calculate, discriminate, and classify land cover accurately, obtaining historical deforestation maps.

Preprocessing: the use of LANDSAT images -derivative of 8 bits- and Sentinel 2 -derivatives of 12 bits-, requires prior radiometric calibration to eliminate alterations in the registration of the image because of weather conditions, in addition to providing a common radiometric scale by obtaining values of reflectance. The lighting adjustment was made with the digital elevation model of 15m ASTER. The parameters of visibility and reflectance of the terrain were established for rural type aerosol in tropical conditions, with constant visibility of 30 km. The preprocessing was performed through the ATCOR algorithm of Focus PCI Software.

The NDVI is a dimensionless index that describes the difference between visible and near-infrared reflectance of vegetation cover and can be used to estimate the density of green on an area of land, Values close to one correspond to the presence of vegetation and close to zero to absence.

[16] **Ghana Forest Plantation Strategy 2016-2040;** page 62, available for download here.

Determination of NDVI values and ranges for forest/no forest – a visual inspection of the image for forest/no forest identification, determination of 40 sample areas (20 each class) & the extraction of the NDVI value of the sampling areas to a text file for later statistical analysis (average).

Table 7 NDVI Ranges Analyzed for Land Cover Determination

NDVI Ranges			
Class	1998	2003	2012
No Forest	0-0.80	0-0.7	0-0.74
Forest	0.81-1	0.71-1	0.75-0.9

By 1998 only 835.5 hectares of forest was still standing across the project area. During the subsequent 14 years this remaining forest area had been reduced by >58%, with only 358.9 ha of forest still occurring within the project boundary in 2012, 10 years prior to the project start date.

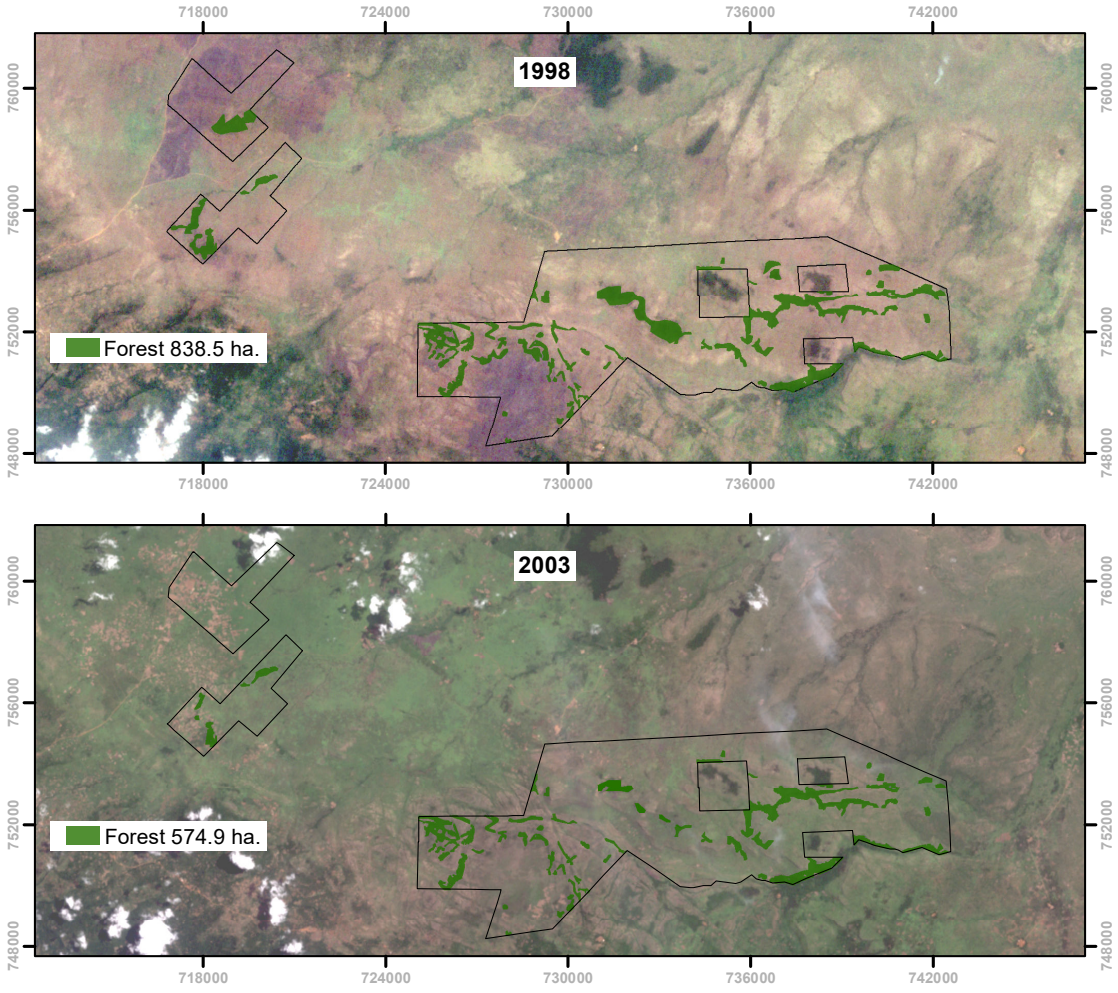
This analysis, combined with visual evidence from different parts of the project boundary, shows that the pre-project land use results in a slow deterioration of forests into open woodlands and ultimately to grasslands, where the land is then converted to use for agricultural purposes. This history has been driven by the following key activities:

- During the period prior to 1998 during the timeframe of heavy deforestation across the country, it is likely that logging of the indigenous hardwoods and valuable timber species occurred.
- This opened up the forest to small scale loggers, predominantly for charcoal production. Charcoal remains the most significant driver of deforestation in Ghana[17] and its illegal production continues today within the project area. The removal of select trees for charcoal production results in continued degradation of the forest reserve.
- As the forest canopy decreases small scale farming activities increases. Such activities are short term given their illegal nature and the periodic patrolling by the Forestry Commission, but serve to further reduce canopy cover.
- As the forest canopy decreases pioneer grasses are able to establish themselves. This attracts the periodic and illegal movement of nomadic Fulani herdsmen with their cattle to move through the Forest Reserve in the drier months. The presence of such grasses results in an increase in forest fires.
- Such fires in turn drive additional forest loss, causing a negative feedback loop and resulting in a transitional ecosystem from forest to open woodland and ultimately to a fire prone grassland.

[17] Amoah, A. & Korle, K; 2020. Forest Depletion in Ghana: the empirical evidence and associated driver intensities. *Forest Economics Review*. Vol. 2 No 1, pp 61-80

- Small patches of what appears to be reforestation are seen to occur between 2011 and the project start date of 2021 on available imagery on Google Earth. However, these areas are not able to achieve the national definition of forest, due to the occurrence of fire, which stunts or more often kills any new re-growth[18]. Fire is only controlled once the project proponent became increasingly active in the project area after the project start date of 2021.

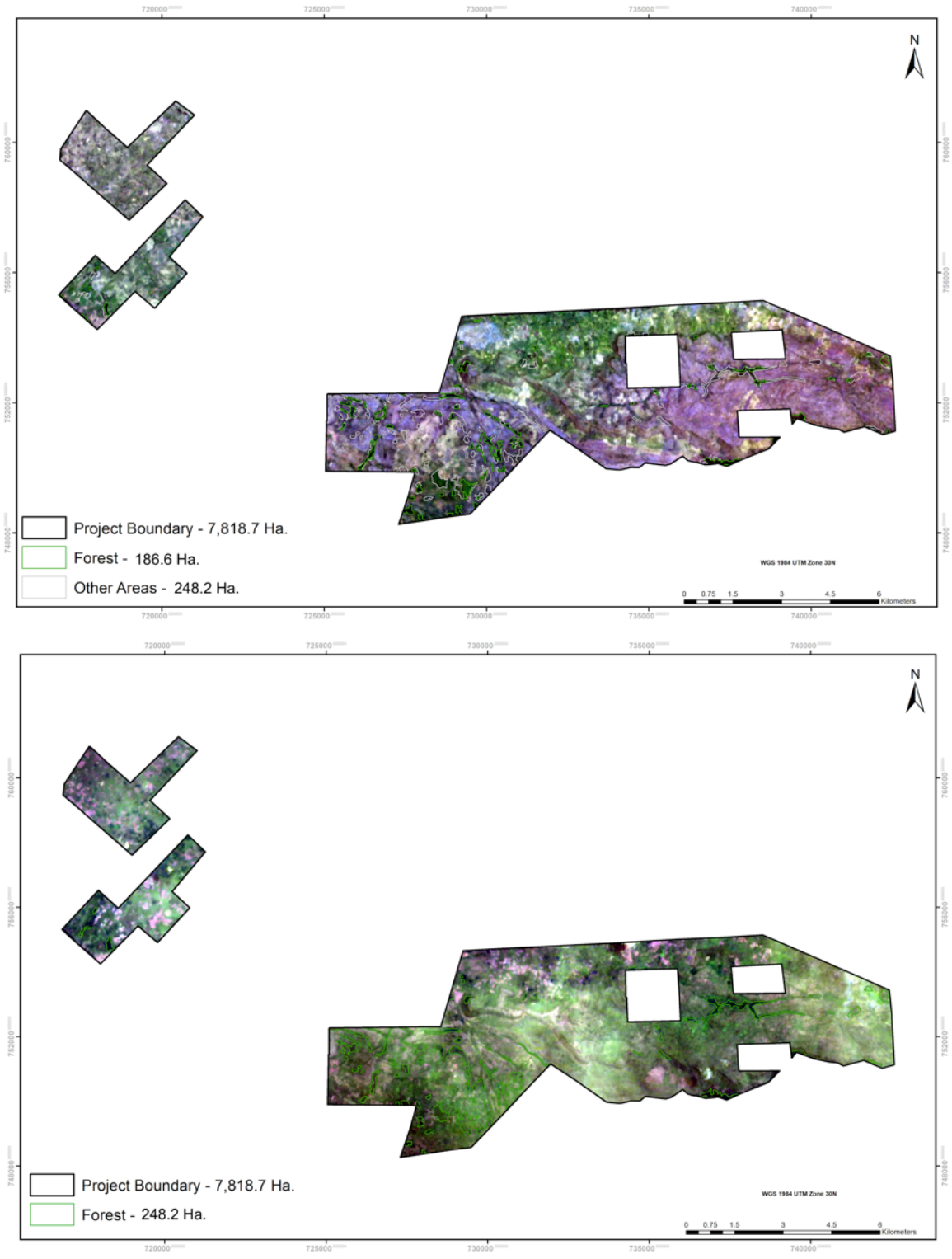
Figure 19 Pre Project Forest Cover Loss 1998 - 2012



Forest cover loss continued through the period leading up to the project start date. Figure 19 shows this trend within the 10 years prior to the project start date, as well as the 186.7 hectares of remaining forest by August 2020.

[18] Field observances, validation audit 04.2022.

Figure 20 Forest Cover Trend 2011 & 2020



A further remote sensing analysis was carried out showing the density of standing trees at the project start date, which emphasizes the different stages of this transitional ecosystem. The following process was undertaken:

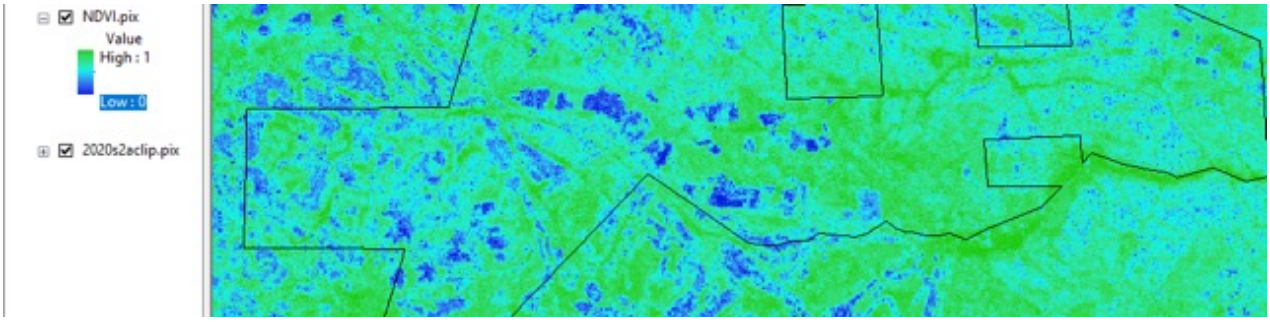
Step 1: definition of 40 sample/training areas, 10 for each vegetation density through visual inspection of the image.

Figure 21 View of Different Vegetation Densities & Sample Areas



Step 2: vegetation index calculation: NDVI = (NIR – Red) / (NIR + Red) with easy model algorithm of PCI geomatics.

Figure 22 NDVI Distribution Across Project Area



NDVI overview: Areas with no trees, low vegetation, moderate vegetation, and forest are shown in dark blue, light blue, light green & dark green respectively.

