Draft Plan Vivo Technical Specification No.

Conservation of miombo woodland in central Mozambique


Miombo woodland in Sofala Province, Mozambique

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Template for Plan Vivo Technical Specifications on Avoided Deforestation

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1. Introduction

This “technical specification” has been developed for use by Plan Vivo projects involving communities participating in central Mozambique (Sofala Province).

Through the Plan Vivo system communities may be able to access carbon finance to assist with the conservation and restoration of forests.

This technical specification sets out the methods that should be used to estimate the carbon benefits from conserving miombo woodland in central Mozambique, the requirements for a Plan Vivo – management plan, and the indicators to be used for monitoring the delivery of the carbon benefit.

The technical specification aims to summarise best available evidence about the environmental benefits associated with sustainable management and conservation of these valuable ecosystems. Further information and research is welcome and will be incorporated periodically.

1.1 Description of the ecosystem and the area

Mozambique is located along the southeastern coast of Africa. The miombo community land use and carbon management – N’hambita pilot project is located in the buffer zone of the Gorongosa National Park (GNP) in Sofala Province, Central Mozambique. The pilot project covers an area of approximately 20,000 hectares (known as the Chicale Regulado). This technical specification is based on work done as part of this pilot project.

The climate in this area is characterised as sub-tropical. There are two distinct seasons each year. The dry season occurs between May to October, and the wet season occurs between November to April. Based on weather data from ARA-Centro (The Mozambican water board) at Chitengo (in the Gorongosa National Park) over the past seven years mean annual precipitation is 749mm distributed mainly between November to April, but with high inter-annual variability.

Elevation within the study area ranges from 35 to 330 m.a.s.l.

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 (ARA-CENTRO, 2004).

According to Mushove (2003) there are several floristic associations in and around the Chicale Regulado i.e. in the buffer zone of the Gorongosa National Park, Sofala Province (Table 1). These include miombo woodland, of which there are three classes, *Combretum* woodland, riverine woodland and *Combretum* / Palm woodland. However miombo is the most common woodland type dominated by genera such as *Brachystegia*, *Julbernardia*, *Erythrophleum*, *Burkea*, *Diplorhynchus*, and *Pterocarpus*

Miombo woodlands extend across approximately 2.8 million km^2 of the southern subhumid 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 distribution of miombo woodland largely coincides with the flat to gently undulating surfaces that form the Central African plateau (Appendix 1). WWF

(2002) calculate that there are approximately 440,000 km^2 of miombo woodland in Mozambique.

The miombo ecosystem is an open canopy deciduous woodland type dominated by a few species of trees. Crowns of trees are typically **NOT** interlocking. Generally grasses are found below the trees making this a fire prone system. Miombo woodland is characterised by dispersed vegetation with few large trees.

Most miombo species are relatively slow growing. Many of these species are deciduous loosing their leaves during the long dry spell. Typically Miombo species are very drought tolerant and frost sensitive.

The extent to which this technical specification may be used the miombo ecoregion has yet to be defined.

1.2 Description of the threats to the ecosystem

The key threats to this ecosystem are:

- Encroachment – land clearances for agriculture. This is observed to occur throughout the area in particular on low lying ground in proximity to water sources.
- Charcoal production. Illegal charcoal production is often cited as the key driver of deforestation throughout sub-Saharan Africa. Local markets for charcoal include Beira, Chimoio, Gorongosa and Inchope. Herd (2007) discovered that the majority of charcoal production occurs within 2 km of main roads.
- Burning. Prior to the introduction of a fire management regime (which commenced within the managed area in 2005) almost the entire project area was burnt annually (by uncontrolled fires). Frequent burning will hinder natural regeneration (and hence stand recovery) and the accumulation of carbon both in biomass as well as in the soils.
- Logging. The majority of logging (cherry picking of the most valuable timber tree species) occurred within this Chicale Regulado prior to the 1980’s.

