GILÉ NATIONAL RESERVE REDD PROJECT

Document Prepared by Etc Terra

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Glossary

AGB	Aboveground biomass
ANAC	Administração Nacional das Áreas de Conservação / National agency for protected areas
AFOLU	Agriculture, forestry and other land use
ASI	Agrisud International
BGB	Belowground biomass
ER-PD	Emission reduction program document
ER-PIN	Emission reduction program idea note
ETC	Etc Terra NGO
FFEM	Fond Français pour l'Environnement Mondial / French Facility for Global Environment
GNR	Reserva Nacional do Gilé / Gilé National Reserve
IGF	Fondation Internationale pour la Gestion de la Faune / International fondation for wildlife management
FAO	Food and Agriculture Organisation of the United Nations
FCPF-CF	Forest Carbon Partnership Facility - Carbon Fund
GHG	GreenHouse Gases
NTFP	Non Timber Forest Products
REDD	Reduction of emissions due to deforestation and degradation of forest
ZILMP	Zambézia Integrated Landscapes Management Program (FCPF-CF ER Program)

1 PROJECT DETAILS

1.1 Summary Description of the Project and its Implementation Status

This PDD presents a reference scenario for the Gilé National Reserve (GNR) REDD project, activities being implemented as part of the project and a monitoring plan for the validation of the project. It also presents the results of the first monitoring period with the quantity of VCUs generated.

The GNR REDD Project is a REDD project, developed in the buffer zone of the Gilé National Reserve in Mozambique, Zambezia Province. The GNR is managed by the ANAC (*Administração Nacional das Áreas de Conservação* – the national public agency responsible for the management of protected areas), which is therefore the project proponent. Since 2007, the Non-Governmental Organization (NGO) IGF, which is partly financed by the FFEM, is supporting the ANAC to improve the management of the Reserve and developed alternatives to deforestation with communities. The FFEM funding complement the national dotation to the GNR, this last being limited by national financial capacities.

The Reserve was created in 1932 initially for hunting purposes. In 2000, it was granted the status of conservation area. Today, the central zone covers an area of 2,100 km². It is composed of Miombo forest and open grassy and wetland ("*Dambo*"). The GNR hosts various endangered wildlife species (Table 24), including a significant elephant population that is facing severe threats. In order to improve the conservation efforts in the Reserve by associating communities, it was decided to create a buffer zone around the core area. In this zone, some activities of the communities are allowed but controlled by a management plan and substantial support is provided to improve subsistence practices and lower pressure on natural resources. Feasibility study and first consultations for the creation of this buffer zone were realised at the end of year 2008 and the process lasted until the end of 2011 when the creation of the buffer zone had been official. This process was led by IGF that supported ANAC for ministerial, provincial and local negotiations and was financed by FFEM since 2009. International funds were necessary to achieve this process as national dotation for the Reserve was not sufficient to cover consultations costs and supports from NGOs in addition to conservation efforts. After this process, those funds were also needed for the different studies required for the development of a REDD Project and for other field activities with communities such as the development of alternatives to slash and burn agriculture that started in 2014.

The creation of the buffer zone marks the beginning of the GNR REDD Project as a main initiative to manage land in this area and a first activity to enable a REDD Project elaboration. The buffer zone, where most of the deforestation of the GNR reserve is located, is considered as the Project Area where the Project aims to decrease deforestation thanks to agricultural support and land management. The Project Area is composed of the forests of the buffer zone of the GNR. It was composed of **124,145 ha of Miombo forest in 2010 (which is therefore the size of the Project Area), just before project start date (01-01-2012)**.

Figure 1: Miombo forest in the central zone of the GNR

Although nobody lives inside the central zone of the Reserve, about 32,000 inhabitants live around it. Subsistence agriculture is their main economic activity, with 89% of the population resorting to "slash and burn" techniques: it is the main driver of deforestation (Figure 21). In the GNR, deforestation is concentrated in the buffer zone (Figure 21). Agricultural activities are leading to a mean historical deforestation level of 2,877 ha/yr (0.65 %/yr) in the reference region (Figure 10) of the project, between 2000 and 2010. This level remained stable all along the reference period (Table 13). This rate is equivalent to a level of 810 ha/yr in the project area.

In order to reduce deforestation, the GNR REDD project is developing several activities:

- **Creation of the buffer zone**: The first activity of the REDD project was the creation of the **buffer zone of the GNR. Although it was required by the Mozambican law; the buffer zone was only created in 2011**. It was published in the official journal on 30th December 2011 and marked the start of the REDD Project, with a project start date set on the 1st **of January, 2012**.
- **Conservation activities**: Conservation within the Reserve is also improved with the activities carried out by IGF and the rangers.
- **Diffusion of agro-ecology techniques**: agro-ecology practices are promoted in villages around the GNR in order to offer alternatives to slash and burn agriculture, which is the main cause of deforestation in the area (section 1.8.2). Agrisud International, a French NGO, designed agro-ecological systems that are suited for the conditions of the surroundings of the Reserve and supported farmers to implement them from 2014 to 2017.
- **Improvement of cashew tree cultivation and value chain:** to help producers improving quality and quantity produced and to furnish a better price.

The objective is to reduce deforestation by 30% against the reference level in the first 5 years of project implementation and by 70% after 10 years. Until now, activities were funded by the FFEM. Once the REDD project is validated, the sale of carbon credits is expected to help financing part of the activities implemented with the communities (see section 2.5.2).

The reference emissions level was calculated for the 2000-2005-2010 period (Reference Period) with multiplication of activity data and emissions factors. Only deforestation is considered as sources of GHG emissions and only carbon stocks changes in Above Ground Biomass (AGB) and Below Ground Biomass (BGB) tree pools are considered. The baseline of the project was established using the VM0007 methodology. Areas of deforestation for the reference period (2000-2010) and for the monitoring period (2010-2016) period were measured with the same method – i.e. a multi-dates analysis of Landsat images that allows classification of land cover and land cover changes (LCLCC) with a satisfactory accuracy (section 2.4.1). Data were extracted from an existing forest cover change (FCC) map produced for a background study realised for a jurisdictional Emission Reduction Program existing in Zambezia Province, the ZILMP (see section 1.8.5), which is currently under development and encompasses the present project. **We calculated a deforestation rate of 360 ha/yr in the PA during the monitoring period** (Table 26).

For pre-deforestation class (Natural Miombo forest), in order to guarantee homogeneity of dataset, emissions factors were established using the results of a biomass and carbon inventory that was realized for the ZILMP program. For post-deforestation class, emissions factors were established using values obtained from an inventory realised on 10-years fallows around the GNR. Both inventories used the same method (section 2.4.2). **Average pre-deforestation carbon stocks used are 84.3 tC/ha and post deforestation are 12.9 tC/ha**. According to the methodology used, after deforestation event, all aboveground tree biomass is considered as emissions while belowground tree biomass is emitted with a default rate of 10% per year.

Emissions reductions were calculated as the difference between estimated baseline emissions and emissions calculated in the project case after the monitoring period (monitoring of deforestation areas), both for the Project Area (PA) and the Leakage Belt (LB). Additional emissions (against LB baseline) in LB were deduced from the emissions reductions. Results for the first monitoring period are **398,277 tCO_2eq** (section 6.5). Non-permanence risk of emissions reduction was evaluated following the methodology requirements. It was used to estimate the size of the buffer to set-aside credits in order to compensate this risk and it results to 10%.

1.2 Sectoral Scope and Project Type

Following VCS definition, the GNR REDD Project falls under the sectoral scope 14, AFOLU, and under project category REDD. More specifically, the project conforms with the REDD category of Avoiding Unplanned Deforestation (AUD) and falls under the mosaic configuration of deforestation because local land use practices produce a patchwork of cleared lands and forests are accessible for deforestation agents (Figure 10).

1.3 Project proponent

The project proponent is the National Mozambican public agency for parks and Reserves conservation, called ANAC. This agency is working with several partners, who are described in the following section.

Organization name	ANAC

Contact person	José Diaz
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1.4 Other Entities Involved in the Project

The following entities are working in strong collaboration with ANAC for the management of the project:

- The provincial REDD+ Unit, in charge of coordinating all activities related to landscape management and REDD+ in the Zambézia province under the supervision of the national REDD+ unit;
- IGF (International Foundation for Wildlife Management), supporting ANAC for the management of the Reserve in the central and buffer areas;
- Agrisud International (ASI), responsible for designing tailored agro-ecological systems for the specific conditions of the surroundings of the GNR. ASI has been supporting communities to adopt those systems since 2014. From 2017 onwards, the support to conservation agriculture in the surrounding of the GNR will be provided by Etc Terra's team.
- Etc Terra, responsible for the redaction of the present document and for the MRV of the REDD project. In 2017, Etc Terra will start to support communities around the GNR in order to improve their agricultural techniques, decrease deforestation and promote specific value chains.

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Role in the project	Provincial coordinator
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Organization name	Etc Terra - Rongead
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Role in the project	Conservation agriculture support
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1.5 Project Start Date

The project start date corresponds to the creation of the buffer zone around the GNR, which was the first activity to reduce deforestation in the project area. Agreement on its delimitation was reached on November 1st, 2011. Its limits were published in the official journal of December 30th, 2011 (see section 1.8.1). Hence, to facilitate definition of the temporal boundaries, project start date was set on January 1st, 2012.

1.6 Project Crediting Period

The project crediting period is 20 years, starting from the beginning of the project on January 1st, 2012, and ending on December 31st, 2031.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

The project will generate less than 300,000 tCO_2eq; according to VCS standard definition, it is not a large project.

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO_2eq)
2012	3,439
2013	8,820
2014	21,705
2015	31,508
2016	51,248
2017	81,596
2018	103,347
2019	117,862
2020	132,914
2021	135,773
Total estimated ERs	**688,212**
Total number of crediting years	**20 years**
Average annual ERs (over 10 years)	**68,821**

1.8 Description of the Project Activity

Small-scale agriculture is, by far, the first driver of deforestation in the project zone. It is due to itinerant ("slash and burn") agriculture, especially for the production of maize and cassava, based on a land extension strategy, aiming at optimizing work productivity – and, to a lesser extent, overcoming poor soil fertility (see section 1.10 and Mercier et al., 2016). Hence, the main agents of deforestation are the households living near forest edges. Deforestation practices for slash and burn agriculture are also serving charcoal production: it has been observed (survey conducted in 2015) that the production of charcoal is almost exclusively derived from trees that are selected in areas that will be deforested for the opening of agricultural fields in the near future – in the project area, charcoal production does not have any additional impact on forest cover, relatively to agriculture.

The forestry sector (inside and outside of forest concessions) is a driver of forest degradation in the project zone but emissions related to this activity are considered as *de minimis* in the project area (see section 4.2.1). This is mainly linked to (i) a too frequent attribution of exploitation licenses to private companies, (ii) a miss-respect of concessions management plans in the reference region and to (iii) illegal logging for precious timber species (especially *Swartzia madagascariensis*) in the GNR and surrounding areas.

The activities developed for the project in order to reduce deforestation are the following:

- Conservation of the forest in the project area: an extension of the size of the Reserve was negotiated in 2011 to improve conservation efforts with the addition of a buffer zone around the central zone of the Reserve. Some activities are allowed for communities in this area but should not jeopardise wildlife and tree biodiversity.
- Improvement of the management of the whole Reserve and development of anti-poaching activities.
- Development of agro-ecology techniques in the communities living around the GNR in order to find alternatives to slash and burn agriculture, which is the main cause of deforestation in the area.
- Improvement of cashew tree cultivation and of its value chain to help producers raising quality and quantity produced and to increase prices.

These activities are further described in the following sections. The project is part of a jurisdictional REDD+ program that is currently being developed and supported by the World Bank for submission to the FCPF-CF. The program is also described later.

In order to develop these activities and to elaborate the present PDD, the GNR REDD project beneficiated from a 2 phases funding from the FFEM (see section 2.5.2 for details):

- The 1st phase focused on the GNR management (central zone and creation of a buffer zone) for conservation purposes from 2008 to 2012, with a partnership between IGF and ANAC. This phase was cofounded by COSV (Italian NGO that worked in the GNR area), MITUR (Mozambican ministry for Tourism), and the FAO.
- The 2nd phase, from 2014 to 2016, intensified the work with communities in order to find alternatives to slash and burn agriculture and lower deforestation.

Through validation and starting from the first verification date of the present PDD, the GNR REDD project aims at selling carbon credits that will contribute financing the activities described hereafter.

1.8.1 Conservation of the Reserve (buffer and central zones)

Since the GNR REDD project is being developed around a national Reserve, the conservation component holds a crucial place in the project design. The GNR is managed by the ANAC with support from the NGO IGF since 2008.

Creation of a buffer zone around GNR (Project Area)

The first activity of the project was the creation of the buffer zone – of which the forests are composing the project area of the REDD project – around the central zone of the Reserve. Although the Mozambican law requires buffer zones to be created for Reserves, the buffer zone of the GNR had not yet been achieved since the creation of the GNR in 1932. The delimitation of this zone was defined by the ANAC (Reserve manager and project proponent) in close collaboration with local communities (see CCB PDD) and other departments of the government of Mozambique. It was officially enforced through the November 1st, 2011 decree – published on December 30th, 2011. A management plan of the buffer zone was designed and submitted to the communities. Since then, the following rules have to be respected (Fusari et al. 2010):

- Agriculture: no specific regulations exist regarding this activity as it is a subsistence activity.
- Timber forest product: no specific regulations exist regarding this activity in the management plan of the Reserve but, at national level, a ban on *Pau ferro* (*Swartzia madagascariensis*) exploitation[1] has been enforced since 2016 and logging of other species for exportation necessitates a permit. Hence, logging is forbidden in the GNR but it is allowed for domestic purpose only in the buffer zone.
- Non-timber forest products:
  - Hunting: the use of fire guns, of non-selective traps (as wolf traps – Figure 9) and of hunting dogs is forbidden in the whole GNR (central and buffer zones) because they are too destructive techniques and can be dangerous for communities (especially traps). Only traditional hunting techniques, based on the use of nets, are allowed in the buffer zone as it is selective and has a strong cultural importance. Awareness rising on the selection of prey (no females, young or protected species) comes along this authorisation.
  - Fishing: traditional fishing techniques are allowed as they do not seem to be too destructive and are necessary for the subsistence of local households. Awareness rising activities on the use of other techniques (fish baskets and poison) are developed.
  - Other: no specific regulations exist regarding the collection of vegetal products or mushrooms. Collection of honey is limited to a quota of 3 kg per year and per households as it implies the destruction of trees for harvest. Collection of reptiles or amphibians is forbidden because they are vulnerable species.
- Mining: it is forbidden in the buffer and central zones.

In various communities around the GNR, some local committees for the management of natural resources in the Reserve and in the buffer zone were created. These committees are called CGRN and are involved in decision-making (types of products, zones for collection, quotas, etc.) dealing with the implementation of the Reserve management plan. The following map presents the location of the main communities implied in the REDD project where the CGRN are present.

[1] The DM 10/2016 banned *Pau ferro* from logging for 5 years. The law entered into force on January 1st, 2016. The same document decrees closed in exploration of the species that produce the first class wood for 5 years period too.

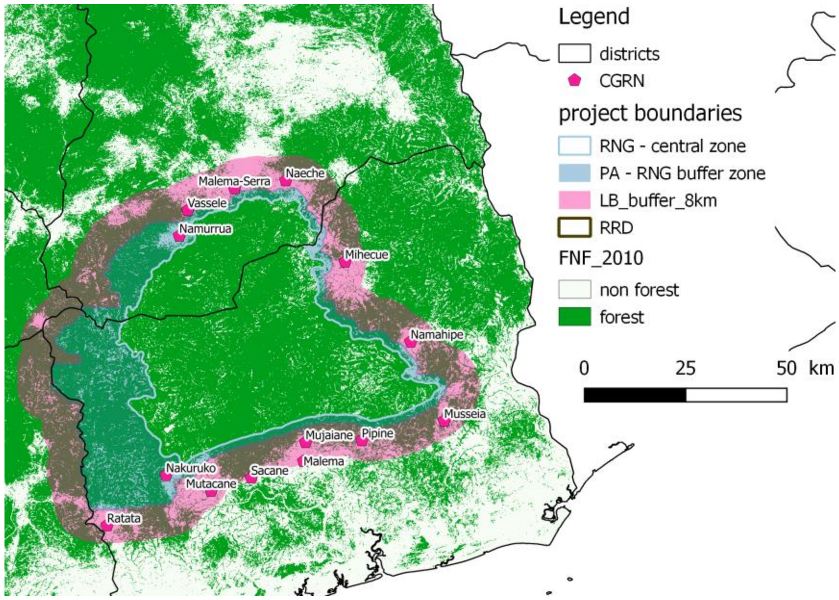

Figure 2: Map of the CGRN around the GNR

Central zone management:

Besides the creation of the buffer zone, since the beginning of the project, the following management activities occupy a central place in the implementation of the GNR conservation strategy, in addition to day-to-day actions:

- Anti-poaching activities, through permanent presence of rangers into the Reserve and the control of roads to arrest trucks transporting illegal logs. Poaching applies for hunting or illegal logging of *Pau ferro*.
- Fire management, by starting, at the beginning of the dry season, early fires that are not destructive for forest cover and wildlife in comparison to intense fires of the end of the dry season, when a high quantity of herbaceous dry material is available.
- Reintroduction of wildlife and monitoring of big mammal populations: considering the damages of hunting and of the civil war in the past, which led to the disappearance of some animal species, a reintroduction program was set-up. Several individuals of species that are natives from Mozambique have already been successfully reintroduced (zebras, buffalos and wildebeest) and others will be in the following years. A monitoring of their population is done frequently (see description in the CCB PDD, biodiversity section).
- Management of Human/Elephant conflicts: GNR technicians are training local communities to the use of chili-guns that throw balls that do not hurt elephants but have a chili taste, known to scare elephants away.
- Development of tourism: the aim is to rehabilitate existing infrastructures for tourism purposes, including walking *safari* in the Reserve, or for hunting purposes, as described hereafter.

Game hunting area (Coutada):

This area is located in the western part of the buffer zone of the Reserve. Its goal is to enhance tourism for game hunting of big mammals with reasoned quotas for the sustainability of animals' populations. Benefits of such a tourism system will be shared between the GNR and the local communities of the area (Impaca and Nakurugu). Hence, this should contribute to increase the interest local population in the conservation of wildlife populations, which become an additional source of incomes; it should also fund some other activities of the GNR. Although the system is not operational yet, the status of this area is already existing, with some estimation of the quotas that could be applied.

1.8.2 Development of agro-ecology as an alternative to slash and burn agriculture

The main cause of deforestation in the project zone is slash and burn agriculture. Agro-ecological techniques (also called conservation agriculture techniques) were designed by Agrisud International in order to maintain fertility in the agricultural soils and, therefore, reduce the need to open new plots of forests. These techniques should lead to an increase of yields and so, of household's revenues. Promoted techniques are based on existing systems that are improved for better soil fertility management:

- Adapted association of crops: cassava or maize (most common food crop) with leguminous (peanuts, pigeon peas, etc.);
- Development of intensive market gardening and orchards;
- Permanent ground cover with crops or mulch;
- No ploughing;
- Conservation of main trees in fields to maintain soil and some carbon stocks – preference for leguminous trees;
- Plantation of small leguminous tree or shrub around field that can also furnish fruit or other products;
- Preparation of compost for banana plants fertilisation and of liquid organic fertilisation for other systems;
- Pruning of fruit trees (citruses and cashew nut trees);
- Preparation of organic pesticides (with Neem and Tabaco).

Figure 3: Agro-ecological systems designed and implemented by ASI with farmers around the GNR – on the left: association of cassava and peanuts and on the right: pineapple field

This activity is so far led by the NGO Agrisud International, who has based several technicians in the communities in the project zone. These technicians give day-to-day advices to the farmers they are working with. In exchange for this technical assistance that will improve their yields, farmers commit themselves to respect the GNR rules and to limit the expansion of their cultivated areas on forest cover. Moreover, land use plans are developed in communities who are benefiting from agro-ecology support. They ensure the sustainability of land use for agriculture and the conservation of delimitated forests. They are realised in a participatory manner with technicians and community members and then distributed in the communities involved (Figure 4).

Figure 4: Land use plan realised by ASI with the communities of the project

1.8.3 Support to cashew nuts value chain development

The cultivation of cashew trees was introduced in Mozambique about 300 years ago; it is now well spread in all the country and around the GNR, where 42% of the population have cashew trees (Rabany 2014). In the intervention area, people have 5 to 10 trees around their dwelling as a source of additional income. Even if trees maintenance is minimal and yields are low, this is a significant source for households around the GNR. However, selling prices are still low because of poor negotiation power with collectors and no storage capacities.

In order to improve farmers' incomes in the area, the following supports from the GNR project will be proposed:

- Support on tree maintenance for yield improvement, including:
    - Maintenance of cashew trees by pruning and pest biological control;
    - Introduction of inter-cropping (Figure 5) that (i) have positive sanitary effects on trees; (ii) can lead to the improvement of yield by increasing water infiltration and organic matter for soil; and (iii) favor weeding of herbaceous, which diminish vulnerability to fires;
    - Promotion of the creation of new orchards (with maintenance strategy following the promoted agro-ecology techniques) around dwellings, through the distribution of improved seedlings, freely made available by INCAJU.
- Diffusion of market information to favour higher prices for producers:
    - Diffusion of market information to producers by text messages in order to help producers get better selling prices.
- Local processing of cashew nut to increase added value:
    - Eventually, in the last phase of the project, if a market for zero-deforestation and fairtrade cashew nut can be identified, a local processing factory could be implanted in order to add value to the exported product beneficiating to local population while guaranting a good quality product.

In return for this technical and market assistance, farmers commit themselves to respect the GNR rules and to limit the expansion of their cultivated areas on forest cover. By increasing incomes, local populations' well-being is expected to be improved and their dependency to slash and burn agriculture (leading to deforestation) reduced.

Figure 5: Cashew tree cultivation systems – left: trees in fallows without maintenance; middle: plantation with maintenance; right: inter-cropping of cashew tree with peanuts

1.8.4 Continuation of activities through Mozbio project

After the end of the present project, activities on the ground will be financed for at least two additional years through the Conservation Area for Biodiversity and Development Project (Mozbio) project, which is also part of the ZILMP (see following section).

The Mozbio project is a large-scale project, supported by the World Bank and focusing on selected conservation areas in Mozambique, with a total budget of USD 46.32 million (at national scale), financed by the International Development Association (IDA) and the Global Environment Facility (GEF). It is also implemented by the ANAC (REDD project proponent), with an overall objective of increasing the effective management of conservation areas and enhancing the contribution of these areas to the living conditions of surrounding communities in Mozambique. It is expected to directly benefit local people living within and around the targeted conservation areas through the promotion of sustainable livelihood activities.

The GNR and its surrounding have been identified as one of these targeted conservation areas and, as such, benefit from a specific component dedicated to piloting sustainable community livelihoods (US$ 1.35 million). Led by Etc Terra (present project partner), in consortium with IGF (present project partner also), this component includes various pilot activities that are implemented in the districts of Gile and Pebane to address the main drivers of deforestation and forest degradation and to promote sustainable forest resources management by local communities and sustainable economic development. Building on the present project, the activities carried out in Mozbio comprise: (i) law enforcement and enhanced protection of biodiversity in and around the GNR, through capacity strengthening and improved surveillance, in order to reduce illegal logging of precious timber species and animal poaching; specific measures to reduce wildfires are also planned; (ii) the development of community management plans for non-timber forest products such as mushrooms or snails, with the establishment of specific collecting allowances, in cooperation with CGRNs; (iii) the promotion of improved techniques for charcoal production, including the training of pre-identified charcoal producers and the establishment of plantations for energy purposes; and (iv) the promotion of a sustainable use of forest focusing on the restoration of degraded lands, with assisted natural regeneration techniques, improved management of fallows and the creation of nurseries to produce indigenous tree species seedlings.

In addition, from January 2017 onwards, agricultural activities around the GNR are all managed by Etc Terra and integrated in the Mozbio project. They include: (v) the promotion of conservation agriculture practices (technical assistance, inputs and seedling, monitoring), with agroforestry systems and locally adapted varieties; and (vi) the valorization of the cashew value chain to increase smallholders' revenues (technical assistance to smallholders for cash crops production, including training on quality standards, and continuation of the Kohiwa information system, based on information newsletters, radio messages and text messages to inform producers on a weekly basis on the cashew market dynamics and prices).

All in all, the Mozbio project was designed and is implemented in the surrounding of the GNR so as to extend the dynamic initiated by the present project following its end, in order to ensure the continuation and further development of key activities that are contributing to reducing deforestation and forest degradation. The fact that Etc Terra and IGF are leading these activities ensures effective linkages of the activities and the promotion of long-term synergies.

1.8.5 Inclusion in a jurisdictional REDD+ initiative: the ZILMP program

The jurisdictional REDD+ program called "Zambezia Integrated Landscapes Management Program" (ZILMP) was, on purpose, elaborated around the GNR (see Figure 6), where large areas of forests still exist and initiatives to lower deforestation are already being implemented. At this stage, an ER-PIN was successfully presented by the Government of Mozambique to the FCPF-CF in 2015[2] and an ER-PD is currently being developed – it will be submitted at the end of 2017.

The present project is fully included in the ZILMP program area (Figure 6) and the GNR REDD project partners are working in strong collaboration with the ZILMP development team. Initially, and in order to facilitate future inclusion in the ZILMP – with the same methods – the reference level and the baseline of the project were derived from the ZILMP ones. However, during the elaboration of the present document, the method used by the ZILMP program for the analysis of historical deforestation changed for the national REL (that was just developed) and it was no more compatible with VCS standard and VM0007 requirements. Therefore, the initial deforestation map of the ZILMP area, produced for a background study in order to respect those requirements, is used for the present project. Emission factors, however, are the same for the project and the program. In the future, the Project will do his best to align with the Program as long as VCS standard is respected. Emission reductions achieved by the project will also be monitored and accounted for within the ZILMP.

1.9 Project Location

The project is located in Mozambique, in the Zambezia province and, more precisely, in the 2 districts of Gilé and Pebane (see Figure 6). The project area is composed of the forest of the buffer zone of the GNR, the GNR being one the most important pieces of Miombo still existing on the African continent. The GNR buffer zone was composed of 124,145 ha of Miombo forest in 2010 (which is therefore the size of the Project Area) at the end of the reference period (project start date is 01-01-2012).

[2] https://www.forestcarbonpartnership.org/mozambique

On the following figure, the location of the GNR in the ZILMP area (see section 1.8.5) is presented.

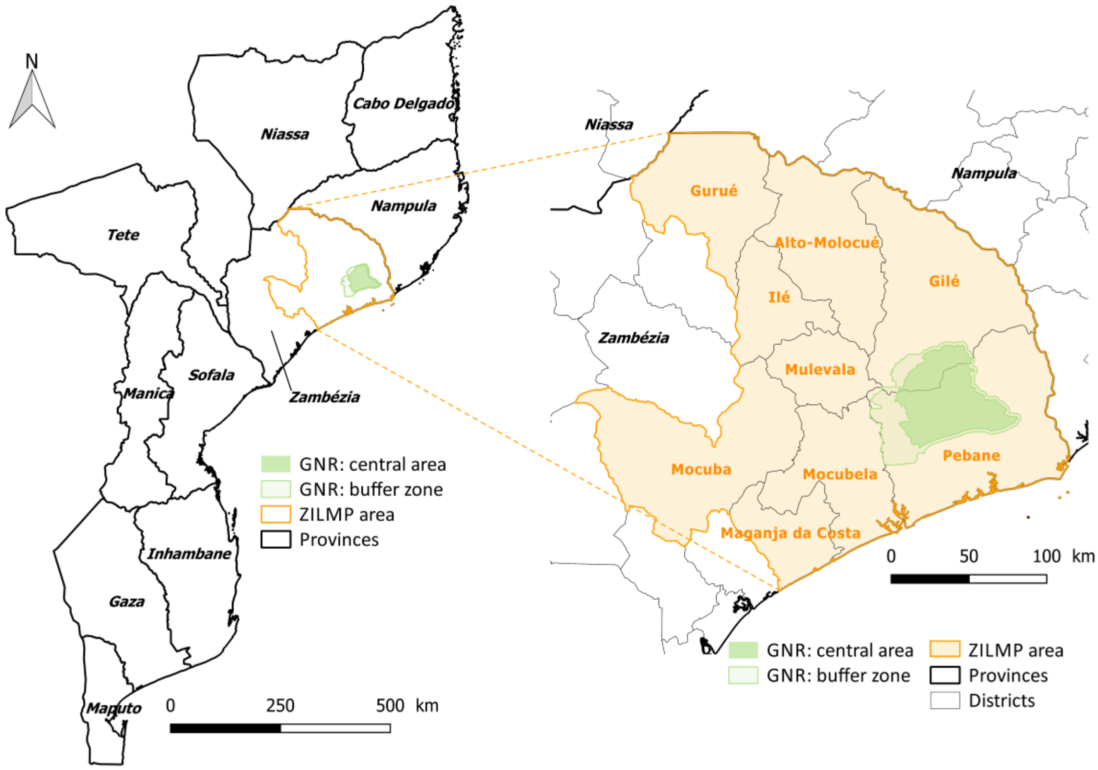

Figure 6: Location of the GNR and of the ZILMP area in Mozambique

1.10 Conditions Prior to Project Initiation

The present REDD project is developed around the Gilé National Reserve (GNR) in the Zambézia Province, in Northern Mozambique (Figure 6). The 2,100 km² Reserve (central zone) was created in 1932 for, initially, hunting purposes (game Reserve) – only black rhinos and elephants were protected. It became a conservation area in 2000. Composed of Miombo forest, the GNR used to be one of the most preserved treasures of biodiversity in Mozambique – it hosted, for instance, the last black rhino population of the country. However, it suffered from the collateral damages of years of uncontrolled hunting, political instability and civil war: in 20 years, its wildlife was reduced to almost zero.

Since the beginning of the REDD project, the Reserve is managed by the ANAC which, since 2007, is supported by the NGO IGF, financed inter alia by the FFEM, to improve the management of the Reserve. Biodiversity of the RNG and its surroundings is presented in detail in the CCB project document elaborated in addition to the present PDD.

1.10.1 Environmental conditions

Topography and soils:

Topography is relatively flat with elevation lower than 500 m (129 m of altitude in average, standard deviation 55 m) and low slopes. Rocky high elevation areas correspond to inselberg and are covered by small vegetation, representative of dry areas.

Two types of soil are present in the area, with different fertility: (i) white sandy soil are distributed in the South of the area and have a low fertility and water retention capacity; (ii) brown loamy and sandy soils are located in the North with higher fertility and water retention capacity (Berton 2013).

Climate:

The climate is characterised by a dry season from May to October and a humid one from November to April, with mean annual rainfall between 800 and 1,000 mm. Temperatures vary from 13°C (minimum in June, in average) to 37°C (maximum in October, in average).

Hydrology:

Several rivers are crossing the project zone. Some of them can dry out during the dry season while the main ones continue flowing. Three main rivers can be mentioned: Mulela in the West of the GNR, Molocué river in the East and Malema inside the GNR. Although fishermen are used to cross them with artisanal dugouts (canoes), these rivers are not use to transport goods. No lakes or permanent ponds are present in the project zone. Only *dambos*, which are humid areas with hydromorphic soils, are present – but they dry out during dry season.