Table 8 Result of NDVI Ranges

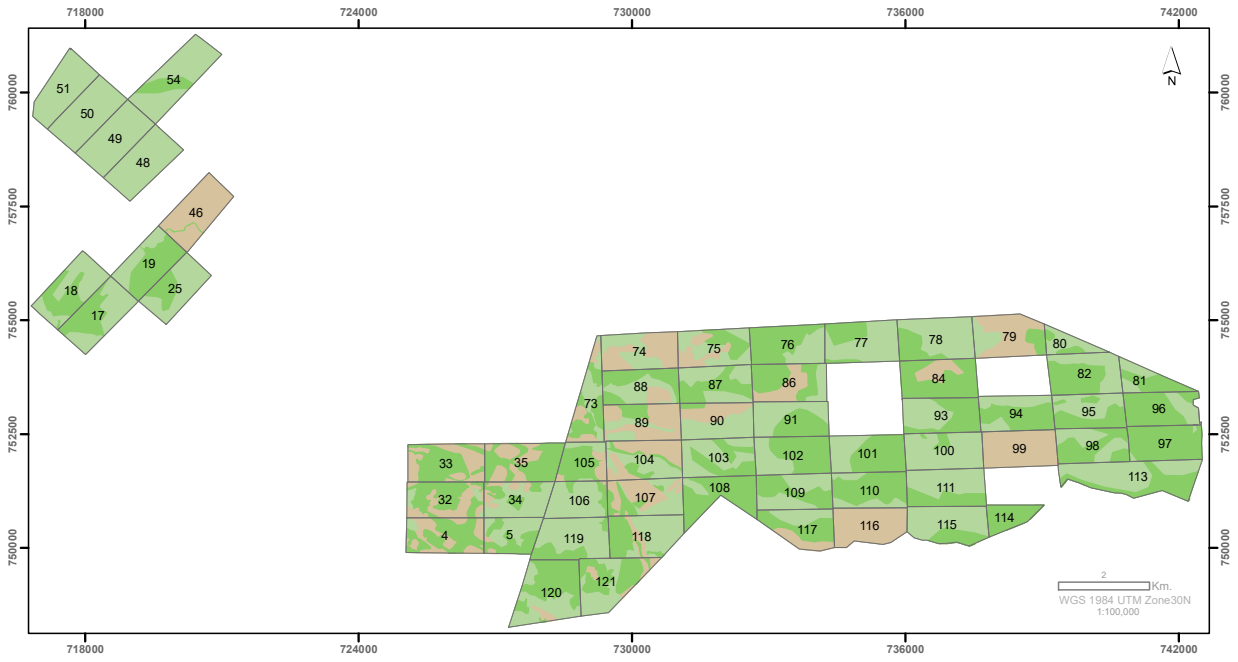
Vegetation Density	Ranges
No trees	0-0.4
Low	0.41-0.6
Moderate	0.61-0.84
Forest	0.85-1

Step 3: Supervised classification of NDVI using the 40 sample areas training areas for the system, performed with maximum likelihood classification.

Step 4: Visual inspection comparing the classification results and NDI vegetation density ranges to identify and fix any misclassified areas. This process is critical because it incorporates visual analysis, improving classification accuracy.

Step 5: Conversion to polygons and area calculation in ha.

Figure 23 Density of Standing Trees, 2020



The remnant patches of forest are distributed primarily in association with water sources and seasonal streams, as well as in the inaccessible areas – those surrounded by rock, or on the higher elevations. Other areas represent different densities of scattered trees as of the project start date.

In the absence of human intervention, the remaining forest patches will continue to get smaller, while the areas of moderate tree cover will transition into low, and eventually to areas with no standing trees, as per the photos below.

The continuation of the pre-project land use scenario is therefore one of continued deforestation and forest degradation.

i. Alternative Scenario 2: Conversion to small scale, un-managed teak plantations

In the Northern Sections of the Bandai Hills Forest Reserve where the land is flatter, and less rocky, there are aa number of small scale plantings of teak. These plantings have been undertaken by either the Ghana Forestry Commission, or by private individuals that have secured leases on individual compartments within this Forest Reserve. Within the Bandai Hills Forest Reserve there are some small (<1 hectare) trials of plantation teak, which have been unmanaged since planting.

ii. Alternative Scenario 3: The current project activity without being registered as an AFOLU project.

Outcome of Sub-step 1a:

The following alternative land use scenarios have therefore been identified as being credible:

- Continuation of the pre-project land use (continued deforestation and forest degradation);
- Conversion to small scale, un-managed teak plantations;
- The current project activity without being registered as an AFOLU project.

Sub-step 1b. Consistency of credible alternative land use scenarios with enforced mandatory applicable laws and regulations

The above alternative land use scenarios were selected as those that were the most plausible activities for the given project area, under the context of the type and structure of land tenure.

Both scenarios are in compliance with mandatory applicable legislations and regulations for land categorized as a Forest Reserve in Ghana.

Outcome of Sub-step 1b:

a) Continuation of pre-project land use (continued deforestation and forest degradation);
b) Conversion to small scale, un-managed teak plantations;
c) The current project activity without being registered as an AFOLU project.

STEP 2. Barrier analysis

Sub-step 2a. Identification of barriers that would prevent the implementation of at least one of the alternative land use scenarios

There are multiple barriers that prevent the implementation of the proposed project activity, without its registration as a VCS AFOLU project and the subsequent carbon financing that such registration generates. These barriers are not specific to either the project proponent or the specific project activity.

The Ghana Forestry Commission described the combined North Bandai and Bandai Hills Forest Reserves as being "as lost cause[19]", and further went on to describe that the Forestry Commission had effectively "written off" these areas or the likelihood of sourcing investment for the required reforestation activities, due to the multitude of barriers presented and the poor performance of the small scale pilot teak planting activities that have previously been carried out. This poor performance and low success rates of teak result would prevent the implementation of Alternative Scenario II[20].

In addition, the proposed project activity represents a unique and innovative nature based solution that integrates bamboo with the setting aside of almost 50% of the land area for the integrated restoration and protection of native species. Both the bamboo and the landscape approach to forest restoration represents the first of its kind in the host country, and in fact the entire continent. As a result, there are multiple barriers that prevent its implementation in the absence of carbon finance. The following barriers occur, as described below.

a) **Investment barriers**

There exist a number of significant investment barriers for the project activities, other than any of the economic or financial barriers detailed within the optional Investment Barrier Analysis. These investment barriers are detailed below.

i. Investors require secure pricing: although an age old crop in China, the growing of bamboo at scale represents a new class of forestry for the rest of the world and in particular Africa. There is no standard market pricing for raw bamboo fiber, and this material does not currently constitute an available commodity. This lack of commodity pricing represents a major barrier for such projects to secure traditional financing.

ii. Investors want proof of market: although markets exist for a wide range of finished bamboo products from timber to toilet paper, no market for bamboo raw material exists out of key growing countries (China and to a smaller extent Vietnam and India). In the target region of

[19] Director of Plantations, Forest Services Division, Ghana Forestry Commission; interview with the VVB; 26th April 2022.

[20] Visual assessment of small scale teak plantations by the VVB, April 2022; Interviews with the Ghana Forestry Commission Executive Director and District Manager, April 2022.

Ghana, West Africa, no manufacturing exists that could absorb the raw material. As a result, there is no guarantee of a market to purchase a future flow of bamboo harvest from the project area, thereby prohibiting such projects from securing traditional investment available for commercial forestry.

iii. Value addition is necessary: as a result of the above barriers, large scale bamboo planting projects require value addition for the future stream of raw material. This results in a chicken and egg scenario for traditional financiers - such investors will not commit to financing a bamboo plantation without the manufacturing being in place. Yet no manufacturing can be conceptualized without absolute security of the raw material. As a result, traditional investment sources are not available for bamboo reforestation projects.

iv. Investors have short term return requirements: although relatively short from a forest plantation perspective, the 6-8 years of development costs required before any harvest of raw material occurs represents a timeframe outside of the accepted timeframe for return on investment for a wide segment of the financial sector.

As a result of the above barriers, bamboo reforestation projects have typically been small scale, financed by NGOs through grant funding, or through bi-lateral development funding. In the case of Ghana, the only projects existing outside of the proposed project activity have been financed through the International Network of Bamboo & Rattan (INBAR), through small scale, grant funded activities[21] and with a strong focus on environmental conservation projects, in particular the use of bamboo as a riparian buffer for increased stability of sensitive ecosystems surrounding Lake Volta.

Carbon financing provides an ideal solution to the above investment barriers, as bamboo's fast growth means that the majority of carbon removals occur within the first 6-8 years after planting. This is the period where the majority of risks for investors occur, while thereafter the bamboo has achieved a permanent canopy cover, and provides a tangible raw resource.

b) Technological barriers

As detailed above bamboo is a relatively new plant to be grown at scale outside of China, and the proposed project activity represents the first and only one at this scale on the African continent. Technology related barriers are a significant reason as to why no such projects at this scale currently exist.

i. Lack of access to planting material: species of giant clumping bamboos, such as those in the proposed project activity flower gregariously over extended time periods, often upwards of 60 years. All plants within a geographic region flower together, and set large volumes of seed, before the parent bamboo clumps die, giving way for the new generation of seedlings. If

[21] Details on INBAR's grant funded projects in Ghana can be accessed at: https://www.inbar.int/country/ghana/

collected, unless stored under specialized conditions the bamboo seed has a short shelf life before germination rates drop rapidly. As a result, such bamboo seed is extremely rare, and access to large volumes of planting material represents a major barrier to reforestation projects at the proposed scale.

ii. No scientific or technical data or information exists in the public domain: there exists little scientifically rigorous data on the growing of the targeted species of bamboo at scale. This represents multiple barriers. The first relates to the actual silvicultural aspects of bamboo management and an understanding of the associated expenses. The second barrier relates to the ability to develop accurate biomass accumulation and associated yield models. Valid allometric equations for the determination of bamboo biomass are few, which further exacerbates the above investment barriers as financiers have no standard accepted yield models to predict future harvests and therefore income streams. Furthermore, this barrier means that project developers must have the skills and expenditure ability to be carrying out extensive and on-going research and development into both the silvicultural management regimes, and growth and yield models.

iii. Project developers must have the ability to add value to the raw bamboo material: available manufacturing equipment is often a major barrier to the successful development of bamboo reforestation projects[22]. Given that there is no market for raw bamboo material, project developers must have the ability and expenditure ability to develop context specific technology for the value addition of the future supply of raw bamboo material from any large scale bamboo reforestation initiative.

c) Barriers due to prevailing practice

The proposed project activity is the first of its kind. No project activity of this type is currently operational in the host country or region. Further detail is provided in the Common Practice Analysis below.

d) Barriers due to local ecological conditions

The proposed project activity faces the following barriers due to local ecological conditions:

i. Catastrophic natural and / or human-induced events: fire, usually human induced outside of the project area but resulting in uncontrolled spread, creates a significant barrier for the proposed project activity, and results in a high cost of project activities for an extended period. Climate change is resulting in a fire season that is becoming longer and drier each year, and therefore requires additional activity and associated capital in order to provide

[22] A recent study carried out by KOICA and the Government of Ethiopia showed that access to manufacturing technology suitable for the African context represents the major barrier for development of bamboo supply chains in Ethiopia. This study is available on request.

adequate mitigation measures. This barrier prevents the implementation of Alternative Scenario II.

ii. Pervasive opportunistic species preventing regeneration of trees: *Imperata cylindrical* or cogon grass is an extremely opportunistic species that is the first colonizer species to return after a fire. In this region of Ghana this grass is extremely pervasive, often growing more than 6 feet in height. Without human intervention, and with a significant carried cost, trees and native vegetation will not be able to regenerate.

iii. Unfavorable course of ecological succession: the above factors combined result in an unfavorable succession over time of the project area from what was once dense forest, to open woodland, to invasive grasslands with scattered trees and ultimately to a grassland of dominant, invasive cogon grass.

e) Barriers due to social conditions

The following social conditions occur as barriers to implementation for the proposed project activities:

i. Lack of skilled and / or property trained labor force: the proposed project is occurring within a rural setting where surrounding communities which live on the fringe of the forest reserve live in traditional villages. Most of these individuals are illiterate – with more than 30% having never received any formal education, and have never had structured employment as no such opportunity exists. As a result, the project proponent is required to invest heavily into training, skills development, and associated aspects in order to ensure that the project has access to sufficient labor in order to achieve the necessary activities, including land preparation, planting and on-going maintenance of the planted seedlings.

ii. Bamboo has typically been viewed as a “poor man’s timber”. Even in rural settings communities and villagers typically view it as a plant with few opportunities for bettering their livelihoods. As a result, project developers must invest heavily into education, awareness and understanding as to the purpose of the project, and the potential importance of the planted bamboo, from both social and environmental perspectives. This commitment to social development is a critical component of success in the early stages of project development. Carbon financing, particularly where it goes hand in hand with a market keen to achieve a suite of co-benefits, allows for the hand in hand development to overcome this social perception.

f) Barriers relating to land tenure, ownership, inheritance and property rights:

The following barriers detailed within the tool, are applicable to the proposed project activity:

i. Barriers relating to markets: no local market exists for raw bamboo fiber within the host country. Additional details relating to this barrier have been provided in part a, investment barriers, above.

ii. Remoteness of AFOLU activities and undeveloped road and infrastructure incur large expenditures: the project activity is in a remote rural area, with poor road accessibility and no available infrastructure. The one access road is in extremely poor condition and during the raining season often becomes impassable. Given the scale of the total project area at 7,818.7ha significant access and infrastructure investment is required to ensure success of the proposed project activities. Such expenditure is required within the first years of the project activity, in order to provide accessibility for land preparation and planting activities. This barrier therefore contributes to and indeed exacerbates the investment barriers detailed in part a above, increasing the capital requirements and reducing the attractiveness to traditional finance sources, particularly when combined with other barriers already detailed.

Outcome of Step 2a:

The following barriers described above prevent one or more of the land use scenarios identified in Step 1b:

- Investment barriers
- Technological barriers
- Barriers due to prevailing practice
- Barriers due to local ecological conditions
- Barriers due to social conditions
- Barriers relating to land tenure, ownership, inheritance and property rights

Sub-step 2b: Elimination of land use scenarios that are prevented by the identified barriers

Land use scenario b – Conversion to small scale, un-managed teak plantations - is prevented by the local ecological conditions as described above. This elimination is substantiated through evidence of the poor performance of historical trial plantings of teak within this area, the subsequent effects of fire and the decision by the Ghana Forestry Commission on the un-suitability of the area for this activity due to the ecological conditions and the resulting prevalence of fire.

Land use scenario c - The current project activity without being registered as an AFOLU project - is prevented by all barriers described in detail above which would prevent the proposed activity from occurring in the absence of the project being registered as an A/R project activity, and the associated carbon financing.

Outcome of Step 2b:

Land use scenario a - Continuation of pre-project land use (continued deforestation and forest degradation) – is not prevented by any barrier.

Sub-step 2c. Determination of baseline scenario.

Reforestation without being registered as an A/R CDM project activity is not included in the list of land use scenarios that are not prevented by any barrier.

