ASSESSMENT OF DEGRADED FOREST LAND AND DEVELOPMENT OF A RESTORATION PROGRAM FOR DJABULA AND DERRE FORESTS

Technical Report

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Executive summary

IUCN is implementing since end 2007 the Livelihood and Landscape Strategies Program (LLS-2007-2011) in Djabula, Maputo Province and Derre Forets Reserve, Zambézia Province. The goal of the LLS Program is twofold: i) to improve landscape sustainable management; and ii) to improve income generation for local communities through forest-based activities. Specific goals for each project site are: 1) to support discussions and review policies governing the land and resources tenure and, land use rights of communities living in and around the Derre Forest Reserve; and 2) to establish a community wood bank for artisans in Djabula Forest. The success of a large program like this can only be achieved if a forest degradation assessment is performed and strategies for forest rehabilitation are defined. With this in mind the IUCN requested this assignment with the following objectives: 1) To identify the extent and nature of forest degradation; 2) To develop a participatory rehabilitation plan; 3) To assess the needs for the establishment of a community nursery; and 3) design specific on-the-job training programs.

The approach used for this study was a combination of a desktop study and a field assessment. The former aimed at understanding the context of the study areas as well as evaluating land cover changes over time (2003-2009). Two contemporaneous Landsat images of the years 2003 and 2009 were classified to define land cover and a global change matrix used to evaluate land cover changes. The number of fires for each year was extracted from 1-km MODIS Active Fire product that provides a daily composite of active fires. Land cover zones were defined using previous studies and land cover classes of the 2009. Field assessment was performed by establishing one 500-m long transect per zone. It aimed at ecologically characterizing the zones in terms of species abundance, importance value index and soils (pH, Organic matter, nitrogen, phosphorous and potassium).

The results for Derre Forest Reserve (DFR) indicate that most of the area (42% in 2003 and 50% in 2009) is covered by median to low density forests (Figure 1). These forests represent not only natural forests, but also different transition states after some kind of forest intervention (agriculture or logging). Between 2003 and 2009, there was a decrease in dense forest cover (from 15% in 2003 to 11% in 2009). The number of fires in DFR between the year 2003 and 2010 estimated from MODIS active fire product ranges between 500 and 900 a year. Based on several evidences we defined three distinct zones in DFR with different intervention requirements (Figure 4): 1) **Integral**

protection zone, requiring elimination of forest disturbances (agriculture, fires and logging), plantation along the rivers where riverine forest was removed and connection of forest fragments; 2) **Rehabilitation zone** that is considered a priority for rehabilitation that needs enrichment planting in some places and natural regeneration in others; 3) **Agriculture and settlement zone,** is the most degraded area and comparing the other zones this is of lower diversity and tree size. It required a better organization of settlement and agriculture activities, but it should be left only for those activities. Conservation agriculture (crop rotation, agroforestry, integrated pest management, etc) should be promoted in this area.

The results for Djabula indicate that most of the area is covered by semi-deciduous forests of low density. Land use land cover dynamics was very high in Djabula between 2003 and 2009 (Figure 6). Non-degraded forests, semi-deciduous forests decreased from 19% in 2003 to 14% in 2009. There was an expansion of tickets, which is partially (about 24%) a result of conversion of regenerating field. Sandalwood regeneration is evident in the northwest of the areas and it is the result of several years of the government's efforts of reestablishing sandalwood in the area, after years of being intensively logged. Based on several evidences we defined six land use ones with different rehabilitation requirements: 1)**_Riverine area:_** along the Tembe river and deprived of its original riverine forest in most of its course. This is considered of high priority for rehabilitation and a buffer of 100 m was defined in which riverine tree species should be planted in rows along the river. 2) **Sandalwood regeneration:** occurring in the northwest of Djabula is an area of sandalwood regeneration but with intense human activity (settlement and agriculture). For this are we recommend reduce and organize human settlements and agriculture and promote sandalwood regeneration to accelerate its growth and recovery. 3)**_Agriculture and settlement:_**it is part of northern Djabula and overlaps with zone 1, 2 and 5.Conservation agriculture should be promoted in this area. 4) **Charcoal production:** located in the south-central portion of Djabula this area is subjected to intensive charcoal production and the preferred species (mfomozi, ncaia and xizi) are disappearing. Thus urgent intervention is needed in order to reestablish the forest resource. The area has a forest management plan (Soto *et al.*, 2000) that should be updated but most of its recommendations are still valid. This should be combined with enrichment plantations and natural regeneration enhancement in others; 5) **Settlement and pasture**: located in the central Djabula it corresponds to the area with higher human density and where livestock is concentrated. Fires are the main management tool here. We recommend keeping the livestock number within the carrying

capacity of this zone; 6) **Licuáti Forest Reserve:** located to west of the area the forest is kept in a good conservation status due to a combination of formal and traditional conservation rules, but no signs of *Afzelia quanzensis* (the target species for conservation) were found. We recommend a profound analysis of this issue and if proved, enrichment planting is suggested.

The implementation strategy for both areas includes prioritization of rehabilitation activities and puts emphasis on local communities' ownership and attitude towards forest resources. The government should promote the activities and work towards implementing the legal framework, while the private sector, NGOs and civil society agencies should bridge the gap between the government and local communities, while at the same time play a crucial role in training and capacity building of both government and local communities. Monitoring is the main component of the program and as such we identified a checklist of monitoring indicators that can be used by local communities. These indicators are: 1) % of vegetative cover; 2) Number of plant species in the forest; 3) Presence of invasive plant species; 4) Presence of charcoal plants species (mfomozi, ncaia, xizi, others); 5) Presence of wild animals and birds; 6) Plant species common in low fertility soils (*Mellinis repens, others);* 7) canopy cover of riverine forests; 8) Presence of soil erosion; 9) water quality (drinkable water); 10) Water quantity (dry streams and rivers); 11) Plant species killed by fires or other disturbances; 12) Number of plant species used as food, medicines, construction materials, hunting; 13) Income (sale of charcoal, handcrafts, etc); 14) Rainfall and pattern; and 15) vigor of established enrichment plantations (height, mortality, density).

Several strengths and weaknesses were identified for each community and based on that analysis the training needs for both communities are: 1) Rehabilitation program implementation; 2) Legal and institutional framework; 3) Institutional organization and dynamics, 4) Environmental awareness; 5) Conservation agriculture and 6) Entrepreneurship Skills.

The main limitation for this assignment was the very limited time span assigned to it. To overcome this we decided to attribute a broader scope and call it a Rehabilitation program that can commodate several small and specific projects for each zone.

1. Background

IUCN is implementing since end 2007 the Livelihood and Landscape Strategies Program (LLS) in Djabula, Maputo Province and Derre Forets Reserve, Zambézia Province. The goal of the LLS Program is twofold: i) to improve landscape sustainable management; and ii) to improve income generation for local communities through forest-based activities. Specific goals for each project site are: 1) to support discussions and review policies governing the land and resources tenure and, land use rights of communities living in and around the Derre Forest Reserve; and 2) to establish a community wood bank for artisans in Djabula Forest.

The Derre Forest Reserve (DFR) in Zambézia Province was established in 1957 to protect 170,000 ha of the miombo ecosystem dominated by tree species of commercial value for timber, which were being over-harvested, allowing therefore the regeneration of forest resources. Nowadays, the reserve is co-managed by the provincial forest service and local communities, but its conservation status has been modified and its area is probably much less than the original. Several factors affect the conservation status of this reserve namely: clearing for agriculture, migratory pressures from war and timber harvesting of the more valuable species (such as Umbila, Chanfuta and Pau-ferro). Despite its degradation status, DFR still presents opportunities for social and economic development through sustainable use of forest resources. This implies a zonation of the area to protect untouched patches of forest while allowing people's activities in other areas. Although experiences of zoning exist in the reserve (Mantilla et al., 2004) there is a need for updating information on forest degradation and define community-based rehabilitation options.

In the case of Djabula, Maputo Province the forest is not totally protected but, part of it is within the Licuát Forest Reserve established in the 1950s aiming at protecting the timber species *Afzelia quanzensis*. In this area the LLS project's main objective is to develop a functional sandalwood bank, which is dependent on a continuous supply of timber for local artisans. However, this objective has been mined by the constant degradation of forest resources by unsustainable charcoal production, which is the main source of income generation for local communities. Clearly like in the Derre Forest Reserve, there is a need to undertake an ecological-based zoning in Djabula forest.

The objectives assigned to this task are (for each site – Djabula and DFR)**:**

1. To identify the extent and nature of forest degradation;

2. To develop a participatory rehabilitation plan;

3. To assess the needs for the establishment of a community nursery;

4. To design specific on-the-job training programs.

2. Institutional and legal framework

3. Methods

To achieve the objectives of this study, a combination o desktop and field work techniques was applied and these are described below.

3.1. Desktop study

A desktop study was conducted aiming at understanding the context of the study areas as well as evaluating land cover changes over time (2003-2009). The first step was a literature review on the history and current status of Derre and Djabula forests. Literature review revealed that there is a wealthy amount of information for both areas as a result of several studies and projects that have run over the years. These provide a good picture of the areas with regards to forest resources and the socio-economic context.

In the second step we conducted a land cover change analysis in order to assess forest degradation. Forests degradation in this study is defined as the partial or total loss of a particular forest type and/or its conversion to an inferior land cover class (lower tree density). Two contemporaneous Landsat images of the years 2003 and 2009 were used. Date selection was based on free images availability from the USGS website (www.glovis.usgs.org). After being co-registered to correct for geometric and orbital distortions, the images were classified using a supervised procedure and a maximum-likelihood statistical method in Erdas 9.2.

Land cover change was performed by using the global land use change matrix method in ArcGIS 9.3. This method crosses the land use maps in 2003 and 2009 by overlaying and comparing them *pixel by pixel*.

For comparison purposes, land cover classification nomenclature used in this study is the same adopted in previous studies (Mantilla *et al.*, 2004 and Geodata, 2009). The vegetation classes used in each area are presented in Table 1.

Table 1. Vegetation types in Djabula and Derre Forest Reserve.

Study area	**Vegetation class**
Djabula (Geodata., 2009)	• Pradaria (grasslands) • Open semi-deciduous forest • Deciduous Forest • Thicket
DFR (Mantilla *et al.*, 2004)	• Dense Forest • Median density Forest • Low density forests • Agriculture

Following the land cover analysis for the year 2009 and based on previous studies (Soto *et al.*, 2000 and Mantilla *et al.*, 2004) we performed a zonation using editing tools in ArcGIS 9.3. For both areas, zoning was performed on the basis of the existing forest resources and the need to protect and/or rehabilitate them. Each zone represents a different degradation level and thus, varied rehabilitation requirements.

Fire has been pointed out as one of the main degradation factors in Mozambique in general and, in the study areas in particular (Mantilla *et al.*, 2004 and Geodata, 2009). Fire is in fact a cheap and accessible management tool that is commonly associated with human activities such as: shifting cultivation, honey collection, hunting, among others. In order to evaluate the extension of this phenomenon in the study areas, we collected information on fire incidence over the period of 8 years (2003-2010). The number of fires for each year was extracted from 1-km MODIS Active Fire product that provides a daily composite of active fires.

3.2. Field assessment

A Field assessment was conducted for each land use land cover zone aiming at characterizing their ecological situation and identifying appropriate rehabilitation measures. We conducted 500-m long transects and within it, established 20x50 m sampling plots every 100 m that means 5 plots per transect or 0.5 ha sampling per transect. The selection of transect sampling method is justified by the need of observing transitions among land cover class or zone. In each transect we collected information on vegetation (species composition, abundance and Importance Value Index-IVI) and fauna (abundance and observation of footprints, sounds and other signals). Any sign of forest degradation was recorded along the transect namely: presence of invasive species, presence of species typical of early stages of succession and abundance of natural regeneration. Soil chemical and physical data were collected and analyzed for texture, pH, organic matter, Carbon, Nitrogen and Phosphorous contents.

Informal and formal conversations as well as a participatory mapping were conducted in both sites. The purpose of these procedures was assess local people's capacities and weaknesses to implement the program, training needs and to raise awareness of the importance to conserve their forest resources.

4. Results

The results of forest cover change and fire incidence are presented in this section, along with an ecological characterization and the rehabilitation recommendations for each zone. The latter includes the implementation strategies, a monitoring plan, an evaluation of local capacities and weaknesses to implement the program and the training needs. This section intends to be independent for each study site.

4.1. FOREST LAND DEGRADATION ASSESSMENT AND REHABILITATION PROGRAM FOR DERRE FOREST RESERVE

I.

1. Brief characterization of Derre Forest Reserve

Derre Forest Reserve (DFR) was established in 1950 in an area of 170,000 ha with the objective of protecting commercial timber trees, especially *Pterocarpus angolensis* (Umbila) and *Swartzia madagascariensis* (Pau-ferro). The reserve has suffered from several processes of degradation over time as a result of increasing shifting cultivation, fire and (illegal) logging. There is a wealthy amount of information for DFR such as Cruz (2001), Mantilla *et al.* (2004), Machele and Mantilla (2004), Sedano (2004), among others. Most of this information was produced as part of the Sustainable management project (PMSR), which aimed at promoting community –based sustainable forest management. In 2004 IUCN initiated the Livelihood and Landscape Strategies Program (LLS) that intended to alleviate pressure over forest resources, by promoting several alternative activities (fisheries, honey and carpentry). Considering the amount of information for this area, this report only characterizes briefly DFR and further details can be found in the referred reports.

DFR belongs to the districts of Morrumbala and Mopeia in Zambézia Province between longitudes of 35.78º and 36.27º East and latitudes of 16.98º S and 17.45º S. The topography is gentle and the altitude ranges from 300 m in the north to 800 m in the south. The river network is rich, being the main permanent rivers: Lumba, Muelidi, Lima and Lualua.

