Sofala Community Carbon Project

Envirotrade

Avoided Deforestation [REDD+]

Conservation of miombo woodland
in Mozambique

Plan Vivo
Carbon management and rural livelihoods

Envirotrade Sofala Limitada

Technical Specification

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Date: 12 January 2016

Version: v3.2 - 120116

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Acknowledgements:

This work undertaken by ECCM as part of the Miombo Community Land Use and Carbon Management Project has only been possible because of the financial support received from the European Commission (Environment budget). Acknowledgements to all the staff of Envirotrade Lda in Mozambique, the University of Edinburgh and to the N'hambita Community.

Contents

A: Introduction

This Plan Vivo technical specification provides a methodology for determining carbon benefits of conservation of miombo woodland in Sofala Province, central Mozambique. It contains:

- A method for quantifying carbon stocks in conservation areas;
- An analysis of the local deforestation rate and areas at risk of deforestation in the absence of project activities;
- A description of the interventions required to reduce the rate of deforestation through the creation of community conservation and sustainable management areas;
- A proposal for a monitoring plan that assesses the effectiveness of project activities;
- A crediting and payment scheme for emission reductions;
- An additionality test;
- A description of the likely environmental and social benefits;
- A framework to address leakage.

The conceptual approach, methodological framework and guidelines will assist project administrators and local communities to develop appropriate project activities and collect the information necessary to produce verifiable reductions in atmospheric carbon dioxide.

This technical specification is derived from, and similar to, a previous technical specification called Reducing greenhouse gas emissions by avoiding deforestation of miombo woodland in central Mozambique. In writing it, the authors have responded to the need of investors to pay ex ante for forest conservation efforts rather than compensate for a reduction of greenhouse gas (GHG) emissions after they have occurred. The financial feasibility of REDD+ activities in dry forest with relatively low carbon stocks is strongly dependent on ex ante payment for GHG emission reductions. This payment structure allows the project implementer with sufficient funding to adequately develop the project and provides community members (who need to forgo opportunities) with adequate, upfront compensation.

The Plan Vivo Foundation authorises the use of technical specifications by registered Plan Vivo projects in accordance with the Plan Vivo Standard and Guidelines.

B: Applicability

This technical specification was developed for the N'hambita Community Carbon Project, located in the Sofala Province, central Mozambique. Whereas approach described is likely to be appropriate for forest conservation projects located across the miombo woodlands of sub-Saharan Africa as well as the dry woodlands of north Africa that share common deforestation drivers, the deforestation rate and carbon stock values presented here, were developed specifically for the reference area described in section E. Applying this technical specification to a broader region would require site-specific information.

While some certain areas of the dry woodlands of sub-Saharan Africa are legally protected (for example in National Parks), there has been a substantial increase in the rate of deforestation across the region and especially in central Mozambique where the project is located. However, the protection of miombo woodland involves a number of short-term costs to local communities and individuals including:

- Opportunity costs of not cultivating wooded land;
- Opportunity costs of a reduced extraction of wood fuel, timber or live plants;
- Additional efforts to control fires;

- Potential negative effects of forest wildlife on crops; and
- Costs of organising community conservation efforts such as governance structures and monitoring.

Aside from carbon-related revenues, there are few other avenues through which to obtain funding or finance to cover these additional costs. An entity may be fortunate enough to obtain short-term funding through international development agencies for a particular project (3-4 years), but long-term, truly sustainable forms of income are clearly not available. The effect of Plan Vivo carbon finance is therefore strongly additional to any activities that might occur in the absence of project activities.

C: Environmental & Social Benefits

While communities and individual farmers may incur some short-term costs as a result of project activities to conserve miombo woodland, the longer-term environmental and social benefits that are likely to accrue include:

- Soil conservation, particularly the prevention of soil erosion associated with heavy rainfall events and silt deposition in water courses;
- Hydrological benefits from harvesting incidental moisture and improved water flows which will help to reduce the risk of catastrophic flooding;
- Maintenance of biodiversity through the protection of wildlife habitat, and potential economic benefits from the visitors this may attract to the Gorongosa National Park;
- Increased connectivity in the landscape outside of the national park;
- Provision of non-timber forest products (NTFPs) including honey from beekeeping, and medicines and fruits from specific trees.

D: Barrier analysis and Additionality test

1. Financial Test

Economic and political conditions in the Sofala Province of Mozambique have prevented significant conservation and forestry management activities taking place. The revenues from the sale of carbon offsets are significantly larger than the resources available to the community through any other source including from the central government. Research conducted in the project area has demonstrated that conditions required for economic development and livelihood creation are largely missing in this region. The income generated by the activities of this project is therefore additional to that which would be generated by the normal subsistence activities of the community. Payments for Environmental Services to individual farmers over a seven year period provide a subsidy or bridging finance to offset the short term opportunity costs associated with land-use change.

2. Barriers Test

It is clear that significant barriers exist to adoption of REDD+ activities under a baseline business as usual scenario; these include local barriers in the form of charcoal production, extreme poverty, lack of surplus labour, health constraints, the financial and institutional capacity to manage forests in a sustainable manner and access potential sources of funding and finance. The project was designed in a particular manner to overcome these barriers.

3. Common Practice Test

The project has introduced a wide range of innovative land-use change measures that are transforming the way in which resources are used by the community. The research conducted in the community prior to the commencement of activities clearly indicated that very different practices were commonplace from those implemented by the project.

4. Legal Test

Whereas the project activities do not breach any local or national laws, the activities are not mandated or required to fulfil the official policies, regulations, or industry standards of the Government of Mozambique or any organisation or institution.

E: Context

E1: Project Reference area and ecosystem characteristics

The Sofala Community Carbon Project is located within the buffer zone of the Gorongosa National Park (GNP) in the Sofala Province of Central Mozambique. The N'hambita pilot project phase 1 and 2 covers an area of approximately known as the Chicale Regulado, phase 3 includes Mucombeze Regulado. The total project area in the Nhambita region is 55,877 ha, which includes contracts signed by 1,422 farmers and the REDD+ area of 9,104 ha.

The area is adjacent to the south-west boundary of Gorongosa National Park between coordinates 18º 49' 30"- 19º 04' 00" South and 34º 02' 00" - 34º 17' 30" East, approximately 60 km west of Vila Gorongosa. The project area can be accessed by the national road (EN-1) and by the rural road ER-418 that serves as the access to west gate of the Gorongosa National Park. The Pungue and Vunduzi Rivers are the southern and western boundaries respectively of Chicale. A map and satellite image of the project reference area to which this technical specification applies are shown in Figure 1 and Figure 2.