The list determined in Step 2b above contains only one land use scenario. Therefore, scenario a, the continuation of pre-project land use (continued deforestation and forest degradation) is defined as the baseline scenario.

3.5 Additionality

Adhering to the: "*Tool for the demonstration and assessment of additionality in VCS Agriculture, Forestry and Other Land Use (AFOLU) project activities" (Version 3.0, 2012),* the subsequent steps for the determination of additionality are carried out below.

The chosen methodology requires the use of the following tool for the demonstration of additionality as part of the combined tool: "*A/R Methodological tool "Combined tool to identify the baseline scenario and demonstrate additionality in A/R CDM project activities" (Version 01").*

The application of the tool as described above resulted in a scenario in Step 2c where the baseline scenario was described as above, and the tool requires the application of Step 4: Common Practice Analysis. The tool applies this step as a credibility check to demonstrate additionality, which complements the barrier analysis described in Section 3.4, Step 2 above.

STEP 4. Common practice analysis

The following bamboo reforestation activities occur within the geographical area of the proposed project activity:

- Bamboo For Integrated Development (BIDG)[23]: this is a small grant run pilot project located within the adjacent region (Afram Planes), designed to educate farmers on the potential for bamboo as a crop. Since 2016 BIDG has been working to reforest a microscale plot of land with bamboo. BIDG is a not for profit NGO. This project has been financed through "through donations (local and International) and volunteerism[24]".

[23] http://www.bambooid.org

[24] https://www.climate-chance.org/en/best-pratices/resilient-bamboo-agroforestry-project/

- International Network for Bamboo & Rattan (INBAR): Ghana has been a signatory to INBAR since 1999. Since this period INBAR and its donors have grant funded a number of pilot projects to attempt to facilitate interest in the sector, and attempt to overcome some of the barriers detailed above. The current project under development between INBAR and the Government of Ghana is a 270 ha riparian reforestation project on the banks of the Volta known as "Bamboo for the Protection of the Volta Lake". This planting is purely for conservation purposes.

Neither of the above projects are comparable to the proposed project activities, in terms of size, and furthermore, neither is comparable as they are both funded by grants.

Furthermore, outside of the immediate project area, considering both West Africa and Africa as a whole, there are no activities that are at similar scale, or that take place in a comparable environment.

Although the GHG emission removals detailed in this project document relate only to the bamboo planting, the project further represents a unique one in its integration of 50% of the total land area into conservation through the reforestation of native species. Combined with the adjacent North Bandai Forest Reserve Reforestation Project, this scale, of a combined 11,145ha makes the project unique across the African continent.

The proposed project activity is therefore proved to not be a common practice, and therefore cannot be the baseline scenario, and hence, therefore, additional.

3.6 Methodology Deviations

As described in Section 4.2, the project proponent has utilized independently developed species-specific allometric equations for the ex ante estimations of the project's GHG emission removals.

This method of ex ante estimations represents a methodology deviation, required due to the absence of existing data.

The deviation effects only the estimation of the ex ante GHG emission removals and has no effect on the ex-post quantification of project related GHG emission removals. The deviation does not negatively impact the conservativeness of the quantification of the estimated emission removals. This has been demonstrated during the project's validation audit by a comparison of the input factors utilized for such estimations, against the actual growth rates as has been evidenced by the project's 7 year old trials which were carried out adjacent to the project area.

The deviation relates only to the ex ante allometric equation used in the projects estimations. It does not relate to any other part of the methodology.

4 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

4.1 Baseline Emissions

The procedure for the calculation of *ex ante* baseline net GHG removals by sinks is as per the applied methodology (AR-ACM0003 v2), section 5.4 "Baseline net GHG removals by sinks".

The baseline emissions for the project areas are those associated with negative land use change as the project areas undergo continued forest degradation and deforestation, as indicated in the historical mapping in Section 3 above.

The baseline net GHG removals by sinks is the sum of the changes in carbon stocks of the selected carbon pools within the project boundary that would have occurred in the absence of the project activity. Under the conditions of the applied methodology, changes in carbon stock of above-ground and below-ground biomass of non-tree vegetation, dead wood, litter and soil organic pools may be conservatively assumed to be zero for all strata in the baseline scenario.

Therefore, the baseline net GHG removals by sinks will be determined as:

$$\Delta C_{BSL,t} = \Delta C_{TREE_BSL,t} + \Delta C_{SHRUB_BSL,t} + \Delta C_{DW_BSL,t} + \Delta C_{LI_BSL,t}$$

Where:

$\Delta C_{BSL,t}$	= Baseline net GHG removals by sinks in year t; tCO_2-e
$\Delta C_{TREE_BSL,t}$	= Change in carbon stock in baseline tree biomass within the project boundary in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities"; t CO2-e
$\Delta C_{SHRUB_BSL,t}$	= Change in carbon stock in baseline shrub biomass within the project boundary in year *t*, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities; t CO2-e
$\Delta C_{DW_BSL,t}$	= Change in carbon stock in baseline dead wood biomass within the project boundary in year *t*, as estimated in the tool "Estimation of carbon stocks and

change in carbon stocks of trees and shrubs in A/R CDM project activities; t CO2-e

$\Delta C_{LI_BSL,t}$ = Change in carbon stock in baseline litter biomass within the project boundary in year t, as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities; t CO2-e

Section 3.4 above determines the baseline scenario – or the most likely scenario in the absence of the project activity – as the continuation of the pre-project land use (continued deforestation and forest degradation).

There are two primary driving factors that result in a baseline scenario where it is unlikely that there would be any increase in woody biomass or tree cover:

Uncontrolled fires: the project area has an extended dry season that is known as the Harmattan and occurs from the end of November through to the middle of March. This season is characterized by dry and dusty north easterly trade winds which blow from the Sahara across West Africa. This extreme dry season, combined with the flammable nature of the invasive grasses that increasingly dominate the project area, result in a high occurrence of wild fires during this period. These fires move extremely fast due to the high winds and dry conditions.

Communities surrounding the project area report that the occurrence of such fires has increased in recent years. When such fires occur they kill any young saplings, and prevent the natural regeneration of the original transitional forests that once occurred across the project area. At the same time, they provide ideal conditions for these fire-resistant grasses to increasingly dominate the landscape. At the same time the continued loss of standing mature trees results in reduced availability of seed required for natural regeneration to occur.

Charcoal production: illegal charcoal production occurs in the project area, targeting indigenous hardwoods. As the availability of larger diameter trees increases, charcoal burners increasingly target smaller diameter trees and saplings and drastically reduce the tree cover. As the tree cover decreases, the fires described above become more frequent due to the increase in occurrence of the invasive grasses that occur in the absence of canopy cover.

Combined these factors result in a baseline scenario in which there are negative GHG emissions resulting from forest degradation, tree loss and associated deforestation.

Therefore, in the baseline scenario the change in carbon stock in baseline tree biomass within the project boundary will be a negative value due to the associated loss of standing trees.

As a result, the changes in carbon stock of above-ground and below-ground biomass of shrub vegetation may be conservatively assumed to be zero for all strata in the baseline scenario.

Therefore:

$\Delta C_{BSL,t} = 0$

In contrast, the project activities ensure the survival and continued growth of existing trees in two ways:

The active presence in these areas reduces any unauthorized harvesting of trees for charcoal, while the project activities specifically result in the protection of the project area from fire, which is the most significant contributor to deforestation and forest degradation in the baseline scenario.

Furthermore, the presence of such trees does not affect the accounting of biomass sequestration related directly to the project activities, due to the clear difference between trees and bamboo clumps. During the implementation of the project activity, no trees within the project boundary are removed. These trees do not represent any issues associated with competition to the establishment and growth of bamboo clumps, and in contrast the increased biodiversity provides enhanced productivity and health of the plantation. Therefore, all existing trees remain on site, and the project activity occurs around these. As a result, the bamboo is inter-planted amongst standing trees, resulting in a mixed-use system. Therefore, in the absence of the project, changes in tree biomass would be expected to decrease in above ground and below ground carbon stock due to biomass loss and therefore may be conservatively assumed to be zero.

Therefore, the baseline net GHG removal by sinks of zero is considered to be conservative, and no stratification of the baseline is required.

4.2 Project Emissions

Procedures for the calculation of ex ante actual net GHG removals by sinks are detailed in the applied methodology (AR-ACM0003 v2), section 5.5 "Actual net GHG removals by sinks".

Ex Ante Stratification

The chosen methodology requires that if biomass distribution over the project area is not homogenous, that stratification should be carried out in order to improve the precision of biomass estimation. For the actual net GHG removals by sinks, the ex-ante estimations are based on the project planting and management plan.

In this scenario, such ex ante stratification is determined by two key factors:

- Year of Planting – planting is scheduled to occur over a 4 year period. The year in which planting of a specific area with bamboo occurs is expected to be a significant determining factor of the project removals during any monitoring event;
- Species – the project aims to plant species within two genera. Both Genus and targeted species are considered giant sympodial (clumping bamboos) with similar growth patterns and therefore biomass accumulation. However, it is conceivable that each planted species might have differing biomass accumulation rates, and therefore this factor is considered to be a potential determining factor of the project removals during any monitoring event.

Stratification is therefore estimated to result in 8 strata, as depicted in the below table.

Table 9 Ex Ante Stratification of the Project Area

Year of Planting	Dendrocalamus asper	Bambusa textilis
2022	Strata 1a	Strata 1b
2023	Strata 2a	Strata 2b
2024	Strata 3a	Strata 3b
2025	Strata 4a	Strata 4b

If any natural or anthropogenic impacts such as fire, or other factors such as soil types that are to be found during the course of monitoring that significantly alter the biomass distribution within the project area, then the project proponent will revise the ex post stratification accordingly.

Actual Net GHG Removals by Sinks

The methodology states that "GHG emissions resulting from the removal of herbaceous vegetation, combustion of fuel, fertilizer application, use of wood, decomposition of litter and fine roots of N-fixing trees, construction of access roads within the project boundary and transportation attributable to the project activity shall be considered insignificant and therefore accounted as zero". As such none of these described activities are described or included in the below calculations.

Therefore, the actual net GHG removals by sinks is limited to changes in the carbon stock attributed to the planted bamboo clumps within the project areas.

These actual net GHG removals by the bamboo clump sinks have been calculated as:

$$\Delta C_{ACTUAL,t} = \Delta C_{P,t} - GHG_{E,t}$$

Where:

$\Delta C_{ACTUAL,t}$	= Actual net GHG removals by sinks in year *t*; tCO_2-e
$\Delta C_{P,t}$	= Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; tCO_2-e
$GHG_{E,t}$	= Increase in non–CO_2 GHG emissions within the project boundary as a result of the implementation of the A/R project activity, in year *t*, as estimated in the tool "Estimation of non–CO_2 GHG emissions resulting from burning of biomass attributable to an A/R project activity; tCO_2-e

The increase in non-CO_2 GHG emissions within the project boundary, as a result of the implementation of the A/R project activities $GHG_{E,t}$ is accounted as zero, due to the fact that the project activities do not include the use of fire for any of the activities highlighted in the relevant tool:

- Fire is not used as a land preparation activity;
- Fire is not used for the clearance of harvest residue prior to replanting;

Furthermore, the impact of wild fires on the project activities is estimated to be insignificant, as described within the Non Permanence Risk Assessment. Therefore:

$$GHG_{E,t} = 0$$

The change in the carbon stocks in the project, occurring in the selected carbon pools in year *t*, are calculated utilizing equation 3 of the methodology, where bamboo has been used in clarification of "trees" within this equation.

$$\Delta C_{P,t} = \Delta C_{BAMBOO_PROJ,t} + \Delta C_{SHRUB_PROJ,t} + \Delta C_{DW_PROJ,t} + \Delta C_{LI_PROJ,t} + \Delta SOC_{AL,t}$$

Where:

$\Delta C_{P,t}$	= Change in the carbon stocks in project, occurring in the selected carbon pools, in year *t*; tCO_2-e
$\Delta C_{BAMBOO_PROJ,t}$	= Change in carbon stock in bamboo biomass in project in year *t* as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R project activities"; tCO_2-e
$\Delta C_{SHRUB_PROJ,t}$	= Change in carbon stock in shrub biomass in project in year *t* as estimated in the tool "Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R project activities"; tCO_2-e
$\Delta C_{DW_PROJ,t}$	= Change in carbon stock in dead wood biomass in project in year *t* as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R project activities"; tCO_2-e
$\Delta C_{LI_PROJ,t}$	= Change in carbon stock in litter biomass in project in year *t* as estimated in the tool "Estimation of carbon stocks and change in carbon stocks in dead wood and litter in A/R project activities"; tCO_2-e
$\Delta SOC_{AL,t}$	= Change in carbon stock in SOC in project in year *t*, in areas of land meeting the applicability conditions of the tool "Tool for estimation of change in soil organic carbon stocks due to the implementation of A/R project activities" as estimated in the same tool; tCO_2-e

Due to the specific characteristics of the project activities and the growth pattern of the sympodial bamboo species being grown, as well as the conditions of the methodology, $\Delta C_{SHRUB_PROJ,t}$ and $\Delta C_{DW_PROJ,t}$ can be conservatively assumed to be zero.