The total number of people living inside the reserve is about 20,000 distributed in 4 main communities: Galavi in the north, Golombe in the center, Guerissa and Chilo in the south. There are also 6 neighboring communities (Nhanzasa, Maticula, Mayama, Mylombe, Mecanga and Machindo) that depend on the resources inside the reserve, which adds on to the pressure to the forest resources. Main activities of these communities include: agriculture (rice in lowland wet soil known as indimba, beans, groundnuts and cassava in sandy soils known as cotócua and cotton, maize, sorghum and cassava in heavy soils known as saiboro), forestry (thatch grasses, bamboo, ropes, reeds, firewood, construction material, among others). Logging is forbidden in the reserve but, some inhabitants get involved in illegal logging as an alternative source of income. Other activities include: cattle production (goats, chicken, etc), carpentry (using residues from logging or timber caught from illegal logging), handcrafting (basketry, etc), among others. Commerce of crop products and other basic stuff is observed across the reserve. It is worth mentioning the existence of the Associação Comunitária da Defesa e Saneamento do Meio Ambiente do Derre

(ACODEMADE) created as part of the PMSR project. ACODEMADE congregates several groups of interest (carpenters, fishermen and artisans). Its main task is to promote conservation of natural resources. Although the existence of this institution can be considered a strengthen in this area, ACODEMADE needs to be capacitated in order to improve its expression in the area.

The forests of DFR belong to sub-humid deciduous miombo dominated by *Brachystegia spciformis*, *B. boehmii* and *Julbernardia globiflora*, associated with different soil types. Other species of importance ar in this area are: *Sclerocarya birrea, Pterocarpus angolensis, Burkea africana, Millettia stuhlmannii, Swartzia madagascariensis, Combretum imberbe* and *Pericopsis angolensis*. According to Mantilla *et al.* (2004) in 2004 forest cover had diminished over the years as a result of the expansion of agriculture and almost every forested area was interspersed by agricultural plots. Intact forest (LF1) constituted in 2004 only 5% of the reserve, while secondary forest and of median to low tree density in different regeneration stages comprised 40% of the area (Mantilla *et al.*, 2004). The authors referred that anthropogenic fires were one of the most damaging factors in the reserve. Consultation to the local communities as well to Matilla's work indicates that forests are still of high value to local people. In fact, a part of land for agriculture forests are a good source of food (fruits and meat), medicines, construction materials, fuel wood, ropes, cultural value, among others (See Mantilla *et al.*, 2004 for detailed information on specific species utilization).

2. Vegetation cover changes over 7 years

Figure 1 reveals that most of the DFR (42% in 2003 and 50% in 2009) is covered by median to low density forests (light green color in the map). As referred above, these forests represent not only natural forests, but also different transition states after some kind of forest intervention (agriculture or logging). It is worth noting the reduction in agriculture/herbaceous fields (from 22% in 2003 to 15% in 2009- blue colors in the map) and the increasing in fallows or regenerating fields (from 15% in 2003 to 20% in 2009-yellow color in the map). The combination of these results indicates that in a way, the agriculture frontier is slowly decreasing, while at the same time, abandoned fields are regenerating. From the point of view of forest recovery this result is promising as it indicates that by eliminating and/or reducing the advance of agriculture frontier may be sufficient to reestablish forests in DFR.

There was a slight decrease in dense forest cover from 15% in 2003 to 11% in 2009, which according to the global land use change matrix, results from a conversion of 12% of dense forests into median to low density forests about (Table 2). This conversion is particularly evident in the

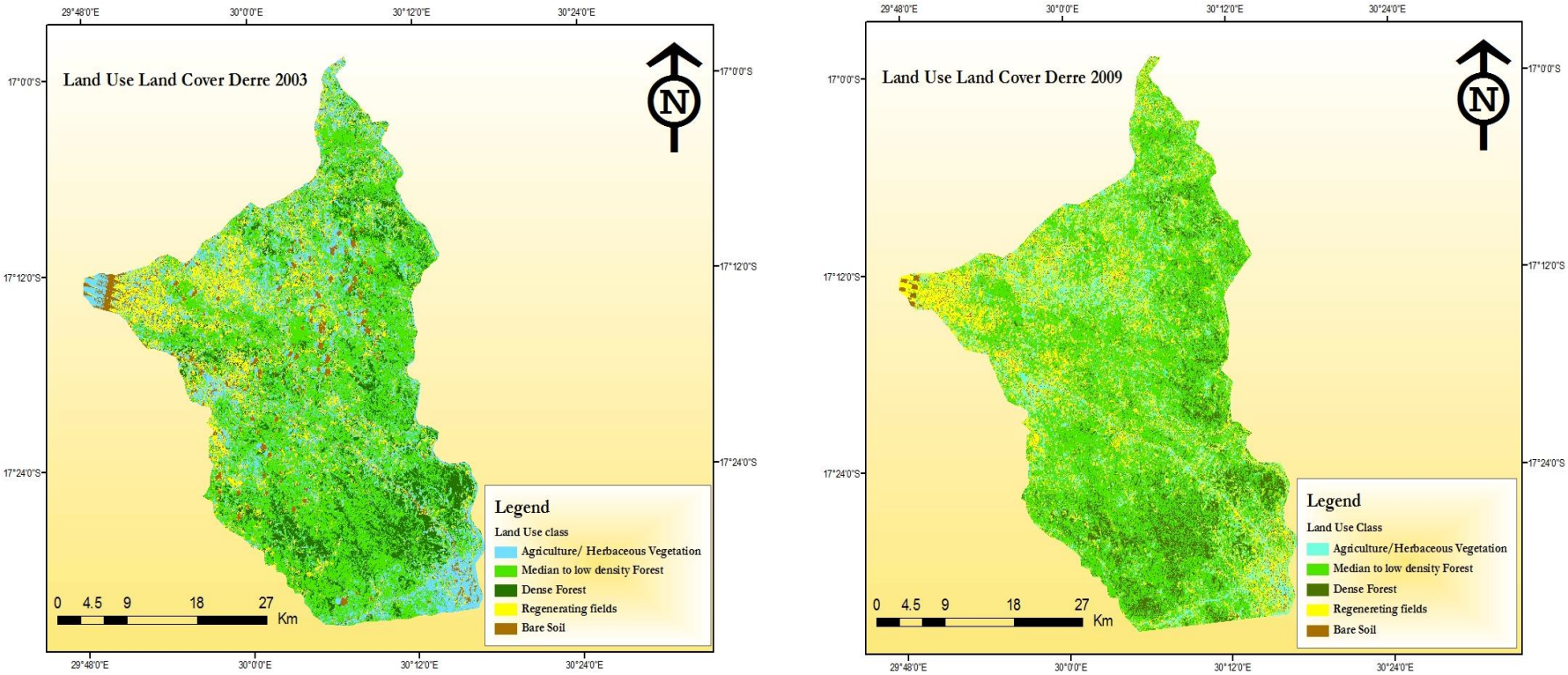


Figure 1. Land use land cover maps of the year 2003 (left) and the year 2009 (right).

south of the reserve. Causes associated to this result might be a combination of logging, fire and or charcoal production that is evident in southern DFR.

About 50% of the median to low density forest class was maintained over the course of 7 years, and this is most probably caused by a combination of regenerating fallows (36%) and decreasing of dense forests (12%). About 34% of bare soils in 2003 were converted into regenerating fields in 2009. Again, these results are an indication of the regenerating capacity of the forests in this area.

Table 2. Global land use area change matrix 2003 (columns) and 2009 (rows).

	2003				
2009	**Dense Forest**	**Median to low density Forest**	**Regenerating fields**	**Agriculture/ Herbaceous Vegetation.**	**Bare Soil**
Dense forest Forest	**32.88%**	11.92%	1.58%	0.90%	2.75%
Median to low density Forest	45.13%	**68.69%**	35.66%	30.73%	26.61%
Regenerating fields	12.97%	11.15%	**36.55%**	31.28%	33.79%
Agriculture/ Herbaceous Vegetation	7.18%	6.94%	21.99%	**31.12%**	29.37%
Bare Soil	1.51%	0.99%	3.63%	4.90%	**6.82%**

3. Fire incidence

The number of fires in DFR between the year 2003 and 2010 estimated from MODIS active fire product ranges between 500 and 900 a year (Figure 2).

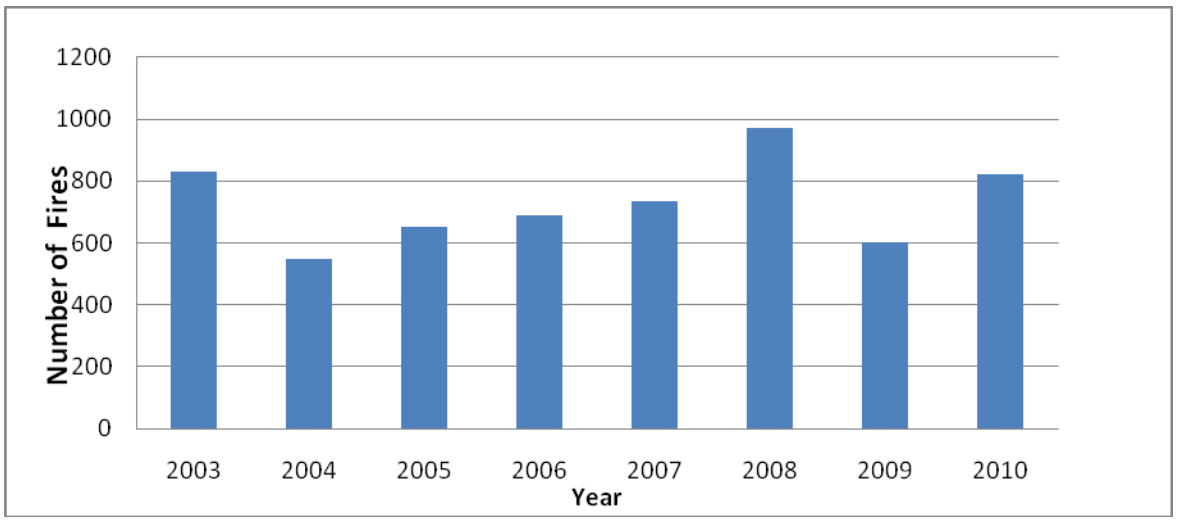


Figure 2. Number of fires between 2003 and 2010 in Derre Forest Reserve.

In general fires are spread all over the reserve and there's no particular place where fire incidence is consistently incident over time, but fire density ranges from around 4 fires/m^2 to more than 20 fires/m^2 (Figure 3). This is expected since, fire is associated with human activities especially opening land for agriculture, honey collection and logging (fire has been reported as the main tool improve visibility for tree identification and selection) and people is spread all over the area. Figure 3 also reveals that in 8 years almost every place in the reserve has burned at least once a year (sometimes more than once).. In fact, during the field visit, almost all measured transects had signs of recent fires (less than a year). This is of particular concern for areas where plantation of native forest species is recommended (see section 5 for details), which may be unsuccessful due to high fire incidence.

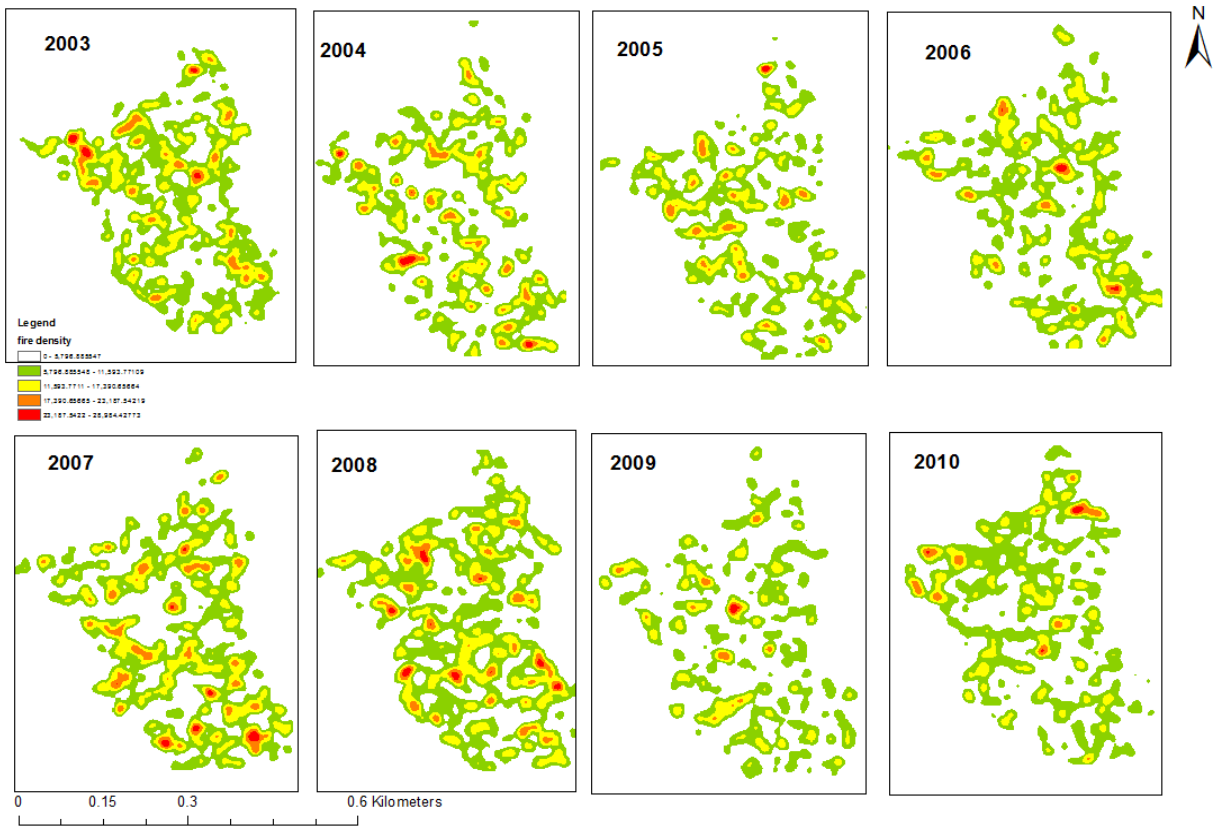


Figure 3. Fire density in Derre Forest Reserve between 2003 and 2010.

4. Degradation Assessment

According to the classified Landsat image of 2009 (Figure 1) and following Mantilla *et al.* (2004) there are three distinct zones in DFR (Figure 4):

1. Integral protection zone;
2. Rehabilitation zone;
3. Agriculture and settlement zone

These zones have different characteristics and thus, varied rehabilitation requirements. In the next sections we first describe the current situation followed by proposed activities for rehabilitation.