Communities and project administrators have mapped the boundaries of specific project areas within this zone to define the target conservation areas that are under management, as described in section H Table 6 and Figure 2.

The altitude of the Chicale Regulado ranges from 35 to 330 m.a.s.l. The climate is characterised as sub-tropical, with two distinct seasons. The cool dry season occurs between May and October, and the hot wet season occurs between November and April. Annual precipitation is around 750 mm and is distributed mainly between November and April, but there is high inter-annual variability. The soils in the Chicale Regulado are generally poor, highly weathered and freely draining sandy loams on the higher ridges and sandy silt loams along stream and river margins.

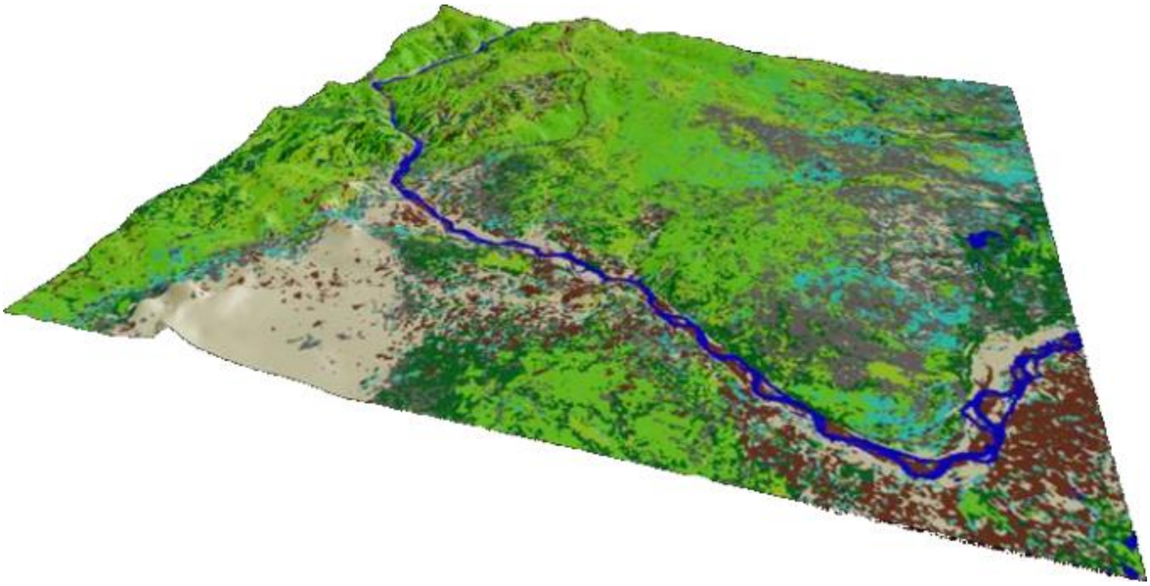

Figure 1: True colour composite 2000 Landsat image of project area showing the rivers in blue, dense woodland in dark green and open woodland and savannah in light green (Spadavecchia, Williams et al. 2004).

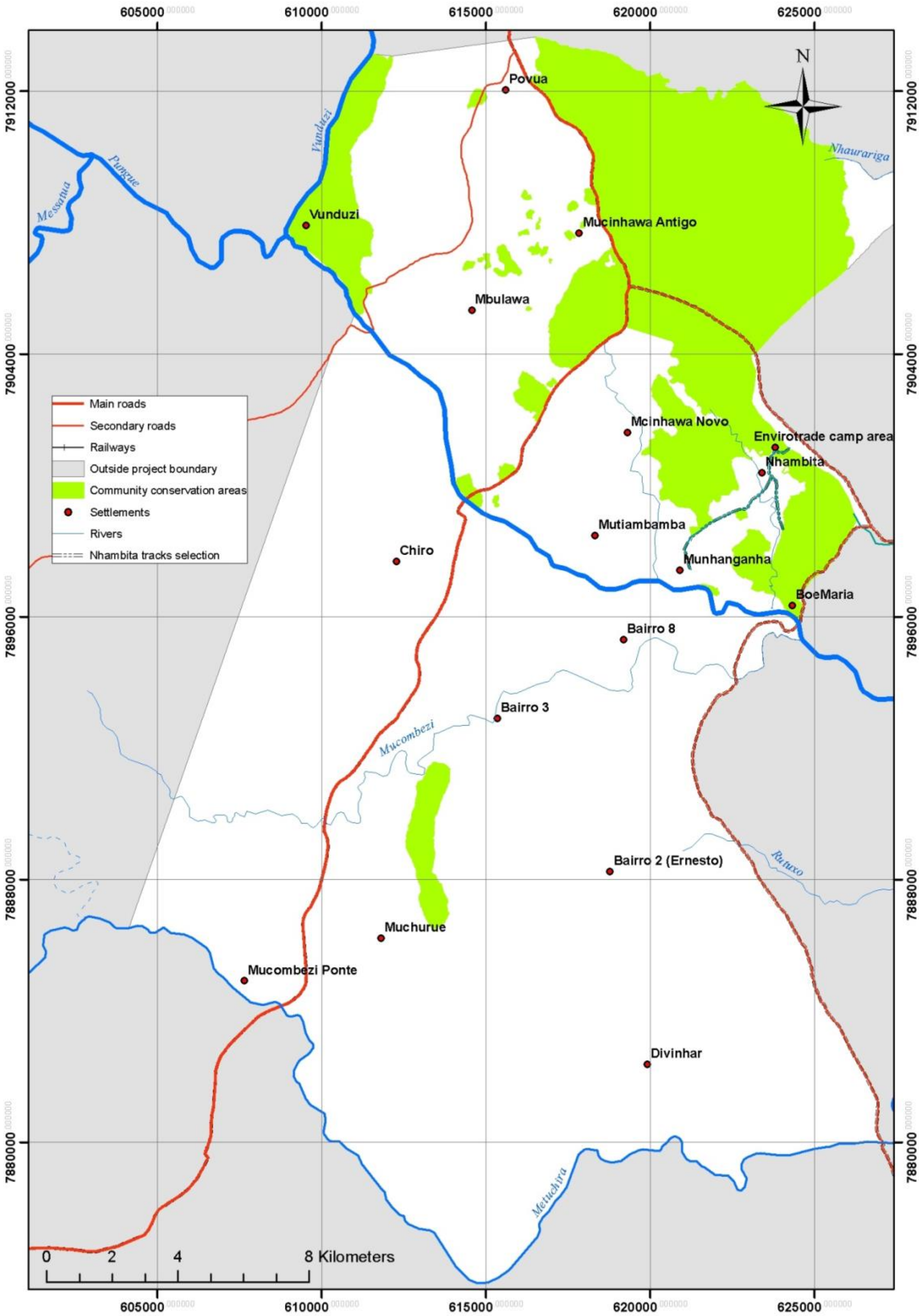

Figure 2: Map of the project area. The area, Comunidade do Regulo Chicale, is between the Pungue, Vunduze and Nhanichindo rivers and the park boundary, the north-west point is 18.82°S, 33.90°W; and south-east 19.21°S, 34.26°W. Community conservation areas under this technical specification are in green, and cover 9,104 ha in total.