Vegetation:

The forest in the Reserve and its surroundings is typical Miombo dry forest, with the occurrence of open wetland and grassland areas called *dambo*. Miombo is characterised by species from the genus *Brachystegia*, *Julbernardia* and *Isoberlinia* (Campbell 1996). The GNR is one of the last area in Mozambique with a relatively large abundance of the tree species *Swartzia madagascariensis (pau ferro)* that faces over-exploitation in the whole country. In the project zone, the following types of vegetation were identified – but dense forest types cannot be differentiated by carbon stocks (Prin 2008):

- Dense forest with *Julbernardia globiflora* and *Dalbergia nitidula;*
- Dense forest with *Dalbergia nitidula* and *Brachystegia spiciformis;*
- Dense forest with *Diplorhynchus condylocarpon*, *Combrandum* and *Brachystegia bohemii;*
- Riparian forests with *Pandanus livingstonianus;*
- Dambos composed of herbaceous species;
- Savanna with *Hymenocardia acida* and *Parinari curatellifolia.*

Figure 7: Miombo forest and track used by illegal loggers in the GNR

Fauna:

The GNR and its buffer zone still host various species that holds the “vulnerable” and “endangered” status as defined by IUCN, including; (i) mammals: African elephants (*Loxodonta Africana*), Temminck's ground pangolins (*Smutsia temminckii*), Hippopotamus (*Hippopotamus amphibius*), African wild dogs (*Lycaon pictus*); and (ii) birds: Southern ground hornbills (*Bucorvus leadbeateri*) and Martial eagles (*Polemaetus bellicosus*), Expected evolution of wildlife without project and measures taken in the context of the project are described in details in the CCB project document.

Population and accessibility:

The only town in the project zone is Gilé (22,000 inhabitants). It is accessible through a dirt road from the concrete road linking Quelimane (Zambezia Province capital) to Nampula (Nampula Province capital). One dirt road links permanently Gilé to the South of the Reserve, in the West of the GNR.

Nobody lives inside the Reserve (which is exceptional in Mozambique) but about 32,000 inhabitants live around it including 12,000 persons in the buffer zone of the Reserve. They belong to different ethnic groups who cohabit without troubles. The main languages are Lomwé, Macua and Muniga in addition to Portuguese – official languages.

1.10.2 Deforestation and forest degradation

In the project zone, deforestation is, by far, driven by small-scale agriculture based on "slash and burn" techniques that are also interlinked with charcoal production.

Degradation of forest is caused by unsustainable logging practices in forest concessions (lands attributed for forest exploitations to private companies as explained hereafter) and illegal logging of precious timber, including out of the concessions and in the central zone of the Reserve.

Expansion of small-scale agriculture and its link with charcoal production

Whereas there is no large-scale agricultural project in the project zone, small-scale agriculture is, by far, the first driver of deforestation in the buffer zone of the GNR. It is due to itinerant ("slash and burn") agriculture, especially for the production of maize and cassava, based on a land extension strategy, aiming at optimizing work productivity – and overcoming poor soil fertility. The first agents of deforestation in the project zone are, therefore, the local population and smallholders.

Traditionally, in Mozambique, smallholders are mostly relying on subsistence agriculture, most of the production being consumed within the household. It is a familial agriculture, practiced by smallholders in rural area. These smallholders' farming systems are capital extensive and use few inputs: less than 5% of households use mineral fertilizers (Leonardo et al. 2015). The cultivation system is usually made in mix fields, including cereals (especially maize), tubers (cassava, sweet potatoes, yams), legumes (peanuts, beans) and horticulture, but the two main food crops are, by far, cassava and maize (Sitoe et al., 2012). Maize and cassava play a key role in the population's diet: those two crops alone represent more than 50% of caloric intake across the country, according to FAO 2011 Food balance sheet (Mercier et al., 2016).

This tendency also applies to the project zone where, according to a survey led in 2015[3] by Etc Terra with communities around the project zone for the development of the present PDD (database available at validation), small-scale agriculture is the main economic activity for 89% of the population. Just like in the rest of the country, where only 5% of households use mineral fertilizers, the main available resources for farmers in the project zone are their land and labor. In the same way, the two main food crops also are cassava and maize, of which most of the production is realized in mixed-fields. Studies have shown that maize cultivation by smallholders is not constrained by land but by labor availability during peak season, especially for weeding (Leonardo et al., 2015; Baudron, 2009). In the current project zone, with no access to external inputs (no animal traction, no mechanization, no fertilizers) and as long as forest land is available, the easiest way to increase labor productivity is to seek better natural fertility and lesser weed presence in newly cleared areas. In other words, in order to reach soils with better fertility and to facilitate fields' maintenance, smallholders are used to open cropland in forest areas by felling trees around villages on about 1 ha per household. In savannahs, competition with herbaceous species implies frequent hoeing that inefficiently increases work-load for lower yield. After 2 or 3 years of cultivation, smallholders would cultivate another forest area; in the meantime, soil fertility would increase again and be restored in the abandoned fallow on which they would come back, after 2 to 10 years,

[3] database of the survey available at validation

depending on the household (fallow duration is 2.2 years in average, according to the survey on household practices that was conducted around the GNR in 2015). Multiple cycles of cultivation on lands, especially when fallow time is short, lead to soil depletion and to the need of conversion of new forest area.

This phenomenon increases with demographic pressure, as new households also need to settle down. Also, land use rights are regulated by customary law, which presents few constraints in terms of agricultural practices. In each village, a traditional figure of authority keeps a memory record of the areas that are free of regulations and people can freely use forest-lands. Usually, the land belongs to those that value it – i.e. including through slashing forest for field settlement.

Admittedly, smallholders' move towards extensification rather than intensification is the very basis of the deforestation mechanism we observe in the project zone (Baudron et al. 2012). **Around villages, the expansion of agriculture has been the main cause of deforestation for decades; it explains the existence of circular non-forest patches around villages (Figure 21). In addition, at the beginning of the project, deforestation due to the expansion of agriculture was gaining the central zone of the Reserve (Figure 21), jeopardizing its integrity.**

Deforestation practices linked to slash and burn agriculture are also serving charcoal production. Charcoal is produced in the area but only around urban centers, where this energy is consumed. Charcoal production is concentrated next to the roads (on a 2-km radius in average) and especially in areas characterized by a good availability of resources – that is, areas where forest cover is higher. In the project zone, it applies to the city of Gilé. According to the 2015 socio-economic survey[3] of local communities around the Project Area conducted by Etc Terra in order to better understand the practices leading to deforestation, the production of charcoal is almost exclusively derived from trees that are selected in areas that will be deforested for the opening of agricultural fields in the near future. Consequently, in the project zone, charcoal production is associated with slash and burn agriculture and does not have any additional impact on deforestation or forest degradation, relatively to agriculture. In rural area, the energy used is firewood which is mainly composed of the dry branches of tree cut during the slash and burn process for the opening of a field. This source of firewood is free for all members of the community thus there is really few collection events on other areas than fields (Trégourès 2015). If this may happen, people would collect dead branches that fall down from trees near villages.

Forestry and illegal logging

In Mozambique, forestry sector is defined by forest concessions (allocation of lands to private companies for 50 years, which requires a precise management plan) and simple licenses (5 years permit for a maximal harvesting amount of 500 m^3 per year on an area that should not exceed 10,000 ha; for Mozambican citizens, only). In recent years, the total surface of land granted in concessions and simple licensing has significantly increased in Zambézia province: in 2011, operational concessions and simple licenses represented, respectively, 15% and 4% of the area covered by the seven districts of Gilé, Pebane, Ilé, Alto Molocué, Mulelava, Mocubela and Maganja da Costa; in 2015, they represented, respectively, 31% and 21% of this area (Mercier et al., 2016). Yet, the most important driver of forest degradation in the project zone is, precisely, the forestry sector. Few forest concession operators are fully compliant with legislation and operational requirements. Outside of forest concessions, in the buffer zone of the GNR, illegal logging accounts for most of forest degradation, with a thorough process of tree selection based on precious timber species.

Around the Reserve, forest concessions and simple licenses are attributed for legal forest exploitation (Figure 15). However, illegal exploitation still occurs in those areas; it is mainly due to the non-respect of defined management plans and concessions boundaries (Ekamn et al., 2013; Mackenzie, 2006; Wertz-Kanounnikoff et al., 2013)[4]. The commercial exploitation of native trees species is done through a selective regime (species and sizes): although the list of commercial timber species in Mozambique's legislation recognizes about 118 species, less than 10 species are actually exploited for commercial purposes (Sitoe et al., 2013). In the project zone, the main targeted species are: *Jambire - Millettia stuhlmannii, Umbila - Pterocarpus angolensis, Pau ferro - Swartizia madagascariensis, Pau preto - Dalbergia melanoxylon*. The presence of forest concessions does not restrain access to lands for agriculture and therefore, does not reduce deforestation (Mercier et al., 2016).

In addition, in the buffer zone of the GNR and in the central zone, illegal logging is responsible for forest degradation. *Pau ferro* (iron wood – *Swartzia madagascariensis*) is by far the main timber forest product that is illegally exploited in the Reserve and its surroundings. It is logged by the local population, who is hired by Chinese entrepreneurs, for exportation in Asia. Since only specific trees of interest are selected, this leads to forest degradation – rather than deforestation. Similarly, tracks for the trunks used for transporting logs are also responsible for forest degradation (Figure 7). Although it occurs in all project zones, this totally illegal exploitation is mainly located in the central zone of the Reserve; it is highly valuable for loggers. Seeking to address the risk of the disappearance of the Pau Ferro due to this over-exploitation (mainly illegal – Mackenzie, 2006), a national ban on its exploitation and exportation was published in 2016. However, for now, it does not seem to have an effect on illegal timber exploitation in the GNR.

It should be noted that forest degradation due to forestry and illegal logging is essentially driven by the international demand and failure of local law enforcement. As stated by Mercier et al. (2016), in Mozambique, the total exported wood quantities are higher than the licensed quantities: most exports are illegal and, therefore, excluded from official reports (Mackenzie 2006a; Mackenzie and Ribiero 2009). Statistical analysis conducted by the Environmental Investigation Agency (EIA, 2014) estimated that, in 2013, 93% of all commercial logging in Mozambique was illegal; between 2007 and 2013 it was, in average, 81% of commercial logging (EIA, 2014). More importantly, 50% of the quantities of timber shipped out of Zambézia is believed to be illegal (Ekamn, Wenbin, and Langa E. 2013b; Mackenzie 2006a; Mackenzie and Ribiero 2009). Illegality lies in different practices, from illegal harvest that do not respect management plans to violation of labor laws, violation of transport laws and illegal exports of unprocessed timber for first class species (Ekamn et al., 2013; Mackenzie 2006; Wertz-Kanounnikoff et al., 2013).

[4] In 2015, the Government of Mozambique held a nation-wide evaluation of 154 forest concessionaires and 727 simple license holders to assess their compliance against a set of criteria based primarily on national legislation. This first evaluation revealed low levels of compliance of the sector with national legislation. In the same way, according to a comprehensive evaluation of Mozambique's forest concession operators in February 2016, only 7 concessions (5%) were fully compliant with legislation and operational requirements. Most forest management plans are outdated or not implemented, technical capacity is low and concessions lack of investments in regeneration, reforestation or protection activities.

Figure 8: Illegal logging (*Pau ferro*) in the GNR

1.10.3 Forest resources exploitation for non-timber forest products (NTFP)

In addition to these, local populations are using forest for the collection of non-timber products, which include: (i) several species that are used for feeding (mushrooms, insects, fruits, leaves, lianas, honey and roots), medicines or rope making; (ii) animals that are hunted for meat (small mammals and medium antelopes) with several types of traps or guns – even though those are forbidden (Fusari et al. 2010, Romann, 2016). Admittedly, unbridled hunting during colonialism as well as the civil war have eased animal poaching and led to a situation where, at the beginning of the project, rare animal species were very low. Regarding emblematic fauna, elephants are still present but rhinos locally disappeared. Since the beginning of the project, the ANAC and IGF have reintroduced some species with relatively good success: African buffaloes, zebras and wildebeest. Locally extinct, they are nevertheless all native species.

Figure 9: Traps used for hunting by local population around the GNR

1.10.4 Evolution of conditions and creation of the buffer zone

The main tendencies of local activities in the Reserve and its surroundings prior to the beginning of project implementation are described hereafter:

- Continual expansion of agriculture, which gained the boundaries of the central zone of the GNR, with increasing loss of forests cover;
- Increasing forest exploitation (for *Pau ferro*) and artisanal mining;
- Continuation of poaching of fauna in the Reserve on the remaining populations of large animals, with increasing loss of biodiversity.

This situation constitutes the baseline of the project.

In order to change this situation, it was decided to create a buffer zone around the GNR. Although the idea of the buffer zone was formulated at the creation of the GNR, it had never been applied. A new area was therefore designed and discussed with communities and the Government of Mozambique; it was officialised by decree at the end of 2011 (beginning of the project). The aim of this buffer zone is to improve the conservation of the Reserve (forest and fauna) by restricting a few activities of the communities in the area, including:

- The use of guns, traps or dogs by local population for hunting purposes. Only the traditional use of nets is allowed;
- The attribution of new forest exploitation licences;
- All kinds of mining activities;
- The collection of non-timber forest products should be regulated after an assessment of the degree of pressure on those resources.

Slash and burn agriculture is not forbidden. Close collaboration with the communities living around the buffer zone and affected by the project should help promoting alternative activities, such as conservation agriculture or the development of cashew nut value chains (see section 1.8), in order to reduce deforestation in the area and, especially, in the buffer zone (project area). This is expected to create a protection for the Reserve against the expansion of agriculture.

In the meantime, activities to improve the management of the whole GNR are implemented in order to protect wildlife. These activities respect the following axes (see section 1.8.1 for more details): law enforcement to reduce poaching (of fauna and flora); re-introduction of species under protection status and that were initially present in the GNR; and creation of a tourism hunting area with sustainable management in order to generate new revenues to local populations. Various mechanisms to manage conflicts between farmers and elephants are also implemented. Moreover, early fires are triggered to prevent strong fires, which are prejudicial for the forest, from occurring at the end of the dry season.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

Since the 1992 Rio Conference on Sustainable Development, the GoM has been undertaking a legal and institutional reform movement to improve the country's ability to manage environmental issue. Those efforts can be observed in local, regional and national laws and regulatory frameworks as well as in the GoM's commitment to international treaties and conventions.

1.11.1 Relevant local, regional and national laws, statutes and regulatory frameworks

Consistency of the project with national development policies and with REDD+ Strategy

The proposed GNR REDD Project is highly consistent with national policies and development priorities in Mozambique. Since the late 1990s and early 2000s, the adoption of various national policies and the valorization of development priorities linked to the reduction of carbon emissions, carbon stock enhancement, and sustainable management of forest and conservation areas has shown the commitment of the GoM to REDD+ initiative.

This commitment has been confirmed with the new Government, who took office in February 2015 after general elections. In the aftermath, the new administration adopted a range of significant policies, such as a Five Year Government Plan (*Plano Quinquenal do Governo* - PQG) for the 2015-2019 period, for economic and social development (Governo de Moçambique, 2015b). The PQG settles five national priorities with, in particular, the 5th strategic pillar focusing on transparent and sustainable management of natural resources and the environment. One of the strategic objectives is to ensure the "conservation of ecosystems, biodiversity and the sustainable use of natural resources". In the same way, the National Sustainable Development Program (Governo de Moçambique, 2015a), promoted by MITADER, provides the key linkages between the country's priorities and REDD+, stressing the need to invest in resilience to climate change with emphasis on the agricultural sector[5]. The GNR REDD Project will contribute to those goals, reaching for the protection of biodiversity and the sustainable use of forest resources and economic rural development through the promotion of sustainable agricultural practices as well as of diversified agricultural production and increased efficiency of charcoal production, through a better management of wood resources, among other components.

Further, the GNR REDD Project has a strong social component and seeks to increase the participation of stakeholders in order to reduce poverty around the GNR: it is coherent with the strategic goals of the Forest Policy and Strategy (2016-2020), especially in relation with its objectives of (i) social participation and equitable benefit sharing mechanisms; (ii) environmental sustainability on the use of forest resources and (iii) increase of the economic contribution of forests to the country's development. It is also fully aligned with the Forest Investment Plan (FIP) of the Climate Investment Fund (CIF), which was approved in January 2017, with a budget of USD 47 million, and is fully integrated to the ZILMP ER Program (see section 1.8.5).

Synergistic potential actions may also be identified in various sectors. For instance, the Ministry of Mineral Resources and Energy (MIREME) promotes actions linked to the production and sustainable

[5] As well as tourism and infrastructure.

use of biomass energy. It has been emphasized in the Strategy for Conservation and Sustainable Use of Energy from Biomass (Ministério da Energia, 2013) that lays down general guidelines for the production of biomass and its transformation into energy and sustainable use. By promoting sustainable techniques for the production of charcoal around the GNR, the GNR REDD Project contributes to this objective. In the same way, the intensification of agriculture to increase production and productivity and improve soil conservation through conservation agriculture techniques, which is an important component of the GRN REDD Project, is also defined as a priority in the Strategic Plan for the Development of the Agricultural Sector (PEDSA - 2011-2020) (Governo de Moçambique, 2011a) and, more importantly, the National REDD+ Strategy.

Approved in November 2016, the National REDD+ Strategy and its action plan promote "integrated multisectoral interventions to reduce carbon emissions associated with land use and land use change through adherence to the principles of sustainable management of forest ecosystems (natural and planted), contributing to global mitigation and adaptation to climate change and to the efforts for an integrated rural development" (MITADER, 2016a). Those coincide perfectly with the planned interventions of the GNR REDD Project, which is based on multiple actions that reflect a variety of interventions from the national REDD+ strategy in a coordinated manner. Mozambique's REDD+ Strategy comprises six strategic pillars, namely:

1. Cross-cutting actions: establish an institutional and legal platform for inter-agency coordination to ensure the reduction of deforestation;
2. Agriculture: promoting alternative sustainable practices to shifting cultivation, which ensure increased productivity of food and cash crops;
3. Energy: increase access to alternative sources of biomass in urban areas and increase the efficiency of production and use of biomass energy;
4. Conservation Areas: strengthen the system of protected areas and find safe ways of generating income;
5. Sustainable Forest Management: promote the system of forest concessions, community management and strengthening forest governance;
6. Restoration of degraded forests and planting trees: establishing a favorable environment for forest businesses, restoration of natural forests and planting of trees for various purposes, production and use of biomass energy.

Obviously, the GNR REDD Project is fully aligned with those objectives and, more specifically, with pillars n°2 (promotion of sustainable agricultural production); n°3 (promotion of improved charcoal production techniques); n°4 (protection of the GNR and the forest of its Buffer Zone); n°5 (support to community management and forest governance); and n°6 (with activities of ANR).

Both, the REDD decree and the Mozambican INDCs are currently under revision. With its permanent presence in Maputo (ANAC and Etc Terra) and its frequent discussions with MITADER, the Project team will follow the evolution of the national framework and apply to the Project any of the rules or regulations emerging from those processes. For now, no specific mention exists for private initiatives. Once the registry system for REDD initiatives will be operational, the Project will complete the procedure to avoid double counting and monitor at its scale all required indicators. The development of the REDD registry will start at the end of the year 2017.

Compliance of the GNR REDD Project with national legislation

The GNR REDD Project is not only in line with national development policies and strategies, including REDD+: it also fully complies with the strict national legal framework. Table 1 provides a list of the main legal instrument regulating the Environmental sector in Mozambique. As detailed below, the GNR REDD Project is well integrated to this framework.

At this stage, it should be noted that it is genuinely recognized that Mozambique has a progressive legal framework for the promotion of sustainable forest management (UT REDD+, 2015a), which seeks to balance social, environmental and economic issues, paying special attention to the role and benefits to rural communities. The very Constitution of the Republic of Mozambique of 2004 (Governo de Moçambique, 2004) specifies that the State shall adopt policies to "ensure the rational use of natural resources to safeguard its renewal capacity, ecological stability and rights of future generations" (Article 117, 2, d) as well as the “rational utilization of its natural resources” (Article 90, 2). The GNR REDD Project is fully keeping with this momentum, as it is expected to contribute to long-term sustainable management of forest in the GNR and its Buffer Zone by addressing the main drivers of deforestation and forest degradation while implementing innovative measures aiming to increase rural communities’ income in the area. By doing so, the GNR REDD Project aims to initiate a virtuous circle reconciling economic development and environmental preservation.

In the same way, the GNR REDD Project is fully in line with the Conservation Areas Law (n° 16/2014), which is applying to the Gilé National Reserve. In particular, this law provides for the adoption of specific Management Plans (which was adopted for the GNR) and promotes the involvement of communities legally living inside Conservation Areas and their buffer zones in income generating activities that promote biodiversity conservation. This is a core objective of the GNR REDD Project, as already stated.

In addition, the GNR REDD Project relies on the promotion of sustainable practices, which are, for the majority, based on conservation agriculture activities. In this senses, it is not expected to generate any sort of pollution or any acceleration of erosion, desertification and deforestation, respecting the requirements of the Environmental Law (20/97). In the same way, as stated in the PDD CCB (see the Biodiversity section), the Project does not comprise the introduction of any invasive nor alien species. In order to fully comply with the Regulation for the Control of Invasive Alien Species (Decree n° 25/2008), the project does not involve the introduction of any invasive species in the project zone, and only uses non-invasive species for the development of conservation agriculture with the promotion of agro-forestry systems based on cashew trees. Cashew trees have historically been growing in Mozambique, including in the project area, and Mozambique is considered to be a historical producer of row cashew nuts. The negative effect of cashew trees on native species is considered as inexistent: cashew trees have been growing in Mozambique for, at least, a century (Rabany, 2014) and their current repartition shows that they are not invasive species, since it is limited to areas where trees have been planted, without any natural regeneration elsewhere.

Other important legal acts with regards to land and forest management in Mozambique are the Forest and Wildlife Law (1999) - which sets the forest sector legislation - and the Land Law (1997) - which comprises procedures for land management. For these two laws, MITADER is the lead agency; it has dedicated directions focusing on these legal mandates. The laws are implemented through regulations and ministerial decrees, which provide some leeway for adjustment and improvement without further legislative action (UT REDD+, 2016).

More specifically, the 1997 Land Law created the concept of Local Community, also serving as the basic unit of natural resource occupation and use in the 1999 Forest and Wildlife Law. The "Local Community" is defined in Article 1(1) of the Land Law as follows: *"A grouping of families and individuals, living in a circumscribed territorial area at the level of a locality [the lowest official unit of local government in Mozambique] or below, which has as its objective the safeguarding of common interests through the protection of areas of habitation, agricultural areas, whether cultivated or in fallow, forests, sites of socio-cultural importance, grazing lands, water sources and areas for expansion".* Such a definition with its various elements of common interest centered on a coherent resource use strategy and system provides an ideal vehicle through which to implement REDD+ initiatives (Tanner, 2017), including the GNR REDD+ Project that focuses on behavioral change, new income sources and benefit-sharing activities and appeals to common interests. It is also coherent with the Environmental Law (n°20/97), which provides for the participation of local communities in the formulation of policies and laws related to natural resource management and the management of protected areas, such as the GNR. It has also been reinforced by the Ministerial Diploma n° 158/2011, which officially set specific procedures for consultation with local communities for the use of lands, recognizing their rights, in accordance with the Regulation of the Land Law.

Based on an extensive community consultation process and working in close collaboration with the 27 identified local communities living around the GNR and potentially impacted by the Project, the proposed GNR REDD Project is therefore fully aligned with both the Forest and Wildlife Law (1999) and the Land Law (1997), in particular with regards to the principles of local community participation in sustainable natural resources management in and outside protected areas - *for details on community consultation for the GNR REDD Project, see the PDD CCB.*

Finally, the GNR REDD Project Benefit Sharing Mechanism will also ensure that those communities receive the appropriate share of benefits resulting from the reduction of emissions as part of the Project's outcomes. These mechanisms are expected to be coherent with the Ministerial Diploma 93/2005, which established the mechanisms for channeling the 20% revenues from wildlife and forestry exploration towards the benefits of communities that inhabit the areas where the exploration of such resources is taking place. From 2017 onwards, those mechanisms will rely on the ZILMP Benefit Sharing Plan, which is currently being designed.

The following table summarized the main laws and regulations that are relevant for the GNR REDD Project or other REDD+ projects in Mozambique. It is adapted from the analyzed realized for the ZILMP ER Program.

Table 1: Summary of the main national regulatory acts relevant for the GNR REDD project

Acts	Description
Environment and biodiversity	
The Environmental Law **(nº 20/97)**	The Environmental Law acts like a framework law, establishing the pillars of the system of legal protection of the environment. It aims at defining the legal basis for the improved use and management of the environment and its components to achieve a system of sustainable development in the country. The legislation prohibits the pollution of all environmental components (air, soil and water) as well as practices that may accelerate erosion, desertification and deforestation. Article 4 establishes a range of basic legal principles, including the principle of rational use and management of natural resources, with a view to further improve the quality of life of the population and the maintenance of biodiversity and ecosystems. It also provides for the participation of local communities in the formulation of policies and laws related to natural resource management and the management of protected areas.
Regulation for the Control of Invasive Alien Species **(Decree n° 25/2008)**	This regulation provides for: (i) the protection of vulnerable and threatened species and ecosystems; (ii) the impeding of unauthorized introduction and dissemination of alien species and invasive alien species; (iii) the management and control of invasive alien species in order to prevent or minimize their damage to the environment and biodiversity; (iv) the eradication of alien species and invasive alien species that may damage ecosystems and habitats; (v) the carrying out of environmental impact studies under Decree nº 45/2004 of 29 September prior to the introduction of exotic species. As previously stated, the plantation of cashew trees planted in the Project context are not considered as an invasive species in Mozambique as proven by a century of presence in the country.
The Environmental Impacts Assessment (EIA) Regulation **(Decree n° 54/2015)**	Mozambique has developed a comprehensive regulation to cover the EIA process, which is included in the Regulation of the Process for Environmental Impact Assessment. The regulations are in line with the international environmental and social management best practices, including World Bank recommendations and procedures. The regulation details the procedures ad criteria for ESIA and ESMP and implies the categorization of projects and subprojects (A+, A, B or C). Although the MITADER is responsible for regulating the EIA in Mozambique, it is the project proponent's responsibility to ensure that standards and identified mitigation measures are met.

Acts	Description
Forest	
The Forests and Wildlife Law (nº 10/99) and its regulations	The objectives to be pursued under this act are to protect, conserve, develop and rationally use sustainable forest and wildlife resources for the economic, social and ecological benefit of current and future generations of Mozambicans. It promotes, *inter alia*, the protection and conservation of specific biodiversity components as well as specific flora and fauna species found in certain places. The law also identifies the principles of local community participation in sustainable natural resources management in and outside protected areas. It introduces Local Participatory Management Councils (COGEPs).
Land	
National Land Policy (Resolution n° 10/95)	The Land National Policy defines the Land as the property of the State in compliance with the guarantee of access and use for population and investors, in full recognition of customary rights of access and management of land for rural population.
The Land Law (nº 19/97) and its regulation	The Land Law defined the regulatory procedures for land management. It provides the basis to define access rights, land use rights and procedures for the acquisition and use of land title by communities and individuals. The same law and its regulation embody key aspects defined in the Constitution in relation to the land, such as the maintenance of the land as state property, which cannot be sold. It introduces *Direitos de Uso e Aproveitamento da Terra* (DUATs), which can be acquired by occupation according to customary norms and practices, the uncontested occupation of a land over a period of ten years or the attribution of discretionary concessions by the State. The law allows local communities to hold a collective DUAT over the area within which they have jurisdiction.
Technical Annex to the Regulation of the Land Law (Ministerial Diploma n° 29-A/2000)	This Annex defines the requirements for the delimitation of the areas that are occupied by Local Communities and individuals in "good faith", as well as for land demarcation in the context of the issuance of titles related to the right to use and benefit from the land.
Specific procedures for the Community consultation (Ministerial Diploma n° 158/2011)	This act provides for the adoption of specific procedures for consultation with local communities for the use of lands, recognizing their rights, in accordance with Regulation of the Land Law.
Creation of the Consultative Forum on Lands (Decree n° 42/2010)	This act establishes the Consultative Forum on Land as a consultation mechanism for the GoM to discuss land and related matters.
Requirements for Simple License Regimes, and the terms, conditions and incentives for the establishment of Planted Forests (Decree nº 30/2012)	Definition of the requirements for logging including the scheme, terms, conditions and incentives for the establishment of forest plantations.

Acts	Description
The Land Planning Law and its regulations (nº 19/2007)	The Land Planning Law establishes key principles for environmental protection in the context of regional planning and establishes hierarchical responsibilities among central, provincial, district and local governments in land use planning processes. It also stipulates that expropriation for public interest will give rise to the payment of fairly calculated compensation in order to compensate for the loss of tangible and intangible goods and productive assets as well as the disruption of social cohesion.
Benefit-sharing	
Ministerial Diploma 93/2005	This key ministerial diploma established the mechanisms for channeling the 20% revenues from wildlife and forestry exploration, towards the benefits of communities that inhabit the areas where the exploration of such resources is taking place. Its stipulated that beneficiaries can only receive money if their community is organized in a legalized association with a bank account.
Conservation areas	
Conservation Areas Law (n° 16/2014)	The 2014 Law on Conservation Areas provides for the legal establishment of Conservation Area Management Boards (CGAC), which advisory bodies covering one or more CA composed of representatives of local communities, the private sector, associations and local state bodies for the protection, conservation and promotion of sustainable development and use of biological diversity. It also legalizes public-private partnerships for CA management and for concession contracts and definied specific criteria and principles for CAs' management plans. It promotes the involvement of communities legally living inside CAs and their buffer zones, in income generating activities that promote biodiversity conservation. This law is applicable to the GNR.
REDD+	
Regulation on procedures for approval of REDD+ projects (Decree nº 70/2013)	The purpose of this Regulation is to establish the procedure for the approval of REDD+ projects and studies, as well as the setting of the institutional framework and competences. It deals, *inter alia*, with the institutional framework, approbation and issuing of license for the marketing of carbon credits. It also discusses the procedures for the approval of REDD+ projects and place emphasis on community consultations. The REDD Regulation states that the REDD+ projects should clearly contain measures to promote and support compliance with the safeguards guidelines. All projects should provide for the distribution of benefits, including local communities under terms to be set by ministerial decree. It also creates the CTR for REDD+ and the UT REDD+.

1.11.2 International conventions and agreements

Mozambique has also ratified various international conventions and regional protocols related to the management of the environment. It should be noted that, under line 2 of article 18 of the GoM's Constitution, the rules of international law have the same value in domestic law and once ratified by the Parliament and Government they become constitutional normative acts. As per point 1 of article 18 of the Constitution, the "*treaties and international agreements duly approved and ratified, are enacted in the Mozambican legal order*" (MITADER, 2016d). The most important acts are summarized in the table below.

Table 2: Summary of the main international agreements ratified by the government of Mozambique and relevant for the GNR REDD Project

Acts	Description and relevance for ER Program
International Convention on International Trade in Endangered Species (CITES, 1979)	CITES is a multilateral treaty to protect endangered plants and animals, aiming to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species in the wild. It accords varying degrees of protection to more than 34,000 species of animals and plants, several of which can be found in Mozambique.
African Convention on Nature and Natural Resources Conservation - ratified by the Parliament's Steering Committee through Resolution nº 18/81, of 30 December	The Convention aims at ensuring the conservation, use and development of land, water, forest and wildlife resources of SADC Member States, bearing in mind not only the general principles of nature conservation, but also the best interests of the communities themselves.
United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, 1992 (amended 1997)	The Kyoto Protocol (1997) is an international agreement linked to the United Nations Framework Convention on Climate Change (UNFCCC, 1992). It is binding for countries that have ratified the protocol to reduce and ultimately cap their greenhouse gas emissions (GHGs). Mozambique signed the UNFCCC on 3 November 1992, and ratified the Kyoto Protocol on 18 January 2005, and entered the protocol into force on 18 April 2005. It should be noted that Mozambique being a developing country, those acts are not biding for the country to reduce GHGs. It nevertheless demonstrates the GoM's political commitment to the reduction of carbon emissions.
UN Convention on Biodiversity - ratified by Resolution nº 2/94, of 24 of August	This international instrument advocates the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings. It is an essential foundation for the creation, development and protection of conservation areas in Mozambique. It is significant for the ER Program, given that forests in Mozambique and elsewhere are the most biologically diverse systems. Forest biodiversity is increasingly threatened as a result of deforestation and forest degradation.