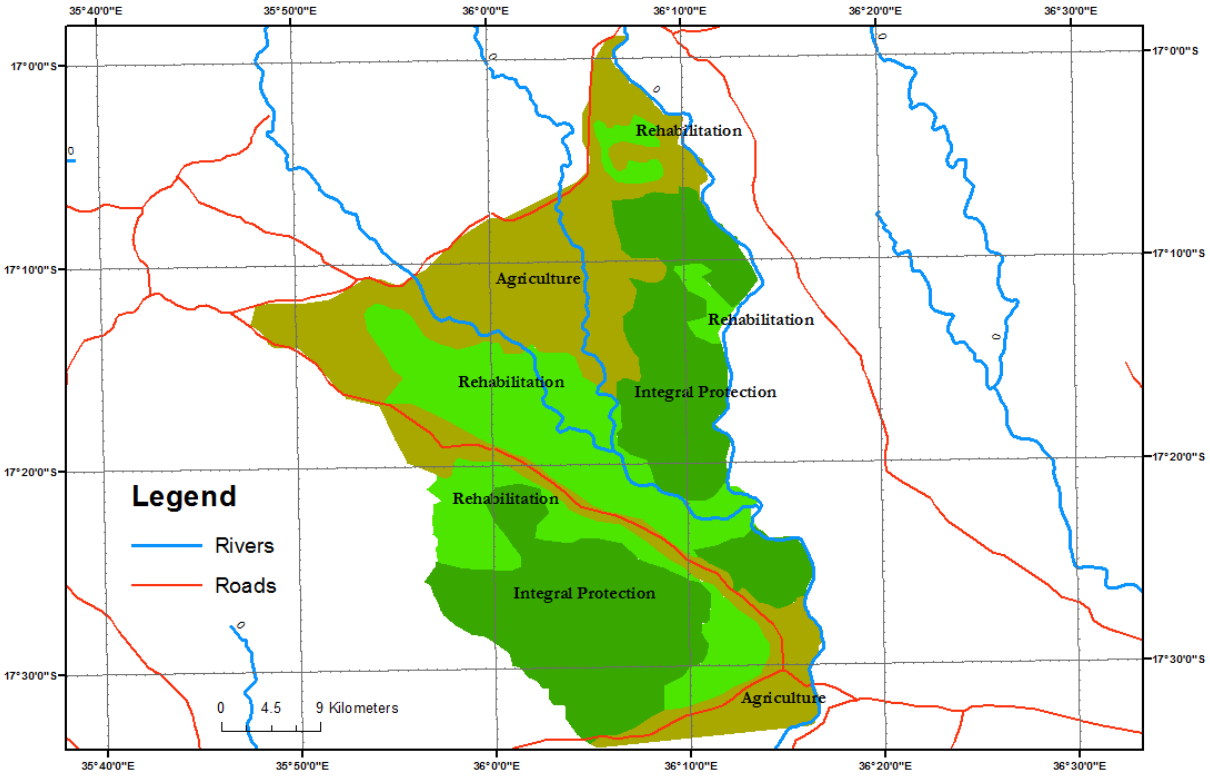


Figure 4. Zoning of land use in Derre forest reserve.

Zone 1: Integral Protection zone

This zone corresponds to the last remnants of dense forest in DFR, which are places that during the period of 7 years (2003-2009) of this analysis maintained a relatively stable dense forest cover. The forests in this zone were classified by Mantilla *et al.* (2004) as *Dense forest class and median density forest class* and are located in the south (of the road to Morrumbala) and northwest of the reserve (along of the Lualua River) in areas of difficult access and deep soils (Figure 4).

Field evaluation revealed that the forests are typically sub-humid miombo woodlands of median to high density with three forest strata: the upper stratum dominated by tree species of about 15 m to 20 m high, the middle stratum of about 7-10 m high dominated by small trees and shrubs and, the lower stratum is sometimes absent but when present is composed of herbaceous and grass species.

The transect in the northwest area (close to the Lualua river) indicates that the forest is still in a good condition (canopy cover of 40-60% and average tree height of 10 m but there are trees 18 m high). The Importance Value Index (IVI) calculated for this transect indicated that the ten most important tree species are: *Brachystegia boehmii* (IVI=71)*, Burkea Africana* (IVI=26), *Pterocarpus angolensis* (IVI=21), *Diplorynchus condilocarpon* (IVI=21), *Albizia antonisiana* (IVI=18), *Julbernardia globiflora* (IVI=11), *Piliostigma thoningii* (IVI=10), *Xeroderris stuhlmannii* (IVI=9), *Diospyrus kirkii* (IVI=9), *Combretum collinum* (IVI=8) and *Afzelia quanzensis* (IVI=7). An evaluation of natural regeneration in indicates that main tree species are regenerating being J. *globiflora* with 18 seedling, the most promising one, followed by a combination of other tree species such as: *P. angolensis, B. boehmii, Pseudolachnotylis maprouneifolia, Hymenocardia acida, Pteleopsis myrtifolia, B. africana, D. condilocarpon*, among others. Herbaceous, vine and grass species abundant in this area include: *Acalypha vilicaulis*, *Hypharrhenia dissolute, Ozoroa insgnis, Ossimum sp., Phyllantus niruris, Cognaughtia squarrosa, Senna mimosoides, Cissus integrifolia, Phyllanthus reticulatus, Hipoxis sp., Cymbopogon escavatus, Setaria incrassata, Hypharrenia dichroa, Hypharrenia anaema, Asparagus africanus, Panicum sp., Eriosema sp., Abrus precatorius, Zamiocucas zamiofolia and Asparagus plumosos.* Half of the transect crosses the Nacôe River, which is a permanent affluent of the Lualua River. The riverine forest in this portion of the river is a very dense forest with dominance of tree species of very big dimensions such as: *Khaya anthoteca*, *Afzelia quanzensis*, among others.

The transect in the south revealed also a dense forest, but with some human interference, since the transect initiated (first 150 m) in farmlands but the last portion of it corresponds to a dense forest with canopy cover between 40-60% and average tree height of 13 m. The 10 most important tree species found in across this transect are: *Margaritaria discoidea* (IVI=66), *Millettia stuhlmannii* (IVI=36), *Sclerocarya birrea* (IVI=28), *Pteleopsis myrtifolia* (IVI=27), *Brachystegia spiciformis* (IVI=20), *Afzelia quanzensis* (IVI=19), *Julbernardia globiflora* (IVI=18), *Bauhinia petersiana* (IVI=12), *Combretum collinum* (IVI=10) and *Tabaernamontana elegans* (IVI=9). Natural regeneration is also diverse dominated by *Margaritaria discoidea* with 60 seedlings, followed by *Julbernardia globiflora* with 30 seedling, *Xylotheca tetensis* (10) and *Millettia stuhlmannii* (8). GRASS AND HERBACEOUS?

The soils of these areas are ……

Both transects present signs of human presence such as logging tracks in the northern transect, fire signs and agriculture activity in both north and south transects. According to local people, less

degraded forests are preferred to collect forest resources (fruits, honey, medicines, etc) because of their higher availability as compared to more degraded areas. Thus, activities in this zone should consider for example, alleviation of the pressure over forest resources.

Zone 2: Rehabilitation Zone

This zone corresponds to low density woodlands (sometimes canopy cover lower than 40%), identified by Mantilla *et al.* (2004) as *thickets*. In general they represent fallow areas with different regeneration levels, but also areas that have been intensively logged.

We conducted three transects in this area, in the north, center and south portions of the reserve. In the northern portion the 10 most important species are: *D. condilocarpon* (IVI=45), *Sterculia quinqueloba* (IVI=27), *J. globiflora* (IVI=27), *P. maprouneifolia* (IVI=22), *Strychnos sp.* (IVI=20), *A. quanzensis* (IVI-18), *Brachystegia boehmii* (IVI=18), *Combretum collinum* (IVI=16), *Terminalia sp.* (IVI=14) and *Dalbergia sp.* (IVI=14). Natural regeneration of tree species is relatively poor and dominated by *Stegamotaemia araliacea* with 19 seedlings, followed by *D. melanoxylon* with 9 seedlings, *D. condilocarpon* with 7 and *B. boehmii* wit only 7 seedlings. The transect presents several signs of degradation with several patches dominated by tall grasses (*Panicum sp., Urochloa mossambicensis, Eragrostis ciliaris* and *Hypharrenia sp.*) and several herbaceous species (*Lippia javannica, Axiranthus sp., Blumea alata, Phyllanthus amara, Acalypha vilicaulis, Adenia gumifera*, among others). Soils….

The transect in the center is dominated by *B. boehmii* (IVI=53), *D. condilocarpon* (IVI=52), *Pterocarpus rotundifolius* (IVI=38), *Acacia nigrescens* (IVI=27), *Combretum collinum* (IVI=19), *Terminalia sp.* (IVI=17), *X. stuhlmannii* (IVI= 13), *Combretum sp.* (IVI= 11) and *Crossopterix fibrifuga* (IVI= 8). At the regeneration level the main woody species dominating the area are: *B. boehmii* with 31 seedlings, followed by *P. rotundifolius* with 9 seedlings and *J. globiflora* with 8. Soils…

In the south, the transect revealed that the most important species are: *B. spiciformis* (IVI=42), *Strychnos sp.* (IVI=31), *Millettia stuhlmannii* (IVI=31), *D. condilocarpon* (IVI=27), *B. africana* (IVI=22), *Albizia antunesiana* (IVI=22), *Parinari curatelifolia* (IVI=19), *Pterocarpus angolensis* (IVI=17), *P. maprouneifolia* (IVI=14) and *Albizia versicolor* (IVI=14). Natural regeneration of tree species is dominated by: *M. stuhlmannii* with 17 seedlings, followed by *B. boehmii* with 8 and *A. quanzensis* with 7 seedlings. Soils…

The three transects present several signs of human interference such as patches of median density forest intermediated with fallows, cassava fields and rice pads. The fallows are dominated by grasses and herbaceous species and regeneration of *B. boehmii* and *J. globiflora*, but also *D. condilocarpon* and *Stegamotaemia araliacea*. Fire incidence was also found in each transect.

In comparison with integral protection zone, this zone has lower species diversity and size of the trees at the adult stage but, higher species diversity of trees at the regeneration level. Due to its degradation level this zone represents a less attractive area to local communities for medicine, food, construction materials, etc. However, people in desperation for supply their livelihoods rely also on these areas for forest products, imposing additional pressure over the forest resources.

Zone 3: Agriculture and settlement

This zone is the most degraded area and was identified by Mantilla *et al.* (2004) as *agricultural and other uses class*. We included here in this zone a buffer of 500 m to each side of the road to Morrumbala (Figure 4). The vegetation type is very low density woodlands (sometimes canopy cover lower than 20%) and recently or currently cultivated areas. It also corresponds to heavily populated areas.

Field assessment indicates that vegetation cover is very scarce at some places and agriculture is the main activity. In some places where natural vegetation persists several typical miombo species are observed but the species diversity is low . For example the central transect presents only 11 species: *B. boehmii* (IVI=90), *Lannea stuhlmannii* (IVI=29), *B. africana* (IVI= 25), *S. birrea* (IVI=24), *S. quinqueloba* (IVI=23), *Ficcus sycomorus* (IVI=22), *Ozoroa insignis* (IVI=22), *Albizia antunesiana* (IVI=16), *P. angolensis* (IVI=16) and *M. stuhlmannii* (IVI=16). The transect in the south presented only one species (*F. sycomorus*). In the north the transect fallen in fallow area abandoned a long time ago (in the 1980's). It presents higher tree species diversity (33) dominated by: *P. rotundifolius* (IVI=29), *C. collinum* (IVI=27), *B. spiciformis* (IVI=24), *B. boehmii* (IVI=18), *Anonna senegalensis* (IVI=17), *Terminalia sp.* (IVI=17), *Piliostigma toningii* (IVI=12), *B. africana* (IVI=12) and *S. birrea* (IVI=11). The natural regeneration is very diverse in the area (more than 15 species were found), but with no particular dominance of any species. Soils….

Due to its high level of degradation, this area has particular value for agriculture for local communities. In fact, this area should be allocated to develop and improve agricultural activities and we recommend several optimized agricultural activities described below.

It's worth mentioning that signs of fauna were not found in any transect in DFR.

