Avoiding Unplanned Mosaic Deforestation and Degradation in Malawi

PLAN VIVO TECHNICAL SPECIFICATION

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Contents

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1. Introduction

This technical specification was developed for use by Plan Vivo projects in Malawi. Through the Plan Vivo system communities may be able to access payments for carbon benefits to assist with the protection and restoration of National Parks, and Forest Reserves.

This technical specification suggests activities that may help reduce threats to forest cover, and ensure that risks of leakage and non-permanence of carbon benefits are minimised. Methods that should be used to estimate the carbon benefits from project activities and the requirements for management plans are described, and approaches that can be used for monitoring the success of the project are suggested.

Many of the approaches described in this technical specification involve the close participation of local stakeholders. Direct experience of resource extraction from forests, and the impacts this brings, gives communities that interact closely with forests a valuable insight in to the likely future of the forests they use. We have therefore developed an approach that requires the close participation of local stakeholder in:

- the design of activities that prevent deforestation and degradation and help to make the protection of forest more attractive than its destruction
- the estimation of the carbon benefits project activities will bring, and
- monitoring of project effectiveness at maintaining forest cover and providing livelihood benefits.

2. Applicability

This technical specification is applicable to National Parks and Forest Reserves of Malawi that are under threat of unplanned mosaic deforestation and degradation. Individual project areas should have management, and payments for carbon benefits, assigned to distinct individuals or community groups. Project areas might be entire Forest Reserves where the areas are relatively small (less than around 5,000 ha), for example Mkuwazi Forest Reserve, or sections of larger National Parks or Forest Reserves for which co-management or resource use agreements can be developed with local communities, for example the Thazima region of Nyika National Park.

2.1 Geographical area

Malawi is a small, narrow land-locked country in south-eastern Africa with a total area of about 118,500 km^2 of which approximately 20% is covered by water. The country's topography is immensely varied ranging from the rift valley floor that embraces Lake Malawi and the Shire Valley to the highland areas that rise to 2300 m with peaks over 3000 m. The gently undulating plateau that boarders the highlands has altitudes between 1000 and 1400 m.

Malawi experiences a uni-modal pattern of rainfall. Between June and August the weather conditions are under the influence of the South African anti-cyclone. Dry eastern winds, with clear skies and brilliant sunshine characterise the weather. These typical dry season conditions are occasionally broken by the effect of the moist Chiperone wind from the south-east that is caused by an eastward shift or anti-cyclone. This causes light rain and mist on windward slopes. During the period from September to November, as the Inter-Tropical Convergence Zone moves south and the dominating anti-cyclone backs east to north-east, temperatures increase and the eastern winds bring in moist oceanic air, causing conventional thunderstorms during November as humidity rises.

Most of the rain falls from December to March. High altitude areas such as Mulanje and the Shire Highlands and the areas along the northern lake shore receive over 1600 mm of rain per year. The plateau areas receive between 875 and 1000mm whilst the Lower Shire Valley, and the leeward plains such as Mzimba west and Rumphi (which are on the leeward side of the Viphya and Nyika Plateaux respectively), receive less than 750 mm of rain per year. Mean annual temperatures are influenced by altitude, and range from around 16 to 24^{O}C .

2.1.1 Forest resources

The total land area of Malawi is 94,080 km^2, around 26% of which is covered by forest (Department of Forestry 2004). Around 6,920 km^2 of Malawi is protected including 5 National Parks and 88 Forest Reserves (World Resources Institute 2003; Figure 1).

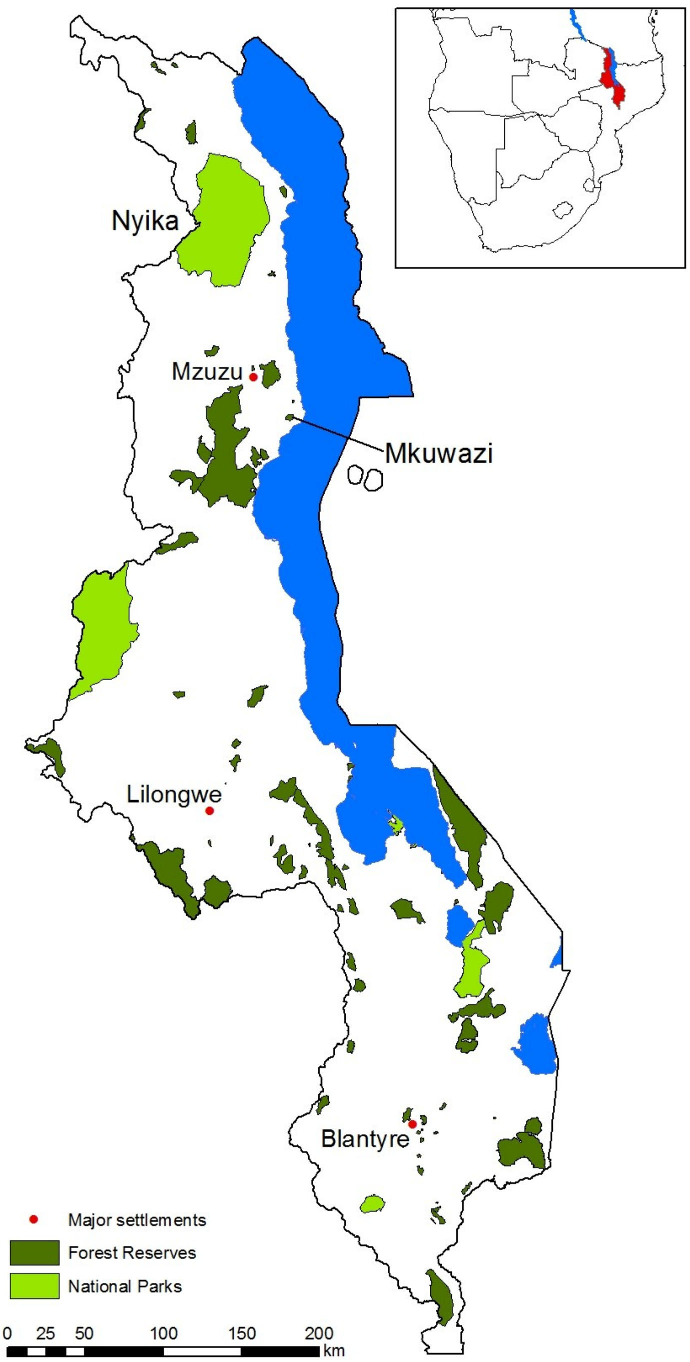

Figure 1. Locations of National Parks and Forest Reserves in Malawi

The forest cover in Malawi is characterised by miombo woodland. Miombo is a vernacular word that has been adopted by ecologists to describe those central, southern and eastern African woodlands dominated by trees of the genera *Brachystegia, Julbernardia* and *Isoberlinia,* three closely related genera from the family *Fabaceae*, subfamily *Caesalpinoideae* (Wild and Fernandes 1967, Calendar 1981, Malaise 1978, Grundy 1995). In several languages in Malawi, miombo is a common vernacular name for forests dominated by two species: *Brachystegia boehmii* and *B. longifolia.* Over most of its range miombo is a closed deciduous non-spinescent woodland occurring on geologically old, nutrient poor soils in a uni-modal rainfall zone. The miombo region has an estimated 8500 species of higher plants, over 54% of which are endemic. Of these 334 are trees.

Miombo woodlands have the potential to either contribute to rising levels of carbon dioxide in the atmosphere, or to help reduce it. If substantial areas of miombo are deforested, 6 to 10 Pg of carbon could be released to the atomosphere, while if the woodlands are managed to maximise carbon storage, a similar amount could be sequestered (Scholes *et al*. in press).

2.1.2 Legal status and community use rights

Forest Reserves and National Parks are owned and managed by the Government of Malawi, with Forest Reserves under the control of the Department of Forestry and National Parks managed by the Department of National Parks and Wildlife. However, the Departments of Forestry, and National Parks and Wildlife are increasingly entering in to co-management and resource use agreements with local communities that make use of these areas. Through these agreements local communities take responsibility for the maintenance and management of forest resources within a defined area and in return are entitled to a share of the benefits that arise from co-management.

2.1.3 Threats to forest cover

The population of Malawi is around 14 million people, and is expanding at a rate of 2.5% per year (The World Bank Group 2008) making Malawi one of the most densely populated countries in sub-Saharan Africa. Forests supply about 93 % of Malawi's energy needs, and provide timber and poles for construction and industrial use, non-timber forest products for food security and income, support for wildlife and biodiversity, and recreational and environmental services (Nkwanda et al. 2008).

The underlying causes of deforestation in Malawi are linked to population increases, poverty, agricultural expansion, woodfuel demands, market and policy failures, structural adjustment programmes, and forest fires (Mindle et al. 2001; Nkwanda et al. 2008).

Direct threats to forest cover in National Parks and Forest Reserves of Malawi include:

- Charcoal production
- Fuel wood collection
- Agricultural expansion
- Pole collection
- Logging for timber
- Curio making
- Fires
- Canoe making
- Collection of medicines

- Collection of wild honey
- De-barking
- Infrastructure development
- Open cast mining

2.2 Deforestation and degradation

Deforestation and forest degradation can either be planned (for example as a result of infrastructure developments planned by the government or land owner), or unplanned (as a result of undesignated activities). For unplanned activities the accessibility of the area is likely to determine the nature of deforestation. Forests where most areas are accessible typically show a mosaic pattern of degradation and deforestation as resources are extracted and forests are cleared in patches. Forests that are relatively inaccessible are likely to be degraded along a frontier that retreats as forest is cleared and new areas become accessible, or as infrastructure developments bring new areas under threat of deforestation and degradation.

Different types of deforestation and degradation are determined by different threats, which require different approaches to alleviate them, and methods for the quantification of carbon benefits. This technical specification is therefore only applicable to unplanned mosaic deforestation and degradation - a pattern that is prevalent in many of the more accessible areas of National Parks and Forest Reserves in Malawi.

In 1975, 57% of Malawi was classified as forest, but by 2000 this had been reduced to 28% (Nkwanda et al. 2008). Data from the FAO (2007) suggest that between 1990 and 2005 around 38,000 hectares of forest land was lost per year, which is equivalent to an annual loss of 0.9% of forest (Table 1), and recent estimates suggest a rate of deforestation of 1.6% per year between 1991 and 2008 (Owen et al. 2008).

Table 1. Changes in land cover over recent years
(adapted from Nkwanda et al. 2008)

	Area ('000 ha)		
Land cover	1990	2000	2005
Forest	3,896	3,567	3,402
Other Land	5,512	5,841	6,006
Total	9,408	9,408	9,408

Source: FAO (2005; 2007)

Other sources suggest higher rates of 2.8% forest loss per year, with rates of up to 3.4 % per year in the northern regions of Malawi where rates of deforestation are highest (EAD 2001).