Acts	Description and relevance for ER Program
Protocol related to Wildlife Conservation and its application in the SADC - Ratified by Resolution nº 14/2002, of 5 of March	This protocol establishes common approaches to conservation and sustainable use of wildlife resources relating to the effective enforcement of laws in the region and within the domestic laws of each Party State.
United Nations Convention to Combat Desertification (UNCCD), 1994	The objective of this Convention is to combat desertification and mitigate the effects of drought in countries experiencing serious drought and/or desertification. Achieving this objective will involve long-term integrated strategies that focus simultaneously, in affected areas, on improved productivity of land, and the rehabilitation, conservation and sustainable management of land and water resources, leading to improved living conditions, in particular at the community level.
COP 21 Paris Agreement on Climate – December 2015	Mozambique is one of the 196 countries that signed and ratified the agreement to reduce greenhouse gas emissions to contain global warming to 2°C.

1.12 Ownership and Other Programs

1.12.1 Project Ownership

As previously explained, the project area of the RNG REDD project is composed of the forests of the buffer zone of the RNG. This area was officially recognised by the ministerial council and the decree n°70/2011 presenting its official creation was published in the republic journal (*Boletim da República*) the 30 of December 2011. The decree specifies that all economic activities scheduled in the management plan – prepared by the ANAC and IGF – are allowed. As the GNR is a national Reserve and the ANAC is the national administration in charge of protected areas of Mozambique, this decree gives to the project proponent (ANAC) the necessary right of use for the management of the REDD project.

1.12.2 Emissions Trading Programs and Other Binding Limits

As presented in section 1.8.5, the project is included in the area of a FCPF jurisdictional program called the ZILMP. However, the Emission Reductions Program Document (ER-PD) is not completed yet and validation is not expected to happen before the end of 2017. Thus, until now, there is no risk of double counting of the achieved emissions reduction thanks to the project activities. During the development of the monitoring system of the ER Program (ZILMP), attention will be paid to ensure that the emissions reductions due to the GNR REDD project are separated from other emission reductions to avoid any double counting risk. The project will follow the monitoring requirement of the program as well as those of the VCS as presented in section 4. From 2018 onwards, it is probable that the ERs generated in the GNR and its surrounding will fully be accounted for in the ER Program area. Neither double counting nor multiple claims of ERs titles linked to the GNR project is therefore expected to arise.

1.12.3 Other Forms of Environmental Credit

The project will not receive other form of GHG-related environmental credits and it is not eligible under other program that would create such form of credits.

1.12.4 Participation under Other GHG Programs

As explained previously, the GNR REDD project may be integrated in the ZILMP (section 1.8.5) but as this program will only be submitted in 2017, there is no registration yet.

1.12.5 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

The present project is not a grouped project so no eligibility criterion has to be specified.

Leakage Management

Activities to be developed with communities (small scale conservation agriculture and cash crop value chain improvement) are presented in section 1.8 as well as the activities to improve their well-being and to prevent leakage. Possible leakage will also be accounted for in section 3.3.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

The methodology used is the VM0007, REDD+ Methodology Framework (REDD-MF), v1.5 (March 2015) developed by Avoided Deforestation Partners. As the GNR project is a REDD project for avoided unplanned deforestation, the required modules used to develop this document are the following:

- Estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation (BL-UP; VDM0007), v3.2
- Estimation of emissions from activity shifting for avoided unplanned deforestation (LK-ASU; VDM0010), v1.1
- Estimation of carbon stocks in the above- and below ground biomass in live tree and non-tree pools (VMD0001, CP-AB), v1.1

- Methods for monitoring of GHG emissions and removals (M-MON / M-REDD; VDM0015), v2.1
- Tool for the demonstration and assessment of additionality in VCS agriculture, forestry and other land use (AFOLU) project activities (VT0001 adapted from the CDM tool), v3.0
- Tool for testing significance of GHG emissions in A/R CDM project activities (T-SIG), v01
- Estimation of uncertainty for REDD+ project activities (X-UNC; VDM00017), v2.1
- The VCS AFOLU Non-Permanence Risk Tool, v3.3

2.2 Applicability of Methodology

As explained in section 1.10, the main cause of deforestation in the GNR project is the conversion of forest to agricultural lands for food production by small-scale farmers who practice subsistence slash and burn agriculture. Deforestation can therefore be considered as unplanned. Baseline was then elaborated with the requirements of the VM0007 REDD-MF methodology and the VMD0007 BL-UP module.

In the forests of the project area, the extraction for woodfuel collection is very rare (the collection of woodfuel is concentrated in fields that were opened for slash and burn agriculture; trees are therefore cut for agricultural purposes and branches are used for energy purpose – see section 1.10.2). Hence, the impact on the forest carbon stocks of the PA is considered to be negligible. However, there is a high pressure for the exploitation of the precious wood ‘pau ferro’ (iron wood – *Swartzia madagascariensis*) but this exploitation is highly selective and mainly occurs in the central zone of the Reserve. Hence, its impact on the carbon stocks of the project area, even if it is difficult to assess, must be low (see section 4.2.1 for estimation of the carbon stocks concerned by illegal logging). Therefore, degradation is conservatively not included in the baseline.

No land area registered under the CDM is present in the GNR region. However, as explained in section 1.8.5, the GNR project will be included in the ZILMP if this jurisdictional program is accepted in 2017 by the FCPF-CF.

All the applicability conditions of the VM0007 methodology are fulfilled by the GNR REDD project:

- All forest in the project areas are old growth forests and can therefore be qualified as forest at least 10 years before the project start date (2012), as it is also demonstrated in the analysis of historical deforestation (section 2.4.1).
- No peatland is present in the project area, so no WRC module is used.
- The baseline agents of deforestation are the households of local communities practicing slash and burn agriculture. They all live in villages in the project area, in the leakage belt or in the reference region. They can be considered either as residents or immigrants (section 1.10). They clear forestlands for small-scale crop production and they have no documented and uncontested legal rights on those lands (see section 1.10). The project therefore respects the applicability condition of VM0007 for unplanned deforestation activities.

- The activities of the project do not include reforestation on post-deforestation land use, nor increase of flooded agricultural land or intensification of livestock.

As required by the methodology (see previous section), for the modules used, the following applicability conditions are respected:

- BL-UP module is applicable because the agents of deforestation (i) clear forestland for crop production; (ii) have no documented rights to deforest lands; and (iii) are either resident or immigrants in the region.
- CP-AB module is applicable to estimate carbon stocks in above- and belowground biomass of all forest types (only aboveground biomass is mandatory). This module can also be used to estimates non-tree aboveground biomass but this pool is not included in the present project.
- LK-ASU module is applicable for estimating carbon stocks changes related to the displacement of activities such as clearing for crop lands that could cause deforestation outside of the project area. This module is mandatory if BL-UP has been used to define the baseline and should respect the same applicability conditions.
- T-ADD must be used to identify credible alternative land use scenarios and to demonstrate the additionality of the project. It is applicable for AFOLU activities and requires the baseline methodology to provide for a stepwise approach justifying the most plausible baseline scenario.
- M-REDD or M-MON module is always mandatory for REDD projects and this module specifies that emissions from logging may be omitted if they can be demonstrated to be *de minimis* using T-SIG (see section 4.3.1.4).
- T-SIG should be used to determine the significance of any decrease in carbon pools and increase in GHG emissions by sources (see section 4.3.1.4).
- X-UNC module is also mandatory to estimate uncertainty of estimates of emissions and removals of emissions generated from REDD project activities.

2.3 Project Boundary

2.3.1 Temporal boundaries

2.3.1.1 Start date and end date of the historical reference period:

For the simple historic approach to project rate of deforestation, the historical reference period should cover 12 years at maximum and end within 2 years of the project start date. The project start date being set at the beginning of the year 2012 (see the following section), the reference period was defined as the period between 2000 and 2010.

The ZILMP historical reference period is different, from 2005 to 2015. If the program is accepted by the FCPF-CF, the GNR project will update its reference level to be in accordance with the one of the ZILMP program according to the rules that will be defined for inclusion of VCS projects. However, these rules are not yet defined.

2.3.1.2 Start date and end date of the REDD project crediting period:

Crediting period will be 20 years from the beginning of the project – i.e. from January 1st, 2012 to December 31, 2031.

2.3.1.3 Periods to revisit the baseline:

The baseline must be renewed every 10 years after the start of the project. The next date at which the baseline will be revisited is therefore 2021. However, if the ZILMP program is accepted before this date, the baseline will be revised according to its rules, if necessary.

2.3.1.4 Duration of the monitoring periods:

The monitoring periods are set once every 5 years. The project starting in 2011, the first monitoring period is 2016. That is why this PDD is a common report with first monitoring.

2.3.2 Geographic boundaries

According to the VM0007 methodology, the following zones have to be delimitated according to the requirement of the module VMD0007 BL-UP:

- Two reference regions: (i) one for the calculation of the deforestation rate: RRD; and (ii) one for the projection of the location of future deforestation: RRL;
- The project area (PA);
- The leakage belt (LB).

The delimitation of these zones is based on forest area. According to national REDD+ strategy of Mozambique (MITADER, 2016), the national definition of forest (provided by the Mozambican Designated National Authority i.e. MITADER) is: a minimum area of 1ha, a minimum cover of 30% and a minimum height at maturity of 5m.

The different zones defined are presented in the following figure and rationales for their delimitation are presented in the following sections. The figure presents global zones for their delimitation but according to the definition of each zone, the exact areas are the forests comprised in those zones (for PA and RRD). As required, the geodetic coordinates of the extent of each GIS layer is presented in

Table 4. All files are available in shp or kml formats.

Table 3: Summary of the different zones areas

Zones	Forest areas (ha) in year		Minimum forest area (ha) according to VM0007 size criteria
	2000	2010	
Project area		124,145	
RRD	440,988	412,145	253,078
Leakage belt		166,502	111,743

Table 4: Geodetic coordinates of the limits of each project zone

Zones	Western limit	Eastern limit	Southern limit	Northern limit
GNR core area	38°04'11'' E	38°49'05'' E	16°50'04'' S	16°13'59'' S
Project area	37°55'01'' E	38°50'06'' E	16°55'56'' S	16°12'50'' S
Leakage belt	37°50'31'' E	38°54'35'' E	17°00'16'' S	16°08'33'' S
RRD	37°55'43'' E	39°08'13'' E	17°17'46'' S	15°44'56'' S

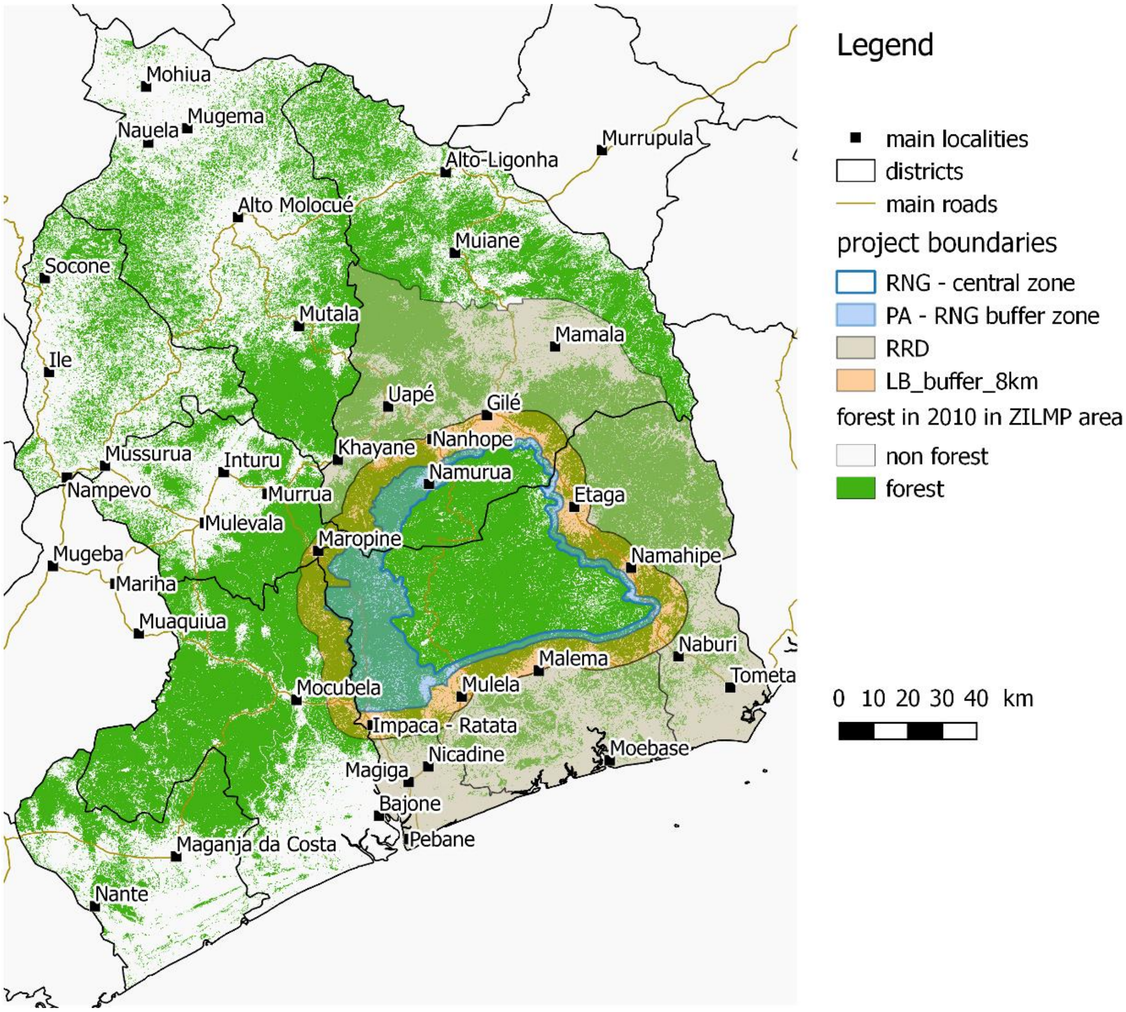

Figure 10: Representation of different zones defined for the elaboration of the reference scenario and the baseline

2.3.2.1 Project area

According to BL-UP module of VM0007 methodology, the Project Area must be completely forested at the beginning of the Project. Hence, to define this Project Area, the forests existing at the end of the reference period in the GNR buffer zone (zone of the GNR prone to deforestation) have been selected. In other words, the project area corresponds to the forests inside the buffer zone around the GNR, which was created in 2011 (as a first project activity). Before this creation, there was no specific land tenure regulation in the area. It was a zone used by communities around the GNR for their usual activities. Since project start, even though this area is under conservation status, more activities for communities are allowed in the buffer zone than in the central zone (see section 1.8.1) of the Reserve. The total area of the GNR buffer zone is 152,799 ha (forest and non-forest areas), including the 124,145 ha of forests that compose the Project Area.

2.3.2.2 Reference region for projecting rate of deforestation (RRD)

According to the module VMD0007, the RRD has to be 100% forested at the beginning of the historical reference period (2000) and not encompass project area or leakage belt. It has also to respect a size requirement (MREF) and similarity criteria with the project area.

Following the VDM0007 module, the similarity criteria are summarised as followed:

a. The same agents of deforestation must be present in both areas, RRD and PA;
b. Landscape factors have to respect similarity conditions in terms of forest and soil types, and slope and elevation classes;
c. Transportation networks and human infrastructures should have similar density in both areas;
d. Social factors must have the same impact in both areas at the start of the historical reference period;
e. Policies and regulations must have the same impact in both areas at the start of the historical reference period;
f. Planned deforestation areas have to be excluded from the RRD.

Definition and size:

The RRD was defined according to the administrative boundaries surrounding the GNR. The “Administrative posts” (smallest administrative scale in Mozambique) in which the central zone of the GNR lies were selected, that is to say, the districts of Pebane (South) and Gilé (North). The entire district of Gilé was not selected, due to VCS size criterion and also because the Northern part of Gilé district is different in terms of forest cover, deforestation agents' dynamics (presence of a sealed road linking big cities) and elevation class (see Figure 13). Additional administrative posts were not added in order not to oversize the area. To insure similarity between policies and regulations (see following paragraph), the central zone of the GNR is not included in the geographical boundaries of the project.

According to the VM007 size criterion, the area of RRD should be larger than 253,070 ha. The defined area, based on administrative boundaries, is 412,145 ha, respecting this criterion.

$$MREF = RAF * PA$$

$$RAF = 7500 * PA^{-0.7}$$

If RAF as calculated using equation 2 is <1, RAF shall be made equal to 1

Where:

MREF	Minimum size of reference region for projecting rate of deforestation; ha
PA	Unplanned deforestation project area; ha
RAF	Reference Area Factor. Factor to multiply project area by to get minimum reference area; dimensionless

Similarity criteria:

According to the methodology, the following criteria have been taken into consideration during the definition of the RRD:

- Agents of deforestation: in the whole PA and RRD areas, deforestation is caused by the same agents – i.e. farmers who are living in the areas. There is no rancher in the region (PA or RRD).
  - Rights for land use are described with more details in the other sections but, generally speaking, there is no specific regulation – except in the GNR. Land use is controlled by customary rights and regulated by customary chiefs who are living in each community. These rights are not constraining and farmers are allowed to extend their fields if it is not on another land that is, either, already occupied, or booked, by another farmer.
  - The immigration rate for settlements not older than 5 years is very low in the project zone. According to a survey conducted in 2015, only 2% of the sampled inhabitants (135 households) immigrated in the previous 5 years. This is also true in the reference region, which is also a rural area: immigration in Zambezia province is more focused towards cities located close to the roads, such as Alto Molocué or Quelimane (Figure 10).
- Landscape factors: the distribution of the landscape factors in the PA and RRD based on an analysis of available GIS databases is presented in Table 5.
  - Forest classes: Since there is no significant elevation gradient or significant differences in carbon stocks between forest classes (Prin, 2008), only one Miombo forest stratum was determined. Hence, forest class is the same in all defined areas and Miombo forest represent 100% of the forest in each zone. Mangroves forests are present in the South of Pebane district but, since they do not exist in the PA, they are not included in the RRD.
  - Soil types: according to field analysis, two types of soil – both sandy soils – exist in the PA (Berton 2013; Figure 11): (i) a brown sandy soil with high quantity of clay; and (ii) a white, sandy soil with fewer clay. These 2 types correspond to only one class of soil (Luvisols), according to the FAO world classification[6]. In the RRD, other classes of soils (Luvisols, Arenosols and Lithosols) also exist. Because they all are suitable for small-scale agriculture, they don't have any impact on deforestation pattern. Hence, as the main type of soil of the region (Luvisols) is present in the main forest areas of PA and RRD, the similarity for this criterion was considered as respected.
  - Slope classes: the majority of lands in all zones is characterized by slopes that are lower than 15% (Figure 12). Those low slopes are those that are preferably chosen by farmers for agricultural practices – first driver of deforestation. The difference between the PA and the RRD with regards to these low slopes is small (Table 5).

[6] http://www.fao.org/geonetwork/srv/en/metadata.show?id=14116

As a consequence, deforestation rate in the RRD is not expected to be biased by this factor. Regarding high slopes (above 15% threshold), the difference between the PA and the RRD is higher and does respect the BL-UP module requirement. High slopes only involve small parts of each zone (Table 5).

- Elevation classes: elevation classes were separated on 500 m intervals as recommended by the methodology (BL-UP module). All lands in the PA and most of those in the RRD are below 500 m of elevation. In the RRD, some lands are above 500 m of elevation (256 ha) but to a very limited extent (see Figure 13). As a consequence, deforestation rate in the RRD is not expected to be biased by this factor

- Transportation networks and human infrastructure: As recommended by the methodology, these criteria were analysed in buffer areas around each zone (the networks in the various zones are also included in the analysis – Table 5). The limits used to analyse these criteria on a GIS software were those used to define the project geographical boundaries – i.e. zones in which forest areas were selected to respect methodology requirements. These zones are presented in Figure 10.
    - Navigable rivers: there are no navigable rivers in the RRD, PA or LB. Rivers are used by fishermen with dugouts (canoes) but are not used for the transport of goods or harvest. Therefore, the presence of rivers does not imply transport that could be linked to deforestation.
    - Road density: Data used for this analysis include dust roads. There is no sealed road in the RRD or the PA (nor in the LB). There are 3 main dust roads going through the RRD, the PA or the LB: one in the Western part of the GNR, one in the Eastern part and one crossing over the Reserve (
    - Figure 14). The road located in the Eastern part is the most commonly used by households of the area. Although it crosses the PA on few areas only, it is considered in the region as an easy access to the buffer zone of the Reserve. Even though roads density is slightly higher in the RDD than in the PA, with a difference above the 20% threshold recommended by Bl-UP module (Table 5), in practice, the fact that the Eastern road is the main used implies a similar access to the RRD and the PA – this is reflected in the deforestation location (Figure 21).
    - Settlements density: this density is higher in the Eastern and Southern parts of the areas defined (
    - Figure 14). Although it is not similar between the PA and RRD, those densities are so low (below 0.01 settlement per km² – see Table 5) that their difference is considered as acceptable. Because national data are only available for the main localities, those are the only ones considered in this analysis. More communities are present in all areas (RRD, PA and LB) but their locations are only known (located by the Project team) in the PA and the LB, because that is where project activities are implemented. Hence, actually, the density of settlements is higher than the one presented in Table 5, but it is not comparable between the PA and the RRD. However, deforestation pattern in circle around localities is a good proxy of the location of settlements and the map of deforestation shows a high

concentration in PA and LB compared to the RRD (Figure 21), which is conservative.

- Social factors: The ethnic composition of the RRD and the PA is homogeneous. All communities belong to the same ethnic group called Lomwé, speaking Elomwé (spoken by 8% of the Mozambican population[7]) with influences of Emakhuwa language (spoken by 25% of the Mozambican population). No gangs or guerrilla has been known in the area since the end of the civil war in the 90's.
- Policies and regulations: in addition to customary rights regulating access on lands for agriculture and other community use of forest (charcoal production, collect of non-timber forest products, etc.), two regulations exist in the Gilé and Pebane districts: conservation status in the GNR and concessions or simple licences for forest exploitation[8]. As previously explained, the central zone of the Reserve was excluded from the geographic boundaries of the project. Concessions or simple licences are widely spread in the two districts (and do not only encompass forest areas): whereas these land use titles are necessary for timber exploitation, they do not lead to land use restriction for communities – in particular, the local population can continue practising slash and burn agriculture within their limits. The oldest data available on these limits are from 2011 (year of the project start date) and show that simple licences and concessions were attributed within the boundaries of both the RRD and PA (Figure 15). According to a background study on the analysis of deforestation pattern in the ZILMP area (Mercier et al., 2016), concessions and simple licences have no significant effects on deforestation quantity.
- Exclusion of planned deforestation: no planned deforestation areas exist in the RRD or in PA.

[7] https://en.wikipedia.org/wiki/Languages_of_Mozambique
[8] Concessions are attributed for 50 years and simple licences were for 1 year until 2016 and are for 5 years currently.

Table 5: Results of the comparison between quantitative criteria for Project Area, Leakage Belt and RRD

Landscape factors	Criteria	Proportion in each zone			Difference with PA (in %)	
		PA	RRD	LB	RRD	LB
Forest class	Proportion of Miombo forest among forests	100%	100%	100%	0%	0%
Soil	Proportion of suitable soil types	100%	100%	100%	0%	0%
Slope	Gentle slopes (< 15 %)	88%	89%	85%	1%	-3%
	Steep slopes (> 15 %)	12%	11%	15%	-9%	18%
Elevation[1]	Between 0 - 500 m	100%	100%	100%	0%	0%
	Between 500 - 1000 m	0.00%	0.06%	0.01%	-	-
		Density of networks on zones			Difference with PA (in %)	
Transportation and infrastructures	Navigable rivers density (m/km²)	-	-	-	0%	0%
	Roads density (m/km²)	54	146	126	63%	57%
	Settlements density (settlements/km²)	0.001	0.004	0.005	79%	83%

Sources of data:[1] ASTER GDEM v2

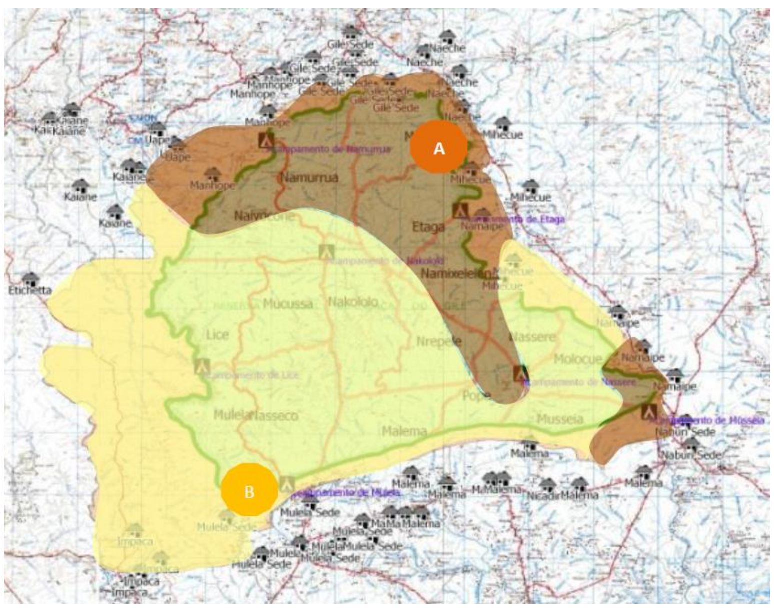

Figure 11: Location of the two types of soils in the GNR: A - brown sandy and clay soils and B - white sandy soils (from Berton, 2013)

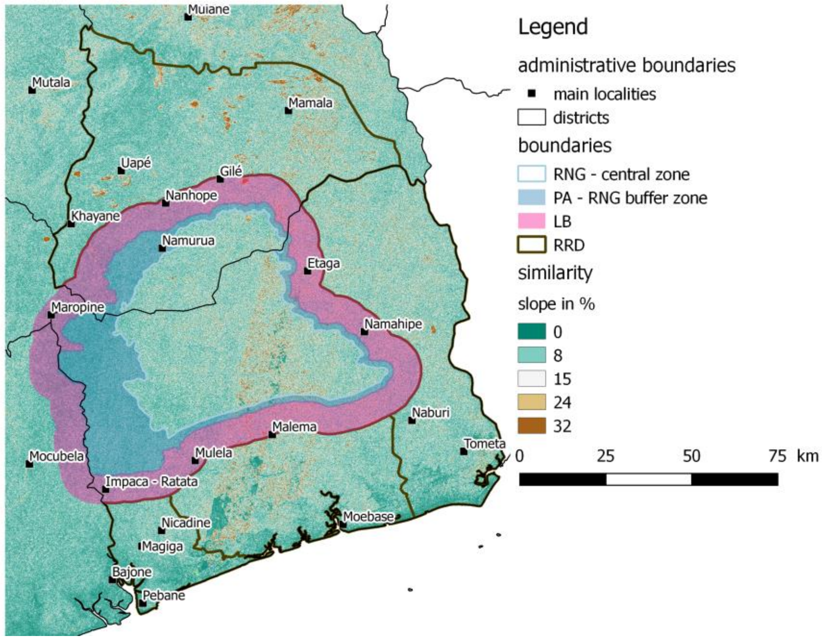

Figure 12: Slope classes (in %) present in the project zones and reference area (source: srtm data)

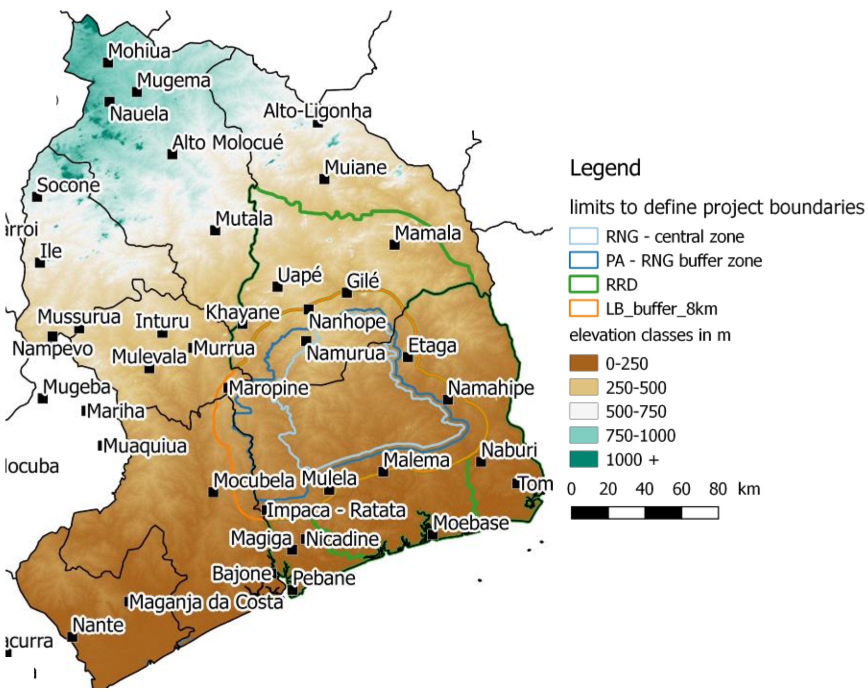

Figure 13: Elevation classes present in the project zones and reference area

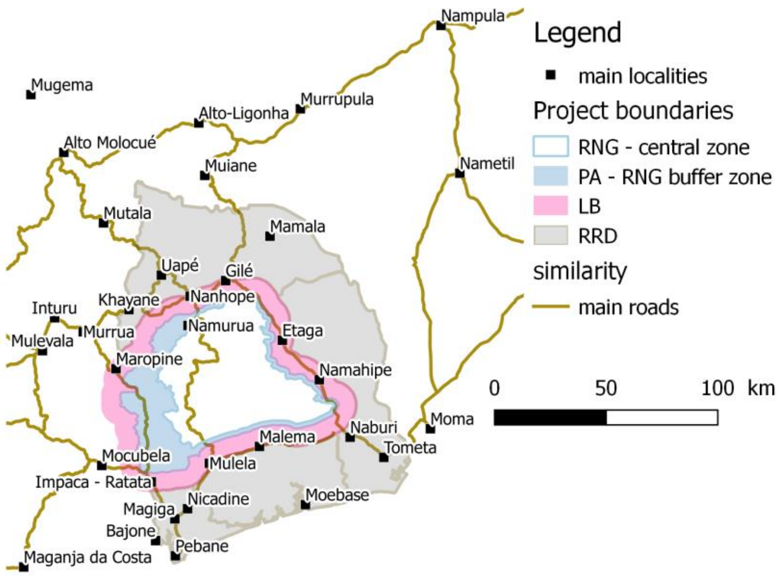

Figure 14: Roads network in the project zones

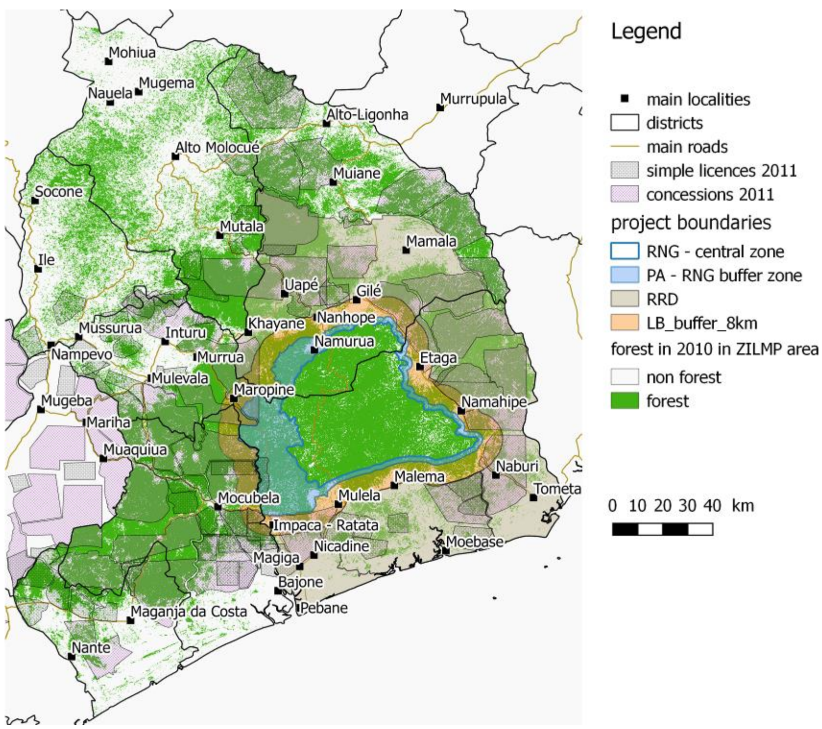

Figure 15: Concessions and simple licences attributed in 2011 within the districts of Pebane and Gilé (including in RRD and PA)

2.3.2.3 Leakage belt

As the GNR project is addressing unplanned deforestation, a leakage belt (LB) must be defined to assess the displacement of deforestation activities due to the implementation of the project. Following VMD0007 module, leakage belt must be (i) composed of the forested area closest to the PA; (ii) accessible by the agents of deforestation; (iii) spatially biased free, in terms of distance of edge of belt from edge of PA. Similarity criteria with the PA have also to be verified and minimum size of the LB should be 90% of the PA.