Therefore

$$\Delta C_{P,t} = \Delta C_{BAMBOO_PROJ,t} + \Delta C_{LI_PROJ,t} + \Delta SOC_{AL,t}$$

Changes in Carbon Stock in Bamboo Biomass due to Project Activities

The change in the carbon stock of the bamboo planted as a direct result of project activities is estimated as follows:

$$\Delta C_{BAMBOO_t} = (\Delta C_{BAMBOO,t2} - (\Delta C_{BAMBOO,t1}) / T$$

Where:

ΔC_{BAMBOO_t}	= Change in the carbon stocks in bamboo, in year *t*; tCO_2-e
$\Delta C_{BAMBOO,t2}$	= The carbon stocks in bamboo, in year *t2*; tCO_2-e
$\Delta C_{BAMBOO,t1}$	= The carbon stocks in bamboo, in year *t1*; tCO_2-e
T	= The time elapsed between year *t2* and year *t1*; yr

Calculation of Bamboo Carbon Stock

The bamboo clumps being grown represent two carbon pools which are included in the project's GHG emission removals. These are:

1. Bamboo Above Ground Biomass (AGB) – this pool consists of bamboo culms, branches and auxiliary leafy material as described in more detail below;
2. Bamboo Below Ground Biomass (BGB) – this pool consists of bamboo rhizomes and extensive root networks as described in more detail below;

The changes in carbon stock as a direct result of the project activities are being calculated at the clump level. There are two different species being grown with different capacities for changes in biomass and associated carbon removals. For each species under consideration, the bamboo carbon stock at any point in time is calculated by the following equation:

$$C_{BAMBOO_CLUMP} = AGB_{CLUMP} * RS * CF$$

Where:

C_{BAMBOO_CLUMP}	= Carbon stocks in a bamboo clump, in year *t*; tC;
AGB_{CLUMP}	= The bone dry above ground biomass included in a bamboo clump, including all bamboo culms, branches and leafy material, in year *t*; tons
RS	= The Root to Shoot ratio of a bamboo clump, used to calculate the below ground biomass represented by bamboo rhizomes and roots, in year *t*; tons
CF	= The carbon fraction of woody biomass, given as 0.47

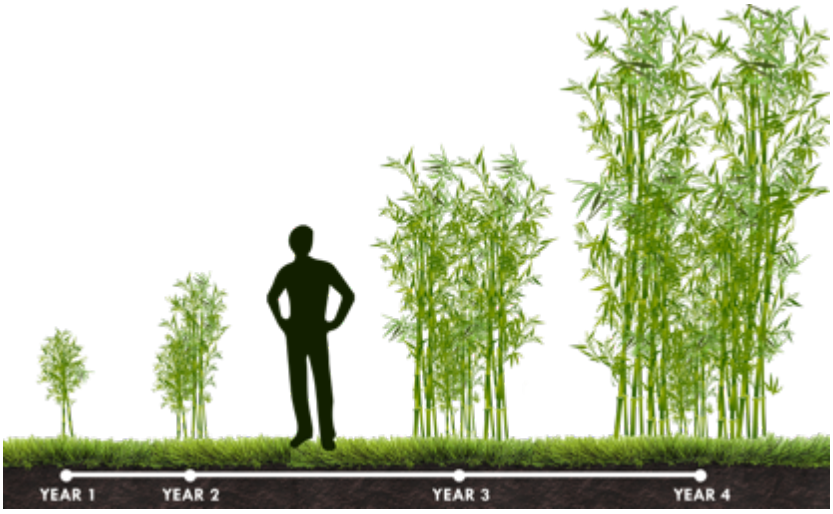
Bamboo clumps have a different growth pattern to trees and therefore they represent unique variables to be considered. Such variables need to be determined for each individual species for which the GHG emission removals are being calculated. The below section describes the factors that need to be taken into consideration when determining the Above Ground Biomass of a bamboo clump, and the subsequent equations.

Above Ground Biomass: AGB_{BAMBOO}

The Above Ground Biomass of a bamboo clump comprises of three distinct sources of biomass: culms (or poles), branches, and leafy material.

Each bamboo clump will have many individual culms. In the early years of growth and development there are multiple factors for consideration. During the first 6-10 years after planting – with the exact timeframe being dependent upon climate, soils, and management regimes - each clump will exhibit the following unique ecology depicted in the below graphic.

Figure 24 Early Year Growth & Development of a Bamboo Clump[25]



Each year the culms will increase in number, height and diameter, until the clump achieves maturity. Thereafter the clump will achieve a steady state of biomass, with new culms emerging year on year, and older ones dying. Bamboo culms do not increase in size year on year, but rather achieve their maximum biomass accumulation within just one growing season.

However, as per the above depiction, each year that the bamboo clump grows, additional culms emerge

[25] Image taken from Lewis Bamboo, accessed Sept 1st 2021. www.lewisbamboo.com

representing an increase in the AGB pool. Therefore, the first variable that requires measurement in order to report on changes in biomass due to the project planting activities, is the total number of culms in the clump, and the average biomass within those culms. This can be calculated using allometric equations where the total biomass of the culm, inclusive of branches and leafy material is a factor of the diameter of that culm.

No available allometric equations for the determination of culm biomass from culm diameter exist from reputable or peer reviewed sources. Therefore, the project proponent has developed species specific allometric equations utilizing data from destructive sampling of the parent bamboo from which the planting material was sourced.

Development of Species Specific Allometric Equations

The methodology requires the use of the "Tool for the Estimation of carbon stocks and changes in carbon stocks of trees and shrubs in A/R CDM project activities". Annex 1, paragraph 6 of this tool states:

For ex-ante estimation the allometric equation, or volume table or volume equation applied to a tree species is selected from the following sources (the most preferred source being listed first):

(a) Existing data applicable to local situation (e.g. represented by similar ecological conditions);

(b) National data (e.g. from national forest inventory or national greenhouse gas (GHG) inventory);

(c) Data from neighbouring countries with similar conditions;

(d) Globally applicable data.

The project is the first of its kind in the local situation, nationally within Ghana, and within neighbouring countries. As a result, there are no existing allometric equations or volume data that meets sources a, b, or c above. A literature assessment shows that no comparable allometric equations or volume data for either species under the project context exist.

As a result, the project proponent has taken the route of developing species-specific allometric equations for the two bamboo species being planted, adhering to the requirements of AR Tool 17. The use of such an allomteric equation for the purpose of ex ante estimations of the carbon removal benefits therefore represents a methodology deviation, as described in Section 3.6 above.

In order to develop the species-specific allometric equations, the following steps were undertaken:

Destructive Sampling of Parent Plants

1. Destructive sampling of more than 50 culms for each species was carried out, across all diameter classes, with a minimum of 5 culms sampled in any one diameter class. Culms were harvested

at the first node.

2. For each culm sampled the leaves and branches were removed, and the following measurements were taken and recorded directly :

    a. Diameter at breast height

    b. Culm length

    c. Culm weight

    d. Weight of branches and leaves

Given that each bamboo clump is comprised of multiple individual culms, the total above ground biomass of a single clump is a factor of the number of culms within that clump.

$$AGB_{CLUMP} = (AGB_{CULM} * MC * N_{CULM})$$

Where:

AGB_{CLUMP}	= Above ground biomass of the bamboo clump at time t; tons
AGB_{CULM}	= The above ground biomass of an individual culm, calculated using the allometric equation as described above; tons
MC	= The moisture content of the bamboo biomass; %
N_{CULM}	= The number of culms found within the bamboo clump at time t; #

Dendrometric Variables

The determination of bamboo biomass requires projections for the number of culms, and the average diameters of those culms based on clump age. Although literature on mature clumps is available, peer reviewed data on young clumps is sparse, as the majority of data on clumping bamboo species comes from naturally occurring stands and bamboo forests, and therefore does not provide for the early year growth and development of new clumps. As a result, the data on the projected growth of the clumps of the two species being grown comes from two sources:

Pilot Plantings: the project planted small trials of both species within the vicinity of the project in 2016. These clumps have been assessed year on year for the average number of culms, and the average diameter of these culms. These clumps have not received any management since planting, and have also been subjected to fire, therefore they represent extremely conservative data for the potential growth of these species under active management

Research Plots: EcoPlanet has been working on bamboo research since 2013 with a focus on the species being grown. A number of research projects have been undertaken to provide data on average biomass production of both species being grown.

As described above, no allometric equations exist for the species and project context. In order to ensure that the ex-ante GHG emission removal estimates are realistic, these were compared against published data[26] for *Dendrocalamus asper*. This study undertook destructive sampling to determine the bamboo biomass and associated carbon content of a hectare of five year old clumps. This study shows the identical value delivered by the species specific allometric equations developed by the project proponent, at 41tC/ha, although the number of planted clumps and associated number of culms per clump differ.

Below Ground Biomass: BGB_{BAMBOO}

The second unique variable for consideration for a bamboo clump is the underground rhizome structure that forms the basis of the fast growth and emergence of bamboo shoots which turn into bamboo culms. The unique biological characteristics of the rhizome mean that when a bamboo culm is harvested, although that above ground biomass is removed, the underground rhizome system remains still alive and continues to produce shoots, rapidly replacing the biomass that has been removed, so long as it is within a limit of sustainability.

For clumping bamboo species destructive sampling to determine the below ground biomass is unrealistic both in terms of time, resources and funds, as well as the fact that such sampling results in the death of the clump. As such, it is recommended that a below ground bamboo biomass expansion factors, (also known as root to shoot ratios) from available literature is used.

Literature sources as detailed in the parameter section below confirm the root to shoot factor across a range of clumping bamboo species to have a value of 1:0.25

Thinning

Bamboo's growth pattern is such that adequate management and the thinning out of older culms can greatly increase the biomass accumulation of well managed clumps, and results in the continued emergence of new culms with each growing season.

The total value of carbon stock per clump of each species was calculated over time, allowing for the removal of mature culms to facilitate the emergence of new growth. This represents a conservative approach. In addition the below ground biomass will continue to increase year on year.

[26] Sujarwo, W. 2015 Bio*mass content of black petung bamboo (Dendrocalamus asper);* Bamboo Journal

Total GHG Removals per Bamboo Clump, by Species

Using the above approach, the changes in total biomass and associated carbon stock of an individual clump of the two species was calculated on a temporal basis.

Calculation of Changes in Soil Organic Carbon

The chosen methodology in requires application of the "Took for estimation of change in soil organic carbon stocks due to the implementation of A/R CDM project activities" Version 01.1.0. This tool is applied to the project as follows.

The project meets the required applicability conditions, as per the areas of land, the baseline scenario, and the project activity. These have been defined in Section 3.4 above and are summarized as:

a) The area of land on which the project activities are occurring:

(i) Are not wetlands;

(ii) Do not contain organic soils

(iii) Are not subject to the land management practices detailed in Tables 1 or 2 of the tool.

i. Table 1 - The project area falls within the Temperature/Moisture Regime described as "Tropical / Moist[27]" but does not include the prohibited land use of "Short-term or set aside cropland".

ii. Table 2 – The project is not located in a grassland agro-ecological zone.

b) The project activity meets the following applicability conditions:

(i) All litter remains on site with no removals;

(ii) Soil disturbance associated with the A/R CDM project activity is carried out to meet the following best practices:

i. All planting follows the contours of the land where appropriate;

ii. Soil disturbance associated with site preparation is limited only to the planting pits which is carried out before planting, with no subsequent disturbance over a more than 20 year period.

Furthermore, the assumptions of the tool are in line with the project activities:

[27] Moisture regimes for tropical zones are defined by precipitation levels; Dry (MAP<1,000mm); Moist (1,000,2,000 mm); and Wet (>2,000) - Good Practice Guideline for Land Use, Land Use Change and Forestry, *Intergovernmental Panel on Climate Change*

a) Site preparation and planting activities take place within a year of each other – under the project's management plan such activities occur within a maximum of 2-3 months of each other;

b) The littler levels of the degraded ecosystem are extremely low in the pre-project scenario to the frequent occurrence of fire. In contrast the implementation of the reforestation activity increased the SOC content of the lands from the pre-project level to a steady state, assumed to be equal to the SOC content under native vegetation.

c) The increase in SOC content is assumed to take place at a steady and constant rate over a 20 year period.

The SOC stock at the start of the project is estimated using the following equation, assuming the Temperature/Regime of the project area as Tropical / Moist as per the reference given above.

$$SOC_{INITIAL,i} = SOC_{REF,i} * f_{LU,i} * f_{MG,i} * f_{IN,i}$$

Where:

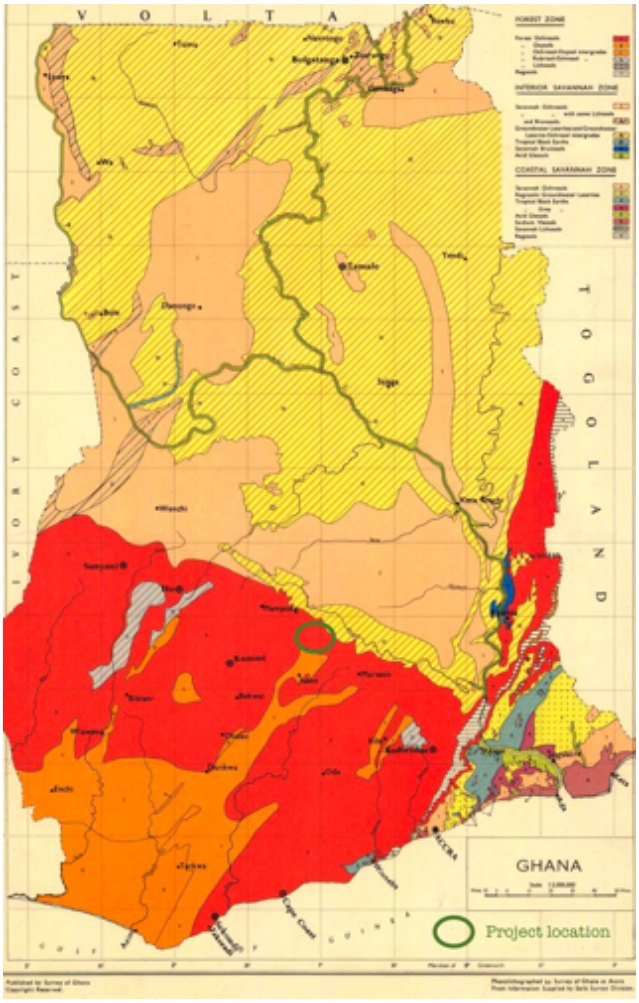
$SOC_{INITIAL,i}$	= SOC stock at the beginning of the A/R CDM project activity, in stratum i of the area of land; tC ha^{-1}
$SOC_{REF,i}$	= Reference SOC stock corresponding to the reference condition in native lands by climate region and soil type applicable to stratum i of the area of land; tC ha^{-1}
$f_{LU,i}$	= Relative stock change factor for baseline land-use in stratum i of the areas of land; dimensionless
$f_{MG,i}$	= Relative stock change factor for baseline management regime in stratum i of the areas of land; dimensionless
$f_{IN,i}$	= Relative stock change factor for a baseline input regime in stratum i of the areas of land; dimensionless

The project area is unified from a baseline, management and input scenario, and therefore for the purpose of this tool, there is only a single stratum.