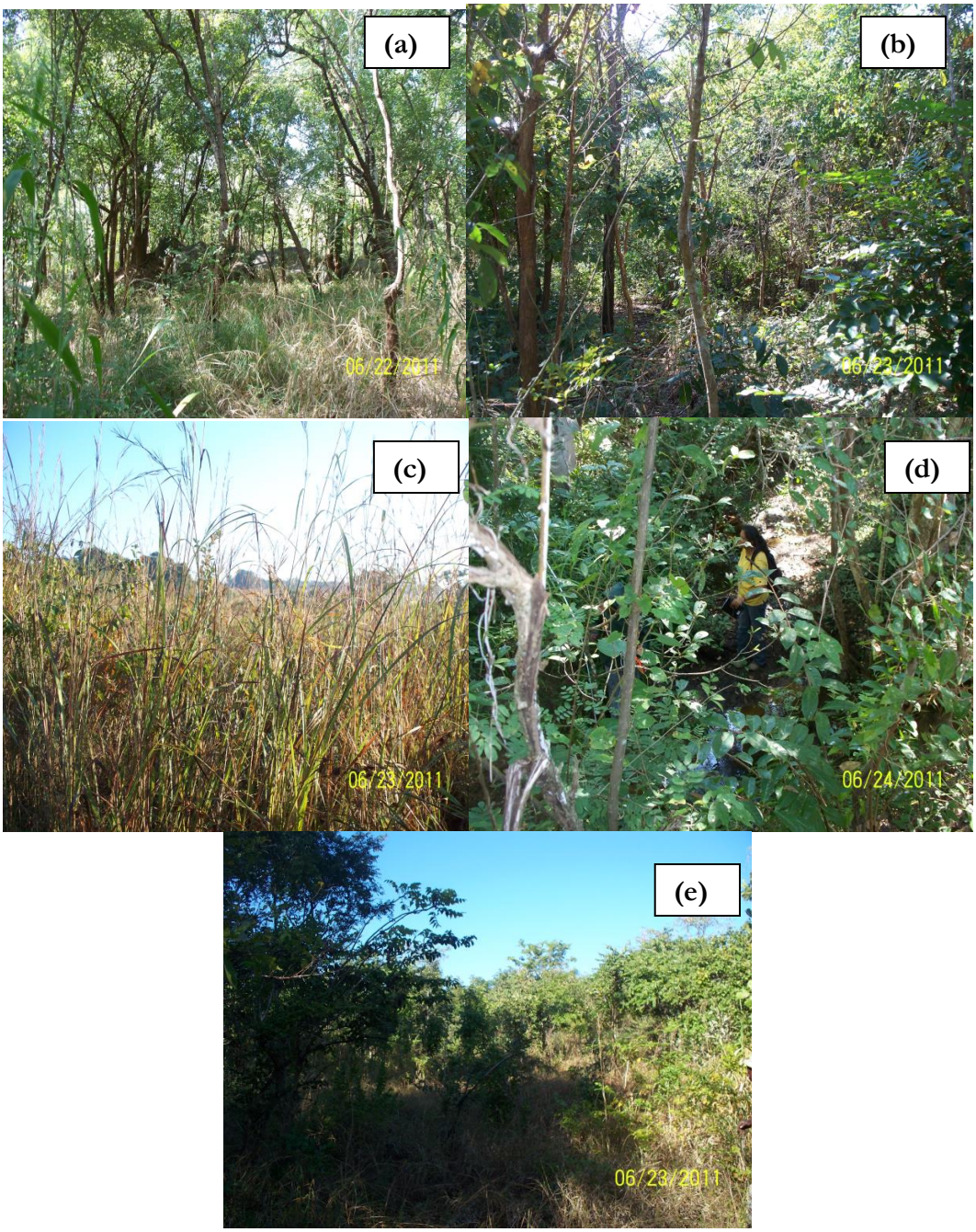


Figure 5. A representation of the main land cover types in Derre Forest Reserve: (a) and (b) dense forest; (c) recent fallow; (d) riverine forest; (e) old fallow.

5. Rehabilitation Program

In this section we present several activities to rehabilitate or manage each zone described above. Rehabilitation activities are essentially technical but, an analysis of local capacities and weaknesses, training needs and strategies for implementation are also presented. Recommended activities intend to be simple from the point of view of their implementation and monitoring by the local communities (annex XX presents a list of simple monitoring indicators that can be used by local people).

5.1. Proposed rehabilitation activities

Integral protection zone

The remnants of high density forest present a good conservation status but they have decreased over time, as demonstrated in section 2. Currently these fragments represent the last remnant of dense forests in DFR and as such, they have to be protected to guarantee their function of conserving biodiversity, hydrographic network and soil conditions. Thus, in this area it is highly recommended the elimination of major disturbance factors such as: shifting cultivation, frequent fires and logging. This will allow the natural ecological processes of seed dispersal, plant species regeneration, nutrient cycling among other to naturally proceed. The task of removing anthropogenic activities has proved to be a difficult if not impossible task especially when alternative sources of income are scarce. The implementation strategy (Section 5.2) gives some recommendations on how to deal with this issue.

There is a small forest remnant in the southwest portion of the reserve, where intervention is needed to avoid further loss of this intact patch. To achieve this objective, we recommend connect this patch with a larger remnant located to the north of it through a biological corridor (Figure 4). Biological corridors are strips of vegetation that intend to connect forest fragments allowing for migration and dispersal of fauna and flora species. This is particularly important for miombo species that have low seed dispersion range (not more than 100 m from the mother tree). The type and extension of biological corridors depend on the matrix that involves the fragments. In the case of DFR, the matrix is a combination of low density forest and agriculture and thus, the proposed

corridor is in the class of stepping stones. This type is recommended when the contrast between forest fragment and matrix is not prominent and it is also cheaper. The idea is to establish five small groups of about 0.5 ha of native species. Recommended species for this strategy are: *Strychnos spinosa*, *Afzelia quanzensis*, *P. maprouneifolia* and *P. thoningii*. Criteria for species selection are: 1) species abundance in the fragments; 2) growth speed; 3) attractiveness to fauna and 4) provide resources to people. A combination of these criteria will allow acquisition of propagation material, while at the same time guarantee rapid land cover and improve fauna income. The time span needed to fully complete this activity is about 6-7 years, considering establishment and initial recover of natural processes.

Extractive activities from local communities such as non-timber forest products (medicines, food, and firewood, among others) may be allowed as long as they are only for subsistence and of low intensity. A detailed study on current uses and projected sustainable uses of NTFP in DFR is recommended.

Rehabilitation zone

According to Mantilla *et al.* (2004) this zone's main function is to protect or rehabilitate degraded forests while at the same time it has the potential to provide local communities with forest products (timber and non-timber) for local subsistence. Agriculture may be allowed in some restricted areas such as in the surroundings of settlements.

At the current level of degradation these forests are not able to provide their function of soil and water protection. For example, at some places the riverine forest has disappeared and in hilly sites signs of erosion (gullies, etc.) are present (Mantilla *et al.*, 2004). At the same time the fauna and flora biodiversity is significantly reduced, revealing its lower capacity to recover naturally as well as to provide resources to local communities. Consequently, this zone requires a large piece of intervention in DFR if forest functions are to be maintained. Recommended rehabilitation activities are:

1. Restoration of riverine forests: As described in section 3 the remnants of riverine forests are dominated by *Khaya anthoteca*, *A. quanzensis*, *S. quinqueloba*, *Strychnos sp.*, *M. stuhlmannii* among others. In order to achieve the objective of protecting water and soil resources it must be considered a priority for DFR to restore this ecosystem. In order to achieve this, we

recommend a plantation that mimics the natural environment by using the dominant species above referred. These species have demonstrated elsewhere (for example in Gorongosa National Park) to be fast growing and to restore soil properties. These are also attractive to fauna, which will accelerate the process of seed dispersal. The recommended plantation design is in the form of isolated plants species spaced 2-3 m, planted at about 10-20 m from the water course. Planted rows will connect riverine forest fragments. Since these areas are of important water sources to people, we recommend the establishment and maintenance of points for water collection as well as prohibiting agricultural activities in a radius of 50 m for each side of the rivers.

2. Buffer zone of 2 km around integral protection zone: this buffer will circulate the forest fragments, where agriculture should be eliminated but forest extraction at subsistence level can be allowed. The radius of 2 km was selected considering that most miombo species are wind-dispersed and their dispersion distances are between 100 m and 2 km from the mother tree. Thus, within this distance it is expected that a simple elimination of disturbance factors will allow natural regeneration to occur. Monitoring of these areas should be done by establishing seed trappers (wooden frame of 1 m^2, with a **net** at the bottom and at 1m from the soil) to analyze the amount of reproductive material that reaches the trapper. These could also serve the function of providing material for the plantation work.
3. Plantation at strategic places: at some places (highly exposed and with signs of erosion) we recommend a plantation with the following native species: *A. quanzensis*, *P. angolensis*, *S. madagascariensis*, *P. maprouneifolia* and *M. stuhlmannii*. These were found in the area (both in intact forests and disturbed areas) and thus, the possibility of acquiring reproductive material is facilitated. The distribution of forest plantation plots (in small islands of about 0.5 ha) dispersed across the area will minimize the costs while, at the same time, guarantee landscape connectivity. Since plantation is an expensive activity we recommend its establishment in phases between the third and fourth years. From year 1 to 3, reproductive material should be collected, tested and produced.

Agriculture zone

In this zone the level of degradation is so high that we recommend confining agriculture activities in this zone. However, additional work for water and soil protection should be conducted especially riverine forest restoration following prescriptions for degradation level II. Conservation agriculture

including: water and soil conservation, integrated pest management, crop rotation, agro-forestry systems, among others is highly recommended. Water being the main limitation, simple irrigation schemes and water collection techniques must be promoted in the area.

5.2. Implementation Strategy

To successfully execute this program a strategic implementation should be adopted. This implies prioritizing actions, establish wise partnerships among different actors and define their responsibilities. The following recommendation will facilitate the implementation of this plan:

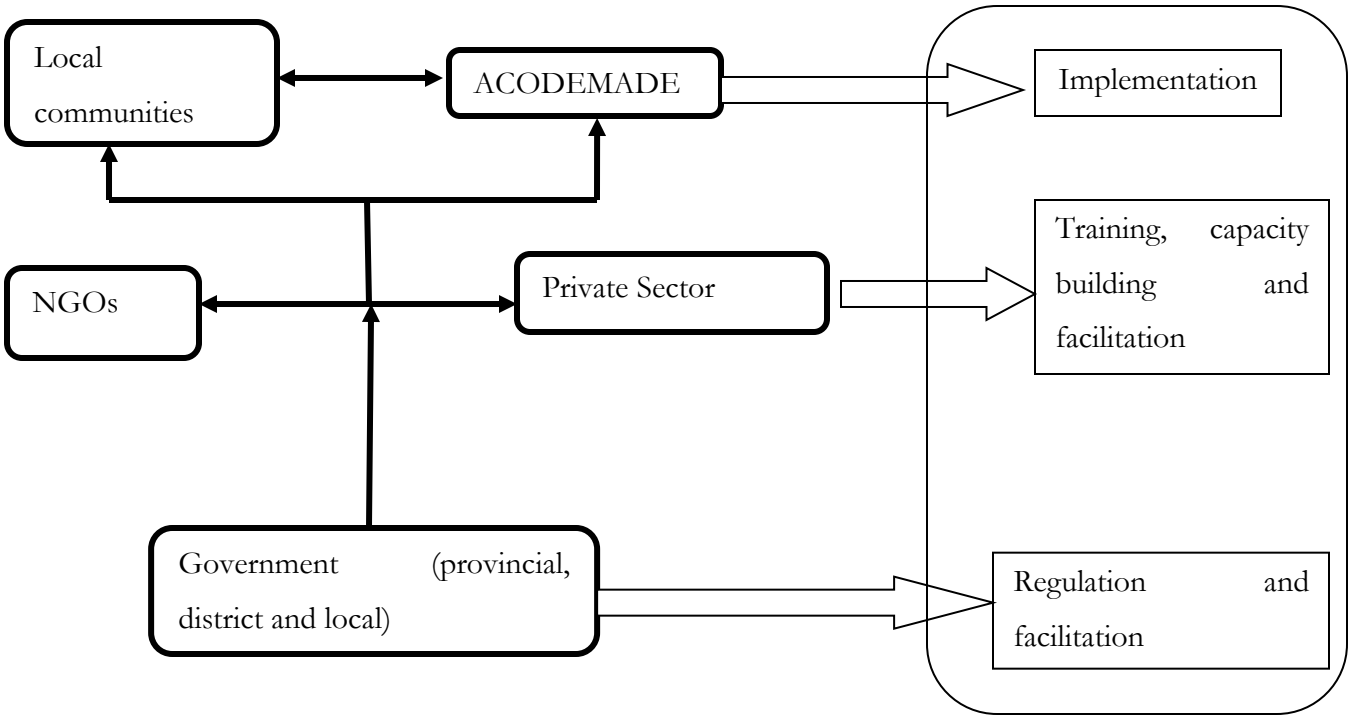
1. **Prioritize activities**
    a. Produce a light version of this plan, which must include the maps, schematic representations of propose techniques and minimal text explanation of some activities.
    b. In order of decreasing importance the most important actions are: (i) creation of appropriate mechanisms of penalization and reward mechanisms; (ii) promotion of conservation agriculture; (iii) protection of water courses through restoration of riverine forests; (iv) connectivity of forest remnants; (v) plantation is places that present signs of erosion; (vi) establishment of small plots of forest plantation at specific places within degradation level II. A chronogram of activities is presented in Table 3.
2. **Attribute responsibilities to existing institutions**
    a. **Local communities**: they are the owners of this program and must have complete knowledge and understanding of proposed activities. They should be responsible for program's implementation, monitoring as well as reporting to government institutions. To facilitate this process, the jurisdiction area of each community is defined and the communities should be responsible for reporting ongoing activities within that area.
    b. **ACODEMADE**: The main objective of this association is to promote environmental conservation. Thus, ACODEMADE has the responsibility of rising awareness and promoting this program's implement. It also has an important role in the monitoring process including the discussion about appropriate indicators.

Another important role of this institution is to establish a link between the government and NGOs.

c. **NGOs and private sector**: this sector should promote the implementation of this program through several actions including: (i) training; (ii) rising awareness; (iii) promoting fund rising; (iv) developing local capacity on team work and pro-active attitude towards the environment; (v) promoting alternative sources of income.

d. **Government:** this structure is represented at different levels through the Administrative post (Chefe), district (SDAE) and provincial governments (SPPFB). These institutions' main responsibility is to guarantee application of the existing policies, through among others: (i) support local institutions; (ii) advice on best practices; and (iv) define appropriate penalization or rewarding mechanisms.

The schematic proposed articulation among these institutions is as follow:



5.4 chronogram of activities and monitoring plan

Table 3 indicates the chronogram of activities to implement this rehabilitation program for a period of five years. Monitoring of rehabilitation techniques should be a frequent activity during the implementation phase and this should follow the monitoring plan presented in Table 4 below and the indicators in Annex XX.

		YEAR				
Activity	**Priority**	**First**	**Second**	**Third**	**Fourth**	**Fifth**
Restoration of riverine forests	I					
Conservation agriculture and fallow improvement	I					
Biological Corridors (Stepping stones)	II					
Plantation in strategic places	III					
Natural regeneration	IV					

Table 3. Chronogram of activities

Table 4. Monitoring plan for suggested rehabilitation activities in Derre Forest Reserve.