2. Approach to community based miombo woodland conservation

2.1 General approach

The overall approach to community based miombo woodland conservation is one of working in a collaborative manner with interested communities to establish effective, long-term conservation management based on existing community structures. 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 of effective local governance structure to set rules necessary for protection and to assign key responsibilities to individuals

- Establish 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.

- Provide financial support through carbon finance to cover the costs of protection

2.2 Description of additionality of community conservation areas for miombo woodland protection in central Mozambique

The recent history of miombo woodland loss in central Mozambique is strong evidence that additional efforts to protect this habitat are required. While some protection is given to areas in designated protection areas (such as nature Reserves, National Parks etc.) there is strong evidence that further efforts are required to conserve the remaining fragments of miombo woodland in all areas in central Mozambique.

The protection of miombo woodland involves a number of short-term costs that communities or individual farmers with land in adjacent areas must bear:
- opportunity cost of not cultivating land
- opportunity cost of not extracting woodfuel or timber or live plants
- additional effort to control fires
- some negative effects of forest wildlife on crops
- cost of organising community conservation efforts (gorvernance, monitoring, etc)

As there are no formal means by which communities can access funding to cover these costs, the effect of Plan Vivo carbon finance is strongly additional.

2.3 Description of the environmental and social benefits from miombo woodland conservation in central Mozambique

While communities and individual farmers living around miombo woodlands incur some short-term costs associated with the conservation of the ecosystem there are long-term benefits that accrue to local communities, downstream populations and society in general.

- Soil conservation - particularly the prevention of soil erosion associated with heavy rainfall events and siltation of water courses (climate change adaptation benefit)
- Hydrological benefit – harvesting of incidental moisture and improved water flows which will help to reduce catastrophic flooding (climate change adaptation benefit)
- Biodiversity benefit – through the protection of wildlife habitat. This may have a long term economic impact by attracting visitors to the Gorongosa National Park.
- NTFP – beekeeping, medicines, fruits etc.

3. Baseline Carbon Emissions

This section sets out the procedure to be used to quantify the "baseline" carbon emissions that would be associated with loss of miombo woodland expected in the absence of conservation measures.

3.1 Initial stock of vulnerable carbon in miombo woodland

This technical specification refers to the conservation of carbon stocks in woodlands in Sofala province, Mozambique. Throughout this region there tends to be a complex matrix of different land use categories (Table 3.1). The base carbon stocks are very variable between the different vegetation categories. Therefore in order to quantify the initial carbon stock (across an area of land supporting a matrix of different vegetation categories), the initial carbon stocks in each vegetation category are calculated separately.

The initial stock of carbon may be estimated using the following methods - biomass survey or default factors:

- ***Biomass survey*** This method will only be applicable to areas of miombo woodland i.e. it cannot be used to quantify carbon stocks in combretum savana and riverine woodlands where the default factor should be used. Above ground biomass of miombo woodland can be calculated using the following allometric equation

  $y = 0.0267d^{2.5996}$; $R^2 = 0.93$; n = 29

  where d, diameter at 1.3 m above the ground is measured in cm, and the biomass is in kg C (Ryan et al, 2007). Assume below ground biomass to be 0.25 of above ground biomass (Grace et al, 2005).

- ***Default factor:*** Based on Grace et al (2007) default factors for base carbon (tC ha^{-1}) may be applied to miombo woodland (where no biomass survey is done) and to combretum savana and riverine woodlands.