Miombo woodlands extend across approximately 2.8 million km^2 of the southern sub-humid tropical zone from Tanzania and the Democratic Republic of Congo in the north, through Zambia, Malawi and eastern Angola, to Zimbabwe and Mozambique in the south. The miombo woodlands are a form of dry deciduous woodland that is dominated by a number of characteristic tree species. A grass layer is usually found below the tree canopy that allows for surface fires to occur. The distribution of miombo woodland largely coincides with the flat to gently undulating surfaces that form the Central African plateau (Figure 3). There are approximately 440,000 km^2 of miombo woodland in Mozambique (WWF 2002).

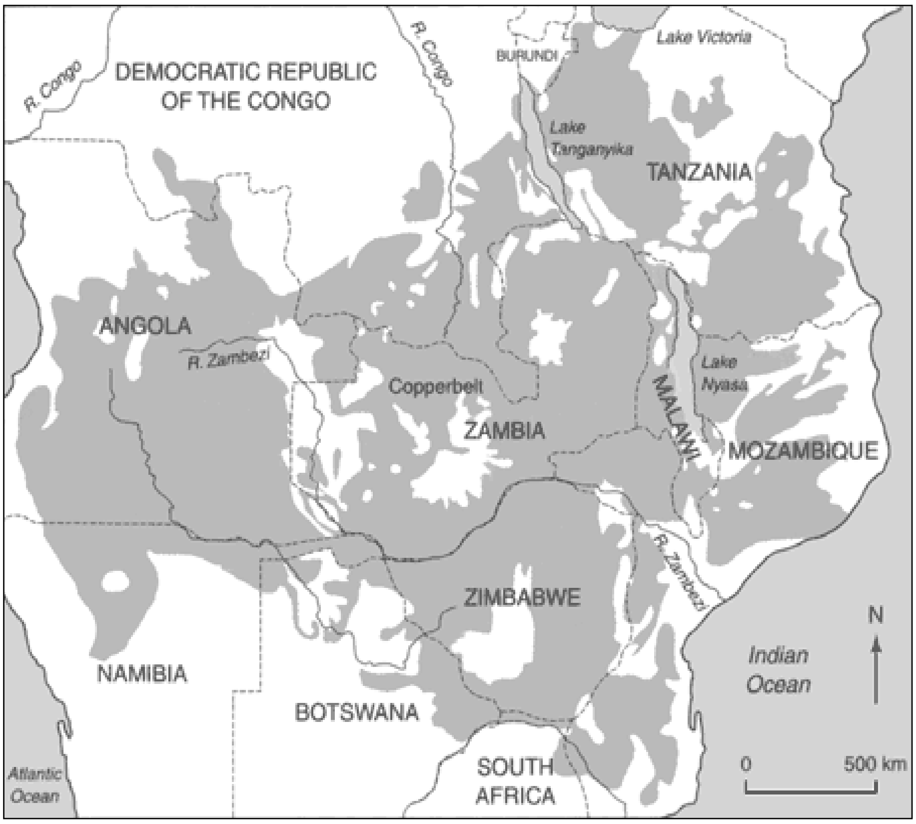

Figure 3: Distribution of miombo woodland across southern and eastern Africa (from Campbell et al: http://www.cifor.cgiar.org/miombo/docs/Campbell_BarriersandOpportunities.pdf)

Several floristic associations are present in and around the Chicale Regulado including miombo woodland, Combretum woodland, riverine woodland and Combretum/palm woodland (Mushgrove 2003). Miombo is the most common woodland type in this area and is dominated by genera such as Brachystegia, Julbernardia, Erythrophleum, Burkea, Diplorhynchus, and Pterocarpus

Most miombo species are relatively slow growing (mean annual diameter increment is typically 0.5 cm yr-1). Many of these species are drought tolerant and frost sensitive, and they are typically deciduous - losing their leaves during the dry season.

E2: Description of the Community

In 1948 the Gorongoza National Park was created by the Portuguese colonial government and in this process people were displaced from their homes to a buffer zone surrounding the entire park. In the buffer zone certain rules were applied, for example hunting and gathering was allowed only for subsistence purposes. The N'hambita Regulado was one of the relocation areas. In colonial years, employment in the form of road building and cotton production for export was available. This ceased at independence in 1975. Shortly afterwards, the Gorongosa area became one of the most intense areas of conflict in the civil war (1976-1992), and farming was hindered by fighting, landmines and a breakdown in infrastructure. There was a severe food shortage. Much of the population was displaced for many years, many of them returning in the mid-1990s. A population survey in 1997 gave the population of the N'hambita Regulado as 612 people in 102 families, living in an area of about 20,000 hectares. Hegde (2008) working in the same area found that households were established only 20 years ago on average, and 86 % were from outside the region.

The main language spoken is Sena, but many speak Portuguese. Literacy is 34 % (Jindal 2003). Females outnumber men by about 1.1 to 1 and many men have more than one wife. About 20% of households are headed by females. Families live in widely scattered homesteads, each with several buildings made of bamboo, grass and mud, usually with livestock (chickens, ducks, goats, pigs) and fruit trees (mango, banana, papaya) with a central area for cooking. Many resources come from the forest. Females spend a large part of their time collecting firewood. O'Keefe et al (1984) estimated firewood consumption for savannas to be 1.1 to 1.7 m3 per year per person. As well as firewood, the forest provides: medicines, construction materials, grass, roots and tubers, fruits and nuts, bushmeat (baboons, rats, gazelles), honey and wax.

E3: Historical land-use changes

From a legal viewpoint, there are three types of land: protected land, buffer zone and community land. The protected area (the Gorongosa Park) is under the State administration, currently managed by the Carr Foundation, a US organisation. The buffer zone immediately adjacent to the Park boundary is jointly managed by the government, communities and other stakeholders. The community land is managed by the communities under the Land Act 1997 which allows subsistence farming, sustainable logging, fishing and hunting. Charcoaling is illegal in the buffer zone. Local leaders have the power to grant permission for new plots of land for farming, called machambas, even to incoming families. Traditionally, no written record of such transactions are made. In March 2002, a Community Association was formed by ORAM (Rural Association for Mutual Support), as part of a national government programme to regularise traditional communities and resolve land use title. The recent pattern of land use change is documented in a series of SPOT images from 1999 to 2007 (figure 4). They show substantial increases in deforestation in recent years.