Zone	Rehabilitation activity	Priority	Implementation strategy	Indicators for monitoring	Monitoring frequency	responsibility
I	Biological Corridors (Stepping stones)	II	Establish stepping stones between fragment I and II first (figure X)	• Growth of planted species (height, dbh) • Abundance of animal species • Abundance of natural regeneration and adults	• Once a year • First year and then every 3 years	Communities and ACODEMADE supported by NGOs
	Natural regeneration	IV	• Regulate activities (agriculture and extraction) in forest fragments by a combination of rising awareness and law enforcement techniques; • Develop a buffer area of 2 km surrounding forest remnants and	• Abundance of natural regeneration and adults	• First year and then every 3 years	Government supported by NGOs for activities regulation on these areas

			regulate activities to promote natural recovery			
II	Restoration of riverine forests	I	Establish plantation along the main rivers to connect intact forest remnants	• Growth of planted species (height, dbh) • Abundance of animal species • Abundance of natural regeneration and adults • Soil properties (organic matter, pH, nutrient content) • Water quality	• First year and then every 3 years • Every 3 years	Communities and ACODEMADE supported by IUCN/NGOs
	Plantation in strategic places	III	• Select site with evident erosion signs and/or bare to conduct native tree species plantation; • Collect seed and vegetative	• Proportion of planted/natural area • Proportion of Cultivated area • Growth of planted species (height, dbh) • Abundance of animal species	• first two years • First year and then every 3 years	Government supported by IUCN/NGOs for activities regulation on these areas + Communities

			reproductive material from buffers surrounding forest fragments	• Abundance of natural regeneration and adults • Soil properties (organic matter, pH, nutrient content)	• Every 3 years	and ACODEMADE supported by IUCN/NGOs for monitoring
III	Conservation agriculture and fallow improvement	I	Promote conservation agriculture practices	• Number of farmers implementing conservation agriculture • Crop yield • Abundance of natural regeneration in fallow	• Second year • Every 3 years	Government supported by IUCN/NGOs for activities regulation on these areas + Communities and ACODEMADE supported by IUCN/NGOs for monitoring

Note: Local people have identified, for each zone, their own regulation for the use on forest and wildlife resources (Mantilla *et al.*, 2004).

5.4. Local capacities and weaknesses

Main local capacities that will support the implementation of the proposed program are:

- Existence of a local association (ACODEMADE). This association is a local initiative, which provides a good foundation to implement any activity. However, there is still a need to define its role in the context of forest resources management and protection;
- Knowledge of forest resources. There is relatively good information regarding to forest resources, which is the result of one forest inventory, one Msc Thesis, and one zoning of the area.
- Existence of some local knowledge on species ecology and propagation and local capacity (human, physical and materials) to produce plants locally.
- Existence of formal and traditional administrative structure, which may help disseminating laws and regulations. Some training activities are needed.
- Experience on working with NGOs such as ORAM, IUCN and RITA project.
- Existence of community agents and scouts responsible for dissemination of good practices for natural resources management and patrolling forest activities.
- Some knowledge of conservation agriculture practices such as cultivation in grooves and ridges observed in almost all area.
- Existence of some remnants of dense intact forests.

Main local weaknesses that may undermine the establishment of this rehabilitation program include:

- Extreme poverty conditions that make local people highly dependent of forest resources and shifting cultivation;
- Lack of alternative sources of income;
- Limited financial independence
- Low commercial value of forest resources
- Limited capacity of the local government to support activities in this plan including monitoring.
- Limited number of NGOs and private sector institutions working in the area. These may play an important role as a platform between the government and local communities.
- Limited number of community agents and scouts (only 4 exist for the 170, 000 ha of DFR).

- Dispersion of local communities throughout the reserve, which may limit the dissemination and training work.
- Limited road network and communication means, which limits patrolling activities.
- Weak decision capacity from local communities on what to do with timber from illegal logging. This decreases the interest of communities to be involved in patrolling actions.
- Emergent charcoal production in southern DFR.

5.5. Training needs

Training on conservation and rehabilitation activities should start even before the beginning of this program's implementation and run throughout the all period of its implementation. The following training needs were identified:

- Rehabilitation program implementation: the light version of the plan should be used to discuss with the communities, strategies for implementation and monitoring and also the support their needs for implementation. Environmental monitoring is one of the main activities of this program and, the main responsibility should be attributed to local communities in coordination with governmental institutions. Box 1 give an example of a short training course on this program's implementation.
- Legal and institutional framework: the success of this plan depends on the understanding of the legal and institutional framework from local communities and governmental authorities. This means that people understand they rights and responsibilities and also, recognize institutions with which they can establish partnerships.
- Institutional organization and dynamics: this kind of training is directed to ACODEMADE, which plays a crucial role in rising awareness and promoting people's involvement in monitoring activities. The success of this depends greatly on the capacity of this association to organize its activities and establish appropriate partnerships with other stakeholders.
- Environmental awareness: people need to be aware of the importance of protecting natural resources in the local, national and international context. Only if people understand the importance of reverting degrading activities as well as of conserving natural resources will then be able to implement proposed activities. The strategy with this issue would be training

of trainers in which the target group (trainer) is ACODEMADE, which will in the future pass the message to local communities.

- Conservation agriculture: conservation agriculture is a type of agriculture that imposes minimum impact to the environment. Thus, regulating activities and conserving resources will require that local communities first understand the concept and then know how to implement it, providing the appropriate tools exist.
- Entrepreneurship Skills: skills like that are extremely important in order that people define their own objectives and also identify alternative sources of income that are compatible with existing resources and capacities, reducing their dependency on external support.

Box 1. Example of a module on this program's implementation

Day 1: general concepts presentation of the rehabilitation program
Day 2: Practice on rapid techniques of degradation assessment
Day 3: rehabilitation techniques proposed in the plan
Day 4: monitoring and implementation
Day 5: field test of monitoring techniques and indicators discussion and modifications to the program

4.2 FOREST LAND DEGRADATION AND REHABILITATION PLAN FOR DJABULA FORESTS

1. Brief characterization of Djabula

The community of Djabula belongs to the locality of Tinonganine, Administrative Post of Bela Vista, Matutuíne District in Maputo Province. The area of the community is located 42 km south of Bela Vista (capital of the district) and 108 km south of Maputo City. The area is limited to north by the Tembe River, to the south and East by the Locality of Tinonganine and to the west by the Patáti River (Geodata, 2009).

There were several studies and activities conducted in this community, most of them during the Licuáti Project coordinated UEM (1997-1999) and the LLS program by IUCN (2007-2011). Apart of those, there have been several initiatives in this area including the livestock program by Helvetas in the 1990s, an activity that was taken over by the project VIDA since 2006. These projects produced a whole lot of information for the community such as: the forest inventory (Brito *et al.*, 1998), the community based forest management Plan (Soto *et al.*, 2000), the status of socio-economy and ecosystems in Djabula (Geodata, 2009), among others. The initiatives also improved local capacity on several issues of natural resources management. The activities proposed in this program are built upon those initiatives, avoiding overlapping and intending to fill the gaps left by them.

The climate in Djabula is dry sub-tropical with a mean annual precipitation o XXX mm and a mean annual temperature of 24ºc. The topography is gentle with altitudes varying between 50 and 350 m. The soils are sandy of low fertility and low water retention capacity. Along the rivers, the soils are clayey of moderate to high fertility, heavy and sometimes saline, which makes them difficult to cultivate. The river network is relatively good in this area, being the main permanent rivers the Tembe, the Mazimenhama and the Patáti rivers. Several ponds and lagoons are scattered across the central and eastern side of the area.

The community of Djabula has 181 families (Geodata, 2009), being more than a half of the population women and each family has an average of 6.2 members (INE, 1999). It is believed that these figures have increased in the last few years, but no updated information was found. The livelihoods of this population are directly related to the forest resources, being the main activities in decreasing order of importance: agriculture, charcoal production, cattle production and extraction of other forest products (medicines, fruits, firewood, etc). Charcoal

commercialization is the main income generation activity, but at the current levels of extraction it is considered unsustainable. In fact, during our conversations and visit to the area, we perceived that adult individual of preferred charcoal tree species (Mfomozi –*Newtonia hildbrandtii*, Xizi – *Margaritaria discoidea* and ncaia -*Acacia nigrescens*) are rare in Djabula.

Sandalwood handcrafting has been promoted in the area as part of the LLS program by IUCN with the idea of alleviating the pressure over forest resources from charcoal production. However, our conservations in the field revealed that this activity is not competitive enough (in terms of time consumption and income generation) with charcoal production to achieve the objective of reducing charcoal activities.

According to Marzoli (2007) 53% of the Djabula area is covered by grasslands with scattered trees of not more than 5 m height and canopy cover of 15-25%. Thirty seven percent of the area is covered by semi-deciduous open forests, 10% by deciduous forests and about 0.6% by shrubby areas. Semi-deciduous and deciduous forests have a canopy cover of 40-50% and the canopy stratum reaches 5 to 7 m. The shrubby vegetation is composed of a dense stratum of shrubs (3-5 m high, more than 65% canopy cover) and emergent trees up to 10 m high (canopy cover of 10-15%). Species diversity is in general low. The grasslands are dominated by *Strychnos spinosa, S. madagascariensis* and *Terminalia sericea.* Other vegetation types are composed by a mixture of several species including: *Afzelia quanzensis, Acacia spp, Combretum spp, Spirostachys africana, Dialium schelechteri* and *Ziziphus mucronata.*

The community-based forest management plan of Djabula (Soto *et al.*, 2000) indicates the volumes, sizes and species that can be used for charcoal production, which does not include the currently exploited species except *M. discoidea.* According to the plan species allowed for charcoal production should be: *Combretum apiculatum, Dischrostachys Cinerea, Margaritatira discoidea* and *Mystroxylom acthiopicum.* These are either permitted by law or abundant in the area. Fauna diversity and abundance are low in the area, being the main specie: Duiker (*Sylvicapra grimmia*), rabbits (*Orictolagus cuniculus*), Reedbuck (*Redunca arundinum*), Sykes' monkey (*Cercopithecus albogularis*) and several bird species. Hunting is one of the livelihood strategies but, people reported that the numbers have been decreasing over the years as a result of forest degradation and climatic changes.

2. Vegetation cover changes over 7 years

Land use land cover dynamics was very high in Djabula during the 7 year-period of this study as observed in Figure 6. For example, the bare soils class (recently open fields and settlement areas) has increased from 14% in 2003 to 25% in 2009, while herbaceous vegetation class has decreased from 30% in 2003 to 18% in 2009. Table 5 reveals that 34% of herbaceous vegetation was converted to bare soils between 2003 and 2009. These changes are more prominent in the central portion of the area, where settlement and livestock activities are concentrated. This is probably caused by increasing settlement as a result of population growth; grazing and use of fires for grass regeneration.

Non-degraded forests class had a slight decrease from 19% in 2003 to 14% in 2009, being the majority of changes observed in the charcoal production area southwest of the area. In fact, Table 5 reveals that 36% of the non-degraded forests in 2003 were converted in ticket or lower density vegetation. Field observations indicate, as described later in this report, that intensive logging for charcoal production is the main cause of these trend. It is also important to note the increase in dense forest within the Licuai Forest Reserve, which reveals that human activities are kept to a minimum degradation level.

Another major change in this area is the expansion of the ticket class, which is partially (about 24%) a result of conversion of regenerating field. This is particularly evident in the northwest portion of the area (Figure 6) where sandalwood regeneration is occurring. This is the result of several years of the government's efforts of reestablishing sandalwood in the area, after years of being intensively logged.

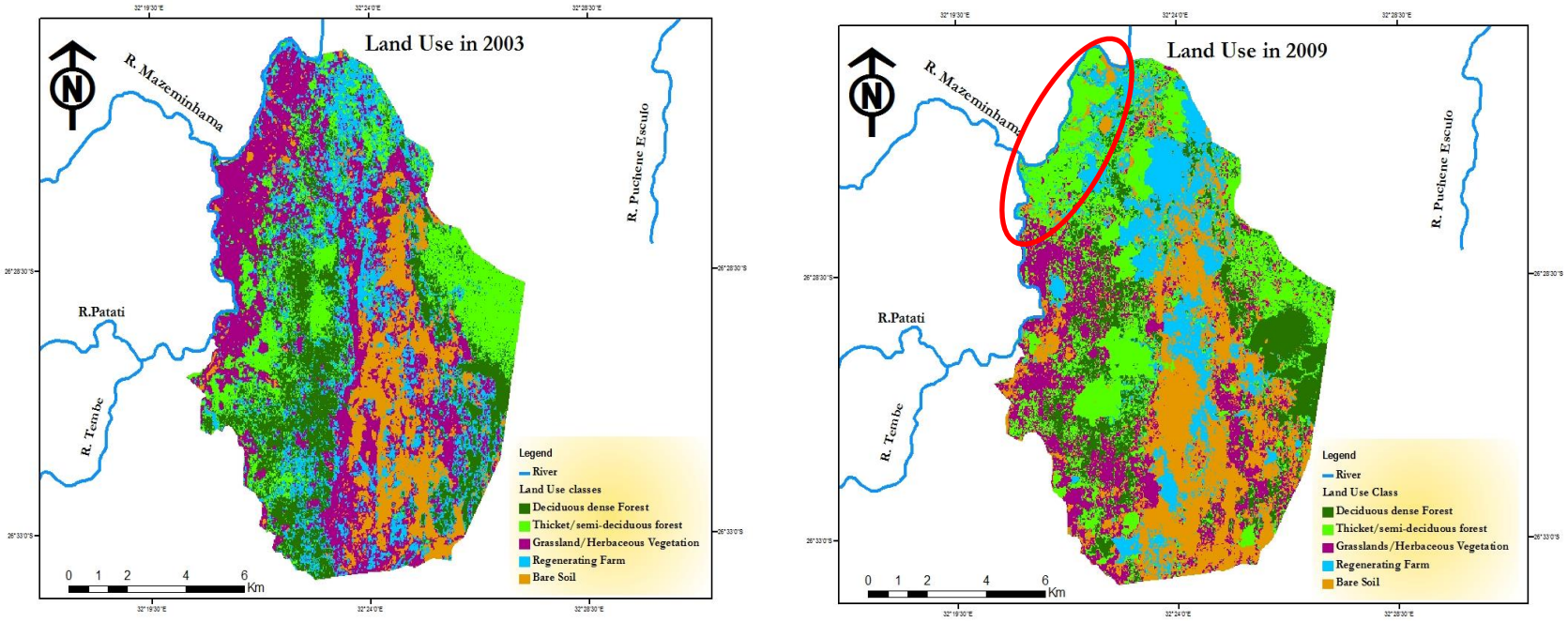


Figure 6. Land cover land use changes in Djabula area between 2003 and 2009. The area under the red circle represents regenerating sandalwood forest, after 11 years of logging regulations and reposition efforts by the government of Mozambique.