Vegetation category	Description	Default carbon stocks
Tropical (miombo) woodland	Tropical woodland including, but not limited to that dominated by the miombo species. The top five species by biomass ranking are: *Brachystegia boehmii, Diplorhynchus condylocarpon, Pterocarpus rotundfolius, Burkea Africana, Brachystegia spiciformis.*	26 tC ha^{-1}
Savanna	This is a relatively less dense vegetation, with more open spaces between trees and few large trees. Savana is dominated by grass, but with sparse woodland of the genera *Combretum* or *Acacia. The top five species are: Combretum adenogonium, Combretum apiculatum, Combretum hereroense, Commiphora mossambicensis, Pterocarpus rotundfolius..*	12 tC ha^{-1}
Riverine or riparian forest	Dense, high woodland adjacent to watercourses. The top five species by biomass ranking are: *Sclerocarya birrea, Khaya anthoteca, Cleistochlamys kirkii, Acacia nigrescens* and *Pterocarpus rotundfolius.*	43 tC ha^{-1}
Secondary Woodland	This includes abandoned machambas and degraded woodland. The top five species are: *Brachystegia boehmii, Julbernardia globiflora, Brachystegia spiciformis, Diplorhynchus condylocarpon, Burkea Africana.*	14 tC ha^{-1}
Machambas	Machambas (agricultural plots). The top five species are: *Sclerocarya birrea, Di plorhynchus condylocarpon, Pterocarpus angolensis, Burkea Africana, Pseudolachnostylis maprouneifolia.*	8 tC ha^{-1}

Table 3.1 Vegetation categories and default base carbon in Sofala province, Mozambique (Grace et al, 2007)

3.2 Rate of Forest Loss in absence of conservation

This section sets out the method to be used to define the baseline rate of woodland loss in Sofala Province, Mozambique.

Evidence of the historic rate of loss of miombo woodland in Sofala Province is limited. The method used to estimate baseline emissions is based on area analysis of historical satellite (SPOT) images combined with ground truthing of vegetation categories. This process of measuring historical changes in land use has been complicated in Sofala as a result of the depopulation that occurred within the study area during the 1980's (resulting from war) and subsequent re-population that has occurred since the mid 1990's. This effectively restricts the timeline available for analysis of historical land use change to no more than 10 years.

The test area was 67,754 hectares in Sofala province (Figure 1). Land use change processes are broadly similar across Sofala Province.

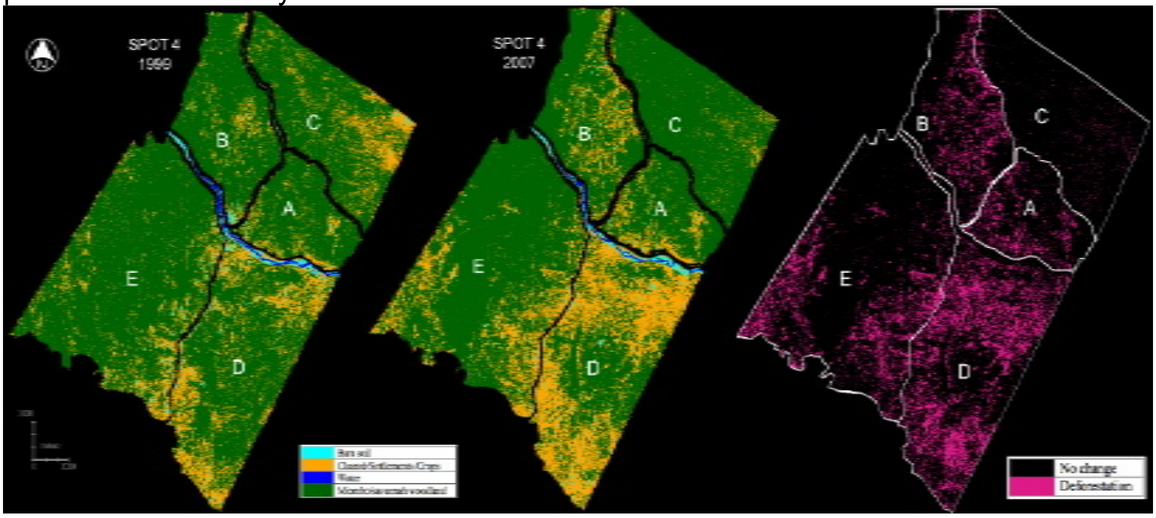

Figure 1. Study area used to calculate rate of deforestation in Sofala province, central Mozambique.