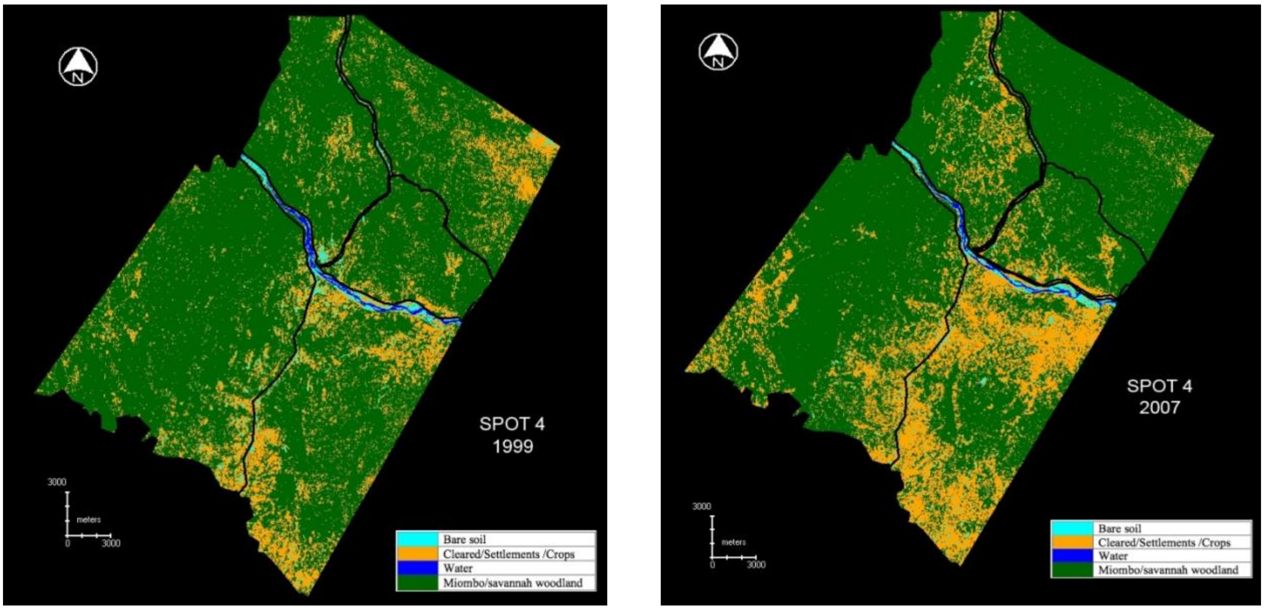

Figure 4: SPOT 4 satellite imagery (Flaherty 2008). Shows of vegetation cover loss between 1999 and 2007 in N'hambita Regulado and surrounds. The local deforestation rate was based on these images (see text).

E4: Drivers of Deforestation

The drivers of deforestation in the project reference area are:

- Agriculture. The clearance of land for agriculture is observed throughout the area in particular on low lying ground in proximity to water sources. This is the largest proximal cause of deforestation in Africa (Geist and Lambin 2002) and visibly the driving force in the region. A socio economic survey carried out between 2004 and 2008 showed that land for agriculture was the most likely reason an individual would move to an area (Jindal 2008).
- Charcoal production. Illegal charcoal production is a driver of deforestation throughout sub-Saharan Africa. Local markets for charcoal include Beira, Chimoio, Gorongosa and Inchope. The majority of charcoal production occurs within 2 km of main roads (Herd 2007).
- Burning. Prior to the introduction of a fire management regime in 2005, most of the project reference area was affected by uncontrolled fires every year (Zolho 2005). Frequent burning hinders natural regeneration (and hence stand recovery) and thus reduces the accumulation of carbon in biomass and soils.
- Logging. Although many of the most valuable timber trees in the Chicale Regulado were harvested prior to the 1980s, many of the trees are commercially valuable and therefore unplanned, unsustainable logging remains a key long-term threat to the remaining woodland.

Deforestation is a process of woodland loss caused by any combination of the above activities.

F: Ex-Ante Carbon Quantification

This section describes methods for quantifying the deforestation that would be expected to occur in the absence of project activities (the baseline scenario) and the carbon benefits that are expected to be achieved as a result of the project activity (the project scenario). The method involves quantifying existing carbon stocks and establishing areas at risk of deforestation in the absence of project activity.

Five investigations contribute to the quantification of carbon in Protected Areas:

1. The type of vegetation cover in the project area were elucidated through a preliminary inventory (Mushove 2004) which located the position of 15 permanent sample plots.
2. The carbon stocks of the vegetation covers are determined through field inventories, the development of a local allometrics and local root shoot ratios (Ryan 2009). Eighty seven plots of between 0.25 and 1.00 hectares were used to determine carbon stocks, 15 permanent sample plots were used to monitor changes in tree growth, burn regime and soil moisture (Ryan 2009).
3. The rate of deforestation in the project area under forest management was determined by a analysis of a time series of SPOT imagery between 1999 and 2007 (Flaherty 2008).
4. The baseline was determined by first determining likely scenarios without the project and then measuring carbon stocks in 32 machambas (Ghee 2009). It is assumed that 'without project' the woodland would be cleared to a few remaining trees as found in Ghee's survey.
5. The vegetation cover was stratified by point transects through the forest management areas, to yield the relative proportion of different woodland types, each characterised by its carbon content.

The data from five investigations form ECCM's carbon calculator (see Figure 6).

Carbon pool	Included?	Justification
Above ground biomass [1]	Yes	Local allometric derived from destructive sampling applied to eighty seven tree inventories to determine carbon stocks of vegetation covers. Community based monitoring possible.
Below ground biomass	Yes	Local root shoot ratios derived from destructive sampling used to relate above ground to below ground biomass. Community based monitoring possible.
Soil carbon	No	While local soil carbon has been defined during a 3.5 year study, and is being monitored in 15 permanent sample plots, this is not included due to large landscape variation and the difficultly of community based monitoring in all forest management areas (see text).
Leaf litter	No	Determined as peaking at 0.75 ±0.13 tC ha-1 during monthly monitoring of permanent sample plots, but not included due to the unknown of permanence of this carbon pool.
Grass biomass	No	Using a locally calibrated (67 samples) disc pasture meter a carbon stock of 1.15 ±0.18 tC ha-1 was derived from 6 Permanent Sample Plots and 8 one off plots. However this is excluded the burn regime at this time threatens the permanence of this pool.