Deforestation and degradation has been particularly severe in primary forests, including areas within National Parks and Forest Reserves. Between 1990 and 2005 there was a loss of 595,000 ha of primary forest, which is equivalent to a loss of 2.3% of original primary forest cover per year, while the areas of disturbed forest and plantations increased (Table 2).

Table 2. Changes in forest cover over recent years
(adapted from Nkwanda et al. 2008)

	Area ('000 ha)		
Land cover	1990	2000	2005
Primary Forests	1,727	1,330	1,132
Disturbed forest	2,037	2,057	2,067
Plantations	132	180	204
Total	3,896	3,567	3,402

Source: FAO (2005)

Simple consideration of past patterns of deforestation may not give an accurate picture of likely future reductions in forest carbon stocks, however. Particularity if degradation that is difficult to detect with remote sensing imagery has occurred, or if future trends are likely to be different from those seen in the past. Evidence that current threats to forest cover in National Parks and Forest Reserves of Malawi are likely to increase in the future includes:

- Growing demand for woodfuel – the deficit between demand and sustainable demand for woodfuel is estimated to increase from 5.8 million m^3 in 1999 to 10 million m^3 in 2010 (NEC 2000)
- Growing demand for charcoal production as sources of wood surrounding major cities decline (Kambewa et al. 2007)
- Increasing encroachment for subsistence agriculture
- Increasing threats from businesses and infrastructure development
- Growing populations in communities surrounding National Parks and Forest Reserves
- Development of timber and tobacco markets

Although National Parks and Forest Reserves are legally protected, constraints to enforcement of restrictions on use prevent their effective protection without the cooperation of local communities. The loss or degradation of forests within National Parks and Forest Reserves of Malawi that are accessible, and have extractable and/or cultivable value is therefore very likely in the absence of project activities that engage communities in the protection and sustainable management of forests.

3. Baseline scenario

The Plan Vivo Standards define a baseline as “The starting reference point from which the carbon benefits of project activities can be measured or calculated”, and state that the baseline against which carbon benefits are measured must be clear and credible (Plan Vivo Foundation 2008a). The “baseline scenario” describes the current status of carbon stocks, and expected changes in the absence of project activities (Plan Vivo Foundation 2008b). Determining a baseline scenario against which the carbon benefits from avoided deforestation can be measured therefore requires information on the existing carbon stocks in forest that is under threat of deforestation or degradation, and the likely reductions in carbon stocks that would result from the deforestation or degradation were it to occur.

3.1 Quantifying initial carbon stocks

Of the potential carbon stocks that could be affected by project activities, only the carbon stocks where the costs associated with the quantification and monitoring are likely to be outweighed by the income from payments for carbon benefits associated with that carbon stock should be accounted for by the project. If a carbon stock is expected to be reduced by project activities it should also be included in the initial survey and monitoring so that any reduction in carbon stocks over time can be subtracted from the carbon benefits of the project. A rationale for inclusion of carbon stocks that is likely to be applicable for many Natural Parks and Forest Reserves in Malawi is presented in Table 3.

Table 3. Rationale for decisions over which carbon stocks to include in an inventory of carbon stocks

Carbon stock	Likely impact of project on carbon stock	Restrictions on measurement	Decision
Above ground tree biomass	Increase	None	Include
Below ground tree biomass	Increase	None	Include
Non-tree biomass	Small increase	Time consuming	Exclude
Dead wood	Increase	None	Include
Leaf litter	Small increase	Time consuming	Exclude
Soil*	Increase	Expensive	Exclude

* See the A/R CDM tool for the conservative exclusion of soil organic carbon http://cdm.unfccc.int/EB/033/eb33_repan15.pdf

To determine the carbon stocks present in the project area, default values for carbon stocks in the forest types present could be used (for example IPCC Good Practice Guidance for National Greenhouse Gas Inventories; Houghton et al. 1996). The use of default values that are not locally defined are likely introduce significant inaccuracies, however, especially if values derived from intact forest are applied to degraded areas. In most National Parks and Forest Reserves of Malawi it will therefore be necessary to carry out a survey of forest carbon stocks within the project area (although as more projects are developed in protected areas of forest in Malawi the use of data from surveys in similar forest types and conditions may be possible).

Standardised methodologies that are in compliance with the IPCC Good Practice Guidelines for Land Use, Land-Use Change, and Forestry (Penman et al. 2003), and Afforestation, Reforestation and Other Land Uses (Eggelston et al. 2006), for example Pearson et al. (2005), should be used for these surveys.

An example such a survey carried out in Mkuwazi Forest Reserve, and the Thazima Region of Nyika National Park is provided in Appendix A and a list of local technical service providers and community technicians trained in this approach is in Appendix B. This type of survey will provide default values for the carbon stock per hectare in each of the main forest types present within the project area. These can then be scaled up by the areas of each forest type present to give an estimate of carbon stocks within the project area.

3.2 Change in carbon stocks in the absence of project activities

To calculate the carbon benefits of avoided deforestation and degradation, it is necessary to determine the reduction in carbon stocks in the absence of the activity (the "baseline scenario"). The construction of a baseline scenario must make use of the best available evidence and methodologies and be wholly transparent, giving the sources of all information used, and justification of any assumptions made (Plan Vivo Foundation 2008b). This requires an objective, threat-based prediction of future reductions in carbon stocks (Plan Vivo Foundation 2008b). Where possible, analysis of contemporary and historical remote sensing imagery from the project area and a wider reference region should be combined with information on socio-economic drivers of deforestation, and environmental predisposing factors, to model the likely future deforestation scenario in the absence of project activities. The Methodology for Estimating Reductions in Greenhouse Gas Emissions from Mosaic Deforestation(BioCarbon Fund 2008), and Sourcebook of REDD

Methods (GOFC-GOLD 2008) provide guidance for this approach.

The current availability of suitable remote sensing imagery, and the time and costs associated with its interpretation currently prevent the use of this approach in many National Parks and Forest Reserves of Malawi. Particularly since in addition to deforestation, much of the loss of carbon stocks from National Parks and Forest Reserves is likely to be in the form of forest degradation, which is difficult to detect remotely. Research currently underway at the University of Edinburgh, and elsewhere, is likely to provide accurate assessments of past patterns of deforestation across Malawi however, and this information should be included in subsequent revisions of this technical specification (Viergever in prep).

In areas where the use of remote sensing, and modelling of future deforestation scenarios is not feasible, ground-based estimates of forest area under threat of deforestation and degradation can be obtained through participatory mapping exercises with local stakeholders, as described in Box 1. A Participatory Threat Mapping exercise carried out to determine the carbon stocks likely to be lost under the baseline scenario in Mkuwazi Forest Reserve was completed by Chirwa et al. (in prep) , and a list of local technical service providers and community technicians trained in this approach is in Appendix B.

Box 1. Participatory Threat Mapping

A participatory approach to threat assessment enables local stakeholders to determine areas likely to be deforested or degraded in the absence of project activities within a defined period of time. In areas where local stakeholders interact closely with the forest, local knowledge of current and future threats to forest cover can contribute to clear and credible estimates for future reductions in carbon stocks, from which the carbon benefits of project activities can be estimated.

Producing a threat map

1. Through discussions with informed individuals from local communities, and those with expert knowledge of local forest conditions, determine a project period over which it is possible for local stakeholders to estimate the impacts of current and future resource use on forest cover. The project period is likely to be in the region of 10 to 50 years.
2. Select a group of around 10 stakeholders from the community or communities involved in the project that have a good knowledge of the forest and common practices of forest resource use in the area. Ensure that genders, age groups, occupations, and villages are sufficiently represented.
3. With one facilitator skilled in participatory mapping techniques, guide the group of stakeholders through the process of producing a sketch map of the main forest types, access routes, landscape features, and population centres in and around the project area.
4. Guide the stakeholder group to produce a sketch map of areas where the forest is used for different purposes (e.g. pole collection, charcoal making, or firewood collection) by overlaying the initial sketch map of forest cover with a transparent sheet onto which the boundaries of different forest resource use activities can be drawn.
5. Guide the stakeholder group to categorise forest areas according to the level of threat to forest cover within the project period, for example: a) Likely to be deforested; b) Likely to be significantly degraded; or c) Unlikely to be degraded or deforested. The boundaries of the areas under each level of threat should be drawn on an additional transparent sheet overlaid on the maps of forest type, and forest resources use.

Calculating carbon stocks likely to be lost under the baseline scenario

1. Using the maps of forest cover, and threats to forest cover produced in steps 1-5 above, and existing topographic maps of the project area, community technicians skilled in the use of GPS should record the geographic coordinates of the boundaries of all identified forest types, and areas under each level of threat to forest cover. The methodologies described in K:TGAL (2009) provide useful guidelines for this activity.
2. GPS points recorded in the field should be transferred to a GIS of the project area with polygons representing the main forest types present, and the areas under each level of

threat.

3. Information from the GIS coverages of forest type, and level of threat, should be combined with information on the carbon stocks in the different forest types present. From this the likely reduction in carbon stocks that result from each of the threat levels identified (determined from surveys of deforested and degraded land) can be used to determine the reduction in carbon stocks in the project area that is expected in the absence of project activities

Potential pitfalls

The success of this activity in producing credible estimates of future reductions in carbon stocks depends on the quality of information provided by the stakeholder group. To ensure that threats are not overstated it is important that the focus of the activity is placed on defining forest types and how the forest is used, rather than on the identification of areas threatened by deforestation. Identified levels of threat should be discussed with the stakeholder group in relation to the forest resource use activities identified for that area, and any apparent discrepancies investigated. Local stakeholders should be encouraged to consider the accessibility, extractable or cultivable value, and level of protection present, as well as their experience of changes to forest cover in recent history, when deciding which threat level to ascribe to different areas. It may be necessary to repeat the mapping exercise with more than one stakeholder group, and investigate any discrepancies. All threat maps produced should also be reviewed by experts from local Universities or relevant government departments prior to the calculation of carbon benefits from project activities.

Change in carbon stocks under the baseline scenario can be calculated using the tool provided in the supporting material for this technical specification (S1).

4. Project activities

Project activities should be designed during the establishment of co-management agreements or resource user agreements between the Department of Forestry, or Department of National Parks and Wildlife, and the communities in the vicinity of the project area.