Reference SOC stock:

- The project area is classified as topical-moist climate, with full details on the climate and associated rainfall provided in Section 1.13 above.
- The soils of the project area fall into the category of low clay activity (LAC). These soils are commonly classified as Forest Ochrosols which fall into a USDA classification of Oxisols.
- Therefore the reference SOC stock for the project area is 47.

Figure 25 Soil Map of Ghana



The baseline land use is not cropland, but rather lands that have been converted to non native grasslands that in the baseline scenario will not recover. Therefore table 6 of the tool is applied, and the baseline land use scenario is assigned a relative stock change factor of 1.

The tool for the "Identification of degraded or degrading lands for consideration in implementing CDM A/R project activities" has been applied. This tool states:

The presence of one of the following is enough for demonstrating that land is "degraded" and/or "degrading":[2]

(a) Provide documented evidence that the area has been classified as "degraded" under verifiable local, regional, national or international land classification system or peer-review study, participatory rural appraisal, satellite imagery and/or photographic evidence in the last 10 years.

The Ghana Forestry Commission describes the North Bandai Forest Reserve as degraded within all legal documentation surrounding these lands, as stamped and approved by the Government Lands Commission. This confidential document has been provided to auditors, along with evidence of the date as being within the required ten year period to mean this condition.

Figure 26 Example of Documented Government Evidence of "Degraded" Status[28]



NOW THEREFORE, it is hereby agreed as follows:

1. PURPOSE OF THE LEASE

This Lease is for access to degraded forest reserve lands for the purpose of developing commercial bamboo plantations.

The baseline management regime of the project area can therefore be described as "Severely Degraded", resulting in a relative stock change factor of 0.70.

The baseline land use scenario does not receive any fertilizer inputs. Therefore the input regime of the project area can best be described as "Low/Medium", resulting in a relative stock change factor of 1.00

Therefore

$SOC_{INITIAL,i}$ = 47 * 1 * 0.7 * 1 = 32.9

The rate of change in SOC stock in project scenario until the steady state SOC is reached is calculated with the following equation:

[28] Land Lease Agreement Executed April 16th 2016

$$dSOC_{t,i} = \left(\frac{SOC_{REF,i} - SOC_{INITIAL,i} - SOC_{LOSS,i}}{20\ years} \right)^2 for\ t_{PREP,i} < t \leq t_{PREP,i} + 20$$

Where:

$dSOC_{t,i}$	= the rate of change of SOC stock in stratum i of the areas of land, in year t; tC ha^{-1}
$t_{PREP,i}$	= the year in which first soil disturbance takes place in stratum i of the areas of land
$SOC_{LOSS,i}$	= the loss of SOC caused by soil disturbance attributable to the A/R CDM project activity in stratum i of the areas of land; 0 tC ha^{-1}
$SOC_{REF,i}$	= Reference SOC stock corresponding to the reference condition of tropical-moist climate, high activity clay soils, applicable to stratum i of the area of land; 46 tC ha^{-1}
$SOC_{INITIAL,i}$	= SOC stock at the beginning of the A/R CDM project activity, in stratum i of the area of land; 32.9 tC ha^{-1};
i	= 1, 2, 3,... biomass estimation strata within the project boundary
t	= 1, 2, 3, ... years elapsed since the start of the A/R CDM project activity

The project activities that result in soil disturbance are limited to the manual digging of planting pits. At a size of 30cm x 30cm, and a frequency of 500 pits per hectare, such disturbance relates to less than 0.5% of the area on which project activities are occurring.

Therefore

$SOC_{LOSS,i}$ = 0

Therefore

$$dSOC_{t,i} = (47 - 32.9 - 0) / 20 = 0.705$$

Calculation of Changes in Litter Carbon

The chosen methodology in requires application of the "Tool for estimation of carbon stocks and change in carbon stocks in dead wood and litter in due A/R CDM project activities" Version 03.

The project activities do not remove any litter from the project boundary and all litter therefore remains in situ.

The project proponents have chosen to make use of the default factor based methodology for the conservative calculation of changes in litter carbon stock as the result of the project activities. Therefore, the below equation has been applied:

$$C_{LI,i,t} = C_{TREE,i,t} \times DF_{LI}$$

Where:

$C_{LI,i,t}$	= carbon stock in litter in stratum *i* at a given point in time in year *t;* tCO_2e
$C_{TREE,i,t}$	= carbon stock in bamboo biomass in stratum *i* at a given point in time in year *t* as calculated in "estimation of carbon stocks and changes on carbon stocks of trees and shrubs in A/R CDM project activities"*;* tCO_2e
DF_{LI}	= conservative default factors expressing carbon stock in litter as a percentage of carbon stock in bamboo biomass; 1%
i	= 1, 2, 3,… biomass estimation strata within the project boundary
t	= 1, 2, 3, … years elapsed since the start of the A/R CDM project activity

The project area biome is described as tropical, with annual rainfall amounts in the 1,000 – 1,600 mm/yr range, resulting in a 1% default factor which has been applied by strata.

Calculation of Changes in Carbon Stock Across All Pool

The project assumes an equal number of clumps of each species are being planted each year. Subsequently, the projected planting timelines was applied to determine to estimate the total GHG removals across the full project activity. Therefore, the estimation of GHG Emission Removals by all pools is calculated as shown in the tables below.

Table 10 GHG Emission Removals All Pools, By Year of Planting, Dendrocalamus

Year	2022 Planting (Hectares)	2023 Planting (Hectares)	2024 Planting (Hectares)	2025 Planting (Hectares)	TOTAL
t	250	500	500	500	tCO2e
2023	704.16	-	-	-	704.16
2024	1,776.29	1,408.31	-	-	3,184.60
2025	5,728.04	11,456.07	1,408.31	-	18,592.42
2026	15,888.01	31,776.02	3,552.57	1,408.31	52,624.91
2027	41,221.38	82,442.77	11,456.07	3,552.57	138,672.80
2028	89,611.96	179,223.92	31,776.02	11,456.07	312,067.98
2029	190,266.24	380,532.48	82,442.77	31,776.02	685,017.50
2030	306,157.16	612,314.31	179,223.92	82,442.77	1,180,138.16
2031	306,803.41	613,606.81	380,532.48	179,223.92	1,480,166.62
2032	307,449.66	614,899.31	612,314.31	380,532.48	1,915,195.76
2033	308,095.91	616,191.81	613,606.81	612,314.31	2,150,208.84
2034	308,742.16	617,484.31	614,899.31	613,606.81	2,154,732.59
2035	309,388.41	618,776.81	616,191.81	614,899.31	2,159,256.34
2036	310,034.66	620,069.31	617,484.31	616,191.81	2,163,780.09
2037	310,680.91	621,361.81	618,776.81	617,484.31	2,168,303.84
2038	311,327.16	622,654.31	620,069.31	618,776.81	2,172,827.59
2039	311,973.41	623,946.81	621,361.81	620,069.31	2,177,351.34
2040	312,619.66	625,239.31	622,654.31	621,361.81	2,181,875.09
2041	313,265.91	626,531.81	623,946.81	622,654.31	2,186,398.84
2042	313,912.16	627,824.31	625,239.31	623,946.81	2,190,922.59

Table 11 GHG Emission Removals All Pools, By Year of Planting, Bambusa

Year	2022 Planting (Hectares)	2023 Planting (Hectares)	2024 Planting (Hectares)	2025 Planting (Hectares)	TOTAL
t	250	500	500	500	tCO2e
2023	950.98	-	-	-	950.98
2024	4,470.50	1,901.95	-	-	6,372.45
2025	13,059.51	26,119.01	1,901.95	-	41,080.47
2026	28,908.19	57,816.38	8,941.00	1,901.95	97,567.52
2027	54,048.94	108,097.88	26,119.01	8,941.00	197,206.84
2028	90,408.00	180,816.01	57,816.38	26,119.01	355,159.41
2029	139,832.40	279,664.80	108,097.88	57,816.38	585,411.47
2030	219,966.55	439,933.10	180,816.01	108,097.88	948,813.54
2031	220,612.80	441,225.60	279,664.80	180,816.01	1,122,319.21
2032	221,259.05	442,518.10	439,933.10	279,664.80	1,383,375.04
2033	221,905.30	443,810.60	441,225.60	439,933.10	1,546,874.59
2034	222,551.55	445,103.10	442,518.10	441,225.60	1,551,398.34
2035	223,197.80	446,395.60	443,810.60	442,518.10	1,555,922.09
2036	223,844.05	447,688.10	445,103.10	443,810.60	1,560,445.84
2037	224,490.30	448,980.60	446,395.60	445,103.10	1,564,969.59
2038	225,136.55	450,273.10	447,688.10	446,395.60	1,569,493.34
2039	225,782.80	451,565.60	448,980.60	447,688.10	1,574,017.09
2040	226,429.05	452,858.10	450,273.10	448,980.60	1,578,540.84
2041	227,075.30	454,150.60	451,565.60	450,273.10	1,583,064.59
2042	227,721.55	455,443.10	452,858.10	451,565.60	1,587,588.34

Finally, to determine the estimated project removals the following equation was used:

$$\Delta C_{ACTUAL,t} = \Delta C_{P_Dendrocalamus,t} + \Delta C_{P_Bambusa,t}$$

Where:

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks in year *t*; tCO_2-e

$\Delta C_{P_Dendrocalamus,t}$ = Change in the carbon stocks of Dendrocalamus asper in the project, occurring in the selected carbon pools (from table 9 above), in year *t*; tCO_2-e

$\Delta C_{P_Bambusa,t}$ = Change in the carbon stocks of Bambusa textilis in the project, occurring in the selected carbon pools (from table 10 above, in year t; tCO2-e

Table 12 Estimated Project GHG Removals Across All Pools By Year

Year (t)	Estimated project removals (tCO_2e)
06.2022 - 06.2023	1,655.13
06.2023 - 06.2024	9,557.05
06.2024 - 06.2025	59,672.89
06.2025 - 06.2026	150,192.44
06.2026 - 06.2027	335,879.64
06.2027 - 06.2028	667,227.38
06.2028 - 06.2029	1,270,428.97
06.2029 - 06.2030	2,128,951.70
06.2030 - 06.2031	2,602,485.83
06.2031 - 06.2032	3,298,570.80
06.2032 - 06.2033	3,697,083.43
06.2033 - 06.2034	3,706,130.93
06.2034 - 06.2035	3,715,178.43
06.2035 - 06.2036	3,724,225.93
06.2036 - 06.2037	3,733,273.43
06.2037 - 06.2038	3,742,320.93
06.2038 - 06.2039	3,751,368.43
06.2039 - 06.2040	3,760,415.93
06.2040 - 06.2041	3,769,463.43
06.2041 - 06.2042	3,778,510.93
TOTAL	**3,778,511**

4.3 Leakage

As per the methodology, any increase in GHG emissions that results from the displacement of pre-project agricultural activities, due to the project activities, should be calculated utilizing A/R Tool “Estimation of

the increase in GHG emissions attributable to displacement of pre-project agricultural activities in the A/R project activity.

This tool defines such potential leakage as originating from the displacement of agricultural activities, crop cultivation and / or grazing activities, should such displacement result in an increase in GHG emissions.

The land included within the project boundary is legally designated as a Forest Reserve, with the legislation detailing the management of such lands and legally allowed activities, described earlier on in this project document. There are no people living inside the project boundaries, and the Ghana Forestry Commission has a regional office located in Juaso with a team of forest rangers who are responsible for maintaining the integrity as state land.

However, there are small scale illegal activities that occur within the project boundaries. These can be categorized into three agricultural activities:

1. Illegal charcoal production: this is the most common illegal activity occurring within the Forest Reserve, and has been one of the most significant drivers of land degradation and transition of the ecosystem from its original forested status. This activity does not occur within the two western blocks of the project boundary which are targeted for the first plantings, but only within the centralized largest area, where the lands still have either low or medium density of standing trees. The project activities aim to eliminate such illegal activity from these areas through two main means:

    a. The provision of more attractive livelihoods to the surrounding communities that might currently rely on charcoal production for income.

    b. Enforcement of the project boundaries, and continued monitoring and patrolling.

    It is likely that charcoal production in the area will decrease as communities' benefit from the provision of sustainable livelihoods and the sustainable development programs undertaken. However, it is also likely that and continuing charcoal production will move from within the project boundaries to outside.

    Regardless, the movement of this activity does not result in any increase in overall GHG emissions associated with charcoal production and therefore there are no leakage emissions associated with this activity.

2. Low intensity grazing: illegal movement of migrant Fulani[29] herdsmen and grazing of their cattle sporadically occurs within the project boundary, most commonly during the dry season as they search for water for their cattle. This activity does not occur within the two western blocks of the project boundary which are targeted for the first plantings, but only within the centralized largest area, where the lands still have either low or medium density of standing trees. The project activities work to prevent such illegal access given the damage that the cattle have the potential to cause for the newly planted bamboo. In addition, the Fulani are often the cause behind uncontrolled fire.

   The tool notes that leakage emissions attributable to the displacement of grazing activities under the following conditions is considered insignificant and hence accounted as zero:

   a. Animals are displaced to existing grazing land the total number of animals in the receiving grazing land (displaced and existing) does not exceed the carrying capacity of the grazing land;

   b. Animals are displaced to existing non-grazing grassland and the total number of animals displaced does not exceed the carrying capacity of the receiving grassland;

   c. Animals are displaced to cropland that has been abandoned within the last five years;

   d. Animals are displaced to cropland to forested land, and no clearance of trees, or decrease in crown cover of trees and shrubs, occurs due to the displaced animals;

   e. Animals are displaced to zero-grazing system.

   The project scenario represents a combination of conditions a and b and can be considered insignificant. Only the planted areas for each year will be protected and the movement of the cattle prevented. At the same time, the project aims to provide water sources for these cattle, to reduce the movement and allow them to stay within the lands that host them for the majority of the year.