Table 1

The project reference area is a mosaic of vegetation types which differ in their carbon stocks. Five vegetation covers were distinguished in an initial inventory carried out in 2004 (Mushove 2004). Eighty seven tree inventories of above between 0.21 and 1.00 hectares were used to determine the carbon stocks of the five vegetation covers in the N'hambita area A guide for distinguishing between vegetation categories is provided in Table 2. Only the carbon stocks in above and below ground biomass are included within the crediting system from this survey, i.e. soil carbon is excluded from the analysis at present (table 1).

The above ground biomass was determined within the land classes through an allometric derived from the same study:

$$\log(B_s) = 2.601\log(D) - 3.629$$

[1] It is expected there will be a small amount of firewood collection from the protected areas. Given that dead branches will be consumed by annual fires and low intensity of this activity in areas outside of cultivation it is expected the impact of this activity will be negligible on the carbon stocks.

Where Bs = dry biomass of stem (kg C) and D is diameter at breast height (DBH) (cm). Height of tree is subject to large bias during measurement and was only found to increase accuracy of biomass calculation by 2% and was thus excluded as a parameter to the allometric. The expected biomass of five different vegetative covers found in miombo woodland in the project region are given in Table 2.

The Root : Stem ratio 0.42 ± 0.01 was also derived from 23 trees and was used to derive the below ground biomass from the above ground biomass. This relationship has been applied to the carbon calculator given in Figure 5 and attached as a spreadsheet to this report "Avoided deforestation carbon calculator".

The carbon in soil organic matter is not included because of the high costs associated with monitoring changes in soil carbon over time. The carbon stock of N'hambita woodland is dominated by soil carbon, 76.3 ±9.9 tC ha-1 (Ryan 2009). Given that upon conversion to agricultural land, miombo woodland lose around 47% of its soil C (to 1.5 m depth) (Walker and Desanker 2004), this implies 36 tC ha-1 is lost from the soil when land is deforested. Not including soil carbon makes the carbon quantification extremely conservative as typically more carbon is lost from the soil than biomass during deforestation in the region. The carbon stored in leaf-litter and dead wood is also likely to increase as a result of conservation measures but does not constitute a large proportion of the total carbon pool and is excluded. A new study started in 2009 will determine the amount of dead wood in a miombo woodland and seek to explain soil carbon variability (pers. comm. Emily Woollen, PhD candidate, Edinburgh University) which will further increase the understanding of carbon cycling and storage in the N'hambita area.

Vegetation Category	Description	Carbon stock (tC ha^{-1})	N
Miombo Woodland	Tropical woodland including, but not limited to that dominated by miombo species. Dominant tree species: *Brachystegia boehmii, Diplorhynchus condylocarpon, Pterocarpus rotundifolius, Burkea africana, and Brachystegia spiciformis.*	27 ± 13	26
Savanna	Characterised by relatively sparce woodland composed of a few large trees in the genera Combretum and Acacia, with open, grassy spaces between trees. Dominant tree species: *Combretum adenogonium, Combretum apiculatum, Combretum hereroense, Commiphora mossambicensis*, and *Pterocarpus rotundifolius*.	14 ± 10	10
Riverine forest	Dense, high woodland adjacent to watercourses. Dominant tree species: *Sclerocarya birrea*, *Khaya anthotheca*, *Cleistochlamys kirkii, Acacia nigrescens*, and *Pterocarpus rotundifolius.*	47 ± 18	6
Secondary Woodland	Abandoned machambas and degraded woodland. Dominant tree species: *Brachystegia boehmii, Julbernardia globiflora, Brachystegia spiciformis, Diplorhynchus condylocarpon,* and *Burkea africana.*	13 ± 9	45
Machambas	Agricultural plots. Tree species sometimes found: *Sclerocarya birrea, Diplorhynchus condylocarpon, Pterocarpus angolensis, Burkea Africana, and Pseudolachnostylis maprouneifolia.*	2.77 ± 0.61	32

Table 2: Estimated carbon stocks in above ground biomass of woodland areas in Sofala province (Ryan 2009). The ± figure measures the spread of the data (the Standard Deviation). It can be used to estimate 95 % confidence intervals when n samples have been made from a new area in the region. All stems above 5 cm DBH and all root biomass above 2 cm diameter were included. The density, moisture content and weight of the biomass was recorded from the destructively harvested trees.

F2: Baseline Analysis

Future deforestation under the baseline scenario

Future deforestation in the absence of project activities was estimated by projecting historical deforestation rates into the future. Depopulation occurred in the project reference area during the civil war in the 1980s and a process of re-population has been ongoing since the mid 1990s when the conflict ended. To avoid underestimating the rate of deforestation the timeline for analysis of historical land-use change was therefore restricted to the period from 1999 to 2007. The satellite images used to define the historical rate of deforestation in the project reference area are shown in Figure 4.

Zone C was excluded from the analysis of historical land-use change and calculation of the baseline rate of deforestation because it falls largely within the legally protected area of the Gorongosa National Park and is therefore not subject to the same deforestation pressures as the unprotected areas of miombo woodland.

The total land area of zones A, B, D & E (the project baseline reference area) is 55,605 hectares. Of this area, 48,952 hectares supported woody vegetation in 1999 (Table 3). Remote sensing data and ground observations indicate the area of woodland in zones A, B, D & E was reduced to 39,473 hectares by 2007. This represents a mean annual historical decrease in woodland area of 1,185 hectares over eight years, which equates to 2.4% of the vegetative area present in 1999 being lost per year.

This annual loss of 2.4% of the initial area of woodland in a project area is therefore adopted as the likely rate of deforestation in the absence of project activity. This rate of deforestation would result in the complete loss of an area of woodland in 42 years. The assumption that the annual area deforested would remain at least as high as this in the absence of intervention is justified for the following reasons:

1. The demand for charcoal is a key driver of deforestation and is likely to increase with future growth in urban populations and increases of urban incomes.
2. Clearance for machambas is likely to increase in the absence of the project as road networks improve and as the demand for food, and possibly biofuel continues to grow.
3. The expansion of charcoal production and agricultural activity is likely to increase the frequency of fires inhibiting the regrowth of miombo woodland.
4. The area continues to attract new settlement and this pattern is likely to be further encouraged by better amenities as the local economy improves.

It is possible that the deforestation rate in the project reference area will increase over time due to the pressures described above, and especially if the population continues to grow. A future annual deforestation rate of 2.4% in the absence of intervention is therefore likely to be a conservative estimate. However, the threats to miombo and related woodland types described in section E4 (agricultural expansion, charcoal production, high frequency fires and logging of high value hardwoods) are largely caused by local environmental and socio-economic factors that vary considerably across the landscape and over time, this projection should therefore be regarded as indicative of the overall level of threat to the remaining carbon stocks rather than a precise projection of future deforestation.