Area C is not included in this study of land use change because it is largely in the GNP and as such is not subject to the same deforestation pressures as woodland that is outside of the GNP.

The total land area of areas A, B, D & E is 55,605 hectares of which 48,952 hectares supported woody vegetation in 1999 (according to the SPOT image). The area of woodland in areas A, B, D & E had reduced to 39,473 hectares by 2007. This represents a mean annual decrease in woodland area of 1,185 hectares which works out as a deforestation rate of 2.4% relative to the forest area in 1999 (48,952 ha) or 3.0% relative to the forest area in 2007 (39,473 ha).

For the purposes of predicting future rates of deforestation (in the absence of intervention) it is assumed that the annual area deforested will remain constant over time. The key drivers of deforestation are charcoal / woodfuel extraction and clearances for machambas, which are unlikely to decrease (in annual area) without intervention. This approach is considered to be conservative because the population is likely to increase which will add further to the pressure for deforestation. However there is no reliable data available of future population growth in this area, so this is not factored into our calculations.

Analysis (Flaherty, s. 2007) of deforestation rates in proximity to roads has shown that this is not a significant factor of deforestation in the region. The topography of this region is relatively flat and there is an abundance of routes giving access to most areas. Analysis (Flaherty, S. 2007) has shown that proximity to roads may only become a factor affecting deforestation rates beyond 8km. However, few areas in this region are more than 8 km from some form of access route and so proximity to roads does not have a significant impact on rates of deforestation.

Year	Remaining woodland area	Annual rate of deforestation relative to remaining woodland area	Remaining woodland as a proportion (%)of total area (55,605 ha)
2008	38,288	3.1	68.9
2009	37,103	3.2	66.7
2010	35,918	3.3	64.6
2011	34,734	3.4	62.5
2012	33,549	3.5	60.3
2013	32,364	3.7	58.2
2014	31,179	3.8	56.1
2015	29,994	4.0	53.9
2016	28,809	4.1	51.8
2017	27,624	4.3	49.7
2018	26,439	4.5	47.5
2019	25,255	4.7	45.4
2020	24,070	4.9	43.3
2021	22,885	5.2	41.2
2022	21,700	5.5	39.0
2023	20,515	5.8	36.9
2024	19,330	6.1	34.8
2025	18,145	6.5	32.6
2026	16,960	7.0	30.5
2027	15,776	7.5	28.4
2028	14,591	8.1	26.2
2029	13,406	8.8	24.1
2030	12,221	9.7	22.0
2031	11,036	10.7	19.8
2032	9,851	12.0	17.7
2033	8,666	13.7	15.6
2034	7,481	15.8	13.5
2035	6,297	18.8	11.3
2036	5,112	23.2	9.2
2037	3,927	30.2	7.1
2038	2,742	43.2	4.9
2039	1,557	76.1	2.8
2040	372	318.4	0.7

Table 3.2 Forecast of future deforestation in Sofala province.

Based on this forecast the entire woodland area is predicted to be lost within 33 years (by 2040) in the absence of intervention (see table 3.2).

The forecast of deforestation is based on an annual deforestation rate of 2.4% relative to the woodland area in 1999, i.e. the annual area of deforestation remains constant over time whilst the annual rate of deforestation relative to the remaining woodland area will increase as the area of remaining woodland area decreases.

Avoided carbon emissions (associated with conservation activities that result in avoided deforestation) are calculated by applying the baseline rate of deforestation (Table 3.2) to the baseline carbon stocks (Table 3.1). Avoided annual carbon emissions per hectare for different woodland categories in the study area range from 0.24 tC to 1.29 tC (Table 3.3).