In order to respect the requirements proposed by VMD0007 module for the definition of the LB, we selected all forests in a buffer zone around the PA that respect the minimum size for LB. The size of the buffer was 8 km (Figure 10). This distance is reachable by the agents of deforestation if they want to migrate because of the project activities and it allows taking into account the closest forested areas to PA.

The area of the LB is 166,501 ha; 90 % of the PA corresponding to an area of 111,743 ha.

Similarity criteria:

According to the methodology, the following criteria have been taken into consideration during the definition of the LB to secure the similarity of conditions with the PA:

- Landscape factors: the distribution of the landscape factors in the PA and LB based on an analysis of available GIS databases is presented in Table 5.
    - Forest classes: as previously explained, only one forest class is considered in this document.
    - Soil types: according to field analysis and to the FAO world classification, the same types of soils are present in the PA and LB. There are luvisols, according to the FAO, which can be divided in 2 strata presented in Figure 11.
    - Slope classes: the majority of lands on all zones presents slopes lower than 15% and the difference between the PA and LB in proportion of these types of slopes is small respecting the threshold of 20% recommended by BL-UP module (Figure 12 and Table 5).
    - Elevation classes: elevation classes were separated on 500 m intervals as recommended by the methodology. All lands in PA and most of those in LB are below 500 m of elevation (Table 5). Only few lands above 500 m of altitude are present in the LB (25 ha). The threshold of 20% recommended by BL-UP module is therefore respected.
- Transportation networks and human infrastructure: As it was done for the RRD, these criteria were analysed in buffers around the areas drawn to define each project zone (networks in different zones are also included in the analysis – Table 5).
    - Navigable rivers: as explained before, no navigable rivers are present within the boundaries of the project.
    - Road density: Data used for this analysis include tracks. No sealed road is present. The proportion of roads is low in all areas but it is slightly higher in the LB, which

is conservative as it can favour the settlement of deforestation agents during project implementation.

- Settlements density: As explained previously, the location of settlements is more precisely known in the PA and the LB, where the activities of the project are implemented (Figure 16). With those data (different from those presented in Table 5), the settlements density in the LB is 0.011 per km², which is slightly higher (by 25%) than in the PA (0.08 per km²). The results with both databases (national database used for Table 5 and Project data presented in Figure 16) give a difference above the threshold recommended by the BL-UP module, granted, but this is conservative, because the level of settlements is slightly higher in the LB than in the PA.

- Social factors: As previously explained, social factors are very similar all around the GNR.
- Policies and regulations: Like in the RRD, some areas in the LB and PA were attributed forest exploitation concessions and simple licences in 2011 (Figure 15). However, as explained, this attribution has no significant effect on deforestation.

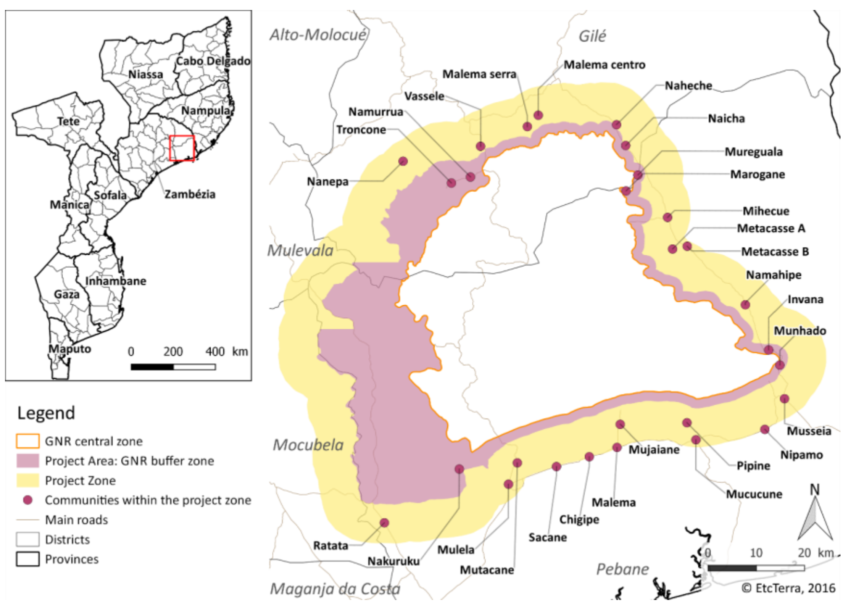

Figure 16: Location of the communities in the project zone

2.3.2.4 Reference region for projecting location of deforestation (RRL)

According to VMD007 module, in the case of mosaic deforestation, such as in the GNR REDD project, location analysis is not required. Therefore, the definition of a RRL is not necessary.

2.3.3 Carbon pools

The carbon pools considered in the project are presented in the following table. All the carbon pools included in the baseline accounting are also included in the project scenario and the leakage emissions accounting.

Table 6: Carbon pools considered in the GNR REDD project activities

Carbon Pool	Inclusion?	Justification/explanation
Aboveground tree biomass	Included	Mandatory for REDD project
Aboveground non-tree biomass	Excluded	Not significant in the forest strata.
Belowground tree biomass	Included	Only belowground tree biomass is included. It is a significant pool in the baseline scenario.
Dead wood	Excluded	Not significant and it is conservative to exclude it.
Litter	Excluded	Not significant and it is conservative to exclude it.
Soil organic carbon	Excluded	It is a significant pool of carbon stocks in forest strata but it is conservative to exclude it.
Wood products	Excluded	Not associated with deforestation in the area (but a cause of degradation). Moreover, forest exploitation for wood product should decrease under the project scenario so it is conservative to exclude it.

2.3.4 Sources of greenhouse gas

Greenhouse gas emission will essentially be generated by the conversion of forests into agricultural lands because of slash and burn agriculture. CO_2 is the main gas emitted but this is taken into account in the baseline scenario via the carbon stock changes in forest. Other gas (CH_4 and N_2O) are also emitted during this conversion, when biomass is burnt, but it is a non-significant part compared to the emission of CO_2. Moreover, it is conservative to ignore these emissions.

Table 7: Greenhouse gases included or excluded in baseline and project scenario

Source		Gas	Included?	Justification/Explanation
Baseline	Biomass burning	CO_2	Excluded	Excluded by the methodology
		CH_4	Excluded	Conservatively excluded as recommended by the methodology.
		N_2O	Excluded	
Project	Biomass burning	CO_2	Excluded	Excluded by the methodology
		CH_4	Excluded	The project activities will tend to decrease fires to clear forest leading to a decrease of biomass burning emissions. Exclusion of this gas in the project scenario is therefore
		N_2O	Excluded	

Source		Gas	Included?	Justification/Explanation
				conservative. Moreover, no additional fires will be created during leakage management activities.
	Combustion of fossils fuels	CO_2	Excluded	Neglected as it is excluded from baseline accounting.
		CH_4	Excluded	Excluded by the methodology because potential emissions are negligible.
		N_2O	Excluded	
	Use of fertilizers	CO_2	Excluded	Excluded by the methodology because potential emissions are negligible.
		CH_4	Excluded	
		N_2O	Excluded	Excluded as fertilizers are not used in the baseline scenario nor in the leakage management activities.

2.4 Baseline Scenario

According to VM0007 requirements, the baseline scenario is established following BL-UP module as the project is concerned by unplanned deforestation.

2.4.1 Estimation of annual areas of unplanned deforestation

The default approach to estimate annual areas of unplanned deforestation is simple historic; it was the one selected for the present project.

2.4.1.1 Analysis of historical deforestation

This step aims to quantify the historical deforestation rate during the historical reference period (section 2.3.1) within the RRD (section 2.3.2).

Collection of appropriate data sources

The historical analysis must respect the following criteria:

- Be conducted on at least 3 time points that are 3 years apart minimum on a maximum period of 12 years (the last date being no more than 2 years before project start date);
- Use remotely sensed spatial data that have medium resolution (30x30m or less);
- Produce a map with 90% accuracy in the classification of forest versus non-forest (the accuracy is assessed via high resolution data or ground truthing points on the last date analysed).

According to the methodology, if interpreted data respecting those criteria already exist, they can be used for the analysis. That is the case for the present project as an ER Program (ZILMP) is currently under development (see section 1.12.4). For the preparation of the ER-PD that will be submitted to the FCPF-CF in the end of 2017, a historical deforestation map was produced respecting the methodology requirements (Mercier et al. 2016). Finally, it will not be used at the jurisdictional level but as the results were available and of good quality, it was decided to use them for the present document. Details on the preparation of the map are furnished in the background study for the development of the ER-PD (Mercier et al. 2016) and are summarised hereafter. It follows the method presented by Grinand et al. (Grinand et al., 2013a) based on a multi-dates analysis for a direct classification of land uses and changes using the algorithm *RandomForest*. The main respected criteria are the following:

- The period of analysis is 1990 to 2013. Hence, data from 2000 to 2010 (3 years: 2000, 2005 and 2010), corresponding to the reference period of the present project, can be extracted from this map.
- The data used to produce the map are Landsat images with a 30m resolution.

Accuracy assessment was specifically done for the present document on the last Forest/Non-Forest map of the reference period, in 2010, cut on the RRD. A sample of validation points were classified on Landsat images and very high resolution images available in *Google Earth*. The overall accuracy is 94%. For forest and non-forest categories, accuracy is respectively 95% and 94% and are in in accordance with the methodology requirements. Results are presented in Table 12.

Table 8: Summary of the method used for the development of the REL in the ZILMP ER-PD draft

Satellite images	**LANDSAT images 5, 7 et 8.** Priority use of GLS (*Global Land Survey*) products dedicated to the analysis of land use changes (orthorectified images). In case of unavailability or presence of clouds on these products, archival images L1T (geo-referenced only) will be downloaded.
Dates and periods	Images for years *circa* 1990, 2000, 2005, 2010 and 2013. For more consistency, the images acquired in the same season will be preferred. The period covered goes far beyond standard requirements. Such a period was chosen to have a better understanding of long-term deforestation dynamics.
Pre-processing	If the images are not pre-processed (*e.g.* L1T level), a radiometric correction and geometric correction are performed. In case of cloud cover greater than 10% in a part of the study area, technical combinations of identical scenes on different dates are implemented to minimize the cloud cover of the final map.
Supervised classification	Use of a supervised classification method (involving the delimitation of training plots and algorithm calibration) and consideration of the 6 IPCC categories of land use (IPCC 2006) and land cover change classes. Visual inspection of *Google Earth* and/or images with very high resolution (2m or better) to assist in the delimitation of these training plots. Use of *ENVI*, *QGIS*, *Grass*, *R* software and *RandomForest* algorithm for classification. **National forest definition:** Mozambican national REDD+ framework defines the forest according to those criteria: minimum height of 5 meters, minimum tree cover of 30%. Those criteria of height and tree cover are taken into account during the photo interpretation control based on *Google Earth* images.
Post-processing	3 post-processing levels are implemented to clean the map and meet the following Minimum Mapping Units (MMU): - Smoothing through a 3x3 majority filter. - Removal of patch of forests of less than 1 ha. - Removal of patch of deforestation of less than 0.36 ha. **National Framework:**

	According to Mozambican national REDD+ framework, forest minimum area is 1 ha.
Validation and quality control	**Internal validation**: Random selection of 70% of the training plots for algorithm calibration; the remaining 30% plots were used to generate the confusion matrix and quality indicators. **External validation**: photo-interpretation of forest state on a high-density random sample of points and high-resolution images to cross-validate those reference observations with the map. **Quality control:** Production of a processing chain command script using the dedicated GIS/RS free software (*R*, *Envi*, *Grass*) for checking and reapplying the method.

Satellite images database

For the background study led to prepare the deforestation map of the ER-Program ZILMP, images from 1990 to 2013 were used but in order to respect the reference period defined for the Project (section 2.3.1.1), results for the period 2000-2010 were extracted in the present document.

The study area is covered by four LANDSAT scenes meeting the following identifiers (path/row): 165/071, 165/072, 166/071 and 166/072. The selected and processed LANDSAT scenes are presented in the following table and figure.

Table 9: Date of selected LANDSAT images

Scene identification	Reference year of images					Area covered (%)
	~1990 (t1)	~2000 (t2)	~2005 (t3)	~2010 (t4)	~2013 (t5)	
USGS data	GLS 1990	GLS 2000	GLS 2005	GLS 2010	Landsat 8 L1T	
166-071	July-92	Aug-99	June-06	May-09	June-13	22
165-071	July-89	Aug-99	Aug-05	May-10	March-14	36
166-072	July-92	Apr-00	Aug-06	May-09	June-13	13
165-072	July-89	Apr-00	March-05	May-10	March-14	29

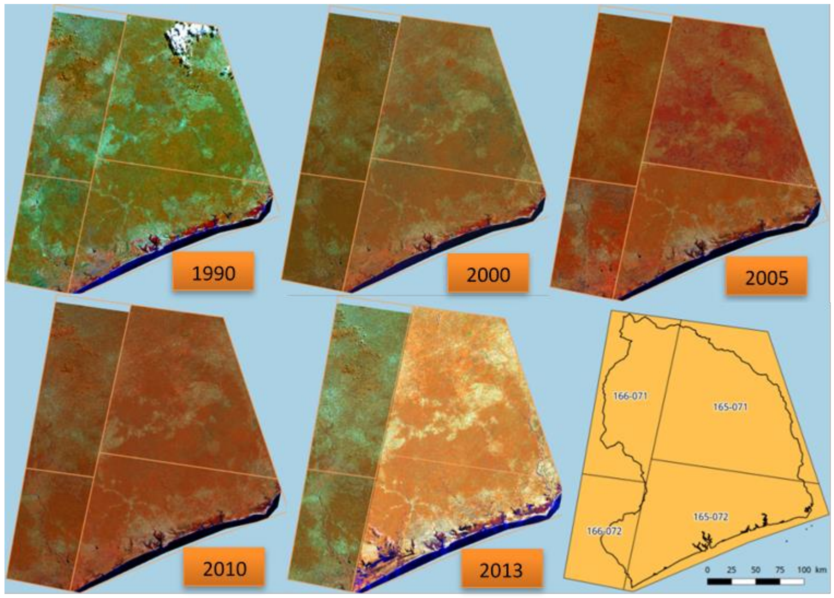

Figure 17: Scope and references of LANDSAT scenes covering the study area

To ensure good geometrical quality images, LANDSAT Global Land Survey products (GLS) and Level-1T (L1T) were used. According to Gutman et al. (2008), these data have sufficient radiometric and geometric qualities to perform land use change analysis. Additionally, we performed a visual inspection of each scene to check their geometric consistencies. We downloaded different images for the last date (2013) and selected the one that meet the geometric criteria. No additional geo-rectification was performed. At the end of this control phase, all images showed a discrepancy of less than 1 pixel. The scenes were then combined into mosaics using a contrast adjustment algorithm in order to reduce discrepancies between scenes, caused by contrasted atmospheric conditions. The mosaics are finally produced by reference years over the whole study area.

Supervised classification

After data pre-processing, the method to establish a deforestation map follows three main steps:

- Definition of land use and land cover changes classes.
- Delimitation of training plots.
- Classification with a specific algorithm.

Land use and land cover change (LULCC) classes that exist in the program areas and are detectable with Landsat imagery are the following:

- Miombo forest (F).
- Mangroves (M).
- Fallows, savannas and cultivated areas (P).

- Wetlands (H).
- Other lands (bear soils, rocks, settlements) (A).

In line with the GOFC-GOLD REDD sourcebook (GOFC-GOLD 2010), for the establishment of the ER Program REL, a “pre-classification method” of land cover changes was applied, instead of a “post-classification” (combinations of independent maps). Such a method should reduce the error in deforestation estimations, as it does not multiply the errors from the independent maps. In practice, this implies to identify stable and dynamic land cover on the multi-date stack of images at a same stage. Hence, the typology presented in the following table was adopted.

Table 10: Typology of land use and land cover changes classes for the study

Numeric code for the map	Identification code in the training plots database	Description of the class
11111	FFFFF	Forest remaining forest over the 1990-2013 period
11113	FFFFP	Forest converted to fallow/cultivated land between 2010-2013
11133	FFFPP	Forest converted to fallow/cultivated land between 2005-2010
11333	FFPPP	Forest converted to fallow/cultivated land between 2000-2005
13333	FPPPP	Forest converted to fallow/cultivated land between 1990-2000
33333	PPPPP	Mosaic of cropland, fallow and savannah land since 1990
44444	HHHHH	Wetland
66666	AAAAA	Rocks, bare soil and sand
77777	MMMMM	Mangrove forest in 2013

Delimitation of training plots

Delimitation of trainings plots is a necessary step to calibrate the classification algorithm when applying a supervised classification. The accuracy of the classification mainly depends on the quality of the delimitation of these training plots. Therefore, a standardized and rigorous photo-interpretation work was conducted. Photo-interpretation was carried on the basis of field knowledge, LANDSAT images patterns and high-resolution images from *Google Earth*. Number of polygons and area delimitated are presented in the table below.

Table 11: Number of polygons and associated delimitated area used as training plots

LULCC Class ID	Number of training polygons	Cumulated area (ha)
AAAAA	42	148.9
FFFFF	174	471.8
FFFFP	78	131.6
FFFPP	45	85.9
FFPPP	76	227.7
FPPPP	81	310.9
HHHHH	45	177.3

MMMMM	26	101.2
PPPPP	162	742.5
Total	729	2,397.7

First, in order to improve the localization and determination of changes, those areas were highlighted by performing a multi-dates color composite (Figure 18). Then, training plots were located in cluster – i.e. by grouping several plots of different categories on a same landscape unit or small area. A landscape unit is defined according to the scale of study: here, it roughly represents an area of analysis below 3 km2 and/or at 1:10,000 scale. In order to reduce noise in training data and to guarantee the appropriate consideration of the forest definition, plots contours were verified by superposition on very high-resolution images available on *Google Earth*. Those images can be originated either by Quickbird or Ikonos satellites, with ground resolution around 0.6 meters. Furthermore, the respect of the national definition of forest from the national strategy (MITADER 2016) regarding tree cover (30% minimum) and tree height (5m at maturity) is also controlled on *Google Earth* high resolution images by verifying the density of tree and that the plots correspond to Miombo forest (largely main forest stratum of the ER Program area) which largely exceeds 5m at maturity and is easily recognisable for the photo-interpretation team, that knows the field (the team participated to some forest inventory), on high resolution imagery (see Figure 18 for example). As explained in Bastin et al. (2017), the identification of high trees (instead of shrubs) is also based on textural, crown diameter and shadows visual interpretation. Moreover, the photo-interpretation team checked the visual aspect (for tree height and crown cover) of inventory plots on Google images and high resolution data for comparison with calibration and validation plots, in order to assure the best inclusion of national forest definition in the classification exercise.

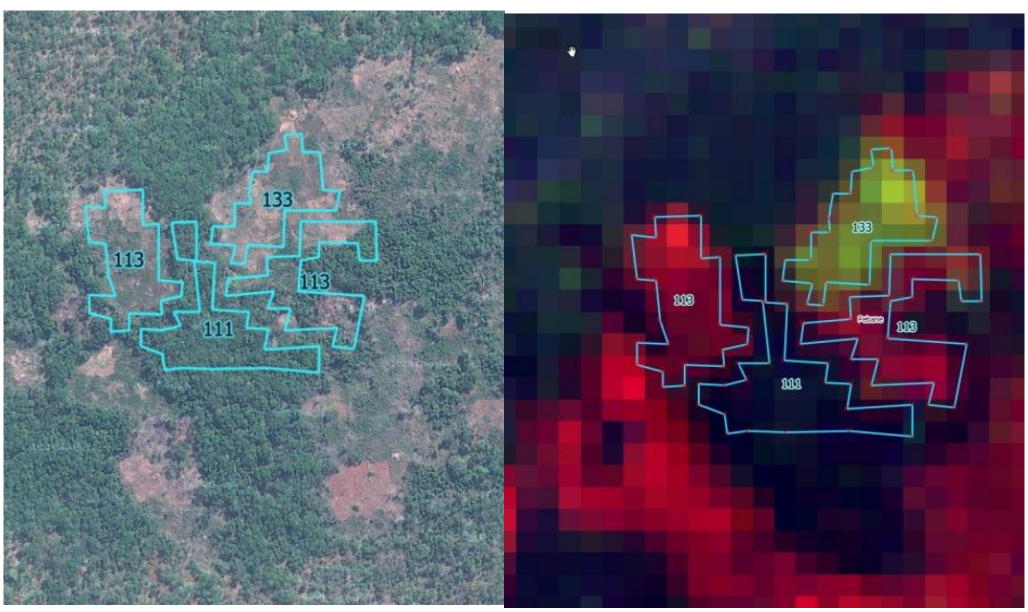

Figure 18: Example of multi-dates colorized composition showing several LULCC classes on the right (R: Band5-2013; G: Band5-2010; B: Band5-2005).
Deforestation between 2005 and 2010 appears in green while deforestation between 2010 and 2013 appears in red. Forests staying forests are in blue and dark green. On the left, plots are overlaid on Google Earth image (Quickbird acquired the 12/08/2013)

Classification

Afterward, the training plot spatial database was correlated with the multi-date stacked image database using a statistical algorithm. The *RandomForest* algorithm, developed by Breiman (2002) and available in *R* software was used. It is a data-mining algorithm that combines bugging techniques and decision tree. It was successfully applied in similar land cover change studies in tropical forest (Grinand et al. 2013b) and more recently in the Miombo forest biome (Kamusoko, Gamba, and Murakami 2014).

RandomForest calibration was performed using 2/3 of randomly selected training plots. The remaining plots (1/3) were used to perform an "internal validation" by the algorithm. Based on a confusion matrix, this validation enabled the operator to identify the remaining confusions in order to add, remove or change the training plots on the GIS and redo the classification until satisfactory results were obtained.

Post-classification treatments

After classification, some isolated pixels of forest were found, giving a noisy appearance to the map. To respect the requirements on MMU (linked to the forest definition), those pixels were removed during post-classification processing. In the present study, MMU is 1 ha for forest and 0.36 for deforestation. A majority filter with a 3x3 window was first used to remove isolated pixels. The classified image was filtered with a Grass/R script for forests and deforestation patches.

External validation of results

This step entails a statistical analysis of the classification results accuracy, with a points sampling approach. This validation was designed specifically for the present Project. It was carried out on Forest/Non-forest map of the last date of the reference period, 2010, as provided by the BL-UP module. In order to reduce the working time to perform this analysis, the map was cut on the area of interest for the validation i.e. the RRD. Validation points were selected independently of training plots that were used for the classification (1000 validation points were spread out on the RRD). The state of the forest was visually inspected on every point and gathered in a spatial database. The inspections were based on very high-resolution *Google Earth* images and on the LANDSAT images that had been used for the classification. The result of the photo-interpretation (reference dataset) was finally compared with the map to produce a confusion matrix. This confusion matrix is used to calculate the accuracy of the map which is presented in Table 12.

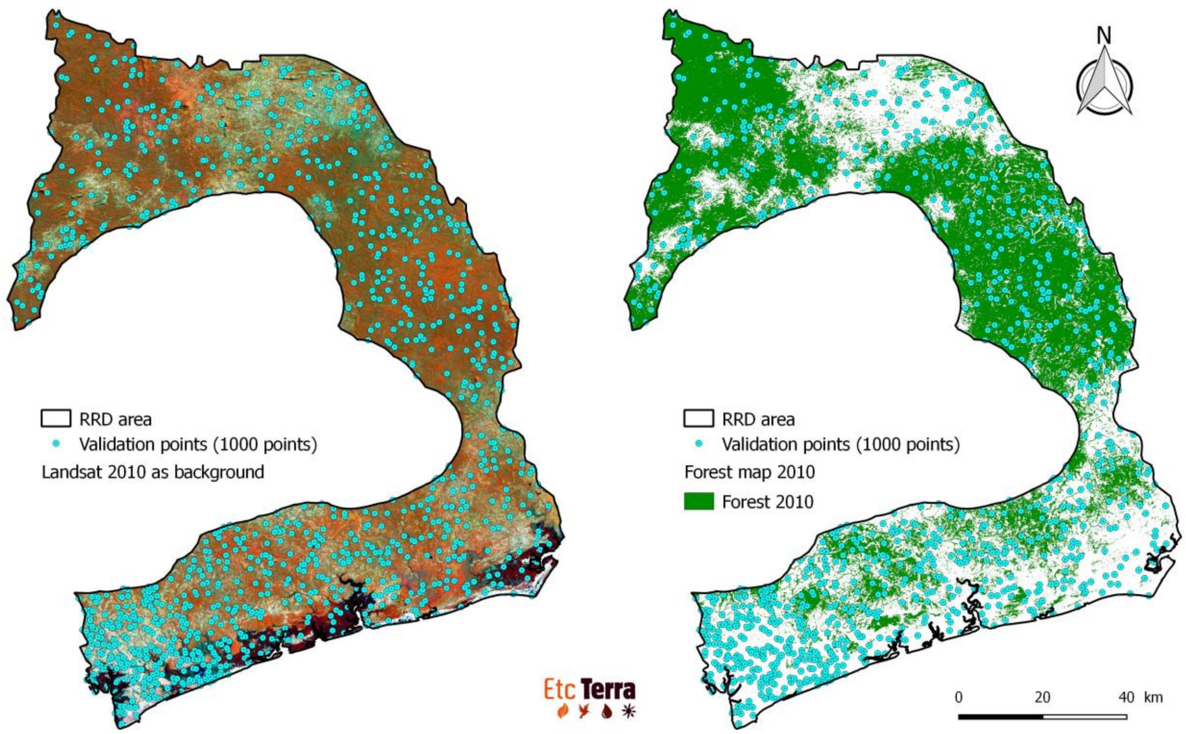

Figure 19: Distribution of the 1000 points randomly selected for the validation sampling in the RRD on the observation data on the left (Landsat or Google Earth images) and on the reference map on the right (Forest/Non-forest map for the year 2010)

Table 12: Confusion matrices (number of points above and percentages below) on the external validation of the historical deforestation map (1900 to 2013) produced for the ER-PD development (Mercier et al. 2016).

Numbers within the matrix are the number of points of land cover between the reference dataset (points) and the prediction of the map.

		Observed (Landsat/Google earth)			User Accuracy
		Non-forest	Forest	**Total**	
Predicted (Forest / Non-forest map)	Non-forest	596	39	**635**	**94%**
	Forest	18	347	**365**	**95%**
	Total	**614**	**386**	**1000**	
Producer Accuracy		**97%**	**90%**		**94%**

		Observed (Landsat/Google earth)		
		Non-forest	Forest	**Total**
Predicted (Forest / Non-forest map)	Non-forest	93.9%	6.1%	100.0%
	Forest	4.9%	95.1%	100.0%
Overall accuracy				**94%**

Mapping of historical deforestation

Using the results of the map produced for the ZILMP background study, forest cover maps for the 3 dates of analysis on the RRD are presented in Figure 20 and deforestation maps are presented in Figure 21. Cloud cover on maps was reduced to 0% on the area of interest thanks the use of multiple-date images and of appropriate calibration plots for the model *RandomForest*.

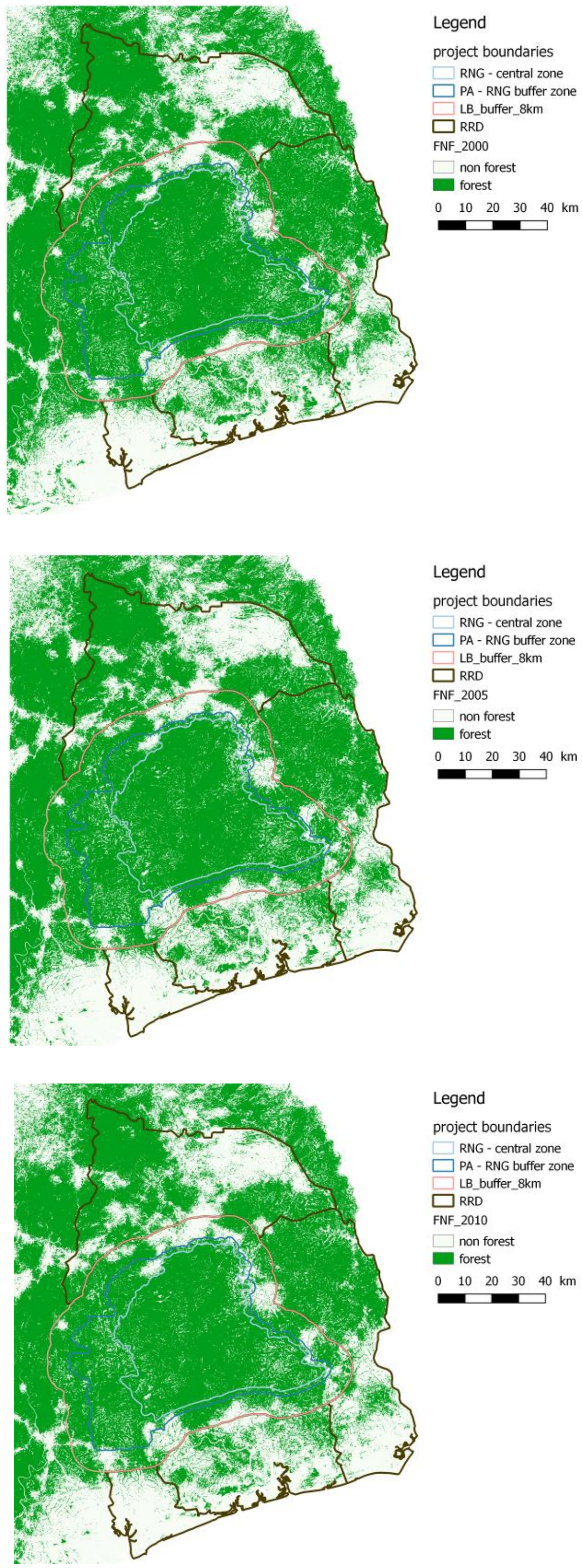

Figure 20: Forest cover maps for the 3 dates of historical analysis (2000, 2005 and 2010) on the RRD of GNR REDD project (from results of ZILMP background study - Mercier et al. 2016)

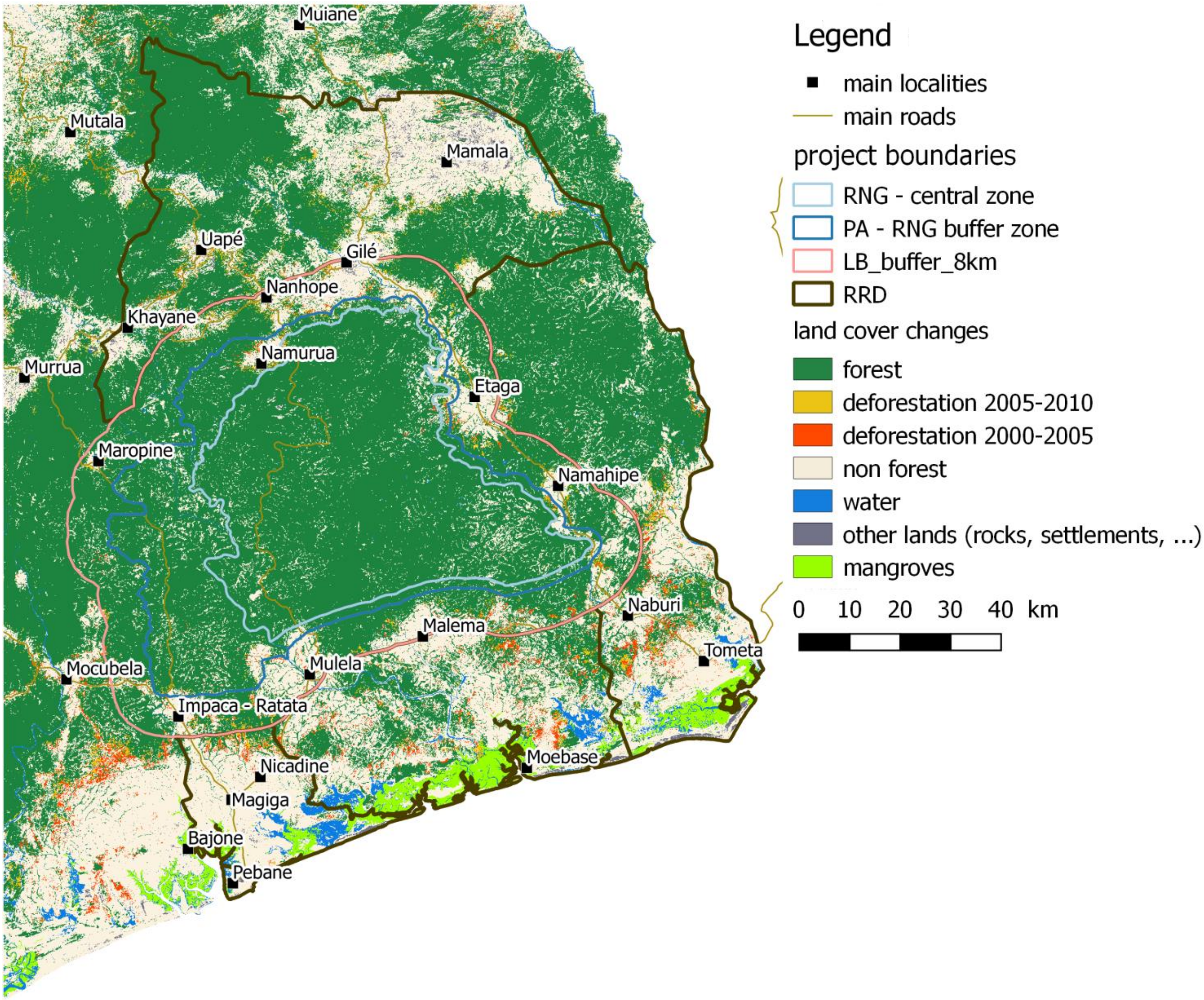

Figure 21: Deforestation maps between 2000-2005 and 2005-2010 on the RRD of GNR REDD project (from results of ZILMP background study - Mercier et al. 2016)

Calculation of the historical deforestation rate

Gross deforestation expressed in hectares and percentage of the RRD is presented in the following table. These results are those extracted from the ZILMP background study on the reference period.