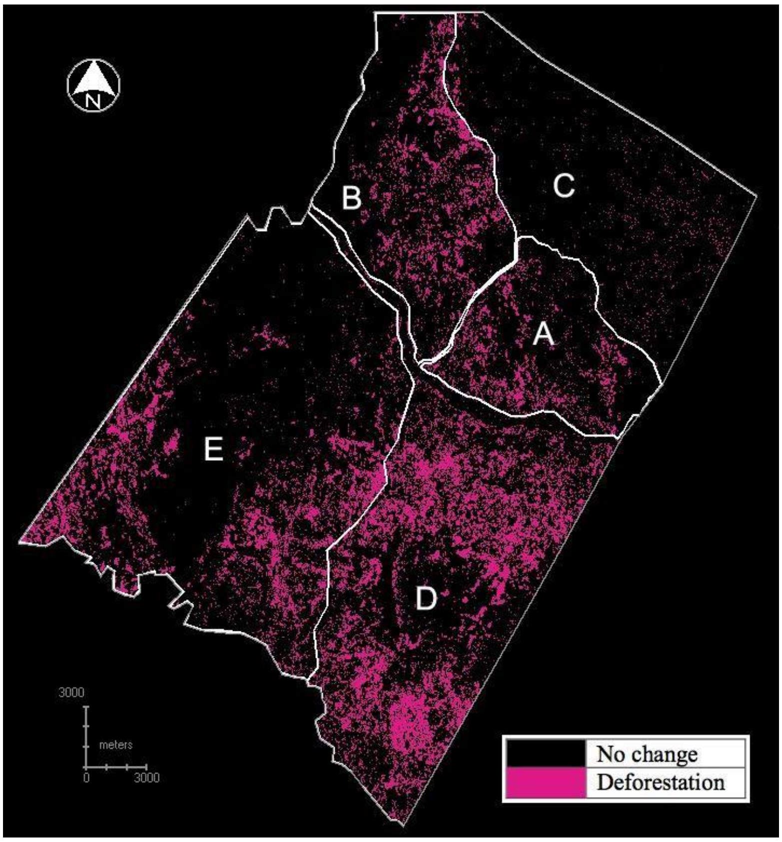

Figure 5: Two SPOT 4 satellite images (20 m resolution) from 1999 and 2007 were used to define historical rates of deforestation (Flaherty 2008). Areas which have lost vegetative cover are shown in pink. The zones are: A, N'hambita, Bue Maria and Posta Da Pungwe; B, Pavua and M'Bulawa; C, a buffer zone only sparsely inhabited, and south of the river Pungue; D, Mucombeze; and E, part Mucombeze and part Pinganganga (the latter falls into Manica province). The land area represented in each image is 67,754 ha (this contains areas outside the Regulado, to the south of the river). The annual forest loss is 1,184 ha (2.4%) per year if area C, which is a protected area, is excluded.

Table 3: Size of reference zones and vegetation loss in Figures 4 & 5

Reference Areas	**A**	**B**	**C**	**D**	**E**
Total Area (ha)	6 378	9 538	12 149	15 669	24 020
Vegetative Cover 1999 (ha)	5 385	8 512	9 706	11 035	24 020
Vegetative cover 2007 (ha)	4 927	7 674	11 538	7 333	19 539
Loss (ha)	458	838	-1 832	3 702	4 481

F3: Spatial distribution of deforestation under the baseline scenario

Although there is spatial variability in the drivers of deforestation, evidence from the N'hambita reference area indicates that the likely distribution of future deforestation can be determined by consideration of some simple criteria. Tracts of land that are Accessible, Cultivable and/or have Extractable value, and are effectively Unprotected (ACEU) are likely to be deforested over the next

40 years (Tipper 2008, personal communication). The ACEU criteria as they apply to the project reference area are shown in Table 5. These criteria should be used to determine whether the woodland in potential project areas would be likely to be deforested in the absence of project activities. If the area does not meet the ACEU criteria the threat of deforestation is relatively low, and it should not be included in the project.

These criteria require some judgement. If there is evidence that land has been deforested in areas of similar conditions in terms of topography and the value of land, this will be considered sufficient evidence for threat.

Table 4: Interpretation of ACEU criteria for woodland in the project reference area (Tipper 2008).

ACEU	Criteria	Justification
Accessibility	<8km from road or track	Topography is relatively flat and the extent of deforestation in areas < 8km from roads or tracks is significantly greater than in areas > 8 km from roads or tracks (Walentin 2006).
Cultivable or Extractable value	Miombo woodland and related woodland types	Virtually all miombo woodland may be cultivated under machamba systems or converted to fuel wood or charcoal.
Unprotected	Outside the core areas of Gorongosa or Marromeu National Parks	Gorongosa National Park has effective conservation policies and little evidence of historic deforestation.

G Quantification of Carbon Benefits

The total expected carbon benefits from successful conservation of ACEU woodland within the project reference area can be estimated from the difference in the carbon stocks of the woodland areas and the carbon stocks of the area after it has been deforested. Since it is unlikely that project activities will completely prevent all deforestation, the calculated emission reductions are based on a 75% reduction in deforestation relative to the baseline scenario.

Farmland is considered the most likely land use after deforestation (Section Eiv). The carbon stocks of farmland are assumed to be 2.8 ± 0.6 tC ha-1, based on a survey of 36 machambas. The carbon stocks on these machambas were calculated by measuring the DBH of the trees remaining on land after clearance (Ghee 2009). A local allometric was used to convert the DBH to above and below ground dry biomass (Ryan 2009). The carbon stock on the machambas was then corrected for growth rates of trees to establish the biomass of a machamba after it has been cleared for cultivation, the growth rates of trees in the area is 0.5 cm per year as recorded for 5 years on 15 permanent sample plots. Four outlying machambas were removed from the analysis which deviated by more than two standard deviations from the mean.

To account for the possibility of unexpected reductions in carbon stocks, for example through fire, illicit logging, or wind damage, a risk buffer of 30% of the total woodland carbon stock is excluded from the calculated emission reductions. The size of risk buffer (based on the perceived risk associated with the project activity) should be constantly reviewed and maintained. This 30% of non-tradeable carbon will cover unforeseen losses of carbon, as outlined in http://www.v-c-s.org/docs/AFOLU%20Guidance%20Document.pdf

The areas of each vegetation category that meet the ACEU criteria (as defined in Step 3) are entered into the spreadsheet provided with this technical specification, "Avoided Deforestation N'hambita Carbon Benefits Calculator", and given below as Table 6.