Woodland category	Total carbon store (tC/ha)	Avoided emissions (tC) / ha / year through conservation activities.
Tropical (miombo) woodland	26	0.78
Savanna	12	0.36
Riverine or riparian forest	43	1.29
Secondary Woodland	14	0.42
Machambas	8	0.24

Table 3.3 Avoided emissions (tC/ha/yr) through conservation activities.

4. Leakage Assessment

Leakage is unintended loss of carbon stocks outside the boundaries of a project resulting directly from the project activity.

In the case of woodland conservation in central Mozambique it is possible that this could displace some activities such as fuel wood collection from the conserved area of woodland to other woodland areas.

The Plan Vivo system requires that potential displacement of activities within the community should be considered and that activities should be planned to minimise the risk of any negative leakage. These actions should include:

- Protection / sustainable management of any woodland areas within the community
- Implementation of agroforestry measures to provide products such as fuelwood or poles that may no longer be available from within the conserved woodland
- A plan to monitor leakage on specific woodland areas outside of the woodland conservation area.

Where communities have a satisfactory plan for managing leakage risk resulting from the conservation of woodlands there should be no assumption of leakage.

5. Management Plan Requirements

This section sets out the requirements for a Plan Vivo management plan for the conservation of woodlands in Sofala Province, Mozambique. The requirements reflect the general principles of the Plan Vivo system that management plans should be:

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

The management plan should contain the following information:

a. **Maps of area**

The map(s) should show the following features:

- Location and extent of vegetation categories within the woodland area
- Location and extent of other vegetation types within the community boundaries
- Elevation
- Ownership boundaries (Regulado, communities, private land, public land)
- Roads and tracks
- Rivers, streams and lakes
- Co-ordinate points
- Directions and location within the province
- Delineation of compartments or divisions within the woodland. If there are compartments or divisions within the woodland that are to be managed for different purposes (e.g. sustainable charcoal production or strict conservation) then these should be marked.

b. **Governance plan**

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

- Management agreement / community agreement stating that the area of protected woodland is to be established as a community reserve. The management 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.
- Responsible people: a list of the people responsible for the conservation / management of the area and representatives with whom the project operator should communicate.
- If possible, a letter of agreement or recognition from the Provincial authorities.

c. Activity plan

The activity plan will list the activities to be undertaken to manage / conserve the forest area. It should contain the following information.

- List of activities with estimates of time inputs for the protection of the woodland area
- List of activities to protect and restore stocks of carbon within other woodland / vegetation within the community (in order to prevent leakage

resulting from the displacement of activities from the protected area of woodland).

- Estimate of cost of implementation
- Estimates of any income from forest products or other outputs (excluding carbon)
- Fire control plan. (separate guidelines to be provided for Fire control plans)

d. Monitoring plan

The monitoring plan will list the indicators to be used to monitor progress with the conservation of the forest area. This should include:

a. 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
b. Remote sensing plan (annual visual inspection of Modis NDVI for the area)
c. Ecological indicators: a plan for monitoring the presence of key indicator species should be developed to
d. Functioning management / governance: the governing committee shall produce a report summarising their activities for the year, problems encountered and
e. including fire breaks
f. Restoration activities

6. Calculation of credits for woodland conservation areas

6.1 Project Crediting Procedure

The annual crediting of carbon from protected areas approved under the Plan Vivo system should take place following monitoring.

Method 1 should be used where a regional risk factor is available.

Method 2 – simplified method for forests under high risk, should only be used with permission of BR&D / Plan Vivo Foundation:

Method 1. Application of regional baseline risk factors (where a regional risk factor is available):

$$\sum Cv(riskcategory) * R(riskcategory) * (44/12)$$

Where:
Cv = stock of vulnerable carbon
R = rate of deforestation (from risk table)
44/12 = conversion factor from carbon to CO2

Total carbon credited over time should not exceed Cv.

The baseline may be re-assessed and case for further crediting reviewed after 25 years.