Table 13: Results of historic deforestation on RRD during the reference period

	Forest area in ha			Annual deforestation area in ha/yr		Annual deforestation rates in %/yr	
	2000	**2005**	**2010**	**2000-2005**	**2005-2010**	**2000-2005**	**2005-2010**
RRD	440,988	426,296	412,145	2,900	2,855	0.62%	0.68%

2.4.1.2 Estimation of the annual areas of unplanned baseline deforestation in the RRD

In order to model the annual area of deforestation for the baseline in the RRD, the calculation has to be based on historical deforestation, with three possible approaches for projection:

- Historical average annual deforestation;
- Linear regression of deforested area against time;
- Non-linear regression of deforested area against time.

According to the BL-UP module, the calibration of a linear or non-linear regression is not possible because there are not enough elements on historical deforestation dynamics. As a consequence, historical average annual deforestation was used for the projection of annual quantity of deforestation in the baseline. Annual average deforestation in the RRD is therefore: **2,877 ha/yr**.

2.4.1.3 Estimation of the annual areas of unplanned baseline deforestation in the project area and leakage belt

Since no spatial modelling will be used to locate baseline deforestation in the RRL, the projected unplanned baseline deforestation in the PA is estimated as follows, and according to the equation that the BL-UP module recommends to use:

$$A_{BSL,PA,unplanned,t} = A_{BSL,RRD,unplanned,t} * P_{PA}$$

Where:

$A_{BSL,PA,unplanned,t}$	Projected area of unplanned baseline deforestation in the project area in year *t;* ha
$A_{BSL,RRD,unplanned,t}$	Projected area of unplanned baseline deforestation in the *RRD* in year *t;* ha
P_{PA}	Ratio of the project area to the total area of *RRD*; dimensionless
t	1, 2, 3, … t^* years elapsed since the projected start of the REDD project activity

The annual area of deforestation in PA, $A_{BSL,PA,unplanned}$ (**810 ha/yr**; Table 14) is used as the baseline for annual area of deforestation in PA as required by BL-UP module.

The same method is applied for the estimation of the LB annual area of deforestation in the baseline with the following equation.

$$A_{BSL,LK,unplanned,t} = A_{BSL,RRD,unplanned,t} * P_{LK}$$

Where:

$A_{BSL,LK,unplanned,t}$	Projected area of unplanned baseline deforestation in the leakage belt area in year *t;* ha
$A_{BSL,RRD,unplanned,t}$	Projected area of unplanned baseline deforestation in *RRD* in year *t;* ha
P_{LK}	Ratio of the area of the leakage belt to the total area of *RRD*; dimensionless
t	1, 2, 3, … t^* years elapsed since the projected start of the REDD project activity t^*

The annual area of deforestation in LB, $A_{BSL,LK,unplanned}$, is therefore **1,086 ha/yr** (Table 14).

Table 14: Summary of annual area of deforestation for the baseline in PA and LB

Project zone	Average deforestation in RRD (ha/yr)	Ratio between project zone and RRD areas	Baseline deforestation in project zone (ha/yr)
PA	2,877	0.28	810
LB	2,877	0.38	1,086

2.4.2 Estimation of carbon stock changes and greenhouse gas emissions

In accordance with the VM007 methodology and the BL-UP module, this section is divided in five steps, presented hereafter.

Estimations for this part are based on the results obtained for the ZILMP ER Program development, so as to respect adequacy with subnational carbon accounting initiative and because there is no reliable carbon stocks estimation available within the 2 years before project start date. Hence, carbon stocks in the area were estimated thanks the work presented in the background study (Mercier et al., 2016). Carbon stocks of Miombo forest were estimated thanks a large forest inventory of 100 plots (Mercier et al., 2016). The methodology of the inventory is presented in the background study (Mercier et al., 2016). The allometric equation that is used is the one of Chave et al. (2014), which is widely recognised and applicable for dry forests.

The carbon pools considered here are those presented in section 2.3.3 – i.e. aboveground and belowground tree biomass for pre-deforestation strata, to which aboveground non-tree biomass is added for post-deforestation strata. Conservatively, and because of difficulties to rigorously assess quantities, harvesting of long-lived wood products are not includes in the baseline and so, shall not be estimated in this section.

2.4.2.1 Stratification of the total area subject to deforestation

Pre-deforestation strata:

According to the background study for the ZILMP development (Mercier et al., 2016), only one pre-deforestation stratum corresponding to Miombo forest was defined. Admittedly, the forest in and around the GNR is relatively homogeneous in terms of carbon stocks with low elevation and climatic variations.

Post-deforestation strata:

Post-deforestation uses of land are agriculture – succession of fields and fallows – and savannas (see section 1.10). It is difficult to discriminate those uses with satellites images. In the same way, carbon stocks are similar on all post-deforestation land uses. Consequently, we did not establish a change matrix and option 1 – simple approach – of BL-UP module was chosen. One post-deforestation stratum and long term average carbon stock of this stratum was therefore used. A biodiversity and biomass inventory was realised around the GNR in 2016 (mainly in PA) following, for biomass estimation, the same method as the one for pre-deforestation data, except that plot size was 10 m of diameter. The inventories were realised on fallows of different ages but, in order to remain conservative, only biomass data from 10 years old fallows are used in the present document – this stratum is represented by 18 plots. The results from this inventory are also used in the ER-PD of the ZILMP.

The location of plots for both inventories is presented in following map.

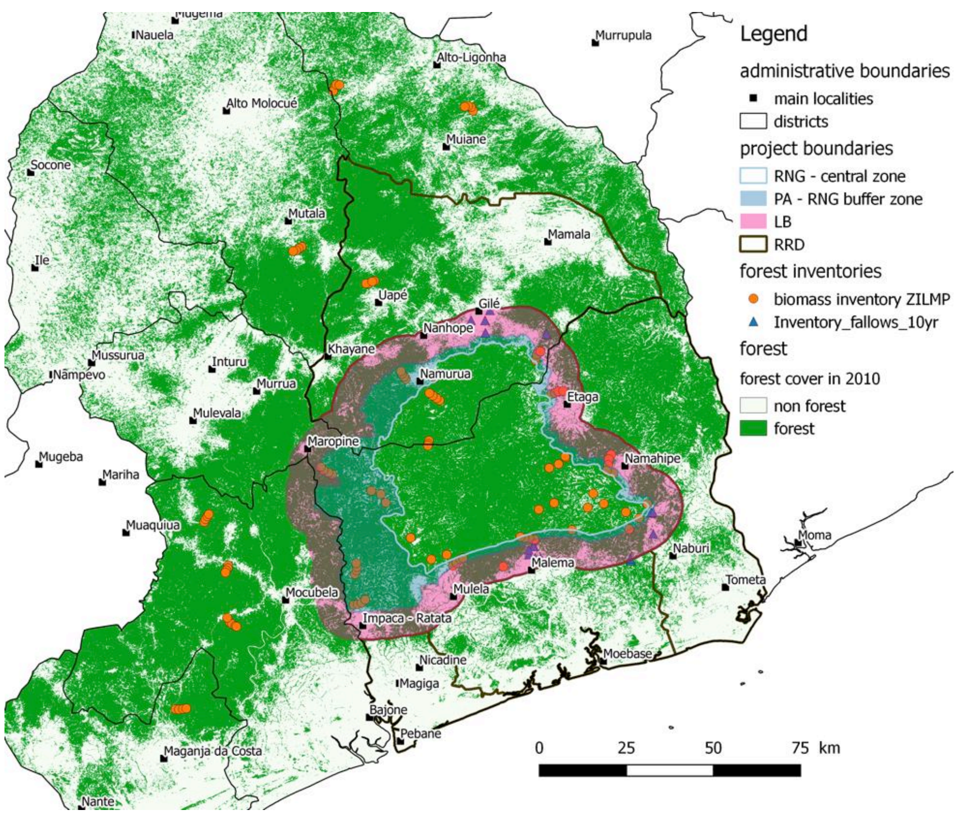

Figure 22: Forest inventories realised on pre- and post-deforestation strata for the ER Program ZILMP

2.4.2.2 Estimation of carbon stocks and carbon stock changes per stratum

Aboveground and belowground carbon stocks of Miombo forest

The results of the ZILMP background study are presented in the following table. Data for aboveground biomass are from field inventories and root-shoot ratio is from default data of IPCC (2006). According to IPCC (2003), carbon fraction in aboveground biomass averages 0.47 tC/tdm and in IPCC (2006), belowground to aboveground ratio (or root-to-shoot ratio) in tropical dry forests is expected to average:

- 0.56 if aboveground biomass is below 20 t/ha.
- 0.28 if aboveground biomass is above 20 t/ha.

For the ZILMP Program, 100 plots were inventoried in the program area (see Figure 22) regrouped in clusters of 4 plots on a topographical transect in order to account for the influence of biophysical variables - such as vegetation indexes, slope or elevation - on biomass variation.

The inventory was conducted on circular plots of 16 m of radius. For each plot, GPS coordinates and altitude were collected. For every trees above 5 cm diameter, the following measurements were gathered: diameter at breast height (DBH), height (with a vertex) and tree species.

Aboveground biomass has been calculated using an allometric equation linking biomass to diameter and height. Given the high species composition heterogeneity in tropical forests, multi-species equations are more relevant. Few generic equations are available for the Miombo forest but they do not apply to the range of diameters found in the inventory used here (see Mercier et al., 2016). Hence, the Chave's global equation for dry forest (Chave et al. 2014) was used. It is presented hereafter. It is based on 4004 sampled trees and entailed some data from Africa - including from Mozambique (Chave et al. 2014). This equation, which is more accurate than the 2005 equation, can be used for all types of forest.

Chave's allometric equation used:

$$AGB = 0.0673 \times (\rho D^2 H)^{0.976}$$

Where AGB is aboveground biomass, ρ is wood density, H is tree height and D is diameter at breast height.

Trees height and diameter are measured during inventories. Wood density for each species encountered during inventories was selected from the global wood density database (Zanne et al. 2009; Chave et al. 2009).

Table 15: Summary of pre-deforestation carbon stocks in forest tree biomass for the Miombo forest according to results of the ZILMP background study (Mercier et al., 2016)

	Aboveground	Belowground	Total
Carbon stocks in tC/ha			
Average	**65.9**	**18.4**	**84.5**
Standard deviation	28.3	7.9	35.9
90 % CI	4.7	1.3	5.9
Carbon stocks in tCO_2eq/ha			
Average	**241.6**	**67.6**	**309.8**
Standard deviation	103.7	29.0	131.8
90 % CI	17.1	4.7	21.8

Post-deforestation carbon stocks

The results are presented in the following table. They were estimated using the same method as the one presented just before (same plot size and measurements, allometric equation and root-to-shoot ratio) but with an inventory realised on 10-years old fallows (see Figure 22). Those results are comparable to other results from another district in Mozambique with regards to crops (9.4 tC/ha in ABG) and savanna (11.5 tC/ha in ABG – McNicol, Williams, and Ryan 2011).

Table 16: Estimation of carbon stocks in 10-years fallows for post-deforestation classes (n=18)

Carbon stocks in tC/ha			
	Aboveground	**Belowground**	**Total**
Average	**9.5**	**3.4**	**12.9**
Standard deviation	11.6	3.2	14.7
Carbon stocks in tCO_2eq/ha			
	Aboveground	**Belowground**	**Total**
Average	**34.8**	**12.5**	**47.3**
Standard deviation	42.6	11.6	53.8

Carbon stocks changes per stratum

Carbon stocks changes after deforestation in the project zones are then estimated as the difference between pre- and post-deforestation strata according to the VDM007 BL-UP module. The results are presented in the following table for the pools considered in this PDD (see section 2.3.3).

Table 17: Estimation of carbon stocks changes after deforestation of Miombo forest in project zones

	Emission factors in tCO_2eq/ha		
	Aboveground tree biomass	Belowground tree biomass	Total
	$\Delta C_{AB,tree}$	$\Delta C_{BB,tree}$	
Average	206.7	55.2	261.9

2.4.3 Reassessing the baseline scenario

As required by the VM0007 methodology, the baseline will be reassessed every 10 years in order to take into account the evolution of the drivers and of the agents of deforestation. This revision should therefore happen in 2021. If the ZILMP jurisdictional program is accepted by the FCPF-CF and is actually implemented in the area, this reassessment will be conducted in accordance with the program baseline at that time.

2.5 Additionality

As required by the VM0007 REDD-MF methodology, additionality of the project is assessed with T-ADD tool VT0001 v3.0, adapted by VCS for AFOLU projects.

As presented in section 1.10, the project area is covered by Miombo forest. The main land use causing deforestation is, by far, slash and burn agriculture, which is practiced by local farmers for, essentially, self-consumption. Without economic alternative in the region, which is remotely located, far from the main cities, it is probable that the dynamic in the area would stay the same with a similar or growing rate of deforestation along with demographic growth.

2.5.1 STEP 1: identification of alternative land use scenarios to the AFOLU project activity

This step aims to identify alternative land use scenario to the proposed baseline scenario.

2.5.1.1 Sub-step 1a: identify credible alternative land use scenarios to the proposed VCS AFOLU project activity

According to the local and national contexts, feasible scenarii that would have occurred in the GNR area in absence of the project are the following:

- **Scenario 1: conversion of forest land for slash and burn agriculture and charcoal production**

  The decrease of soil fertility – after several cycles of cultivation separated by increasingly short fallow periods – and growing demography in the area increase the needs for forest lands on which slash and burn agricultural practices would be maintained or intensified. Since a significant part of the communities living in the area is dependant on agriculture for subsistence, the majority of local population is composed of farmers seeking new lands in forest. This is reinforced by the lack of alternatives to those practices, due to the remoteness of the area, the poor diffusion of other techniques and low investment capacities. Moreover, the increasing demography and the need to generate rapid incomes result in local population producing charcoal from forests outside of their fields. This is linked to the increasing demand for cheap energy and the low access to forest resources for firewood in the town of Gile. Slash and burn agriculture and charcoal production lead to a progressive decrease of remaining forest area, as shown in section 1.10, and jeopardise the integrity of forest cover of the GNR.

- **Scenario 2: conversion from slash and burn agriculture to small scale conservation agriculture and agroforestry outside of forest areas**

  Being confronted to the progressive reduction of forest area and, as a consequence, to the decrease of forest land availability, it is possible that farmers change their practices to cultivate in savannah areas that were created from previous deforestation. However, this represents a risk for farmers if new agricultural techniques have not been properly disseminated; it can be expected that only a small part of the population would take such a risk and/or have investment capacity to foster an early change of practices. The promotion of diversified small-scale agriculture and agroforestry systems (with, for instance, cashew nuts seedlings being distributed for free in Zambezia province) would offer diverse sources of incomes for smallholders. Those incomes would be spread along the year and foster financial security for households, in contrast to current incomes being concentrated on the harvest period. Moreover, agroforestry is also a source of fuelwood in areas located next to housing. However, despite access to free seedlings of cashew trees, no dissemination of such cropping techniques is observed yet. This may be explained by the poor diffusion of maintenance techniques and by the lack of incentive prices that would have been negotiated with collectors.

- **Scenario 3: extension of the protected area without external financing**

  Before the beginning of the project, although the central zone of the GNR already guaranteed an overall good conservation of forest cover (see Figure 21), illegal logging for *pau ferro (Swartzia madagascariensis)* became a significant phenomenon, including and especially in the GNR, where large stocks exist. Concerned by increasing deforestation in Zambezia province after the end of the civil war (90's), the government could have extended the area under protection status and improved conservation in the central zone of the Reserve. However, evident lack of funds dedicated to such policies and poor political will prevented such a scenario from happening. This is why external funds were required for the initiation of the present project and for the support to ANAC, as presented in section 2.5.2. Besides, this scenario would require to declassify forest concessions or to change licences for timber extraction for the surrounding concessions.

- **Scenario 4: extension of illegal logging and declassification of the GNR**

  In Zambezia province and especially in the GNR, for now, illegal logging is almost exclusively focused on one single species (*pau ferro – Swartzia madagascariensis)* (Mercier et al., 2016). However, the progressive disappearance of *Pau Ferro,* combined with permanent poor law enforcement, could make illegal logging extend to other valuable species that are exploited in other areas of Mozambique (Mercier et al., 2016). This could also increase illegal logging in and around the GNR where there are still wood stocks. After the sharp decrease of wildlife due to animal poaching, the decrease of timber flora biodiversity would irrecoverably lead to the declassification of the GNR as a Reserve. If the GNR loses its protection status, the whole area would be exposed to other; possibly unsustainable, land uses – such as agriculture, forestry and mining activities.

- **Scenario 5: concessions for large or small scale commercial mining**

  The subsoil of the GNR is rich in several minerals or precious stones of interest for small scale or industrial mining. No exploration permit was requested around GNR area yet but illegal mining is observed in the Reserve and practices in other regions of Mozambique make this scenario be possible.

2.5.1.2 Sub-step 1b: consistency of credible land use scenarios with enforced mandatory applicable laws and regulations

This section illustrates how the identified scenarii are consistent with national laws and regulations and their level of enforcement.

- **Scenario 1: conversion of forest land for slash and burn agriculture and charcoal production**

  No official regulation exists to prevent slash and burn practices in agriculture. Customary rules exist for the attribution of new lands but they do not constrain practices and uses. Basically, lands belong to the one who valorise it in the first place. It is unlikely that this common practice stops without external intervention through a project.

- **Scenario 2: conversion from slash and burn agriculture to small scale conservation agriculture and agroforestry outside of forest areas**

  In Mozambique, there is neither law nor regulation preventing this type of conversion, which would reduce deforestation, from happening. However, the poor diffusion of new techniques and the low investment capacities of local households are strong barriers for the development of this scenario.

- **Scenario 3: extension of the protected area without external financing**

  The extension of a protected area would be consistent with the national regulations. The condition is the availability of funds and the assurance of their sustainability. This was not the case for national funds at the beginning of the project. However, external funds (FFEM) through the elaboration of a REDD project were available and fully compatible with national laws and regulations. Concessions and licences for timber extraction should be revised by national authorities in this scenario.

- **Scenario 4: extension of illegal logging and declassification of the GNR**

  Illegal logging is per definition not respecting the law and regulations of Mozambique. However, poor law enforcement and high rates of corruption maintain this activity in the whole country *(Mackenzie 2006b; German and Wertz-Kanounnikoff 2012; Wertz-Kanounnikoff S., Falcão M.P., and Putzl L. 2013c)*. No law enforcement may be enough to totally prevent this practice that is intense and widely spread. This would be even more difficult in the absence of the REDD project, which is expect to highly contribute to reduce illegal logging

As a conclusion, all those scenarii are consistent with national laws and regulations and their level of enforcement and can be considered as feasible.

2.5.1.3 Sub-step 1c: selection of the baseline scenario

In the absence of the project, the most plausible baseline scenario is the one described in the previous sections, characterized by the diminution of forest cover due to the conversion of forest into agricultural plots – through slash and burn practices – and to the extension of charcoal production for cheap energy and complementary incomes. It corresponds to the direct continuation of local land uses without changes in practices. Moreover, significant barriers exist for changing local agricultural practices without project activity.

Illegal logging is already prevalent in and around the GNR but it is still maintained to a specific species and, for the moment, is not excepted to lead to the declassification or the Reserve.

Finally, the extension of the protected area is plausible inside a REDD project (it corresponds to one of the project activity) but seems difficult outside of this framework, because of a lack of necessary funds in the long term. Indeed, this cannot be considered as a common practice.

2.5.2 STEP 2: Investment analysis

The objective is to determine whether the activities of the proposed project would, without the revenues of GHG credits, be financially less attractive than at least one of the other land use scenarii.

The only scenario generating significant revenues are the creation of mining concessions and the extension of illegal logging to private companies that would lead to high increase of deforestation.

The other scenarii can also generate revenues but only for specific households; the overall impact on communities would remain low.

As investment analysis was carried out, barriers analysis (step 3) is not mandatory.

2.5.2.1 Sub-step 2a: determine appropriate analysis method

As described in section 1.8, the activities of the GNR REDD project can be summarised in 3 components:

- **Forest conservation**: (i) Extension of the size of the Reserve through the creation of a buffer zone where some activities are allowed for communities and (ii) improvement of conservation efforts in the whole Reserve.
- **Small-scale conservation agriculture**: Development of agro-ecology techniques in villages that are located around the GNR in order to find alternatives to slash and burn agriculture practices, which is the main cause of deforestation in the area.
- **Development of cash crop value chain**: Improvement of cashew tree cultivation and of its value chain to help producers (i) improve quality and quantity produced and (ii) increase selling prices.

Regarding forest conservation, since tourism activities will not be able to be implemented before, the first component will only be a source of costs for at least the 10 first years of project implementation. At first, it will not generate any income through any economic activity.

As for the other components, the totality of the financial and economic benefits generated by their activities will be directly shared to households around the project area, through the increase of yields and the diversification of agriculture. Benefits for cash crop value chains for exportation will be shared between communities and the venture created. This activity rather aims to improve communities' revenues than being directly linked to forest conservation in the project area. Hence, the project proponent will not make any profits from the project activities but will only support costs of implementation.

The revenues obtained by GHG credits will only serve to cover project costs and to finance the upscaling of project activities, if possible. Therefore, we proceed to a simple cost analysis – option 1.

2.5.2.2 Sub-step 2b: Option 1 – simple cost analysis

For its first 10 years of implementation, the average annual expenditures of the project were estimated at 650 000 USD (financial plan available at validation). At the beginning of the project, these expenditures are covered by international funding (by the FFEM until 2016 and by the World Bank through the Mozbio project between 2016 and 2018). After this period, no additional funds have been secured and the project will mainly rely on the sale of carbon credits. The level of activity from 2018 onwards will have to be adjusted, according to the incomes generated by the sales of carbon credits. In any case, as the project proponent, the ANAC, is a public institution and the partners, IGF and Etc Terra, are non-profit organisations, all benefits will be reinvested in the implementation of project activities. The financial plan is updated every year, depending on the adjustment of incomes and of unexpected costs.

The costs of the project are divided as followed:

- 54% of the budget is used for the management of the GNR (human resources and operational costs);
- 42% of the budget is used for agricultural support to communities, with the promotion of conservation agriculture and value chain strengthening;
- 4% of the budget is used for the development of REDD activities, such as the preparation of carbon accounting and PDD and the community consultation.

The incomes of the project come from:

- International funding, which covers 98% of costs for the first 5 years of project implementation and 21% in the following 5 years;
- State budget, which covers less than 5% of the income of the project over the first 10 years (11,000 USD per year and 100,000 USD from the Biofund in 2017 and 2018);
- Carbon credits, which are expected to represent 75% of the benefits of the GNR. This is very important since, during the second period of 5 years (2017-2021), carbon credits are expected to finance the project after the end of international funding. Depending on the success of the sale of carbon credits, the level of activities will be adjusted upward or downward.
- Additional income from eco-tourism is a plausible potential benefit but this is not expected to happen before the end of first project period (10 first years).

2.5.3 STEP 4: Common practice analysis

As previously mentioned, the activities of the GNR REDD project rely on the improvement of the conservation of the Reserve and on the development of sustainable agricultural techniques as alternatives to slash and burn agriculture, associated with the elaboration and implementation of communities-based land use management plans.

In Mozambique, other national Reserves or protected areas have already developed the same kind of activities – that is, the promotion of improved agricultural techniques and/or the creation of conservation and hunting areas, with financial benefits being shared with communities. However, they are characterize by significant differences with the GNR[9]:

- Some Reserves are not located in forested areas (e.g. Marromeu, Ponta do Ouro) and, consequently, are facing different types of pressures. Other are covered by different types of forest (e.g. the protected area "*Ilhas Primeiras e Segundas*" contains mangroves and a largely smaller proportion of terra firme lands). In Mozambique, the GNR is the national Reserve with the largest area of intact Miombo forest and, therefore, with the most important appealing potential for slash and burn agriculture.

[9] http://www.biofund.org.mz/en/base-de-dados/

- Several protected areas are located in more easily accessed areas and are composed of a more diversified and significant wildlife: they attract tourists and generate additional income – outside of the scope of the State budget – for the development of their activities9 (e.g. the Niassa National Reserve, the Quirimbas National Park, the Gorongosa National Park). The GNR is difficult to access and, above all, does not yet have the necessary infrastructures for tourism (the number of tourists per year is null for the GNR).

The socio-economic, geographic and natural contexts of the GNR cannot be found in other protected areas in Mozambique. Another REDD+ project has been identified in Mozambique: the Sofala Community Carbon Project, certified by Plan Vivo and located in the buffer zones of the Gorongosa National Park and Marromeu National Reserve. The REDD component of this project is developed on 9,599 ha (according to the project PDD), which is not a comparable scale to the GNR REDD project (PA = 124,159 ha). Moreover, it proves necessitating carbon finance to sustains its activities.

Other development projects focusing on small scale agriculture also exist in Mozambique, especially in Zambezia province, but they don't have the same objective of reducing deforestation (e.g. COSV project around GNR[10], ESSOR – Escola Familiar rural[11], ICEI – Eco Ilhas[12], etc). Moreover, they receive short term financing that limit their scale of action.

Even if the financing of the elaboration of the GNR REDD project is maintained until 2016, the costs analysis presented on the previous section shows that long-term activities will require additional funds on the long term, making GHG credits be necessary additional revenues for the continuation of the project after 2016.

2.6 Methodology Deviations

The following methodology deviation was applied for the establishment of the baseline:

- The BL-UP module of the VM0007 REDD-MF methodology requires that carbon stocks of pre-deforestation strata be estimated with data acquired within 2 years before project start date (2011). However, since this document was developed after project start date and no reliable data were available before, we used forest inventory data that were produced in 2015 (4 years after project start date) for the development of the ZILMP subnational program around the project zone. Carbon stocks may have changed since 2011 but if it is the case, they decreased, because of forest illegal exploitation of *pau ferro (Swartzia madagascariensis)*. Thus, this deviation remains conservative, as it would lead to an under-estimation of carbon stocks in PA at the beginning of baseline period.

[10] http://www.cosv.org/conservation-of-natural-resources-in-the-national-reserve-of-gile-and-its-peripheral-areas-through-the-strengthening-of-economic-and-productive-activities-of-rural-communities/?lang=en
[11] http://www.essor-ong.org/pt/programas/no-mocambique/renforcement-de-7-efr.html
[12] http://www.icei.it/icei/en/project/sviluppo-eco-sostenibile-di-sistemi-di-gestione-agro-silvo-pastorali-e-della-pesca-artigianale/

3 ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

3.1 Baseline Emissions

The procedure for the quantification of the baseline emissions follows the VDM007 BL-UP module of the REDD-MF methodology. It requires estimating emissions due to (i) carbon stocks changes, for the baseline estimations of area of unplanned deforestation (see section 2.4); and to (ii) greenhouse gas emissions, in the project area and leakage belt. Estimations apply to the 10 years of the validity of the baseline, from 2011 – beginning of the project (see section 2.3.1).

3.1.1 Estimation of the sum of baseline carbon stock changes

Among the carbon pools that are considered in this PDD, according to the BL-UP module, stock changes in aboveground biomass are emitted at the time of deforestation, while emissions from belowground biomass are emitted at an annual rate of 1/10 for 10 years, as it is presented in the equations hereafter. In the following equation, the mail parameters used are: $A_{unplanned,PA,t}$ = 810 ha/yr and $A_{unplanned,LB,t}$ = 1,086 ha/yr as presented in Table 14 and, C_{AB_tree} = 206.7 and C_{BB_tree} = 55.2 as presented in Table 17. The other parameters are set to zero as they are not included in the baseline (see section 2.3.3).