Land use land cover dynamic is Djabula is demonstrated in Table 5, by denoting the 23% conversion of regenerating fields to either bare soils or herbaceous vegetation. As referred above, the main causes associated to this dynamic is increasing agriculture activity as a result of population growth and livestock activities.

Table 5. Global change matrix of changes between 2003 (columns) and 2009 (rows).

	2003				
2009	**Deciduous dense Forest**	**Thicket/semi-deciduous forest**	**Regenerating Farm**	**Grasslands/Herbaceous vegetation**	**Bare soil**
Deciduous dense Forest	**37%**	**26.35%**	6.16%	2.55%	1.05%
Thicket/semi-deciduous forest	**36.11%**	**45.57%**	**23.80%**	18.47%	3.30%
Regenerating Farm	6.63%	8.68%	**23.83%**	20.89%	**24.38%**
Grasslands/Herbaceous vegetation	16.46%	16.45%	**22.65%**	**22.64%**	7.85%
Bare soil	3.27%	2.40%	**22.89%**	**34.22%**	**62.92%**

3. Fire incidence

The number of fires in Djabula between the years 2001 and 2010 estimated from MODIS active fire product ranges between 1 and 27 a year (Figure 7), which is considered low. However, as observed in the field, in particular places fires are intensively used as a land management techniques. For example, in the grasslands of the center fire is used to stimulate grass regrowth to improve animal feeding. In other places such as charcoal production areas in the south, fire is set to improve visibility as well as for honey production. In this areas fires are set every year and according to field observations trees in grasslands present several signs of damage by fire including: torched stems, stem cavities, stem contortions among others.

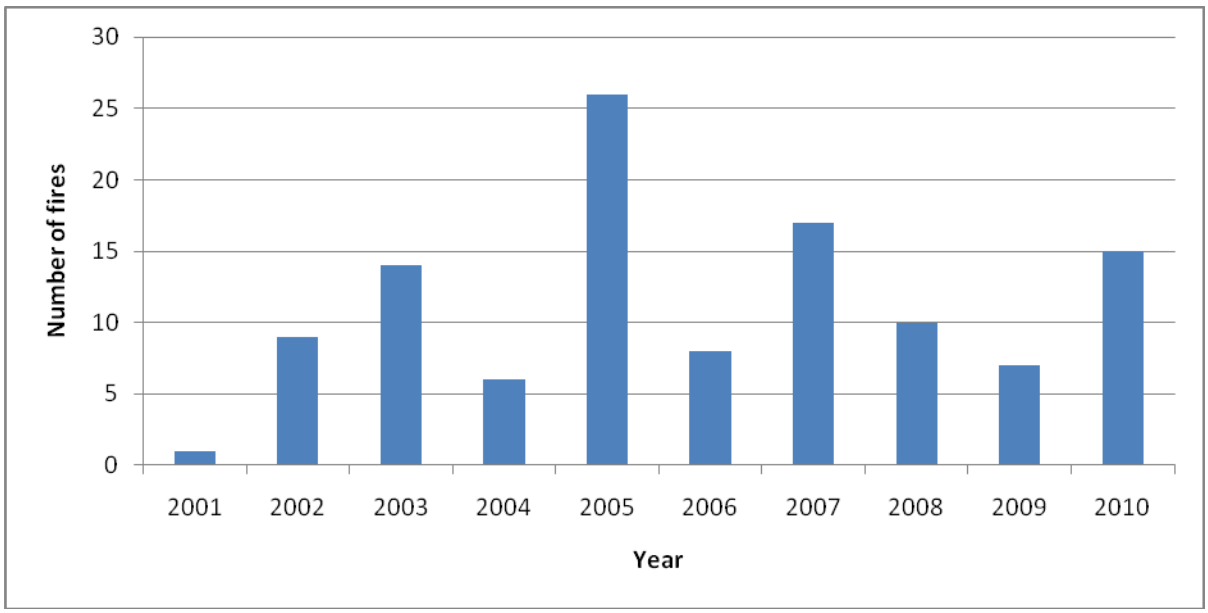


Figure 7. Number of fires between 2001 and 2010 in Dlabula.

4. Degradation Assessment

For the purposes of this program and following existing separation of activities within Djabula area, we defined six distinct land use zones with different intervention requirements (Figure 8). The zoning was defined during the participatory zoning conducted in 1998 by Soto as part of the Licuáti Project (Soto *et al.*, 2000) and had into account natural characteristic of the area as well stock availability. However, management activities proposed in 2000 are not being implemented and consequently, degradation of forest resources has occurred over this period of 11 years since that plan was released. In this study we redefine some of the existing zones (location and names) to reflect the current situation. The six proposed zones are: i) riverine area; ii) sandalwood regeneration; iii) agriculture and settlement; iv) charcoal production; v) pasture and settlement; and vi) Licuáti Forest Reserve. Following is a brief description of the current situation in each zone (Figure 8).

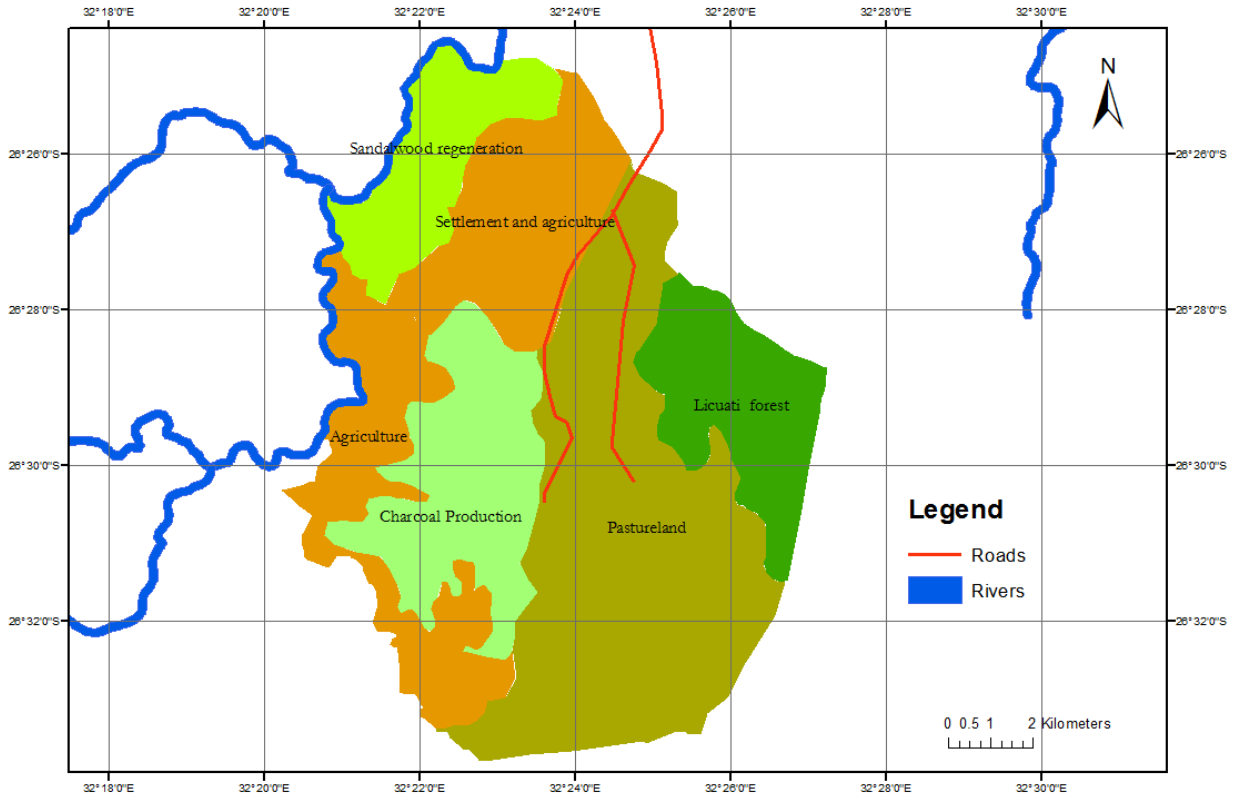


Figure 8. Zonation of the Djabula community area.

Zone 1: Riverine area

The Tembe/Patáti Rivers run along the west limit of the Djabula community from north to south and their arms are spread across the western Djabula. This creates appropriate edaphic and hydrological conditions for cultivation all year round. Beds of seasonal streams are cultivated during the dry season, while in the wet season farming is concentrated up to 100 m of the river margins. All riverine places visited during the field season are completely deprived of its original vegetation (Figure 9f).

The transect conducted in this zone started in the margins of a small river and clearly reveals the degradation of riverine forests. We only found four individuals of *Acacia xanthoplhoea* and a dominance of grass and herbaceous species such as: *Panicum sp., Digitaria sp., Capparis tomentosa, Themeda triandra, Ipomea sp., Gossypium herbaceum, Roycissus rivoilii, Cissus rotundifolius*, among others. No

signs of erosion were observed. In general, tree species diversity is extremely low across the all transect, with only five species recorded: *A. xanthoploea* (IVI=169), *Spyrostachys africana* (IVI=40), *Acacia nigrescens* (IVI=31), *Sclerocarya birrea* (IVI=31) and *Acacia nilotica* (IVI=30). Trees are sparsely distributed across. Natural regeneration of tree species is extremely poor and dominated by *Dichrostachys cinerea* (30 seedlings) a species that colonize the first few years of regenerating degraded areas. Other regenerating species are: *Phyllanthus reticulatus* with 7 seedlings, *A. nilotica* with 11 seedlings and *S. africana* with only 5 seedlings. The soils of this area are: XXX. A few signs of fauna were found such as rats (*vondos*) and a few birds.

According to local people, in the beginning of the 1980s riverine forests were prominent and dominated by highly valuable riverine species such as: *Acacia xanthophloea*, *Kigelia africana*, *Acacia robusta* among others. But, beginning in the 1990s forests have been lost due to intensive charcoal production and agriculture. Currently, the latter is the major factor hampering the regeneration of riverine forests and charcoal production was completely eliminated.

Zone 2: Sandalwood regeneration

This zone is located to the northwest of the area, where population density is high. It includes some riverine areas as well as agriculture and settlement. The reason of separating this zone from the others is to salient this important ongoing natural process. This area was heavily logged for charcoal in the past, which resulted in a complete degradation of the forest and especially of sandalwood (*S. africana*). As revealed by local people, in the 1980s the area was dominated by *S. africana* (*xilati* in local language) but as a result of intensive charcoal production the area was deprived of this species. As a result the government of Mozambique in collaboration with the Licuati Project (1997-1999) has forbidden *Xilati* extraction from these areas, since the year 2000 and promoted its plantation in some places. According to conversations with local people, growth of this species is slow but the results are promising in terms of reestablishing the species.

The transect across this area was not actually assessed but the observations revealed high density of *machambas* and fallows within this zone. Fallows are dominated by the grass *Melinis repens* and the small tree *D. cinerea*. These species are indicators of low soil fertility after few years of being cultivated. For the local people these are an indication that the "land needs to rest and we have to

move to a different farming plot" (Mr. Mbantuani Tembe interviewed on 13/06). Apart of the regenerating *xilati*, there are still some forests remnants of small size and low species diversity. Herbaceous and grass species are: *Hypertelia dissoluta, Heteropogon contortus, Corchorus junodii, Melhania forbesii, Tephrosia sp, Panicum sp*., among others. Our transect through a forest remnant revealed that the canopy cover is higher than 60% and dominant tree species are: *Entandophragma caudatum, Boscia sp., Euphorbia grandidens, Pteleopsis myrtifolia, Catunaregan spinosa*, among others. The dominant height is of about 10-12 m and the DBH is of more than 35 cm, but young individuals of these trees also exist. Birds and other small rodents were observed in the area.

Although at a minimal scale, charcoal is still produced in the zone and is specially concentrated in the few forest remnants. In fact, a few charcoal stoves were observed during the field visit. The main reason for small scale logging is deprivation of forests from charcoal species.

Zone 3: Agriculture and settlement

This zone is located to the west of the area, along the river margins and inlands. It merges with zone 2 in the north but, towards the center and south *machambas* and fallows are very well spread across the west area. Settlement in mainly concentrated in to the north of the Djabula limits. Machambas are of about …ANICETO PODES DESCREVER ESTA AREA POR FAVOR

Zone 4: Charcoal production

This zone is scarcely populated and forests of varied density still dominate the area. However, heavy logging imposes severe degradation of these forests even though a management plan was designed for the community (Soto *et al*., 2000). We conducted two transects in this area, one in the south and one in the center. Both transects revealed that adult individuals of the most preferred charcoal species (*Newtonia hildebrandtii*-mfomozi*, Acacia nigrescens*- ncaia and *Margaritaria discoidea*-xizi) are either absent or in very low quantities. Natural regeneration of this species is also very low in both transects. Although this area is mostly used for charcoal production, agriculture is also another major land use in this zone, especially along the river margins and stream beds. Together they represent the main degradation factors to this zone as described below.

Through the transect in the south we observed transitional states of vegetation. The open areas (less than 20% of canopy cover) are dominated by grass (*Digitaria eriantha, Hypharrenia sp, Perotis patens, Panicum sp.*) and herbaceous species (*Pelaea viridis, Bulbostylis burchellis, Cissampelos hirta, Commelina bengalensis, Corchorus junodii, Tephrosia sp., Roicissus rivoili, Oxygonum dlagoensi*s, among others). *Dichrostachys cinerea* also dominates the regeneration stage in the open patches. Closed forest patches have a canopy cover of more than 40% with low tree species diversity (only 15 species). The most important species are: *Albizia forbesii* (IVI = 62), *Combretum apiculatum* (IVI=33), *Pteleopsis myrtifolia* (IVI=32), *Terminalia sericeae* (IVI=30), *Balanites maughamii* (IVI=22), *Afzelia quanzensis* (IVI=19), *Albizia versicolor* (IVI=17), *Strychnos madagascariensis* (IVI=16.5) and *Erythrophloeum suaveolens* (IVI=15). Natural regeneration along this transect is dominated by *Senna petersiana* (58 seedlings), *Landolphia petersiana* (50 seedlings) and *Pteleopsis myrtifolia* (24 seedlings) The area is burned every year and the trees present evidence of fire damage such as multi-stems, contort and torched stems, among others.