3. Illegal farming activities: small scaling illegal farming activities, predominantly for the production of plantain and to a lesser degree maize, occur on occasion within the project boundaries. Such activities tend to be short term and shifting, due to the nature of plantain which needs to be replanted year on year. Furthermore, these activities by nature are shifting, with farm land being rotated. Prior to the onset of project activities, a socio-economic assessment was carried out by a 3rd party to determine the driving causes behind such illegal activities, which determined that there were two predominant reasons:

[29] *Ghanaians are not a pastoralist society. The Fulani are pastoral and nomadic people typically of Muslim faith that are migrant to Ghana, typically from Senegal, Mali and Mauritania.*

a. Opportunistic – interviewed individuals from fringe communities stated that they had access to existing farming lands, but that they farmed illegally in the Forest Reserve due to proximity and resulting ease.

b. Lack of farm land – a single community, known as Aberewepon, stated that they did not have access to farm land.

The prevention of the farms occurring under scenario a result in their movement to existing locations outside of the project boundary, and does not result in any increase in GHG emissions.

The prevention of the farms occurring in scenario b cannot result in any shifting of these activities given the lack of available lands to which they might be moved, and therefore does not result in any increase in GHG emissions.

Under both scenarios where illegal farming activities are discovered as part of land preparation and planning, farmers are identified, registered, and allowed to continue the management and of their crop through harvest.

It should be noted that as part of the project activities, as described in Section 2 above the project includes a five year plan towards improved regenerative agriculture and transfer of technology. The project targets the development of sustainable permaculture farms in each of the targeted fringe communities, aiming at reducing the shifting nature of farming in the region and allowing for improved yields and diversity of crops while promoting healthy soils.

Therefore, following the relevant tool:

$$LK_t = LK_{AGRIC,t}$$

Where:

LK_t	= GHG emissions due to leakage, in year *t*; tCO_2-e
$LK_{AGRIC,t}$	= Leakage due to the displacement of agricultural activities in year *t* as estimated in the tool "Estimation of the increase in GHG emissions attributable to displacement of pre-project agricultural activities in A/R project activity"; tCO_2-e

It is determined that for all project areas:

$LK_{AGRIC,t}$ = 0

Therefore:

LK_t = 0

4.4 Net GHG Emission Reductions and Removals

According to the applied methodology, the net anthropogenic GHG removals by sinks shall be calculated using the following equation:

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t} - \Delta C_{BSL,t} - LK_t$$

Where

$\Delta C_{AR-CDM,t}$	= Net anthropogenic GHG removals by sinks, in year *t*; t CO2-e
$\Delta C_{ACTUAL,t}$	= Actual net GHG removals by sinks; in year *t*; t CO2-e with values
$\Delta C_{BSL,t}$	= Baseline net GHG removals by sinks; in year *t*; t CO2-e
LK_t	= GHG emissions due to leakage; in year *t*; t CO2-e

As described in the sections above:

$\Delta C_{BSL,t}$ = 0

And

LK_t = 0

Therefore

$$\Delta C_{AR-CDM,t} = \Delta C_{ACTUAL,t}$$

Where

$\Delta C_{AR-CDM,t}$ = Net anthropogenic GHG removals by sinks, in year *t*; t CO2-e

$\Delta C_{ACTUAL,t}$ = Actual net GHG removals by sinks; in year *t*; t CO2-e with values drawn from Table 11

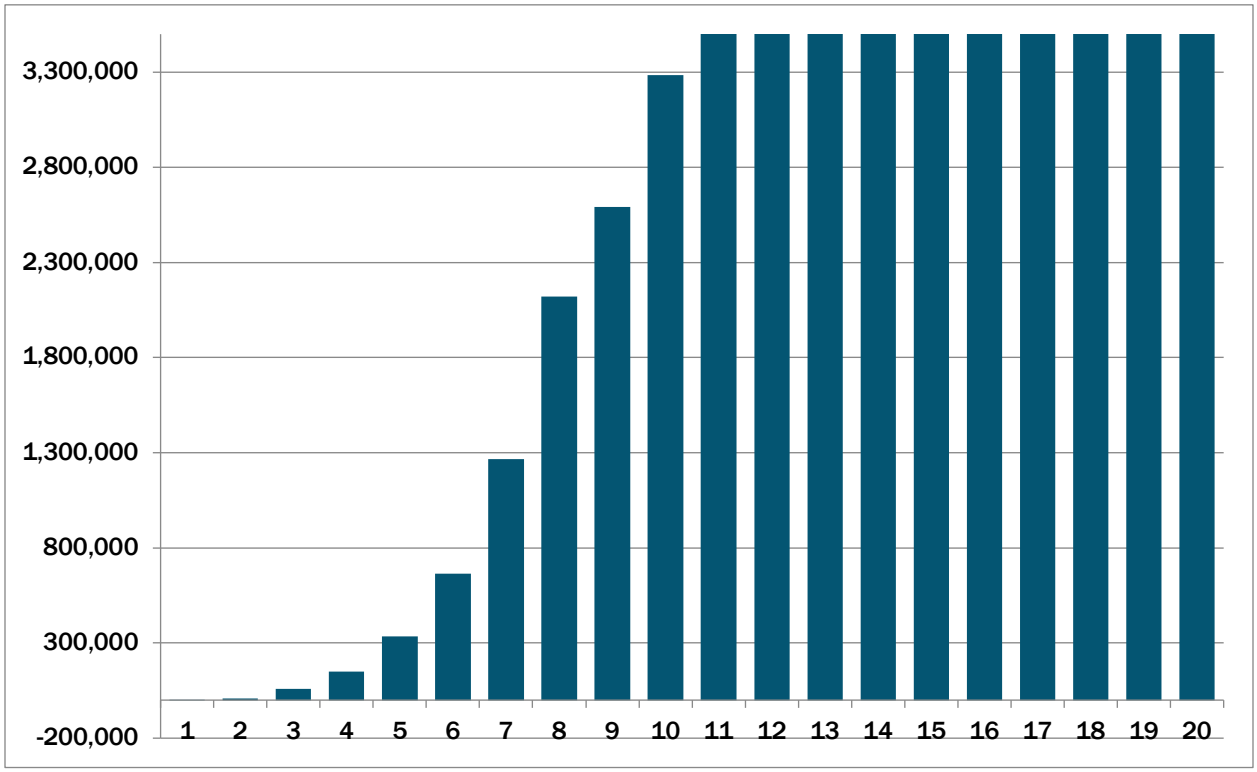
Therefore, the total net GHG emission removals have been estimated as follows.

Table 13 Estimated Net GHG Emission Removals (tCO_2e)

Year	Estimated baseline emissions or removals (tCO_2e)	Estimated project removals (tCO_2e)	Estimated leakage emissions (tCO_2e)	Estimated net GHG emission removals (tCO_2e)
06.2022 - 06.2023	0	1,655.13	0	1,655.13
06.2023 - 06.2024	0	9,557.05	0	9,557.05
06.2024 - 06.2025	0	59,672.89	0	59,672.89
06.2025 - 06.2026	0	150,192.44	0	150,192.44
06.2026 - 06.2027	0	335,879.64	0	335,879.64
06.2027 - 06.2028	0	667,227.38	0	667,227.38
06.2028 - 06.2029	0	1,270,428.97	0	1,270,428.97
06.2029 - 06.2030	0	2,128,951.70	0	2,128,951.70
06.2030 - 06.2031	0	2,602,485.83	0	2,602,485.83
06.2031 - 06.2032	0	3,298,570.80	0	3,298,570.80
06.2032 - 06.2033	0	3,697,083.43	0	3,697,083.43
06.2033 - 06.2034	0	3,706,130.93	0	3,706,130.93
06.2034 - 06.2035	0	3,715,178.43	0	3,715,178.43
06.2035 - 06.2036	0	3,724,225.93	0	3,724,225.93
06.2036 - 06.2037	0	3,733,273.43	0	3,733,273.43

06.2037 - 06.2038	0	3,742,320.93	0	3,742,320.93
06.2038 - 06.2039	0	3,751,368.43	0	3,751,368.43
06.2039 - 06.2040	0	3,760,415.93	0	3,760,415.93
06.2040 - 06.2041	0	3,769,463.43	0	3,769,463.43
06.2041 - 06.2042	0	3,778,510.93	0	3,778,510.93
TOTAL				**3,778,510.93**

Figure 27 Estimated GHG Emission Removals Over the Project Crediting Period



Buffer Allocation

As per the Non Permanence Risk Assessment, the project has a risk rating of 10%. The buffer GHG credits are therefore summarized as:

- Estimated Net GHG emission removals: 3,778,511
- Estimated Buffer credits (10% of Net GHG Benefits): 377,851
- Estimated Total GHG credits / VCUs: 3,400,660

Table 14 Net Emission Removals, After Buffer Stock Allocation

	Expected Total GHG Benefits	Total Credits Available Each Year	VCUs After 10% Buffer Stock Allocation
Year	tCO2e	VCUs	VCUs
1	1655	1,655	1,490
2	9557	7,902	7,112
3	59673	50,116	45,104
4	150192	90,520	81,468
5	335880	185,687	167,118
6	667227	331,348	298,213
7	1270429	603,202	542,881
8	2128952	858,523	772,670
9	2602486	473,534	426,181
10	3298571	696,085	626,476
11	3697083	398,513	358,661
12	3706131	9,048	8,143
13	3715178	9,048	8,143
14	3724226	9,048	8,143
15	3733273	9,048	8,143
16	3742321	9,048	8,143
17	3751368	9,048	8,143
18	3760416	9,048	8,143
19	3769463	9,048	8,143
20	3778511	9,048	8,143
Total Available Credits			**3,778,511**
Total VCUs After Buffer Stock Allocation			**3,400,660**

5 MONITORING

5.1 Data and Parameters Available at Validation

The project monitoring plan has been developed according to the Monitoring Procedure included within the approved methodology, AR-ACM0003.

The following data and parameters are determined or available at validation, and remain fixed throughout the project crediting period – i.e., no monitoring of the below parameters exists. All data and parameters monitored during the project lifetime are detailed in Section 5.2 below.

Data / Parameter	$AGB_{CULM_TEXTILIS}$
Data unit	Kg
Description	Allometric equation for the calculation of above ground biomass of Bambusa textilis
Source of data	Destructive Sampling & Subsequent Analysis[30]
Value applied	AGB = 0.933722 x D^1.802318
Justification of choice of data or description of measurement methods and procedures applied	There is little available data for the quantification of bamboo biomass. The project proponent therefore developed species specific allometric equations for the quantification of changes in biomass of the planted *Bambusa textilis* from measurements of culm diameter.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	AGB_{CULM_ASPER}
Data unit	Kg
Description	Allometric equation for the calculation of above ground biomass of Dendrocalamus asper

[30] Development of Allometric Equations for Bambusa textilis from Destructive Sampling; March 2022.

Source of data	Destructive Sampling & Subsequent Analysis[31]
Value applied	AGB = (0.084491 x D^2.647555) x BEF
Justification of choice of data or description of measurement methods and procedures applied	There is little available data for the quantification of bamboo biomass. The project proponent therefore developed species specific allometric equations for the quantification of changes in biomass of the planted *Dendrocalamus asper* from measurements of culm diameter.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	$BEF_{_ASPER}$
Data unit	Dimensionless
Description	Biomass expansion factor for the calculation of total biomass from measurements of culm diameter
Source of data	Destructive Sampling & Subsequent Analysis
Value applied	1.4
Justification of choice of data or description of measurement methods and procedures applied	There is little available data for the quantification of bamboo biomass. The project proponent therefore developed species specific allometric equations for the quantification of changes in biomass of the planted *Dendrocalamus asper* from measurements of culm diameter.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	Litter Carbon
Data unit	tCO_2 / ha
Description	This variable represents the tCO_2 / ha contained within the litter carbon pool within the bamboo plantation
Source of data	IPCC Guidelines

[31] Development of Allometric Equations for Dendrocalamus asper from Destructive Sampling; March 2022.

Value applied	1% of the total bamboo biomass for each strata
Justification of choice of data or description of measurement methods and procedures applied	The project has chosen to utilize the default factor for the relationship between carbon stock in litter and carbon stock in living trees (bamboo), for a tropical biome with rainfall of between 1,000 – 1,600 mm/yr.
Purpose of Data	Calculation of project removals
Comments	NA

Data / Parameter	Soil Organic Carbon (SOC)
Data unit	tC / ha
Description	This variable represents the annual increase of SOC within the bamboo plantation
Source of data	IPCC Guidelines
Value applied	0.8 tC / ha / yr
Justification of choice of data or description of measurement methods and procedures applied	This value was estimated according to the IPCC guidelines (UNFCC/CCNUCC 2010 a), which recommends that a value of 0.8 tCO_2 can be used as a default value for the stock change per year.
Purpose of Data	Calculation of project removals
Comments	NA

Data / Parameter	RS
Data unit	Dimensionless
Description	The root to shoot ratio is the ratio of above to ground biomass applied to calculate the below ground biomass of sympodial bamboo species
Source of data	Peer Reviewed Literature[32][33]

[32] Arango & Camargo 2012

[33] Gurmessa et al. 2016. *Allometric Equations to Estimate the Biomass of Oxytenanthera Abyssinica (A. Rich.) Munro. (Ethiopian Lowland Bamboo) in Dicho Forest, Oromia Region, Western Ethiopia*. International Journal of Research Studies in Biosciences (IJRSB), Volume 4, Issue 12.