These co-management or resource use agreements should be based on the overall objectives:

- To ensure continuous forest cover for carbon conservation, maintenance of biodiversity, protection of watersheds, and prevention of soil erosion
- To ensure increased and continued supply of forest products

Specific management objectives should include:

- Developing an income from carbon finance for forest conservation
- Establishment of livelihood activities that provide an income or resources without degrading forest cover
- Water catchment protection
- Maintenance of biodiversity
- Reducing demand for woodfuel and charcoal though the distribution of fuel efficient and alternative energy cook stoves

The standards and guidelines for participatory forestry in Malawi (Department of Forestry 2005) provide a framework for best practice in preparing forest reserve co-management plans which includes the following stages:

- Preparation for co-management

- Assessing the resource
- Analysing supply and demand
- Planning for the future
- Agreeing roles responsibilities and sharing of benefits

The guidelines provided in the Department of Forestry (2005) standards should be followed for each of these stages in the development of co-management or resource use agreements, and the design of project activities, with the full participation of local communities.

Project activities should help ensure the maintenance of forest carbon stocks directly by preventing unsustainable use or occasional catastrophic loses, and indirectly by providing alternative sources of income and resources that make the protection of forest more attractive than its destruction.

Potential project activities that reduce threats to deforestation and degradation, and/or reduce risks of leakage and non-permanence include:

- Establishment of agroforestry plantations and woodlots in homesteads and customary land surrounding the National Park or Forest Reserve to provide sustainable sources of timber, poles, firewood, and fruits
- Beekeeping
- Sustainable harvesting of non-timber forest products such as mushrooms, medicinal plants, thatch, fruits, insects, basket making materials, and firewood
- Patrolling
- Establishment of ecotourism
- Intensification of agriculture outside the National Park of Forest reserve, through introduction of livestock or fish ponds, or increased use of fertilisers
- Establishment of micro-finance facilities to enable the development of local businesses
- Distribution of fuel efficient cook stoves

4.1 Effectiveness

To determine the carbon benefits of a project it is necessary to estimate the impact that project activities will have on avoiding the deforestation and degradation expected under the baseline scenario. This can be achieved by determining the impact that expected annual achievements for project activities identified in the activity plan (see Section 8.3) would be expected to have on the main threats of deforestation and degradation in the project area.

Expected achievements in threat reduction as a result of project activities can be estimated by local stakeholders and technical experts by identifying threats to forest cover in the project area, ranking the threats by area and intensity of impact (Box 2), and estimating of the likely impacts of project activities on those threats over the project period (Box 3, Section 9.2).

If a direct link is assumed between threats of deforestation and degradation, and actual patterns of forest loss and degradation then the expected threat reductions can be used as a proxy for the effectiveness of project activities in avoiding deforestation and degradation. For example if project activities are expected to reduce threats to deforestation and degradation by an average of 80% over the project period, it can be assumed that project activities will avoid 80% of the deforestation and degradation expected under the baseline scenario.

An example of estimated reductions in threats to deforestation and forest degradation in Mkuwazi Forest

Reserve is in Appendix C, and a list of local technical service providers and community technicians trained in this approach is in Appendix B. The spreadsheet in supplementary material S.1 can be used for calculating an estimate of project effectiveness.

Box 2. Participatory ranking and rating tools

Pairwise ranking

Pairwise ranking can be used for helping to reach consensus about the relative importance of a list of items, for example for determining the relative importance of a list of threats of deforestation or forest degradation.

1. Construct a pairwise matrix with a box representing a comparison between each of the possible combinations of items
2. Through consensus orientated discussion determine which of the two items is of greater importance for each of the pairwise comparisons
3. Record the number of the item which is decided to have greater importance in each of the boxes
4. Count the number of times each item appears in the matrix
5. Rank the items in order of the number of times each item appears in the matrix, the most important item being the one that appears the most times
6. If any items appear the same number of times, the one given the higher rank should be determined from the item deemed most important in the comparison of those two items

Simple rating system

When determining the importance of a list of items, simple rating systems can help to encourage participation in the decision making process. One method that can be successful is the use of counters (such as stones or seeds) placed next a description of the item to indicate relative importance. For example 1 counter might indicate a low importance, 2 - medium importance, and 3 - high importance. The counters can then be moved during the discussion until consensus is reached.

4.2 Greenhouse gas emissions

If project activities result in significant emissions of greenhouse gases, these should be subtracted from the carbon benefits of the project. Significant emissions are those that are greater than 5% of the total carbon benefits of the project (see the CDM tool for determining the significance of greenhouse gas emissions; http://cdm.unfccc.int/EB/031/eb31_repan16.pdf).

Potential sources of greenhouse gas emissions from project activities that should be considered are listed in Table 4.

Since most projects will include some emissions from the use of fossil fuels for transport during design and implementation (for example for monitoring activities), these should be recorded, and subtracted from the carbon benefits of the project if they are significant. A tool for the calculation of greenhouse gas emissions from transport during the design and implementation of project activities is provided in the supplementary material to this technical specification (S2).

Table 4. Rationale for inclusion of potential sources of greenhouse gas emissions in assessment of project emissions

Sources	Gas	Decision
Biomass burning e.g. from site preparation for tree planting	CO_2	Include if a significant source
	CH_4	Include if a significant source
	N_2O	Include if a significant source
Combustion of fossil fuels by vehicles[a]	CO_2	Include if a significant source
	CH_4	Exclude - Not a significant source
	N_2O	Exclude - Not a significant source
Use of fertilisers[b]	CO_2	Exclude - Not a significant source
	NH_4	Exclude - Not a significant source
	N_2O	Include if a significant source
Livestock emissions from enteric fermentation, and manure	CO_2	Exclude - Not a significant source
	CH_4	Include if a significant source
	N_2O	Include if a significant source

[a] http://cdm.unfccc.int/EB/033/eb33_repan14.pdf
[b] http://cdm.unfccc.int/EB/033/eb33_repan16.pdf

4.3 Environmental benefits

Plan Vivo projects must demonstrate that they contribute to the maintenance of biodiversity and protection of watersheds within project areas. The National Parks and Forest Reserves of Malawi have typically been established in areas of high conservation and watershed value. Project activities that aim to conserve these areas of forest are therefore highly likely to bring important benefits to both biodiversity and watersheds.

Co-management and resource user agreements for National Parks and Forest Reserves in Malawi encourage positive resource use, which has the potential to benefit biodiversity for example through:

- Fire management
- Protection of wildlife; including prevention of removal, damage, or poaching
- Reporting of illegal activities
- Environmental education programmes with surrounding communities

4.4 Livelihood benefits

The project activities suggested in Section 4.1 highlight the importance of developing livelihood benefits from a diversity of sources. In addition to payments for carbon benefits from avoided deforestation, co-management agreements between communities and the Department of Forestry or Department of National Parks and Wildlife give community groups legal mandate to access non-timber forest products in designated areas of National Parks and Forest Reserves and Nyika National Park.

Potential livelihood benefits from the activities suggested in Section 4.1 include:

- Income from carbon payments for forest conservation
- Use and sale of timber from agro-forestry plantations

- Sale of seedlings from tree nurseries
- Use and sale of non-timber forest products collected from within the project areas
- Reconnection with traditional lands
- Development of ecotourism

5. Additionality

The carbon benefits from avoided deforestation, must be additional to those that would be achieved in the absence of project activities. It is therefore necessary to demonstrate that despite the project activities will bring benefits in addition to those that would occur under normal management practices for the project area; and to describe the barriers that prevent the implementation of project activities in the absence of payments for carbon benefits.

5.1 Comparison to normal practice

Although co-management agreements with communities surrounding National Parks and Forest Reserves in Malawi have previously been established without the inclusion of carbon finance from avoided deforestation, their success has been limited. For example, co-management agreements with communities around Nyika National Park did not result in any reductions in illegal use of the forests within the park (DNPW 2004). Activities for generating alternative sources of income through co-management agreements are unlikely to provide sufficient incentive to prevent activities that cause degradation and deforestation, unless they receive sufficient support to develop these activities in to viable businesses that provide an equal or greater income than can be obtained through unsustainable forest use.

The financial benefits from carbon finance are likely to provide a far stronger incentive for forest protection than has previously been present, either through direct payments, or indirectly by providing the initial finance required for establishing a diverse range of livelihood development initiatives. Payments for carbon benefits are therefore likely to encourage the establishment of co-management agreements in areas where they would not previously have been considered, and help to ensure the success of existing agreements.

5.2 Barrier analysis

A project is additional if it, and the activities supported by it, could not have happened were it not for the availability of carbon finance. Potential barriers to the implementation of avoided deforestation projects in National Parks and Forest Reserves are described in Table 5.

Table 5. Barrier analysis to demonstrate additionality of avoided deforestation activities in many National Parks and Wildlife Reserves of Malawi

Type of barrier	Description	How project will overcome the barrier
Economic	Insufficient funds to purchase seedlings for tree planting activities, or purchase necessary equipment for harvesting non-timber forest products	Provision of funds from carbon finance for establishment of nurseries, and provision of equipment for collection of non-timber forest products and beekeeping
	Under developed markets for non-timber forest products	Provision of access to markets for non-timber forest products
Technical	Lack of expertise in species selection and tree propagation and care necessary for tree planting activities	Provision of advice on appropriate species selection for agroforestry and woodlot establishment, and training on propagation and care of trees
	Lack of expertise necessary to provide tourist guide services	Training for tourist guides
	Lack of expertise necessary for successful propagation and/or harvesting of non-timber forest products	Training in techniques necessary for the propagation and harvest of non-timber forest products e.g. beekeeping
Institutional	Weak enforcement of forest use regulations	Engage communities in monitoring and protection of forest resources
	Lack of power for communities to enforce forest use regulations	Empower communities to act against improper forest use by providing monitoring mechanisms and channels of communication with FD and DNPW

6. Leakage

Any reduction of carbon stocks or increase in greenhouse gas emission that occur outside the boundaries of a project, but that are the direct result of project activities, are described as “leakage”. The risk of leakage stems from a need for continued supply of resources, energy, and financial income.

The risk of leakage of activities that cause deforestation and degradation will be limited when project areas are National Parks and Forest Reserves that do not have nearby areas of forest that are suitable for exploitation, but project activities must be designed that limit the chance of leakage by providing the necessary resources and/or alternative sources of income. Where leakage is unavoidable, the estimated reductions in carbon stocks and increases estimates of project effectiveness in avoiding loss of carbon stocks from avoided deforestation and forest degradation should be corrected to account for the likelihood that some carbon benefits will be lost.

6.1 Minimising the risk of leakage

With avoided deforestation projects, there is the chance that project activities will displace forest use activities such as timber harvesting or fuel wood collection from the project area to other forest areas in the vicinity. For each project area it is therefore necessary to identify potential sources of leakage and design measures that mitigate the risk of leakage by providing necessary resources and alternative sources of income in a manner that does not contribute to reductions in forest carbon stocks, or produce significant greenhouse gas emissions. Potential sources of leakage, and mitigation measures that are likely to be applicable to avoided deforestation projects in many National Parks and Forest Reserves of Malawi, are described in Table 6.