The transect in the center is also highly degraded and started in the Tembe River, which is the west limit between Djabula and Mahau communities. It belongs to the area that was once intensively logged for charcoal. Currently, it is still used for charcoal production but with very low intensity due to its low timber stocks. In fact, during our walking we passed a charcoal stove in preparation, which clearly indicates that logging is still in place imposing further degradation to this zone. The riverine forest is completely absent, but some individuals of *Acacia xanthophloea* are still present. Other young individuals of *Eryhtroxylum zambesiaca* and *Ziziphus mucronata* are also found in the riverine margins. Grasses (*Panicum maximum, Digitaria sp.* and *Themeda triandra*) and herbaceous species (*Phyllanthus reticulatus*, *Capparis tomentosa*, *Ipomea sp., Pulchea sp., Roicissus rivoilii, Cissus rotundifolius, Gossipium herbaceum*, among others) dominate open areas, but *Dichrostachys cinerea* is also present. The transect crosses some very dense ticket dominated by *D. cinerea* and other spiny shrubs. In decreasing order of importance the dominant tree species in this transect are: *Abizia sp.* (IVI=87), *Abizia anthelmintica* (IVI=39), *Spyrostachys africana* (IVI=30), *Ziziphus mucronata* (IVI=24) and *Acacia nigrescens* (IVI=23). Natural regeneration is dominated by: *Acacia sp.* (48 seedlings) followed by *Euclea divinoro* (28 seeldings), *S. africana* (22 seedlings) and *D. cinerea* (13 seedlings).

Although the sampling used in this study is not representative of the whole area, it is important to mention that we didn't find any representative (in any developmental stages) of the most preferred charcoal species – *N.* hildbrandtii and *M. discoidea*. This is an indication of the low charcoal

productivity of this area, which is most probably a result of years of unsustainable logging. It is also important to refer that we didn't find any signs of animal activity along our transects.

Zone 5: Settlement and pasture

This zone is located in the central portion of the Djabula area between the charcoal and farming areas in the west and the Licuati Forest in the east (Figure 6). It lays on sandy soils with very poor nutrient content XXX and low water retention capacity. Vegetation here is characterized by open semi-deciduous woodlands with canopy cover between 20 and 30% and a high grass cover. Agriculture is barely practiced here due to poor soil conditions, but settlement, commercial development and livestock are also concentrated in this zone.

The transect conducted in the area indicates very low tree species diversity with only 5 species, being the dominant: *Strychnos spinosa* (IVI=106), *Terminalia sericea* (IVI=91) and *S. madagascariensis* (IVI=51). Dominant grasses include *Perotis patens*, *Heteropogon contortus*, *Panicum sp.* and *Eragrostis sp.* herbaceous and vine species include: *Commelina bengalensis*, *Asparagus aethiopicus*, *Oxygonum delagoensis*, *Abrus preactorius*, *Oslundia opposita*, *Monontotax sp.* and *Cryptolepsis kirkii*. The palm *Hyphaene coriacea* is also abundant in this zone and it is utilized by local people to produce a local beer called u*tchema* (or sura). Along the whole transect the area have been burnt every year (more that once a year) to produce good quality pasture. These frequent (controlled) fires are most probably one of the determinant factors of the type of vegetation along with soils and topography factors. The only animal sign observed in this zone was rabbit.

Zone 6: Licuáti Forest Reserve

This is the less degraded zone in the Djabula community area and belong to the Licuati Scared Forest (or Licuati Forest Reserve) that is protected either by formal or traditional laws. The Licuati forest was decreed forest reserve in 1950s? to protect a high diversity forest, especially the species *Afzelia quanzensis* a timber tree that once was abundant in this forest. The forest is also a sacred place for local people that conduct rituals and as such they protect it. It is located in the north east side of the Djabula limits but, it stretches to a strip south to the official limits of the reserve.

Our transects across the zone indicate that forest cover have been maintained in a relatively stable state over the years. In fact, the canopy cover is high (>than 75%) to moderate between (40-75%). Trees height ranges between 3 and 14 m. Although forest cover was maintained over the years, tree species diversity is very low (12 tree species found in 0.6 ha, which means 20 species/ha). The results reveal high dominance of the fruit tree species *Dialium schelchteri* (IVI=171), but other important tree species include: *Hymenocardium ulmoides* (IVI=31), *P. myrtifolia* (IVI=14) *and Balanites maughamii* (IVI=10). Even though the transects are not representative of the Licuati forest, we found no evidences of *A. quanzensis*, the target conservation species in the reserve. Further investigations on this issue should be conducted and if confirmed low abundance of *A. quazensis*, enrichment plantation are recommended. The soils of these areas are ……

Consultation to the local communities as well to Geodata's work (Geodata, 2009) indicates that these forests are of high value to local people. In fact, a part of their cultural value these forests are used for hunting, honey gathering, medicine and firewood collection (See Geodata, 2009 for detailed information on specific species utilization). These activities are complementary to agriculture in the sense that people combine forest derived products according to their availability and crop production for their food security, especially during critical periods (dry season for example). The advance of degradation in other zones associated with climatic variations increases the probability of crop failure, which may impose a greater pressure over the less degraded forest of Licuati Reserve in the future. Thus, activities in this zone should consider a strict control over forest resources exploitation.

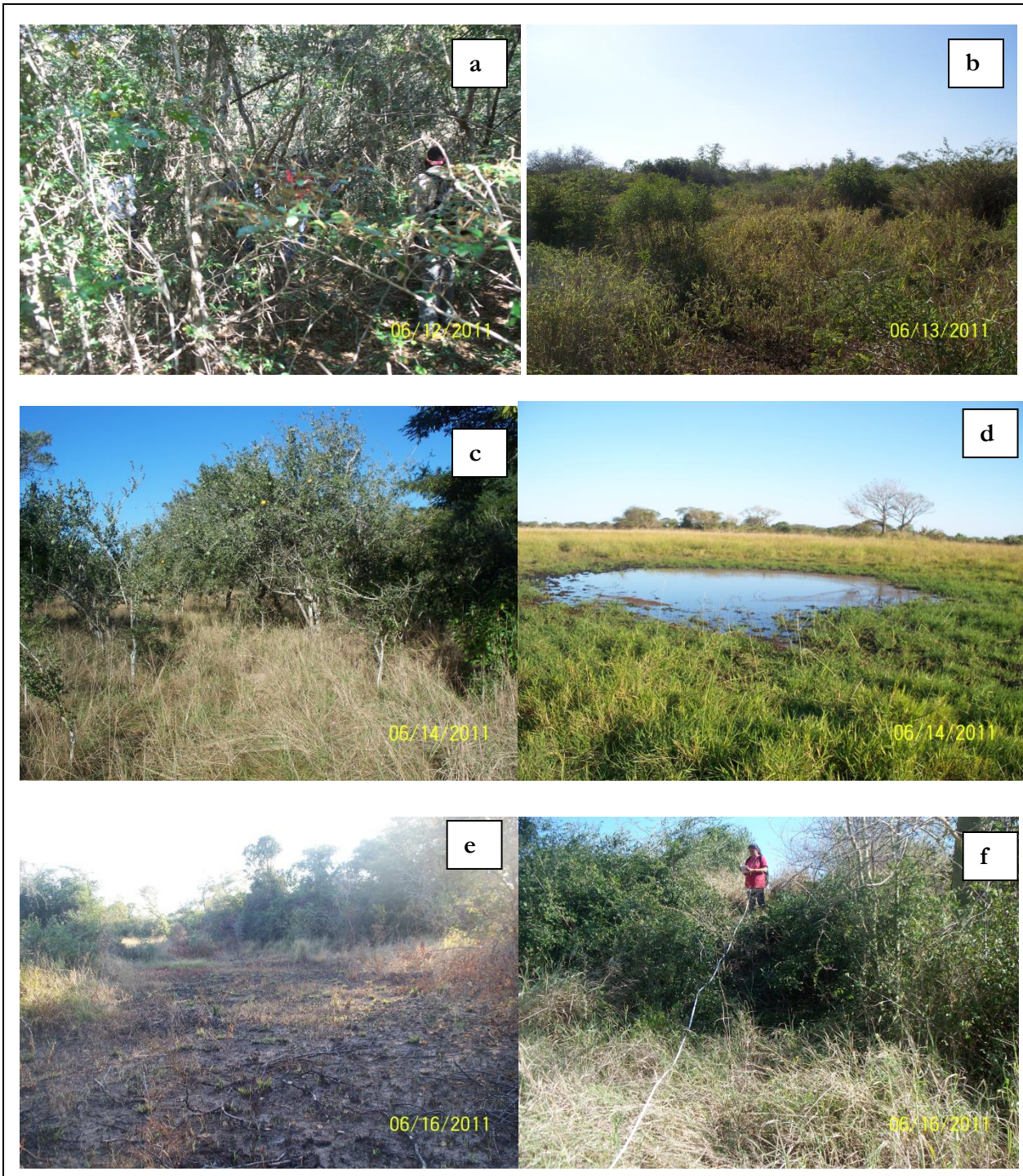


Figure 9. Illustration of the vegetation cover in Djabula: (a) Licuati Forest Reserve; (b) Sandalwood regeneration; (c) pasture land; (d) lagoon in the pasture zone; (e) charcoal production zone after fire; (f) a degraded riverine margin.

5. Rehabilitation Program

In this section we present several activities to rehabilitate or manage each zone above described. Rehabilitation activities are essentially technical, but an analysis of strategies for implementation, local capacities and weaknesses and training needs are also presented. Recommended activities intend to be simple from the point of view of their implementation and monitoring.

5.1. Proposed rehabilitation activities

Zone 1: Riverine area

As described, these areas present high levels of degradation with riverine forests removed from more than 70% of the riverine area. Due to its ecological importance of soil and water conservation we recommend that this area is considered priority one for rehabilitation. Since the river margins are highly degraded the first proposed action is to delimitate an area of 50-100 m from the river bed in which agriculture activities are forbidden. However, dry season's cultivation on river beds may be allowed as long as the agriculture maintains its subsistence levels. In the 50-100 m strips reposition of riverine forest is highly recommended. Plantation should be stepwise by first identifying priority areas for plantation, which are places with high slopes, intensive agriculture activity and exposed soils. In the next step, forest reposition of two to three lines of mixture of various species such as: *A. xanthophloea*, *A. quanzensis* and *Acacia robusta* (in the first line) and *S. africana, A. quanzensis* and *Kigelia africana* in the following lines (farthest from the river). These species were observed in the area and they are reported as being very abundant in the riverine forest in the past. Several mother trees still exist in the area to serve as seed sources.

Removal of agriculture activities in this zone must be accompanied by a compensatory location of farming plots, such as for example along several lagoons in the areas. Complementary activities should also be considered and these may include: irrigation alternatives, conservation agriculture (crop rotation, water conservation strategies, integrated pest management, agro-forestry systems among others).

Zones 2 and 3: Sandalwood regeneration and agriculture and settlement

This area is densely populated and farming is intense and, as described above, zone 2 was severely logged in the past with special incidence on *S. africana* (sandalwood) but also other charcoal species (*N. hildebrandtii* and *A. nigrescens*). Due to relatively good regeneration levels, the priority for rehabilitation of this zone is 3. The area also presents some forest remnants. Charcoal production is still present in the area but we recommend phasing it out due to high levels of forest degradation.

We recommend for this zone a balance between settlement, farming, forest regeneration and conservation of forest remnants. This means allowing farming in particular areas that not conflict with sandalwood regeneration and forest conservation. For example, each family should be cultivate permanent farming plots of about one ha in which cultivation should be performed in small plots of 0.2-0.25 ha for two years. After two years the farmer can move in to the next 0.25 ha and allow the former plot to rest for at least 6 years. Farming must be conducted outside the 50 m from the river to allow riverine forest recovery. Appropriate cultivation techniques such as conservation agriculture should be promoted.

Forest remnants should be enhanced through for example favoring regeneration by clearing a radius of about 2-5 m around selected saplings. Sapling selection should consider species diversity (consider species abundance described above) and vigor (height and growth). Enrichment plantation should also be considered if the area does not meet the sapling selection criteria. Management of sandalwood regeneration sapling should be conducted urgently in order to promote growth of the most promising saplings. Since animal activity was observed in this zone, we recommend that vegetation management should be combined with animal activity monitoring in order to follow the reestablishment of natural ecological processes: seed dispersal, plant species regeneration, nutrient cycling among others.

In this zone extractive activities from local communities such as non-timber forest products (medicines, food, and firewood) may be allowed as long as they are only for subsistence and of low intensity. A detailed study on current uses and projected sustainable uses of NTFP and sandalwood for handcrafting is recommended.

Zone 4: charcoal production

These areas have shown severe forest degradation over the last 10 years and although they still provide the charcoal production function, it is severely depressed from its original biodiversity. This may in the near future produce a *dead* forest in terms of its productive function. Thus, rehabilitation priority for this area is 2.

It is important to mention again that the community of Djabula has a biomass forest inventory (Brito et *al.*, 1998) and a community-based forest management plan (Soto *et al.*, 2000) both produced as part of the Licuati Project. The management plan clearly gives recommendations for forest management including reposition either through planting or sapling management. Apparently, that plan has not been fully implemented and in addition, is out-of-date. Although some of the recommendations are still applicable, it needs to be updated. In order to achieve this, the biomass forest inventory should be updated in order to have an exact estimation of this forest's productivity. An inventory of the all area is costly, thus targeting only this zone should reduce the costs. The results will allow an adjustment of Soto's management plan. However, most probably the following management actions are still valid (Soto *et al.*, 2000):

a. Delineate management units;
b. Define logging areas per year according to the timber volumes;
c. Select individuals for logging according to defined criteria (4^{th} class according to the forest regulation, dbh between 10 and 35 cm to allow mother trees to disperse seed);
d. Determine the number of trees per ha (or per management unit) that comprise the allowed logging volume;
e. Allow at least 4 mother trees per ha to remain to allow natural regeneration;
f. Avoid selective logging of *N. hildbrandtii*, *A. nigrescens* and *M. discoidea* at least during the next 5 years;
g. Follow recommendations for fire management suggested in the management plan.