Value applied	1.0.25
Justification of choice of data or description of measurement methods and procedures applied	Destructive sampling of a bamboo clump is extremely expensive and time consuming, and results in the death of the clump. As a result, destructive sampling to determine the below ground biomass held in the intricate root and rhizome system of sympodial bamboo is not realistic, and it is necessary to rely on literature and where necessary results from similar species for the calculation of this parameter.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	CF_{BAMBOO}
Data unit	tC(t d.m)-1
Description	The fraction of dry bamboo biomass that can be attributed to being carbon.
Source of data	IPCC Guidelines
Value applied	0.47
Justification of choice of data or description of measurement methods and procedures applied	IPCC default factor for the fraction of woody biomass
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	t_{VAL}
Data unit	Dimensionless
Description	Two-sided Student's t-value, at infinite degrees of freedom, for 90% confidence level

Source of data	Tool for the "Calculation of the number of sample plots for measurements within A/R CDM project activities" (Version 02.1.0)[34]
Value applied	1.645
Justification of choice of data or description of measurement methods and procedures applied	Confidence level of 90%, degree of freedom "infinite"
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	s_i
Data unit	t.d.m
Description	Estimated standard deviation of biomass stock in stratum *i.*
Source of data	Tool for the "Calculation of the number of sample plots for measurements within A/R CDM project activities" (Version 02.1.0)
Value applied	35%
Justification of choice of data or description of measurement methods and procedures applied	For areas where no pre-measurements are conducted, a conservative value of 35% of the mean biomass stock is applied.
Purpose of Data	Calculation of project emissions
Comments	None

Data / Parameter	*E*
Data unit	t.d.m
Description	Acceptable margin of error (i.e., one-half the confidence interval) in estimation of the biomass stock within the project boundary

[34] EB 58 Annex 15. Calculation of the number of sample plots for measurement within A/R CDM project activities (Version 02.1.0) https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf/history_view

Source of data	Tool for the "Calculation of the number of sample plots for measurements within A/R CDM project activities" (Version 02.1.0)[35]
Value applied	10%
Justification of choice of data or description of measurement methods and procedures applied	A default value of 10% of the mean biomass stock within the project boundary may be used unless a different value is prescribed in the methodology.
Purpose of Data	Calculation of project emissions
Comments	None

5.2 Data and Parameters Monitored

All parameters and variables included within the monitoring plan correspond to those used specifically for assessing the growth, productivity, carbon stock and changes in carbon stock of sympodial (clumping) bamboo species, and take into account the unique growth and development patterns of this group of plants.

The project proponent has a set of standard operating procedures (SoP) relating to Quality Control and Quality Assurance which are available on request.

Data / Parameter	$N_{CLUMP_SPECIES_t}$
Data unit	Dimensionless
Description	The total number of clumps of each species planted by year as the result of the project activities
Source of data	Project Records
Description of measurement methods and procedures to be applied	The project utilizes a Forestry Software, to plan and subsequently record all reforestation activities, including the number of individual seedlings planted during each planting year. Measurements are taken by forest management unit (compartment), each of which has a unique identification number. The species planted and the exact number of clumps is recorded along with the date of planting.

[35] EB 58 Annex 15. Calculation of the number of sample plots for measurement within A/R CDM project activities (Version 02.1.0) https://cdm.unfccc.int/methodologies/ARmethodologies/tools/ar-am-tool-03-v2.1.0.pdf/history_view

Frequency of monitoring/recording	For each strata this parameter is monitored three times; During planting as seedlings are put in the ground; 12 months after planting to monitor mortality and plan blanking (replanting) activities; and finally 24 months after the initial planting at which point no further mortality is expected.
Value applied	Determined ex post.
Monitoring equipment	Forestry software combined with project records and GIS data.
QA/QC procedures to be applied	Multiple measurements across a 24 month period; Use of GIS spatial data to correlate data; Further described in the QA/QC procedures, Standard Operating Procedure for Monitoring of Planted Clumps.
Purpose of data	Calculation of project emissions.
Calculation method	NA
Comments	None

Data / Parameter	N_{CULM}
Data unit	Dimensionless
Description	The number of culms found in each of the bamboo clumps sampled during the monitoring event and counted numerically.
Source of data	Field sampling / monitoring from permanent sample plots.
Description of measurement methods and procedures to be applied	The project will develop a number of permanent sample plots, in accordance with the relevant tool. For each bamboo clump within a permanent sample plot, the total number of culms is manually counted by the field team and recorded numerically.
Frequency of monitoring/recording	During monitoring events
Value applied	Determined ex post
Monitoring equipment	Tablets for direct input of data.
QA/QC procedures to be applied	As per the QA/QC Standard Operating procedures. The field monitoring team should be fully trained in an understanding of clump growth and in field data collection. Data is input directly into tablets to reduce errors. Field measurements shall be checked by a qualified manager to ensure quality control and reduce technical

	errors.
Purpose of data	Calculation of project emissions
Calculation method	NA
Comments	None

Data / Parameter	D_{CULM}
Data unit	Dimensionless
Description	The diameter at breast height of a bamboo culm
Source of data	Field sampling / monitoring from permanent sample plots.
Description of measurement methods and procedures to be applied	Measured using a caliper, with measurements taken at the middle of an internode closest to breast height (1.2m) of each bamboo culm within the bamboo clump being monitored. For each culm recorded a unique number is given.
Frequency of monitoring/recording	Each time a verification event occurs
Value applied	Determined ex post
Monitoring equipment	Caliper for measurements and tablet for direct input of data.
QA/QC procedures to be applied	As per the QA/QC Standard Operating procedures. The field monitoring team should be fully trained in the methods to take such measurements. Data is input directly into tablets to reduce errors. Field measurements shall either be taken by, or be checked by a qualified manager in order to ensure quality control and reduce technical errors.
Purpose of data	Calculation of project emissions
Calculation method	NA
Comments	None

Data / Parameter	T
Data unit	Year

Description	The time period in years between estimations of the change in carbon stock of bamboo biomass
Source of data	Monitoring records
Description of measurement methods and procedures to be applied	NA
Frequency of monitoring/recording	Annual
Value applied	NA
Monitoring equipment	NA
QA/QC procedures to be applied	NA
Purpose of data	Calculation of project emissions
Calculation method	$T = t_2 - t_1$
Comments	If calculations in the change in bamboo carbon stock are carried out in different months of the year, then a fractional value (number of months / 12) is applied.

Data / Parameter	n
Data unit	Dimensionless
Description	The number of sample plots (clumps) by stratum (species and year of planting) required for the estimation of biomass stocks within the project boundary.
Source of data	Calculation
Description of measurement methods and procedures to be applied	NA
Frequency of monitoring/recording	Calculated for each monitoring event.
Value applied	Determined ex post
Monitoring equipment	NA

QA/QC procedures to be applied	NA
Purpose of data	Calculation of project emissions
Calculation method	As described in the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities"
Comments	None

Data / Parameter	Above Ground Bamboo Biomass of a Bamboo Culm (AGB_CULM)
Data unit	Kg
Description	The total above ground biomass per culm, calculated for all culms measured within each permanent sample plot.
Source of data	Permanent sample plot data will be analyzed utilizing species-specific allometric equations.
Description of measurement methods and procedures to be applied	Allometric equations will be developed from destructive sampling of each targeted species as part of a monitoring event, in order to develop a relationship between individual culm diameter and total biomass.
Frequency of monitoring/recording	At a minimum species specific allometric equations will be developed in Years 5, 10 and 15.
Value applied	Determined ex post
Monitoring equipment	NA
QA/QC procedures to be applied	Development of site-species specific allometric equations will occur. Information from destructive sampling will be analyzed by a qualified statistician following the relevant tool for the development of scientifically rigorous species and site specific allometric equations.
Purpose of the data	Calculation of project removals.
Calculation method	Calculated using excel spreadsheets and applying the allometric equation to data collected from the monitoring event.
Comments	NA

Data / Parameter	i
Data unit	Dimensionless

Description	Ex post strata within the project boundaries
Source of data	Monitoring data
Description of measurement methods and procedures to be applied	Ex post strata are determined based upon the actual achieved project activities, with strata determined as a combination of species planted and year of planting
Frequency of monitoring/recording	Calculated for each monitoring event
Value applied	Determined ex post
Monitoring equipment	NA
QA/QC procedures to be applied	As per the QA/QC Standard Operating procedures. The project records will determine the actual number of bamboo clumps of each targeted species, planted each year.
Purpose of data	Calculation of project emissions
Calculation method	NA
Comments	None

5.3 Monitoring Plan

In accordance with the applied approved methodology, the monitoring plan shall provide for collection of all relevant data necessary for:

a) Verification that the applicability conditions listed under paragraphs 3 and 4 have been met;

b) Verification of changes in carbon stocks in the pools selected;

c) Verification of project emissions and leakage emissions.

The data collected shall be archived within the project proponent's database for a period of at least two years after the end of the last crediting period of the project activity.

The methodology requires that commonly accepted principles and practices of forest inventory and forest management in the host country are implemented. Given that there are no such commonly accepted practices with regards to bamboo in the host country, the project utilizes standard operating procedures

(SOPs) specifically for the collection of data relevant for sympodial bamboo and utilizes quality control/quality assurance (QA/QC) procedures, including field data collection and data management.

a) Verification of Methodology Applicability Conditions

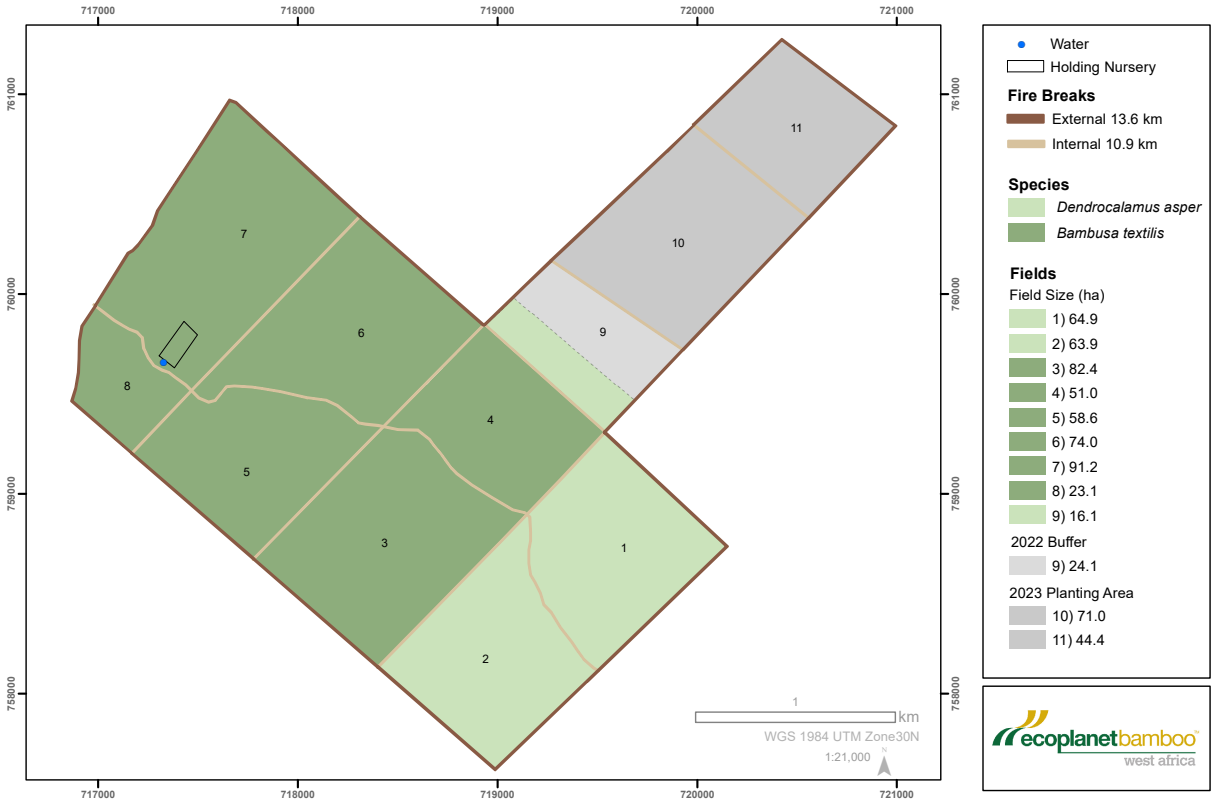
Monitoring of project boundaries: there are no expected changes to the project boundary over the life time of the project, given that the land is occurring within land designated as a Forest Reserve that is demarcated with periodic external boundary markets. With the exception of where a project boundary represents a river, as per the southern boundary, each unique project boundary will have a 6m fire break around it, which provides for clear demarcation. As such, frequent monitoring of the project boundary is not considered necessary.

Within the project area there are different areas set aside for bamboo, and those set aside for conservation forests and protection purposes. The GHG removals associated with the project are limited to the specific areas within which bamboo planting has occurred. Therefore, at each monitoring event the boundaries of the areas planted with bamboo will be monitored, through either GIS/remote sensing, or utilizing drone photography. This monitoring aspect includes the identification and monitoring of ex post strata, based upon the actual date of planting and species planted within each planted area.

At the end of each planting season the boundaries of the areas under which the reforestation activities occurred is uploaded in the form of shape files into the project's forestry software platform. Such annual monitoring of the boundaries is carried out in order to demonstrate that the actual area afforested conforms to the bamboo planting activities as outlined in the overall project plan and each annual operational plan.

Monitoring of bamboo establishment: as above, in addition to monitoring of project boundaries and the it is necessary to monitor the actual bamboo establishment against planned rates. For each field that undergoes reforestation activities the exact area and the exact number of bamboo clumps planted is uploaded into the forest software platform. Any deviation from the planned bamboo establishment will be documented.

Figure 28 Example of Planned Reforestation Activity and Management Units



b) Verification of Changes in Carbon Stocks in Selected Pools

The below monitoring parameters are those required for the determination of bamboo growth and therefore for the determination of changes in bamboo carbon stock. These parameters will be gathered from permanent sample plots, established for each ex post strata.

All data and information collected will be stored in project databases, and forest software platform. This software allows for the gathering of spatial data via its app on cell phones or tablets during the daily operations of the reforestation project. Such data is automatically synced with the project's master database whenever individual devices come into connectivity.

Such spatial data is then used for the development of stratification maps and clear delineation of the number of planted bamboo clumps for each Field, as the unit of reforestation.

Bamboo Clump Mortality

Bamboo clumps are most susceptible within 6-9 months post planting or until the next raining season after planting. After this initial establishment period, mortality rates are expected to be extremely low, as once the bamboo clump has achieved the production of an established below ground rhizome system, and the above ground biomass is emerging as woody biomass, the clumps are not highly susceptible to drought, fire, or pests.