Method 2. Application of a simplified baseline for forests at high risk. This method should only be used with permission of BR&D / Plan Vivo Foundation:

$$Cv \div 25$$

Where:
Cv = stock of vulnerable carbon

6.2 Monitoring and indicators for crediting
Monitoring should be undertaken by the project operator annually. Crediting for forest conservation may continue as long as project indicators remain Green (see table 6.1). If a project indicator turns amber then crediting should be delayed by 50% for that year until corrective actions have been implemented to the satisfaction of the operator. If a project indicator turns red then crediting should be suspended until issues have been resolved and corrective actions implemented.

Crediting	Governance	Activities	Physical damage
Continue	Governance working effectively	Protection activities implemented as per plan	Woodland / forest conservation consistent with management plan
Delay 50% until CARs implemented	Significant breakdown in governance	Protection activities not properly implemented	Loss of woodland / forest at 50% of baseline rate
Suspend crediting until issues resolved	Governance not functioning	No effective protection activities	Loss of woodland / forest proceeding at or above baseline scenario

Table 6.1

Annual site monitoring should combine techniques of satellite remote sensing (to monitor changes in extent of woodland distribution) and ground truthling based on sampling methods described in Ryan et al (2007) for rapid assessment of carbon stock in the N'hambita area.

6.3 Verification of the Monitoring System

Independent verification of the monitoring system should be undertaken to ensure that the monitoring of indicators is being carried out to the required Plan Vivo Standard (REF).

References

De Jong, B. H. J. A. Hellier, M. A. Castillo-Santiago and R. Tipper (2005) Application of the 'Climafor' Approach to Estimate Baseline Carbon Emissions of a Forest Conservation Project in the Selva Lacandona, Chiapas, Mexico. *Mitigation and Adaptation Strategies for Global Change*. Vol. 10 (2).

De Jong, B. H. J. (2006) Application of the "Climafor" baseline to determine leakage: the case of Scolel Té. *Mitigation and Adaptation Strategies for Global Change*

Grace J, San Jose J, Meir P, et al. (2006) Productivity and carbon fluxes of tropical savannas. *Journal of Biogeography* 33, 387-400.

Grace J, Ryan C, Williams M, with assistance from Silvia Flaherty, Sarah Carter, Joanne Carrie, and contributions from Evelina Sambane, Roberto Zolho, Joao Fernando, William Garrett, Luke Spaddevechia and help from Envirotrade (2007). An inventory of tree species and carbon stocks for the N'hambita Pilot Project, Sofala Province, Mozambique

Grace, J. Williams, M. & Ryan, C. (2008) An inventory of tree species and carbon stocks for the N'hambita Pilot Project, Sofala Province, Mozambique

Herd, A. R. C. (2007) Exploring the socio-economic role of charcoal and the potential for sustainable production in the Chicale Regulado, Mozambique. University of Edinburgh Masters Degree dissertation. Unpublished.

Laguna, RR., Pérez, J. J., Calderón, O. A., Trevino Garza, E. J., (2006) Estimación del carbono almacenado en un bosque de niebla en Tamaulipas, México. CIENCIA UANL / VOL. IX, No. 2, ABRIL-JUNIO

Mushove P (2003) *Preliminary inventory of N'hmabita community forest, Gorongosa District, Mozambique.* Commissioned report, with additions from M Williams, School of GeoSciences, University of Edinburgh.

Ryan, Williams and Grace (2007) Guidelines for the rapid assessment of vegetation carbon stocks in the N'hambita area. Unpublished document. School of GeoSciences, University of Edinburgh.

Sambane E (2005) *Above-ground biomass accumulation in fallow fields at the N'hambita community, Mozambique.* Unpublished MSc dissertation, School of GeoSciences, University of Edinburgh.

Appendix 1.