For management units that are already degraded we recommend either promoting natural regeneration or enrichment plantations according to saplings availability. Specific plantation design depends on site conditions and size that have to be evaluated in the field as part of the implementation strategy. Enrichment of management units that show a need for a plantation should

be done at a minimal cost. This means that plantation of dispersed nucleus of plants across the unit followed by an effort of favoring/managing planted trees. Other recommendations include:

1. Establish a nursery that maximized the use of local equipment and construction materials riverine area in this zone was pointed out as potential site for the nursery, but due to low accessibility and time constraints we didn't visit the area.
2. The group of charcoal producers must have the ownership of the management plan for this zone. It was observed in the field that this group meets every Wednesday to decide the places where to log but, the decision is based on existence of the resource. However, discussions on forest reposition are inexistent though they have the conscience that it is important. Consequently, we recommend several awareness rising campaigns as well as training on management and nursery activities targeting specifically this group. Also, ownership means people independently conduct activities without a major interference from outsiders. To achieve this objective, charcoal producers should be trained on finances management to include for example, allocation of a small percentage of their profit to maintain the nursery and conduct management activities. Government authorities (DPA and SDAE) play a major role in implementing this plan by promoting training; defining mechanisms of payment for environmental services and punishing illegal activities. Due to limited capacity of the government, NGOs operating in the area such as VIDA, LUPA and others should be considered a major platform between the government and the community.

Zone 5: Settlement and pasture

Human and animal populations density is still low in Djabula and consequently, we don't think current densities are affecting the capacity of this area to offer the main resource – pasture. This zone is of very poor sandy soils that limit agriculture activities extensively. Thus, agriculture development in this area is unexpected. Fire is one of the management techniques in the area in order to promote higher quality pasture. To deal with this situation we recommend following Soto (2000) suggestions for fire management. A part of fire management no major rehabilitation activities are recommended for this area. However, we suggest the definition of carrying capacity to sustain livestock in the future.

Zone 5: Licuáti Forest Reserve

The area is still under a good conservation status and thus we don't recommend further actions on this area. Forest exploitation should continue to be limited to non-timber forest products (NTFP) and cultural activities. An assessment of abundances of *A. quanzensis* is recommended and if proved to be low, enrichment plantings should be considered. Priority for rehabilitation is 5 and depending of forest condition assessment. An assessment of sustainable use levels of the main NTFP is also recommended.

5.2. Strategies for implementation

To successfully implement this plan a strategic implementation should be used. This implies defining prioritize activities, establish wise partnerships among different actors and define their responsibilities. The following recommendation will facilitate the implementation of this plan:

1. Prioritize activities

a. The first activity to be conducted is to produce a light version of this plan, which must include most of the maps, schematic representations of propose techniques and minimal text explanation of some activities.
b. In order to decreasing importance the most important actions are: (i) promotion of conservation agriculture; (ii) riverine forest recovery; (iv) natural regeneration improvement in charcoal and sandalwood regenerating areas; (v) plantation in strategic places, especially in charcoal production area.
c. Establish demonstration and trial plots.

2. Attribute responsibilities to existing institutions

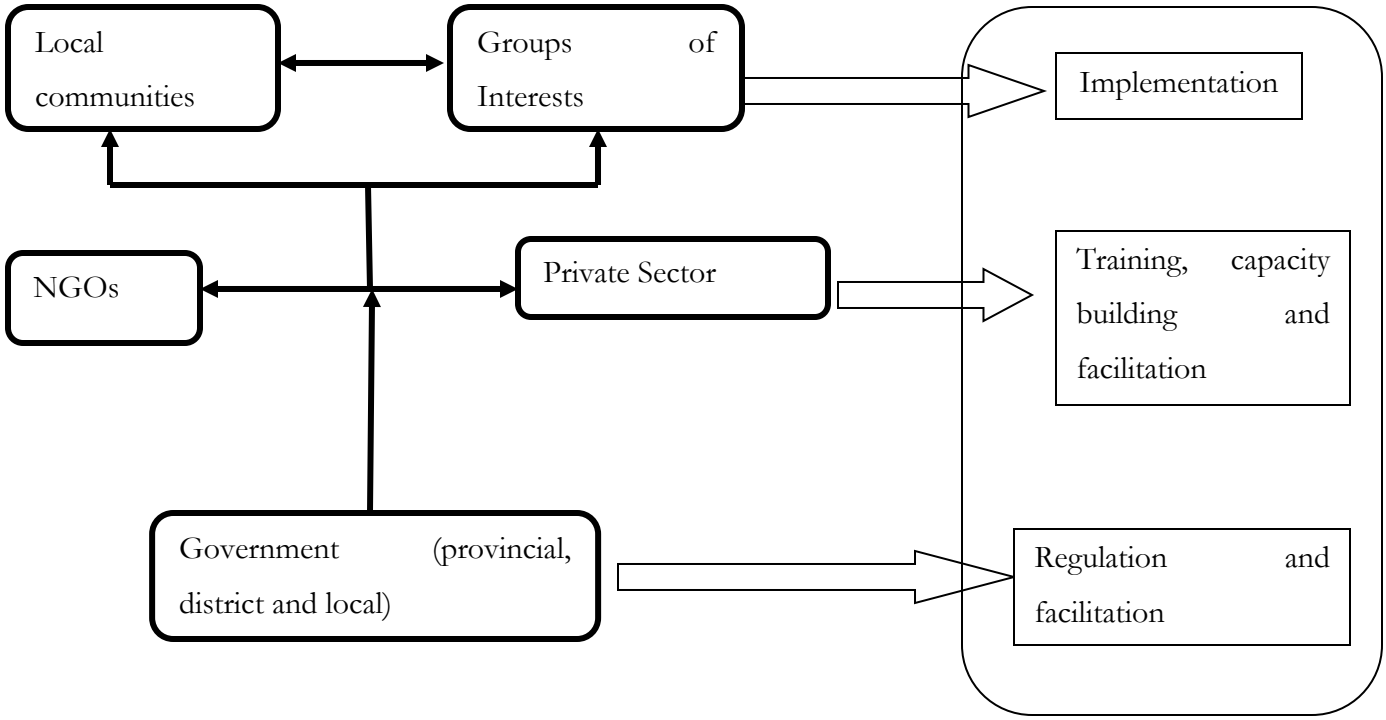
d. **Local communities**: they are the owners of this plan and must have complete knowledge and understanding of activities proposed. They are responsible for implementing the plan and conduct monitoring as well as report to government institutions.
e. **Groups of interest:** these groups have been informally formed as a result of several years of activities and the need to coordinate among different users. Groups have been also capacitated by several projects in the area, specially the charcoal producers

group and the cattle producers group. These institutions gather frequently to discuss and organize the activities including the definition of areas to explore. Within the context of this plan, these groups have the responsibility of managing the forest resources including the implementation of this plan. They also have an important role in the monitoring process including the discussion about pros and cons of the plan. It is then important to improve their capacity and raise awareness on environmental issues.

f. **NGO's (IUCN, VIDA, LUPA)**: these organization have been working in the area, which has contribute to build a trust relationship with this community. They should then be considered as he main stakeholders in the implementation of this program through for example: (i) training; (ii) rising awareness; (iii) promoting fund rising; (iv) developing local capacity on team work and pro-active attitude towards the environment; (v) promoting alternative sources of income.

g. **Government:** this structure is represented at different levels through the Administrative post (chefe), district (SDAE) and provincial (SPFFB) governments. These institutions' main responsibility is to guarantee application of the existing policies, through among others: (i) support local institutions; (ii) advice on best practices; and (iv) inspection.

The schematic articulation among these institutions is as follow:



5.3. Chronogram of activities and monitoring plan

Table 7 presented the chronogram of activities for implementing the rehabilitation plan, while table 7 presents the monitoring plan for this program.

Table 6. Chronogram of activities to implement the 5 year rehabilitation program.

		YEAR				
Activity	**Priority**	**First**	**Second**	**Third**	**Fourth**	**Fifth**
Restoration of riverine forests	I					
Conservation agriculture and fallow improvement	I					
Plantation in strategic places	III					
Natural regeneration	IV					

Table 7. Monitoring and management plan for Djabula forests.

Zone	Rehabilitation activity	Priority	Implementation strategy	Indicators for monitoring	Monitoring frequency	responsibility
I	Restoration of riverine forests	I	Establish plantation along the main rivers to connect intact forest remnants within strips of 50-100 m of the river margins	• Growth of planted species (height, dbh) • Abundance of animal species • Abundance of natural regeneration and adults • Soil properties (organic matter, pH, nutrient content) • Water quality	• First year and then every 3 years	Communities and groups of interest supported by NGOs
II	Sandalwood regeneration	II	• Regulate activities (agriculture and charcoal extraction) in forest fragments by a combination of rising awareness and law enforcement techniques.	• Abundance of natural regeneration • Growth of planted species (height, dbh) • Proportion of planted/natural area cultivated area	• First year and then every 3 years	Government supported by IUCN/NGOs for activities regulation on these areas
IV	Plantation in strategic places	III	• Select site with low regeneration of tree species for plantation; • Collect seed and vegetative material	• Growth of planted species (height, dbh) • Abundance of animal species • Abundance of natural regeneration and adults • Soil properties (organic matter, pH, nutrient content)	• first year • First year and then every 3	Government supported by IUCN/NGOs for activities regulation on these areas

	Promote natural regeneration		previously selected in the area • Favoring of natural regeneration by avoiding competition and improving light conditions to selected saplings.		years • Every 3 years	+ Communities and groups of interest supported by IUCN/NGOs for monitoring
II and III	Conservation agriculture and fallow improvement	I	• Promote conservation agriculture techniques	• Number of farmers implementing conservation agriculture • Crop yield • Abundance of natural regeneration in fallow	• Second year • Every 3 years	Government supported by IUCN/NGOs for activities regulation on these areas + Communities and groups of interest supported by IUCN/NGOs for monitoring

5.4. Local capacities and weaknesses to implement rehabilitation activities

Main local capacities that will support the implementation of the proposed plan are:

- Existence of local groups of users (charcoal, cattle and agriculture) and community scouts. User groups are informal and meet frequently to discuss issues related to their activities. Although this is a major capacity of this community, there is still a need to define its role in the context of forest resources management and protection. Local scouts have been trained as part of Licuati and LLS projects.
- Knowledge of forest resources. There is relatively good information regarding to forest resources, which is the result of one forest inventory (Brito et al., 1998), community-based management plan (Soto *et al.*, 2000) and description of conservation status of the main ecosystems (Geodata, 2009).
- Existence of several institutions working on the area (Vida, Lupa, IUCN).
- The community of Djabula has faced over the years several projects that have created several capacities including: training, formation and trained local scouts, zoning of the area, awareness rising.

Main local weaknesses that may undermine the establishment of this rehabilitation plan include:

- Limited local knowledge on species ecology and propagation and local capacity (human, physical and materials) to produce plants locally.
- Extreme poverty conditions that make local people highly dependent of forest resources (especially charcoal productions) and shifting cultivation;
- Lack of alternative sources of income. IUCN's project of LLS didn't produce comparative results in terms of profit in relation to charcoal. Reasons may be various such as short period of the project, approach, and resistance to accept a new activity. Thus, we recommend that sandal carving continues to develop in Djabula but the chain value needs to be better explored an commercialization promoted;
- Limited financial independence;
- Low commercial value of forest resources;
- Limited capacity of the local government to support activities in this plan including monitoring;

- Negative attitude towards forest protection and value of natural resources.

5.5. Training needs

This section results from the analysis of previous section especially with regards to the weaknesses. Training need is similar to those identified for the Derre Forest Reserve and to avoid repetition through this report, we recommend consultation of section 4.1/5.5 for detailed description of training needs.

5. General comment

This rehabilitation program was designed as part of the LLS program from IUCN and intends to revert forest degradation in Djabula and Derre forests. The limited amount of time assigned to complete this task (only 2 months) is the main constraint of this assignment. During this period, we had to conduct both the desktop study and field assessment and design the program. As a result in-depth assessment and analysis of the zones and definition of appropriate rehabilitation techniques were not conducted. To overcome this limitation, the scope of this assignment was kept to the level of a Program that can accommodate several small projects in each particular zone after a detailed analysis is conducted.

Implementation of this program depends greatly on local communities' attitudes and capacity to understand this program. Thus, it is crucial not only provide training and build capacity (see section 5.5) of this communities but also define the right partnerships and coordination mechanisms among the different stakeholders (government, NGOs, private and local communities). Governmental institutions through Provincial Forestry Services (SPF) should define forestry conservation and rehabilitation as a priority for Mozambique and enhance its capacity to inspect forestry activities including the implementation of mechanisms to penalize infractions and reward good practices. On the other side, local communities should be given more leadership and authority to manage forest resources. Clearly, this will only be achieved if people feel ownership over the resources and are able to decide the best options for them. The traditional leaders play a major role on this issue and they should be capacitated for that. Capacity building and training of leaders and local communities should be attributed to the private sector, NGOs and civil society organization. These play a major

role in promoting the conservation activities and should bridge the gap between the government and the communities.

6. References

Annexes

Interviews

Mapping with local communities

Light version of the plan

Checklist for monitoring

Indicator	**yes**	**no**	**maybe**	**Where (which zone)?**
% of vegetative cover				
Number of plant species in the forest				
Presence of invasive plant species				
Presence of charcoal plants species (mfomozi, ncaia, xizi, others)				
Presence of wild animals and birds				
Plant species common in low fertility soils (*Mellinis repens, others)*				
canopy cover of riverine forests				
Presence of soil erosion				
Good water quality (drinkable water)				
Water quantity (dry streams and rivers)				
Plant species killed by fires or other disturbances				
Number of plant species used as food, medicines,				

construction materials, hunting				
Income (sale of charcoal, handcrafts, etc)				
Rainfall and pattern				
vigor of established enrichment plantations (height, mortality, density)				