Following this method, results are emissions of **1,920,420 tCO_2eq** for PA and of **2,575,648 tCO_2eq** for LB, after the 10 years baseline period (Table 18).

$$\Delta C_{TOT} = \sum_{t=1}^{t}\sum_{i=1}^{M}\Delta C_{BSL,i,t}$$

$$\Delta C_{BSL,i,t} = A_{unplanned,i,t} * (\Delta C_{AB_{tree},i} + \Delta C_{AB_{non-tree},i} + \Delta C_{LI,i})$$
$$+(\sum_{t-10}^{t} A_{unplanned,i,t}) * (\Delta C_{BB_{tree},i} + \Delta C_{BB_{non-tree},i} + \Delta C_{DW,i}) * \left(\frac{1}{10}\right)$$
$$+(\sum_{t-20}^{t} A_{unplanned,i,t}) * (C_{WP100,i} + \Delta C_{SOC,i}) * \left(\frac{1}{20}\right)$$

Where:

ΔC_{TOT}	Sum of the baseline carbon stock change in all pools up to time *t**; t CO_2-e (calculated separately for the project area [PA] and the leakage belt [LB]
$\Delta C_{BSL,i,t}$	Sum of the baseline carbon stock change in all pools in stratum *i* at time *t*, t CO_2-e
$A_{unplanned,i,t}$	Area of unplanned deforestation in forest stratum *i* at time *t*; ha
$C_{WP100,i}$	Carbon stock entering the wood products pool at the time of deforestation that is expected to be emitted over 100-years from stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{AB\_tree,i}$	Baseline carbon stock change in aboveground tree biomass in stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{BB\_tree,i}$	Baseline carbon stock change in belowground tree biomass in stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{AB\_non\text{-}tree,i}$	Baseline carbon stock change in aboveground non-tree biomass in stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{BB\_non\text{-}tree,i}$	Baseline carbon stock change in belowground non-tree biomass in stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{DW,i}$	Baseline carbon stock change in dead wood in stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{LI,i}$	Baseline carbon stock change in litter in stratum *i*; t CO_2-e ha^{-1}
$\Delta C_{SOC,i}$	Baseline carbon stock change in soil organic carbon in stratum *i*; t CO_2-e ha^{-1}
i	1, 2, 3, … *M* strata
t	1, 2, 3, … *t* years elapsed since the projected start of the REDD project activity

Table 18: Sum of carbon stocks changes after deforestation of Miombo forest in project zones after 10 years of baseline period in PA and LB

PROJECT AREA		Emission in tCO_2eq for carbon pool and total			
Number of years (t)	Year	Aboveground	Belowground	Total $\Delta C_{BSL,PA,t}$	Sum $\Delta C_{TOT,PA}$
1	2012	167,471	4,468	171,938	**171,938**
2	2013	167,471	8,935	176,406	**348,344**
3	2014	167,471	13,403	180,873	**529,217**
4	2015	167,471	17,870	185,341	**714,558**
5	2016	167,471	22,338	189,808	**904,366**
6	2017	167,471	26,805	194,276	**1,098,642**
7	2018	167,471	31,273	198,743	**1,297,385**
8	2019	167,471	35,740	203,211	**1,500,596**
9	2020	167,471	40,208	207,678	**1,708,274**

PROJECT AREA		Emission in tCO_2eq for carbon pool and total			
Number of years (t)	Year	Aboveground	Belowground	Total $\Delta C_{BSL,PA,t}$	Sum $\Delta C_{TOT,PA}$
10	2021	167,471	44,675	212,146	**1,920,420**

LEAKAGE BELT		Emission in tCO_2eq for carbon pool and total			
Number of years (t)	Year	Aboveground	Belowground	Total $\Delta C_{BSL,PA,t}$	Sum $\Delta C_{TOT,PA}$
1	2012	224,610	5,992	230,602	**230,602**
2	2013	224,610	11,984	236,593	**467,195**
3	2014	224,610	17,975	242,585	**709,780**
4	2015	224,610	23,967	248,577	**958,357**
5	2016	224,610	29,959	254,569	**1,212,926**
6	2017	224,610	35,951	260,561	**1,473,487**
7	2018	224,610	41,943	266,553	**1,740,039**
8	2019	224,610	47,935	272,544	**2,012,584**
9	2020	224,610	53,926	278,536	**2,291,120**
10	2021	224,610	59,918	284,528	**2,575,648**

3.1.2 Estimation of the sum of baseline greenhouse gas emissions

Except for CO_2, all the other greenhouse gases emitted during deforestation are conservatively excluded from this PDD (see section 2.3.4). Additional emissions due to biomass burning, use of fossil fuels or fertilisation are therefore not considered.

3.1.3 Calculation of net CO_2 equivalent emissions

Since there is no other GHG emissions accounted for in this document, the net total baseline emissions are those due to carbon changes.

$\Delta C_{BSL,PA,unplanned}$ **= 1,920,420 tCO_2eq**

$\Delta C_{BSL,LK,unplanned}$ **= 2,575,648 tCO_2eq**

Where:

$\Delta C_{BSL,PA,unplanned}$	Net CO_2 emissions in the baseline from unplanned deforestation in the project area; t CO_2-e
$\Delta C_{BSL,LK,unplanned}$	Net CO_2 emissions in the baseline from unplanned deforestation in the leakage belt; t CO_2-e

3.2 Project Emissions

In accordance with the VMD0015 M-Mon module that has to be applied following the VM0007 REDD-MF, the net GHG emissions in the project scenario are equal to the sum of carbon stocks changes due to deforestation and degradation, and other GHG emissions due to project activities minus any eligible carbon stock enhancement, as presented in the following equation.

$$\Delta C_P = \sum_{t=1}^{t*} \sum_{i=1}^{M} \left(\Delta C_{P,DefPA,i,t} + \Delta C_{P,Deg,i,t} + \Delta C_{P,DistPA,i,t} + GHG_{P-E,i,t} - \Delta C_{P,Enh,i,t} \right)$$

Where:

ΔC_P	Net greenhouse gas emissions within the project area under the project scenario; t CO_2-e
$\Delta C_{P,DefPA,i,t}$	Net carbon stock change as a result of deforestation in the project area in the project case in stratum *i* at time *t*; t CO_2-e
$\Delta C_{P,Deg,i,t}$	Net carbon stock change as a result of degradation in the project area in the project case in stratum *i* at time *t*; t CO_2-e
$\Delta C_{P,DistPA,i,t}$	Net carbon stock change as a result of natural disturbance in the project area in the project case in stratum *i* at time *t*; t CO_2-e
$GHG_{P-E,i,t}$	Greenhouse gas emissions as a result of deforestation and degradation activities within the project area in the project case in stratum *i* in year *t*; t CO_2-e
$\Delta C_{P,Enh,i,t}$	Net carbon stock change as a result of forest growth and sequestration during the project in areas projected to be deforested in the baseline[2] in stratum *i* at time *t*; t CO_2-e
i	1, 2, 3 …*M* strata
t	1, 2, 3, … *t** years elapsed since the start of the REDD project activity

3.2.1 Carbon stock changes as a result of unavoidable unplanned deforestation in the project case

The project is designed to reduce deforestation in the project area. However, the efficiency of its activities will not be total as deforestation activities are mainly due to subsistence agriculture. In this section, we try to assess the overall effectiveness of the project to curb deforestation rate, based on the knowledge of the main threats and of the project activity plans. Activities do not all start at the beginning of the project. They will be implemented and deployed throughout the lifetime of the REDD project. Hence, the effectiveness of the project activities will increase with time. This analysis is summarised in Table 19.

The creation of the buffer zone was the first activity to be implemented; it marked the beginning of the project, in 2011. Although it improved conservation awareness among the population, it is not expected to drastically decrease deforestation, since it does not regulate agricultural activities and does not provide for alternative practices to the local population – agents of deforestation. However, conservation of the central zone of the GNR proved to be relatively efficient in the past as it is revealed by the historical dynamics of deforestation (Figure 21). For those reasons, the efficiency of the creation of the buffer zone was estimated to stay relatively low at the end and was set to 10% (Table 19). Similarly, the improvement of the management of the GNR will enhance environmental awareness but may only have a low impact on deforestation in the PA as (i) this management exist for years and already allowed to maintain a low deforestation rate and (ii) it will mainly concern the central area of the reserve (outside of PA). The effectiveness of this activity was set to 2% (Table 19). However, the creation of a hunting game area in the buffer zone of the Reserve should provide for additional economic incomes to the communities and may contribute to lower deforestation, if awareness rising effort is efficient. However, this activity will start later in the REDD project – it is planned for 2019, that is why the efficiency is maintained low during the baseline period (2% - Table 19).

On the other hand, the promotion of sustainable agricultural techniques and the strengthening of cash crop value chains constitute solid alternatives to subsistence agriculture activities for the local population who is affected by the project, as previously explained. However, for them to be effective, these activities require relatively long periods of demonstration to convince smallholders and, subsequently, to increase their adoption rate. Hence, the effectiveness of the project is expected to slowly increase. In order to change the scale of implementation and increase the effectiveness of the reduction of deforestation, new funds (i.e. carbon credits, or other) will be targeted towards new beneficiaries. Thanks to the progressive adoption of agro-ecological practices and the up-scaling of those activities, effectiveness is expected to increase from 3% to 40% (Table 19) during the baseline period as more and more households will be included in this activity. The support to cash crop value chain, however, will have a less direct impact on deforestation as it does not directly target slash and burn fields but households' revenues. Hence, efficiency was estimated to be lower, between 5 and 15% along the baseline period, increasing with the number of households supported in the timeframe of the project (Table 19).

Based on those considerations, the average project effectiveness is estimating at 36% of deforestation reduction over 10 years (Table 19), but should raise to 69% at the end of the first baseline period (in 2021 - Table 19).

Table 19: Assessment of the evolution of project activities effectiveness along the baseline period

Baseline period		Effectiveness of activities					
Number of years	Year of start	Buffer zone creation 2011	GNR management 2011	Agro-ecology 2013	Cash crop 2017	Hunting zone 2018	Total
0	2011	2%	0%	0%	0%	0%	**2%**
1	2012	5%	2%	0%	0%	0%	**7%**
2	2013	5%	2%	3%	0%	0%	**10%**
3	2014	10%	2%	5%	0%	0%	**17%**
4	2015	10%	2%	10%	0%	0%	**22%**
5	2016	10%	2%	20%	0%	0%	**32%**
6	2017	10%	2%	30%	5%	0%	**47%**
7	2018	10%	2%	35%	10%	0%	**57%**
8	2019	10%	2%	35%	15%	1%	**63%**
9	2020	10%	2%	40%	15%	2%	**69%**

10	2021	10%	2%	40%	15%	2%	**69%**
Average		**8%**	**2%**	**20%**	**5%**	**0%**	**36%**

Based on the analysis of expected project effectiveness, ex-ante project emissions due to deforestation were calculated with a direct application of the effectiveness percentage on baseline emissions in the project area. Results are presented in the following table. They show an estimation of total project emissions **after 10 years of 1,136,187 tCO_2eq, which corresponds to a decrease of 784,233 tCO_2eq in comparison to the baseline scenario**.

Table 20: Ex-ante assessment of project emissions as a result of deforestation based on project effectiveness analysis

Baseline period		Emission due to unplanned deforestation in tCO_2eq					
Number of years	Years	Baseline case		Project scenario		Difference between baseline and project scenarios	
		Annually	Sum	Annually	Sum	Annually	Sum
1	2012	171,938	171,938	159,902	159,902	- 12,036	**- 12,036**
2	2013	176,406	348,344	158,765	318,667	- 17,641	**- 29,676**
3	2014	180,873	529,217	150,125	468,792	- 30,748	**- 60,425**
4	2015	185,341	714,558	144,566	613,358	- 40,775	**- 101,200**
5	2016	189,808	904,366	129,070	742,428	- 60,739	**- 161,938**
6	2017	194,276	1,098,642	102,966	845,394	- 91,310	**- 253,248**
7	2018	198,743	1,297,385	85,460	930,853	- 113,284	**- 366,532**
8	2019	203,211	1,500,596	75,188	1,006,041	- 128,023	**- 494,554**
9	2020	207,678	1,708,274	64,380	1,070,422	- 143,298	**- 637,853**
10	2021	212,146	1,920,420	65,765	1,136,187	- 146,381	**- 784,233**

3.2.2 Carbon stock changes as a result of degradation in the project case

According to the M-Mon module, degradation from human activities or natural disturbance should be accounted for.

Miombo forest in and around the GNR is an old-growth forest that is adapted to fire. Thus, even if fires occur each year during the dry season, they do not cause damages on forests that would lead to significant decrease of carbon stocks. No other natural disturbances that could have a significant impact can be identified.

Human activities leading to forest degradation in the project area are illegal timber exploitation and charcoal production. No legal logging will occur in the GNR buffer zone. This is justified by the fact that, before the project start date, there was little charcoal production in the project area. In addition, the project will enhance environmental awareness and improve the efficiency of charcoal production; therefore it should not have significant impact on the carbon stocks of the project area. In the same way, through the GNR management, the project aims to stop illegal timber exploitation and, since the buffer zone can more easily be controlled (presence of roads, tracks), no degradation due to this activity is expected to happen in the project area.

As a consequence, ex-ante estimation of carbon stock changes due to degradation in the project area is 0%. However, carbon stocks will be monitored according to the method presented in the VDM0015 M-Mon module.

3.2.3 Greenhouse gas emission in the project case

No other GHG are taken into consideration in this document and the project is not expected to change their emissions: no fertilisers will be used, fossil fuels will only be used for project cars – not significant – and biomass burning should decrease with the development of alternatives to slash and burn agriculture – it is conservatively not accounted for.

3.2.4 Carbon stock enhancement

Miombo forest in and around the GNR is an old-growth forest that is not expected to grow significantly. Carbon stocks are at their optimum. Moreover, no activity to improve those stocks is planned within the project. Hence, carbon stock enhancement in the project area is expected to be null.

3.2.5 Ex-ante estimation of net greenhouse gas emission under the project scenario

Only the reduction of deforestation is expected to have a significant impact on emissions in the project scenario. Ex-ante estimation of emissions reduction is presented in Table 19. **After 10 years of project, emissions are estimated at 1,136,187 tCO_2eq, which corresponds to a decrease of 784,233 tCO_2eq in comparison to the baseline scenario**.

3.3 Leakage

As required by the VM0007 methodology, the VDM0010 module (LK-ASU) is applied to assess ex-ante leakage because of project activity and expected evolution of deforestation in the LB. The following steps have to be respected:

- Step 1: estimation of baseline carbon stock changes and GHG emissions in the LB. This step was fulfilled in section 2.4;
- Step 2: estimation of the proportions of area deforested by immigrant and local deforestation agents in the baseline;
- Step 3: estimation of unplanned deforestation displaced from the PA to the LB;
- Step 4: estimation of unplanned deforestation displaced from the PA to outside of the LB;
- Step 5: emissions from activity shifting in peatland drainage. This project is not concerned by this step as there is no peatland in any project zones;
- Step 6: emissions from leakage prevention activity;
- Step 7: estimation of total leakage due to the displacement of unplanned deforestation.

3.3.1 Estimation of areas deforested by immigrants and local deforestation agents in the baseline

According to a survey led in 15 communities (that is, in 50% of the main communities) around the PA in 2015, only 2% of the interrogated persons (n=135) were recent immigrants that settled in the area in the previous 5 years. All the other immigrants (7%) settled more than 15 years ago and the majority of them actually settled more than 30 years ago. Given that almost all people are small scale farmers practicing slash and burn agriculture for subsistence needs and that the number of immigrants is very low, we can consider that the proportion of areas deforested because of those agents of deforestation is negligible.

3.3.2 Ex-ante estimation of unplanned deforestation displaced from PA to LB

The only activity implemented by the project that constrains the activities of the agents of deforestation is the creation of the buffer zone (project area). However, this will not limit the rights of population for land appropriation for agriculture (see section 1.10). The only existing limitations apply to the collection of some non-timber forest products and to hunting practices, restraining specific technics and defining proper periods for those activities. Moreover, the local population is not used to migrate as long as resources are sufficient (which is still the case with relatively high forest cover) and security ensured (after the civil war, for instance, high level of migration movements were observed with people returning to their initial homes, which they had left due to outbreaks of violence).

Nevertheless, the settlements of population after the war in areas located next to elephant habitats, combined with emerging conservation initiatives aiming at protecting and increasing again the elephant population, could trigger conflicts between farmers and elephants. As a consequence, agricultural fields may be moved to areas located further from villages (no displacement of habitations) and from the Reserve (outside of the RNG buffer zone). This would contribute to a decrease of deforestation in the PA, while increasing it in the LB. To our knowledge of the area, this concerns only few villages in the south of the PA. Hence, **we estimate leakage due to displacement of the activities of deforestation agents at 5% each year of the baseline period**.

3.3.3 Ex-ante estimation of unplanned deforestation displaced from PA to outside LB

Zambezia Province is one of the most forested areas in Mozambique, with Cabo Delgado and Niassa provinces, in the North of the country (Figure 6 & Figure 23). Particularly, in Zambezia province, the GNR and its surrounding represent the largest piece of existing dense forest cover. Moreover, in the whole country, areas located around the main roads show high level of deforestation. Hence, if the local population living in the project zone has to migrate to practice agriculture (which is, by far, the first cause of deforestation in the whole province – cf. ER-PIN), it is unlikely that they would go further than the boundary of the LB. Hence, **we estimate the unplanned deforestation displacement from the PA to outside the LB at 0%.**

Figure 23: Tree cover (2000) and tree cover loss (2001-2014) in Mozambique from Global Forest Watch[13]

3.3.4 Emission from leakage prevention activity

No other GHG are taken into consideration in this document and the implementation of leakage prevention activities (section 1.8) is not expected to change their emissions: no fertilisers will be used, fossil fuels will be used for project cars but this is not considered significant and biomass burning should decrease with development of conservation agriculture or early fire spark.

3.3.5 Ex-ante estimation of leakage due to displacement of unplanned deforestation

As a result of the estimation of the effectiveness of leakage prevention activities and of the potential leakage of unplanned deforestation due to displacement of agents of deforestation, it is evaluated that leakage would correspond to 5% of project emission baseline. It corresponds to **96,021 tCO_2eq** additional emissions in the LB during the 10 years baseline period (Table 19).

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13 http://www.globalforestwatch.org

Table 21: Ex-ante assessment of emissions in the leakage belt due to displacement of unplanned deforestation based on emissions estimation in the project case

Emission due to unplanned deforestation in tCO_2eq				
Number of years	**Baseline case for LB**	**Baseline case for PA**	**Expected leakage (5% of baseline for PA)**	**Total emissions expected in LB with project scenario**
1	230,602	171,938	8,597	239,198
2	236,593	176,406	8,820	245,414
3	242,585	180,873	9,044	251,629
4	248,577	185,341	9,267	257,844
5	254,569	189,808	9,490	264,059
6	260,561	194,276	9,714	270,274
7	266,553	198,743	9,937	276,490
8	272,544	203,211	10,161	282,705
9	278,536	207,678	10,384	288,920
10	284,528	212,146	10,607	295,135
Total	**2,575,648**	**1,920,420**	**96,021**	**2,671,669**

3.4 Estimated Net GHG Emission Reductions and Removals

3.4.1 Summary of total ex-ante estimation of net GHG emissions reductions and removals

According to the VM0007 methodology, the total net greenhouse gas emissions reductions of the GNR REDD project are calculated as follows:

$$C_{REDD,t} = \Delta C_{BSL} - \Delta C_P - \Delta C_{LK}$$

Where:

$C_{REDD,t}$ = Total net greenhouse gas emission reductions at time *t*; t CO_2-e

ΔC_{BSL} = Net greenhouse gas emissions under the baseline scenario; t CO_2-e (cf. section 3.1)

ΔC_P = Net greenhouse gas emissions within the project area under the project scenario; t CO_2-e (cf. section 3.2)

ΔC_{LK} = Net greenhouse gas emissions due to leakage; t CO_2-e (cf. section 3.3)

Results are presented in the following table. Based on the previous sections and on the calculations for the baseline in the PA, the project emissions reductions and the expected leakage, **it is expected that after 10 years of implementation, the project will achieve net emission reductions of 685,882 tCO_2eq.**

Table 22: Ex-ante assessment of total net greenhouse gas emission reductions for the GNR REDD project along the 10 years baseline period

Year	Estimated baseline emissions or removals (tCO_2eq)	Estimated project emissions or removals (tCO_2eq)	Estimated leakage emissions (tCO_2eq)	Estimated net GHG emission reductions or removals (tCO_2eq)
1	171,938	159,902	8,597	3,439
2	176,406	158,765	8,820	8,820
3	180,873	150,125	9,044	21,705
4	185,341	144,566	9,267	31,508
5	189,808	129,070	9,490	51,248
6	194,276	102,966	9,714	81,596
7	198,743	85,460	9,937	103,347
8	203,211	75,188	10,161	117,862
9	207,678	64,380	10,384	132,914
10	212,146	65,765	10,607	135,773
Total	**1,920,420**	**1,136,187**	**96,021**	**688,212**

3.4.2 Estimation of VCS buffer

In order to account for non-permanence risks associated with an AFOLU project, VCS registration requires to set aside in a buffer a fraction of the total carbon stock benefits. According to the VM0007 methodology, leakage emissions do not factor in this calculation. To calculate the buffer that has to be applied to the GNR REDD project, the VCS AFOLU non-permanence risk tool (v3.3) was used. This analysis is presented in Annex 2. We obtained a rating of 10 (the minimum risk rating) and converted it into a percentage in order to obtain the buffer that must be applied according to the following equation:

$$Buffer_{TOTAL} = Buffer_{UNPLANNED} = (\Delta C_{BSL} - \Delta C_P) * Buffer\%$$

Where:

$Buffer_{TOTAL}$ = Total permanence risk buffer withholding; t CO_2-e

ΔC_{BSL} = Net greenhouse gas emissions under the baseline scenario; t CO_2-e

ΔC_P = Net greenhouse gas emissions within the project area under the project Scenario; t CO_2-e

$Buffer\%$ = Buffer withholding percentage; %

The buffer is therefore 10%.

3.4.3 Uncertainty analysis

As required by the VM0007 methodology, module X-UNC must be used to combine uncertainties for the total net GHG emissions reduction. This estimation must be adjusted at each point in time following the methods that are described in the module. Uncertainties have to be estimated for several components of the emission reduction calculation.

Step 1: uncertainty in projection of baseline rate of deforestation

In the module X-UNC, it is assumed that there is zero uncertainty in baseline rate of deforestation if it is based on a long-term average. Uncertainty of step 1 is therefore: **0%** ($Uncertainty_{BSL,RATE,t^*}$).

Step 2: uncertainty of emissions and removals in the project area baseline scenario

Uncertainties have to be expressed with a 95% confidence interval as a percentage of the average for each carbon pool and stratum with the following equation for addition of uncertainties (same equation for pools or strata). According to X-UNC module, uncertainty is first propagated across pools within strata meaning that in the present case, it is estimated first for pre- and post-deforestation strata and it is after combined with the following equations:

$$U_{REDD\_BSL,SS,i} = \frac{\sqrt{\sum_1^n (U_{REDD\_BSL,SS,i,pool\#} \times E_{REDD\_BSL,SS,i,pool\#})^2}}{\sum_1^n E_{REDD\_BSL,SS,i,pool\#}}$$

Where:

$U_{REDD\_BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline case in stratum *i* (%)
$U_{REDD\_BSL,SS,i,pool\#}$	Percentage uncertainty for carbon stocks and greenhouse gas sources in the REDD baseline case in stratum *i* (%)
$E_{REDD\_BSL,SS,i,pool\#}$	Carbon stock or GHG sources in the REDD baseline case (t CO_2e)
i	1, 2, 3 …*M* strata (unitless)

Uncertainty across combined strata must be assessed as follows:

$$Uncertainty_{REDD\_BSL,SS} = \frac{\sqrt{\sum_{i=1}^M (U_{REDD\_BSL,SS,i} \times E_{REDD\_BSL,SS,i})^2}}{\sum_{i=1}^M E_{REDD\_BSL,SS,i}}$$

Where:

$Uncertainty_{REDD\_BSL,SS}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline case (%)
$U_{REDD\_BSL,SS,i}$	Percentage uncertainty in the combined carbon stocks and greenhouse gas sources in stratum *i* in the REDD baseline case (%)
$E_{REDD\_BSL,SS,t,i}$	Sum of combined carbon stocks and GHG sources in the REDD baseline case (t CO_2-e)
i	1, 2, 3 …*M* strata (unitless)

Uncertainties of pre-deforestation stratum are estimated to be 7% (173.9 tCO_2eq/ha): 8% for AGB (241.6 tCO_2eq/ha) and 8% for BGB (67.6 tCO_2eq/ha). Uncertainties of post-deforestation stratum are estimated to be 42% (22.3 tCO_2eq/ha): 56% for AGB (34.8 tCO_2eq/ha) and 43% for BGB (12.5 tCO_2eq/ha). This leads to a total uncertainty for emission factor (206 tCO_2eq/ha – see section 2.4.2.2) of **8%** ($Uncertainty_{REDD\_BSL,SS}$).

Step 3: total uncertainty in REDD baseline scenario

Total uncertainty is calculated with the following equation:

$$Uncertainty_{REDD\_BSL,t*} = \sqrt{Uncertainty_{BSL,RATE,t*}^{\,2} + Uncertainty_{REDD\_BSL,SS}^{\,2}}$$

Where:

$Uncertainty_{REDD\_BSL,t^*}$	Cumulative uncertainty in REDD baseline scenario up to time *t* (%)
$Uncertainty_{REDD\_BSL,RATE,t^*}$	Cumulative uncertainty in the baseline rate of deforestation *up to* time *t* (%)
$Uncertainty_{REDD\_BSL,SS}$	Total uncertainty in the combined carbon stocks and greenhouse gas sources in the REDD baseline case (%)
t	1, 2, 3, …*t** time elapsed since the start of the project activity (years)

Total uncertainty accounts for uncertainty for activity data ($Uncertainty_{BSL,RATE,t^*}$ = 0%) and emission factor ($Uncertainty_{REDD\_BSL,SS}$ = 8%). Total uncertainty is therefore 8%.

Implication for project accounting

As the total uncertainty for the project baseline is below the threshold of 15%, no deduction to the net emission reductions should be operated.

3.4.4 Calculation of Verified Carbon Units

Expected VCUs correspond to the net emission reductions according to the baseline, minus the non-permanence risk buffer (10% in the present case) and minus the uncertainty buffer (0% in the present case). The ex-ante estimation of VCUs to be generated during the first 10 years is presented in the following table.

Table 23 : Ex-ante calculation of the expected Verified Carbon Units during the first 10 years of the Project

Year	Estimated net GHG emission reductions or removals (tCO_2eq)	Buffer of 10 % (tCO_2eq)	Deduction due to uncertainties (tCO_2eq)	VCUs
1	3,439	344	-	3,095
2	8,820	882	-	7,938
3	21,705	2,170	-	19,534
4	31,508	3,151	-	28,357
5	51,248	5,125	-	46,123
6	81,596	8,160	-	73,436
7	103,347	10,335	-	93,012
8	117,862	11,786	-	106,076

Year	Estimated net GHG emission reductions or removals (tCO_2eq)	Buffer of 10 % (tCO_2eq)	Deduction due to uncertainties (tCO_2eq)	VCUs
9	132,914	13,291	-	119,623
10	135,773	13,577	-	122,196
Total	**688,212**	**68,821**	**-**	**619,391**

4 MONITORING

4.1 Data and Parameters Available at Validation

The tables below present all the data and parameters that are determined or available at validation, and remain fixed throughout the project crediting period.

Data / Parameter	Forest cover area
Data unit	ha
Description	Forest cover area on three time dates during the reference period (2000 – 20005 – 2010) for the different project zones: RRD, PA and LB. PA and LB are fully forested at the beginning of the project; the forest areas for 2000 and 2005 are the same than those for 2010.
Source of data	Remote sensing images: Landsat scene of 30-m resolution.
Value applied:	**In 2000**: RRD: 440,988 ha **In 2005**: RRD: 426,296 ha **In 2010**: RRD: 412,145 ha PA: 124,145 ha LB: 166,502 ha
Justification of choice of data or description of measurement methods and procedures applied	Landsat images are free with a medium resolution and a good temporal and spatial couverture.
Purpose of Data	Determination of the baseline scenario
Comments	The method used and the detailed results of the analysis of the data are available in Mercier et al. (2016)

Data / Parameter	$A_{BSL,RRD,unplanned}$
Data unit	ha/yr
Description	Mean annual area of unplanned deforestation in the RRD during the reference period

Source of data	Maps of historical deforestation during the reference period (Mercier et al., 2016)
Value applied:	2,877 ha/yr
Justification of choice of data or description of measurement methods and procedures applied	Maps were available for the development of the ZILMP jurisdictional program (Mercier et al., 2016). Data of deforestation were extracted from this maps, based on Landsat remote sensing images.
Purpose of Data	Determination of the baseline scenario
Comments	

Data / Parameter	$A_{BSL,PA,unplanned}$
Data unit	ha/yr
Description	Mean annual area of unplanned deforestation in the PA during the reference period
Source of data	Maps of historical deforestation during the reference period in the RRD
Value applied:	810 ha/yr
Justification of choice of data or description of measurement methods and procedures applied	The average annual deforestation for the PA is proportional to the annual deforestation in the RRD, according to the ratio of sizes between RRD and PA.
Purpose of Data	Determination of the baseline scenario
Comments	This method was used because it does not rely on any projection of the location of deforestation, enabling to avoid inconsistencies with the ZILMP reference period (2005-2014).

Data / parameter	$A_{BSL,LB,unplanned}$
Data unit	ha/yr
Description	Mean annual area of unplanned deforestation in the LB during the reference period
Source of data	Maps of historical deforestation during the reference period for the RRD
Value applied:	1 086 ha/yr
Justification of choice of data or description of measurement methods and procedures applied	The average annual deforestation for the LB is proportional to the annual deforestation in the RRD, according to the ratio of sizes between RRD and LB.
Purpose of Data	Determination of the baseline scenario

Comments	This method was used because it does not rely on any projection of the location of deforestation, enabling to avoid inconsistencies with the ZILMP reference period (2005-2014).

Data / Parameter	$\Delta C_{AB,tree}$
Data unit	tCO_2eq/ha
Description	Carbon stock changes due to unplanned deforestation in Miombo forest stratum in aboveground tree biomass.
Source of data	Field biomass forest inventory.
Value applied:	207.4 tCO_2eq/ha
Justification of choice of data or description of measurement methods and procedures applied	This method is described in Mercier et al. (2016). Biomass was estimated with field measurement and the use of Chave et al. (2014) allometric equation. This is the common method recommended by the VM0007 methodology.
Purpose of Data	Calculation of baseline emissions
Comments	Miombo forest is the only forest stratum considered in this document.

Data / Parameter	$\Delta C_{BB,tree}$
Data unit	tCO_2eq/ha
Description	Carbon stock changes due to unplanned deforestation in Miombo forest stratum in belowground tree biomass.
Source of data	Field biomass forest inventory.
Value applied:	53.1 tCO_2eq/ha
Justification of choice of data or description of measurement methods and procedures applied	This method is described in Mercier et al. (2016). Biomass was estimated with field measurement and the use of Chave et al. (2014) allometric equation. This is the common method recommended by the VM0007 methodology.
Purpose of Data	Calculation of baseline emissions
Comments	Miombo forest is the only forest stratum considered in this document.

Data / Parameter	$\Delta C_{BSL,PA,unplanned}$
Data unit	tCO_2eq
Description	Sum of greenhouse gas emission in the baseline scenario (10 years) for the PA
Source of data	Sum of carbon stocks changes on unplanned deforestation areas according to the baseline scenario

Value applied:	1,916,875 tCO_2eq (after 10 years)
Justification of choice of data or description of measurement methods and procedures applied	The method is described in the BL-UP module.
Purpose of Data	Calculation of baseline emissions
Comments	

Data / Parameter	$\Delta C_{BSL,LB,unplanned}$
Data unit	tCO_2eq
Description	Sum of greenhouse gas emission in the baseline scenario (10 years) for the LB
Source of data	Sum of carbon stocks changes on unplanned deforestation areas according to the baseline scenario
Value applied:	2,570,893 tCO_2eq (after 10 years)
Justification of choice of data or description of measurement methods and procedures applied	The method described in the BL-UP module.
Purpose of Data	Calculation of baseline emissions
Comments	

4.2 Data and Parameters Monitored

The tables below present all the data and parameters to be monitored during the project crediting period.

4.2.1 Monitoring of emissions due to deforestation in PA and LB

Data / Parameter	$A_{def,PA,unplanned}$
Data unit	ha/yr
Description	Annual area of unplanned deforestation in the PA during the monitoring period
Source of data	Map of deforestation during the monitoring period in the PA
Description of measurement methods and procedures applied	Production of forest cover change map in the PA and LB by detecting forest cover and land cover change, following the method described in (Grinand et al. 2013a) – this is the same method as for the ZILMP deforestation map that was used to establish the baseline. Images used will be from Landsat sensor in order to be

	consistent with data used for the establishment of the baseline at the dates of the monitoring periods.
Frequency of monitoring/recording	A deforestation map every 5 years at the dates of the monitoring period
Value applied:	-
Monitoring equipment	GIS software and Landsat satellite images
QA/QC procedures applied	An accuracy assessment will be realised with validation plots and a confusion matrix will be produced, showing the map precision.
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	This data will also be used as an activity data for the areas that are burnt for slash and burn agriculture, in order to assess the emissions due to biomass burning during deforestation.