Table 6: Area of each landcover type within the project boundary, 2007

Landcover type	Area (ha)
Miombo woodland	6,739.7
Savannah	1,461.6
Riverine forest	574.4
Secondary woodland	251.8
Machamba	77.1
Total	9,104.6

The total carbon benefits of the project are calculated using the parameters described above in the associated Avoided Deforestation N'hambita Carbon Benefits Calculator. These result in an estimate of a total benefit of the project of 571,690 tCO_2e, made up of 400,183 tCO_2e of marketable Plan Vivo Certificates, and a buffer of 171,507 tCO_2e.

H Management Activity

H1 Summary of overall approach

The overall approach to community-based miombo woodland conservation involves building on existing community structures to establish long-term conservation management plans, processes, roles and responsibilities. The main pillars of this approach are as follows:

- Development of an understanding within the community that the long-term benefits of conservation will outweigh the short-term costs of protection. Building effective local governance structures to determine and enforce the rules necessary for protection, and to assign key responsibilities to individuals. Establishment of effective teams to monitor the area, undertake fire protection activities and promote complementary economic actions to prevent or reduce any "leakage" effects associated with the protection of the area (the issue of "leakage" is addressed in Section 6.4 of this report).
- Provision of financial support through carbon finance to cover the costs of protection.

H2 Management plan requirements

The requirements for a Plan Vivo management plan for the conservation of miombo woodland reflect the general principles of the Plan Vivo Standards. Management plans should be:

- Based on local needs and capabilities;
- Developed through participatory approaches;
- Agreed by relevant community authorities (for project areas that include communal lands);
- Simple enough to be understood by the community; and
- Practical to implement with local resources

The management plan should contain:

- Maps of the project area;
- A governance plan;
- A plan for project activities; and
- A plan for monitoring the achievements of the project.

H2a Maps of project area

The map(s) should include:

- Location of the project area within the wider landscape.
- Location and extent of vegetation categories within project area.
- Location and extent of other vegetation types within the community boundaries.
- Altitude.
- Ownership boundaries to distinguish between community, private, and public land.
- Roads, tracks and other access routes.
- Rivers, streams and lakes.
- Co-ordinates of access points and other prominent features.
- Delineation of compartments or divisions within the woodland where management for different purposes (e.g. sustainable charcoal production or strict conservation) are planned

H2b Governance plan

The governance plan should explain who controls the area and how the management of the area will be governed. It should contain:

- A management agreement or community agreement stating that the area of protected woodland is to be established as a community reserve. The agreement should include a statement relating to the protection of any other woodland areas outside the boundaries of the agreement over which the community has direct control.
- A list of the people responsible for the conservation and management of the area and representatives with whom the project administrator should communicate.
- Whenever possible, a letter of agreement or recognition from the Provincial authorities.

H2c Activity plan

The activity plan lists the activities necessary for the conservation and sustainable management of the project area. It should contain:

- A list of activities with estimates of time inputs for the protection of woodland in the project area.
- A list of activities to protect and restore stocks of carbon in other woodland areas under the control of the community (to minimise the risk of displacement of activities that result in woodland degradation to areas outside the project area).
- An estimate of the cost of implementing the project activities
- Estimates of any income from forest products or other outputs (excluding carbon).
- A fire management plan.

H3 Effect of management activities on ex ante carbon calculations

Three activities which are part of forest management and utilisation may have an effect on the carbon calculations:

- Firewood collection
- Sustainable timber extraction
- Fire management via fire breaks

Firewood collection may occur close to settlements. Dead branches which will be used for firewood collection are not taken into account in the carbon stock estimation. Sustainable timber extraction under a community licence is expected to be low impact and not have a net impact on carbon stocks, however this should be monitored ex post and subtracted from carbon stocks where necessary. Fire management is expected to increase biomass in woodland, this is excluded from carbon calculations but will also be monitored ex post and may be included in carbon benefits in the future.

H3a Monitoring plan

The monitoring plan lists the activities and indicators to be used to monitor the achievements of project activities. It should contain details of the following activities and items:

- Annual boundary inspection. A project representative shall patrol the boundary of the community reserve no less than once per year to inspect fire breaks, incursions and integrity of the boundary controls.
- Visual inspection of NDVI (Normalized Difference Vegetation Index) for the project area and surrounding landscape, to assess the integrity of woodland in the project area, and identify any possible leakage of forest degradation to areas outside the project area. This should be carried out in the late dry season when the grass has died back so that there is maximum contrast between woodland and non-woodland areas. This should be carried out in year 1, 3, 5 and 10.
- Monitoring of carbon stocks in forest management areas through tree inventories in years 1, 3, 5 and 10.
- A plan for monitoring the presence of key indicator species.
- Monitor fires annually using the MODIS fire procedure.

- Annual assessment of governance structures. The governing committee should produce a report summarising their activities for the year, any problems encountered, and corrective actions required.

Table 7: Ground based monitoring indicators

Vegetation Category	Key indicator tree species	Number of trees per hectare (mean)	Means basal area (m2/ha)
Tropical (miombo) woodland	*Brachystegia boehmii* *Diplorhynchus condylocarpon* *Pterocarpus rotundfolius* *Burkea africana* *Brachystegia spiciformis*	406	10
Savanna	*Combretum adenogonium* *Combretum apiculatum* *Combretum hereroense* *Commiphora mossambicensis* *Pterocarpus rotundfolius*	386	5.8
Riverine or riparian forest	*Sclerocarya birrea* *Khaya anthoteca* *Cleistochlamys kirkii* *Acacia nigrescens* *Pterocarpus rotundfolius*	421	13.8
Secondary woodland	*Brachystegia boehmii* *Julbernardia globiflora* *Brachystegia spiciformis* *Diplorhynchus condylocarpon* *Burkea africana*	561	8
Machamba	*Sclerocarya birrea* *Diplorhynchus condylocarpon* *Pterocarpus angolensis* *Burkea africana* *Pseudolachnostylis maprouneifolia*	38	2.4

H3b Monitoring of woodland – fieldwork

The extent and condition of woodland in the project area must be monitored in years 1, 3, 5 and 10. Monitoring should be appropriate to community technician's technical capacity. The purpose of ground based sampling is to determine whether the woodland carbon stocks conform to the default values expected for that vegetation category, or if there has been a reduction in carbon stocks through degradation that may not be detected by the use of remote sensing. Tagging of large trees, inventories and perimeter walks would be suitable and a management and monitoring plan should be developed to include these.