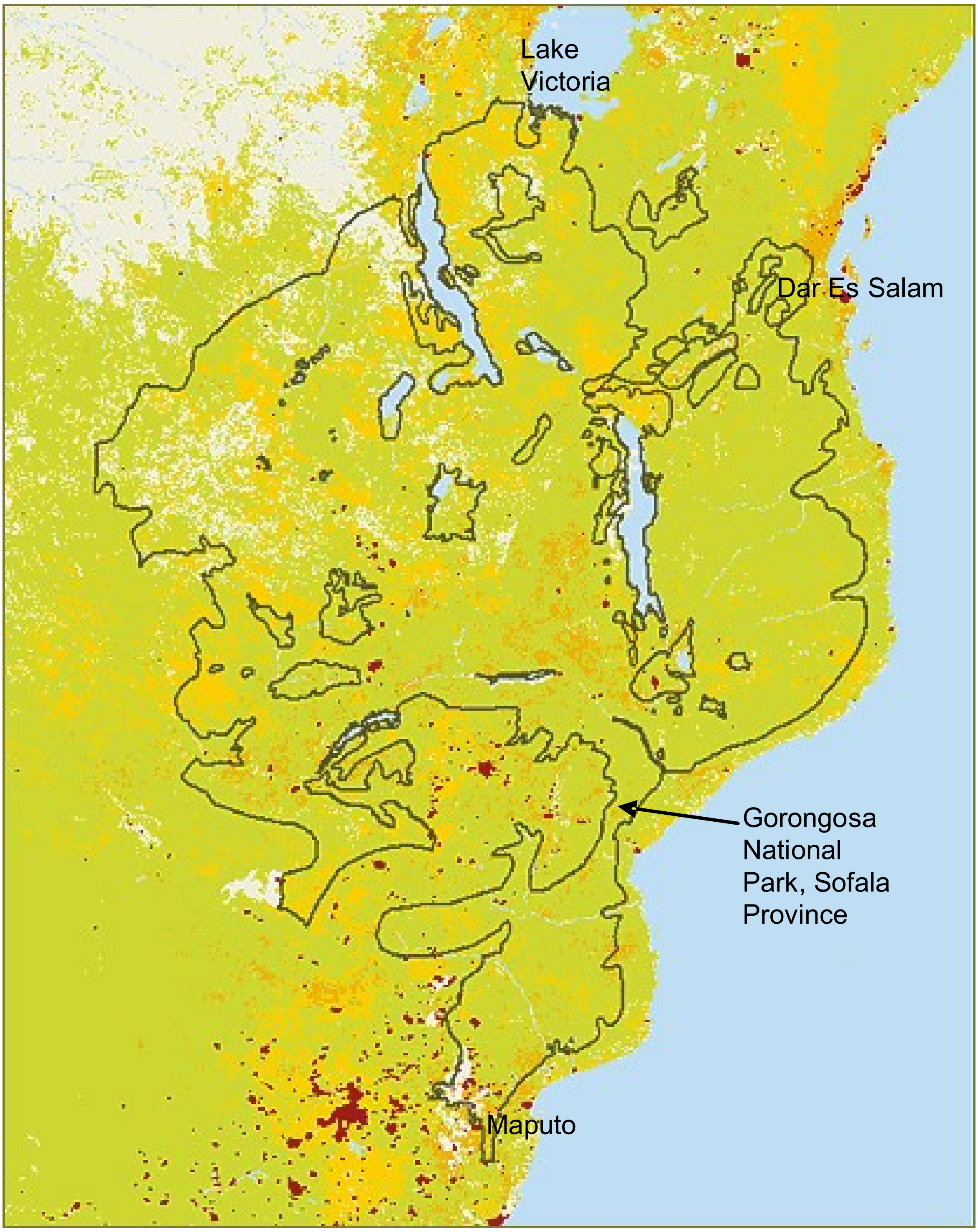

Figure 1. Distribution of miombo woodland across southern and eastern Africa.