Table 6. Potential sources of leakage and mitigation measures

Potential sources of leakage	Mitigation measures
Increased harvesting to meet demand for timber and poles	Establishment of woodlots, and agroforestry plantations in private and customary land to provide a sustainable source of timber and poles
	Introduction of alternative construction methods
	Activities that provide alternative sources of income such as beekeeping, and non-timber forest product collection
Increased charcoal production	Activities that provide alternative sources of income such as beekeeping, and non-timber forest product collection
	Establishment of woodlots, and agroforestry plantations in private and customary land to provide a sustainable source of wood for charcoal production
	Introduction of alternative sources of fuel
	Distribution of fuel efficient cookstoves
Increased fuelwood collection	Establishment of woodlots, and agroforestry plantations in private and customary land to provide a sustainable source of fuelwood
	Introduction of alternative sources of fuel
	Distribution of fuel efficient cookstoves
Agricultural expansion	Introduction of more intensive agricultural production (although any increased emissions from the use of fertilisers and fossil fuels would need to be deducted from carbon benefits)
	Introduction of improved seed varieties, and agricultural production and storage practices, leading to increase productivity
Increased harvesting of wood for curios	Introduction handicrafts that do not require harvesting of trees
	Providing information to tourists on the implications of their choices when purchasing curios
	Activities that provide alternative sources of income such as beekeeping, and non-timber forest product collection
	Establishment of woodlots, and agroforestry plantations in private and customary land to provide wood for curio production

6.2 Quantification of leakage

The need for resources and income that were being met by unsustainable forest use at the start of the project are unlikely to be diminished over time, so if project activities are successful in reducing unsustainable forest use within the project area these needs must be met from elsewhere. The project activities described in Section 6.1 will help to minimise leakage but may not eliminate the risk entirely, especially in the short term, while activities that generate alternative sources of income and resources become established (for example it may take several years for agroforestry plots to produce poles that can be used for house construction). It is therefore necessary to estimate the risk of leakage for each of the main threats identified for the project area, so that the carbon benefits of the project can be reduced by an amount that reflects the likely impacts on carbon stocks outside the project area.

Risk of leakage for each of the main threats to forest cover can be estimated by local stakeholders, with the support of the project coordinator and technical service providers. A simple rating system can be used to estimate the percentage reduction in project effectiveness that leakage is likely to cause (Box 2, and Table 7). An example of the estimation of leakage from activities within Mkuwazi Forest Reserve is provided in Appendix C, and a spreadsheet used to calculate the effectiveness of project activities, with and without leakage, is in the supplementary material (S1).

Table 7. Adjustments to be made to expected project effectiveness for different level of risk from leakage for each of the main threats to forest cover.

Risk of leakage	Description	Cause	Adjustment to expected project effectiveness
HIGH	It is likely that most of the unsustainable extraction from within the project area will be transferred to forest outside the project area.	Leakage mitigation measures do not provide necessary income and resources, and demand remains undiminished	Reduce by 70%
MEDIUM	Some of the unsustainable extraction from within the project area is expected to be transferred to other areas of forest.	Leakage mitigation measures provide some of the necessary income and resources, and/or there is some reduction in demand	Reduce by 40%
LOW	Little transferral of unsustainable extraction from the project area to other areas of forest is expected.	Leakage mitigation measures are largely effective, and/or demand is significantly reduced	Reduce by 10%
NONE	No transferral of unsustainable extraction.	Leakage mitigation measures provide all income and resources that were previously obtained from unsustainable extraction from the project area, and/or demand is entirely removed	None

7. Permanence

The Plan Vivo Standards define permanence as “a sustainable land use that is maintained for a period of at least 100 years” (Plan Vivo Foundation 2008a). Project activities should be designed to address the risk that carbon benefits will be non-permanent. When risks to non-permanence are unavoidable the level of risk should be estimated so that an appropriate proportion of carbon benefits from project activities can be set aside and left unsold to insure against the risk of non-permanence.

7.1 Minimising the risk of non-permanence

Potential risks to non-permanence of carbon benefits from avoiding deforestation and forest degradation in National Parks and Forest Reserves of Malawi are listed in Table 8.

Table 8. Direct risks of non-permanence and mitigation activities

Risk	Mitigation activities
Fire	Maitenance of fire breaks
	Fire monitoring and control
	Raising awareness among local communities
Ineffective enforcement	Activities that build support for forest protection by delivering benefits to local communities
	Increased intensity and efficacy of patrols, through the provision of more patrol staff
Donor dependency	Ensure that payments for carbon benefits are invested in livelihood development
	Ensure that project activities have an appropriate exit strategy that will ensure they can continue after the cessation of payments for carbon benefits
	Provide training in business management for community groups involved in project activities
Earthquakes	None
Insect damage	Biocontrol
	Pheremone traps
Political instability	Activities that raise awareness of the benefits of forest protection
Drought	None

7.2 Risk buffer

Since it is not possible to mitigate all risks of non-permanence, a proportion of the carbon benefits from the project must be left unsold as a method of insuring against unavoidable future losses to carbon stocks within the project area. The percentage of unsold credits is the "risk buffer", which must be at least 10% of the total carbon benefits of the project (Plan Vivo Foundation 2008). The proportion of carbon benefits that are not sold should reflect the risks of non-permanence within the project area. Local stakeholders, with the assistance of the project coordinator and technical service providers, can estimate the risks of non-permanence by identifying the main risks to non-permanence in the project area using a simple rating system to describe the level of the risk (Box 2, and Table 9). When more than one risk is identified for the project area, the level of the risk buffer should be set to the level of the highest risk identified. An example of a risk buffer determined for Mkuwazi Forest Reserve is in Appendix B.

Table 9. Risk buffers to insure against the risk of non-permanence of carbon benefits

Risk of non-permanence	Description	Risk buffer
HIGH	It is likely that the risk to non-permanence will affect some of the project area within 100 years	50%
MEDIUM	It is possible that the risk to non-permanence will affect parts of the project area within 100 years	25%
LOW	It is unlikely that the risk to non-permanence will affect any of the project area within 100 years	10%

8. Management

Management plans that ensure tangible and quantifiable benefits are achieved, and that communities have the capacity to fulfil, should be developed by communities involved in the project with the assistance of project coordinators and technical service providers. Management plans should contain:

- Maps of project areas depicting ownership boundaries, land use and land cover, expected deforestation and degradation, and locations for project activities
- Governance plans including a management agreement and responsible parties
- Activity plans including a list of all activities to be carried out and estimates of costs and expected income
- Monitoring plans including indicators to be used to monitor the impact of project activities

8.1 Maps

Maps produced for each project area should include:

- Boundaries and location of the project area
- Location and extent of forest and other vegetation types
- Areas expected to be deforested or degraded within the project period (see Box 1)
- Access routes, rivers and water bodies
- Topographic features
- Locations where project activities will be carried out
- Locations of villages and other population centres

8.2 Governance plan

Governance plans should explain the roles of project partners, and community groups and the management structures through which they will interact.

The governance plan should include:

- A management agreement or equivalent community agreement (e.g. a co-management or resource-use agreement) stating that the project is to be managed for forest conservation
- A governance structure describing the roles of, and relationships between, the main parties involved in the project including community groups, project coordinators, and technical service providers
- A letter of agreement or recognition from Municipal and/or State authorities

8.3 Activity plan

Activity plans designed by community groups with the assistance of the project coordinator and technical service providers should describe the activities to be undertaken to avoid deforestation, and limit the risks of leakage and non-permanence.

The activity plan should include:

- A list of activities and tasks that will be carried out by community groups including any inputs required from the project coordinator and technical service providers
- Estimated time inputs and resource requirements for each task
- Estimates of the costs for implementation, and expected incomes from each of the tasks
- A time-frame indicating the months of the year when tasks will be carried out
- Expected annual achievements for each of the activities, which will be used as indicators of the success of project implementation
- Details of the frequency and requirements for reporting details of activities to the Community Coordination Group, and the Project Coordinator

8.4 Monitoring plan

To determine whether the project is achieving the expected environmental, livelihood, and carbon benefits a detailed plan should be developed that describes indicators of carbon stocks, threats to forest cover, implementation of project activities, and leakage that can be used for periodic monitoring to determine whether payments for carbon benefits should be received and if corrective actions are necessary. Monitoring should be carried out by a group of community technicians who will receive training and support from the project coordinator and technical service providers. Where community technicians are involved in project activities, they should not be responsible for monitoring their own activities. A register of community technicians and details of training received should be recorded in a project database. Details of training received by community technicians and technical service providers for Mkuwazi Forest Reserve are provided in Appendix C.

The monitoring plan should include:

- Indicators of deforestation such as extent of forest cover (see Box 1)
- Periodic measurement of forest inventory plots to determine the extent of forest degradation (see section 3.1)

- Indicators of threats to forest carbon stocks to be monitored by periodic Threat Reduction Assessment (see Box 3)
- Indicators of the implementation of project activities to be monitored by comparing reports on community group activities to the expected outcomes described in the activity plan
- Guidelines for monitoring leakage
- Details of the methodologies to be used for monitoring
- Details of the frequency, intensity, time requirements and estimated costs for implementation of all monitoring activities
- Details of plans for corroboration of monitoring carried out by community technicians by the project coordinator or technical service providers
- Details of the frequency and requirements for reporting of monitoring results to the project coordinator

All data collected during monitoring should be stored in a project database, and monitoring plans should be periodically reviewed and updated as appropriate.

9. Monitoring

To ensure that project activities achieve the expected carbon, biodiversity, and watershed benefits it is necessary to monitor their success in avoiding deforestation and degradation. Since reductions in forest cover or degradation of forest carbon stocks will only be apparent after they have occurred, it may also be desirable to monitor threats to deforestation and degradation as a failure to reduce threats in line with expectations could allow mitigating actions to be initiated before there has been significant loss or degradation of forest cover. Forest cover and threats should therefore be monitored in the project area, and in areas identified as potential areas where leakage could occur. Monitoring the implementation of project activities is necessary to ensure that the project is achieving anticipated livelihood benefits, and provides an added incentive for continued project activity.

9.1 Methods

The methods used for identifying deforestation and degradation or improvement in forest condition, and for monitoring changes in threat levels, should be those that provide the necessary information in the most cost and time effective manner, and where most of the work can be carried out by appropriately trained community technicians. Some suggested methods for quantifying or estimating the extent or intensity of deforestation, degradation, and threats are shown in Table 10. A list of training received by community technicians and local technical service providers, in some of these methods is provided in Appendix C.