Mortality monitoring occurs in Q2 of the year after planting, following the initial onset of the rains. At this time the operational team can easily determine any clumps that have suffered mortality. Such monitoring co-incides with maintenance activities of the previous year's plantings, including ring weeding around each clump and the control of inter-row grasses.

Following mortality monitoring, re-stocking occurs to maximize the stocking density to the targeted 500 clumps per hectare.

Ex Post Stratification

If biomass distribution over the project area is not homogeneous, stratification should be carried out to improve the precision of biomass estimation. Different stratifications may be appropriate for the baseline and project scenarios in order to achieve optimal precision of estimation of net GHG removals by sinks. In the context of the project activities:

(a) For baseline net GHG removals by sinks – the project areas represent a homogenous strata as planting occurs on an individual clump basis with each hectare measured comprising of 500 bamboo clumps, and no removal of trees or woody vegetation is undertaken for the planting of bamboo.

(b) For actual net GHG removals by sinks – no ex ante stratification of the project area is necessary. However, the *ex post* estimations is based on the actual implementation of the project planting and management plan. Ex post stratification is dependent upon two factors;

- Year of planting
- Bamboo species planted

Table 15 Ex Post Stratification By Year of Planting and Species

Year of Planting	Dendrocalamus asper	Bambusa textilis
2022	Strata 1a	Strata 1b
2023	Strata 2a	Strata 2b
2024	Strata 3a	Strata 3b
2025	Strata 4a	Strata 4b

The changes in the biomass within the project area during the crediting period of the project will be monitored through the sampling design based on the number and area of each strata. Each strata will consist of the set of blocks in the project area based on the planting date and species of bamboo.

Sampling

Areas that were defined as standing forest in the project document have been discounted from the project boundary. Sampling was carried out in accordance with the stratification as defined above. Permanent sample plots will be developed for the first project instance, while new permanent sample plots have been identified for the project areas that were included during the last monitoring and verification event.

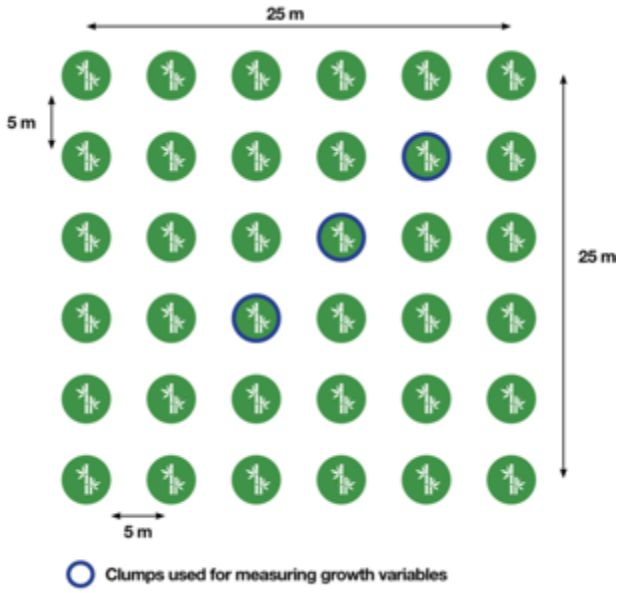
The specific sampling design that was applied is stratified random sampling with new PSP locations added as per the methodology defined in the project document.

The maximum allowable margin of error for the estimation of the bamboo biomass assessed in the monitoring plan is 10% at 90% confidence level.

Development of Permanent Sample Plots

Some studies (Camargo 2006, Schumacher 2006, Rijal 2006 and Camargo et al. 2008) have been carried out to in order to define an optimal plot design for bamboo inventory of giant sympodial species. As a result, the size of permanent sample plots will be of 625 m^2 for all strata. Limitations associated with the establishment of circular plots within bamboo forests representing a high effort, being unjustifiably time consuming and consequently carrying a high costs result in the delineation of square sample plots of 25m x 25m. Within the sample plots three bamboo clumps will be monitored and measured at each verification event, as depicted in the image below.

Figure 29 Permanent Sample Plot Design



The location of permanent sample plots will be determined through a random selection process. A grid with the size of plots will be overlaid on the digital map of the bamboo planted area, excluding areas of conserved forest. Using Hawth's extension of the software ArcMap 9.2 randomly selected plots are defined and the co-ordinates of the center point the plot will be registered and marked.

Calculation of Sample Size

The total number of permanent sampling plots to be monitored will be estimated in line with the tool "Calculation of the number of sample plots for measurements within A/R CDM project activities" (version 02.1.0). Sample plots will be located randomly inside each stratum and measured at least every five years, or at shorter intervals depending on the desire frequency of verification events.

The tool allows for a simplified equation for the estimation of the number of sample plots where the total sampling is less than 5% of the total project.

Application of the Tool

The maximum number of sample plots by stratum is calculated as:

$$N = \frac{A}{AP}$$

The number of sample plots for the project area is thereafter calculated using the following equation, establishing a confidence interval of 95% and a margin of error of 10%.

$$n = \frac{N * t_{VAL}^2 . \left[\sum_{i=1}^{L} Wi.S_{ti} \right]^2}{\left(N.E^2 \right) + t_{VAL}^2 * \sum_{i=1}^{L} w_t . (S_{ti})^2}$$

n	Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
N	Total number of possible sample plots within the project boundary being as calculated as above;
t_{VAL}	Two-sided Student's t-value, at infinite degrees of freedom, for the required confidence level; calculated as 1.960
W_i	Relative weight of the area of stratum i (i.e., the area of the stratum i divided by the project area); as defined in the assumptions above

S_i Estimated standard deviation of biomass stock in stratum i; t d.m. ha-1

E Acceptable margin of error (i.e., one-half the confidence interval) in estimation of culm diameter, defined as <10%.

The tool defines that for a small sampling fraction (that is, when area sampled is less than 5% of the project area), the following simplified equation can be used for estimating the number of sample plots:

$$n = \left(\frac{t_{VAL}}{E}\right)^2 * \left(\sum_i w_i * s_i\right)^2$$

n = Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless

t_{VAL} = Two-sided Student's t-value, at infinite degrees of freedom, for the required confidence level; dimensionless

E = Acceptable margin of error (i.e., one half the confidence interval) in estimation of biomass stock within the project boundary; t d.m. (units used for s_i)

w_i = Relative weight of the stratum *i* (i.e., the number of clumps of the stratum *I* divided by the total project planted clumps; t d.m.

s_i = Estimated standard deviation of biomass stock in stratum *i*; dimensionless

i = 1a; 1b; 1c; 2a… biomass stock estimation strata within project boundary

Given that the project has multiple strata, the allocation of the total number of sample plots to different strata is calculated as:

$$n_i = n * \frac{w_i * s_i}{\sum_i w_i * s_i}$$

Where:

n_i	= Number of sample plots allocated to stratum *i*; dimensionless
n	= Number of sample plots required for estimation of biomass stocks within the project boundary; dimensionless
w_i	= Relative weight of the stratum *i* (i.e., the number of clumps of the stratum *I* divided by the total project planted clumps; t d.m.
s_i	= Estimated standard deviation of biomass stock in stratum *i*; dimensionless
i	= 1a; 1b; 1c; 2a… biomass stock estimation strata within the project boundary

The project will utilize a 90% confidence level, as prescribed by the tool, for the determination of biomass stock in A/R projects.

After calculating the sample size, the plots selected within each stratum will be permanent and monitoring shall always will be conducted out on these throughout the project life. New plots will be added for each strata as applicable.

Monitoring of Bamboo Clump Parameters

The species being grown have similar growth and ecological patterns. Both are sympodial (clumping) bamboo species. Such bamboos have a tight knit rhizome system with above ground culms emerging within a compact “clump”, giving this group of bamboos the common name “clumping” bamboo. Each bamboo clump that is planted will consist of multiple culms (or poles), with these culms growing in number and size over a number of years after planting, until the clump achieves its maximum productive biomass, and therefore carbon removals.

The growth of individual clumps and their culms within sample plots will be measured at each monitoring event for the estimation of above-ground bamboo biomass. For each clump included within permanent sample plots, the following monitoring will be carried out:

Step 1:

- Use of a GPS to record the clump location, and the number of the clump within the permanent sample plot as Clump 1, Clump 2, Clump 3.
- Confirmation of bamboo species.
- Counting of the total number of culms within the clump including all culms that are taller than breast height, measured at 1.3m.

Step 2:

Culms will be recorded as Culm 1, Culm 2, Culm 3 etc. Individual culm measurements will be taken for all culms within the clump, using a caliper:

- Culm diameter at breast height (cm)

Step 3:

The appropriate allometric model is fitted from culm diameter to determine the total Above Ground Biomass of each individual culm, for all culms identified in the clump and the associated Total Above Ground Biomass of the clump.

The below ground biomass will be extrapolated from above-ground biomass using the Root to Shoot ratio for clumping bamboo.

Litter & Soil Carbon Pools

The changes in carbon content in the litter and soil attributable to project activities are not measured as part of the monitoring plan, as these are calculated using default factors following IPCC guidelines. This represents a conservative approach.

Monitoring of Pre-existing Trees

The project area includes a number of pre-existing trees. The carbon associated with these standing trees will not be measured and accounted for. This represents a conservative approach, as the baseline scenario assumes the removal and reduction of these trees. Given the clear differences between trees and bamboo monitoring of only bamboo clumps does not represent a challenge.

However, in order to ensure no net environmental harm, the project will monitor the survival and health of these trees.

Monitoring will occur within the Permanent Sample Plots detailed above. Within each 100m^2 sample plot, all trees that occur will be recorded with the following information:

a) Tree number
b) Diameter at breast height
c) Status (dead or alive)

In addition an aerial image using a drone will be taken from the center point of each sample plot depicting the canopy cover.

Monitoring Frequency of Clump Parameters

The monitoring of information critical for achieving the project management plan will be recorded and monitored annually. This includes the actual planted bamboo clumps by species each year, and the subsequent determination of clump mortality.

For the estimation of changes in biomass stock in the planted bamboo, monitoring of clump parameters will occur either every five years, or at each verification event, depending on the frequency of such events.

Quality Assurance / Quality Control

The project provides quality assurance and quality control (QA/AC) measures through the development of standard operating procedures for all aspects of project implementation and monitoring. This includes the necessary training of all field personnel in bamboo clump inventory.

Ensuring that the net GHG emission removals as a direct result of project activities are Monitored, Reported & Verified using best practices and as credibly and precisely as possible. Monitoring is focused on the growth rates and biomass accumulation of the planted bamboo, and accurate reporting on such factors.

To ensure that both operational and changes in biomass and associated carbon stocks as a result of the project activities are managed professionally, the project is implementing the Micro Forest forestry software platform, which records information based on forest management units (fields) spatially and temporally.

In all aspects of project development and reporting, a conservative approach will be maintained.

Structure and Responsibility

Three levels of responsibility exist within the project proponent's team for the analysis and reporting of the monitoring event:

Camille Rebelo: EcoPlanet Bamboo Chief Operating Officer and carbon specialist, Camille has 15 years of experience in AFOLU project implementation, as well as 10 years of experience in the development and management of bamboo. Camille is responsible for the development of the monitoring plan, oversight of fieldwork, analysis of all data collected during the monitoring event and the delivery of monitoring reports and documentation.

VP of Forestry: EcoPlanet's VP of Forestry oversees all reforestation projects, manages the Micro Forest platform and associated database of information, and provides support to the in country operational teams. He/she is responsible for the training of teams to ensure consistency and credibility of data collection across all projects.

General Manager, West Africa: EcoPlanet has an experienced forestry professional who serves as the General Manager of the West African operations, covering the Bandai Hills Reforestation Project and the adjacent North Bandai Reforestation Project. This senior position has extensive experience in the development and management of sustainable forestry operations across Africa and is responsible for all day to day operations, including the collection of data during monitoring events.

Data Collection, Storage and Reporting

In order to guarantee the quality of the information collected during the monitoring event the standard operating procedures described in the monitoring plan ware adhered to. All inventory and field work is carried out in accordance with the requirements established in the IPCC GPG LULUCF guidelines, where applicable to bamboo plantations. Statistical criteria and the principals of forest inventory are utilized as a quality control / quality assurance procedure for inventory operations, including field data collection and data management.

Once the infield sampling portion of each monitoring event is completed the data will be aggregated, collated and sent to EcoPlanet Bamboo's management team for analysis.

Data collected during the monitoring event has been archived electronically and shall be kept for a minimum of two years. Data is stored online in company Dropbox accounts.

The project database will include all information related to the monitoring of project activities: forest management unit and / or PSP identification codes and coordinates for each sampling plot, dates when sampling has been made, the person responsible for the sampling and the sampling results.

c) Verification of Project Emissions and Leakage Emissions.

Project Emissions: according the applied methodology the only increase in GHG emissions within the project boundary that requires being accounted for is the non-CO_2 GHG emissions from burning of woody biomass for site preparation and/or forest management. The monitoring of emissions is required only if the emissions are considered significant; if insignificant, evidence should be provided (e.g., in the relative part of the monitoring plan of each project instances that the assumption for the exclusion made in the ex-ante assessment still hold in the ex post situation.

The project activities do not result in any burning of biomass, whether for land preparation or as part of the forest management. However, under the scenario where wild or uncontrolled fires occur within the project areas, the monitoring and estimation of GHG emissions associated with such an occurrence will be done in accordance with the latest version of the tool "Estimation of non-CO_2 GHG emissions resulting from burning of biomass attributable to an A/R CDM project activity".

Leakage Emissions: under the applicability conditions of the applied methodology, no leakage emissions are expected. Monitoring activities will ensure that this assumption is accurate in the observations of the ex post project scenario.

Procedure for Addressing Non Conformities

Any non-conformities associated with documentation and reporting are dealt with by EcoPlanet Bamboo Group's management team, while non conformities in the field are dealt with by instruction to the General Manager, West Africa.

APPENDIX

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