Data / Parameter	$A_{def,LB,unplanned}$
Data unit	ha/yr
Description	Annual area of unplanned deforestation in the LB during the monitoring period
Source of data	Map of deforestation during the monitoring period in the LB
Description of measurement methods and procedures applied	Production of a forest cover change map in the PA and LB by detecting forest cover and land cover change, following the method described in (Grinand et al. 2013a) – this is the same method as for the ZILMP deforestation map that was used to establish the baseline.. The images used will be based on Landsat sensor in order to be consistent with the data used for the establishment of the baseline at the dates of the monitoring periods. If the ZILMP is validated and if maps are produced for the program, the GNR project will use those results according to the ER Program MRV procedures.
Frequency of monitoring/recording	A deforestation map every 5 years at the dates of the monitoring period
Value applied:	-
Monitoring equipment	GIS software and Landsat satellite images
QA/QC procedures applied	An accuracy assessment will be realised with validation plots and a confusion matrix will be produced, showing the map precision.
Purpose of data	Calculation of leakage
Calculation method	-
Comments	-

Data / Parameter	$C_{AB,tree}$

Data unit	tCO_2eq/ha
Description	Carbon stock in aboveground tree biomass of Miombo forest stratum
Source of data	Field biomass forest inventory
Description of measurement methods and procedures applied	The method is described in Mercier et al. (2016). Biomass will be estimated with forest inventory of the same characteristic as those used for the present document (tree height and diameter – above 5cm – are measured on plots) and the Chave et al. (2014) allometric equation will be used. This is the common method recommended by the VM0007 methodology. Biomass is calculated for each tree, summed over the trees per plot and then over plots to finally obtained an average per hectare (CP AB module). Chave's allometric equation used: $AGB = 0.0673 \times (\rho D^2 H)^{0.976}$ Where *AGB* is aboveground biomass, ρ is wood density, H is tree height and D is diameter at breast height. Wood density for each species encountered during inventories was selected from the global wood density database (Zanne et al. 2009; Chave et al. 2009). Carbon stocks from AGB is calculated thanks to carbon fraction which is estimated to be 0.47 tC/tdm (IPCC, 2003).
Frequency of monitoring/recording	Every 10 years
Value applied:	241.6 tCO_2eq/ha
Monitoring equipment	DBH is measured with a measuring tape and tree height with an electronic clinometer
QA/QC procedures applied	Forest expert will supervise field inventory and check the database.
Purpose of data	Calculation of baseline emissions (baseline renewal)
Calculation method	Activity data are multiplied by carbon stocks changes (before and after deforestation) as presented in section 2.4.2.2
Comments	Miombo forest is the only forest stratum considered in this document Carbon stock in belowground tree biomass is calculated by applying a default factor from IPCC, as presented in section 2.4.2.2

Data / Parameter	DBH
Data unit	cm
Description	Diameter at Breast Height

Source of data	Field biomass forest inventory
Description of measurement methods and procedures applied	In each plot of the biomass inventory, DBH of all trees is measured as a parameter of Chave equation. Chave's allometric equation used: $AGB = 0.0673 \times (\rho D^2 H)^{0.976}$ Where *AGB* is aboveground biomass, ρ is wood density, H is tree height and D is diameter at breast height. Wood density for each species encountered during inventories is selected from the global wood density database (Zanne et al. 2009; Chave et al. 2009). Carbon stocks from AGB is calculated thanks to carbon fraction which is estimated to be 0.47 tC/tdm (IPCC, 2003).
Frequency of monitoring/recording	Every 10 years
Value applied:	
Monitoring equipment	DBH is measured with a measuring tape
QA/QC procedures applied	Forest expert will supervise field inventory and check the database.
Purpose of data	Calculation of baseline emissions (baseline renewal)
Calculation method	The parameter is used in Chave equation to calculate biomass per tree. Carbon stocks is then calculated by plot by adding all trees' biomass.
Comments	

Data / Parameter	H
Data unit	m
Description	Tree Height
Source of data	Field biomass forest inventory
Description of measurement methods and procedures applied	In each plot of the biomass inventory, H of all trees is measured as a parameter of Chave equation. Chave's allometric equation used: $AGB = 0.0673 \times (\rho D^2 H)^{0.976}$ Where *AGB* is aboveground biomass, ρ is wood density, H is tree height and D is diameter at breast height.

	Wood density for each species encountered during inventories is selected from the global wood density database (Zanne et al. 2009; Chave et al. 2009). Carbon stocks from AGB is calculated thanks to carbon fraction which is estimated to be 0.47 tC/tdm (IPCC, 2003).
Frequency of monitoring/recording	Every 10 years
Value applied:	
Monitoring equipment	Tree height is measured with an electronic clinometer
QA/QC procedures applied	Forest expert will supervise field inventory and check the database.
Purpose of data	Calculation of baseline emissions (baseline renewal)
Calculation method	The parameter is used in Chave equation to calculate biomass per tree. Carbon stocks is then calculated by plot by adding all trees' biomass.
Comments	

Data / Parameter	$C_{BB,tree}$
Data unit	tCO_2eq/ha
Description	Carbon stock in belowground tree biomass (BGB) of Miombo forest stratum
Source of data	Estimated from $C_{AB,tree}$
Description of measurement methods and procedures applied	This parameter is estimated by multiplying aboveground tree biomass per a default root-to-shoot ration from IPCC (2003). In tropical dry forests is expected to average: • 0.56 if aboveground biomass is below 20 t/ha. • 0.28 if aboveground biomass is above 20 t/ha. This is the common method recommended by the VM0007 methodology (CP AB module). Belowground biomass is calculated for each tree and as per aboveground biomass, it is summed over the trees per plot and then over plots to finally obtained an average per hectare. Carbon stocks from BGB is calculated thanks to carbon fraction which is estimated to be 0.47 tC/tdm (IPCC, 2003).
Frequency of monitoring/recording	Every 10 years
Value applied:	67.6 tCO_2eq/ha
Monitoring equipment	Equipment necessary for field inventory as presented for the estimation of AGB
QA/QC procedures applied	Forest expert will supervise field inventory and check the database.

Purpose of data	Calculation of baseline emissions (baseline renewal)
Calculation method	Activity data are multiplied by carbon stocks changes (before and after deforestation) as presented in section 2.4.2.2
Comments	Miombo forest is the only forest stratum considered in this document Carbon stock in belowground tree biomass is calculated by applying a default factor from IPCC, as presented in section 2.4.2.2

4.2.1 Monitoring of emissions due to forest degradation in PA and LB

Data / Parameter	Existence of forest degradation in the PA
Data unit	-
Description	Assessment of forest degradation occuring in the PA, due to illegal logging – specification of the species targeted – and/or charcoal production, or if new activities leading to degradation are developed.
Source of data	Participatory rural appraisal
Description of measurement methods and procedures applied	Surveys on degradation in communities living around the PA, about activities leading to forest degradation. The types of activities, their location and the level of pressure will be established. If a significant proportion of households declares that degradation occurs in the area, dedicated forest inventories will be realised.
Frequency of monitoring/recording	Every 5 years from validation
Value applied:	-
Monitoring equipment	Identify equipment used to monitor the data/parameter including type, accuracy class, and serial number of equipment, as appropriate.
QA/QC procedures applied	-
Purpose of data	Calculation of project emissions
Calculation method	-
Comments	-

4.2.2 Other sources of greenhouse gas in PA and LB

Following section 2.3.4, no other gas are included in the baseline: either the emissions related to them are not significant, or it is conservative. Hence, no parameters are presented in this section.

4.3 Monitoring Plan

4.3.1 Monitoring of carbon stocks changes and greenhouse gas emissions in PA and LB

4.3.1.1 Monitoring of carbon stocks

Only the carbon pools that are included in the baseline will be monitored (see Table 6). In principle, the carbon stocks that are included in the project should not change during the crediting period because forests of the project are mature. However, in order to maintain high quality information, the monitoring of carbon stocks of Miombo forest is planned every 10 years (2021 and 2031). To guarantee comparability with current data, the same methodology for forest inventory as the one used for the present document will be used (see section 2.4.2). As it was done for the present estimation, aboveground tree biomass will be derived from results of biomass forest inventory and the use of allometric equations; belowground tree biomass will be estimated thanks to default values for the root-to-shoot ratio.

If the ZILMP jurisdictional program is effectively developed and performs forest inventory, results will be used for the monitoring of the GNR REDD project in order to guarantee consistency with subnational approaches.

4.3.1.2 Monitoring of project implementation

Information on geographic position of the project boundaries (PA and LB) and of any stratification must be provided. Since the project area is the forest cover inside the buffer zone of the GNR, which boundaries are fixed by a national decree, there is no reason for this boundary to change, unless there is a change of management strategy that would imply a monitoring of the PA limits. In the same way, the LB is based in a buffer of 8 km around the PA (outside of the GNR) and should not be modified if PA is not. Finally, only one stratum, Miombo forest, is considered in the present document; no monitoring of stratification is necessary.

The location of each Project activity will be monitored and will be made available on a GIS web platform[14] which is updated regularly (at least 2 times a year). The deforestation maps used for monitoring of activity data are also available on that platform. For the Mozbio project, that allows the continuation of the international funding for the project, a special website has been built presenting all the results of the monitoring of the implementation of the project (http://mozbio-gile.org/). For the agricultural component, the monitoring of the project implementation is assured by the technicians team (10 technicians distributed in communities of the project zone supervised by a project officer based in Gilé) that realised the agricultural support. Besides the following of the good application of agro-ecological practices, they monitor the number of households following project advices, the size of their fields, the yields obtained and the evolution in the frequency of the practice of slash and burn agriculture. The support to value chain is also monitored by the Etc Terra Gilé team that follows the number of households beneficiating from advices on prices (through the number of subscribers to the service via mobile text messages[15]) and through the evolution of yields and revenues for households around the project zone. For the management of the GNR, the

[14] http://bit.ly/2v0R8Su
[15] http://nkalo.com/

monitoring of the project implementation is realised by the report of guard patrols, the number of poachers verbalized and the following of the animal population reintroduced (see CCB PDD for more details on this last subject). A monitoring plan of the biodiversity is also existing for the GNR and it is presented in the CCB PDD. The monitoring of the conservation component is realised by ANAC and IGF teams based in Museïa.

4.3.1.3 Monitoring of land use and land cover changes

The monitoring of land use and land cover changes (deforestation) will be carried out with multi-date remote sensing analysis, based on the same methodology as the one used for the present document – described in Grinand et al. (2013a). Medium resolution images (30m) will be used for land cover change analysis whereas high resolution ones (Google Earth) will be used for the calibration and validation of the maps. This analysis of deforestation will be done in the PA and LB to enable the comparison of effective conditions to those estimated ex-ante for the baseline establishment, in the case of the project scenario.

At the end of each monitoring period (2016, 2021, 2026, 2031) the following will be achieved to monitor areas of deforestation **in PA and LB**:

- Updating the forest cover change map by detecting forest cover and land cover change on the 5 years analysis (Grinand et al. 2013a). An accuracy assessment will be realised and the quality of the mapping will be verified in order to make sure it respects VM0007 requirements (see section 2.4.1)
- Extracting areas of deforestation in the PA and LB for the monitoring period (5 years) and in the remaining areas of forest in the PA and LB.
- Net carbon stock changes due to unplanned deforestation in the PA and LB will be calculated by multiplying areas of deforestation by emission factors (net carbon stocks changes in tree biomass pool in tCO_2eq/ha – see section 2.4.2), as presented in section 3.2.1.

At the time of baseline revision (2021 and 2031), the same steps will be realised **in the RRD to update the forest cover benchmark maps** for the reference area. The baseline will consequently be updated with calculation of ex-ante emissions in the PA and LB.

4.3.1.4 Monitoring of forest degradation through wood extraction

According to VM0007 methodology, the project has to monitor significant source of emissions due to degradation of forest following M-MON module requirements.

In the case of the GNR REDD project, 3 types of forest degradation through wood extraction can be accounted for:

- Illegal logging;
- Harvesting wood for charcoal production;
- Wood extraction for illegal mining activities.

Illegal logging

Illegal logging in the project area focuses on species almost exclusively: *Pau ferro – Swartzia madagascariensis* (see section 1.10). M-MON module specifies that emissions from logging may be omitted if it can be demonstrated they are de minimis using T-SIG tool i.e. if they represent less than 5% of project emissions. No specific inventory was led to assess the proportion of emissions due to the illegal logging of *Pau ferro*, but this was estimated with forest inventory realised to assess carbon stocks of Miombo forest.

All inventoried *Paus ferros* were selected and the total biomass they represent was estimated following the same methodology as for tree carbon stocks estimation – using Chave et al. (2014) allometric equation. The proportion of *Paus ferros* biomass vs all other trees of the inventory was considered to represent the proportion of potential emissions due to illegal logging if all *Paus ferros* were harvested.

Over 100 forest inventory plots, 25 (1/4th) contained *Paus ferros*. A total of 44 trees of this species were found on these plots. They represent a total of 9 tC, while biomass of all inventoried trees is 1 130 tC. Hence, if all *Paus ferros* of this inventory where cut down, this would represent emissions of 0.8 % of the biomass. Consequently, emissions due to forest degradation because of the illegal logging of *Paus ferros* can be considered as not significant, compared to those of unplanned deforestation: they will therefore not be monitored.

However, regular participatory rural appraisal (PRA) will be realised every 5 years to assess if other species begin to be targeted for logging. The PRA will be realised by the Project team that will also assure the forest inventory. It will be conducted by surveys of the communities around the project zone besides transect inventories in the PA to assess if marks of illegal logging are observed. The objective of the PRA is to assess the number of illegal loggers, the species targeted and the number of tree cut annually. If the number of species increases or marks are observed, a new estimation of emissions due to this activity will be done through a specific inventory with a sample of transect that will allow to evaluate the number of tree cut and their carbon stocks.

Charcoal production

As explained previously (section 1.10), few people in the project practice charcoal production. The production around GNR is located in Gilé (Mercier et al., 2016) and tree selected for charcoal production are located in future field: since the tress used for charcoal production are the same as those affected by slash and burn agriculture, charcoal production is not causing any additional impact on the decrease of carbon stocks.

Moreover, during the survey realised in villages around the project area, 6 persons over 135 (4%) were producing charcoal at least once in a year. This low proportion and the fact that charcoal production is associated to agricultural itineraries lead to the conclusion that charcoal production does not generate significant emissions compared to the baseline scenario. Consequently, forest degradation due to this activity will not be monitored. However, regular survey will be realised (every 5 years) and if the number of charcoal producers increases, a new estimation of emissions due to this activity will be done. This survey will be realised by the same team that will realise the PRA presented previously, during the same visit of the communities. If the number of charcoal producers increase significantly, the impact on forest cover will be assessed thanks to the estimation of the wood resources used (number of tree per kiln and number of kiln per year) and the source of the resource (either it is from slash and burn fields or from the natural forest).

4.3.1.5 Monitoring of carbon stocks enhancement

The GNR REDD Project did not identified area expected to accumulate carbon in the duration of the project (except in fallows but they are regularly cleared of trees for agriculture so they do not stock carbon permanently). Hence, no monitoring of carbon stocks enhancement will be realised.

4.3.1.6 Monitoring of project GHG emissions

Non-CO_2 GHG emissions have to be estimated if they are significant (i.e. above 10% of total emissions). Two sources of non-CO_2 GHG emissions exist for the GNR REDD project:

- Emissions linked to the use of fossil fuel for the cars: as previously explained (section 2.3.4), emissions from this source are not significant as few distances are operated per month by 4 cars.
- Emissions from fires occurring at the end of the dry season and after the conversion (i) of forest to cropland (slash and burn agriculture), and (ii) of grass in savannas. Those last emissions were not accounted for in the baseline because they were not estimated as significant. However, they will be monitored (with MODIS burnt area product – MCD45A1 - that furnishes monthly estimation of the fire surfaces) and included in the project emissions if they are found to be significant ex-post.

Emissions from biomass burning on deforested lands will be estimated following the VMD0013 module (E-PBP) to assess if they are significant at the end of each monitoring period. As presented hereafter, the parameters used to calculate emissions due to biomass burning are mainly default parameters from IPCC (see following table). The only parameter to monitor is the area burnt that corresponds to the areas deforested for slash and burn agriculture purposes, already monitored through the monitoring of unplanned deforestation (section 2.4).

Emissions from biomass burning in the deforested lands (conversion of forest to fields):

Activity data for this part of emissions correspond to activity data for deforestation, since almost all forest-lands are converted for slash and burn agriculture (section 2.4). According to VMD0013 module, emissions will be estimated as follows:

$$E_{biomassburn,i,t} = \sum_{g=1}^{G} \left(\left(\left(A_{burn,i,t} \times B_{i,t} \times COMF_i \times G_{g,i} \right) \times 10^{-3} \right) \times GWP_g \right)$$

Where:

$E_{biomassburn,i,t}$	Greenhouse gas emissions due to biomass burning as part of deforestation activities in stratum *i* in year *t* of each GHG (CO_2, CH_4, N_2O) (t CO_2e)
$A_{burn,i,t}$	Area burnt for stratum *i* in year *t* (ha)
$B_{i,t}$	Average aboveground biomass stock before burning stratum *i*, year (t d.m. ha^{-1})
$COMF_i$	Combustion factor for stratum *i* (unitless)
$G_{g,i}$	Emission factor for stratum *i* for gas *g* (kg t^{-1} d.m. burnt)
GWP_g	Global warming potential for gas *g* (t CO_2/t gas g)
g	1, 2, 3 ... *G* greenhouse gases including carbon dioxide[1], methane and nitrous oxide (unitless)
i	1, 2, 3 …*M* strata (unitless)
t	1, 2, 3, … *t** time elapsed since the start of the project activity (years)

The following default values will be used:

Variable	Gas	Value	Source
B	-	140.2	Present document – section 2.4.2.2
COMF	-	0.45	IPCC (primary open tropical forest)
G_g	CH_4	6.8	VMD0013 module for tropical forest
	N_2O	0.2	
GWP_g	CH_4	21	IPCC, 2003
	N_2O	310	

4.3.2 Organisation and responsibilities of parties involved for monitoring

The monitoring of the project will be ensured by Etc Terra technical team, which is composed of the following experts:

- The impact assessment and carbon monitoring expert, based in France, will supervise all the monitoring process. This technical assistant will design the forest inventory plan following the method presented in the present document, and train field agents if necessary. He will also design survey to perform participatory rural appraisal in order to assess if forest degradation is occurring in the project area. Finally, he will coordinate the different studies needed for the monitoring and collect all results produced by other experts to calculate carbon emissions and perform the entire monitoring plan.

- The remote sensing specialist, also based in France, will update deforestation maps and the monitoring of the areas affected by fire. He will be responsible for the collection of appropriate data and for their processing, following the method presented in the present document. Results will be activity data for deforestation and areas affected by fires.
- The inventory and survey technician, based in Gilé in Mozambique, will ensure field work with teams recruited locally when necessary. This technician will lead field work when necessary at each monitoring period. He will be previously trained by the carbon monitoring expert. Field work will be composed of biomass inventory and of survey for participatory rural appraisal. With a daily presence in the field, he will also be responsible for checking and informing if exceptional anthropic or natural disturbances lead to deforestation or forest degradation and for estimating the extent of affected areas with the support of the two other technical assistants previously cited above.

The GNR technical assistant will guarantee that the data and methods used are consistent with those used in the present document to make sure that results for project emissions are comparable to the baseline. If changes are done, they will be documented and justifications will be done on how changes do not affect the consistency of results. All results will be communicated to ANAC (the project proponent on the behalf of the Mozambican Government) for approval before diffusion.

For the carbon accounting component, the storage of data and the QA/QC procedures are the following:

- For deforestation mapping, a sample of the calibration plots and the validation points is controlled by a different person from the one who produces those data by comparison to (very) high-resolution data or to ground-truthing point (forest or non-forest points and points for which the date of deforestation is known thanks to discussion with farmers). A verified R script is available for this type of analysis and it is validated for each analysis by the GIS team leader of Etc Terra (Clovis Grinand).
- For forest inventories, the trained field team is responsible for it and a sample of plots was verified (by redoing the entire inventory on the randomly selected plots) by the Forest inventory team leader (Marie Nourtier). This has been done for pre- and post-deforestation inventories. If significant differences in the results (number of trees and carbon stocks) are observed, the forest inventory would have to be repeated on the same plot locations. The database has been checked by a third person to identify aberrant values and check on the field inventory forms (these forms are currently being digitalized and they will be saved in the server – a few examples have been added to the Dropbox folder shared with the auditor). Basic statistics are also performed before the validation of the database to assess the distribution of diameter and the global relationship between height and diameter measurements. Before the choice of the allometric equation, different available equations were also tested on the collected data.
- For each analysis, the procedure implies to save the final results on the Etc Terra server (including satellite images, calibration or validation plots, GPS points of inventory plots, databases and analysis, etc.). This server currently contains the analysis of historical deforestation, database for forest inventory and all required analyses for the PDD (GIS database and the different spreadsheets). GIS data are available on the project *geoportail:* www.rng-redd.org.

All the other documents concerning project implementation are available at Museia camp and saved in the archives of ANAC (José Diaz) and IGF (Alessandro Fusari), entities responsible for the management of the Reserve. Data on the monitoring of biodiversity are centralised by IGF and saved by the teams in Mozambique and in France. For activities of the Mozbio project, documents are centralised by the project head (Jean Baptiste Roelens) in Etc Terra Office at Gilé and digital versions are also saved in Etc Terra server. Data and reports are made available in Portuguese to public - in order to be transparent on the implemented activities and also on the evolution of deforestation - on the following website: www.mozbio-gile.org.

5 SAFEGUARDS

5.1 No Net Harm

The potential negative impacts of the Project and the mitigation measures that are planned are presented with details in the CCB PDD. Here, a summary is provided.

The main socio-economic negative impacts that have been identified are the following:

- The improvement of the Reserve management and higher control of illegal activities can reduce incomes for communities, increase their vulnerability to poverty or lead them to displace their unsustainable activities (in the Leakage Belt for example). This risk is mitigated with agricultural support (food and cash crops) to communities who are impacted by the project. This support should increase their yields and incomes and reduce their vulnerability to climate hazards through the diversification of cultivations. Moreover, the link with international markets for cash crops should be improved with a system of information on selling prices that will also contribute to increasing incomes.
- Communities' improved incomes thanks to the project can be re-invested in agricultural expansion, which may increase deforestation. This would be a rebound effect. Nevertheless, this is unlikely because the limitation of the expansion of deforestation for agriculture is not an issue of financial means but of available human workforce. Moreover, emphasize will be put on raising awareness about the negative impacts of deforestation (see PDD CCB) and agricultural support to local population will depend on their commitment to give up on un-sustainable practices responsible for deforestation (slash and burn agriculture).
- The competition on cashew nuts market in the region could increase because of the support of the Project to nearby communities. However, the size of the international market leaves room for an increase of the production and since information on selling prices will be disseminated through mobile text messages, the number of beneficiaries is not limited – it can be increased all along the project if voluntary people ask for it.
- Conflicts between communities and the project proponent could arise, linked to the sale of carbon credits and the share of benefits. A benefit sharing plan will be established and presented to all impacted communities. They will benefit from the sale of carbon credits, at least through investment on project activities, but some direct payment can also be considered. This system is currently being developed. The Project will guarantee transparency and equity in the benefit-sharing plan.

The main environmental negative impacts that have been identified are the following:

- The improvement of the Reserve management and higher control of illegal activities can also lead to a displacement of poaching outside of the reserve. However, the main fauna and flora resources are located in the core area of the GNR, so it is unlikely that such a displacement actually occurs. Moreover, as previously explained, the populations of the project zones do not easily move and the support to agricultural activities provided by the project should further decrease this risk of displacement.
- A risk for the REDD project would be to only focus on deforestation issue and to ignore other issues related to biodiversity. However, the present Project is included in a larger strategy and in other projects (such as the Mozbio projects and the ZILMP ER Program). Moreover, it is led by ANAC, who is in charge of the management of the entire reserve and in partnership with IGF, who has a strong focus on fauna management, while Etc Terra and Agrisud International are responsible working with communities and for the development of strategies to reduce deforestation. Hence, partnerships around the Project are the main guarantee to a well-balanced attention to different environmental issues.

The other positive environmental impacts are described in the following section, as required.

5.2 Environmental Impact

Biodiversity

As previously stated, the GNR and its buffer zone belong to a semi-arid forest and savannah formation, commonly known as Miombo, which is widely found across Southern and Central Africa. Although this is not a rare woodland formation, the size and density of forest habitat make the GNR and its buffer zone be of particular value for biodiversity conservation.

With regards to vegetation, the project zone is a diverse botanical resource with 70 identified tree species and 10 identified gramineae species (Prin 2008). It is mainly composed of Fabaceae (including *Brachystegia boehmii, Julbernardia globiflora, Dalbergia nitidula, Brachystegia spiciformis, Pterocarpus angolensis, Burkea africana, Erythrophleum africanum, Pterocarpus rotundifolius and Millettia stuhlmannii*) but, also, by some other species that are noteworthy because their occurrence is the GNR and its buffer zone is part of a limited range in Mozambique and in the world. Miombo forests contain some of the world's most precious hardwood timbers, including *Pterocarpus angolensis (umbila), Millettia stuhlmannii (jambirre), Pericopsis angolensis (muaga) and Swartzia madagascariensis* (pau ferro)*, Dalbergia melanoxylon* (snake bean, or Pau-preto in Mozambique). Those species only comprise, in average, from 5% to 20% of the total volume of trees in Miombo forests (Mackenzie, 2006). They are all present in the project zone.

The fact that the project zone hosts *Swartzia madagascariensis* is significant in terms of biodiversity, as this is probably their last viable population in Mozambique[16]. In the same way, the

[16] https://www.theguardian.com/sustainable-business/2016/aug/31/mozambique-illegal-logging-china-timber-deforestation

project zone is the only formal place at global scale to host the Habenaria villosa orchid (Fondation IGF, 2011). As a terrestrial orchid located in dry dambo long grass, Habenaria villosa has, so far, only been described in Tanzania (two times, in 1898 and 1968) and Malawi (in 1991) but is now without any formal locality or habitat (IUCN SSC East African Plants Red List Authority, 2013). Its unique presence in the GNR is therefore a strong sign of biodiversity value.

In addition, wildlife in the project zone is significant: at project start, between 59 and 69 species of mammals were estimated to be present in the project zone17; those figures have been updated in 2012 by Deffontaines (2012), accounting for 75 different species of mammals in the project zone (including African buffaloes). In the same way, up to 210 identified species of birds have been identified. More importantly, the GNR supports 10 mammal species and 2 bird species that are considered to be globally threatened or nearly (see following table). Among them, the elephant population has been drastically reduced in Mozambique since the 1960s. In project scenario, they are subject to special protection measures – see PDD CCB for more details.

Table 24: List of threatened wildlife species in the GNR

English name	Scientific name	IUCN Red list Status
African wild dog	*Lycaon pictus*	**Endangered**
African elephant	*Loxodonta africana*	**Vulnerable**
Hippopotamus	*Hippopotamus amphibius*	**Vulnerable**
Lion	*Panthera leo*	**Vulnerable**
Southern ground hornbill	*Bucorvus cafer*	**Vulnerable**
Temminck's ground pangolin	*Smutsia temminckii*	**Vulnerable**
African clawless otter	*Aonyx capensis*	**Near Threatened**
Bateleur eagle	*Terathopius ecaudatus*	**Near threatened**
Chequered sengi	*Rhynchocyon cirnei*	**Near Threatened**
Leopard	*Panthera pardus*	**Near Threatened**
Spotted-necked otter	*Lutra maculicollis*	**Near Threatened**

In addition to those species, the project zone also hosts African buffaloes. Although they are considered to be "lower risk" species according to the IUCN ranking, buffaloes are quickly declining in Mozambique (East, 1999). In the same way, Lichtenstein Hartebeests, who have been identified in the project zone, are in danger of extinction in Mozambique (Fusari et al. 2010). Finally, three species of turtles have been identified in the project zone: it is worth noticing that one of them, the serrated hinged terrapin (*Pelusios sinuatus*), is endemic to Eastern African countries and can only

[17] According to Mésochina et al. (2010, p. 34): "Following the surveys carried out by Dutton et al. (1973), Chande et al. (1997) and Carpaneto (2001), Gallego-Lizon (2002) considered that 69 species of mammals had been identified in the GNR. However, only 59 species were reported as occurring in the management plan of the GNR (Fusari & Cumbane, 2002) ». In 2010, Fusari, Lamarque, Chardonnet and Boulet (2010) registered 67 different species of mammals in the project zone.

be found from the South of Tanzania to the Rio Save in Mozambique. The presence of those species in the GNR is therefore an additional sign of significant biodiversity value.

The main threats to biodiversity are deforestation, forest degradation through illegal logging and poaching; those are the basis of the management plan of the GNR that aims to conserve local biodiversity. To this end, the activities presented in this document are all focusing on reducing deforestation, illegal logging and poaching – including with ranger patrol. Moreover, systems to scare elephants away are implemented in order to reduce human/elephant conflicts around crop fields. The GNR also reintroduced some species (zebras, buffalos and wildebeest), which were locally extinct, and will reintroduce other in the future. These populations are monitored to assess the success of the reintroduction. All these activities are described in the management plan of the Reserve (Fusari et al. 2010) and in the PDD CCB. Hence, net impact of the project on biodiversity will be positive, as it is one of the main objective of the GNR and of the present REDD project. This impact on biodiversity is detailed in the CCB PDD of the present project.

Water

Rivers provide essential services to the communities living in the area. Yet, deforestation of nearby forests can modify local micro-climate and water infiltration (Ellison et al., 2017). This will influence water fluxes in rivers, which may generate deep hydric stresses with serious consequences for local populations.

Because of regular hydric stresses at the end of the dry season (from September to November), one of the main preoccupations of local communities is the access to clean water (Materrula et al. 2009). In addition to traditional water wells, some improved fountains have been built by national or international NGOs, but they still are too few and sometimes far distant. In this context, rivers are often the main access to water, although they may be dried up during the dry season. The North-western part of the Project Zone is deeply disadvantaged in terms of water access, may it be for people or livestock: rivers are scarce and fountains are far. In this context, some riversides are progressively appropriated by some of the community members with the aim of digging traditional water wells for their own family. The consequences of deforestation, in terms of clean water availability, would lead to social conflicts for water access and could have severe consequences on human health. Hence, by reducing deforestation, the GNR REDD project should have positive impact on water resources.

5.3 Local Stakeholder Consultation

In 2016, a process of communities' consultation was organised in order: (i) to inform about the objectives and expected results of the GNR REDD project; (ii) to raise awareness and inform communities on the importance of forest conservation; (iii) to explain the validation and verification processes of the project; and (iv) to receive commentaries about the project activities that are already implemented and on those that will be. This process involved all the communities who are affected by the project activities in the project area, that is, 27 communities. The consultation lasted

2 days in each community[18], the first being opened to everybody with the presence of local and customary authorities for a presentation of the project and its implications and the second day being dedicated to a deepening of certain impacts for the communities and explanation of the relation between slash and burn agriculture and deforestation and the local consequences. The second days was organised with a smaller group of voluntaries and customary authorities. The project was partly explained through the use of posters that had previously been designed by a local illustrator, representing the without project scenario and the project scenario and their respective impact on natural resources, forests, agriculture and water availability. At the end of each session of presentation, members of the communities had the time to present their commentaries or ask questions. Commentaries were recorded in the minutes of the meetings (available at validation). Finally, two meetings in Gilé and Pebane were organised with different State services (agriculture, Forest, Economy, Land planning, Health and Education) to present the REDD+ mechanism and all the Project's activities in presence of all partners including ANAC, the project proponent.