Table 10.. Methodologies that can be used for monitoring the main indicators of project success

Method	Indicators	Description	Intensity and Frequency	Responsible parties	Equipment	Corroboration
Remote sensing analysis	Forest cover; Agricultural expansion	Analysis of satellite imagery to determine changes in forest cover over the monitoring period	Images should be analysed for the entire project area, and areas of potential leakage at least every 5 years	Technical service providers with expertise an analysis of remote sensing data	Remote sensing data, GIS software, Computer	Review by remote sensing expert
Boundary mapping	Forest cover; Agricultural expansion	Map the boundaries of all forest patches and agricultural areas using techniques described in Box 1.	All boundaries within the project area, and areas of potential leakage should be mapped annually	Survey: Community technicians for the survey Training and analysis: Technical service providers with experience of GIS analysis	Survey: GPS, Stationary Analysis: Computer, GIS software	Technical service provider to re-survey 10% of the area surveyed by community technicians
Forest inventory plots	Average carbon stock per hectare of each forest type; Signs of threats e.g. pole collection	Temporary sample plots as described in Section 3.1; Also record signs of disturbance linked to any identified threats that are likely to be efficiently sampled at this scale, for example pole collection	The number of plots necessary to sample in each forest type should be determined by the levels of variation identified in a pilot study. A tool for calculating sample size (e.g. REF) can then be used to determine the necessary number of plots. The specified number of plots should be surveyed annually	Survey: Community technicians for the survey Training and analysis: Technical Service providers with experience of calculating forest carbon stocks	Survey: Tape measure, Diameter tape, GPS, Compass, Clinometer, Camera Analysis: Computer	Technical service provider to re-survey 10% of plots the plots surveyed by community technicians
Threat transects	Quantitative estimates of threat levels for threats that are effectively sampled at this scale, e.g.: Charcoal production, Timber harvesting, Curio production, Canoe making	Transects either randomly located or following paths, along which all signs of the identified threats are recorded	Width of transects should be determined by the limits to visibility within the forest type being surveyed, for example 5 meters either side of the transect is usually feasible. Transects of around 1km per 100 ha of the project area, or area of potential leakage should be surveyed ensuring that all areas and forest types are represented. Surveys	Survey: Community technicians Training and analysis: Technical service provider with experience of quantitative analysis	Survey: GPS, Camera, Diameter tape, Tape measure	Technical service provider to re-survey 10% of the transects surveyed by community technicians

			should be completed annually			
Household surveys	Qualitative estimates of levels of threats e.g.: Firewood collection, Pole collection, Charcoal production, Curio production, Timber harvesting	Through semi-structured interviews with members from a representative sample of households, determine estimates of the levels of the main threats identified. For example by enquiring about levels of personal use, and opinions about the number of others engaged in activities within the project area, and area of potential leakage	Annual survey of 5 to 10% of the households from villages in the vicinity of the project area	Survey: Community technicians Training and analysis: Technical service provider with experience of socio-economic survey techniques and analysis	Stationary	Technical service provider to re-visit 10% of households surveyed by community technicians

9.2 Deforestation and degradation

Surveys of forest cover and forest carbon stocks should be compared to surveys completed at the start of the project to determine whether they have increased or declined. Thresholds for initiation of corrective activities, and releasing of payments in response to reported monitoring results are shown in Table 11.

9.3 Threat reduction assessment

Threat reduction assessment makes use of quantitatively or qualitatively estimated levels of threats identified at each monitoring event, compared to their levels at the beginning of project implementation to give an indication of project successes in reducing the levels of the most important threats to forest cover. This can provide a cost effective method for monitoring the success of project activities (see Box 3). Thresholds for implementation of corrective actions and release of payments for carbon benefits are suggested in Table 101

Box 3. Threat Reduction Assessment

Monitoring the threats to forest cover provides a method of identifying project successes, and allows the identification of increases in threats that can allow corrective actions to be made before there has been deforestation, or significant degradation of carbon stocks. The identification of threats, and progress in mitigating those threats, by local stakeholders can provide a reliable method for monitoring the impacts of project activities. An adaptation of the Threat Reduction Assessment methodologies for monitoring the impacts of biodiversity conservation projects (Margoluis and Salafasky 2001) is summarised below. The activity should be facilitated by someone with experience of participatory methods of working with local stakeholder groups.

Identify threats to forest carbon stocks and define a 100% reduction to threats

1. With a group of local stakeholders in which genders, age groups, occupations, and villages are sufficiently represented, determine the main threats to forest carbon stocks within the project area. When threats are linked to more than one underlying cause (for example timber harvesting for personal use and for commercial purposes) list the threats separately (i.e. timber harvesting for personal use, and timber harvesting for commercial use)
2. Through discussion with the stakeholder group, for each threat define and record what a 100 percent reduction in the threat would mean. For example if charcoal production is identified as a threat to forest cover, a 100 percent reduction in that threat may be that no charcoal is produced within the project area. However it will not always be necessary to prevent all exploitation to achieve a 100 percent reduction in the threat, as if sustainable exploitation can be achieved this would effectively prevent the threat to forest cover.
3. Rank each threat for intensity giving the largest number given to the threat likely to cause the most severe losses of forest carbon stocks. If there is any dispute over the relative intensity of threats, pairwise ranking methods can be used to help reach consensus (Box 2).
4. Rank each threat for area, with the largest number given to the threat that will affect the largest proportion of the project area.
5. Rank each threat for urgency, with the largest number given to the threat that will cause deforestation and/or forest degradation the soonest.

Describe initial threat levels

At the start of the project a quantitative or qualitatitve assessment of threat levels should be determined. The methods selected for determining threat levels should be those that are the most accurate, reliable, cost-effective, feasible and appropriate given the time and resource constraints of the project. An example of a quantitative method for assessment of the level of a threat might be to count number of bags of charcoal produced within the project area in that year. Although this may not be feasible to measure so an alternative qualitative approach would be to interview charcoal producers to estimate how much charcoal is produced within the project area.

Record percentage reductions in threats during project monitoring

At the end of each monitoring period threat levels should be assessed using the same methodologies as were used to describe the initial threat levels. Results should be recorded as a percentage of the initial threat level, e.g. a 50% reduction in charcoal production would be recorded as 50%.

Calculate the Threat Reduction Assessment Index

At the end of each monitoring period the Threat Reduction Assessment Index should be calculated by completing the following steps:

1) Calculate the Total Ranking for each threat by summing Intensity, Area, and Urgency rankings
2) Multiply the Total Ranking by the % Threat Reduced to give a Raw Score for each threat
3) Sum the Raw Scores for all threats to give a Total Raw Score
4) Divide the Total Raw Score by the sum of all Total Rankings to give the Threat Reduction Assessment Index.

The Threat Reduction Assessment Index gives an indication of the percentage reduction in threats to forest carbon stocks achieved since the initiation of the project.

A tool for calculating Threat Reduction Assessment Index is provided in the supplementary material to this technical specification (S1).

9.4 Project activities

The activity plan for a project should provide details of expected annual achievements against which progress can be monitored. By comparing annual reports from community groups involved in each activity with the anticipated achievements, the project coordinator can determine if community groups are performing as expected, and if the anticipated livelihood benefits are being delivered. The satisfactory performance of project activities does not have to be directly linked to the release of payments for carbon benefits, but project coordinators should consider the performance related control of payments to further incentivise performance of project activities.

9.5 Leakage

Potential areas where leakage could occur as a result of project activities should be identified and included in monitoring of deforestation, degradation, and threats to forest cover. If the extent or quality of forest cover, or the occurrence of the main threats increases relative to its level at project initiation by a proportion greater than that identified as expected leakage for that monitoring period the thresholds for corrective actions and release of payments for carbon benefits are described in Table 10.

10. Carbon benefits

Payments for carbon benefits are determined from the areas expected to be deforested or degraded within the project period, and the expected effectiveness of project activities. It is therefore important that successes in avoiding deforestation and mitigating threats to deforestation are monitored, so that corrective action to prevent any deviation from achievement of the predicted carbon benefits can be made.

10.1 Quantification of carbon benefits

The prevented loss of carbon stocks from avoided deforestation and degradation over the project period is calculated by multiplying the loss of carbon stocks under the baseline scenario (Section 3.2) by the effectiveness of project activities in preventing that loss (Section 4.1), after incorporating the risk of leakage in to estimates of project effectiveness (Section 6.2).

The total carbon benefits of the project can then be calculated by subtracting any significant greenhouse gas emissions related to project activities (Section 4.2) from the prevented loss of carbon stocks.

The total saleable carbon benefits generated over the project period are calculated by subtracting a percentage of carbon benefits equal to the estimated risk of non-permanence (Section 7.2) from the total carbon benefits.

Spreadsheets for the calculation of carbon benefits are in the supplementary material (S1).

10.2 Payments for carbon benefits

Payments for the total carbon benefits can be made annually or at other periods determined by the project coordinator and community groups. Payments can be phased over the entire project period to help ensure that project activities are maintained. Alternatively, if the costs of establishing the activities that will ensure the long term sustainable management of the forest exceed the income from payments phased over the entire project period, a shorter crediting period can be used. Payments over a period shorter than the project period are known as “ex-ante” payments since they are made prior to the realisation of the carbon benefits from project activities. If the payment period is shorter than the project period there must be a commitment to continue project activities after the termination of carbon payments, and to establish systems that ensure the long term sustainable management of the forest. A spreadsheet for calculating carbon payments is in the supplementary material (S1.3). In all cases issuance of payments for carbon benefits should only be made if targets for maintaining forest cover and carbon stocks, and for reducing threats to forest cover, are met; and all payments must be recorded in the project database to ensure traceability of sales.

10.3 Indicators for crediting

Indicators of project success should be used to determine whether payments for carbon benefits are released by the project coordinator. Indicators for the release of payments for carbon benefits should be linked to the expected project effectiveness used to calculate the carbon benefits (Section 4.1). Thresholds that should be used to determine whether payments are made are described in Table 11.

Table 11. Thresholds for release of carbon payments

	Deforestation[a]	Degradation[b]	Leakage[c]	Threats[d]	Activities[e]
Payments continue as scheduled	Forest cover at or above expected level	Carbon stocks at or above expected level	Threats in potential leakage areas equal to or less than estimated level	Threats reduced by expected amount or more	Project activities meet or exceed expected achievements
50% of payments for this monitoring period withheld, and corrective actions initiated	Forest cover less than expected level	Carbon stocks less than expected level	Threats in potential leakage area greater than estimated level	Threats reduced by less than expected amount	Project activities fail to reach expected achievements
100% of payments for this monitoring period withheld, and corrective actions initiated	Forest cover less than 90% of expected level	Carbon stocks less than 75% of expected level	Threats in potential leakage area more than 125% of estimated level	Threats reduced by less than 75% of expected amount	Little or no progress in project activities

[a] Expected level of forest cover is a percentage of initial forest cover equal to the average project effectiveness over the project period, prior to adjustment for expected leakage (Section 3.1)
[b] Expected level of carbon stocks is the % confidence interval of initial carbon stocks equal to the average project effectiveness over the project period, prior to adjustment for expected leakage.
[c] Estimated level of threat in potential leakage areas is equal to an increase in threat of the percentage estimated for that monitoring period (Section 6.2)
[d] Expected reduction to threats is the expected threat reduction assessment index for the monitoring period
[e] Release of payments in response to project activity is at the discretion of the project coordinator, and these thresholds are suggestions only.