To assist the monitoring process a list of indicator species, tree densities, and basal areas that are representative of the default carbon values for each vegetation category is provided in Table 7. An area can be considered for payment adjustment under the following circumstances:

1. The key indicator tree species for a vegetation category are not present; and/or

2. Tagged trees have been removed;
3. Monitoring plots show significant degradation of vegetation categories.
4. Perimeters have been encroached.

Payment adjustments and management responses to be applied in the case of different levels of deforestation are described in Table 8.

Table 8: Deforestation indicators and responses

Deforestation indicator	Likely contributing factors		Payment response/ adjustment
Deforestation <25% of baseline rate	Governance working effectively	Protection activities implemented effectively	Payment continues as per schedule
Deforestation 25-75% of baseline rate	Significant breakdown in governance	Protection activities not properly implemented	Payment reduces by 50% until next annual monitoring and enforcement of corrective actions
Deforestation >75% of baseline rate	Governance not functioning	No effective protection activities	Payment suspended until next annual monitoring and enforcement of corrective actions

H4 Addressing leakage risk

The term ‘leakage’ in an avoided deforestation project is used to describe any unintended loss of carbon stocks outside the project boundaries resulting directly from the project activities. For example, in the case of woodland conservation in central Mozambique it is possible that project activities could displace an activity such as fuel wood collection from the conserved area of woodland to other woodland areas in the vicinity of the project area.

It is a requirement of the Plan Vivo Standards that the potential for project activity to cause displacement of emission generating activities to other woodland areas in the vicinity of the project area should be considered and that project activities should be planned and structured to minimise any such leakage risk. These actions should include:

- Incorporation into the project of as many communities and woodland areas in the region as possible.
- Implementation of agroforestry and improved crop management measures to increase crop yields and reduce encroachment into surrounding woodland areas for agricultural land.
- Establishment of sustainable woodlots to provide products such as fuel wood or poles that may no longer be available from within the conserved woodland.
- Monitoring leakage in woodland areas outside the project area.

Where communities have a satisfactory plan for managing leakage risk it should be assumed that there is no leakage.

H5 Third-party verification

Third-party verification of the monitoring system should be undertaken in accordance with the Plan Vivo Standards to ensure that the monitoring of indicators and implementation of corrective actions are being undertaken as required.

I Carbon Crediting and Payments

The Sofala Community Carbon Project consists of a number of different but related activities that together lead to a net improve in the management of forest resources and ecosystem services in the project area (including. the planting of fruit trees and woodlands, activities that reduce deforestation and forest degradation, and the avoided burning of agricultural residues – see project PDD for full list) Due to the manner in which the project was developed and the slow emergence of REDD+ as a recognised form of climate change mitigation, the project activities were initiated in two phases.

The first phase included all the agro-forestry related activities (e.g. establishment of fruit orchards and indigenous woodlots). The second instalment only includes the two remaining activities - the REDD+ activities described in this technical specification and the avoided burning of agricultural residues.

In terms of start date and time frame for implementation, the first phase of activities were initiated in 2004 and each contracted agroforestry activity will continue for 7 years with a 3rd party monitoring and validation event once every 5 years. Following the start date of 2004 the first instalment of activities were validated for the first time in late 2009 with the reports and validations being issued in 2010, with the next monitoring and validation event scheduled in 2015.

Due to the high costs of monitoring and validation, monitoring and validation events for both instalments need to be scheduled at the same time. The sheer cost of remote sensing, field surveys and especially the logistics and professional fees associated with third party auditing by a recognised international firm, makes simultaneous monitoring and validation fundamental to the financial viability of the project.

We hope that by setting up the project based on the value of the forest initially, and to deal with high initial costs, a single 10 year crediting period will protect the forest for the subsequent 42 years, within the project effectiveness bounds of 75% set out above. Ideally the project would be split into more crediting periods, but the reality is that formal project management of the site is unlikely to be possible beyond year 10.

Therefore, this technical is designed to work with one 10 year ex-ante crediting, it is recommended that the 2015 verification should check that the project is on track to exceed its protection criteria over this period before carrying on to the next period. To align monitoring and validation events, the following timeframe is proposed for the REDD+ activities described in this technical specification.

Start date:	1 January 2007
Project period:	40 years
End date:	2047
Crediting period:	Single period - 10 years
Monitoring:	Every 5 years

This timeframe, although shorter than 42 years, will allow monitoring and evaluation events for all project activities to occur simultaneously. In addition, it reduces the crediting period to 10 years as recommended by the Plan Vivo Standard.

Key
enter data
values
entered by the project operator in agreement with the Plan Vivo Foundation
default values for N'hamita
calculated values

Assumptions		
Project effectiveness	75.00%	
Risk buffer	30.00%	
Price per tCO_2e	$6.00	
Payment period	10	years

Carbon stocks		
Miombo woodland	27.00	tC/ha
Savannah	14.00	tC/ha
Riverine forest	47.00	tC/ha
Secondary woodland	13.00	tC/ha
Machambas	2.77	tC/ha

Carbon calculations

	STEPS 1-3	STEP 4	STEP 5		STEP 6	STEP 7	
	Initial area of ACEU woodland in project area	Initial C stock of ACEU woodland in project area	Carbon stock under deforestation scenario	Change in carbon stock under deforestation scenario	Carbon benefit of project	Carbon benefits eligible for crediting (after buffer subtraction)	
	(ha)	(tC)	(tC)	(tC)	(tC)	(tC)	(tCO_2e)
Miombo woodland	6,740	181,972	18,669	-163,303	122,477	85,734	314,644
Savannah	1,462	20,462	4,049	-16,414	12,310	8,617	31,625
Riverine forest	574	26,997	1,591	-25,406	19,054	13,338	48,950
Secondary woodland	252	3,273	697	-2,576	1,932	1,352	4,963
Machamba	77	214	214	0	0	0	0
Total	**9,105**	**232,705**	**25,006**	**-207,698**	**155,774**	**109,042**	**400,183**
						Buffer	***171,507***

Payment summary		
Total carbon benefits of project	**571,690**	tCO_2e
Total marketable credits	**400,183**	tCO_2e
Total buffer pool	**171,507**	tCO_2e
Total value marketable credits	**$2,401,096.49**	US Dollars

Figure 6. Carbon calculator for use with this technical specification.

J Risk Buffer

Provision must be made for a project risk buffer of a minimum of 30%, meaning that no more than 70% of total emission reductions achieved can be credited and sold. The project risk buffer effectively represents non-tradable carbon credits which are held in case of unforeseen losses in carbon stocks. Annual carbon benefits and payments achieved through can be calculated with the spreadsheet calculator provided with this technical specification (see Figure 6).

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