Communities' participation in the consultation process was good with, in average, 40 individuals per community attending the consultation. For each meeting, a representative of the GNR, a representative of the district and a member of the NGO Etc Terra – developing the present document – attended. Elderly persons of the communities took advantages of the meetings to warn the young people about the consequences of deforestation that they can already ascertain and to insist on the importance of the "with project" scenario. Hence, the project was globally very well perceived. Interrogations and worries were mainly about;

- **Humans/elephants conflicts:** the tools that are used to scare elephants away (such as chilli guns) are efficient but are not enough available. The time to reach fields when elephants invade them often is too long for people who are trained to use such tools, due a lack of quick means of transportation;
- **Illegal logging**: Some of the communities found that the rangers of the Reserve are not effective enough in limiting illegal logging in the GNR;
- **CGNR:** Communities wish to empower and boost natural resources local management committees (CGRN) who have not been supported enough in the past few years;
- Clarification about prohibited activities concerning hunting and collection of NTFP were asked;
- Questions about the real possibility to develop tourism in the GNR and especially in the coutada were also raised.

Those commentaries mainly concern the management of the reserve. They will be taken into account in the revision of the management strategy. For example, a high level of effort is currently made to work with communities on humans/elephants conflicts through a higher diffusion of

[18] Local leaders were informed by the project team of the date of the consultation at least 2 weeks before the beginning of the meetings and they were in charge to invite all members of the community. Transport and alimentation facilities were organised by the Project team for the members of communities who wanted.

elephants scaring techniques. Moreover, new techniques are under development with the Mozbio project (for example, with the settlements of beehives that are known to scare elephants away).

Figure 24: Presentation of the 'with project' scenario during the consultation process

Communities' consultation is described with more details in the CCB PDD of the present project. All minutes of meetings (in Portuguese) are available on demand.

5.4 Public Comments

To date, no public comments were received.

6 ACHIEVED GHG EMISSION REDUCTIONS AND REMOVALS

The results that are presented in this section correspond to those of the first monitoring period of the project, from early 2012 to early 2017. Emissions are expressed in equivalent of CO_2 due to unplanned deforestation. The calculation files are available on demand.

6.1 Data and Parameters Monitored

As presented in section 4.3, activity data for unplanned deforestation were monitored with Landsat satellite images and emission factors remain the same as those used to establish the baseline – the time lapse since the last forest inventory does not require an update of carbon stocks estimations. The data available at validation are presented in section 4.1.

The deforestation map was updated for the 2010-2016 period, following the reference period 2000-2005-2010. The data used are presented in following table.

Table 25: Satellite images used for monitoring of deforestation between 2010 and 2016

Landsat scene	Dates	
165-071	10/05/2010	29/07/2016
165-072	10/05/2010	29/07/2016

The method of classification is the same as the one used for the establishment of the deforestation map during the reference period (see section 2.4.1). Results show an overall precision of 94% according to the confusion matrix presented in Table 27.

Forest areas in the PA and LB were reported (see Table 26) and were used to calculate the annual rate of deforestation presented in the following monitoring table.

Figure 25 shows deforestation dynamics for the reference period and the first monitoring period (from 2000 to 2016) in the RRD and GNR.

Data / Parameter	$A_{def,PA,unplanned}$
Data unit	ha/yr
Description	Annual deforestation in the PA derived from deforestation data in ha in the PA during the monitoring period
Value applied:	361
Comments	-

Data / Parameter	$A_{def,LB,unplanned}$
Data unit	ha/yr
Description	Annual deforestation in the LB derived for deforestation data in ha in the LB during the monitoring period
Value applied:	1,181
Comments	-

Table 26: Forest area and deforestation in PA and LB during the monitoring period and the previous 5 years period

	Forest area in ha			Deforestation area in ha	
	2005	**2010**	**2016**	**2005-2010**	**2010-2016**
PA	125,578	123,929	121,688	1,648	2,241
LB	170,902	165,749	158,411	5,153	7,339
Total	**296,439**	**289,633**	**280,039**	**6,806**	**9,594**

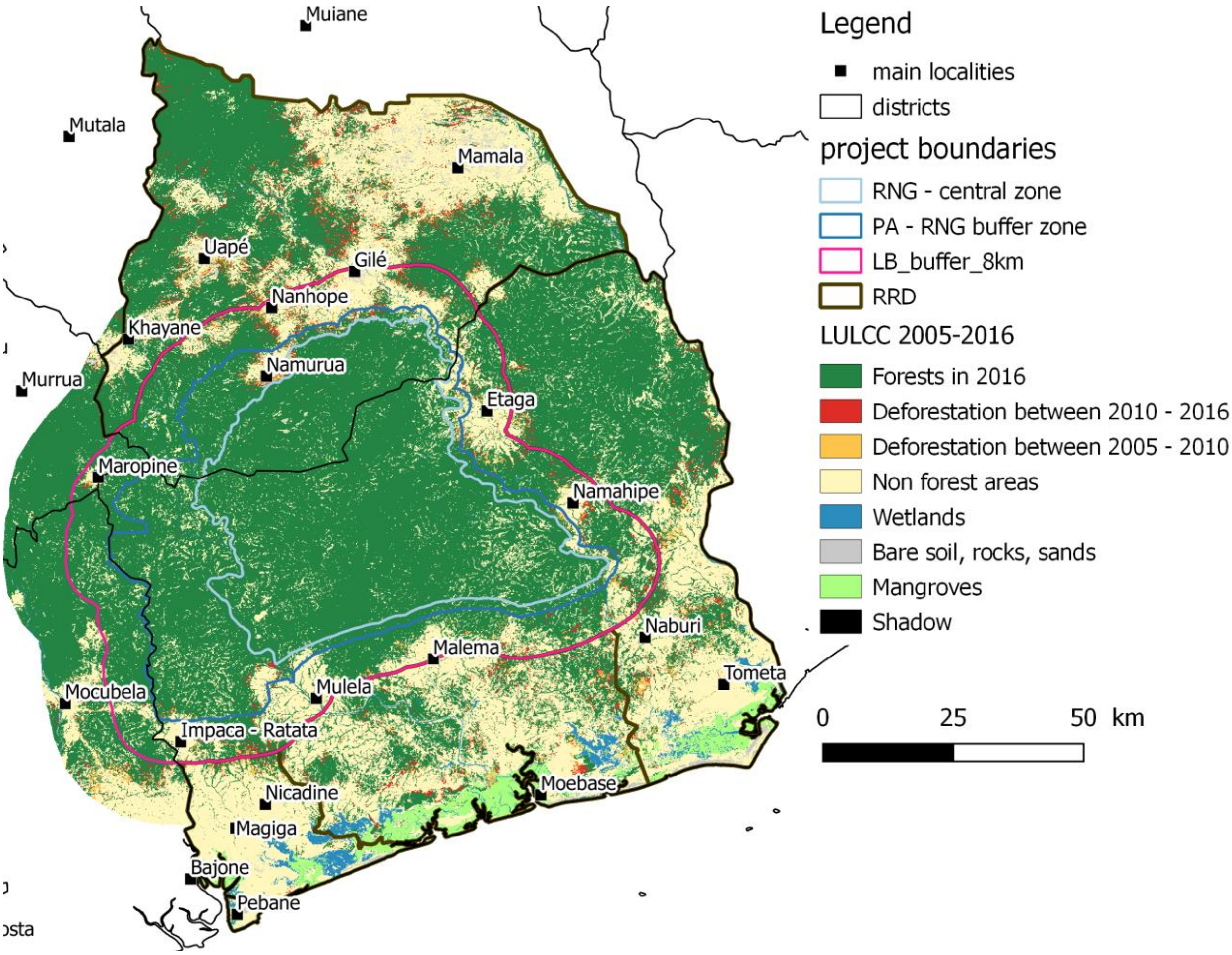

Figure 25: Deforestation in the RRD and GNR for the period 2005-2016

Table 27: Confusion matrix for the LULCC map between 2010 and 2016

11: forest remaining forest – 13: deforestation between 2010 and 2016 – 17: mangroves (RRD) – 33: crops and savannas – 44: water – 66: other lands

		Observations							
		11	13	17	33	44	66	**Predicted**	**% good prediction**
Model	11	1,699	3	1	14	0	0	1,717	98.95%
	13	7	110	0	1	0	0	118	93.22%
	17	3	0	142	0	0	0	145	97.93%
	33	20	5	1	286	1	4	317	90.22%
	44	2	2	0	2	30	0	36	83.33%
	66	2	1	1	10	0	222	236	94.07%
Observed	**2,489**	1,733	121	145	313	31	226	**2,333**	
% good observation		98%	91%	98%	91%	97%	98%	**Global accuracy**	**94%**

6.2 Baseline Emissions

The baseline emissions for the present monitoring period (2012-2017) are those presented in section 3.1.1 for the PA and LB, from years 1 to 5.

6.3 Project Emissions

As for the calculation of the baseline (see section 3.1.1), carbon emissions due to deforestation are a multiplication between activity data (annual deforestation) and emission factor (difference between pre- and post-deforestation carbon stocks) with a 10% rate of emission for BGB. Project emissions correspond to the difference between emissions for the baseline in the PA (see section 3.1.1) and calculated emissions for annual deforestation in the PA during the monitoring period, as presented in section 6.1. Activity data for the baseline in PA are 810 ha/yr (see section 2.4.1.3 and Table 14) and 361 ha/yr for the monitoring period (see section 6.1 for calculation method and Table 26). Emissions factors are the same for the baseline and the monitoring period because the monitoring of carbon stocks (aboveground and belowground biomass) is planned every 10 years (see section 4.3.1.1 and Table 17). The results for emissions during the monitoring period are presented in the following table. They show that there was indeed emission reductions in comparison to the baseline.

Table 28: Difference between baseline and monitored emissions in PA (in tCO_2eq)

Year of monitoring period	Year number	Baseline emissions or removals for PA (tCO_2eq)	Monitored emissions or removals in PA (tCO_2eq)	Net GHG emission reductions or removals in PA (tCO_2eq)
2012	1	171,938	76,461	95,477
2013	2	176,406	78,447	97,958
2014	3	180,873	80,434	100,439
2015	4	185,341	82,421	102,920
2016	5	189,808	84,408	105,401
Total		**904,366**	**402,171**	**502,195**

6.4 Leakage

The same calculation steps are used for emissions in the LB. Project emissions in the LB correspond to the difference between emissions for the baseline in the PA (see section 3.1.1) and calculated emissions for annual deforestation in PA during the monitoring period, as presented in section 6.1. They are presented in the following table. The emission in LB during the monitoring period are above those expected in the baseline. There was an increase of emissions in LB. Hence, those emissions will be deducted from emission reductions in the PA (see next section).

Table 29: Difference between baseline and monitored emissions in LB (in tCO_2eq)

Year of monitoring period	Year number	Baseline emissions or removals for LB (tCO_2eq)	Monitored emissions or removals in LB (tCO_2eq)	Net GHG emission reductions or removals in LB (tCO_2eq)
2012	1	230,602	250,358	-19,757
2013	2	236,593	256,864	-20,270
2014	3	242,585	263,369	-20,784
2015	4	248,577	269,874	-21,297
2016	5	254,569	276,379	-21,810
Total		**1,212,926**	**1,316,844**	**-103,918**

6.5 Net GHG Emission Reductions and Removals

Net emission reductions for the first monitoring period (2012-2017) are presented in the following table. They account for emissions in the project area and increase of emission in the leakage belt, in comparison to the baseline for those two areas.

Table 30: Net emission reductions for the first monitoring period (2012-2017)

Year	Baseline emissions or removals (tCO_2eq)	Project emissions or removals (tCO_2eq)	Leakage emissions (tCO_2eq)	Net GHG emission reductions or removals (tCO_2eq)
1	171,938	76,461	19 757	75,721
2	176,406	78,447	20,270	77,688
3	180,873	80,434	20,784	79,655
4	185,341	82,421	21,297	81,623
5	189,808	84,408	21,810	83,590
Total	**904,366**	**402,171**	**103,918**	**398,277**

According to the non-permanence risk rating (see section 3.4.2 and Annex 1), a buffer of 10% must be deducted to emissions reductions. The VCUs presented in the following table are therefore generated during the present monitoring period.

Table 31: VCUs generated during the first monitoring period of the Project (2012-2017)

Year	Net GHG emission reductions or removals (tCO_2eq)	Buffer of 10 % (tCO2eq)	Deduction due to uncertainties (tCO_2eq)	VCUs
1	75,721	7,572	-	68,148
2	77,688	7,769	-	69,919
3	79,655	7,966	-	71,690
4	81,623	8,162	-	73,461
5	83,590	8,359	-	75,231
Total	**398,277**	**39,828**	**-**	**358,450**

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APPENDIX 1: NON-PERMANENCE RISK REPORT

This report was realised following the requirement of the VCS AFOLU non-permanence risk template v3.2 and AFOLU non-permanence risk tool v3.3.

Internal Risk

Internal risk for project management is considered as null according to the following justifications:

- No GHG credits are associated with tree plantations. Some plantations of cashew tree may be created (event though the main activities concern existing trees) for leakage management activities, but this is anecdotal compared to the carbon stocks in natural forest. Besides, although cashew trees are not native of the region, they have been present in the area for decades, proving their adaptation to the agro-ecological conditions; they are not an invasive species.
- Law enforcement to prevent illegal logging of *pau ferro* in the project zone is part of the project activities. Currently, the project management team did not succeed in reducing illegal logging to zero. However, this activity concerns far less than 50% of carbon stocks, as only one species is targeted for selective logging.
- As presented in the CCB project document associated to this PDD, the management team includes individuals who have the required skills and experience. Moreover, the team is located in two areas close to the PA: Museïa camp for the management team of the GNR – that is, inside of the PA, in the south east – and in Gilé for the team who is in charge of the development of leakage management activities – that is, in the north of the GNR. Both teams are supervised by managers in Maputo (Mozambique) and in Paris (France).

Project Management		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
a)	Species planted (where applicable) associated with more than 25% of the stocks on which GHG credits have previously been issued are not native or proven to be adapted to the same or similar agro-ecological zone(s) in which the project is located.	0
b)	Ongoing enforcement to prevent encroachment by outside actors is required to protect more than 50% of stocks on which GHG credits have previously been issued.	0
c)	Management team does not include individuals with significant experience in all skills necessary to successfully undertake all project activities (ie, any area of required experience is not covered by at least one individual with at least 5 years experience in the area).	0
d)	Management team does not maintain a presence in the country or is located more than a day of travel from the project site, considering all parcels or polygons in the project area.	0
e)	**Mitigation:** Management team includes individuals with significant experience in AFOLU project design and implementation, carbon accounting and reporting (eg, individuals who have successfully managed projects through validation, verification and issuance of GHG credits) under the VCS Program or other approved GHG programs.	0

Project Management		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
f)	**Mitigation:** Adaptive management plan in place	0
Total Project Management (PM) [as applicable, (a + b + c + d + e + f)] Total may be less than zero.		**0**

The financial viability of the project is guaranteed until the year 2018, with the availability of identified international funding, such as from the FFEM and the World Bank – the Mozbio project, for instance, will continue the current project activities involving communities and the conservation of the Reserve[19] – see section 1.8.4) (financial plan available at validation). Those funds cover all the costs of the GNR without any expected benefits, as only public institutions and non-profit organisations manage the project (see section 2.5.2). Hence, without carbon credits, cumulative cashflow is around 0 USD until the end of 2018 (without carbon credits). According to the financial plan, international funds (FFEM and World Bank), in addition to annual State donation to the Reserve, cover 41% of the Project costs over 20 years (from 2012 until 2031) but carbon credits are necessary to maintain a positive cash flow. Discussions are currently undertaken for the benefit sharing plan of the project and should lead to a part of more than 80% of the sale benefits for the GNR Project management.

From 2017 onwards, the sale of carbon credits is expected to cover the costs of the GNR REDD project. The total amount of credits can cover the costs of the project but it is difficult to assess, ex-ante, the number of credits that will be sold, since no buyer has been identified yet. Benefits from the sale of VCUs will be re-invested in the project activities by ANAC. The level of project activities will be readjusted depending on the success of the selling of VCU. Hence, the cumulative cashflow is positive after 2017 but based on the hypothesis of the sale of all VCU; in the following table, we selected option a) for the breakeven point, in order to choose a conservative hypothesis.

Financial Viability		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
a)	Project cash flow breakeven point is greater than 10 years from the current risk assessment	3
b)	Project cash flow breakeven point is between 7 and up to less than 10 years from the current risk assessment	0
c)	Project cash flow breakeven point between 4 and up to less than 7 years from the current risk assessment	0
d)	Project cash flow breakeven point is less than 4 years from the current risk assessment	0

[19] http://www.etcterra.org/fr/redd-afolu/mozbio

Financial Viability		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
e)	Project has secured less than 15% of funding needed to cover the total cash out before the project reaches breakeven	0
f)	Project has secured 15% to less than 40% of funding needed to cover the total cash out required before the project reaches breakeven	2
g)	Project has secured 40% to less than 80% of funding needed to cover the total cash out required before the project reaches breakeven	0
h)	Project has secured 80% or more of funding needed to cover the total cash out before the project reaches breakeven	0
i)	**Mitigation:** Project has available as callable financial resources at least 50% of total cash out before project reaches breakeven	0
Total Financial Viability (FV) [as applicable, ((a, b, c or d) + (e, f, g or h) + i)] Total may not be less than zero.		**5**

The baseline scenario relies on the expansion of subsistence agriculture that is, by far, the main economic activity in the area, as previously described. All the activities proposed by the project with regards to communities aim at increasing their revenue and/or at sustaining agricultural practices. Moreover, the development of communities' subsistence activities is not constrained, except for some specific hunting techniques (see section 1.10). They are only incentives. The analysis made for CCB (see dedicated project document) shows that the net impact for communities will be positive. Hence, the risk factor for opportunity costs is set at zero, according to the non-permanence tool. Moreover, the project is managed by the government – the ANAC that is in charge of the management of protected areas – in association with NGOs (see section 1.4), that are non-profit organizations – limiting the opportunity cost.

Opportunity Cost		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
a)	NPV from the most profitable alternative land use activity is expected to be at least 100% more than that associated with project activities; or where baseline activities are subsistence-driven, net positive community impacts are not demonstrated	0
b)	NPV from the most profitable alternative land use activity is expected to be between 50% and up to100% more than from project activities	0
c)	NPV from the most profitable alternative land use activity is expected to be between 20% and up to 50% more than from project activities	0
d)	NPV from the most profitable alternative land use activity is expected to be between 20% more than and up to 20% less than from project activities; or where baseline activities are subsistence-driven, net positive community impacts are demonstrated	0
e)	NPV from project activities is expected to be between 20% and up to 50% more profitable than the most profitable alternative land use activity	0

Opportunity Cost		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
f)	NPV from project activities is expected to be at least 50% more profitable than the most profitable alternative land use activity	0
g)	**Mitigation:** Project proponent is a non-profit organization	-2
h)	**Mitigation:** Project is protected by legally binding commitment to continue management practices that protect the credited carbon stocks over the length of the project crediting period (see project longevity)	0
i)	**Mitigation:** Project is protected by legally binding commitment to continue management practices that protect the credited carbon stocks over at least 100 years (see project longevity)	**0**
Total Opportunity Cost (OC) [as applicable, (a, b, c, d, e or f) + (g + h or i)] Total may not be less than 0.		**-2**

The project area is the buffer zone of a national Reserve in Mozambique, which was created by governmental decree in 2011. Thus, it is covered by a legal agreement that rules the management of protected areas in Mozambique. For this reason, project longevity was set to 50 years, which is the minimum credible duration for the project activities.

Project Longevity		
a)	Without legal agreement or requirement to continue the management practice	0
b)	With legal agreement or requirement to continue the management practice	5
Total Project Longevity (PL) May not be less than zero		**5**

As a consequence of the present analysis, the internal risk estimation is 7 as presented in the following table.

Internal Risk	
Total Internal Risk (PM + FV + OC + PL) Total may not be less than zero.	**8**

External Risks

The project area is the buffer zone of the Gilé National Reserve. Hence, it is a recognized area with a legally permanent restriction, managed by the government of Mozambique in accordance with national law. A decree formalizing the creation of this buffer zone was published in November 2011 (see section 1.12.1) and local communities who live around the GNR fully recognize it. Hence, there is no dispute on land rights in the project area. Resources rights are ruled by the management plan of the GNR that is clear and also recognized by local communities – no conflicts exist with regards to the GNR and its resources. A grievance mechanism aiming at dealing with any queries and complains related to the use of natural resources does exist and is managed by the GNR management team. It is described in the CCB project document.

Land Tenure and Resource Access/Impacts		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
a)	Ownership and resource access/use rights are held by same entity(s)	0
b)	Ownership and resource access/use rights are held by different entity(s) (eg, land is government owned and the project proponent holds a lease or concession)	0
c)	In more than 5% of the project area, there exist disputes over land tenure or ownership	0
d)	There exist disputes over access/use rights (or overlapping rights)	0
e)	WRC projects unable to demonstrate that potential upstream and sea impacts that could undermine issued credits in the next 10 years are irrelevant or expected to be insignificant, or that there is a plan in place for effectively mitigating such impacts	0
f)	**Mitigation:** Project area is protected by legally binding commitment (eg, a conservation easement or protected area) to continue management practices that protect carbon stocks over the length of the project crediting period	-2
g)	**Mitigation:** Where disputes over land tenure, ownership or access/use rights exist, documented evidence is provided that projects have implemented activities to resolve the disputes or clarify overlapping claims	0
Total Land Tenure (LT) [as applicable, ((a or b) + c + d + e + f + g)] Total may not be less than zero.		**0**

As described in the general section of the CCB document dedicated to the project, a consultation process was initiated at the creation of the GNR buffer zone and during the development of the present PDD for the implementation of the GNR REDD project. The communities who were selected for the consultations are those whose daily economic activities are dependent on the context of the project area and who may therefore be impacted by the project. This selection was based on the project team's knowledge on the activities of local communities, thanks to their work with the communities and the realization of several enquiries since the beginning of the project. Although not all households were present during the presentations of the project, the communities had been classified and assembled according to geographic criteria. Individuals who had previously been selected by the whole population during a meeting to which they were all invited represented each group during the consultations. More details are given in the CCB project document and reports of consultations are available. This document shows that the net impact on communities should be positive.

Community Engagement		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
a)	Less than 50 percent of households living within the project area who are reliant on the project area, have been consulted	0
b)	Less than 20 percent of households living within 20 km of the project boundary outside the project area, and who are reliant on the project area, have been consulted	0
c)	**Mitigation:** The project generates net positive impacts on the social and economic well- being of the local communities who derive livelihoods from the project area	-5
Total Community Engagement (CE) [where applicable, (a + b + c)] Total may be less than zero.		**-5**

Based on the average of Governance Score, calculated across the 6 indicators of the World Bank Institute's Worldwide Governance Indicators[20], and on the most recent five years (2010-2014 for Mozambique), as required by the non-permanence tool, the overall average of governance score for Mozambique is estimated to be 0.40.

Moreover, Mozambique has been benefiting from the support of the FCFP, through its Readiness fund, for the development of a REDD+ jurisdictional Emission Reductions Program in Zambezia Province, the Zambézia Integrated Landscape Management Program (ZILMP). The present RNG project is included in this program (see section 1.8.5). The ER-PD will be submitted to the FCPF-Carbon Fund in late 2017.

Political Risk		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
a)	Governance score of less than -0.79	0
b)	Governance score of -0.79 to less than -0.32	4
c)	Governance score of -0.32 to less than 0.19	0
d)	Governance score of 0.19 to less than 0.82	0
e)	Governance score of 0.82 or higher	0
f)	**Mitigation:** Country implementing REDD+ Readiness or other activities such as: a) The country is receiving REDD+ Readiness funding from the FCPF, UN-REDD or other bilateral or multilateral donors b) The country is participating in the CCBA/CARE REDD+ Social and Environmental Standards Initiative c) The jurisdiction in which the project is located is participating in the Governors' Climate and Forest Taskforce	-2

20 http://info.worldbank.org/governance/wgi/index.aspx#reports

Political Risk		
Risk Factor	**Risk Factor and/or Mitigation Description**	**Risk Rating**
	d) The country has an established national FSC or PEFC standards body e) The country has an established DNA under the CDM and has at least one registered CDM A/R project	
Total Political (PC) [as applicable ((a, b, c, d or e) + f)] Total may not be less than zero.		**2**

External Risk	
Total External Risk (LT + CE + PC) Total may not be less than zero.	**0**

Natural Risks

The natural risk identified in the project zone is the occurrence of fires. Each year, fires occur at several points in the project zone, may they be natural or triggered by human activities (for hunting purpose or loss of control when burning of a new field through slash and burn agricultural practises). Depending on when exactly they happen during the dry season, fires can reach different intensities, which vary with the quantity of available dry herbaceous. Their impact on forest cover depends on this intensity (Ryan and William, 2011) but it is not systematically significant – there is no systematic death of trees resulting in a loss of carbon stock loss: this can be explained by the fact that Miombo forest is adapted to this pressure. The impact of fires is higher on regeneration potential, since they prevent seedlings from growing. However, the high capacity of Miombo species to coppice (Williams et al., 2008) ensures the maintenance of high regeneration rates. Still, in order limit the impact of fires on forest cover in the GNR and its surrounding, the project management team voluntarily starts low intensity fires at the beginning of the dry season in order to immediately burn the dry vegetation and limit the intensity of future fires, occurring later on during the dry season. This mitigation measure was launched at the beginning of the project and proved its efficacy, as no drastic loss of tree carbon stocks because of fires was registered.

No other natural risk in the project zone has been identified:

- Extreme weather that could affect trees include long drought (due to the increase of the dry season period) but, until now, such extreme conditions did not lead to tree death as Miombo forest is adapted to them (while it is observed in other types of forests ecosystem, such as the Mediterranean one). The vulnerability of forest to drought could increase if the dry season frequently and significantly lasts longer, due to climate change (Tadross 2009; Warner et al. 2015). However it is difficult to predict the intensity and frequency of tree mortality in such conditions. This type of event will probably affect crop cultivation more than forest. Moreover, the Disaster Risk Assessment in Mozambique classify the risk in Pebane and Gilé districts as low to moderate (GRIP and UNDP, 2011) – the risk score was set to 0.

- Cyclones regularly occur in Mozambique, and were registered during the reference period (Fitchett and Grab, 2014) without any significant impact on carbon stocks of the project zones. Moreover, if the risk of cyclones could increase with climate change, there no clear evidence regarding the historic period and this does not appear as a risk for carbon stocks within the project area.

- Flood is another risk linked to climatic hazard in Mozambique that regularly occurs but according to the bibliography, the risk is considered as low to moderate in the districts of intervention (Warner et al., 2015; GRIP and UNDP, 2011).
- Geologic risks can be related to the presence of volcano (there is no volcano in the area), the occurrence of seism or of landslide. According to the Disaster Risk Assessment in Mozambique, the project area is located in an area with low seismic activity and no seism was registered between 1905 and 2008 (GRIP and UNDP, 2011). Moreover, landslides do not occur in the area because slopes are relatively flat (section 1.9).

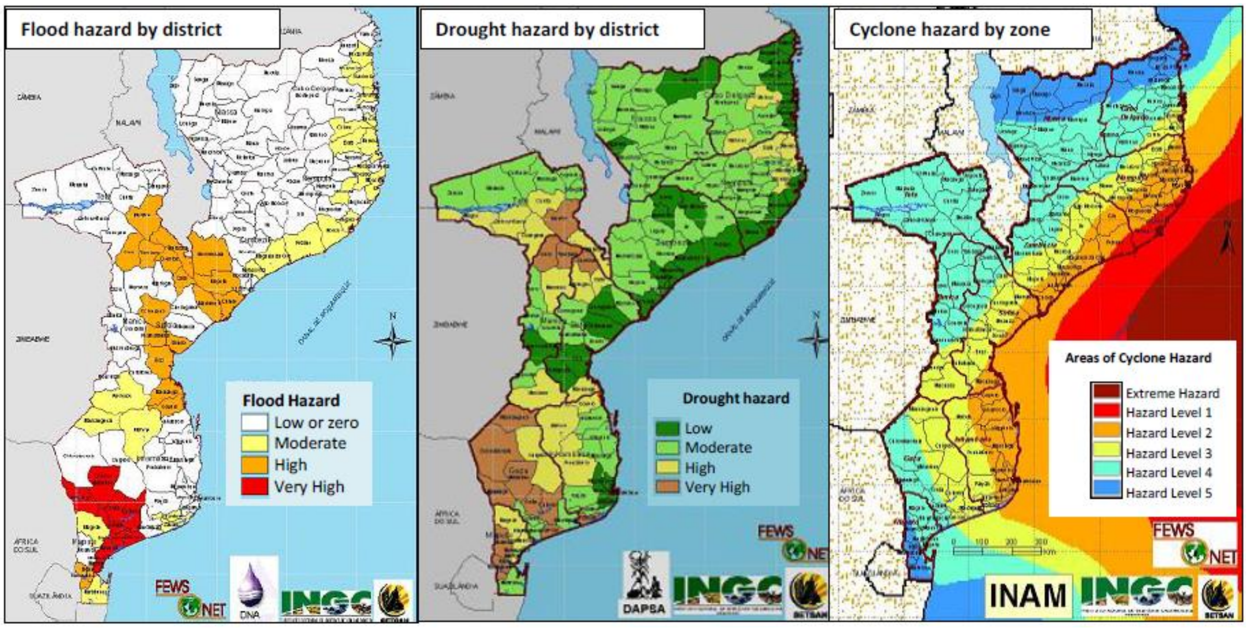

Figure 26: National maps of natural risks according to climatic events (From INGC – *Instituto Nacional de Gestão de Calamidades* - in GRIP and UNDP, 2011)

Natural Risk – Fire	
Significance	Minor (5% to less than 25% loss of carbon stocks)
Likelihood	Less than every 10 years
Score (LS)	5
Mitigation	0.25

Score for each natural risk applicable to the project (Determined by (LS × M)	
Fire (F)	1.25
Pest and Disease Outbreaks (PD)	0.00
Extreme Weather (W)	0.00

Score for each natural risk applicable to the project (Determined by (LS × M)	
Geological Risk (G)	0.00
Other natural risk (ON)	0.00
Total Natural Risk (as applicable, F + PD + W + G + ON)	**1.25**

Overall Non-Permanence Risk Rating and Buffer Determination

Overall Risk Rating

The overall risk rating calculated for the GNR REDD Project is 9.25 and therefore set to 10, the minimum granted risk.

Risk Category	Rating
a) Internal Risk	8
b) External Risk	0
c) Natural Risk	1.25
Overall Risk Rating (a + b + c)	**10**

Note: Overall risk rating shall be rounded up to the nearest whole percentage

The minimum risk rating shall be 10, regardless of the risk rating calculated

If the overall risk rating is over 60 then the project fails the entire risk analysis

Calculation of Total VCUs

Expected VCUs correspond to the net emission reductions according to the baseline, minus the non-permanence risk buffer (10% in the present case) and minus the uncertainty buffer (0% in the present case). The ex-ante estimation of VCUs to be generated during the first 10 years is presented in the following table. The calculation of estimated expected net GHG emission reductions is presented in the section 3.4 of the VCS PDD.

Year	Estimated net GHG emission reductions or removals (tCO_2eq)	Buffer of 10 % (tCO_2eq)	Deduction due to uncertainties (tCO_2eq)	VCUs
1	3,439	344	-	3,095
2	8,820	882	-	7,938
3	21,705	2,170	-	19,534
4	31,508	3,151	-	28,357
5	51,248	5,125	-	46,123
6	81,596	8,160	-	73,436
7	103,347	10,335	-	93,012
8	117,862	11,786	-	106,076

9	132,914	13,291	-	119,623
10	135,773	13,577	-	122,196
Total	**688,212**	**68,821**	**-**	**619,391**