If payments are made annually, annual monitoring of the indicators should also be carried out; although if the cost or time required for monitoring certain indicators longer monitoring periods for that indicator may be necessary (for example if purchase of remote sensing imagery for monitoring deforestation is necessary).

If monitoring indicates that all the indicators of project success are within the green sections of Table 10, payments should continue as planned. If one or more of the indicators are in the yellow section of Table 10, 50% of payments should be suspended for that monitoring period, corrective actions should be encouraged (see Table 10 for potential corrective actions), and the withheld payments should be made once monitoring indicates a return to the threshold in the green section. If monitoring indicates that one or more of the indicators is in the red section of Table 10, 100% of payments should be suspended for that monitoring period, and corrective actions should be encouraged; 50% of the withheld payments should be made once monitoring indicates a return to the threshold in the yellow section, and the remainder of withheld payments should be made once monitoring indicates a return to the threshold in the green section.

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Supplementary material

S1. Spreadsheet for estimation of project effectiveness, prevented loss of carbon stocks from project activities, and for calculating payments for carbon benefits

S2. Spreadsheet for calculating the greenhouse gas emissions from use of transport (in prep)

Appendix A

Inventory of carbon stocks in Mkuwazi Forest Reserve and the Thazima region of Nyika National Park, Malawi

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Summary

To assess the potential for developing a carbon finance project from avoided deforestation of Mkuwazi Forest Reserve and Nyika National Park, Malawi, we inventoried forest carbon stocks in these areas. Estimated forest carbon stocks in above and below ground biomass and dead wood were 211,889 ± 23,694 tC in the 1,767 ha of Mkuwazi Forest Reserve, and 995,446 ± 120,385 tC in the 35,910 ha Thazima region of Nyika National Park. The carbon finance that could be derived from these carbon stocks depends on the degree of threat to the forest areas, the success of project activities in reducing that threat, and the structure of carbon payments. If 75% of the forested areas were threatened with deforestation, and project activities succeeded in preventing 80% of the deforestation that would occur in their absence; annual payments made over a 50 year period at a carbon price of US$ 6 per tonne of CO_2e would be $39,400 per year for Mkuwazi, and $141,888 per year for Thazima.

Introduction

Carbon finance provides a potential source of funding for forest conservation activities. The Mkuwazi Forest Reserve and Nyika National Park in Malawi have been proposed as potential areas for development of forest carbon projects. To determine the potential for carbon payments in these areas it is necessary to: 1) establish the existing carbon stocks within these areas, and the likely carbon stocks that would occur if the area was deforested, and 2) determine whether the areas in question are under threat of deforestation in the absence of project activities, and the reduction in deforestation project activities are likely to achieve. Here we consider step 1 in this process to determine the potential carbon benefits and payments that could received for forest conservation in these areas.

Methods

Study areas

The carbon stock inventory was carried out in two areas of Malawi, Mkuwazi Forest Reserve and the Thazima region of Nyika National Park over a two week period in October 2008.

Mkuwazi Forest Reserve is located in the Nkhata Bay district of Malawi, (11º72'S, 34º05'E), it is characterised by annual rainfall of up to 2,200 mm and high temperatures, which create an environment suitable for the development of large broad leaved trees. The area is dominated by *Brachystegia speciformis* and *B.longifolia* on the lower dryer slopes and evergreen forest composed of *Afrosersalisia cerasifera, Erythrophloem saueolens, Pterocareous stolzii* and *Chlorophora*

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excelsa along rivers and in damper areas (Chapman and White 1970).

Nyika National Park is in the northern region Malawi (10°33'S, 33°50'E). The park is characterised by a distinct mountain plateau at an elevation of around 2,600 m.a.s.l., and associated hills and escarpments that descend to 580 m.a.s.l. The park covers a total area of 3,134 km^2 and has a cool moist climate that is influenced by elevation and orientation to Lake Malawi creating conditions for lush evergreen forest to the east of the park and dry miombo forest to the west of the plateau.

Landsat imagery from 2000, existing literature and land use maps, community consultations, and site visits were used to estimate the areas covered by different land use and land cover classes present in each of the project areas. Carbon stocks were calculated separately for land use and land cover classes that were expected to differ in their carbon stocks. The size of the park prevented a complete inventory over the entire area, and instead efforts were concentrated in the Thazima region, with a view to extending activities over the entire area at a later date.

Carbon stocks included in the inventory

Of the five potential forest carbon stocks considered for inclusion in the inventory, three were selected (see Table 1). Carbon stocks were only excluded from the inventory if they were not expected to be negatively impacted by project activities, and if the cost or time required for their quantification was too high for the project to support.

Table 1. Rationale for decisions over which carbon stocks to include in the inventory

Carbon stock	Likely impact of project on C stock	Restrictions on measurement	Decision
Above ground woody biomass	Increase	None	Include
Below ground woody biomass	Increase	None	Include
Non-tree biomass	Small increase	Time consuming	Exclude
Dead wood	Increase	None	Include
Leaf litter	Small increase	Time consuming	Exclude
Soil organic carbon	Increase	Expensive	Exclude

Carbon inventory

The carbon inventory followed standardised methods (Penman et al. 2003; Pearson et al. 2005). Within each land use and land cover stratum identified, plot locations were determined on a regular 250 m grid for areas where understorey vegetation did not inhibit movement, and by selecting a random distance along existing paths and a random distance from the path (between 20 m and 200 m) in more densely vegetated areas.

Temporary, nested sample plots were used to inventory above and below ground woody biomass. Square plots were used in areas with dense understorey vegetation, and circular plots were used in areas with more open vegetation structure (see Table 2 for details). Coarse woody debris was surveyed along two 50 m transects running north to south and east to west through the centre of circular plots, and along the external perimeter of square plots. The total number of plots necessary to ensure 95% confidence that the estimated carbon stock in each stratum was accurate, with a precision of 10%, was determined from an initial survey of around 10 plots in each stratum (Pearson et al. 2005).

Table 2. Dimensions of subplots and trees measured within the temporary sample plots

	Dimensions	Area	Trees recorded
Square plots			
Small subplot	10 m × 10 m	0.01 ha	5 – 20 cm dbh
Medium subplot	20 m × 20 m	0.04 ha	20 – 50 cm dbh
Large subplot	30 m × 30 m	0.09 ha	> 50 cm dbh
Circular plots			
Small subplot	5.64 m radius	0.01 ha	5 – 20 cm dbh
Large subplot	17.84 m radius	0.1 ha	> 20 cm dbh

For each plot the longitude, latitude, and altitude of the centre of circular plots and the southwest corner of square plots was recorded with a handheld GPS. The diameter at 1.3 m above ground level (DBH) of all trees was measured. For trees with buttresses or deformities at 1.3 m, measurements were taken according to standard guidelines for carbon inventory (Pearson et al. 2005). Standing dead trees were categorised according to a 4 point scale: 1) with branches and twigs remaining, 2) small and large branches remain but twigs are absent, 3) only large branches remain, 4) no branches. The height and diameter of the stem at the top of the tree was estimated for trees in classes 2, 3, and 4.

The diameter of all fallen dead wood ≥ 5 cm diameter at the point at which it intercepted the transects for coarse woody debris was recorded, and any hollows were noted. Coarse woody debris was categorised as: 1) Sound - firm to the touch, 2) Intermediate - possible to push a sharp object into the wood, or 3) Rotten - crumbles to the touch.

Calculation of carbon stocks

We used allometric equations to convert DBH measurements to an estimation of the above ground biomass of each live tree (see Table 3). Existing equations that most closely matched the forest types present were used, and a carbon content of 50% of biomass was assumed for all species. Values were scaled up for each subplot to give estimates of carbon stock per hectare, and we calculated average values for each land use and land cover stratum.

Table 3. Allometric equations used for calculating above and below ground biomass of trees in different strata

Equation[a]	Applicable forest type	Source	Strata
$AGB = 0.0267\, d^{2.5996}$	Miombo woodland	Mozambique (Grace et al. 2007)	Miombo woodland and Customary land
$AGB = 0.5(0.2035\, d^{2.3196})$	Dry tropical forest	(Brown et al. 1989)	Evergreen and Riverine forest
$AGB = 0.5(0.079\, b^{1.36})$	Savannah	(Rosenschein 1999)	Savannah
$BGB = 0.25\, AGB$	Miombo woodland roots	Mozambique (Grace et al. 2007)	Miombo woodland and Customary land
$BGB = \exp(-1.0587 + 0.8836 \ln(AGB))$	Tropical forest	(Cairns et al. 1997)	Evergreen and Riverine forest, and Savannah

[a] *AGB* is above ground biomass in kg C, *d* is DBH in cm, *b* is basal area in cm^2, *BGB* is below ground biomass in kg C.

For dead trees in condition class 1, the equations for live trees were used to estimate biomass, and the total value was reduced by 10% to account for decay. For dead trees in classes 2, 3, and 4 only the biomass within the stem was included as it was not possible to determine what proportion of branches had been lost after the tree had died. We calculated stem volume as a truncated cone with the equation: Volume (m^3) = $1/3\ \pi h(r_1^2 + r_2^2 + r_1 r_2)$ where h is the height of the stem, r_1 is the radius at 1.3 m and r_2 is the radius at the top of the tree. We used the average wood density of African trees (520 kg m^{-3}; Reyes et al. 1992) to estimate biomass, assuming a 10% reduction in wood density from decay, and a 50% carbon content of biomass.

The volume of coarse woody debris in each decay class was estimated with the equation:
Volume ($m^3\ ha^{-1}$) = $\pi 2(\Sigma di/8L)$ where d_i is the diameter of each piece of dead wood measured and L is the length of the transect. Wood density values of 90%, 70%, and 40% of the average wood density of African trees were assumed for coarse woody debris in decay classes 1, 2, and 3, respectively.

Results

Stratification of project areas

The estimated extent of each of the land use and land cover classes present in the project areas are shown in Table 4.

Table 4. Estimated areas covered by each of the land use and land cover classes present within Mkuwazi Forest Reserve and the Thazima region of Nyika National Park

	Area (ha)	Percentage
Mkuwazi		
Evergreen forest	600	34.0
Miombo woodland	620	35.1
Shrubs and scattered trees	300	17.0
Open grassland	100	5.7
Cultivated land	147	8.3
Total	1,767	100.0
Thazima		
Evergreen forest	1,796	5.0
Miombo woodland	12,569	35.0
Savannah	718	2.0
Open grassland	20,828	58.0
Total	35,910	100.0

Carbon stocks within project areas

We surveyed 203 plots, and measured a total of 3,733 trees and 908 pieces of coarse woody debris. The main characteristics of each land use and land cover stratum inventoried, and estimated carbon stocks are shown in Table 5. Applying these values to the areas of under different land cover and land use types in Table 4, the carbon stock in Mkuwazi Forest Reserve is estimated to be 211,889 tC ± 95% confidence interval of 23,694 tC. In the Thazima region of Nyika National Park the forest carbon stocks are estimated to be 995,446 ± 120,385 tC.

Table 5. Mean ± SD number of trees, DBH, basal area, and carbon stocks of main forest types present in Mkuwazi forest reserve and the Thazima region of Nyika National Park, Malawi, and customary land outside park and forest reserve boundaries

	Number of plots	Total plot area (ha)	Number of trees per ha				Average DBH	Basal area (m^2 ha^{-1})	Carbon stocks in woody biomass (tC ha^{-1})				
			5-20 cm DBH	20-50 cm DBH	>50 cm DBH	>5cm DBH			Above-ground	Below-ground	Standing dead wood	Coarse woody debris	Total
Mkuwazi													
Evergreen forest	28	2.52	829 ±502	198 ±121	48 ±40	1075 ±484	22.9 ±6.4	41.10 ±17.03	171.26 ±78.43	32.32 ±13.10	4.46 ±9.16	8.12 ±9.62	215.87 ±94.09
Miombo woodland	35	3.50	723 ±456	188 ±123	33 ±23	944 ±513	21.8 ±4.6	32.42 ±13.40	98.76 ±42.40	24.69 ±10.60	1.85 ±2.71	8.76 ±9.20	132.85 ±54.24
Customary land[a]	4	0.40	200 ±163	35 ±40	8 ±10	243 ±167	34.4 ±28.1	10.07 ±4.38	32.73 ±16.13	8.18 ±4.03	0.00 ±0.00	0.00 ±0.00	40.91 ±20.16
Thazima													
Evergreen forest	16	1.44	781 ±435	230 ±124	52 ±31	1063 ±499	24.4 ±5.4	46.75 ±22.54	205.61 ±106.13	37.87 ±17.46	2.87 ±5.24	14.55 ±14.15	260.90 ±123.35
Miombo woodland	68	6.80	1428 ±996	92 ±58	1 ±5	1521 ±969	13.1 ±3.9	16.60 ±6.04	32.14 ±13.88	8.04 ±3.47	0.13 ±0.58	1.12 ±2.10	40.75 ±17.24
Riverine forest	2	0.18	1550 ±212	313 ±159	17 ±8	1879 ±61	15.4 ±0.96	35.16 ±3.25	131.31 ±4.19	25.82 ±0.73	1.74 ±1.12	3.96 ±0.25	162.83 ±3.55
Savannah	19	1.90	158 ±204	14 ±14	2 ±4	174 ±205	18.3 ±12.0	3.48 ±5.02	15.75 ±18.09	3.73 ±3.88	0.97 ±2.42	0.00 ±0.00	20.45 ±23.19
Customary land[a]	31	3.10	777 ±585	25 ±28	1 ±3	803 ±582	11.4 ±5.5	6.36 ±4.27	11.51 ±9.25	2.88 ±2.31	0.00 ±0.01	0.00 ±0.00	14.39 ±11.57

[a] Plots in customary land were close to the boundaries of Mkuwazi Forest Reserve and Nyika National Park, in areas that were previously covered by forest

Discussion

Potential carbon benefits from forest conservation

The carbon benefits of a forest conservation project can be calculated from the difference between the carbon stocks of forested land, and the likely carbon stocks of that area after it has been deforested. The carbon stocks (± 95% confidence interval) on land that had already been deforested were 40.91 ± 10.08 tC in Mkuwazi, and 14.39 ± 2.11 tC in Thazima. However, the relatively small sample size of plots on customary land in Mkuwazi included areas that maintained some tree cover, and are unlikely to be representative of the fate of deforested land in that area. Potential carbon benefits of forest conservation projects in Mkuwazi Forest Reserve and the Thazima region of Nyika National Park are shown in Table 6.

Table 6. Potential carbon benefits and annual payments for emissions reductions that could result from forest conservation activities in Mkuwazi forest reserve and the Thazima region of Nyika National Park

	Mkuwazi	Thazima
Carbon stock of forested land (tC)[a]	188,195	875,061
Carbon stock of deforested land (tC)[b]	63,939	427,589
Potential carbon benefits of forest conservation (tC)[c]	99,404	357,977
Tradeable emissions reductions credits (tCO_2e)[d]	328,331	1,182,398
Potential annual payments for forest conservation (USD)[e]	$ 39,400	$ 141,888

[a] Lower 95% confidence limit of estimated carbon stock
[b] Assuming a carbon stock of deforested land equal to the upper 95% confidence limit of customary land in Thazima (18.46 tC), and a loss of 75% of forest area as even in the most severely threatened forest areas 100% deforestation is unlikely to occur
[c] Assuming that project activities prevent 80% of deforestation
[d] After converting tC to tonnes of carbon dioxide equivalent (tCO_2e), and removing 10% of credits as a risk buffer to insure against the permanence of emissions reductions
[e] Assuming annual payments over a 50 year period at a carbon price of $6 per tCO_2e

Future refinement of carbon stock estimates

The estimates of forest cover used here are based on a conservative interpretation of available information and may therefore underestimate actual carbon stocks for some areas. It may therefore be desirable to verify these estimates with reference to recent high resolution satellite imagery if this is available in the future. Additional work that would contribute to the accuracy of estimates of carbon stocks in these areas could include the development of allometric equations that are specific to the species and conditions encountered in the project areas, and quantification of the carbon stocks not considered here such as soil organic carbon, and leaf litter, which may be considerable components of carbon stocks in some forest types.

Acknowledgements

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Mazibuko, Michael Chirwa, Vincent Chithila, Henry Kadzuwa, Edward Missanjo, Brian Tambo, Robert Bita, and Bagie Serchand; to the staff of the Deparment of Parks and Wildlife in Thazima, and the Forestry department guards and assistants in Mkuwazi; and to the community technicians from Thazima and Mkuwazi. Input from the Director of Forestry, Dennis Kayambazinthu is also greatly appreciated.

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Appendix B

Training to build competency in forest carbon survey and quantification within communities around Mkuwazi Forest Reserve and Nyika National Park, with local staff from the Department of Forestry, the Department of National Parks and Wildlife, and the COMPASS II project; and with staff and masters students from Chancellor College was conducted by Nicholas Berry and Catriona Clunas, from Ecometrica, UK, and Gemma Cassells from the University of Edinburgh. The training activities were fully funded by COMPASS II/USAID with support provided by COMPASS II project under the leadership of its Chief of Party, Ms. Bagie Sherchand. The training activities were carried out between 10th and 22nd October 2008. Skills covered included:

Forest carbon survey

- Identification of land-use/ vegetation strata
- Identifying plot location and using random sampling techniques
- Setting up nested circular and square plots
- Forest measurement techniques (above ground biomass and deadwood)

Quantification of forest carbon stocks

- Data entry
- Determining number of samples necessary
- Use of allometric equations
- Calculating above and below ground biomass
- Calculating dead wood biomass
- Introduction to remote sensing

Training-for-trainers

- Teaching biomass survey techniques

Participants in training on forest carbon survey, quantification of forest carbon stocks, and training-for-trainers biomass survey were:

Brian Tambo, Edward Missanjo, Henry Kadzuwa, Michael Chirwa, Vincent Chithila, and Dickson Mazibuko, all from Chancellor College.

Participants in training on forest carbon survey in Mkuwazi Forest Reserve were:

Community technicians: Evelyn Mnthal, Gracean Zimba, Maxwel Muyaya, Thomas Njikhu, Felix Ngwira, Kambombo Goma, Jessie Nyanhango, Chipolomba Banda; and 4 forest guards from Mkuwazi Forest Reserve.

Participants in training on forest carbon survey in Nyika National Park were:

Community technicians: Axwell Mahone, Baxter, Malango Mahone, Joel Mghogho; and Robert Bita from the COMPASS II project, and George Nxumayo, Hetherwick Msiska, Obede Gomezga, Henry, and Mghogho from the Department of National Parks and Wildlife.

Training to build competency in the identification and monitoring of forest carbon stocks within communities around Mkuwazi Forest Reserve, with local staff from the Malawi Environment Endowment Trust, Forest Research Institute of Malawi, National Herbarium of Malawi, Department of Forestry, and the COMPASS II project; and with staff and masters students from Chancellor College was conducted by Nicholas Berry from Ecometrica, UK. The training activities were fully funded by COMPASS II/USAID with support provided by COMPASS II project under the leadership of its Chief of Party, Ms. Bagie Sherchand. The training activities were carried out between 2nd and 10th May 2009. Skills covered included:

Participatory threat mapping

- Developing a base map
- Mapping forest types
- Mapping forest uses
- Mapping areas at risk of deforestation and degradation
- Ground truthing information from sketch maps using topographic maps and GPS

Threat reduction assessment

- Defining threats to forest cover and the meaning of a 100 percent reduction to the threat
- Use of pairwise ranking to determine the relative importance of threats in terms of area affected, intensity, and urgency
- Calculation of the Threat Reduction Assessment Index

Facilitator training

- Facilitating participatory threat mapping and threat reduction assessment activities

Participants in training on participatory threat mapping, threat reduction assessment, and facilitator training were:

Michael Chirwa and Henry Utila from the Forest Research Insititue of Malawi, and Gibson Mphepo and Henry Kadzuwa from Chancellor College.

Participants in training on participatory threat mapping, and threat reduction assessment were:

Innocent Chikopa, Elijah Wanda, Wilbert Chitaukali, Victor Kasuzweni, Rex Mbewe, and Elizabeth Bandason from Chancellor College, and Jamestone Kamweado from the National Herbarium of Malawi.

Participants in participatory threat mapping and threat reduction assessment activities in Mkuwazi forest reserve were:

Community technicians - Maxwell Myaya, Keverton Kaunda, Thomson Ngwirah, Jessie Mhango, Gracian Zimba, Mecter Nyirenda, Thomas Njikho, Chipolomba Banda, Juliyas Banda, L.B. Missi, and E.K. Nyasulu.

Appendix C

Definition of threats to forest cover, project effectiveness, and risks of leakage and non-permanence in Mkuwazi Forest Reserve

Gibson Mphepo[1], Henry Utila[2], Nicholas Berry[3]

1.0 Introduction

Mkuwazi Forest Reserve and Nyika National Park have been proposed as potential areas for development of forest carbon project. Results from the following two major activities would qualify the two areas potential for carbon payments (Berry et al. 2008):

- Assessment of existing and potential carbon stocks
- Assess threat of deforestation in the absence of project activities

The first activity was done in 2008 and a draft report was compiled in November (the same year).However, by the first week of May 2009, the second activity had not yet been done.

It is against the above background that a field trip to Mkuwazi Forest involving selected members of staff from MEET, FRIM, LEAD and COMPASS was done from 7th to 10th May 2009. Actual field work took two days.

2.0 Aim and Objectives

The aim of the trip was to conduct a participatory threat reduction analysis (PTRA) with local communities coming from 7 villages around the reserve. Specific objectives of the PTRA were:

1) Re-examine and reaffirm the six major threats that were previously mentioned by the target local communities
2) Explain what a 100 % threat reduction meant to local communities
3) Rank threats in order of how much damage is done to areas and also how intensive is the damage.
4) Conduct participatory prediction of changes in the level of threats over a 30 year period.
5) Assess risks of leakage and non-permanence

3.0 Methods

3.1 Description of the participants

1 Leadership for Environment and Development (LEAD), Chancellor College, University of Malawi
2 Forest Research Institute of Malawi (FRIM), PO Box 270, Zomba, Malawi
3 Ecometrica, Kittle Yards, Edinburgh, EH9 1PJ, UK

A total of 20 local community representatives, 50% female, participated in the PTRA exercises. Participants came from seven villages surrounding the reserve. Because of their proximity to the reserve, we felt these local communities pose greatest threat to the forest. The same communities are likely adversely affected by the presence of the reserve. For instance, the reserve might have contributed to shortage of land for the communities around.

The main local language is Tonga. However, during the discussions, we were also using Tumbuka and Chewa to convey our messages.

3.2 Proceedings of the participatory methods used

3.2.1 Re-examining and re-affirming the threats

Local community representatives were requested to outline the current major threats to the forest. These threats were then compared with the threats mentioned by local communities of the area in the earlier meetings. Any new major threats were added to the original list.

3.2.2 Description of the 100 % threat reduction

Since this concept is apparently difficult to understand, local communities were simply requested to categories threats (which are also activities) into two categories: those activities (threats) that should be totally banned and those that should continue on a sustainable basis. Participants were also being asked to explain why a particular activity should continue on a sustainable basis or should be totally banned.

3.2.3 Pair-wise ranking threats in order of how much damage is done to areas and also how intensive is the damage.

The facilitators started by defining what damage by area and intensity mean in this context. “Damage by area” was defined as how much area is covered when a particular activity (e.g. firewood collection) is undertaken while “damage by intensity” was defined as how much destruction is done to a single plant per unit of time. A pair of threats was being compared to check which of the two poses a higher risk in terms of area or intensity. The threat which participants felt posed a higher risk than the other was recorded in an appropriate cell of the table. For example, if agricultural expansion posed a higher risk than curio making, then it (agricultural expansion) was recorded in the agricultural expansion x curio making cell.

The final process involved adding up of the frequencies for each threat. The threat with the highest overall frequency was ranked as number 1—implying it poses the greatest threat.

3.2.4 Assess risks of leakage and non-permanence

This session started by defining leakage and non-permanence. Leakage was defined as shifting a problem from one area (e.g. Mukwazi Forest) to another forest (e.g. Vizara Rubber Estate). Non-permanence was defined as continued existence of the problem (threat) to the detriment of the carbon benefits.

In both cases, participants were requested to rank the risk as either low, medium or high. Conventionally, the method requires that changes in damage by area and intensity over time should be expressed as percentages. Noting that use of percentages might pose a challenge for local communities to understand, we used maize seeds--the larger the number of maize seeds the higher the damage. A representative from the participants was then requested to put 5 maize seeds for the first five years and then vary the number of seeds every five years (up to 30 years) depending on their perception of the level of change of the risk of leakage. The same approach was used for risk of non-permanence over a 100 year period. In all these processes, views from other participants were also being sought.

4.0 Results

4.1 Quantifying threats to forest cover

The following were threats to forest cover as mentioned by participants:

- Charcoal
- Canoe making
- Curio making
- Poles
- Agricultural expansion
- Timber
- Firewood
- Medicinal purposes.
- House construction/settlements

From the above list, charcoal, canoe making, curio making, poles, agricultural expansion, firewood and medicinal purposes were rated as major threats. After comparing this list of threats with the previous threats that were mentioned by the same target communities, we noted that "medicinal purposes" was not mentioned in the earlier meetings we had with the local communities. It was included this time because most participants agreed that this is one of the major threats.

4.2 Definition of 100 % reduction

Table 1: Threats (activities) that should be either totally banned or used on a sustainable basis

100 % reduction	Activities	Justification
Total ban	Charcoal	Involves cutting down of big mature trees
	Canoe making	Involves cutting down of big mature trees.
	Curios	Curio makers are not residents of the surrounding villages. The makers are "foreigners." So total ban will not affect the surrounding communities
	Agricultural Expansion	Involves clearing of large areas of the forest
Use sustainably	Poles	After cutting, trees will be given time to regenerate. Poles will not be collected from one area to reduce intensity of tree cutting
	Firewood	Only dead wood will be collected
	Medicinal purposes	Destructive harvesting methods such as digging and ring-

		barking will be minimized. As a tradition, most people still rely on traditional medicine in the areas around

Table 2: Ranks for area

	Agric. Expansion (1)	Firewood (2)	Charcoal (3)	Poles (4)	Canoes (5)	Medicine (6)	Curios (7)
1	X	x	x	x	x	x	x
2	2	x	x	x	x	x	x
3	3	2	x	x	x	x	x
4	4	2	4	x	x	x	x
5	5	2	3	4	x	x	x
6	6	2	6	4	6	x	x
7	7	2	3	4	6	6	x

Table 3: Tallies and ranks by areas

Threat	1	2	3	4	5	6	7
Tally	0	6	3	5	2	4	1
Rank	1	7	4	6	3	5	2

From table 3 above, it can be noted that firewood (2) had the highest rank and Agricultural Expansion (1) had the least. This implies that currently, firewood collection involves the biggest area while agriculture expansion involves the smallest area.

Table 4: Ranks for intensity

	Agric. Expansion (1)	Firewood (2)	Charcoal (3)	Poles (4)	Canoes (5)	Medicine (6)	Curios (7)
1	x	x	x	x	x	x	x
2	1	x	x	x	x	x	x
3	3	3	x	x	x	x	x
4	1	4	3	x	x	x	x
5	1	5	3	5	x	x	x
6	1	6	3	6	6	x	x
7	1	7	3	7	5	6	x

Table 5: Tallies and ranks by intensity

Threat	1	2	3	4	5	6	7
Tally	5	0	6	1	3	4	2
Rank	6	1	7	2	4	5	3

From table 5 above, it is observed that charcoal (3) burning had the highest rank (7) while firewood collection (2) had the least (0).

Table 6: Expected reduction in threats over the 30 year project period

	Agric. Expansion	Charcoal	Firewood	Canoes	Poles	Medicine	Canoes
0	5	5	5	5	5	5	5
5	4	3	4	2	4	2	4
10	3	1	4	1	2	2	3

15	2	0	3	0	1	1	2
20	1	0	2	0	0	0	1
25	0	0	1	0	0	0	0
30	0	0	0	0	0	0	0

Table 6 above shows that in thirty years' time, participants felt that 100 % reduction in charcoal and canoes will be achieved in 15-year's time. Firewood collection will take the longest period (30 years) to be reduced by 100 %.

4.3 Risks of leakage

Table 7: Expected level of risk of leakage (none/low/medium/high) for each of the main threats—30 year-period

	Agric. Expansion	Charcoal	Curios	Canoes	Medicine	Poles	Firewood
0	3	2	2	3	2	3	0
5	2	1	1	2	1	2	0
10	1	0	0	1	0	1	0
15	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0

Note: 3 = High; 2 = Medium; 1= low; 0 = None

Table 7 above shows that poles, canoes and agriculture expansion will have high risk of leakage at project start while firewood collection will have no risk of leakage from project start to the end of the project.

4.4 Risks of non-permanence of carbon benefits

Participants gave the following risks of no-permanence: Conflicts, jealousy, theft, selfishness and too much love for money to the detriment of the project and laziness. The following risks were suggested by the facilitator to which the participants also agreed: politicians, pests and diseases, invasive species and fire.

Table 8: Expected level of risk of non-permanence (none/low/medium/high) over a hundred year period

Risk	Level
Conflicts	1
Jealousy	2
Theft	1
Love of money	2
Laziness	1
Politicians	1
Pets and diseases	1
Invasive species	1
Fire	1

Note: 3 = High, 2 = medium, 1 = low

Table 8 above shows that over a 100-year period, most of the risks will be at low level. However, love for money and jealousy are expected to be at medium level by the end of 100 years. For analysis of the non-permanence of carbon benefits it was decided that only direct risks should be included. More abstract risks such as jealousy and love of money were not included.

5.0 Discussion

That most of the threats stated by the participants during this meeting were the same as those previously mentioned in earlier meetings suggests and confirms that these are the major threats. An addition of medicinal plants to the original list could be a result of changed composition of the participants. The earlier meetings might have involved fewer traditional medicine practitioners that could not easily recall use of medicinal plants. These results agree with concerns of the Malawi Government as outlined in key policy documents such as the National Biodiversity Action Plans and National State of Environmental Reports, National Adaptation Programme of Action (NAPA).

Regarding the 100 % reduction and indeed the reductions over a 30-year and 100-year period, it can be inferred that some of the predicted levels of threat reduction (tables 1, 6, 7 and 8) are mere wishes by participants. For instance, total ban on some activities such as charcoal making (table 1) is a tall order. Charcoal making and selling is a lucrative business and banning it will be a tall order by local communities. Compounding the problem is that most of the charcoal making seems to be done by villagers around and that market is readily available for charcoal. Consequently, most of the threats that participants felt will be totally banned will likely continue. The results might also have been affected by the period over which participants were requested to make predictions. For example, predicting a change for the next 100 years can be questioned because lots of things will have changed over the next few decades. The method therefore renders itself to a number of errors. That participants misunderstood the terms like leakage and non-permanence cannot be completely ruled out. The results might have been affected by such misconceptions, although predicted patterns fitted well with expectations suggesting that a good level of understanding was reached.

Since firewood had the highest rank by area (table 3) it can be inferred that firewood collection involves the largest area. Disturbance to the forest and its ecology is therefore higher in firewood collection compared to other threats indicated in table 2. The ranking of other threats in the same table seems to indicate a true reflection of the concept of threat by area. Regarding ranks by intensity (tables 4 and 5), charcoal burning had the highest rank, suggesting that it is the most destructive per unit of area.

6.0 References

Berry, Nicholas J, Clunas Catriona, J, Tipper Richard (2008). Estimating Carbon Stocks: Toward Forest Conservation in Mkuwazi Forest Reserve and Thazima Region of Nyika National Park. USAID.